POLICY RESEARCH WORKING PAPER 2197

Production Sharing in East Asia

Who Does What for Whom, and Why?

Francis Ng
Alexander Yeats

Components have been a dynamic leading sector in East Asian imports and exports East Asian global exports of parts and components totaled $178 billion in 1996, imports, $12 billion less Components now account for a fifth of East Asian exports of manufactures

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Summary findings

Ng and Yeats analyze empirical information on the nature and magnitude of, and motivation for, international production sharing in East Asia. To do so, they use a largely untapped source of data on inter- and intraregional trade in parts and components. Some of their findings:

- East Asian trade in components is considerably greater than often recognized. Regional global exports of parts and components totaled $178 billion in 1996, and imports of those products about $12 billion less. Components now constitute one-fifth of East Asian exports of manufactures.
- Imports of components, measured as a share of all manufactures, are growing considerably faster in East Asia than in OECD Europe or North America. The value of East Asian global imports of components rose more than ninefold over the period 1985–96. Almost three-quarters of all East Asian imports of telecommunications equipment are components for further assembly.
- East Asian global exports of components grew faster than any other major product group over 1984–96, when their exchange increased 15 percent a year (compared with 11 percent for all products). Although Japanese exports declined slightly in 1997, shipments from most other East Asian countries increased 9 to 16 percent.

Why did production sharing expand?

Analyses of traditionally revealed comparative advantage use export statistics to determine whether a country has a comparative advantage in the *production* of a good. The same indices, calculated using import statistics for components, can show whether a country has a comparative advantage in the *assembly* of a product. Using statistics on component imports, Ng and Yeats find that

- Japan, Singapore, and Taiwan (China) — which are exiting most assembly operations — increased their specialization in the manufacture of components. Assembly operations, which are labor-intensive, tend to migrate to low-wage East Asian countries.
- Indonesia, Malaysia, and Thailand have the broadest and most mature assembly capacity for components. But no East Asian country has developed its domestic assembly operations as much as Mexico, which has a comparative advantage in 70 percent of all component groups.
- Collectively, East Asian countries are strengthening their comparative advantage in the production of components; the results are mixed for assembly operations.

This paper — a product of Trade, Development Research Group — is part of a larger effort in the group to improve the growth prospects of developing countries. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Lili Tabada, room MC3-333, telephone 202-473-6896, fax 202-522-1159, Internet address ltabada@worldbank.org. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/html/dec/Publications/Workpapers/home.html. The authors may be contacted at fng@worldbank.org or ayeats@worldbank.org. October 1999. (57 pages)

Production Sharing in East Asia: Who Does What for Whom and Why?

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Summary

This study's primary purpose is to analyze empirical information on the nature, magnitude and motivation for international production sharing in East Asia. To accomplish this objective it utilizes a, heretofore, largely untapped data source on inter- and intra-regional trade in parts and components. The following are some of the main points emerging from these data;

- East Asian trade in components is considerably greater than often recognized. Regional global exports of parts and components totaled $178 billion in 1996, while Asian imports of these products were about $12 billion lower. Components now constitute one-fifth of East Asian exports of manufactures

- Asian imports of components, measured as a share of all manufactures, is growing considerably faster than in OECD Europe or North America. The value of Asian global imports of components rose more than nine-fold over 1985-1996. Almost three-quarters of all Asian imports of telecommunications equipment now consist of components for further assembly

- Asian global exports of components grew faster than any other major product group over 1984-1996 when their exchange increased at an annual rate of 15 percent (as opposed to 11 percent for all products). Intra-regional trade outpaced the rapid expansion in global components exports as the share of this exchange in total trade almost doubled from 25 to 46 percent.

- *A*vailable statistics (through 1997) indicate the recent Asian economic slowdown has not had a major detrimental impact on regional trade in parts and components. Although Japanese exports declined slightly in 1997, shipments from most other East Asian countries increased by between 9 to 16 percent. Since Asian trade in components has been such a dynamic leading sector in regional imports and exports there is an obvious interest in monitoring future changes in this exchange.

To help analyze the motivation for the expansion of production sharing this study employs an empirical approach that can indicate whether a country has a comparative advantage in either the production or assembly of components. Traditionally revealed comparative advantage (RCA) analyses use export statistics to determine whether a country is at a comparative advantage in the *production* of a good. However, if these indices are calculated using import statistics for components they can show whether a country has a comparative advantage in the *assembly* of a product.

The application of this empirical approach to import statistics for components reveals several important points:

• *A*ssembly operations are tending to migrated to the relatively low wage Asian countries, while countries like Japan, Singapore, and Taiwan increased their specialization in the manufacture of components. Overall, the revealed comparative advantage profiles conform to predictions based on factor proportions theory. Low wage countries have a disproportionately high revealed comparative advantage in assembly operations (most of which are assumed to be labor intensive in nature), while the wealthier Asian countries have high RCAs for the production of components.

• East Asian assembly operations have become quite diverse with 5 of the 10 regional countries having RCAs above unity in 40 percent, or more, of the component groups. However, no Asian country has yet developed its domestic assembly operations to the same extent as Mexico which has a comparative advantage in 70 percent of all component groups.

• Collectively, East Asian countries are strengthening their comparative advantage in the production of components, but the results are mixed for assembly operations. Nine of the ten countries increased the percentage of component industries in which they have a production comparative advantage over 1985-1996, with Thailand and Taiwan's share doubling. In contrast, the corresponding shares for assembly operations fell, or held constant, for 7 of the 10 countries.

• A "stages" approach analysis of Asian RCA profiles shows Indonesia, Thailand and Malaysia have the broadest and most mature assembly capacity for components. However, these Asian profiles are less developed than Mexico's which suggests the former may still have the capacity to further expand these operations. RCA profiles for Singapore, Taiwan and Japan indicate these countries are in a "sunset" stage and are exiting most assembly operations.

• Cross correlations between East Asian countries' RCA indices often fail to achieve statistical significance. One possible explanation is that locational, wage and communications costs, along with the specific mix of skills and infra-structure required for assembly in specific component industries are more binding than sometimes thought. Correlations between specific country's 1985 and 1996 RCA assembly profiles are often highly significant indicating these operations may not be as "footloose" as is sometimes suggested.

Finally, this study stresses the fact that important detailed data sources are available (including the newer harmonized system statistics) for empirical analyses of factors leading to the remarkable growth in global production sharing, and those influencing the motivations for, and nature of, this activity. Since United States trade statistics tabulate international transport and insurance costs for all components and assembled products, these data seemingly constitute an important statistical source for research on the geographic location of production sharing.

Production Sharing in East Asia: Who Does What for Whom and Why?

Francis Ng and Alexander Yeats*

I. INTRODUCTION

Published studies that utilized trade statistics from, at least, the 1960s document the remarkable increase in international production sharing as reflected in far above average growth rates for the exchange of components or partially assembled manufactured goods.[1] In its most recent form, production sharing involves the development of specialized (often) labor-intensive activities within vertically integrated international manufacturing industries. As an example, electronic semi-conductors, valves, tuners and other components are now assembled for multinational firms in places like Mexico, Malaysia, or the Philippines. Parts of wearing apparel and leather goods are assembled in Jamaica and the Dominican Republic for re-export to the US market – one estimate by the World Bank (1994b) puts the value of assembly exports from the Caribbean at over $3 billion. Among the many other industries where major parts of a production process were transferred abroad include television and radio receivers, sewing machines, calculators and other

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

office equipment, electrical machinery, power and machine tools, typewriters, cameras and watches (USITC 1996).

Theoretical analyses that examined the motivating factors for international production sharing generally agree on two key points: (i) that manufacturing processes for some goods can be separated into distinct stages (like the cutting of cloth for eventual sewing into clothing), and (ii) due to differences in the nature of the processes at each stage significant differences may exist in the comparative advantage of countries over a manufacturing chain.[2] There is a presumption in much of this literature that manufacturing stages that are labor intensive in nature (like many assembly operations) would be transferred from richer to poorer developing countries where wage costs are relatively low. However, recent statistics published by the USITC (1996, p. B-4) showing that Japan and Germany are among the major suppliers of finished goods that utilized US parts and components assembled abroad seemingly are at odds with this assumption.

Using a, heretofore, largely untapped data source on production sharing this study provides new empirical information on the magnitude, direction and motivation for this operation in East Asia. East Asia was chosen for study because the available evidence indicates regional production sharing is expanding at a far faster pace than in either North America or Europe.

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[2] There exists a fairly broad number of empirical studies that examined the size of and motivations for this exchange. Many earlier analyses focussed on the effects of United States and European tariff provisions for the further assembly abroad of domestically produced components. Under these provisions, components (say) produced in the United States could be shipped abroad for further assembly and then re-exported back to the U.S. with a tariff applied only to the value added component of the processed good. Finger (1975)(1976) authored some of the most influential early studies on this activity. More recently, the US International Trade Commission was mandated by Congress to provide annual reports on the magnitude and economic effects of production sharing in North America and Europe. See, for example, USITC (1991)(1996).

The paper proceeds as follows. First, it describes the nature of the newer data sources on production sharing and assesses it strengths and limitations for empirical analysis. Second, it employs the available statistics to analyze the magnitude, composition and direction of production sharing in East Asia. Third, the paper describes a methodological procedure that determine which countries have a comparative advantage in *either* the assembly or production of components of a specific manufactured good, and also indicates how a country's further developmental potential for these operations might be assessed. This new methodological approach is then applied to statistics on East Asian trade in components in order to determine what motivates the regional pattern of this exchange, and also to determine how Asian comparative advantage in production sharing is evolving. The paper closes with an evaluation of how well the observed empirical results "square" with much of the theoretical discussion and what their implications are for future research..

II. DATA SOURCES ON PRODUCTION SHARING

Key Point

Revisions to the original Standard International Trade Classification (SITC) system provide extensive new information on international trade in parts and components. The SITC Revision 2 system distinguishes between 60 broad groups of component products, but in the recently adopted harmonized system (HS) over 200 hundred such product groups are identified. As more countries begin to report trade data in terms of the HS the potential for empirical research on production sharing will greatly increase.

In its original form, the Standard International Trade Classification (SITC) system did a less than adequate job of distinguishing between trade in final goods as opposed to parts and components. At the lowest (five digit) level the SITC identified about 800

individual products – only 10 of which consisted of "parts." However, in the late 1970s and early 1980s many countries also adopted the more detailed SITC Revision 2 system which expanded the number of product groups composed solely of components. The coverage of these groups was most extensive within the machinery and transport equipment sector (SITC 7) where about 60 individual three, four, and five-digit groups consisting solely of components of manufactured equipment to be assembled were identified.[3]

Outside this sector the SITC Revision 2 still fails to differentiate sufficiently between assembled goods and components so tabulations of the true magnitude of trade in parts are clearly downward biased. Furthermore, some developing countries did not shift to the SITC Revision 2 system until the early or mid-1980s, so it is not yet possible to fully monitor longer-term trends in this exchange.[4] It should, however, be noted that the recent shift by many countries to reporting trade data in terms of the harmonized system has the potential to greatly expand future opportunities for empirical research on international production sharing.

Given the potential importance of these newer data sources, we undertook several checks aimed at verifying the underlying quality of the Revision 2 trade statistics compiled

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[3] This analysis is based exclusively on product groups defined as consisting solely of components. This causes estimates of East Asian production sharing to be downward biased. Specifically, some other SITC 7 product group exports (like television picture tubes) may be used for further assembly operations, but it is not possible to accurately determine whether, or to what extent, these items are used for further assembly. Some empirical studies, like Balassa (1965a), utilized product classification schemes that included groups called "intermediate input groups I and II" which were composed of items like yarns, pig iron, leather and some chemicals. Although we do not do so, other empirical analyses of trade in components might consider the use of such products in their investigations.

[4] In the early 1990s, countries began reporting trade statistics to the United Nations in terms of the more detailed harmonized system (HS). At its lowest six-digit level the HS distinguishes between approximately 3,600 individual items, of these some 200 consist solely of parts and components. The current disadvantage of the harmonized system is that a sufficient reporting period has not yet elapsed for adequate time series information to become available, as is the case with the SITC Revision 2 data.

by the United Nations. These tests, which included partner country comparisons, revealed three anomalies that should be noted:

• **From 1984 through 1995 the Philippines classified approximately 20 percent of all imports, and 30 percent of all exports, as SITC 931 "special transactions". Very few countries reporting to UN COMTRADE have trade shares for this item close to these levels. Partner country data suggest some exchange reported in SITC 931 involves assembly operations which are not recorded correctly. As a result, the available data probably understate the importance of the Philippines assembly operations.**[5]

• **Hong Kong's trade data consistently incorporate some of the largest negative trade balances for components observed in any UN country's statistics. For example, in 1996 component imports of $18.7 billion were reported as opposed to $3.1 billion in exports. We suspect that some transit trade with China, Macau and other East Asian countries may be incorrectly included in the data reported to the United Nations.**

• **Singapore stopped reporting any trade with Indonesia in 1964. We contacted UN Statistical Office officials on this problem, but they were unable to provide an explanation as to why this was occurring. However, in 1995 Indonesia reported exports of $3.7 billion to, and imports of $2.4 billion from, Singapore. Singapore's reporting practices will bias downward some of our estimates of intra-regional components trade.**

In spite of these few problems, the available UN Revision 2 data reflects the relative importance of the East Asian countries' trade in components. For example, in 1996, the United States and Germany were (according to this source) the two largest exporters and importers of components, but Singapore, Hong Kong, Japan, Malaysia and China were among the 10 largest exporters or importers of these goods (see Appendix Table 1). Furthermore, the Revision 2 statistics show recent growth rates for East Asia trade in components has been above corresponding rates those for any other major regional group of countries.

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[5] This "error" has also been incorporated in IMF data series. The reader may wish to verify that in the 1980s and 1990s the IMF Direction of Trade Statistics report sizeable Indonesian exports to, and imports from, Singapore. However, the Singapore statistics show no trade with Indonesia.

III. East Asian Trade in Parts and Components

Key Point

East Asian trade in components is considerably greater than often recognized. Regional exports of parts and components totaled $178 billion in 1996, while Asian imports of these products were about $12 billion lower. Components now constitute one-fifth of East Asian exports of manufactures.

Table 1 utilizes the UN statistics to examine the composition and relative importance of the individual component product groups in East Asian trade. The table identifies each product by SITC (Revision 2) number, it provides a short description of the item, and also indicates its value and share of East Asian global imports and exports of all components (these totals include the combined trade of Japan, Hong Kong, Republic of Korea, China, Singapore, Taiwan (China), Malaysia, Thailand, Indonesia, and the Philippines).

One interesting point evident from these statistics is that East Asian component trade is concentrated in a relatively few items. Specifically, 5 of the 60 SITC groups account jointly for almost 75 percent of all imports (79 percent of exports), with parts of telecommunications equipment (SITC 764) alone accounting for about one-quarter of this exchange. An analysis of underlying individual East Asian country's trade statistics reveals little variation in the relative importance of these products across countries (see Appendix Tables 2 and 3). A similar high level of product concentration has also been observed in global statistics on components trade, except that motor vehicle parts were the largest single traded product group on all world markets (Yeats 1997). In East Asia, these items are the fourth largest product group.

Table 1. The 1996 Value and Share of East Asian Countries' Imports and Exports of Parts and Components Identified in the SITC Revision 2 Classification System. (values in US$ million)

SITC Rev. 2 – Description*	Imports		Exports	
	Value	Share (%)	Value	Share (%)
711.9 Parts of Steam boilers and auxiliary plants	426.8	0.26	495.5	0.28
713.19 Parts of aircraft internal combustion engines	139.9	0.08	142.8	0.08
713.31 Parts of outboard motors	99.1	0.06	483.0	0.27
713.32 Parts of outboard motors, nes	388.7	0.23	462.9	0.26
713.9 Parts of internal combustion engines, nes	3,341.3	2.02	5,107.1	2.87
714.9 Parts of engines and motors, nes	2,362.8	1.43	889.0	0.50
716.9 Parts of rotating electric motors	1,748.3	1.06	1,385.4	0.78
718.89 Parts of water turbines and hydraulic motors	40.1	0.02	42.0	0.02
721.19 Parts of cultivating equipment	32.2	0.02	38.6	0.02
721.29 Parts of harvesting machinery	60.7	0.04	64.3	0.04
721.39 Parts of dairy machinery	27.0	0.02	4.8	0.00
721.98 Parts of wine making machinery	9.0	0.01	4.3	0.00
721.99 Parts of other agricultural machinery, nes	54.3	0.03	17.6	0.01
723.9 Parts of construction machinery	1,245.6	0.75	705.3	0.39
724.49 Parts of spinning and extruding machinery	420.3	0.25	291.7	0.16
724.69 Parts of looms and knitting machinery	469.7	0.28	293.2	0.16
724.79 Parts of textile machinery, nes	201.8	0.12	147.2	0.08
725.9 Parts of paper making machinery	704.7	0.43	201.2	0.11
726.89 Parts of bookbinding machinery	16.7	0.01	6.3	0.00
726.9 Parts of printing and typesetting machinery	399.0	0.24	151.5	0.09
727.19 Parts of grain milling machinery	30.8	0.02	29.1	0.02
727.29 Parts of food processing machinery	24.9	0.02	1.5	0.00
728.19 Parts of machine tools for special industries	237.1	0.14	167.9	0.09
728.39 Parts of mineral working machinery	648.7	0.39	132.0	0.07
728.49 Parts of machines for special industries, nes	4,009.3	2.42	2,065.4	1.16
736.9 Parts of machine tools for metal working	1,149.6	0.69	810.6	0.45
737.19 Parts of foundry equipment	182.3	0.11	186.7	0.10
737.29 Rolling mill parts	615.7	0.37	573.5	0.32
741.49 Parts of refrigerating equipment	350.4	0.21	350.4	0.19
742.9 Parts of pumps for liquids	686.1	0.41	473.3	0.27
743.9 Parts of centrifuges and filters	1,772.0	1.07	1,260.4	0.71
744.19 Parts of fork lift trucks	111.3	0.07	59.6	0.03
744.9 Parts of lifting and loading machines	2,993.2	1.81	2.027.5	1.14
745.19 Parts of power hand tools	104.6	0.06	125.1	0.07
745.23 Parts for packing machinery	279.2	0.17	72.0	0.04
749.99 Parts of non-electric machinery, nes	715.1	0.43	738.7	0.42
759 Parts of office and adding machinery	30,726.8	18.56	47,130.9	26.10
764 Parts of telecommunications equipment	41,013.1	24.77	42,459.9	23.86
771.29 Parts of electric power machinery	2,178.9	1.32	1,673.3	0.93
772 Parts of switchgear	19,003.0	11.48	21,625.0	12.18
775.79 Parts of domestic electrical equipment	113.7	0.07	85.0	0.05
775.89 Parts of electrothermic appliances	472.7	0.29	606.3	0.35
776.89 Parts of electronic components, nes	19,849.7	11.99	7,868.6	4.46
778.19 Parts of electronic accumulators	184.7	0.11	161.8	0.09
778.29 Parts of electric lamps and bulbs	136.1	0.08	79.9	0.04
778.89 Parts of electrical machinery, nes	451.0	0.27	4,228.7	2.42
784 Parts of motor vehicles and accessories	11,983.6	7.24	21,373.6	12.03
785.39 Parts of carriages and cycles	2,419.8	1.46	4,012.3	2.26
786.89 Parts of trailers and non-motor vehicles	141.0	0.09	169.9	0.09

Table 1. Continued

SITC Rev. 2 - Description*	Imports		Exports	
	Value	Share (%)	Value	Share (%)
791.99 Parts of railroad equipment and vehicles	391.9	0.24	126.7	0.07
792.9 Parts of aircraft and helicopters	4,514.5	2.73	2,360.9	0.98
821.19 Parts of chairs	421.6	0.25	367.9	0.20
821.99 Other furniture parts	731.6	0.44	976.5	0.53
874.29 Parts of measuring or drawing machines	719.7	0.43	307.0	0.18
881.19 Parts of still cameras, nes	1,799.6	1.09	1,144.8	0.62
881.21 Parts for cameras under 16mm	40.6	0.02	12.2	0.01
881.29 Parts of cameras under 16mm, nes	43.4	0.03	19.6	0.01
884.11 Parts of unmounted optical elements	262.5	0.16	174.2	0.09
885.29 Parts of clocks and watches	1,683.4	1.02	1,420.1	0.68
899.49 Parts of umbrellas and canes	167.4	0.10	154.2	0.09
ALL ABOVE ITEMS	165,548.5	100.0	178,546.7	100.0
MEMO ITEM: EAST ASIA TRADE				
All Above Parts and Components	165,548.5	18.2	178,546.7	20.6
All Manufactures Excluding Chemicals	907,522.5	100.0	944,083.5	100.0

*The trade statistics represent the combined imports and exports of the following East Asian Countries: Japan, Hong Kong, Republic of Korea, China, Singapore, Taiwan (China), Malaysia, Thailand, Indonesia, Philippines.

Source: Computed from UN COMTRADE statistics.

With regard to the relative importance of parts and components in total East Asian trade, the table's memo item shows these goods account for approximately one-fifth of the regions total exports and imports of manufactures. There is, however, considerable variation in this share across East Asian countries. Appendix Table 2 shows that components consist of almost 30 percent of the Philippines imports of manufactures, as opposed to about 7 percent for Japan. In contrast, exports of components account for about 20 percent of Japan's exports, as opposed to under 4 percent for Indonesia (Appendix Table 4).

A. On the Relative Importance of Components Trade

Key Point

Asian imports of components, measured as a share of all manufactures, is growing considerably faster than in OECD Europe or North America. The value of Asian global imports of components rose more than nine-fold over 1985-1996. Almost three-quarters of all Asian imports of telecommunications equipment consist of components for further assembly.

Table 2 provides a different perspective on trade in parts by showing the value of all components imports within two-digit SITC groups, along with their share of all group imports in 1985, 1990 and 1996 (Appendix Table 4 provides similar statistics for exports). For comparison, similar statistics are shown for OECD Europe and North America (Canada, Mexico and the United States).

One striking point reflected in these statistics concerns the "dynamism" in East Asian parts trade as reflected in their changing relative importance in all imports. From 1985 to 1996 the share of components in all SITC 7 and 8 product imports rose by about

Table 2. The Relative Importance of Parts and Components Imports in Selected Regional Groups

Regional and Product Group (SITC)	Value of Parts and Components Imports ($million)			Share of Parts and Components In Product Group Imports (%)		
	1985	1990	1996	1985	1990	1996
EAST ASIA						
Power Generating Equipment (71)	1,478	4,816	8,547	35.3	39.1	35.9
Special Industry Machinery (72)	1,637	4,527	8,592	14.9	17.0	16.1
Metal Working Machinery (73)	171	656	1,948	10.3	12.0	13.9
General Industrial Machinery (74)	637	2,471	7,012	8.7	11.9	13.3
Office Machinery (75)	1,866	8,515	30,727	32.5	46.5	47.2
Telecommunications (76)	3,150	13,707	41,013	43.0	61.8	71.8
Electric Machinery (77)	5,338	13,575	42,390	33.3	27.6	25.2
Road Vehicles (78)	1,759	10,020	14,544	25.1	42.0	35.6
Other Transport Machinery (79)	854	2,271	4,906	8.4	15.8	19.3
Misc. Manufactures (8)	803	3,269	6,870	4.0	4.6	3.7
All Above Products	17,693	63,827	165,549	19.5	24.1	25.1
OECD EUROPE						
Power Generating Equipment (71)	5,221	14,660	19,548	37.8	43.0	40.7
Special Industry Machinery (72)	4,620	10,893	12,298	25.3	22.2	24.2
Metal Working Machinery (73)	905	2,898	2,929	20.2	19.7	22.1
General Industrial Machinery (74)	3,089	11,312	15,765	13.9	17.6	19.2
Office Machinery (75)	10,237	24,316	35,871	35.7	33.9	33.3
Telecommunications (76)	6,455	21,567	38,088	47.4	51.8	64.1
Electrical Machinery (77)	7,518	19,836	29,480	24.2	24.1	22.0
Road Vehicles (78)	14,581	37,345	61,005	29.8	25.0	28.8
Other Transport Machinery (79)	3,911	8,399	15,863	32.6	22.7	44.5
Misc. Manufactures (8)	1,590	5,284	7,937	2.1	2.4	2.9
All Above Products	58,128	156,510	238,783	21.5	20.6	23.4
NORTH AMERICA						
Power Generating Equipment (71)	5,092	7,739	13,655	37.7	34.4	39.5
Special Industrial Machinery (72)	3,162	4,098	5,678	24.1	21.5	21.4
Metal Working Machinery (73)	738	979	2,040	19.1	19.4	22.3
General Industrial Machinery (74)	1,581	4,313	6,628	13.7	18.5	16.6
Office Machinery (75)	6,549	11,004	26,655	41.9	32.6	33.7
Telecommunications (76)	9,625	14,532	23,902	43.9	53.7	54.9
Electrical Machinery (77)	5,407	10,642	19,902	23.3	23.6	18.3
Road Vehicles (78)	23,277	30,014	42,792	28.4	29.8	30.0
Other Transport Equipment (79)	2,965	4,767	5,647	45.4	45.7	43.1
Misc. Manufactures (8)	408	2,504	5,175	0.7	2.5	3.1
All Above Products	58,084	90,591	152,073	23.5	23.4	22.9

Source: Computed from UN COMTRADE statistics

Box 1
The Relative Importance of Recent and "Vintage" Production Sharing

While most recent analyses of international production sharing focus on the fragmentation of manufacturing processes (see Arndt and Kierzkowski 1999 for an overview), this activity has long been a major and evolving process. One of its earlier forms involved the production of primary commodities in developing (and some developed) countries, shipment of these goods to (largely) industrial nations for further processing, and then the re-exportation (in part) of the processed product back to the primary commodity producer or third countries. As an example, tin ores might be mined in Thailand or Malaysia, shipped to Japan for refinement and further manufacture – some of which might be shipped back to the primary product producers. In part, these "production sharing" trade flows were based on comparative advantage (some processing activity like the fabrication of metals from ore is highly capital intensive), but factors such as "escalation of industrial countries" trade barriers contributed to this exchange pattern.

A question of interest is how does the magnitude of the trade in these "traditional" production inputs (unprocessed commodities) compare with that now reflected in the international exchange of manufactured parts and components. For answers, East Asian global imports and exports of agricultural raw materials (SITC 2-22-27-28) and ores, minerals and nonferrous metals (27+28+68) were tabulated along with certain types of unprocessed foodstuffs (like cocoa and coffee beans) that have no discernable end use in their natural form. These goods, like those manufactured components listed in Table 1, are being shipped elsewhere for further processing.

The statistics shown below compare the value of East Asian trade in "traditional inputs" with manufactured components for selected years over 1984-1996. The figures attest to the remarkable growth dynamism in the exchange of the latter. In 1984, Asian imports of traditional inputs were more than double those of manufactured components, but by 1996 their relative position was reversed and component imports were $67 billion higher. Over the full 1984-96 period the annual growth rate for components (20.4 percent) was about two and one half times greater than that for traditional products.

	Value of East Asian Trade in US$ billion				Growth Rate (%)	
Trade Flow/Product	1984	1988	1992	1996	1984-96	1988-96
East Asian Imports						
Traditional Production Inputs	39.2	68.0	71.4	98.9	8.0	4.8
Manufactured Components	17.9	46.4	80.8	165.6	20.4	17.2
East Asian Exports						
Traditional Production Inputs	17.0	26.3	25.1	37.6	6.8	4.6
Manufactured Components	33.0	73.1	108.9	177.8	15.1	11.8

Source: Computed from UN COMTRADE data.

While 1984 Asian exports of manufactured components ($33 billion) were approximately twice as large as traditional inputs, the former increased to five times larger by 1996. In short, whether measured by either exports or imports the statistics attest to the remarkable dynamism in and importance of East Asian trade in manufactured parts and components.

six percentage points and now accounts for 25 percent of all trade in these goods. As such, East Asian trade in parts went from levels that were relatively less to more important than in OECD Europe and North America (both had a share of about 23 percent) over this interval. The striking growth in East Asian trade in parts is most evident in the telecommunications group (SITC 76) where imports rose from $3 billion in 1985 to over $41 billion in 1996, while the value of "parts trade" in electronic machinery experienced a slightly smaller (eight fold) increase over this same interval.[6] Table 2 also shows the growth in the relative importance of East Asia's components trade, as reflected in their increased share of all imports, occurred for all but two of the SITC groups (electrical machinery and miscellaneous manufactures).

B. Dynamic Aspects of Asian Components Trade

Key Point

East Asian global exports of components grew at an annual rate of 15 percent over 1984-1996 which was more than 4 points above the growth rate for all goods (10.6 percent). However, exports of components to other East Asian markets grew at a considerably faster than average pace (about 20.9 percent). As a result, the share of all parts and components exports destined for regional markets almost doubled from 25 to 46 percent.

[6] In contrast to imports, the relative importance of East Asia's exports of parts and components is below that of OECD Europe or North America – a fact that probably reflects Asia's comparative advantage in assembly operations (see Table 6). However, the 1985 to 1996 share of components in total SITC 7 and 8 exports was static in Europe (at 23 percent), and declined in North America (from 36 to 31 percent). Over this period East Asia's share increased by 6 points to 22 percent.

Table 3. East Asian Global and Regional Trade Trends for Parts and Components and Other Major Product Groups.

Year	All Items	Foods & Feeds	Agricultural Materials	Mineral Fuels	Ores & Metals	All Manufactures	Of which:			
							Chemicals	Transport & Machinery	Other Manufactures	Parts & Components
	Value of exports to East Asia in terms of US$ million									
1984	110,992	8,888	5,655	25,081	3,201	66,391	6,516	28,595	31,280	8,457
1988	197,831	15,920	9,383	17,207	6,832	146,253	14,513	64,616	67,124	23,940
1992	332,906	21,883	8,968	27,540	7,603	263,444	22,944	120,991	119,509	42,258
1996	557,338	30,899	11,889	35,521	13,174	459,287	41,057	248,477	169,753	82,487
	Value of exports to the world in terms of US$ million									
1984	347,247	20,916	10,442	34,480	5,485	268,948	12,853	138,958	117,138	32,983
1988	563,168	30,172	15,694	21,505	9,275	476,607	25,570	253,374	197,662	73,106
1992	792,603	39,063	14,310	34,213	10,010	684,126	39,071	372,509	272,546	108,885
1996	1,157,622	51,710	19,170	43,275	17,313	1,010,745	67,289	591,553	351,880	178,547
	Annual growth rate of exports to East Asia (%)									
1992-96	13.75	9.00	7.30	6.57	14.73	14.91	15.66	19.71	9.18	18.20
1988-96	13.82	8.64	3.00	9.48	8.55	15.47	13.88	18.34	12.29	16.72
1984-96	14.39	10.94	6.39	2.94	12.51	17.49	16.58	20.43	15.14	20.90
	Annual growth rate of exports to the world (%)									
1992-96	9.93	7.26	7.58	6.05	14.68	10.25	14.56	12.26	6.60	13.16
1988-96	9.42	6.97	2.53	9.13	8.11	9.85	12.86	11.18	7.48	11.81
1984-96	10.55	7.83	5.19	1.91	10.05	11.66	14.79	12.83	9.60	15.11
	Share of East Asian intra-trade in total exports of the group (%)									
1984	32.0	42.5	54.2	72.7	58.4	24.7	50.7	19.2	26.7	25.6
1988	35.1	52.8	59.8	80.0	73.7	30.5	56.8	25.5	34.0	32.7
1992	42.0	56.0	62.7	80.5	76.0	38.5	58.7	32.5	43.8	38.8
1996	48.1	59.8	62.0	82.1	76,1	45.4	61.0	42.0	48.2	46.2

Source: Computed from UN COMTRADE statistics

Table 3 provides additional information on the extraordinary expansion of Asian trade in components. The top two rows of the table shows the value of East Asian exports of these goods, to the region and globally, for selected years over 1984-96. This is followed by statistics showing the corresponding annual growth rates of regional and global exports. Finally, the last (fifth) row of the table shows the share of global exports destined for East Asian intra-trade. To help assess the implications of these statistics the table provides similar information for other broad product groups like foodstuffs, agricultural raw materials, chemicals, and transport and machinery equipment. Several important points emerge from these statistics:

• Asian global exports of components increased more than five-fold over 1984-96 while total exports of all goods grew by a factor of approximately three. However, the value of component exports to the region grew by a factor of about ten which was roughly double that for all regional trade.

• Over 1984-96, components recorded the fastest annual growth rates for all the major product groups in both regional (20.9 percent) and global exports (15 percent). These rates were approximately 3 points per year higher than those for all manufactures and 5 to 6 points higher than for all goods. In short, trade in parts and components was dramatically increasing in relative importance.

• Sizeable shifts occurred in the share of all ten product group exports going to the region over 1984-96, but this shift was greatest for transport and machinery equipment, other manufactures, and components. In 1984, 26 percent of all component exports went to other regional countries, but 12 years later this share increased to 46 percent.

As further illustrated in Table 4, the dramatic expansion of East Asian trade in components was largely a intra-regional phenomenon that was unmatched in trade with any other geographic groups of countries. For example, over 1985-96 the share of East Asian imports of components from Europe held relatively stable in the 14 to 16 percent range, while North America's share of both imports and exports fell by 14 percentage

points. The Asian group of countries appears to be the big gainer, but the table shows that other sub-regional Asian groups (like South Asia or Oceania) did not participate in the expansion, that is, their East Asian import shares remained low and static. In

Table 4. The Origins and Destinations of East Asian Countries Trade in Parts and Components

	Imports			Exports		
Region	1985	1990	1996	1985	1990	1996
	Value of Trade in US$ million					
WORLD	17,693	63,827	165,549	33,152	89,469	178,547
	Share of Trade Destined for or Originating in					
WORLD	100.0	100.0	100.0	100.0	100.0	100.0
ASIA	43.5	59.4	58.5	31.9	41.2	49.6
Of which:						
Japan	28.7	29.1	25.6	1.7	3.2	5.3
Other East Asia	14.2	29.3	32.0	24.2	34.9	41.3
South Asia	0.2	0.2	0.3	1.5	1.0	1.0
Oceania	0.5	0.6	0.6	3.8	1.9	1.5
Former Soviet Union	--	0.1	0.1	0.8	0.3	0.4
NORTH AMERICA	37.1	25.1	23.3	44.9	35.3	29.5
Of which:						
United States	36.2	24.3	22.3	41.8	32.4	27.2
EUROPE	16.6	15.0	17.0	14.0	19.2	16.2
Of which:						
European Union	15.5	13.8	16.0	13.1	18.3	15.3
Eastern & Other Europe	1.1	1.3	1.0	0.9	0.9	0.9
LATIN AMERICA	0.2	0.2	0.4	3.1	2.3	2.8
Of which:						
Mercosur	0.1	0.1	0.2	0.8	0.6	1.1
MIDDLE EAST	0.1	0.1	0.3	4.0	1.1	1.0
AFRICA	--	--	--	1.6	0.6	0.4
Of which:						
Sub-Saharan Africa	--	--	--	0.9	0.3	0.2
UNSPECIFIED COUNTRIES	2.4	0.2	0.7	0.5	0.2	0.4

Source: Computed from UN COMTRADE statistics.

contrast, the share of East Asian imports originating in other (non-Japanese) East Asian countries more than doubled to about 32 percent.

A similar pattern is evident in the export statistics. The 1985-96 shares of East Asia's components exports going to Europe essentially remained stable, while North America's shares experienced a sizeable decline. Within the Asian regional sub-groups the relative importance of South Asia's was low and virtually unchanged, while the share of East Asian exports destined for Oceania declined by more than 2 points from its 1985 level (3.8 percent). As with imports, it was in the other (non-Japanese) East Asian countries that regional exporters registered their greatest relative trade gains. In short, as measured by either exports or imports the driving force for the expansion of production sharing in East Asia largely came from other East Asian countries.

Table 5 provides additional information on the pattern of intra-trade by showing the 1996 value of component exports from each East Asian country to its specific regional destination. In addition, the middle third of the table shows bilateral regional percentage trade balances for components (that is, the value of exports less imports expressed as a percentage of total exports), while the lower third of the table shows trade intensity indices for components. These latter statistics measure the tendency for two countries to trade more, or less, heavily than expected given their global importance in trade. If the intensity index is above unity, the countries are said to have a greater than

Table 5. The Matrix of 1996 Intra-Trade and Trade Balances in Parts and Components Among East Asian and Other Major Countries

	Exporting Country									
Partner	China	Hong Kong	Indonesia	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand	Japan
	Values of Exports of Components in US$ Million									
China	--	2,152	4	828	84	10	671	110	32	3,548
Hong Kong	2,686	--	62	535	564	154	1,872	4,154	287	3,500
Indonesia	131	18	--	334	124	19	--	305	64	2,135
Korea Rep.	494	58	28	--	151	42	465	372	79	4,445
Malaysia	205	77	128	314	--	94	5,436	632	363	3,959
Philippines	64	68	6	250	154	--	603	425	49	2,197
Singapore	475	331	615	524	4,201	175	--	863	1,597	3,635
Taiwan	345	95	24	166	292	104	644	--	156	4,514
Thailand	83	94	39	226	732	611	1,612	623	--	4,157
Japan	2,126	158	310	1,053	1,186	686	1,230	1,740	945	--
All East Asia	6,609	3,051	1,216	4,230	7,488	1,895	12,533	9,244	3,572	32,090
World	10,706	4,227	1,767	11,917	12,504	3,570	23,558	21,521	7,071	80,939
	Trade Balance in Components as a Share of Component Exports (%)									
China	--	-222.0	-2,155.2	29.2	-213.5	-496.7	-29.3	-159.3	-760.5	25.4
Hong Kong	51.4	--	70.3	78.6	-11.5	-189.2	39.7	94.7	54.7	92.4
Indonesia	911.3	-117.1	--	91.5	-88.4	12.5	--	88.6	50.2	82.8
Korea Rep.	-94.2	-1,056.7	-308.3	--	-197.1	-646.7	-0.1	46.7	-142.4	71.4
Malaysia	21.8	-570.9	66.9	63.2	--	-129.9	21.2	56.3	-138.7	74.0
Philippines	37.4	-136.8	-37.8	89.2	-20.1	--	60.1	87.3	-607.6	56.9
Singapore	-38.3	-466.6	63.8	50.4	36.4	-252.9	--	62.5	57.2	78.1
Taiwan	-310.3	-2,750.9	-543.9	-109.1	-151.9	-174.3	-82.1	--	-198.9	55.1
Thailand	-135.0	-116.8	-38.5	64.1	-11.5	80.6	6.2	74.3	--	77.3
Japan	-153.0	-3,437.1	-741.4	-376.1	-313.0	-369.5	-356.6	-120.1	-552.3	--
All East Asia	-53.1	-513.2	-172.5	-55.5	-45.3	-179.2	-22.0	-120.6	41.6	67.9
World	-60.4	-517.7	-276.0	-16.5	-53.5	-186.7	-12.6	64.2	-101.5	70.7
	Trade Intensity Index for Components									
China	--	17.7	0.1	2.5	0.2	0.1	1.0	0.2	0.2	1.5
Hong Kong	5.8	--	0.8	1.1	1.0	1.0	1.8	4.6	0.9	1.0
Indonesia	1.1	0.4	--	2.6	0.9	0.5	--	1.3	0.8	2.4
Korea Rep.	2.0	0.6	0.7	--	0.5	0.5	0.9	0.8	0.5	2.4
Malaysia	0.6	0.6	2.3	0.8	--	0.8	7.2	0.9	1.6	1.5
Philippines	0.4	0.9	0.2	1.2	0.7	--	1.5	1.2	0.4	1.6
Singapore	1.0	1.8	8.1	1.0	7.7	1.1	--	0.9	5.2	1.0
Taiwan	2.5	1.8	1.1	1.1	1.8	2.3	2.1	--	1.7	4.3
Thailand	0.3	0.9	1.0	0.8	2.5	7.4	2.9	1.3	--	2.2
Japan	5.1	0.9	4.6	2.3	2.4	5.0	1.3	2.1	3.4	--

expected bilateral trade based on their share in world trade. If the index is below unity the intensity of trade is lower than expected.[7]

Three interesting points emerge from the regional trade matrix.

• **Even though Table 4 shows exports from other regional countries are rapidly expanding, Japan is still the largest components exporter accounting for $32 billion, or approximately 40 percent of intra-regional trade in these goods. Japan also has a positive trade balance with every one of the East Asian countries which appear to specialize in the assembly of Japanese produced components. This pattern conforms to expectations since Japanese average annual wage costs ($40,404 as reported by the World Bank 1999) are more than 10 times higher than those in Malaysia and 16 times higher than those in the Philippines.**

• **Again, as expected, low wage countries like Thailand, China, Malaysia and the Philippines generally have sizeable negative intra-regional trade balances, while the results are mixed for higher wage countries like Korea, Singapore and Taiwan.[8] We have not been able to find a satisfactory explanation for Hong Kong's persistent large negative trade balances with every one of the other Asian countries, but (as noted) suspect there may be a problem with the proper recording of transit trade.**

• **Japan's trade intensity indices are at, or above, unity for every one of the East Asian countries which indicates Japan's production sharing operations are quite widely dispersed in the region. Similarly, with the exception of Hong Kong, trade intensity indices for other East Asian exports to Japan are also above unity. The fact that the indices for Indonesia and the Philippines are between 4.6 and 5 suggests that some component products may be manufactured using labor intensive production processes.[9]**

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[7] The trade intensity index (I_{ij}) is defined for country i's exports to country j as the share of i's exports going to j (X_{ij}/X_{iw}) relative to the share of j's imports in world imports ($M_{jw}/(M_w-M_i)$). That is,

(1) $I_{ij} = (X_{ij}/X_{iw})/ (M_{jw}/(M_w-M_i))$.

[8] Table 2.6 in the World Bank's 1999 World Development Indicators reports statistics on average annual labor costs in manufacturing over 1990-94 for East Asian and other countries. Average wage costs in the Philippines are $2,459 as opposed to $15,819 in Korea and $21,534 in Singapore. Regional wage costs were highest in Japan at $21,534 and lowest ($1,008) in Indonesia.

[9] At first glance, the fact that low wage countries like Indonesia and the Philippines have such high trade (export) intensity indices with Japan may appear contrary to reason. These results are largely due to the fact that Japan has relatively low *import* shares for componentss. As such, the relatively small denominator in the formula for the trade intensity index (equation 1) can produce what appear to be relatively large index numbers. The shares of Indonesia and the Philippines exports of components to Japan are small, but they are relatively larger than Japan's world share of component imports.

C. The Influence of the Recent Asian Slowdown

Key Point

Available statistics (through 1997) indicate the recent Asian economic slowdown has not had a major detrimental impact on regional trade in parts and components. Although Japanese exports declined slightly in 1997, shipments from most other East Asian countries increased by between 9 to 16 percent. Since Asian trade in components has been such a dynamic leading sector in regional imports and exports there is an obvious interest in monitoring future changes in this exchange.

A question of obvious interest concerns the influence of the recent Asian economic recession on intra-regional trade in components. Here, two alternative scenarios exist. First, if assembled goods which utilize imported components are destined primarily for other Asian countries' markets, a general decline in effective demand would probably cause a marked reduction in the trade in parts. However, if the assembled goods were largely destined for non-Asian markets the reduction would likely be less severe. Indeed, the economic situation within East Asia may increase the importance of expanding these, and other types of exports, to build up foreign exchange reserves. This could be a scenario leading to an increase in intra-trade in components.

Unfortunately, at the time this report was completed (March 1999), 1996 was the last full year UN COMTRADE statistics were available for all the East Asian countries. However, 1997 export statistics were available for Japan, Thailand, Singapore, Republic of Korea, Hong Kong and China and these data should provide some information on the initial impact of the slowdown. In general, there is little evidence of an extensive adverse impact on trade in components. Regional exports of China, Indonesia, and Thailand all increased by at least 16 percent from 1996 to 1997, while those of Singapore and Malaysia rose by 9 to 10 percent. In contrast, component

exports from Japan and Hong Kong fell slightly by 2 to 3 percent from their 1996 levels.[10] Given that East Asian trade in components has been such a dynamic leading sector in regional imports and exports there is an obvious interest in monitoring future changes in this exchange.

IV. COMPARATIVE ADVANTAGE IN PRODUCTION SHARING

Key Point

Traditionally, "revealed" comparative advantage (RCA) indices have been computed using export statistics. These results show whether a country has a comparative advantage in the manufacture of a product. When RCA indices are computed using import statistics for a given component product the results should indicate whether a country has a comparative advantage, or disadvantage, in assembly operations.

Economists often utilized the concept of "revealed" comparative advantage to identify countries whose factor endowments make it advantageous for them to specialize in the production of a good. The revealed comparative advantage (RCA) index for country i in the production of product j has been defined as;

$$(2) \qquad RCA_{ij}^{p} = [x_{ij}/X_j]/[x_{wj}/X_w] * 100$$

where x_{ij} and x_{wj} represent the value of j exported by country i and the world, while X_j and X_w are total exports by j and the world, respectively. The index has a relatively simple interpretation. If its value exceeds unity the country is said to have a comparative advantage in the *production* of product j, in contrast, if the RCA index is below one the

[10] The most recent UN trade statistics show 1997 exports from the Philippines falling by over 55 percent from their 1996 levels. It is difficult to assess the implications of this change since a similar marked reduction also occurred in trade reported as SITC 931 "special transactions." We have asked officials at the UN Statistical Office to verify the most recent Philippines trade statistics.

country is at a comparative disadvantage in the good.[11] However, equation (2) must be used with some caution since domestic measures, that have nothing to do with comparative advantage (like local subsidies) or foreign trade barriers, can impart a bias in the index.[12]

This study employs a variant of equation (2) to also identify countries that appear to have a comparative advantage in further upstream operations – that is, the *assembly* of the next stage of the manufacturing process. Specifically, the revealed comparative advantage of country i in the assembly of product j is;

$$(3) \qquad RCA_{ij}^{a} = [m_{ij}/M_j]/[m_{wj}/M_w] * 100$$

where the m's represent imports, but otherwise correspond to the terms in equation (2). The reasoning behind this proposition is relatively straightforward. Parts and components typically have no general end use in themselves, but are exchanged for further assembly into a product that does.[13] Therefore, it follows that countries with above average import shares for components have a comparative advantage in the assembly operation.

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[11] Balassa (1965) developed and applied the concept of "revealed" comparative advantage and also made important extensions in Balassa (1977b) (1979).

[12] For example, some governments have actively encouraged the importation and assembly of specific electronic components reasoning that this could be an initial first step leading to the development of a full comparative advantage in "high-tech" industries. See World Bank (1994a) for a discussion of China's policies in this respect. The use of financial and other government incentives to attract offshore assembly operations in the Caribbean is well documented by the World Bank (1994b)

[13] There is one exception when an imported component is used as a replacement for a failed part in an already assembled good. However, this should have a neutral effect across countries unless failure rates for parts in assembled products differed substantially between nations, or there was wide differences in the intensity of use of a given finished product across countries. The latter might be a factor between (say) very rich and very poor countries, but should be less important in a region like East Asia.

Box 2
Changes in the Geographic Dispersion of Comparative Advantage in Production and Assembly

The previous analyses (Table 3) demonstrated that, over the last decade, East Asian global exports of parts and components were growing at a considerably faster pace than exports of all goods and about 30 percent per year faster than the rate for all manufactures. To what extent is this recent dynamism reflected in the comparative advantage profiles of East Asian countries for assembly or production operations? Also, do these changes give any indication as to the potential magnitude and direction of future changes?

The statistics reported below provide summary information on the extent to which the 10 East Asian countries had a comparative advantage in the assembly, or production, of all 60 parts and component product groups in 1985 and 1996. For example, in 1985 only two or three countries had a comparative advantage in the assembly of 30 percent of all the component groups, but by 1996 this had changed to 36.7 percent. In 1996, only two or three countries had a comparative advantage in the production of 16.7 percent of the components – this is down from an average of 20 percent in 1985. The rightmost column shows the average number of East African countries with a comparative advantage in all 60 component groups. In 1996, this average was 3.48 for assembly operations as opposed to 1.77 countries for the production of parts

	Percent of Industries Ranked by the Number of Countries with RCAs Exceeding Unity					Ave. No. of Countries With RCAs Over Unity
Operation/Year	0 or 1 Countries	2 or 3 Countries	4 or 5 Countries	6 or 7 Countries	8 or 9 Countries	
Assembly of Parts						
1996	20.0	36.7	20.0	16.7	6.6	3.48
1985	16.7	30.0	35.0	8.3	10.0	3.83
Production of Parts						
1996	66.7	16.7	3.3	8.3	5.0	1.77
1985	71.6	20.0	6.7	1.7	0.0	1.12

Source: Computed from the data in Tables 6 and 7

Several interesting points emerge from these statistics. First, East Asian comparative advantage is considerably broader in assembly operations than in manufacturing components. In 1996, an average of 3.5 countries had a comparative advantage in the assembly of the sixty product groups which was more than double the average (1.77 countries) for production operations. The slight 1985-96 decline in the overall assembly average is due entirely to the Philippines where the available data seemingly suggest a loss of comparative advantage in 21 assembly industries note our earlier reservations concerning this nation's data quality).

Six or more countries had an assembly comparative advantage in about 23 percent of the 60 industries as opposed to about 13 percent for manufacturing. Second, an analysis of the tabulations suggests that nominal transportation costs may be a determinant of the extent to which Asian countries have developed a comparative advantage in individual industries. Between 6 to 8 Asian countries have developed an assembly comparative advantage in component groups like switchgear, electronic components, or office machinery where low bulk high value products normally should be involved. In contrast, none of the 10 countries has a comparative advantage in products like harvesting machinery, cultivating equipment, or dairy machinery.

A. Implications of the Profile of RCA Indices

Key Point

The structure of a country's overall RCA profile can sometimes provide useful information about its potential for the development of future assembly or manufacturing operations when examined in a "stages" context.. Relatively "immature" countries whose potential for future development may be large, typically have highly skewed RCA profiles with few indices above unity. These profiles tend to flatten out as the capacity of the country to engage in assembly or production increases.

Aside from the use of import statistics for estimating RCA indices, we propose to further expand the "informational content" of this measure by analyzing the structure of index values across different component products. This extension could convey information on the "stage of development" or "maturity" of a country in the production of components, or in their upstream assembly. Several previous studies show that countries which are just moving into the production of manufactures have different RCA profiles for these goods than nations where these operations are broadly based and expanding.[14] We propose to extend this concept to trade in components.

This line of analysis argues that useful information on a country's comparative advantage may be observed in a profile of its RCA indices for each component product if they are ranked from their highest to lowest value. Several different conceptual profiles are illustrated in Figure 1. A country which is either in: (i) an early stage of development as either a manufacturer or assembly point for components, or (ii) has economically advanced (grown sufficiently high cost and wealthy) to the point it is "exiting" assembly operations, may have a pronounced comparative advantage in a

[14] To the best of our knowledge this line of analysis was first developed by Watanabe and Kajiwara (1983). Yeats (1991) undertook a similar analysis using revealed comparative advantage indices for the Peoples Republic of China.

limited number of component products, but practically no advantage in most others.[15] Countries falling in this category would have a profile similar to (f) in Figure 1. As the capacity for production or assembly improves, the RCA indices for other component products, which previously were low, begin to rise and gradually level out. That is, the country's RCA profiles might shift from (say) e, or f towards a. This schema can convey useful information about the *potential* for broadening future operations. However, we recognize that adverse developments like an unanticipated wage inflation might prevent a country from achieving its potential capacity.

Our intention is to empirically examine the structure of East Asian countries' RCA profiles for the production and assembly of parts and components within this "stages" approach To assist in this effort we compare the East Asian profiles with those for Mexico, Hungary and Poland, all countries with extensive assembly operations, and with the United States which is the worlds largest exporter of components.

B. Asian Comparative Advantage in Assembly an Production Operations

Key Point

Assembly operations are tending to migrated to the relatively low wage Asian countries, while countries like Japan, Singapore, and Taiwan increased their specialization in the manufacture of components. Overall, the revealed comparative advantage profiles conform to predictions based on factor proportions theory. Low wage countries have a disproportionately high revealed comparative

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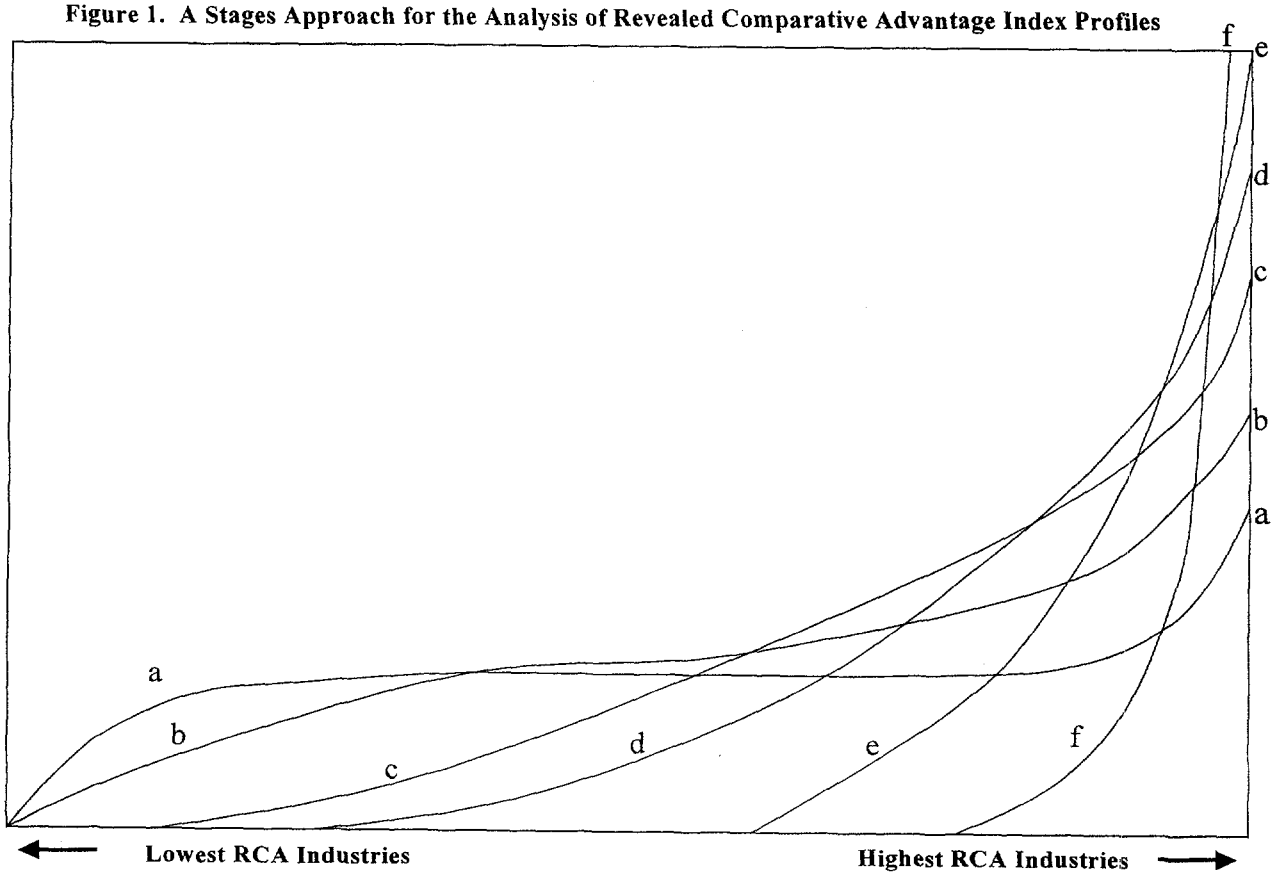
[15] We envisage a certain "life cycle" in these operations that pushes a country forward or backward through the stages reflected in Figure 1. For example, in the 1950s and 1960s Singapore and Japan were relatively high skill and low wage cost assembly centers which caused their RCA profiles for these operations to shift in the direction of (f) to (a). However, subsequent domestic wage increases reduced their competitiveness in assembly operations which pushed their RCA profiles in opposite directions - that is, in the direction of (f) towards (a). As such, position (f) in Figure 1 would be consistent with both: (i) an immature assembler with considerable potential for further development, or (ii) a country whose advanced stage of industrialization was causing it to exit assembly operations. We differentiate between the two based on factors such as relative GDP or wage costs.

Figure 1. A Stages Approach for the Analysis of Revealed Comparative Advantage Index Profiles



advantage in assembly operations (most of which are assumed to be labor intensive in nature), while the wealthier Asian countries have high RCAs for the production of components.

Table 6 shows each East Asian country's RCA indices which were calculated using their 1996 import statistics. As noted, these data should indicate whether or not the country has a comparative advantage in the assembly of each product.[16] Similarly, Table 7 shows 1996 RCA indices computed using export data which indicate whether these countries have a comparative advantage in the production of components. To help summarize the implications of this information, two additional statistics are shown (see the memo item). The first is an aggregate RCA index estimated for all component products taken as a group, while the second is a count of the number of individual components in which each country has a comparative advantage. Finally, the table also includes (as a comparator) similar data for the United States which is both the world's largest importer and exporter of parts and components (see Appendix Table 1).

The pattern reflected in these statistics generally conforms to expectations based on factor proportions theory. Japan, which has the highest unit wage costs in the region, only has a comparative advantage in the assembly of 8 of the 60 component product groups which is three less than the United States. Furthermore, Japan lost a comparative advantage in assembly of 7 component groups in which its 1985 RCA indices exceeded unity (see Appendix Table 5). This contrasts markedly with the results for low wage

[16] To help determine how comparative advantage profiles changed, Appendix Table 5 shows similar statistics computed from 1985 import statistics. Appendix Table 6 shows RCA indices computed using 1985 export statistics and is intended to help assess the 1996 RCA indices shown in Table 7.

Table 6. The Revealed Comparative Advantage of East Asian Countries in Assembly Operations as Reflected in Their 1996 Import Statistics

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Steam boilers	2.09	1.26	8.56	1.72	2.36	1.48	0.86	0.23	0.19	0.63	0.39
Aircraft engines	0.30	0.02	3.83	0.60	4.29	0.46	4.60	0.29	0.06	0.59	1.25
Outboard motors	0.16	0.73	1.30	0.57	1.56	0.26	0.39	0.24	0.35	0.15	1.30
Outboard motors, nes	1.79	0.22	0.90	1.94	1.60	0.41	1.60	0.61	0.27	0.38	0.91
Combustion engines, nes	0.77	0.58	0.91	1.19	0.30	0.39	0.64	1.63	0.59	0.37	0.98
Engines and motors, nes	0.22	0.23	1.18	0.92	0.63	0.16	0.42	0.15	0.06	1.15	1.37
Rotating electric motors	2.77	1.53	1.51	1.21	1.65	0.81	1.11	2.52	0.86	0.56	0.79
Water turbines	0.62	0.01	1.93	0.07	0.22	0.13	0.08	0.01	0.16	0.14	0.27
Cultivating equipment	0.05	0.01	0.11	0.56	0.13	0.27	0.27	0.16	0.07	0.22	1.05
Harvesting machinery	0.17	0.08	0.12	0.83	0.17	0.09	0.12	0.04	0.10	0.18	0.71
Dairy machinery	0.20	0.04	0.53	0.52	0.18	0.11	0.21	0.37	0.04	0.23	0.20
Wine making machinery	7.79	0.13	0.99	0.15	0.63	0.34	0.30	1.79	0.52	0.05	0.35
Agricultural machinery, nes	0.92	0.04	1.87	1.28	0.62	1.14	0.17	0.18	0.34	0.41	0.92
Construction machinery	1.46	0.39	3.65	1.36	2.16	0.64	5.39	1.09	0.18	0.38	0.52
Spinning machinery	2.14	0.28	5.17	1.36	0.91	0.67	0.41	1.80	2.28	0.36	0.79
Looms and knitting machinery	1.40	1.12	2.18	0.96	1.22	0.45	0.30	0.66	1.85	0.77	0.82
Textile machinery, nes	1.59	0.96	2.13	0.48	1.30	1.70	0.62	0.70	0.62	0.30	0.48
Paper making machinery	0.53	0.10	12.12	0.81	0.32	0.85	0.35	2.61	0.15	0.34	0.73
Bookbinding machinery	0.04	0.21	0.30	0.25	0.07	0.08	0.32	1.42	0.08	0.61	1.15
Printing machinery	0.66	0.49	0.54	0.39	0.54	0.70	1.53	0.36	0.30	0.68	0.71
Grain milling machinery	1.06	0.10	4.30	0.48	0.44	3.32	0.45	0.31	0.11	0.19	0.42
Food processing machinery	0.00	2.05	0.00	0.00	0.00	15.61	0.00	0.00	0.00	0.00	0.00
Machine for special industries	1.32	0.48	1.67	0.83	2.36	0.57	1.24	0.63	0.66	0.43	0.80
Mineral working machinery	1.30	0.27	13.47	0.38	2.54	4.81	0.70	1.86	0.38	0.33	0.52
Special industry machines, nes	1.76	0.42	1.04	2.59	1.80	5.22	1.98	1.09	1.18	0.98	0.80
Machines for metal working	1.19	0.30	0.60	1.69	1.38	0.85	1.01	1.04	0.63	1.08	0.93
Foundry equipment	5.38	0.18	1.10	1.49	0.40	0.27	0.67	0.17	0.72	0.23	1.58
Rolling mill parts	2.18	0.03	1.94	1.79	0.63	0.80	0.08	5.56	1.38	0.51	1.32
Refrigerating equipment	0.67	0.47	3.19	0.19	0.54	0.92	1.27	0.89	0.33	0.40	0.46
Pumps for liquids	0.50	0.16	1.93	1.17	0.27	0.51	0.85	0.38	0.32	0.51	0.87
Centrifuges and filters	0.88	0.50	1.40	1.58	1.26	0.91	0.88	0.77	1.19	0.73	0.80
Fork lift trucks	0.12	0.02	0.93	15.38	0.33	0.64	3.67	1.29	0.03	0.08	0.63
Lifting and loading machines	1.14	0.45	4.41	0.88	0.70	0.92	1.83	0.74	0.34	0.47	0.87
Power hand tools	0.19	0.17	2.50	0.37	0.75	1.33	1.56	0.18	0.25	0.36	1.07
Packing machinery	0.76	0.47	0.77	0.62	0.23	0.74	0.24	1.20	0.23	0.37	0.72
Non-electric machinery, nes	0.88	0.24	1.23	1.49	1.05	0.49	1.60	1.42	1.14	0.73	0.21
Office and adding machinery	0.87	1.04	0.06	0.52	1.63	2.28	2.64	1.57	0.43	1.29	1.32
Telecommunications equipment	1.63	1.79	1.94	1.02	1.41	2.21	1.47	0.99	0.55	1.18	0.84
Electric power machinery	3.21	3.80	0.52	1.75	2.94	2.40	2.09	1.82	0.49	0.56	0.48
Switchgear	1.15	0.84	0.97	1.04	2.25	1.26	1.73	1.70	1.32	0.61	0.84
Domestic electrical equipment	0.89	0.91	0.50	0.32	0.40	0.14	0.66	0.11	0.11	0.40	0.98

Table 6. Continued

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Electrothermic appliances	2.14	2.53	0.64	0.39	1.27	0.91	0.60	1.22	0.42	0.66	0.83
Electronic components, nes	0.72	1.16	0.14	2.00	17.38	25.27	3.44	6.40	1.97	0.14	0.32
Electronic accumulators	3.50	1.02	1.63	0.71	0.31	0.69	0.53	0.21	0.27	0.16	0.32
Electric lamps and bulbs	1.04	0.34	2.70	1.94	1.12	2.96	0.22	1.30	0.42	0.36	0.44
Electrical machinery, nes	0.93	0.01	0.23	0.31	1.08	2.17	0.33	1.23	0.55	0.42	0.19
Motor vehicles and accessories	0.33	0.14	1.51	0.41	0.18	0.34	0.25	1.69	0.51	0.27	0.99
Carriages and cycles	1.31	1.23	13.34	0.20	1.00	0.77	0.97	2.59	2.66	0.69	0.62
Non-motor vehicles	0.11	0.04	0.56	0.15	0.72	0.16	0.54	0.61	0.16	0.20	0.36
Railroad vehicles	0.28	0.19	1.67	2.81	0.70	0.30	0.11	0.19	0.47	0.20	0.96
Aircraft	0.64	0.12	0.87	0.99	0.33	0.68	1.58	1.41	0.22	0.43	0.69
Chairs	0.05	0.04	0.06	0.16	0.36	0.12	0.09	0.08	0.39	0.76	1.76
Other furniture	0.10	0.37	0.07	0.22	0.17	0.45	0.52	0.17	0.48	1.61	1.00
Drawing machinery	0.59	0.37	0.28	2.38	2.83	0.23	1.50	0.37	0.72	2.17	0.76
Still cameras, nes	6.38	4.48	0.93	1.25	3.51	8.40	1.02	1.49	3.16	1.75	0.39
Cameras under 16mm	0.59	0.31	0.84	0.56	0.72	0.97	1.69	0.17	0.92	0.77	0.88
Cameras under 16mm, nes	0.23	0.53	0.12	0.35	1.29	14.14	1.73	0.04	0.33	0.39	0.57
Unmounted optical elements	0.30	0.53	0.39	0.57	0.36	0.06	1.19	0.19	0.39	2.46	0.56
Clocks and watches	4.28	7.75	0.06	1.52	2.19	4.62	1.69	4.23	0.43	0.62	0.12
Umbrellas and canes	8.70	5.71	0.83	0.46	0.47	1.53	0.16	2.25	0.24	0.71	0.45
MEMO ITEM											
RCA Index for All Components	1.00	0.86	1.44	0.89	1.73	2.27	1.40	1.54	0.67	0.76	0.93
Number of Product Groups with An RCA Over Unity	26	14	30	24	27	19	25	27	9	8	11

* See Table 1 for the SITC Revision 2 classification number of each component product group

Source: Computed from United Nations COMTRADE Statistics

Table 7. The Revealed Comparative Advantage of East Asian Countries in the Production of Components as Reflected in Their 1996 Export Statistics

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Steam boilers	0.34	0.02	0.03	0.43	0.11	0.46	0.15	0.00	0.15	2.07	1.78
Aircraft engines	0.01	0.00	0.00	0.04	5.06	10.43	3.35	0.01	0.02	0.06	2.83
Outboard motors	0.05	0.78	0.00	0.03	0.06	0.00	0.10	0.01	0.00	5.62	2.43
Outboard motors, nes	0.05	0.00	0.01	0.61	0.08	0.00	0.67	0.68	0.00	1.56	0.95
Combustion engines, nes	0.15	0.15	0.40	0.12	0.05	0.01	0.34	0.11	0.15	1.85	1.41
Engines and motors, nes	0.04	0.00	0.01	0.11	0.02	0.02	0.12	0.05	0.11	0.33	2.69
Rotating electric motors	0.97	0.98	0.11	0.24	0.28	0.02	1.23	0.40	0.77	1.38	1.29
Water turbines	0.07	0.00	0.00	0.03	0.06	0.00	0.04	0.01	0.01	0.68	0.71
Cultivating equipment	0.21	0.00	0.03	0.26	0.02	0.00	0.08	0.03	0.73	0.10	1.17
Harvesting machinery	0.19	0.00	0.01	0.07	0.03	0.00	0.05	0.01	0.60	0.18	1.63
Dairy machinery	0.01	0.25	0.00	0.00	0.01	0.00	0.17	0.00	0.04	0.02	0.88
Wine making machinery	0.18	0.00	0.01	0.00	0.97	0.00	1.75	0.03	0.87	0.02	1.35
Agricultural machinery, nes	0.09	0.01	0.00	0.04	0.12	0.00	0.04	0.14	0.73	0.01	2.72
Construction machinery	0.09	0.12	0.42	0.25	0.38	0.00	2.30	0.10	0.01	0.07	5.29
Spinning machinery	0.18	0.21	0.05	0.85	0.12	0.03	0.22	0.03	0.68	0.84	0.74
Looms and knitting machinery	0.31	0.23	0.00	0.71	0.06	0.00	0.27	0.01	0.92	0.71	0.23
Textile machinery, nes	0.41	1.02	0.02	1.52	0.29	0.51	0.38	0.03	0.55	0.37	0.77
Paper making machinery	0.03	0.03	0.20	0.16	0.04	0.07	0.17	0.07	0.44	0.29	1.06
Bookbinding machinery	0.01	0.17	0.02	0.04	0.02	0.00	0.12	0.00	0.27	0.17	0.48
Printing machinery	0.06	0.40	0.00	0.05	0.08	0.13	0.37	0.12	0.23	0.28	1.17
Grain milling machinery	0.47	0.47	0.33	0.06	0.68	0.02	0.41	0.09	1.37	0.15	1.15
Food processing machinery	0.00	4.71	0.00	0.00	0.00	1.02	0.00	0.00	0.00	0.00	0.00
Machine for special industries	0.10	0.25	0.00	0.37	0.22	0.00	0.50	0.04	1.86	0.49	0.94
Mineral working machinery	0.26	0.09	0.02	0.16	0.29	0.09	0.21	0.04	0.23	0.18	1.44
Special industry machines, nes	0.14	0.41	0.10	0.67	0.38	0.14	0.72	0.05	0.45	0.87	1.83
Machines for metal working	0.27	0.20	0.00	0.18	0.16	0.48	0.33	0.20	0.70	0.90	1.96
Foundry equipment	0.15	0.26	0.17	0.58	0.06	0.00	0.51	0.01	0.66	1.39	0.65
Rolling mill parts	0.37	0.00	0.02	0.21	0.06	0.01	0.03	0.07	0.29	1.76	0.47
Refrigerating equipment	0.19	0.13	1.32	0.55	0.53	0.01	0.76	0.47	0.45	0.77	1.45
Pumps for liquids	0.17	0.21	0.00	0.10	0.08	0.09	0.36	0.02	0.21	0.65	1.48
Centrifuges and filters	0.20	0.23	0.04	0.14	0.18	0.16	0.36	0.20	0.84	0.91	1.44
Fork lift trucks	0.19	0.00	0.01	0.59	0.07	0.00	4.03	0.06	3.16	0.08	2.07
Lifting and loading machines	0.24	0.07	0.24	0.48	0.14	0.07	0.93	0.17	0.15	0.73	1.78
Power hand tools	0.17	0.05	0.17	0.06	0.17	0.00	0.70	0.02	2.18	0.71	1.52
Packing machinery	0.03	0.18	0.00	0.05	0.03	0.01	0.11	0.03	0.28	0.13	0.95
Non-electric machinery, nes	0.19	0.24	0.03	0.25	0.07	0.17	0.94	0.15	1.34	0.81	0.72
Office and adding machinery	0.05	1.65	0.48	0.24	2.94	3.46	3.34	2.06	2.71	1.50	1.54
Telecommunications equipment	1.07	1.20	0.83	1.13	1.90	1.52	1.73	1.07	1.08	1.13	1.24
Electric power machinery	0.93	5.06	0.07	1.02	1.64	0.14	1.70	2.24	2.81	1.05	1.53
Switchgear	0.62	1.35	0.24	0.42	1.36	0.74	1.24	1.22	1.33	1.41	1.09
Domestic electrical equipment	0.28	2.55	0.00	0.73	0.24	0.04	0.47	0.17	0.65	0.09	2.17

Table 7. Continued

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Electrothermic appliances	0.70	10.04	0.01	3.12	1.03	0.00	0.64	0.66	1.64	0.45	1.10
Electronic components, nes	0.34	2.49	0.23	1.17	4.17	2.45	4.19	3.33	0.74	3.74	0.91
Electronic accumulators	0.39	7.92	0.65	0.15	0.10	0.05	0.38	0.49	1.01	0.82	1.36
Electric lamps and bulbs	0.35	0.31	0.02	0.27	0.22	0.27	0.44	0.23	1.37	0.30	1.40
Electrical machinery, nes	0.25	0.00	0.01	10.60	0.26	0.00	0.36	1.30	4.10	0.52	1.08
Motor vehicles and accessories	0.08	0.00	0.07	0.26	0.04	0.44	0.13	0.09	0.38	1.26	1.60
Carriages and cycles	1.64	0.00	2.67	0.09	1.18	0.65	1.61	2.95	6.76	2.31	0.42
Non-motor vehicles	0.12	0.01	0.01	0.42	0.16	0.14	0.55	0.07	1.14	0.03	0.71
Railroad vehicles	0.15	0.00	0.00	0.17	0.01	0.01	0.20	0.00	0.21	0.20	1.85
Aircraft	0.07	0.00	0.14	0.12	0.38	0.67	0.43	1.54	0.00	0.25	3.21
Chairs	0.06	0.00	0.49	0.14	0.16	0.03	0.03	0.36	0.19	0.34	1.69
Other furniture	0.99	0.09	4.59	0.14	1.14	4.26	0.12	1.28	1.38	0.02	0.54
Drawing machinery	0.15	0.10	0.01	0.21	0.25	0.01	0.75	0.06	0.27	0.95	1.47
Still cameras, nes	1.25	10.22	0.29	0.60	2.36	3.46	1.31	2.85	3.52	3.13	0.97
Cameras under 16mm	0.08	0.00	0.06	0.01	0.52	0.29	0.86	0.00	0.02	0.12	1.62
Cameras under 16mm, nes	0.17	0.01	0.25	0.01	1.03	0.00	2.49	0.01	0.32	0.06	2.68
Unmounted optical elements	0.47	1.00	3.98	0.19	0.13	0.03	1.58	2.39	0.28	0.13	2.75
Clocks and watches	2.06	22.07	0.63	0.30	4.40	3.05	3.02	11.97	1.96	1.28	0.20
Umbrellas and canes	2.90	0.08	0.37	0.03	0.03	0.00	0.13	0.63	18.48	0.11	0.06
MEMO ITEM											
RCA Index for All Components	0.47	0.90	0.39	0.59	1.15	1.12	1.27	0.95	1.11	1.17	1.54
Number of Product Groups with An RCA Index Over Unite	5	12	4	6	12	8	15	12	19	16	40

* See Table 1 for the SITC Revision 2 classification number of each component product group

Source: Computed from United Nations COMTRADE Statistics

countries like Indonesia, Malaysia and Thailand which have a comparative advantage in the assembly of about half of the 60 product groups. With the exception of the Philippines, where the quality of the underlying data is suspect, relative wage costs appear to be an important determinant of where assembly operations have been, and will be located.[17]

The pattern reflected in the RCAs derived from 1996 export statistics (Table 7) also generally conforms to what is expected. Higher wage countries like Japan, Singapore, Taiwan and Hong Kong have the largest number of RCAs exceeding unity (but still less than half that for the United States) while Indonesia and China only have a comparative advantage in the production of 4 or 5 product groups. In fact, the statistics in Appendix Table 6 show all of Indonesia's 1985 RCA indices for production operations were below unity.

Table 8 summarizes statistics on the 1985 and 1996 levels and changes in East Asian RCA profiles. Shown here is the percentage of all 60 component product groups in which each Asian country had a 1985 or 1996 comparative advantage in the production or assembly of components. For example, in 1996 China only had a comparative advantage in the production of 8.3 percent of the 60 component groups as opposed to 26.7 percent for assembly operations. For comparison, the table also provides similar information for the United States and Mexico (the latter engages in extensive assembly operations geared toward the US market), and for Hungary and Poland which appear to be developing as assembly centers for the European Union.

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[17] The pattern reflected in the statistics on assembly operations parallels that observed for trade in goods. Lary (1968), for example, employed U.S. Census Bureau statistics to estimate the labor intensity of different manufactured goods and then showed developing countries had a production advantage in the

Table 8. The Percentage of All Parts and Components Products in Which East Asian Countries Have a Comparative Advantage

Country	Country Classification*	Exports-Production Operations		Imports-Assembly Operations	
		1985	1996	1985	1996
East Asia					
China	e	6.7	8.3	36.7	26.7
Hong Kong	e	16.7	21.7	28.3	23.3
Indonesia	c	0.0	6.7	63.3	50.0
Rep. of Korea	d	0.0	10.0	26.7	40.0
Malaysia	c	20.0	20.0	46.7	45.0
Philippines	d	10.0	13.3	66.7	31.7
Singapore	d	25.0	26.7	36.7	41.7
Thailand	c	10.0	20.0	36.7	45.0
Taiwan	e	15.0	31.7	16.7	16.7
Japan	e	21.7	26.7	25.0	13.4
Comparators					
Mexico	b	18.3	16.7	70.0	70.0
Hungary	d	na	38.3	na	36.7
Poland	d	na	20.0	na	43.3
United States	e	58.3	66.7	16.7	16.7

* The letters shown below attempt to classify the 1996 RCA component import profiles as shown in Figure 1. Countries with an "a" or "b" profile have a broad and diverse comparative advantage in the assembly and export of parts and components while those with an "e" or "f" profile have an advantage in the assembly of very few industries. See the Annex figures for graphs of each of these countries ranked RCA assembly profiles.

Source: Computed from the RCA statistics in Table 6 and Table 7.

Several noteworthy points are evident in these summary statistics;

• **These comparisons reaffirm the earlier observation that assembly operations for components tend to be established in the relatively low wage Asian countries while countries like Japan, Taiwan, and Singapore have an advantage in production. Collectively, East Asian countries are strengthening their comparative advantage in the production of components. Nine of the ten countries increased the percentage of component industries in which they have a production comparative advantage with Thailand and Taiwan's share doubling. A similar pattern is not evident in the corresponding shares for assembly operations which fell, or held constant, for 7 of the 10 countries**

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most labor intensive items. Yeats (1989) extended Lary's analysis through the 1980s and showed developing countries greatly improved their OECD market shares for the most labor intensive products.

- **As reflected in the RCA statistics the diversity of assembly operations in the middle and low income Asian countries have expanded to about the same degree as in Poland and Hungary, which have a comparative advantage in about one-third of the 60 component groups. Similarly, the United States and Japan now are at a comparative disadvantage in most assembly operations, but the U.S. comparative advantage in production of components is far broader.**

C. On the Maturity of Asian RCA Profiles

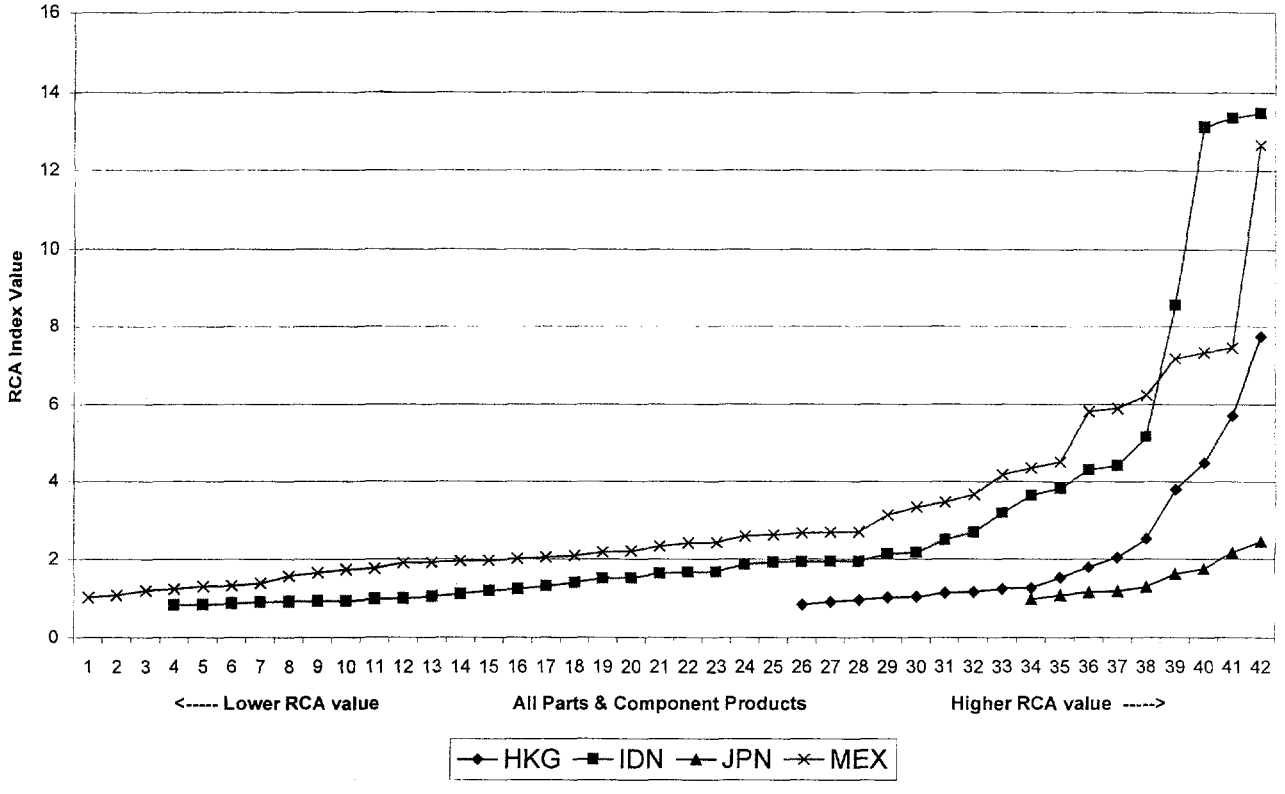
Key Point

A "stages" approach analysis of Asian RCA profiles shows Indonesia, Thailand and Malaysia have the broadest and most mature assembly capacity for components. However, these Asian profiles are less developed than Mexico's, which suggests the former may still have the capacity to expand these operations. RCA profiles for Singapore, Taiwan and Japan suggest these countries are in a "sunset" stage and appear ready to exit most assembly operations.

We earlier suggested the "maturity" of a country's involvement in component production or assembly might be assessed by analysis of its overall RCA profile for these operations (Figure 1). For an initial test, Figure 2 plots the 1996 RCA import indices for Indonesia, Hong Kong, and Japan. In addition, Mexico's profile is included for comparison given this country's extensive involvement in assembly operations (see Table 8). Component groups with RCAs less than 0.8 were not included since these distributions "tails" seemingly have a small information content. Adoption of a 0.8 cut-off can provide some indication as to the number of assembly operations in which the country is close to achieving a comparative advantage. Similar comparisons for other East Asian countries are presented in Appendix Figures 1 and 2, while Appendix Figures 3 through 5 provide RCA index distributions derived from export statistics. .

As Figure 2 shows, the four countries' RCA profiles incorporate important differences. Japan's profile is the shortest of the four with the ranked indices falling below the 0.8 "cut-off" well in the figures rightmost portion. Hong Kong has a similar

Figure 2: The Relative Maturity of Asian Countries and Mexico's 1996 Import RCA Indices



profile, but its distribution extends a bit further to the left. A subjective judgement might classify these countries profiles as corresponding to the "e" (Hong Kong) and "f" (Japan) distributions in Figure 1. Given the level of their wage costs and high level of industrialization, it might be reasonable to expect that the two countries distributions will further shift to the right (reflecting a continuation of 1985-1996 changes) as their comparative advantage in the few remaining "sunset" assembly operations further erodes.

In contrast, the RCA profile of Indonesia extends further to the left and reflects a broader base of operations, but still falls well short of that for Mexico. This observation

has several interesting implications. First, there appear to be similarities between the "stage of development" of Indonesia's RCA profile and those for the Philippines, Malaysia and Thailand. However, all four Asian countries' profiles truncate well to the right of Mexico's profile – which could be classified as corresponding to the "a" or "b" distributions in Figure 1. If one proposes that Mexico's profile represents an "achievable standard" it appears these four Asian countries (and China) could potentially further broaden their domestic assembly operations.[18]

Similar conclusions emerge from the RCA profiles derived from export statistics (Appendix Figures 3 through 5). One difference, however, is that these indices often truncate further to the right than the indices derived from import statistics. This suggests Asian production operations for components are collectively at a less mature stage than are assembly operations and may have a greater potential for development.[19] The fact that the East Asian RCA export profiles truncate far to the right of the United States distribution give some credence to this view.

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[18] Some geographic factors could cause important permanent differences between the profiles for Mexico and the East Asian countries. The first is proximity as Mexico borders the United States and is connected to main US centers of consumption by well maintained road, rail, and shipping links. Nominal transport costs for components and assembled goods may be significantly lower for Mexico than in East Asia which could prevent the latter from developing production sharing to the same degree as in North America. Second, aside from some Caribbean countries, transport and other required infrastructure in Latin American countries (as well as political instability) may make it unprofitable, or riskier, to establish foreign assembly operations. In short, there may be more choices on where to locate assembly operations in Asia. If so, then both transport costs and the availability of more alternative locational cites could prevent Asian countries from developing RCA profiles which are as broad as those for Mexico.

[19] This point is also evident in the data reported in Table 8. On average, the 10 East Asian countries have a 1996 comparative advantage in the production of 19 percent of the component groups as opposed to an average of 33 percent for assembly operations.

D. How Similar Are Asian Assembly Operations ?

Key Point

Cross correlations between East Asian countries' RCA indices often fail to achieve statistical significance. One possible explanation is that locational, wage, and communications costs, along with the specific mix of skills and infra-structure required for assembly in specific component industries, are more binding than is often thought. Correlations between specific country's 1985 and 1996 RCA assembly profiles are often highly significant indicating these operations may not be as "footloose" as is sometimes suggested.

A question for consideration is whether the economic factors responsible for East Asian production sharing in specific manufacturing processes are limited to a few locations, or are relatively well dispersed across countries. If the former is the case, one could expect relatively few similarities between the RCA profiles of most Asian countries. That is, if the *specific mix* of locational (transport cost), wage rate, communications and other production requirements needed for assembly of a given component group only occur in a relatively few Asian countries, and if these requirements differ among types of components, sizeable differences in Asian countries RCA profiles could result.[20] In contrast, if locational and production requirements are less binding sizeable differences in these the profiles need not occur.

Table 9 tests this proposition by reporting bilateral correlation coefficients between each Asian country's 1996 RCA (assembly) indices for all 60 component product groups. The table also reports results when each country's 1996 RCA indices

[20] Published studies which tested "transport cost estimation equations" show distance has a major impact on shipping costs, particularly after stowage factors and product value are accounted for (see Yeats 1981 for a survey). The sizeable distances between many Asian countries might influence where it is feasible to locate assembly operations. If Japan was the intended market for consumption of a relatively bulky final good, shipping costs might dictate that assembly operations be located in a country close to Japan. Some Asian tariffs also appear to be set at levels that would influence the location of production sharing (Appendix Table 7).

were correlated with its earlier (1995) profile. The objective here was to assess the stability of comparative advantage over time. This issue is important since it some contend that assembly operations are often "footloose" with the result that offering substantial financial incentives to attract this activity, or making sizeable investments in any required infrastructure, may not be advisable.[21]

For the most part, the results reported in Table 9 reflect important dissimilarities in the RCA (assembly) profiles of most East Asian countries. For example, all the cross-country correlations involving Indonesia and Japan fail to achieve statistical significance, while China's profile only is significantly correlated with Hong Kong, and the Republic of Korea is only correlated with Singapore. Cross-country correlations involving Malaysia and the Philippines are statistically significant in four instances, but this runs counter to the normal pattern which suggests important differences exist in the assembly capacity of Asian countries.[22]

Somewhat different conclusions result from the 1985 and 1996 RCA profiles of each Asian country. In 7 of the 10 cases strong positive significant correlations occurred with only Indonesia, Republic of Korea and Thailand failing to achieve significance.

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[21] In the late 1960s, when international development agencies like UNCTAD became increasingly aware of the potential economic importance of foreign assembly operations, concerns were expressed about the construction of "factory ships" which were floating plants that (theoretically) had the capacity to move easily and quickly from country-to-country to take advantage of the most depressed wages, or most attractive financial incentives offered by governments. It was generally assumed that, if they were viable, factory ships would greatly limit any wage or other economic benefits for developing countries.

[22] Gereffi (1996) suggests that intra-Asian cultural and ethnic factors have played an important role in the spread of production sharing in the region and are at least partially responsible for the differences that exist in the assembly capacity of different countries.

Altogether, the results suggest the comparative advantage profiles of the 10 countries were generally relatively stable over this 11 year period, a point that suggests assembly operations are not as footloose as is sometimes thought.

Table 9. Correlation Coefficients for the 1996 RCA Profiles of East Asian Countries for All Parts and Component Products

1996 RCA Profile and Country	1996 RCA Profile for All Parts and Components Imports									
	China	Hong Kong	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan	Japan
China	1.000									
Hong Kong	0.674*	1.000								
Indonesia	-0.028	-0.103	1.000							
Rep. of Korea	-0.056	-0.037	-0.074	1.000						
Malaysia	0.040	0.170	-0.019	0.054	1.000					
Philippines	0.079	0.244	-0.048	0.030	0.825*	1.000				
Singapore	-0.087	0.055	-0.025	0.364*	0.463*	0.304*	1.000			
Thailand	0.284	0.375*	0.142	0.101	0.559*	0.502*	0.161	1.000		
Taiwan	0.289	0.215	0.155	-0.021	0.372*	0.350*	0.012	0.431*	1.000	
Japan	0.047	0.201	-0.151	-0.085	-0.002	-0.044	0.082	-0.104	0.251	1.000
1996 RCA Profile versus 1985 Profile**	0.518*	0.844*	0.131	0.105	0.838*	0.385*	0.604*	0.288	0.864*	0.578*

* Statistically significant at the 99 percent confidence level.
** China did not report SITC Revision 2 trade data to UN COMTRADE until 1987. Therefore, the correlation for this country compare 1987 and 1996 RCA profiles.

Source: Computed from the RCA statistics shown in Table 6.

V. CONCLUSIONS

Key Point

Two of this study's key findings are that production sharing in East Asia is considerably greater than is generally recognized, and these countries' comparative in production or assembly operations conforms to factor intensity theory. Even more important, however, is that the study demonstrates data sources are now available (including the newer harmonized system statistics) for empirical research and analyses of factors leading to the remarkable growth in, and location of, production sharing.

This analysis newer statistics on production sharing in East Asia shows this activity is of major importance to regional countries and that trade in components was growing at a far above average pace. These findings are consistent with an earlier study that detected well above global growth rates for components and estimated that trade in these goods may now account for as much as 30 percent of world trade in manufactures (Yeats 1997). The current study, however, extended the earlier investigation that factor intensities appear to be an important driving force behind the spread of this activity. Countries with relatively low wages generally have a higher and more extensive revealed comparative advantage in assembly operations (which are generally labor intensive in nature) while high wage countries like Japan generally have a stronger comparative advantage in the production of components.

A point which has, as yet, not been discussed concerns the implications of the existence of these data sources on production sharing (that is, the Revision 2 of the SITC and newer more detailed harmonized system (HS) statistics). Since the Rev. 2 data are now available for more than 100 countries, and often extend back as far as the mid-1970s, a rich source of empirical information exists for the empirical testing of

hypotheses relating to the causes, extent, and location of production sharing. Concerning this latter point, special mention should be made on the research potential of the United States trade statistics. The United States is one of a relatively few countries that tabulates and publishes statistics on freight costs for all imports, by product and by country of origin, so it should be possible to shipping costs influence the location of production sharing and the types of goods for which this activity is feasible (see Yeats 1981 for a further discussion of this data source and examples of studies that have employed it in analyses of international shipping costs).

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APPENDIX TABLES AND FIGURES

Appendix Table 1. Major Exporters and Importers of Parts and Components in 1996.

	Trade in Parts and Components			
	Imports		Exports	
Country	Value ($million)	Share of All Manufactures*	Value ($million)	Share of All Manufactures*
United States	102,141	17.4	114,672	29.6
Germany	52,109	18.1	74,161	19.3
United Kingdom	43,886	22.1	39,739	22.2
Canada	33,156	26.4	23,006	20.1
France	30,847	17.6	36,402	19.7
Singapore	26,524	26.3	23,558	24.2
Hong Kong	26,108	16.2	4,227	17.2
Japan	23,724	14.2	80,939	22.4
Malaysia	19,196	32.3	12,504	22.0
China	17,176	18.7	10,706	9.0
Mexico	16,776	25.2	12,878	18.2
Italy	16,663	14.9	27,835	13.5
Netherlands	16,451	17.0	14,258	16.9
Spain	16,089	21.5	9,839	13.9
Belgium	14,620	15.7	10,601	10.3
Thailand	14,252	28.8	7,838	20.7
Korea	13,888	16.6	11,917	11.3
Sweden	10,314	23.3	17,957	29.3
Philippines	10,235	42.6	3,570	21.4
Australia	7,831	17.3	2,585	22.0
Austria	7,738	16.0	6,915	15.0
Taiwan (China)	7,710	12.6	21,521	21.3
Brazil	7,315	23.7	3,351	15.1
Switzerland	7,225	12.9	8,768	16.2
Indonesia	6,644	27.0	1,767	7.4
Ireland	5,566	24.0	6,865	26.2
Saudi Arabia	4,673	26.4	14	1.0
Denmark	4,393	16.7	4,443	18.2
Norway	4,074	17.0	2,091	21.2
Portugal	4,050	18.6	1,193	6.4
Finland	3,721	19.6	6,012	19.2
Poland	3,653	15.9	1,347	8.3

*Excludes chemicals. Manufactures are defined here as SITC 6 through 8 less 68.

Source: Computed from UN COMTRADE statistics

Appendix Table 2. East Asian Countries 1996 Imports of their Ten Largest Parts and Component Products (US$ million)

SITC Rev. 2 – Description (components of)	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	Asia (10)
764 Telecommunications	5,416	10,420	1,724	3,070	3,024	1,917	5,333	1,759	1,217	7,098	40,978
759 Office Machines	2,375	4,990		1,301	2,883	1,637	7,955	2,315	785	6,439	30,680
776.89 Electronic Components	460	1,291		1,161	7,133	4,200	2,398	2,190	833		19,666
772 Switchgear	2,093	2,694	477	1,725	2,653	601	3,465	1,667	1,606	2,013	18,994
784 Motor Vehicles	1,103	843	1,359	1,245	381	300	917	3,063	1,136	1,633	11,981
792.9 Aircraft	498		180	698		138	1,343	586		609	4,052
728.49 Special Industry Machines	542			730	360	422	670		243	548	3,514
713.9 Piston Engines	427	565	135	597			386	484	216	368	3,177
744.9 Lifting Machines	420		436		167	89	740			317	2,169
785.39 Carriages and Cycles		386	638					249	315		1,589
714.9 Engines and Motors			153	404	196					1,006	1,759
771.29 Electrical Machinery		771			220						991
881.19 Still Cameras	420	519				145			138		1,222
743.9 Centrifuges and Filters				315	177				172		664
716.9 Rotating Electric Motors								193			193
885.29 Clocks and Watches		835				74					909
723.9 Construction Machinery							557				557
821.99 Other Furniture Parts										420	420
725.9 Paper Making Machinery			314								314
728.39 Mineral Working Machines			208								208
All Above Items	13,754	23,314	5,624	11,246	17,194	9,523	23,764	12,506	6,661	20,451	144,037
ALL COMPONENT IMPORTS	17,176	26,018	6,644	13,888	19,195	10,235	26,524	14,252	7,710	23,723	165,455
All Component Imports as a Percentage of All Imports	12.4	13.0	15.5	9.2	24.6	29.5	20.2	19.7	7.5	6.8	12.7

Source: United Nations COMTRADE statistics

Appendix Table 3. East Asian Countries 1996 Exports of their Ten Largest Parts and Component Products (US$ million)

SITC Rev. 2 – Description (components of)	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	Asia (10)
759 Office Machines	1,909	1,321	339	733	4,874	1,677	9,457	2,344	7,971	15,773	46,398
764 Telecommunications	4,688	1,081	724	4,404	3,968	931	6,159	1,530	4,005	14,941	42,431
772 Switchgear	1,500	675	117	909	1,583	253	2,471	971	2,755	10,423	21,657
784 Motor Vehicles	383		62	1,037		282	488	139	1,474	17,446	21,311
776.89 Electronic Components	127	196		396	761	131	1,307	418	241	4,333	7,910
713.9 Piston Engines										4,491	4,491
778.89 Electrical Machines, nes				2,605				118	962		3,685
785.39 Carriages and Cycles	368		120		127	20	295	217	1,288	1,574	4,009
792.9 Aircraft			30		198		384	557		848	2,018
728.49 Special Industry Machines				262	80		259			1,169	1,770
744.9 Lifting Machines			25	218			388			1,141	1,771
771.29 Electrical Machinery	135	151		132	114			107	346		984
885.29 Clocks and Watches	136	301			139	28		260			866
716.9 Rotating Electric Motors	177	37									214
743.9 Centrifuges and Filters									209		209
881.19 Still Cameras		117				27					144
821.99 Other Furniture Parts	196		184		108	119			235		842
723.9 Construction Machinery			22				487				508
775.89 Electrothermic Appliances		132		177							309
884.11 Unmounted Optics			32								32
All Above Items	9,619	4,011	1,655	10,875	11,952	3,468	21,695	6,661	19,486	72,139	161,559
ALL COMPONENT IMPORTS	10,706	4,227	1,767	11,917	12,504	3,570	23,558	7,071	21,521	80,939	177,780
All Component Imports as a Percentage of All Imports	7.1	15.4	3.5	9.2	16.0	17.4	18.8	12.6	18.6	19.7	15.3

Source: United Nations COMTRADE statistics

Appendix Table 4. The Relative Importance of Parts and Components Exports in Selected Regional Groups

Regional and Product Group (SITC)	Value of Parts and Components Exports ($million)			Share of Parts and Components In Product Group Exports (%)		
	1985	1990	1996	1985	1990	1996
EAST ASIA						
Power Generating Equipment (71)	2,604	4,499	8,994	44.2	35.9	37.9
Special Industry Machinery (72)	1,021	2,914	4,312	11.4	14.9	12.8
Metal Working Machinery (73)	464	641	1,569	13.6	9.7	12.1
General Industrial Machinery (74)	710	2,426	5,102	7.5	10.9	11.5
Office Machinery (75)	3,678	16,905	46,416	25.0	35.1	38.8
Telecommunications (76)	9,998	26,368	42,433	34.6	47.2	54.4
Electric Machinery (77)	5,840	13,206	36,476	22.6	21.0	19.9
Road Vehicles (78)	6,909	18,275	25,584	15.3	23.8	26.6
Other Transport Machinery (79)	394	1,080	2,357	3.1	9.5	10.1
Misc. Manufactures (8)	1,535	3,156	4,569	2.9	2.8	2.6
All Above Products	33,152	89,469	177,811	15.9	20.8	22.4
OECD EUROPE						
Power Generating Equipment (71)	6,696	16,749	24,023	38.2	40.3	40.9
Special Industry Machinery (72)	7,711	15,721	19,541	23.8	21.2	21.5
Metal Working Machinery (73)	1,509	3,826	4,622	20.1	19.8	22.0
General Industrial Machinery (74)	4,671	14,885	20,777	13.8	18.0	17.3
Office Machinery (75)	8,976	18,573	25,485	41.8	38.3	31.6
Telecommunications (76)	8,687	19,470	47,032	69.5	63.4	76.1
Electrical Machinery (77)	9,532	22,270	36,275	28.7	27.5	25.4
Road Vehicles (78)	18,342	45,468	64,142	27.6	27.4	27.0
Other Transport Machinery (79)	4,316	6,991	15,988	26.0	17.3	32.1
Misc. Manufactures (8)	1,936	5,424	8,068	2.2	2.7	2.9
All Above Products	72,376	169,377	265,952	22.0	21.4	23.2
NORTH AMERICA						
Power Generating Equipment (71)	7,412	10,382	14,179	57.4	50.1	44.6
Special Industrial Machinery (72)	4,657	6,039	10,478	40.2	36.1	36.7
Metal Working Machinery (73)	403	929	1,738	27.0	31.3	30.2
General Industrial Machinery (74)	1,360	4,671	7,608	15.3	24.2	21.3
Office Machinery (75)	7,555	11,921	21,877	45.6	42.6	44.6
Telecommunications (76)	5,628	9,426	25,085	83.9	87.2	77.8
Electrical Machinery (77)	3,666	9,596	16,424	24.5	29.4	21.3
Road Vehicles (78)	17,963	21,645	35,190	41.3	36.4	32.3
Other Transport Equipment (79)	5,806	11,273	13,540	34.8	31.8	35.0
Misc. Manufactures (8)	266	1,715	4,438	1.4	4.0	5.2
All Above Products	54,714	87,596	150,556	36.0	32.6	30.5

Source: Computed from UN COMTRADE statistics.

Appendix Table 5. The Revealed Comparative Advantage of East Asian Countries in Assembly Operations as Reflected in Their 1985 Import Statistics

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Steam boilers	2.62	2.70	2.17	1.08	0.26	4.27	1.64	2.48	0.22	0.01	0.35
Aircraft engines	90.02	1.19	3.24	0.09	6.41	0.69	4.15	0.29	0.00	0.10	0.11
Outboard motors	0.13	1.06	1.35	0.12	2.42	0.18	0.55	0.00	0.00	0.16	0.82
Outboard motors, nes	0.38	0.72	1.15	13.25	1.28	0.27	2.06	0.00	0.00	0.59	1.08
Combustion engines, nes	0.22	0.23	1.39	0.93	0.94	1.37	1.29	2.45	0.00	0.30	0.79
Engines and motors, nes	0.13	0.05	1.13	1.29	0.07	0.25	0.32	0.30	0.00	3.26	1.45
Rotating electric motors	2.00	0.99	3.06	1.27	1.21	1.58	1.06	0.00	0.00	1.12	0.93
Water turbines	0.39	0.00	22.58	0.29	0.53	1.35	0.12	0.05	0.00	0.32	0.89
Cultivating equipment	0.04	0.06	0.27	0.18	0.22	0.54	0.10	2.42	0.00	0.34	1.25
Harvesting machinery	0.46	0.00	0.12	0.56	0.30	0.16	0.05	0.03	0.00	0.21	1.34
Dairy machinery	0.05	0.12	3.34	0.24	0.16	1.36	0.08	0.02	0.00	0.27	1.74
Wine making machinery	12.57	0.00	10.92	0.19	2.81	6.96	0.26	0.58	0.00	0.26	1.47
Agricultural machinery, nes	0.50	0.13	0.62	0.05	0.39	0.58	0.11	0.07	0.00	0.10	0.91
Construction machinery	0.79	0.61	13.19	0.36	3.80	1.42	3.48	2.94	0.00	0.24	0.62
Spinning machinery	3.70	0.64	4.03	1.97	0.34	1.90	0.30	0.01	5.34	0.84	0.92
Looms and knitting machinery	1.48	1.23	1.77	0.63	0.61	3.36	0.21	3.68	0.97	1.61	1.01
Textile machinery, nes	1.70	1.13	0.84	0.35	0.86	1.04	0.15	0.80	0.00	0.19	1.50
Paper making machinery	1.18	0.08	1.21	0.48	15.02	1.34	0.06	2.59	0.00	0.66	1.14
Bookbinding machinery	0.09	0.17	0.24	0.06	0.79	0.42	0.20	0.04	0.00	0.69	1.27
Printing machinery	0.37	0.30	0.56	0.24	0.43	0.32	0.36	0.10	0.00	0.62	1.35
Grain milling machinery	0.30	0.09	12.06	0.25	0.96	10.67	0.31	0.25	0.00	0.08	0.98
Food processing machinery	0.87	0.30	2.99	0.23	0.45	4.42	0.29	2.96	0.00	0.42	1.34
Machine for special industries	0.43	0.37	3.51	0.42	1.00	3.35	0.65	0.00	0.00	0.61	1.14
Mineral working machinery	0.45	0.35	2.56	0.25	1.74	2.82	0.74	0.00	0.00	0.15	0.92
Special industry machines, nes	1.88	0.52	6.15	0.91	2.74	16.22	0.61	2.63	0.00	0.97	1.19
Machines for metal working	0.67	0.20	1.28	0.68	0.63	1.06	1.07	0.66	0.75	0.79	1.02
Foundry equipment	6.97	0.19	3.03	0.56	1.02	4.06	0.62	2.73	0.00	0.64	0.94
Rolling mill parts	4.44	0.08	2.63	1.64	0.84	37.98	0.14	0.80	0.00	0.36	1.39
Refrigerating equipment	6.78	0.89	1.83	0.13	1.49	1.03	1.49	0.99	0.00	0.57	1.50
Pumps for liquids	0.57	0.22	5.06	0.82	0.71	2.50	1.34	1.16	0.00	0.86	1.04
Centrifuges and filters	0.52	0.33	1.07	0.72	0.89	2.52	1.31	2.08	0.00	2.21	1.54
Fork lift trucks	0.25	0.15	0.28	0.69	0.41	2.33	0.28	0.12	0.56	0.08	1.11
Lifting and loading machines	1.01	1.34	1.73	0.80	1.11	1.80	0.91	0.00	0.00	0.72	1.17
Power hand tools	0.11	0.10	7.88	0.25	1.75	1.08	0.72	0.22	0.00	0.50	1.07
Packing machinery	0.58	0.34	0.66	0.52	0.66	3.29	0.32	0.58	0.00	0.52	1.58
Non-electric machinery, nes	0.33	0.23	1.10	0.98	1.39	2.75	0.82	0.57	1.03	0.93	0.61
Office and adding machinery	0.34	1.03	0.19	0.44	0.32	0.26	1.68	1.14	1.01	1.04	1.41
Telecommunications equipment	1.64	1.33	1.13	1.51	1.77	1.23	1.43	1.94	1.50	0.77	0.70
Electric power machinery	1.17	2.32	1.24	3.44	3.28	3.27	1.24	0.00	2.29	0.23	0.70
Switchgear	0.43	0.87	1.30	1.45	1.88	1.47	2.18	3.75	2.49	1.16	1.09
Domestic electrical equipment	1.04	2.90	0.85	0.08	0.52	0.84	0.30	1.34	0.00	0.45	1.04

Appendix Table 5. Continued

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Electrothermic appliances	0.23	1.95	0.22	0.00	1.07	0.33	2.73	0.67	0.00	0.08	1.62
Electronic components, nes	0.37	1.32	0.80	10.46	27.88	23.62	8.77	0.02	0.00	0.26	0.98
Electronic accumulators	0.06	0.74	3.72	0.26	2.28	2.37	0.46	0.37	0.07	0.20	0.00
Electric lamps and bulbs	0.11	0.47	2.62	1.95	0.50	4.24	0.80	1.62	0.41	0.24	0.00
Electrical machinery, nes	1.80	1.73	4.12	2.72	0.25	21.19	0.01	2.79	3.20	1.18	0.00
Motor vehicles and accessories	1.37	0.14	0.40	0.26	0.20	0.41	0.25	1.23	0.45	0.18	1.02
Carriages and cycles	1.05	0.42	3.56	0.50	1.04	1.05	0.63	4.99	5.26	0.38	1.04
Non-motor vehicles	0.07	0.04	0.14	0.11	0.94	0.10	0.34	0.41	0.67	0.07	0.00
Railroad vehicles	1.58	0.47	0.88	0.64	0.25	1.26	0.06	1.00	0.43	0.35	0.93
Aircraft	0.83	0.35	1.55	1.22	0.61	1.48	1.49	0.22	0.09	1.47	0.92
Chairs	0.01	0.07	0.37	0.34	0.46	0.11	0.57	0.32	0.00	1.41	0.00
Other furniture	0.20	0.90	0.30	0.64	0.52	0.05	1.06	0.00	0.20	1.54	0.00
Drawing machinery	0.61	0.07	6.95	0.78	1.69	0.47	0.44	1.03	0.00	1.25	0.00
Still cameras, nes	1.71	4.77	0.34	3.11	4.72	3.26	0.57	0.58	7.93	1.40	0.59
Cameras under 16mm	0.33	0.02	1.48	0.06	1.16	0.09	4.90	0.00	0.00	0.00	0.98
Cameras under 16mm, nes	0.41	0.93	0.95	0.36	0.79	0.39	0.85	0.13	0.00	1.26	0.53
Unmounted optical elements	0.12	1.50	0.09	0.76	0.53	0.14	1.20	0.51	0.90	2.66	0.98
Clocks and watches	19.54	19.87	0.13	6.98	1.79	3.92	1.98	6.14	2.27	0.61	0.20
Umbrellas and canes	2.26	5.22	1.91	2.26	2.67	6.71	2.94	8.00	0.04	3.76	0.37
MEMO ITEM											
RCA Index for All Components	1.07	0.75	1.38	1.15	1.81	1.99	1.33	1.55	0.87	0.74	0.95
Number of Product Groups with An RCA Index Over Unity	23	17	39	16	26	40	22	23	10	15	29

* See Table 1 for the SITC Revision 2 classification number of each component product group

Source: Computed from United Nations COMTRADE Statistics

Appendix Table 6. The Revealed Comparative Advantage of East Asian Countries in the Production of Components as Reflected in Their 1985 Export Statistics

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Steam boilers	0.03	0.00	0.00	0.42	0.19	0.03	0.09	0.01	0.02	2.97	1.66
Aircraft engines	0.03	0.00	0.00	0.05	7.35	0.00	3.21	0.19	0.00	0.03	7.00
Outboard motors	0.05	1.32	0.00	0.00	0.03	0.06	0.68	0.00	0.00	5.40	0.00
Outboard motors, nes	0.19	0.00	0.00	0.01	0.11	0.00	1.76	0.00	0.00	2.00	0.00
Combustion engines, nes	0.08	0.13	0.00	0.06	0.04	0.03	0.71	0.10	0.00	0.96	1.97
Engines and motors, nes	0.01	0.00	0.00	0.33	0.13	0.00	0.09	0.00	0.00	0.09	3.36
Rotating electric motors	0.14	0.31	0.03	0.16	0.12	0.00	2.57	0.00	0.00	0.99	1.85
Water turbines	0.63	0.00	0.00	0.00	0.12	0.00	0.17	0.10	0.00	0.74	1.14
Cultivating equipment	0.40	0.01	0.00	0.17	0.06	0.00	0.03	0.02	0.00	0.08	2.26
Harvesting machinery	0.14	0.00	0.00	0.00	0.02	0.02	0.07	0.01	0.00	0.13	2.45
Dairy machinery	0.00	0.00	0.00	0.00	0.02	0.45	0.03	0.00	0.00	0.30	0.93
Wine making machinery	0.68	0.00	0.00	0.00	1.18	0.00	0.03	0.00	0.00	0.52	0.00
Agricultural machinery, nes	0.17	0.00	0.00	0.00	0.03	1.06	0.17	0.66	0.00	0.01	1.01
Construction machinery	0.03	0.00	0.04	0.03	0.99	0.01	3.42	1.57	0.00	0.22	4.78
Spinning machinery	0.52	0.02	0.00	0.03	0.02	0.00	0.88	0.00	0.03	0.68	1.20
Looms and knitting machinery	0.56	0.16	0.00	0.20	0.01	0.00	0.11	0.17	0.34	0.62	0.51
Textile machinery, nes	0.14	0.24	0.00	0.04	0.05	0.03	0.08	0.00	0.00	0.25	0.98
Paper making machinery	0.00	0.00	0.00	0.05	0.08	0.00	0.04	0.00	0.00	0.36	1.31
Bookbinding machinery	0.01	0.00	0.00	0.06	0.01	0.00	0.59	0.00	0.00	0.06	1.65
Printing machinery	0.01	0.05	0.00	0.01	0.09	0.00	0.22	0.04	0.00	0.17	2.25
Grain milling machinery	0.44	0.00	0.00	0.01	0.18	0.00	0.86	0.20	0.00	0.25	0.00
Food processing machinery	0.15	0.00	0.00	0.01	0.14	0.00	0.04	0.07	0.00	0.11	0.00
Machine for special industries	0.01	0.00	0.00	0.13	0.07	0.01	0.21	0.00	0.00	0.16	3.32
Mineral working machinery	0.19	0.00	0.00	0.06	0.43	3.05	0.24	0.00	0.00	0.30	1.28
Special industry machines, nes	0.37	0.11	0.00	0.03	1.05	0.04	0.98	0.22	0.00	0.48	0.57
Machines for metal working	0.15	0.02	0.00	0.04	0.08	0.01	0.65	0.08	0.49	0.39	1.66
Foundry equipment	0.11	0.00	0.00	0.00	0.74	0.00	0.01	0.31	0.00	2.87	0.00
Rolling mill parts	0.07	0.01	0.00	0.02	0.11	0.00	0.62	0.00	0.00	2.03	0.26
Refrigerating equipment	0.07	0.04	0.00	0.13	0.12	0.06	0.37	0.03	0.00	0.86	0.00
Pumps for liquids	0.04	0.01	0.00	0.06	0.28	0.03	0.66	0.03	0.00	0.40	2.48
Centrifuges and filters	0.03	0.05	0.00	0.02	0.13	0.00	1.10	1.14	0.00	0.62	0.44
Fork lift trucks	0.02	0.02	0.00	0.81	0.09	0.00	0.18	0.01	0.01	0.57	2.54
Lifting and loading machines	0.11	0.02	0.00	0.10	0.35	0.09	0.42	0.00	0.00	0.48	1.16
Power hand tools	0.03	0.00	0.00	0.00	0.14	0.00	0.66	0.00	0.00	0.46	2.81
Packing machinery	0.00	0.01	0.00	0.01	0.04	0.02	0.05	0.01	0.00	0.12	1.53
Non-electric machinery, nes	0.10	0.06	0.02	0.05	0.22	0.00	1.61	0.00	0.88	0.82	0.97
Office and adding machinery	0.05	2.10	0.00	0.28	0.24	0.01	1.98	0.93	0.37	0.62	2.87
Telecommunications equipment	0.33	1.47	0.16	0.77	1.40	0.25	1.72	0.05	1.34	1.75	1.16
Electric power machinery	0.13	10.98	0.01	0.47	1.95	0.00	1.30	0.00	2.59	0.96	0.56
Switchgear	0.14	0.56	0.00	0.18	1.17	0.63	4.41	8.21	0.82	0.92	1.16
Domestic electrical equipment	0.62	1.86	0.00	0.12	0.16	1.45	0.51	0.06	0.00	0.43	2.13

Appendix **Table 6. *Continued***

Component Product Group*	China	Hong Kong	Indonesia	Rep. of Korea	Malaysia	Philippines	Singapore	Thailand	Taiwan, China	Japan	USA
Electrothermic appliances	0.16	4.45	0.00	0.00	0.32	0.03	1.05	0.02	0.00	1.79	1.59
Electronic components, nes	0.07	0.88	0.13	0.78	18.40	3.71	9.67	0.00	0.00	1.77	2.27
Electronic accumulators	0.09	0.03	0.17	0.18	0.11	0.19	0.40	1.89	0.67	0.13	1.65
Electric lamps and bulbs	0.15	0.16	0.01	0.10	0.02	0.34	0.04	0.14	1.43	0.31	1.18
Electrical machinery, nes	0.12	1.09	0.00	0.07	0.25	0.00	0.14	0.98	10.55	0.29	0.00
Motor vehicles and accessories	1.59	0.00	0.00	0.08	0.02	0.45	0.17	0.10	0.30	0.76	2.00
Carriages and cycles	1.27	0.00	0.14	0.25	0.05	0.00	0.60	0.36	4.45	2.86	0.10
Non-motor vehicles	0.02	0.00	0.00	0.68	0.14	0.00	0.13	0.00	0.43	0.05	0.62
Railroad vehicles	0.24	0.00	0.00	0.19	0.02	0.00	0.01	0.09	0.01	0.57	2.03
Aircraft	0.10	0.00	0.04	0.11	1.72	0.01	0.97	0.05	0.01	0.06	4.50
Chairs	0.22	0.01	0.11	0.07	0.27	0.31	0.22	0.28	0.00	0.09	0.00
Other furniture	0.72	0.60	0.98	0.20	0.51	43.80	0.32	0.00	12.92	0.04	0.00
Drawing machinery	0.04	0.08	0.00	0.12	0.13	0.00	0.28	0.01	0.00	1.06	0.00
Still cameras, nes	0.05	1.75	0.02	0.45	1.36	0.00	0.46	0.05	1.52	3.53	0.84
Cameras under 16mm	0.20	0.00	0.00	0.11	14.51	0.00	8.08	0.00	0.00	2.84	0.24
Cameras under 16mm, nes	0.11	0.01	0.00	0,09	6.17	0.00	0.30	0.63	0.00	0.16	2.61
Unmounted optical elements	0.11	0.28	0.00	0.23	0.54	3.41	2.39	4.91	0.50	0.73	1.84
Clocks and watches	27.41	11.52	0.00	0.36	3.40	0.20	1.10	4.91	1.45	1.62	0.24
Umbrellas and canes	1.76	1.80	0.00	0.13	0.21	0.57	0.52	0.22	20.67	0.13	0.05
MEMO ITEM											
RCA Index for All Components	0.65	0.69	0.04	0.25	0.84	0.66	1.42	1.01	0.64	0.87	2.05
Number of Product Groups with An RCA Index Over Unity	4	10	0	0	12	6	15	6	9	13	35

* See Table 1 for the SITC Revision 2 classification number of each component product group

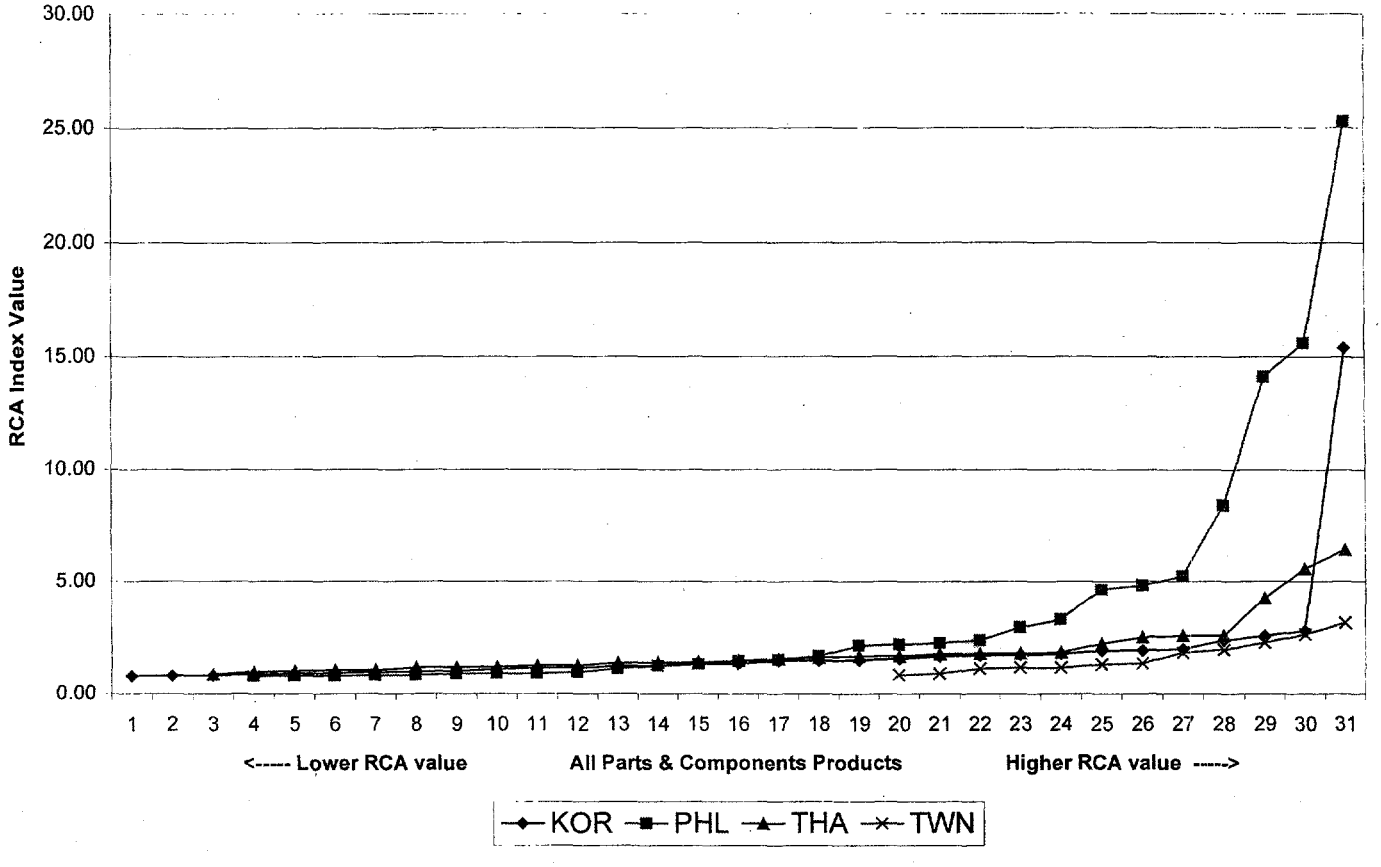
Source: Computed from United Nations COMTRADE Statistics

Appendix Table 7: Average Tariff Rates of Parts and Components in East Asia and Other Major Countries (Unweighted in %)

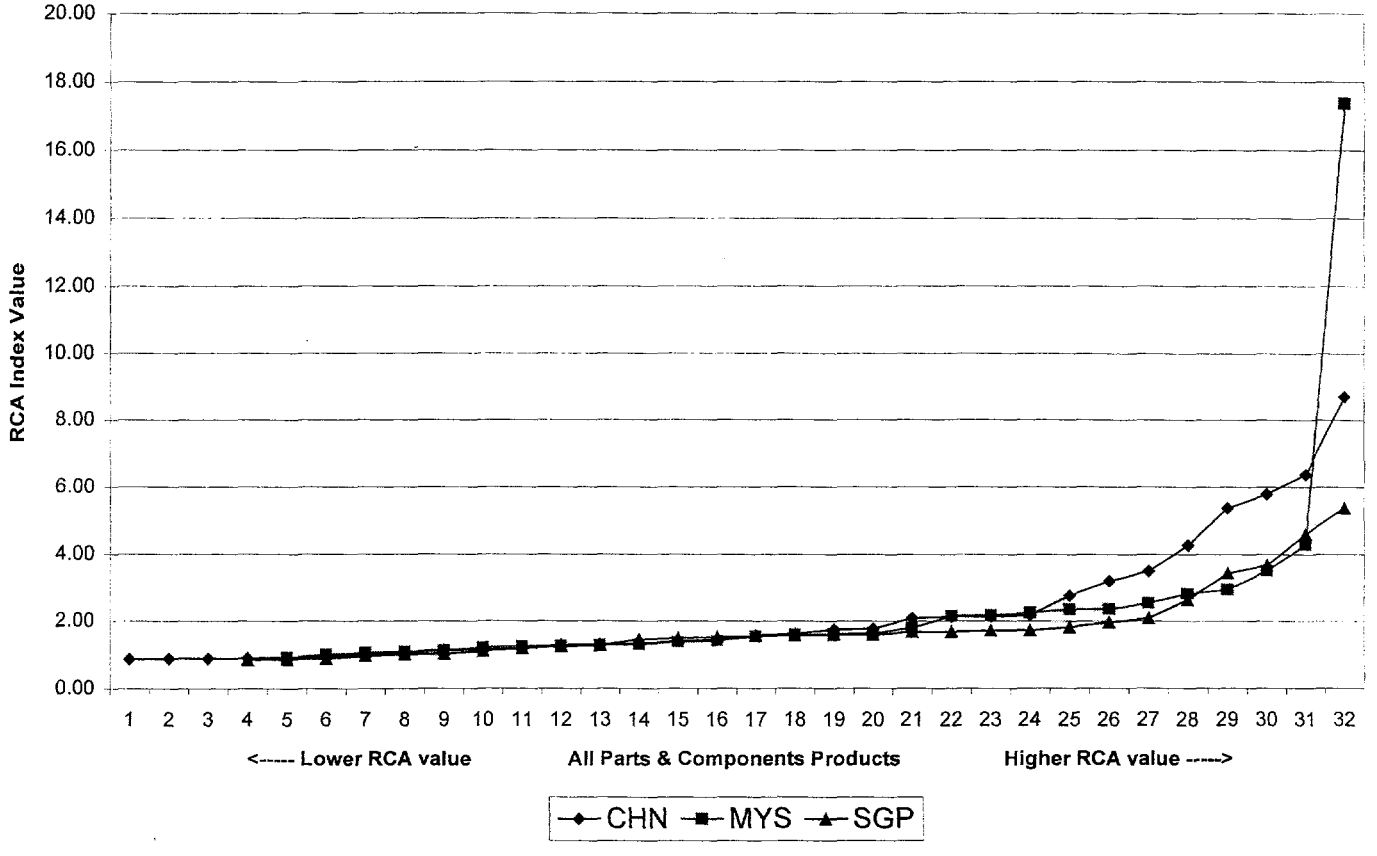
Commodity SITC Rev. 2	CHN (95)	HKG (95)	IDN (94)	KOR (96)	MYS (96)	PHL (96)	SGP (95)	THA (95)	TWN (95)	JPN (95)	USA (96)
7119 PTS NES OF APP OF 711	N.A.	0.0	21.7	8.0	3.3	3.0	0.0	10.0	N.A.	0.0	6.2
71319 PTS NES OF ENGN OF 71311	N.A.	0.0	0.0	5.0	0.0	3.0	0.0	22.5	N.A.	0.0	0.0
71331 PTS OF OUTBOARD	N.A.	0.0	2.5	8.0	0.0	3.0	0.0	20.0	N.A.	0.0	0.0
71332 PTS OF OTH THAN OUTBOARD	N.A.	0.0	11.7	8.0	0.0	3.0	0.0	20.0	N.A.	0.0	0.0
7139 PISTON ENGINE PARTS NES	N.A.	0.0	5.0	7.7	15.0	10.0	0.0	16.7	N.A.	0.0	2.2
7149 ENGINE & MOTOR PARTS NES	N.A.	0.0	2.0	6.5	0.0	3.0	0.0	5.0	N.A.	0.0	1.4
7169 PTS NES OF ROT ELEC PLNT	N.A.	0.0	5.0	8.0	6.3	3.0	0.0	10.7	N.A.	0.0	3.8
71889 PARTS NES OF 71881,71882	N.A.	0.0	2.8	4.5	0.0	3.0	0.0	20.0	N.A.	0.0	1.7
72119 PTS NES OF MACHY OF 7211	N.A.	0.0	5.0	8.0	0.0	20.0	0.0	12.5	N.A.	0.0	0.0
72129 PTS NES OF MACHY OF 7212	N.A.	0.0	5.0	8.0	0.0	6.5	0.0	5.0	N.A.	0.0	1.2
72139 PTS NES OF MACHY OF 7213	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	0.0
72198 PTS NES OF MCHY OF 72191	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	2.5
72199 PTS NES OF MCHY OF 72197	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	0.0
7239 CONSTR ETC MACHY PTS NES	N.A.	0.0	4.4	8.0	1.1	6.4	0.0	5.0	N.A.	0.0	1.8
72449 PTS NES OF MACHS OF 7244	N.A.	0.0	5.0	6.9	0.0	3.0	0.0	5.0	N.A.	0.0	3.7
72469 LOOM,KNT MCH ETC PTS NES	N.A.	0.0	5.0	8.0	0.0	5.3	0.0	10.0	N.A.	0.0	3.8
72479 TEXTILE MACHINRY PTS NES	N.A.	0.0	10.0	8.0	13.8	3.0	0.0	25.0	N.A.	0.0	1.3
7259 PTS NES OF MACHS OF 725	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	1.3
72689 PTS NES OF BOOKBIND MCHS	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	2.2
7269 PTS NES OF MCH OF 7263/7	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	2.0
72719 PTS NES OF MCHY OF 72711	N.A.	0.0	20.0	8.0	0.0	6.5	0.0	5.0	N.A.	0.0	2.1
72729 PTS NES OF MCHY OF 72722	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	1.6
72819 PTS NES OF TOOLS OF 7281	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	1.9
72839 PTS NES OF MACHY OF 7283	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	1.7
72849 PTS OF MACHS OF 7284 ETC	N.A.	0.0	8.8	8.0	0.8	3.0	0.0	5.0	N.A.	0.0	2.5
7369 PTS NES OF TOOLS OF 736	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	3.0
73719 PTS NES OF MCHY OF 73711	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	0.0
73729 ROLL-MILL PTS NES, ROLLS	N.A.	0.0	2.5	8.0	5.0	3.0	0.0	5.0	N.A.	0.0	2.9
74149 PTS NES OF REFRIG EQUIPT	N.A.	0.0	15.0	8.0	5.0	11.5	0.0	15.0	N.A.	0.0	2.3
7429 PTS NES OF PUMPS OF 742	N.A.	0.0	5.0	8.0	5.0	5.3	0.0	5.0	N.A.	0.0	1.5
7439 PTS NES OF APP OF 7435/6	N.A.	0.0	10.0	8.0	5.0	3.0	0.0	11.7	N.A.	0.0	1.5
74419 PTS NES OF VEHC OF 74411	N.A.	0.0	5.0	8.0	5.0	3.0	0.0	25.0	N.A.	0.0	0.0
7449 PTS NES OF MACHY OF 7442	N.A.	0.0	9.3	8.0	0.0	3.0	0.0	8.8	N.A.	0.0	0.9
74519 PTS NES OF TOOL OF 74511	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	13.3	N.A.	0.0	1.5
74523 PACKING ETC MCHY PTS NES	N.A.	0.0	5.0	8.0	12.5	16.5	0.0	5.0	N.A.	0.0	2.3
74999 MACH PARTS NONELEC NES	N.A.	0.0	7.5	8.0	1.7	11.5	0.0	12.5	N.A.	0.0	5.0
759 OFFICE,ADP MCH PTS,ACCES	N.A.	0.0	15.0	7.6	1.4	3.0	0.0	17.5	N.A.	0.0	1.3
764 TELECOM EQPT,PTS,ACC NES	N.A.	0.0	14.5	8.0	12.2	10.8	0.0	16.3	N.A.	0.0	4.7
77129 PTS NES OF MACHY OF 771	N.A.	0.0	4.2	8.0	0.0	3.0	0.0	16.0	N.A.	0.0	1.5
772 SWITCHGEAR ETC,PARTS NES	N.A.	0.0	12.7	8.0	14.7	11.2	0.0	9.1	N.A.	0.0	4.6
77579 PTS NES OF EQUIP OF 7757	N.A.	0.0	20.0	8.0	25.0	30.0	0.0	30.0	N.A.	0.0	3.5
77589 ELECTRTHRMC APPL PTS NES	N.A.	0.0	10.0	8.0	10.0	11.5	0.0	20.0	N.A.	0.0	1.6
77689 ELECTRNIC COMPON PTS NES	N.A.	0.0	0.0	8.0	0.0	3.0	0.0	0.2	N.A.	0.0	0.0
77819 ELEC ACCUMULATOR PTS NES	N.A.	0.0	17.5	8.0	23.3	30.0	0.0	20.0	N.A.	0.0	4.5
77829 PTS NES OF LAMPS OF 7782	N.A.	0.0	7.1	8.0	0.0	11.5	0.0	20.0	N.A.	0.0	3.4
77889 ELEC PARTS OF MACHY NES	N.A.	0.0	20.0	8.0	0.0	20.0	0.0	20.0	N.A.	0.0	2.3
784 MOTOR VEH PRTS,ACCES NES	N.A.	0.0	66.3	8.0	17.9	14.5	0.0	43.5	N.A.	0.0	1.7
78539 PARTS,ACCES NES OF 785	N.A.	0.0	26.4	8.0	14.3	20.0	0.0	25.0	N.A.	0.0	4.7
78689 PTS NES OF TRAILERS ETC	N.A.	0.0	30.0	8.0	23.9	20.0	0.0	40.0	N.A.	0.0	2.9
79199 PARTS NES OF 7911/7915	N.A.	0.0	0.0	5.0	0.0	3.0	0.0	5.0	N.A.	0.0	3.0
7929 AIRCRAFT PARTS NES	N.A.	0.0	0.0	0.0	0.0	3.0	0.0	5.0	N.A.	0.0	0.0
82119 PTS NES OF CHAIRS ETC	N.A.	0.0	40.0	8.0	30.0	30.0	0.0	40.0	N.A.	1.3	2.2
82199 OTHR FURN,FURN PARTS NES	N.A.	0.0	23.3	8.0	17.5	20.0	0.0	40.0	N.A.	0.0	2.4
87429 PTS NES OF INST OF 87421	N.A.	0.0	5.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	5.9
88119 PTS NES OF APPAR OF 8811	N.A.	0.0	5.0	8.0	0.0	10.0	0.0	20.0	N.A.	0.0	5.8
88121 -- FOR FILM UNDER 16MM	N.A.	0.0	30.0	8.0	0.0	3.0	0.0	5.0	N.A.	0.0	4.0
88129 PTS NES OF APPAR OF 8812	N.A.	0.0	30.0	8.0	0.0	3.0	0.0	20.0	N.A.	0.0	5.6
88411 OPTICAL ELMNTS UNMOUNTED	N.A.	0.0	6.0	8.0	5.0	3.0	0.0	8.3	N.A.	0.0	5.7
88529 CLOCK,WATCH PARTS NES	N.A.	0.0	10.0	8.0	0.0	20.0	0.0	12.0	N.A.	0.0	6.6
89949 PARTS NES OF 89941/89942	N.A.	0.0	34.0	8.0	17.0	10.0	0.0	25.0	N.A.	6.4	4.2
All Above Parts & Components Average	N.A.	0.0	11.0	7.7	4.9	7.9	0.0	13.6	N.A.	0.1	2.5
All Machinery & Transport Equipment Average (SITC 7)	N.A.	0.0	18.7	7.6	12.9	9.5	0.0	14.6	10.4	0.1	3.1

Source: WTO, IDB CD-ROM statistics.

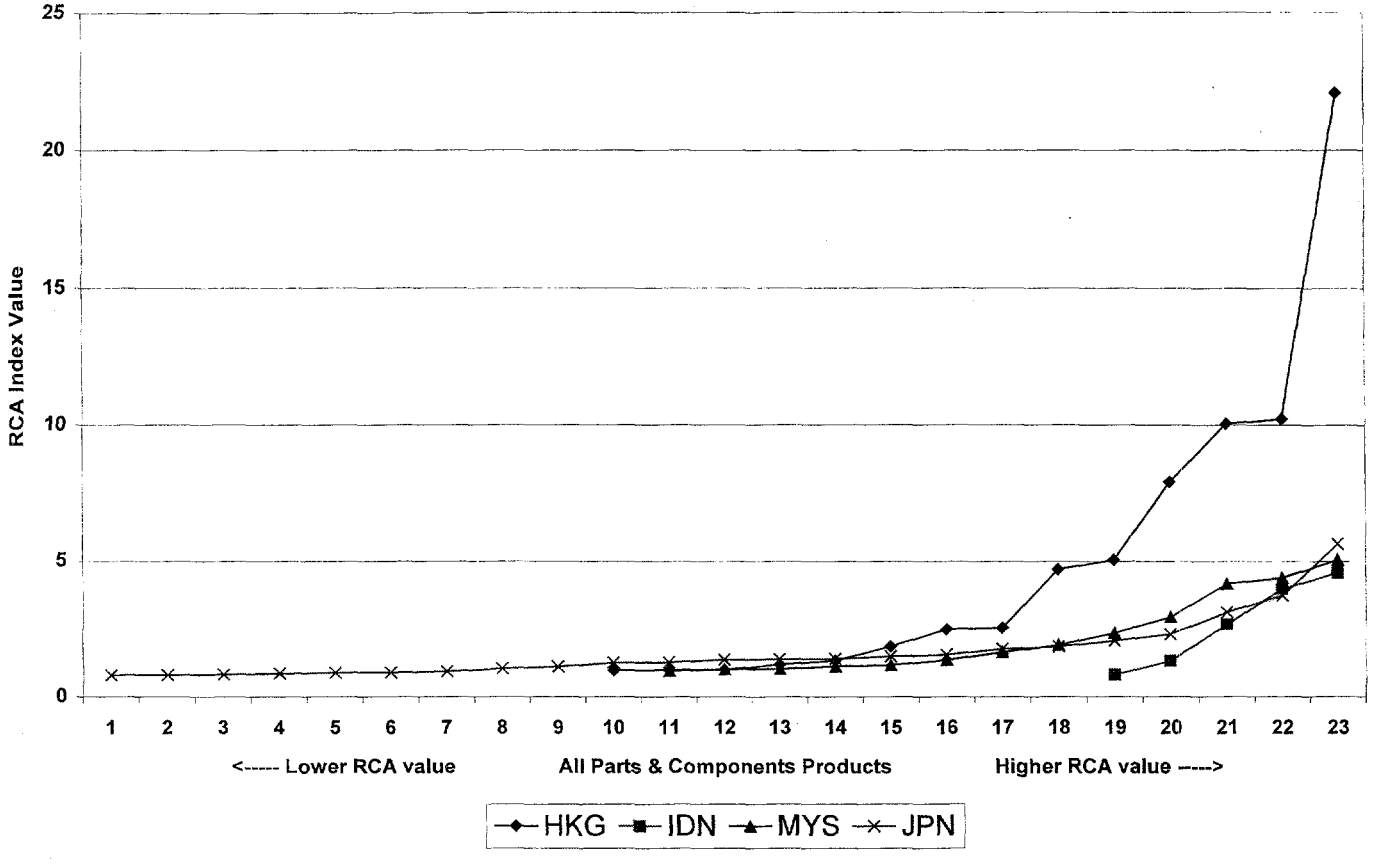
Appendix Figure 1: The Relative Maturity of Korea, Philippines, Thailand and Taiwan's 1996 Import RCA Indices



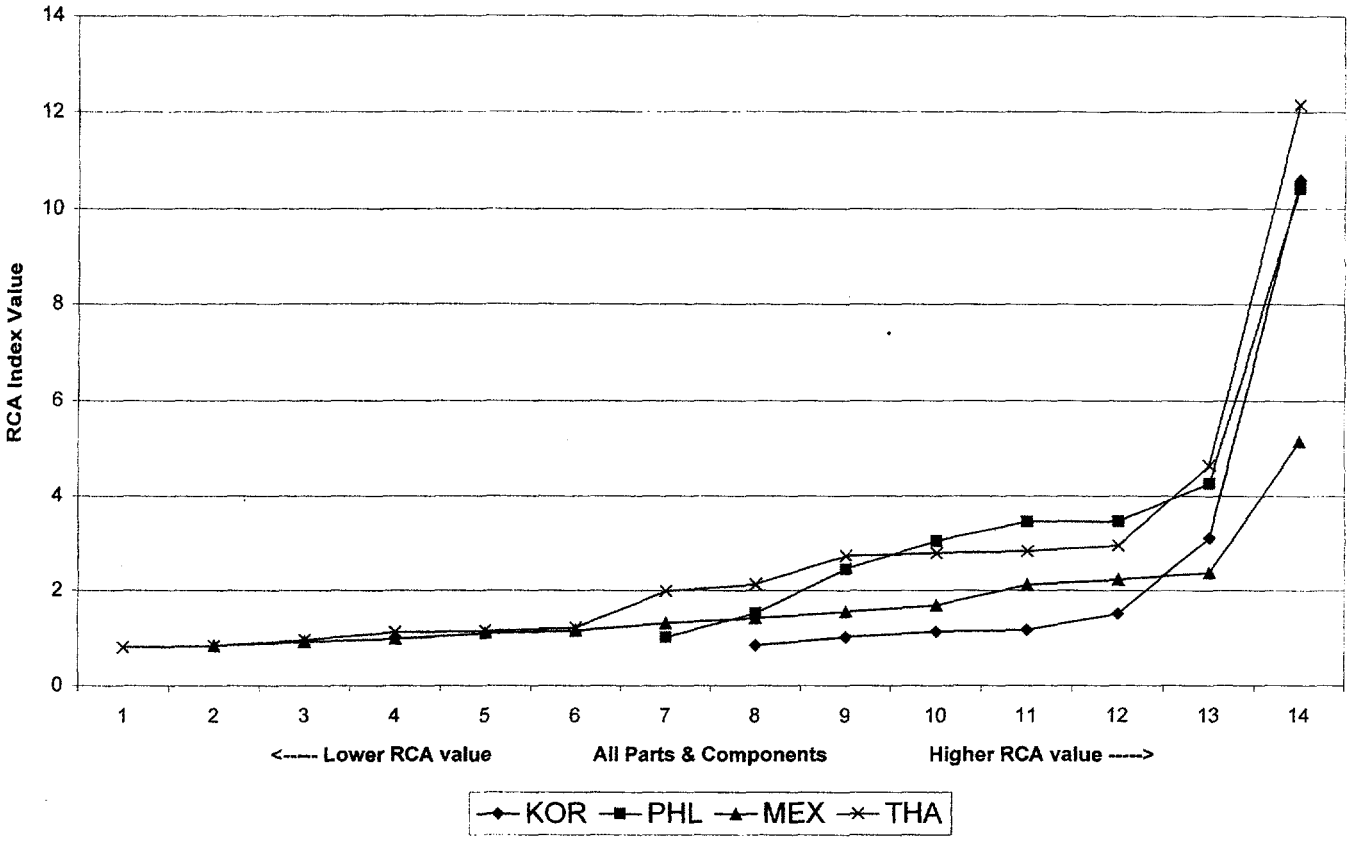
Appendix Figure 2: The Relative Maturity of China, Malaysia and Singapore's 1996 Import RCA Indices



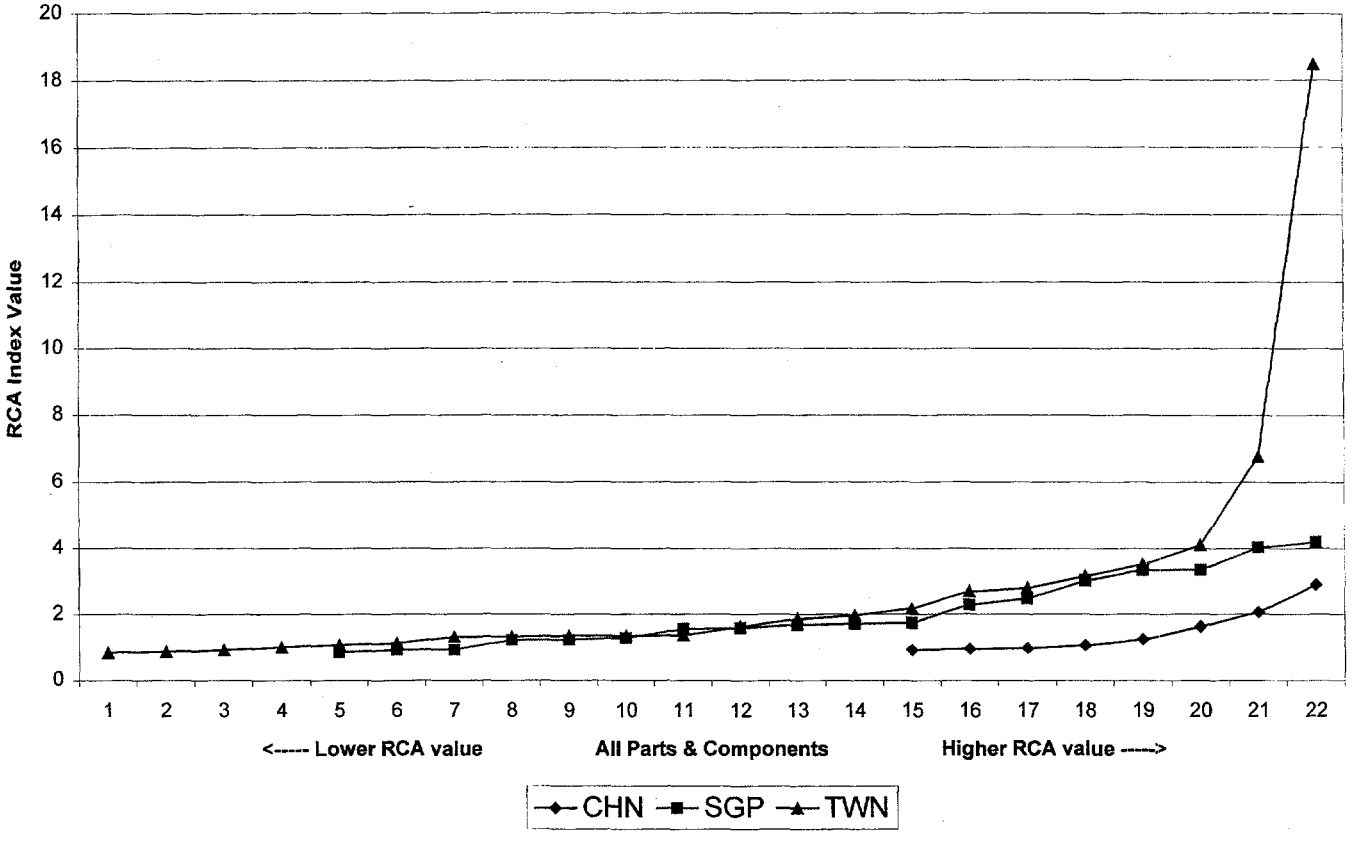
Appendix Figure 3: The Relative Maturity of Hong Kong, Indonesia, Malaysia and Japan's 1996 Export RCA Indices



Appendix Figure 4: The Relative Maturity of Korea, Philippines, Thailand and Mexico's 1996 Export RCA Indices



Appendix Figure 5: The Relative Maturity of China, Singapore and Taiwan's 1996 Export RCA Indices



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