Production Sharing and Comparative Advantage: The Cases of East Asia and Mexico*

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Abstract: The industrial structures and strategy of the country, which exports parts and components, seem to have a significant effect on the pattern of production sharing of the country where assembly takes place. In the case of some East Asian countries, the pattern and the competitiveness in the assembly of final products strongly depends on the industrial structure and production sharing strategy of Japan. However, the relationship between Mexico and the United States seems to be completely different in that the pattern of production sharing of the first has little relationship with the export pattern of the second of parts and components. This difference may be explained through the difference between the United States and Japan in terms of the pattern of production sharing. Japan's production sharing is based on specialization, whereas the production sharing of the United States is based on intra-industrial trade.

Keywords: production sharing, parts and components, revealed comparative advantage.

Resumen: La estructura y estrategia industrial del país que exporta partes y componentes, tiene un efecto significativo sobre el patrón de producción compartida en los países que ensamblan estos bienes. En el caso de algunos países del este asiático, el patrón y la competitividad en el ensamble de los bienes finales depende fuertemente de la estructura industrial y estrategia de producción compartida de Japón. Sin embargo, la relación entre México y Estados Unidos es totalmente diferente en el sentido de que el patrón de producción compartida del primero tiene poca relación con el patrón de exportación de partes y componentes por parte del segundo. Esto se debe a que la estrategia de producción compartida de Estados Unidos es diferente a la de Japón.

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La estrategia de producción compartida de Japón se basa en la especialización, mientras que la de Estados Unidos se basa en comercio intra-industrial.

Palabras clave: producción compartida, partes y componentes, ventaja comparativa revelada.

I. Introduction

Production sharing is a specific kind of specialization in trade. Each country specializes not only in particular goods, but also in the specific processes within the whole production process of a certain goods. A typical form of production sharing can be found in the assembly, in developing countries, of the parts or intermediate inputs produced by industrialized countries. Production sharing has been on the increase in recent years, especially in East Asian and some Latin American countries.

Mexican *Maquiladora* industry shows a unique kind of production sharing which handles the goods imported for re-export in a special way; *Maquiladora* program allows the import of raw materials and equipments without tariffs. The equipments must be used for the purpose of setting up the manufacturing plants, which will produce final products or components that would be exported mainly to the United States. When final products are exported to the United States, tariffs are paid only on the value that has been added to those products by Mexican labor. Parts and components are exported to factories in the United States, where they are assembled into final products.

Production sharing occurs mostly because of the difference between developing and industrialized countries in terms of wage. In general, the production of parts and components is capital-intensive, while their assembly is labor intensive. However, the combination of industries that utilizes production sharing varies across countries. One important determinant of the pattern may be the wage in developing countries. But even if the wage is low in most developing countries, it is not the same across countries, as the wage in some developing countries may be ten times as high as that of other developing countries. Considering that countries with similar level of wage do not necessarily exhibit the same pattern of production sharing, wage does not seem to be the sole determinant

of the production sharing pattern. For example, Mexico has a production sharing pattern which is completely different from that of any Asian country. For most countries, Revealed Comparative Advantage (*RCA*) indices for imports, which reflect the pattern of production sharing, show relatively stable patterns in the medium run. Then, if countries with the similar level of development show different patterns of import *RCA*, what can possibly cause this difference?

Although domestic variables, such as wage, availability of skilled labor, infrastructure, and so forth, have a strong effect on the possibility of a certain country's engaging in the assembly of some products, there are other important factors to consider. One significant aspect may be found in the industrial structure and strategy of the country that is exporting the necessary parts and components to the assembling country, which could be a neighboring industrialized country. In the case of Korea and Malaysia, the possibility of participation in production sharing and its competitiveness in the assembly of final products will strongly depend on the industrial structure and production sharing strategy of Japan. In the case of Mexico, the industrial pattern of production sharing may have a close relationship with the production sharing strategy of the United States.

The purpose of this paper is to analyze the factors that determine the pattern of production sharing in East Asian countries and Mexico. The pattern of production sharing and the comparative advantage in the assembly of final products in East Asian countries and Mexico may be influenced by the industrial structures and production sharing pattern of Japan and the United States respectively. For the analysis, we compare the industrial pattern of production sharing of East Asian countries and that of Mexico. Our analysis then will show that the pattern of production sharing in Mexico and that of East Asian countries exhibit different behaviors. The pattern of production sharing in Mexico is not significantly influenced by the production sharing strategy of the United States, while the pattern of production sharing in East Asian countries are heavily affected by the production sharing strategy of Japan.

The organization of this paper is as follows: first, we describe the nature of the data sources on production sharing and assess their usefulness and limitations for empirical studies. Second, we calculate the *RCA* indices of the East Asian countries, which measure

the comparative advantages in parts production or assembly within the production sharing. Finally, by analyzing the correlation between the *RCA* indices of the parts-importing countries and those of the parts-exporting countries, we investigate whether the pattern of production sharing in developing countries is influenced by the comparative advantages of parts-exporting countries.

II. Background

Production sharing is defined as the internationalization of a manufacturing process in which several countries participate in different stages in the manufacturing of specific goods. This process is of considerable economic importance, since it allows each stage production to be located where it can be undertaken most efficiently at the lowest cost (Yeats, 1998). One typical form of production sharing can be seen in the assembly, in developing countries, of the parts or intermediate inputs produced by industrialized countries. Production sharing has been on the constant increase; industrialized countries can remain competitive in an increasingly price-sensitive market and maintain consistent quality standards in a high-volume environment, and on the other hand, developing countries can benefit from increased employment, technology transfer and direct foreign investment, and thus improve the standard of living (Helio, 1998).

Japan, for example, exports parts and components for vehicles, telecommunication devices and electronics to other East Asian countries, where they can be assembled taking advantage of the lower wage. Thailand, the Philippines and Malaysia are the main countries in which assembling operation is quite well developed in coordination with Japan. In case of North America, *Maquiladora* in Mexico presents the most representative form of production sharing. Production sharing in East Asia and North America has significantly contributed to improving the competitiveness of the firms involved, as well as the increased employment and technology transfer in the countries where the assembly takes place.

Production sharing in Mexico's *Maquiladora* has also contributed to enhancing the comparative advantage of Mexico in assembling operation, especially in electronic machinery, electronic material and accessories, vehicles and telecommunication devices among others. According to Ng and Yeats (1999), Mexico shows high

import *RCA* indices across most parts and components, and therefore can be classified as a mature country in which wide assembling operation has been carried out. The success of these assembly operations is partly due to the Mexico's *Maquiladora* program, which allows *Maquiladora* to import on a duty free basis, machinery, equipment, material, parts and components, and other items necessary for the assembly of finished goods for subsequent export. This program, together with lower wage, stable labor supply and geographical proximity has allowed Mexico to attract direct foreign investment from many corporations in the United States.

Until recently, the literature on production sharing mostly contains theoretical research rather than empirical studies due to the lack of the adequate data that distinguish parts from final products. Theoretical research has focused on the trade of intermediate inputs and the source of comparative advantages. Sanyal (1983) built a model with a continuum of stages of intermediate products. What causes trade in his model is the difference in the production technology. Some countries have comparative advantages in the earlier stage of production and others in the later. Each country specializes in some stage of production and the only way to change this pattern of specialization is the change in technology. In Kim (2001), trade in intermediate products takes place because of the difference in factor endowment. The equilibrium is determined by an interaction between the transportation cost and the cost of processing the intermediate input to a higher stage. In Dixit and Grossman (1982), the intermediate product at a higher stage is produced from one unit of lower stage intermediate product, and capital and labor that can be substituted for each other.

As more data have become available recently, a few empirical studies have been conducted. Yeats (1998), by using the SITC classification system (Revision 2), calculated the volume and share of global production sharing within key machinery and transportation equipment (SITC 7) group, which includes approximately 50 percent of world trade in all manufactures (Yeats 1998). The data has shown that over the last decade, trade in machinery and transportation equipment components has grown at a considerably faster rate than for final stage products in this group. Later on, he further developed the import *RCA*, in which he calculates an index of import share ratio with the UN data of SITC Revision 2 system in which the value of exports and imports of the

parts and components are provided. In his paper, he has applied and adjusted Balassa's *RCA* index, which determines whether a country has comparative advantage in the production of certain goods (the so-called export *RCA*); he has also calculated the import *RCA* indices, which reflect the degree of the global production sharing. According to Yeats (1998), the sharing of different stages of manufacturing processes among different countries is of major and growing importance, since some East Asian countries have a comparative advantage in either producing or assembling components. He has argued that by providing a stage approach for the analysis of Revealed Comparative Advantage Index Profiles, Indonesia, Thailand, and Malaysia have the broadest and the most mature capacity for components. In contrast, Singapore, Taiwan, and Japan were in the sunset stage (Ng and Yeats, 1998). However, he has focused more on the number of industries with comparative advantages than the industrial pattern of production sharing, and has not explained why countries with the similar level of development exhibit different patterns of the import RCA and what causes the difference.

III. Methodology and Data

III.1. Methodology

More than thirty years ago, Bela Balassa published a paper (Balassa, 1965), using for the first time, the 'revealed comparative advantage (*RCA*)' to measure the extent of an international trade specialization in different commodities. Since then the measure has been applied in numerous reports and academic publications as a measure of international trade specialization.

Traditionally, 'revealed' comparative advantage (*RCA*) indices have been computed using export statistics. The *RCA* shows whether a country has a comparative advantage in manufacturing a certain product. The revealed comparative advantage (*RCA*) index for country i in the production of product j has been defined as:

$$RCA_{ij}^{p} = \frac{x_{ij} / X_i}{x_{wj} / X_w} \qquad (1)$$

Where x_{ij} and x_{wj} represent the value of the product j exported by country i and by the world respectively. X_i and X_w are total exports by the country i and by 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 a product j. In contrast, if the *RCA* index is below one, the country is at a comparative disadvantage in the production of the said merchandise.

This paper employs a variant of equation (1) to identify countries that appear to have a comparative advantage in further upstream operation - that is, the assembly in the next stage of the manufacturing process. When the *RCA* indices are computed using import statistics for a given components product, the results should indicate whether a country has a comparative advantage in assembly operations (Balassa, 1965). Specifically, the revealed comparative advantage of country i in the assembly of product j is;

$$RCA_{ij}^{a} = \frac{m_{ij} / M_i}{m_{wj} / M_w} \qquad (2)$$

In the above formula, the m's represent imports, and all other notions correspond to the terms in equation (1). The reasoning behind this proposition is relatively straightforward. Parts and components typically have no general end use in themselves, but are used in the assembly of the final products that use them as intermediate inputs (Ng and Yeats, 1998). Therefore, it follows that countries with above average import shares for components have a comparative advantage in the assembly operation.

As RCA^{p} is calculated using export values and RCA^{a} using import values, let us call them the export *RCA* and the import *RCA* respectively. To draw meaningful implication from the calculations of the export *RCA* and the import *RCA*, we need to analyze the relationship between these two indices within a country and across countries at the same time.

Table 1. The 1999 Value and Share of East Asian Countries' Imports and Exports of Parts and Components in SITC Revision 3 Classification System

	SITC Revision 3-Description	*Import*		*Export*	
		Value	*Share*	*Value*	*Share*
7119	Parts of steam boilers and auxiliary plants	403795	0.29	454304	0.35
71319	Part of the aircraft engines	91821	0.07	82148	0.06
71331	Outboard motors	68487	0.05	797251	0.61
71332	Other spark-ignition reciprocating or rotary engine	11784	0.01	44369	0.03
7139	Parts of internal combustion engines, nes	2444945	1.76	4630529	3.57
7149	Parts of engines and motors, nes	2602659	1.88	1153295	0.89
7169	Parts of rotating electric motors	1818181	1.31	1246920	0.96
72119	Parts of cultivating equipment	21649	0.02	30522	0.02
72129	Parts of harvesting machinery	32046	0.02	47942	0.04
72139	Parts for milking machines and dairy machinery	11599	0.01	5686	0.00
72198	Part of the wine making machinery	2903	0.00	4261	0.00
72199	Parts of the other agricultural machinery, nes	25183	0.02	11604	0.01
7239	Parts of construction machinery	2127428	1.53	1779011	1.37
72449	Parts of spinning and extruding machinery	175714	0.13	204440	0.16
7259	Parts of paper making machinery	287904	0.21	77865	0.06
72689	Parts for bookbinding machinery	10682	0.01	5391	0.00
7269	Parts of printing and typesetting machinery	322512	0.23	176699	0.14
72719	Parts of grain n milling machinery	16959	0.01	13620	0.01
72729	Part for food processing machinery	59715	0.04	30635	0.02
72819	Parts of machine tools for special industry	172209	0.12	127676	0.10
72839	Parts of mineral working machinery	126289	0.09	112354	0.09
72849	Parts of machines for Special Industries	7701802	5.55	7625299	5.88
73719	Parts of foundry equipment	62084	0.04	44249	0.03
73729	Rolling mill parts	322811	0.23	338040	0.26
74149	Parts of refrigerating equipment	228262	0.16	299627	0.23
7429	Parts of pump for liquid	513152	0.37	523083	0.40
7439	Parts of centrifuges and filters	587552	0.42	437690	0.34

Table1. Conclusion...

	SITC Revision 3-Description	*Import*		*Export*	
		Value	*Share*	*Value*	*Share*
74419	Parts of folk lift trucks	24362	0.02	36915	0.03
7449	Parts of lifting and lodging machines	796530	0.57	789243	0.61
74519	Parts of power hand tools	82456	0.06	90244	0.07
74523	Machinery for cleaning, drying bottles	43614	0.03	2753	0.00
74999	Other machinery parts	524454	0.38	524465	0.40
759	Parts of Office and adding Machinery	33158080	23.90	26298739	20.26
764	Telecommunications Equipment	36165681	26.06	24188781	18.64
77129	Part of electric power machinery	2078479	1.50	1402390	1.08
772	Parts of switch gear	16536107	11.92	19908285	15.34
77579	Parts of domestic electric equipment	99321	0.07	105340	0.08
77589	Parts of electronic appliances	367898	0.27	375758	0.29
77689	Parts of electronic components, nes	16587014	11.95	5552033	4.28
77819	Parts of the electric accumulators	206431	0.15	197643	0.15
77829	Parts of electric lamps and bulbs	117429	0.08	43382	0.03
77889	Parts of electric machinery, nes	415820	0.30	731803	0.56
784	Parts of the motor vehicles	5873127	4.23	25377849	19.55
78689	Parts of the trailers and non-motor vehicles	75262	0.05	141185	0.11
79199	Parts of railroad equipment and vehicles	246516	0.18	225126	0.17
7929	Parts of aircraft and helicopters	4121640	2.97	2975630	2.29
82119	Parts of chairs	453724	0.33	354575	0.27
88121	Parts for cameras under 16mm	9210	0.01	39056	0.03
88411	Contact lenses	455176	0.33	169374	0.13
89949	Parts of umbrellas and canes	69435	0.05	33191	0.03
All above items		*138757893*	*100*	*129783445*	*100*
Memo Item: East Asia Trade					
All above parts and Components		138757893	25.44	129783445	16.82
Total East Asia import/export of SITC 7-8		545349165		771585890	

SOURCE: Computed from UN CONTRADE statistics.
East Asia: Japan, Hong Kong, the Republic of Korea, China, Singapore, Malaysia, Thailand, Indonesia and the Philippines.

III.2. Data

In its original form, the Standard International Trade Classification (SITC) system did a less adequate job of distinguishing between trade in terms of 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 2 system, which has 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 manufactured to be assembled were identified (Ng and Yeats, 1999).

It was not until early or mid 1980s that developing countries shifted to the SITC Revision 2 system. Recently the United Nations (henceforth, UN) provided the data according to the SITC Revision 3 system, in which 100 countries' export and import data are contained. The Revision 2 and the Revision 3 system is a little problematic because the data that were available in the SITC Revision 2 is no longer available in the SITC Revision 3 system. In this paper, we included 50 parts and components using from 3 to 5 digits even though Ng and Yeats (1999, oct.) analyzed 60 parts and components. Taiwan's data is not available any more, and therefore was excluded from the analysis.

Table 1 utilizes the UN statistics to examine the composition and relative importance of the individual component product groups in the East Asian trade. The table identifies each product by the SITC (Revision 3) number, provides a short description of the items, and also indicates the value and share of the East Asian aggregated imports and exports of all components (these totals include the combined trade of Japan, Hong Kong, the Republic of Korea, China, Singapore, Malaysia, Thailand, Indonesia, and the Philippines).

Overall, the share of all import and export of parts and components in those of all manufactures (SITC 7-8) in East Asia accounts for 25.44% of imports and 16.82 % of exports respectively, indicating the importance of parts and components in total East Asian trade. One thing to note in these statistics is that East Asian components trade is concentrated in a relatively few items. Specifically, five of the 50 SITC groups (SITC 72849, 759, 764, 77689) accounts for 79.38%

of imports (64.4% of exports), with parts of telecommunication equipment (SITC 764) alone accounting for more than one-quarter (26%) of this exchange.

IV. Empirical Analysis

In general, a large import of certain goods indicates the lack of competitiveness in the production of those particular goods, which is reflected in a low *RCA*. However, a large import of parts and components, although it is a sign of the lack of competitiveness in the production of the specific merchandise, can be interpreted as a strong competitiveness in the assembly or production of the final goods, which uses those parts or components as intermediate input. This reasoning follows from the fact that parts and components do not have other uses than for the assembly of the final product.

Generally speaking, the production of parts and components requires intensive technology and capital, whereas the assembly of those parts and components is labor-intensive. Therefore, industrialized countries have comparative advantages in the production of parts and components, while developing countries have comparative advantages in the assembly. Of course, the comparative advantages of developing countries may move from the assembly to the production of parts as they accumulate capital and technology.

As developing countries have comparative advantages in the assembly, they have large imports of parts and components, leading to a high import *RCA*. In contrast, industrialized countries have a high export *RCA* and a low import *RCA* in parts and components. Table 2 shows the import *RCA* and export *RCA* for the aggregate of 50 parts and components analyzed in this paper. China, Hong Kong, Indonesia, Malaysia, and the Philippines have import *RCA*'s higher than unity and export *RCA*'s lower than unity.

Japan has an export *RCA* slightly higher than unity and an import *RCA* lower than unity, which reflects its high comparative advantages in the production of parts and components and low comparative advantages in assembly. Korea seems to follow the pattern of Japan, losing its comparative advantages in assembly and gaining more advantages in the production of parts and components. Singapore and Mexico seem to maintain strong competitiveness in

Table 2. Import/Export RCA in East Asia, Mexico and USA

	Import RCA					*Export RCA*				
	1995	*1996*	*1997*	*1998*	*1999*	*1995*	*1996*	*1997*	*1998*	*1999*
China	1.36	1.22	1.21	1.35	1.30	0.55	0.60	0.61	0.67	0.77
Hong Kong	1.11	1.05	1.17	1.17	1.20	0.24	0.19	0.17	0.13	0.10
Indonesia	1.29	1.31	1.31	0.85	N/A	0.19	0.27	0.28	0.30	0.37
Korea	1.01	0.92	0.83	0.72	0.84	1.29	1.14	0.99	0.88	1.33
Malaysia	1.14	1.09	1.09	1.27	1.32	0.18	0.22	0.21	0.19	0.18
Philippines	1.25	2.63	2.87	3.26	1.89	0.59	1.53	1.55	1.41	0.71
Singapore	1.85	1.80	1.81	1.71	1.78	1.79	1.70	1.73	1.67	1.69
Thailand	1.81	1.78	1.81	1.54	1.60	1.06	1.20	1.37	1.56	1.53
Japan	0.52	0.59	0.61	0.66	0.66	1.13	1.00	1.04	0.94	0.95
Mexico	1.53	1.70	1.66	1.52	1.65	1.28	1.24	1.30	1.39	1.45
USA	1.69	1.69	1.74	1.66	1.64	1.09	1.08	1.10	1.01	0.93

both the production and assembly of parts and components. High *RCA*'s in both exports and imports may reflect the intra-industrial trade and active participation in production sharing. For example, Mexico is not only assembling automobiles with parts produced in the United States but is also supplying parts to the United States for the assembly of cars of different models. The United States, even if it is an industrialized country, seems to have a strategy for production sharing that is completely different from that of Japan. The export *RCA* of the United States, as well as its import *RCA*, is greater than unity. This result seems to follow from the following two facts: first, the foreign firms are producing final products in the United States by assembling imported parts and components to evade the non-tariff barriers as antidumping measures; second, intra-industrial trade is more important than inter-industrial trade for the United States.

The import *RCA* seems to be relatively stable in most countries. Ng and Yeats (1999) shows that *correlations between specific country's 1985 and 1996 RCA assembly profiles are often lightly significant* and suggests that it indicates that *these operations may not be as footloose as is sometimes suggested.* But this is not always the case. Table 3 shows the correlation coefficients between the import *RCA*'s of 1985, 1995, and 1999. We can see from the table that the countries that experienced the strongest change in the pattern of

import *RCA*'s, measured by the low correlation of import *RCA*'s between two distant years, are China, Korea, and Thailand. The industrial pattern of production sharing in China and Thailand stabilized in the late 1990's, but Korea's comparative advantages in production sharing seem to be continuously changing. The change in the pattern of production sharing may reflect the dynamism in structural changes and the gain of competitiveness in new industrial activities.

Table 3. Correlation coefficients between the import *RCA*'s of 1985, 1995 and 1999

Countries	*85-95*	*85-99*	*95-99*
China	-0.02	-0.05	0.75*
Hong Kong	0.81*	0.73*	0.93*
Indonesia	0.23	0.36*	0.87*
Korea	0.08	0.07*	0.31*
Malaysia	0.86*	0.86*	0.99*
Philippines	0.44*	0.54*	0.73*
Singapore	0.57*	0.57*	0.89*
Thailand	0.14	0.14	0.85*
Japan	0.58*	0.60*	0.93*
Mexico	N/A	N/A	0.81*

* Significant at the 0.05 level.

However, the pattern of production sharing varies among countries. Ng and Yeats (1999) shows that *cross correlation between East Asian countries' RCA indices often fail to achieve statistical significance.* They suggest that one possible explanation may be that location, 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.

However, in our view the pattern of production sharing in East Asian countries has similar characteristics, whereas that of Mexico does not. The pattern of production sharing of Mexico is completely different from that of most East Asian countries and even of those countries with similar wage or per capita GDP. Table 4 shows the bilateral correlation coefficient between the import *RCA* of each East Asian country and that of Mexico. A positive and significant correlation coefficient may be interpreted as a sign of the similarity in the pattern of production sharing.

As can be seen from the table, the correlation between any two of Malaysia, the Philippines, Singapore and Thailand is very high. In the case of Hong Kong, the only correlation that is statistically significant is the one with China. Korea seems to have a very different pattern when compared with other East Asian countries. However, the correlation of Korea's *RCA* with China's *RCA* showed an increase to a significant level in 1999. This increase may be due to the fact that Korea and China are very dynamic in the structural change and have recently gained competitiveness in similar sectors.

The correlation coefficient between the import *RCA* of Mexico and that of each of East Asian countries is very low and statistically insignificant in most cases, which indicates that the pattern of production sharing in Mexico is completely different from that of any East Asian country. The only exception is the correlation with Korea's import *RCA* in 1999, which is positive and significant, implying some convergence in the pattern of production sharing. Now the question arises why the pattern of production sharing varies and what causes the difference.

Table 4. Correlation coefficients for the 1995 and 1999 import *RCA* profiles of East Asian countries and Mexico

	China	*Hong Kong*	*Indonesia*	*Korea*	*Malaysia*	*Philippines*	*Singapore*	*Thailand*
Hong Kong	0.64*							
	0.38*							
Indonesia	0.11	-0.08						
	0.26	-0.16						
Korea	0.10	-0.11	0.01					
	0.53*	0.14	0.03					
Malaysia	-0.02	0.00	-0.10	0.06				
	-0.03	0.03	0.05	0.02				
Philippines	0.12	0.04	0.02	-0.01	0.62*			
	0.04	0.00	-0.10	0.11	0.92*			
Singapore	-0.05	0.06	-0.06	0.47*	0.55*	0.26		
	-0.07	0.06	0.10	0.10	0.33*	0.24		
Thailand	0.29*	0.21	0.08	0.04	0.78*	0.61*	0.41*	
	0.09	0.20	-0.17	0.19	0.91*	0.93*	0.29*	
Mexico	-0.07	0.04	-0.10	-0.15	-0.09	-0.07	-0.13	-0.11
	0.13	0.13	-0.06	0.44*	-0.11	0.02	-0.11	0.03

* Significant at the 0.05 level.

The reason seems to lie in the distinct suppliers of parts and components. For East Asian countries, Japan is the most important supplier of parts and components, whereas the United States is the main supplier for Mexico. Therefore, we would expect a high and positive correlation between the import *RCA* of East Asian countries and the export *RCA* of Japan, as well as between the import *RCA* of Mexico and the export *RCA* of the United States.

Ng and Yeats (1999) has estimated the correlation between the import *RCA* of Japan and that of other East Asian countries to see whether East Asian countries have a pattern of production sharing that is similar to that of Japan. However, in production sharing, Japan is the main exporter of parts and components, and therefore has a high export *RCA* rather than a high import *RCA*. As can be seen in Table 2, the overall import *RCA* of Japan in parts and components was 0.60, whereas its export *RCA* was 1.01 between 1995 and 1999. In contrast, Malaysia's import *RCA* and export *RCA* in the same period were 1.18 and 0.19 respectively. Therefore, it is only natural for Japan's import *RCA* not to be correlated with the import *RCA* of other East Asian countries. On the contrary, a negative correlation is expected if Japan imports types of parts and components that are distinct from those imported by some developing countries in East Asia.

Table 5 shows that the correlation coefficients between Japan's export *RCA* and East Asian countries' import•*RCA* are mostly positive but not always significant. The coefficients are statistically

Table 5. Correlation between East Asian countries' trade and Japanese trade

	Import with Japanese export					*Export with Japanese Import*				
	1995	*1996*	*1997*	*1998*	*1999*	*1995*	*1996*	*1997*	*1998*	*1999*
China	0.06	0.04	0.06	0.23	0.18	0.03	0.19	0.04	0.05	0.07
Hong Kong	0.02	0.03	0.02	-0.03	0.00	-0.05	0.02	-0.04	-0.07	-0.05
Indonesia	-0.02	-0.05	-0.10	-0.04	-	0.52*	0.21	0.85*	0.84*	0.81*
Korea	0.09	0.02	0.31*	0.16	0.34*	-0.07	0.01	0.03	0.02	-0.02
Malaysia	0.44*	0.43*	0.43*	0.30*	0.29*	-0.05	-0.15	-0.10	-0.15	-0.08
Philippines	0.19	0.36*	0.37*	0.33*	0.27	0.20	0.16	-0.01	-0.09	-0.10
Singapore	0.17	0.08	0.01	-0.02	-0.01	0.15	0.02	0.26	0.17	0.17
Thailand	0.41*	0.34*	0.39*	0.30*	0.29*	0.00	-0.03	-0.02	-0.03	0.00
Mexico	-0.06	0.11	0.15	0.13	0.16	0.04	0.14	-0.08	0.07	0.01
USA	0.28*	0.21	0.08	0.08	0.19	0.37*	0.10	0.24	0.24	0.26

* Significant at the 0.05 level.

significant for those countries in the middle-income range, such as Malaysia, the Philippines and Thailand, although all of these countries show a decline in the coefficients over time. For the case of Malaysia, the coefficient was 0.44 in 1995, but it decreased to 0.29 in 1999. In the case of Korea, the correlation coefficient was significant in 2 years out of the 5-year period. The correlation coefficients between the export *RCA* of Japan and the import *RCA* of other East Asian countries are not statistically significant. The correlation coefficients between Japan's export *RCA* and Mexico's import *RCA* were not statistically significant either. As for the case of the United States, the coefficient was positive, but statistically significant only in 1995.

When it comes to the import *RCA* of Japan, its correlation coefficients with the export *RCA* of most East Asian countries including China, Hong Kong, Korea, Malaysia, the Philippines, and Thailand are not statistically significant. One interesting point worth mentioning here is the positive and statistically significant correlation between the export *RCA* of Indonesia and the import *RCA* of Japan. The value of the correlation coefficient was over 0.80 in 1997 through 1999. This correlation implies that the types of parts and components exported by Indonesia are very similar to those imported by Japan; Japan imports labor-intensive parts and components in which Indonesia has comparative advantages. The export *RCA* of the United States also shows a positive correlation with the import *RCA* of Japan, which may imply its complementary relationship with Japan in the production of parts and components. However, in the case of Mexico, the coefficient was not statistically significant.

As shown above, the pattern of production sharing in East Asian countries seems to be influenced by the pattern of Japan. The regional characteristics of the production sharing may be related to the transportation cost; because of the geographical proximity and low transportation cost, Japan may prefer East Asian countries to Mexico or other Latin American countries for the assembly of parts and components produced domestically. Thus Japan would have a large share in East Asian countries' imports of parts and components.

The high correlation of the export *RCA* of Japan with the import *RCA*'s of some East Asian countries, and its low correlation with the import *RCA*'s of other East Asian countries and Mexico, can be explained by the share of Japan in each country's imports of parts

and components. In Table 5 we can see that Japan's share in the total imports of parts and components is very high for Korea, Malaysia, the Philippines and Thailand, although the trend is decreasing in most countries, which may account for the declining trend of the correlation coefficient shown in Table 5. Turning to a strange case found in Indonesia, Japan's share in Indonesia's import is very high, but still the correlation coefficient is statistically insignificant and negative.

Table 6. Japan's share in East Asian countries' import of parts and components

	1995	*1996*	*1997*	*1998*	*1999*
China	0.190	0.194	0.188	0.162	0.167
Hong Kong	0.174	0.143	0.123	0.117	0.120
Indonesia	0.422	0.314	0.371	0.246	N/A
Korea	0.345	0.320	0.317	0.301	0.313
Malaysia	0.459	0.398	0.372	0.266	0.267
Philippines	0.442	0.223	0.187	0.167	0.337
Singapore	0.173	0.139	0.141	0.126	0.125
Thailand	0.316	0.278	0.258	0.248	0.257
Total	0.261	0.222	0.207	0.172	0.198

The above-mentioned puzzling case of Indonesia seems to be due to the production sharing strategy of Japan. Japan may use the middle-income countries – Malaysia, the Philippines, and Thailand – as the assembly center of the main parts and components produced domestically. Korea may participate in the assembly of high-end parts, which is technology-intensive, and Indonesia in the assembly of low-end parts, which is labor-intensive. If this is the case, the parts assembled in Korea and Indonesia may not be the main parts exported by Japan, resulting in a low correlation coefficient between the export *RCA* of Japan and the import *RCA*'s of Korea and Indonesia.

Then, does the pattern of production sharing in Mexico reflect that of the United States? The answer seems to be negative.

In Table 7, it is shown that, against the expectation, the export *RCA* of the United States has negative and statistically insignificant correlation with the import *RCA* of Mexico. The relationship between the United States and Mexico seems to be completely different from the one between Japan and other East Asian countries. Table 7 also shows that the correlation between the

Table 7. Correlation between the US and Mexico trade *RCA*

	USA Export						*USA Import*				
	1995	*1996*	*1997*	*1998*	*1999*		*1995*	*1996*	*1997*	*1998*	*1999*
Mexico Import	-0.16	-0.12	-0.11	-0.01	0.01	Mexico Export	0.13	0.33*	0.16	0.08	0. 08

* Significant at the 0.05 level.

import *RCA* of the United States and the export *RCA* of Mexico is not statistically significant; even though the United States imports some labor-intensive goods from Mexico, the size of the economy of the United States is so large that it is not affected by a large amount of imports from a single country, *i.e.,* Mexico. Furthermore, the United States has diversified lines of import from all over the world.

The low correlation between the export *RCA* of the United States and the import *RCA* of Mexico was rather surprising given that the share of the United States in Mexico's import of parts and components is over 75%, as can be seen in Table 7. The share of any other country is lower than 10%. Then, why is the correlation coefficient so low if the share of the United States in Mexico's import is so high?

The answer can be found in the difference in the pattern of production sharing between the United States and Japan on one hand and the difference between the US-Mexico relationship and the relationship between Japan and other East Asian countries on the other. Table 9 shows that the share of East Asian countries in Japan's export of parts and components is very high, although it has been continuously decreasing in recent years. This implies that Japan heavily depends on other East Asian countries for the assembly of the parts and components produced domestically. The main pattern of Japan's production sharing consists of producing parts and components domestically and having them assembled in other East Asian countries, where the wage is relatively low. The share of developing countries in the imports of parts and components produced in Japan is over 70%.

Table 8. Share of main exporters of parts and components to Mexico

	1995	*1996*	*1997*	*1998*	*1999*	*1995-99*
1. USA	0.740	0.759	0.756	0.777	0.767	0.763
2. Germany	0.052	0.053	0.053	0.058	0.056	0.055
3. Japan	0.084	0.059	0.060	0.043	0.044	0.055
4. Canada	0.010	0.019	0.021	0.018	0.022	0.019
5. Taiwan	0.017	0.016	0.013	0.015	0.014	0.015
6. Korea	0.008	0.010	0.010	0.011	0.014	0.011
7. France	0.018	0.011	0.010	0.011	0.009	0.011
8. Sweden	0.004	0.004	0.007	0.006	0.015	0.008
9. China	0.005	0.005	0.008	0.007	0.009	0.007
10. Malaysia	0.011	0.008	0.008	0.006	0.004	0.007

Table 9. The share of East Asian countries in Japan's export of parts and components

Destination	*1995*	*1996*	*1997*	*1998*	*1999*
China	10.5	11.3	11.6	12.9	14.0
Hong Kong	10.7	9.3	10.7	11.2	9.5
Indonesia	4.7	4.1	4.0	1.7	N/A
Korea	11.5	11.3	9.9	6.3	8.9
Malaysia	9.4	9.0	8.8	7.7	7.5
Philippines	2.1	6.1	7.6	8.2	4.5
Singapore	11.4	11.2	10.4	8.7	9.0
Thailand	11.4	12.2	8.8	5.4	6.4
Total	**71.6**	**74.6**	**71.7**	**62.1**	**59.8**

This pattern does not apply to the case of the United States. As shown in Table 10, the main destinations of the exports of parts and components by the United States are industrialized countries, such as Canada, Japan, the United Kingdom, Germany, and so forth. Canada's share is over 23%, while Mexico's share is only about 12% although it is the second largest importer of these products. More importantly, Mexico is the only developing country ranked within five largest importers of parts produced in the United States.

Table 10. Share of main importers of parts and components from the US

Destination	*1995*	*1996*	*1997*	*1998*	*1999*	*1995-99*
1. Canada	0.235	0.232	0.224	0.230	0.246	0.233
2. Mexico	0.104	0.106	0.117	0.125	0.131	0.118
3. Japan	0.077	0.085	0.077	0.076	0.074	0.078
4. UK	0.059	0.057	0.059	0.063	0.065	0.061
5. Germany	0.046	0.044	0.038	0.039	0.043	0.042
6. France	0.034	0.033	0.033	0.033	0.034	0.033
7. Korea	0.039	0.038	0.034	0.021	0.027	0.031
8. Singapore	0.031	0.034	0.030	0.027	0.027	0.030
9. Brazil	0.022	0.025	0.031	0.031	0.028	0.028
10. Netherlands	0.023	0.022	0.027	0.028	0.030	0.027

This reflects the difference between the United States and Japan in the pattern of production sharing; the production sharing of Japan is based on specialization, whereas the production sharing of the United States is based on intra-industrial trade. As can be seen in Table 11, the correlation between the import *RCA* and the export *RCA* is negative in the case of Japan, while it is positive in the case of the United States. A positive correlation indicates that the country imports similar kinds of parts and components it exports, and therefore reflects inter-industrial trade. Negative correlation implies that the country imports types of parts that are different from those it exports, and reflects specialization.

Table 11. Correlation coefficient between the import *RCA* and the export *RCA*

	1995	*1996*	*1997*	*1998*	*1999*
Japan	-0.24	-0.20	-0.18	-0.14	-0.15
USA	0.10	0.01	0.20	0.27	0.25

As the general scheme of the production sharing of the United States is based on intra-industrial trade, its production sharing with Mexico, which is mostly based on specialization due to the wage gap, is not representative of the production sharing strategy of the United States. On the contrary, the production sharing between Japan and other East Asian countries is representative of the production sharing scheme of Japan that is based on specialization.

V. Conclusion

Mexico has a pattern of production sharing which is very different from that of some East Asian countries. It seems that although wage is an important determinant of the pattern of production sharing, there are other significant factors that also affect this pattern. The industrial structures and strategy of the country, which exports parts and components, seem to have a significant effect on the pattern of production sharing of the country where assembly takes place. In the case of some East Asian countries, the pattern and the competitiveness in the assembly of final products would strongly depend on the industrial structure and

production sharing strategy of Japan. In the case of Mexico, the industrial pattern of production sharing may have a close relationship with the pattern of production sharing of the United States.

However, the relationship between the United States and Mexico seems to be completely different from the one between Japan and some East Asian countries. The correlation between the export *RCA* of the United States and the import *RCA* of Mexico is not statistically significant, whereas the correlation between the export *RCA* of Japan and the import *RCA* of some East Asian countries is positive and statistically significant. This difference may be explained through the difference between the United States and Japan in terms of the pattern of production sharing. Japan's production sharing is based on specialization, whereas the production sharing of the United States is based on intra-industrial trade. Since the United States realizes production sharing by intra-industrial trade, its production sharing with Mexico, which is based on specialization due to the wage gap, is not representative of the production sharing scheme of the United States. On the contrary, the production sharing between Japan and other East Asian countries is representative of the production sharing scheme of Japan that is based on specialization.

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Cyclic Pricing by a Durable Goods Monopolist: Corrigendum

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Abstract: In this paper we make a new analysis of the model presented in Conlisk, Gerstner and Sobel (1984). They propose a model in discrete time, such that at each period a new cohort of agents enters the market —each cohort is composed by two types of agents, high value and low value agents— and a monopolist offering a durable good. They argue that in this model the monopolist charge a cyclic price path as a subgame perfect equilibrium. Instead of this, we show that either the monopolist charge a single price forever as a subgame perfect equilibrium or a subgame perfect equilibrium does not exist.

Keywords: Durable goods, monopolist, heterogenous agents, subgame perfect equilibrium.

Resumen: En este trabajo hacemos un nuevo análisis del modelo presentado en Conlisk, Gerstner y Sobel (1984). Ellos proponen un modelo en tiempo discreto, tal que en cada periodo entra una nueva generación de agentes —cada generación está compuesta de dos tipos de consumidores, los de valoración alta y de valoración baja— y un monopolista ofreciendo un bien durable. Ellos argumentan que el monopolista cargará una senda de precios cíclica como un equilibrio perfecto en subjuegos. En vez de esto, nosotros probamos que o bien el monopolista carga un precio fijo como equilibrio perfecto en subjuegos, o bien no existen equilibrios perfectos en subjuegos.

Palabras Clave: Bienes durables, monopolista, agentes heterogéneos, equilibrios perfectos en subjuegos.

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