Primary Information Sector Services and Foreign Trade: Evidence from Korea and Japan*

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Industrialized economies and Newly Industrializing Countries are increasingly information intensive. To some, this heralds 'deindustrialization', to others it indicates a new stage in economic development, i.e. the advent of the global information economy. The paper contributes to this debate by exploring the trade involvement of primary information sector services in Japan and Korea. Empirical evidence of direct and total exports of such services and their future prospects, is discussed. We then explore the hypothesis that purchased information services are a statistically significant determinant of comparative advantage and export involvement of manufacturing sectors. This test is only partly successful. Although useful for some other analytical purposes, our information services variable is likely to be too heterogeneous for fruitful trade analysis.

I. Introduction

There is increasing realization that trade in services is linked to trade in manufactured goods. Grubel, for example, proposes a taxonomy of services trade which has two main components: i) direct trade and ii) embodied trade. He argues that most trade in services falls into the second category. This leads him to conclude that the growth of services sectors and decline of manufacturing sectors observed in advanced economies is not a sign of "deindustrialization" and loss of competitiveness. Rather, it is a precondition for comparative advantage in manufacturing industries which themselves have become increasingly services intensive.[1] Others take a similar position, arguing that because services are a complement rather than a substitute for merchandise trade, countries with large mer-

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*The author is grateful for comments provided by an anonymous referee.
[1]See Grubel (1987).

chandise trade defictis, e.g. the US, cannot realistically expect a compensatory surplus in directly exported services. Merchandise and services trade move in tandem.[2]

The present study contributes to the debate on services trade. It is an empirical analysis of the trade involvement of a sub-group of services, i.e. primary information sector services, in Japan and Korea in 1980.[3] Both economies have been among the most successful over the last decades, and their success is widely acknowledged to be associated with their trade performance. They are well suited as case studies for assessing the degree of information services trade and for testing the hypothesis that the use of purchased information services as intermediate inputs is a determinant of comparative advantage in manufacturing industries.[4] The rapid expansion of information services sectors in Korea from the mid to late 1970s has been demonstrated elsewhere.[5] Moreover, in Korea as well as in Japan, some information services sectors seem to have a high growth potential and a low degree of policy conflict for simultaneously achieving output, income and employment objectives.[6] Further analysis indicates that in both economies, purchased information services are underused in manufacturing industries. Also, the relative underuse seems larger in Korea than in Japan, indicating that economic policies promoting the development of information services industries might be more urgent in Newly Industrializing Countries (NICs) than in developed countries (DCs).[7] These findings are similar to those obtained by an increasing number of analysts who point out the importance, if not pivotal role, of information services industries for economic development and foreign trade.[8]

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[2]Landefeld (1987) and Rada (1987). Grubel (1987) goes so far to argue that there is no valid distinction between trade in goods and in non-factor services. This has important implications for trade policy. If free trade in goods also implies free trade in non-factor services, there is no need for a separate "services" GATT.

[3]For a discussion of the definition of "information sector", of which primary information sector services are a part, see, e.g., Engelbrecht (1985).

[4]It has to be emphasized at the outset that the analysis covers only part of the total amount of information services produced and consumed in an economy. Many information services are provided "in-house", i.e., they are not purchased from outside the company. The test of the hypothesis that *total* information services use is an important determinant of comparative advantage has to await further research.

[5]Engelbrecht (1986a, 1987a).

[6]Engelbrecht (1986a, 1986b).

[7]See Engelbrecht (forthcoming).

[8]See, for example, Feketekuty and Aronson (1984), Riddle (1987), Rada (1987), and Tucker and Sundberg (1986).

However, there is a dearth of empirical studies assessing the relationship between the use of information services, exports and comparative advantage.

The paper is organized as follows. First, we focus on the information services *producing* sectors and discuss their size and direct trade involvement. Then, estimates of total, i.e., direct plus indirect, information services exports are presented. Secondly, we focus on the information services *using* manufacturing sectors. The degree of information services "embodiment" in manufacturing output is measured, and sectoral as well as inter-country differences are discussed. Finally, we attempt an empirical test to establish whether purchased information services are a statistically significant determinant of comparative advantage in manufacturing.

II. The Information Services Producing Sectors

A. Direct Exports and Imports

The information services sectors included in the analysis comprise sectors 8 communication, 9 finance and insurance, 10 real estate services, 11 business services, 12 other information services and 13 education and research (see Table 1). Most of these sectors are not identical to those shown in the published input–output (I / O) tables. Their derivation has been discussed elsewhere.[9] Table 2 presents comparative summary data on the size of the six sectors in Japan and Korea in 1980.[10] Data for Korea in 1975 were also available and are included for comparative purposes. The contribution of

[9]The I / O databases used in this study were derived to measure and analyze the so-called primary information sector (*PRIS*) of Japan and Korea (see Engelbrecht 1986a, b). This sector comprises, first, goods and services which intrinsically convey information or which are directly useful in its production, processing and distribution and which, secondly, are transacted on established markets (OECD 1981, p. 34). The sector includes certain activities conventionally classified as "manufacturing", i.e., high-tech sectors like electronics and computer industries, as well as many "service" sectors (see Table 1). Some *PRIS* sectors are easily identifiable from published I / O tables. However, many are lumped toether with non-information activities. Therefore, the published I / O tables were "taken apart" and rearranged (see Engelbrecht 1986a, b; Karunaratne 1986).

[10]One might aruge that a comparison of the size of services sectors of countries at different levels of economic development is misleading because of the well-known "splintering" effect of services during the process of economic development (see Bhagwati 1984). However, this argument is less likely to apply to information services, and more typically to personal non-information services (Rada 1987). Moreover, Japan and Korea have similar types of economies, i.e., both have attained an advanced industrial structure.

TABLE 1
SECTOR CODE OF REARRANGED INPUT-OUTPUT TABLES

Primary information sector

1 Printing, publishing, paper & paper products
2 Office machinery-supplies-furniture & repairs
3 Electronic and communication equipment, including parts
4 Precision instruments & apparatus
5 Other informational manufactures (machinery & products)
6 Information infrastructure construction
7 Distribution of information goods & services (wholesale & retail trade)
8 Communication
9 Finance and insurance
10 Real estate services
11 Business services
12 Other information services
13 Education and research

Manufacturing

14 Food, beverages & tobacco
15 Textiles, clothing, leather products
16 Wood, wood products & furniture
17 Paper, paper products
18 Chemical, rubber, petroleum & coal products
19 Non-metallic mineral products
20 Basic metal products
21 Fabricated metal products
22 General industrial machinery & parts
23 Electrical machinery
24 Transport equipment
25 Miscellaneous manufacturing

Others

26 Services
27 Trade and transport
28 Agriculture, fishery and forestry
29 Mining and quarrying
30 Utilities
31 Construction
32 Undistributed

TABLE 2
SIZE OF INFORMATION SERVICES SECTORS
(AS PERCENT OF TOTAL ECONOMY)

Country	Year	Value Added	Output	Final Demand	Employment
Japan	1980	16.7	10.7	9.8	13.3
Korea	1980	15.1	8.6	9.6	9.9
Korea	1975	10.7	6.4	7.2	6.1

Source: Calculated from rearranged input-output tables.

TABLE 3

EXPORT AND IMPORT SHARES OF INFORMATION SERVICES SECTORS
(IN PERCENT)

Japan (1980)		Korea (1980)		Korea (1975)	
Exports	Imports	Exports	Imports	Exports	Imports
1.0	1.2	0.8	0.7	0.6	0.5

Note: Total exports(imports) equal 100 percent.
Source: See Table 1.

information services sectors to value added in the two economies in
1980. is fairly similar. This is probably due to the fact that many of
the manufacturing sectors in Korea have very low value added
coefficients compared to Japan. Therefore, the relative weight of
the information services sectors in that economy is larger. The data
in Table 2 support the hypothesis that information services sectors
increase in importance during the process of economic development.
However, despite the size of the sectors, their (direct) exports and
imports are negligible (see Table 3).

Although much less research has been conducted into the determi-
nants of trade in services as compared to trade in munufactured
goods, there is evidence that the static and dynamic Heckscher-
Ohlin (H-O) models explain trade in both goods *and* services.[11] Re-
search into the determinants of Korea's comparative advantage in
technology exports comes to similar, albeit somewhat refined, con-
clusions. It assigns a central role to the accumulation of human and
institutional capital, and less to the accumulation of physical capital,
in explaining these exports.[12] A study of technology exports from
five NICs (Argentina, Brazil, India, Korea and Mexico) comes to the
same conclusion, pointing out that few, if any, of such exports de-
rive from the invention of radically new technologies on part of the
NICs.[13] Moreover, all these authors introduce and add dimension.
It is not just changing factor proportions, but also government poli-
cies and firm strategies which, in a complex interrelationship, de-

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[11]Sapir and Lutz (1981), Sapir (1985), and Hindley and Smith (1984). Sapir (1985, p.
36), for example, concludes:
  "It follows that there exists an *input complementarity* between goods and services:
  countries which are relatively abundantly endowed with human and physical capital
  tend to have a comparative advantage in (human and physical) capital intensive goods
  and in services. This helps to explain why the industrialized countries tend to enjoy
  a trade surplus in services with the developing countries."
[12]Westphal, Rhee, Kim and Amsden (1984).
[13]Dahlman and Sercovich (1984).

termine comparative advantage. This is also confirmed by Sapir, who analyzes NICs' trade in investment–related information services (professional, technical, construction and engineering services). Besides differences in relative factor endowments, he points to the following determinants of comparative advantage: ability to absorb foreign technology, R & D, financing facilities and scale economies, the latter of which are reported to be substantial for many information services.[14]

It should also be noted that (direct) trade in information services, irrespective of the existence of comparative advantages, is likely to be even more affected by protectionist policies than trade in manufactured products. This applies not only to those information services and data flows which could be seen to infringe national security or personal privacy, but to the whole spectrum of information services.[15] This is one of the reasons why NICs' information services exports are so far exclusively directed towards LDCs.[16]

There is little evidence of increasing direct information services exports from Japan and Korea during the 1970s and early 1980s. But international observers predict that NICs, let alone Japan, will become large direct exporters of such services in future.[17] There is, however, quantitative evidence that both countries had substantially increased their exports of technology by 1980. While Japan's trade balance in technology in 1980 was still highly negative and characterized by importing "high" technology from the West and selling large amounts of "medium" technology to South East Asian countries, it has shown signs of improvement over time.[18] It has especially been noted that many of the country's largest corporations, which are concentrated in shipbuilding, the steel industry and the production of chemical and synthetic fibers, had become net exporters of technology by 1980.[19] The export of technology and informa-

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[14]Sapir (1986). For a detailed review of the usefulness of theories of comparative advantage in explaining trade in services see, for example, Tucker and Sundberg (1986).

[15]Feketekuty and Aronson (1984).

[16]Sapir (1986), p. 620.

[17]Feketekuty and Aronson(1984, pp. 84–5). During the last couple of years, this prediction has certainly come true for direct Japanese exports fo financial services, causing alarm amongst some Western observers. See, for example, Wright and Pauli (1987).

[18]Japan, Science and Technology Agency (1983). the Bank of Japan's index of receipts / payments for technology improved from 22.6 in 1975, to 26.3 in 1980, and to 29.3 in 1982 (see Japan Statistics Bureau, Prime Minister's Office 1984, Table 1, p. 354).

[19]A survey conducted among 638 Japanese firms listed on the country's stock exchanges revealed a surplus of 23.7 billion Yen in their balance of technology trade in 1980, compared with a deficit of 16.5 billion Yen in 1975 (*Japan Economic Journal*, 1981,

tion services from NICs has been a subject of increasing interest to development economists in recent years. Korea has become a leading exporter in this area.[20] However, the research shows that these exports are almost exclusively embodied in capital goods, plant, and construction project exports. This emphasizes the importance of the type of analysis presented below which tries to account for total, instead of just direct, exports of information services sectors.

B. Total Information Services Exports

Direct trade is but one way, and most likely the less important way, in which information services affect the trade balance of economies. Information services inputs, such as communication, finance and business services, might well be crucial for developing or sustaining comparative advantage in any export industry. To obtain a quantitative measure of the degree of total export involvement of information services sectors, the interindustry transactions expressed in the rearranged I / O tables have to be taken into account. This is done by calculating the following export ratios:

$$\text{Direct export ratio } (DLR) \text{ of sector } j\text{: } E_j / X_j \tag{1}$$

$$\text{Total export ratio } (TER) \text{ of sector } j\text{: } \frac{[(I - A^d)^{-1}E]_j}{X_j} \tag{2}$$

where E = column vector of (direct) exports
E_j = (direct) exports of sector j (element of E)
X_j = output of sector j
$(I - A^d)^{-1}$ = domestic Leontief inverse
$j = 1, \cdots, 32$ (see Table 1)

The primary information services sectors do not have particularly high *DER*s. However, the difference between *DER*s and *TER*s is often very large, indicating that the sectors' export involvement is mainly indirect, i.e. it is embodied in other exports (see Table 4).

Several general conclusions emerge from the data in Table 4. First, a sizeable percentage of total information services sector output enters (direct) exports as intermediate inputs. This is more prominant in Korea than in Japan. The *TER*s of some of the information services sectors are in fact as high as those of some secondary sectors. This applies in particular to sector 9 in the case

"Japanese firms become sellers of technologies", June 16, p. 1). For a recent assessment of Japan's trade in technology using 1983 data, see, for example, Saxonhouse (1985).

[20]For detailed country studies see Westphal et al (1984).

TABLE 4
DIRECT AND TOTAL EXPORT RATIOS OF INFORMATION
SERVICES SECTORS (IN PERCENT)

Sector	Japan (1980)		Korea (1980)		Korea (1975)	
	Direct	Total	Direct	Total	Direct	Total
8	0.4	10.0	6.3	23.7	3.6	18.1
9	1.9	14.1	2.4	28.7	2.0	23.1
10	–	10.4	0.2	9.1	1.8	6.0
11	0.2	12.4	0.2	19.8	0.3	19.2
12	0.5	5.8	0.5	2.2	1.4	3.4
13	0.01	3.2	0.01	0.4	0.01	0.01
a	14.5		9.7		8.0	

Note: a = Ratio of total exports to direct exports

of Japan, and sectors 8, 9, and 11 in the case of Korea.[21] Secondly,
sectors 12 other information services and 13 education and research
export little of their output. This shows the limitations of the analy-
sis, which cannot indicate the (maybe pivotal, but quantitatively neg-
ligible) importance of, for example, R & D expenditure for export
performance. Thirdly, there seems to be a positive relationship be-
tween the ratio of total to direct exports calculated for sectors 8 to
13 and the level of economic development. The ratio is much larger
in Japan than in Korea, as can be seen from the last row in Table 4.
Moreover, it increased in Korea from 1975 to 1980.

III. Primary Information Sector Services Use in Manufacturing

So far, we focussed on the information services sectors them-
selves. We now change perspective and focus on manufacturing sec-
tors and their use of purchased information services as intermediate
inputs, i.e., we measure the primary information sector services con-
tent of manufacturing output. Secondly, we test the hypothesis that
these services are a statistically significant determinant of compa-
rative advantage in manufacturing.[22] It should be kept in mind that

[21] The *DER*s and *TER*s for all sectors in the economy are reported for Korea in
Engelbrecht (1987b), pp. 5–17, Tables 5 and 6. The detailed results for Japan are avail-
able from the author.

[22] However, it should be noted that our analysis does *not* imply that growth of primary
information services sectors is *only* due to increased demand from within the information
services and other serveces sectors in the economy (see, for example, Beyers and Alvine
1985, pp. 33–45; Tucker and Sundbery 1986). Moreover, it has been argued elsewhere

TABLE 5
PURCHASED INFORMATION SERVICES CONTENT OF MANUFACTURING SECTORS'
INTERMEDIATE INPUTS (IN PERCENT)

Sector	Direct			Total		
	Japan (1980)	Korea (1975)	Korea (1980)	Japan (1980)	Korea (1980)	Korea (1975)
1	7.9	6.3	5.2	9.3	6.6	4.9
2	4.1	2.6	0.9	8.3	5.2	3.3
3	9.7*	4.2*	2.1*	9.6*	5.4*	3.1*
4	11.6	5.5	5.2	10.0	6.2	5.0
5	9.3	5.8	3.6	9.4	5.7	3.9
14	3.8	2.0	2.3*	7.6	4.0	3.4*
15	6.2	4.2*	2.4*	8.8	5.3*	3.4*
16	4.4	4.6	3.8	8.1	5.7	4.3
17	4.7	5.0	3.4	8.2	5.9	4.2
18	6.3	2.5*	2.5*	8.4	4.3*	3.6*
19	5.9	5.0	3.9	8.9	5.7	4.4
20	3.3*	2.2*	1.6	6.9*	3.8*	2.6
21	6.7	5.7	3.4	8.4	5.5	3.6
22	7.6*	6.2	4.8	8.9*	5.9	4.3
23	9.6	5.4	3.0	9.4	5.6	3.5
24	5.2*	6.2	3.1	8.2*	6.0	3.8
25	4.4	5.3	2.9	8.3	6.8	4.9
Range	3.3–11.6	2.0–8.3	0.9–5.2	6.9–10.0	3.8–6.8	2.6–5.0
Average	6.5	4.8	3.2	8.6	5.5	3.9

Note: The sector classification is explained in Table 1. The top four direct
     exporting sectors are indicated by an asterix.
Source: Rearranged input–output tables.

the analysis presented below is conducted in purely quantitative
terms. This is likely to result in an underestimation of the import-
ance of information services. Qualitative aspects of information ser-
vices might be a prerequisite for successful exporting. However,
they are not assessed in this study.

A. Purchased Information Services Content of Manufacturing Output

Sectorally disaggregated estimates of the amount of primary in-
formation sector services embodied in manufactured products are
provided in Table 5. For comparative purposes, they have been ex-

that there is a two-way relationship between information services sector and manufactur-
ing growth in Korea (Engelbrecht 1986a, pp. 185-6). Some authors go as far as to predict
services-led manufacturing growth in future (Gershuny 1987) or the general predomi-
nance of services over manufacturing growth (Riddle 1987).

pressed in percentages of total intermediate inputs. The first index, "direct information services inputs," is calculated from the rearranged I / O tables as the sum of intermediate inputs purchased from sectors 8 to 13 by the manufacturing sector, divided by the total value of intermediate inputs consumed by the sector. The second index, "total information services inputs", is a more comprehensive measure of infomration services embodiment, taking into account the direct *and* indirect purchases of information services. It is calculated from the closed Leontief inverse matrices and shows the percentage of direct plus indirect information services inputs in total direct plus indirect intermediate inputs.[23] Tabel 5 also includes the "primary information sector" manufacturing sectors 1 to 5 (see Table 1), i.e., in the following the term "manufacturing sector" is used in the conventional sense. Output homogeneity is assumed, i.e., that domestically consumed and exported output is produced with the same technology and that it can be characterized by the same input mix. The four largest direct export sectors (in terms of export value) in each country are indicated by an asterix in the table.[24]

The data in Table 5 suggest that the higher the level of economic development, the higher the primary information sector services input levels in manufacturing, i.e., the higher the purchased information services intensity of production.[25] Furthermore, there are some large sectoral differences in direct information services input levels

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[23]The methodology is described in more detail in Engelbrecht (1986b).

[24]These sectors cover, respectively, 66 percent, 68 percent and 72 percent of all direct exports of the sectors contained in Table 5 in Japan 1980, Korea 1980 and Korea 1975. By far the largest direct export sector in Korea in both years is sector 15 textiles, alone accounting for 41 percent (1975) and 32 percent (1980) of the total. The largest directly exporting manufacturing sector in Japan in 1980 is sector 24 transport equipment, accounting for 27 percent of total direct exports of the seventeen sectors.

[25]Because imports of information services sectors are relatively small compared to imports of other sectors, the percentage of *domestic* information services in *domestic* sectoral intermediate inputs is larger than the input levels shown in the table. In the case of Japan, the range of total input levels rises to 8.5-10.9 (from 6.9-10.0), the average total input level rises to 9.5 (from 8.6); i.e., almost 10 percent of all domestically supplied intermediate inputs are purchased information services. If the expenditure on the "in-house" production of information services is added, which is on average about 17 percent of total intermediate inputs for sectors 14 to 25 in Japan in 1980 (calculated from Engelbrecht 1986b, Table 7, p. 291), information services often account for more than 25 percent of total (direct plus indirect) intermediate inputs of manufacturing sectors! It has also been shown that the use of "information labour", which is another information input into manufacturing sectors, increases with the level of economic development (Engelbrecht 1990).

between Japan and Korea in 1980. The index for Japan is more than twice as large as that for Korea in case of sectors 3 electronic and communication equipment, 4 precision instruments and 18 chemicals. Large differences also appear for sectors 2, 5 and 23. However, for four sectors (16, 17, 24, 25) the input level in Japan appears similar, or even somewhat smaller, than in Korea. Direct information services input levels in Korea increased for all but two sectors (14, 18) between 1975 and 1980, reflecting the rapid growth of information services sectors during that period. The low and constant input level for sector 18 chemicals is somewhat surprising, given the strong government support for the development of that sector. Two sectors, 14 food and 20 basic metal, have the lowest input levels in both economies, and for both the direct and total index.

Because total information services input index also includes the multitude of indirectly used information services, one can expect the differences between sectors to be less pronounced than for the direct index, and the value of the index to be generally higher. This is indeed the case. Using the total index, intermediate information services input requirements are appreciably larger in Japan in 1980 than in Korea in 1980, and in Korea in 1980 compared to 1975, for *every* sector. The differences in total information services input levels between Japan and Korea in 1980 can be interpreted to indicate a huge shortfall in the use of information services in Korea.[26] This interpretation is supported by the findings of a manufacturing sector production function study of the two economies.[27]

Concentrating on the largest direct export sectors, the hypothesis that Japanese exports embody relatively more purchased information services than those from Korea is confirmed. However, the main direct export sectors are not necessarily the sectors with highest information services input levels. This is certainly true for the largest direct export sector in each economy, i.e., sector 24 transport equipment in Japan and sector 15 textiles in Korea (see Table 5).

B. *Purchased Information Services and Comparative Advantage in Manufacturing*

In order to test the hypothesis that purchased information ser-

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[26]Assuming that there are no large differences between the relative amounts of purchased and "in-house" information services used in the two economies. Otherwise the comparison will be biased.

[27]Engelbrecht (forthcoming).

vices are a statistically significant determinant of comparative advantage and exports, the general relationship observed for Japan and Korea between the level of economic development and degree of information services embodiment has to be analyzed in more detail, identifying country and sector specific factors. Such factors include differences in factor endowments and intensities, in the level of technology and ability to absorb new (information) technologies, R & D, economies of scale, imperfect competition, and the balance between purchased information services and the "in–house" production of information services. Domestic demand for information services is also influenced by government policies. Price distortions in the economy might result in the non–optimal use of services. Subsides paid and protection granted to inefficient domestic information services producers might encourage their use as intermediate inputs. On the other hand, government might pursue policies which encourage the efficient production of information services. The degree of embodied information services export will also depend on the level and nature of international trade barriers. Embodying services in traded goods is one way of circumventing barriers to direct services exports.[28]

The approach adopted here takes into account some of the factors mentioned, but neglects others. To analyze Japan's and Korea's manufacturing trade in 1980, we regress a sectoral comparative advantage index and direct export ratios on sectoral factor intensity variables, including purchased information services intensity variables.[29] The data sample used is fairly small, i.e., it covers fifteen comparable manufacturing sectors in the two economies. They are those shown in Table 5, except sectors 5 and 16.[30]Before discussing our results, we briefly introduce the variables used in the analysis.

[28]For a discussion of the relationship between barriers to trade in goods and services and the balance of direct / embodied services trade, see Tucker and Sundberg (1986), pp. 40-2.

[29]We do not attempt to correlate our estimated coefficients with factor endowment variables, an approach which has often been used to empirically test the Heckscher–Ohlin hypothesis of trade patterns, according to which a country will export those commodities which intensively use its abundant factor(s) (see, for example, Balassa 1979, 1986; Noland 1986; Lee 1986). Such tests have proved notoriously difficult (see the discussion in Bowen, Leamer and Sveikauskas 1987). Moreover in our two–country, multi–factor context, the H–O model assumption of identical technologies and no factor–intensity reversal is certainly violated.

[30]Sector 5 is an aggregation of several diverse manufactured products. Sector 16 is a natural resource industry. The latter are commonly excluded in order to avoid distortion of the results (see, for example, Harkness and Kyle 1975).

A) Definition of Variables

The comparative advantage index is calculated as:[31]

$$CA = (X_{ji} - M_{ji}) / C_{ji} \qquad\qquad (3)$$

where C_{ji} = country i's consumption of sector j's output

A value for CA greater than zero indicates comparative advantage. The data on X, M and C are available from our I / O tables. The direct export ratio of sectors defined in (1) should be interpreted to indicate the export openness, or the degree of direct export involvement, of sectors, but not comparative advantage.[32] In the case of Korea, there is evidence that government policies were directed towards capacity growth and export volumes in manufacturing.[33] Therefore, a rising or high DER in an industry might be seen as an early indicator of a developing comparative advantage.

There is a large difference between Japan and Korea in the degree of correlation of the two dependent variables CA and DER.[34] This is explained by the low level of Japanese manufactured imports, i.e., indices based on exports are closely correlated with the comparative advantage indices because of Japan's small intra–industry trade. Korea, on the other hand, imports many of its intermediate inputs. Therefore, its rank correlation between CA and DER is lower.

The factor intensity variables included in the regressions are calculated from the rearranged I / O databases and sectoral employment data, i.e., they are country–specific factor intensities. Human capital intensity (HCI) is determined as employee compensation divided by number of people employed by sector,[35] physical capital intensity (PCI) as "other value added" divided by number of people employed, where other value added is total sectoral value added minus employee compensation. If the regression coefficients of HCI

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[31]See, for example, Bowen (1983).

[32]However, direct export ratios are often classified as comparative advantage indices (see, for example, Ballance, Forstner, and Murray 1987).

[33]Cohen (1978) and Westphal (1978).

[34]For 1980, the Spearman rank corrleation coefficient between CA and DER is 0.94 for Japan, but only 0.49 for Korea.

[35]Compansation of unskilled labour should be excluded from the HCI measure. However, we do not have the necessary sector specific wage data to do this. We therefore disregard this problem and assume that all sectors pay the same wage rate to unskilled workers (see Lee 1986).

and *PCI* are of similar type, i.e., both either positive, negative, or statistically insignificant, total capital intensity (*TCI*) is used instead in order to preserve degrees of freedom. *TCI* is value added per person employed, i.e., it is the sum of *PCI* and *HCI*. Negative or statistically insignificant regression coefficients for *TCI, PC* and *HCI* can be interpreted to indicate unskilled labor intensity of production. In addition to these "conventional" factor intensity measures, two intensity variables derived from an information sector perspective are included:[36] Purchased information services intensity *PISI* and total purchased information services intensity *TPISI. PISI* for sector *j* is calculated as the sum of the sector's direct intermediate purchases from sectors 8 to 13, as shown in sector *j*'s column in the transactions table, divided by numnber of people employed in the sector. *TPISI* for sector *j* is calculated as the sum of elements 8 to 13 of sector *j*'s column in the inverse matrix $(1 - A^d)^{-1}$ times the sector's output, giving its amount of directly and indirectly purchased information services, divided by number of people employed in the sector.[37]

B) Discussion of Results

The pattern of specialization was quite different in Japan and Korea in 1980. This is revealed by the ranking of sectors exhibiting comparative advantage. The six sectors with highest *CA* indices in both countries are shown in Table 6. Japan's comparative advantage is widely dispersed across manufacturing sectors, whereas Korea's is concentrated in three sectors (i.e., 25, 15, 21).[38] Moreover, it is precisely these light manufacturing, (unskilled) labor intensive sectors which had distinctly high direct and total export ratios in Korea in 1980 and which operated under a free trade regime.[39]

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[36]It is not uncommon to include intermediate input intensity variables in trade analysis. Examples are energy variables (see, for example, Urata 1983; Lee 1986) and R & D expenditure variables. The latter has been used extensively in tests of neo-technology theories of trade. For a recent summary, see Hughes (1986).

[37]*PISI* is likely to be the more appropriate variable if a large proportion of information services is imported. Otherwise, *TPIST* should be used. See, for example, Ballance (1987, ch. 6) and Lee (1986).

[38]Japan has a positive *CA* for 12 (out of 15) sectors. It does not seem to have a comparative advantage in sectors 14, 17 and 18. On the other hand, the sectors in Table 6 exhaust Korea's sectors with positive *CA*. The Spearman rank correlation coefficient between the *CA*s for Japan and Korea in 1980 is −0.28, indicating that the two economies had very different patterns of comparative advantage.

[39]See Engelbrecht (1987b, Table 2, p. 10). Evidence at the three–digit commodity level shows that during the 1960s, exports were even more concentrated (Lee 1986, Table 3, p.

TABLE 6
TOP-RANKING COMPARATIVE ADVANTAGE SECTORS

	Japan (1980)			Korea (1980)		
Rank	CA Value	Sector No.	Sector	CA Value	Sector No.	Sector
1	0.362	(24)	Transport equipment	0.730	(25)	Miscellaneous manuf.
2	0.330	(4)	Precision instruments	0.464	(15)	Textiles
3	0.259	(2)	Office machinery	0.447	(21)	Fabricated metal products
4	0.251	(3)	Electronic and com. eq.	0.088	(19)	Non-metallic mineral prod.
5	0.160	(23)	Electrical machinery	0.073	(3)	Electronic and com. eq.
6	0.151	(22)	General industrial mach.	0.043	(1)	Printing, publishing

Other manufacturing sectors were subject to a protective system of both tariffs and quantitative controls. This enabled the development of the more capital and skill intensive backward linkage sectors associated with the export sectors. It is widely recognized that the government's industrial policy resulted in a lopsided free trade regime, giving rise to a "coach-and-two-patter" of manufacturing growth, or a pattern of dual industrial growth.[40] We expect that in Korea, comparative advantage is associated with unskilled labor intensive production. To account for the lopsided trade regime and government policies, a dummy variable D is used in some of the regressions for Korea, taking the value of zero for industries operating under a free trade regime, and the value of one otherwise.

Equations are estimated by ordinary least squares, using the factor intensities as independent variables and, in turn, CA and DER as dependent variable. They are estimated in linear and log form. Because many of the regressions produced similar results, only a representative sample is shown in Table 7. In general, there is little evidence of multicollinearity. The estimates provide some interesting results not only in regard to information services intensity, but also in regard to capital and labour intensities. For Japan, the PCI coefficient is nagative and significant, whereas the HCI coefficient is positive and significant, i.e., Japan seems to have a comparative advantage in human capital intensive, but not physical capital intensive, exports (equation 7.1).[41]

In the case of Korea, the coefficients of PCI and HCI are statistically insignificant. Moreover, the null hypothesis of the F-test

155).

[40]See Uchida, Imaoka and Yanagihara (1983) and Ohno and Imaoka (1987).

[41]None of the DER regressions for Japan are statistically significant (F too low).

TABLE 7
REGRESSION RESULTS

	Japan (1980)	Korea (1980)	
Eq. No.	7.1	7.2	7.3
Dependent Variable	CA	CA	DER
Independent Variables			
PCI	−0.076ᵃ		
	(−2.4)		
HCI	+0.114ᵇ		
	(1.53)		
TCI		+0.02	−0.014
		(0.405)	(−0.548)
PISI	+0.108	+0.016	+0.009
	(0.907)	(0.051)	(0.055)
D		−0.611ᵃ	−0.273ᵃ
		(−3.68)	(−3.12)
Constant	−0.101	+0.367ᵃ	0.487ᵃ
	(−0.638)	(2.03)	(5.12)
R^2 adjusted	0.21	0.54	0.558
F	2.244**	6.477*	6.892*

Notes: 1. All equations are estimated in linear form.
2. t statistics are given in parentheses.
3. a: significant at 5% level (one–sided test).
4. b: significnat at 10% level (one-sided test).
5. *: significant at 5% level, **: significant at 10% level.

could not be rejected. The dummy variable D was then included in the regressions to account for the lopsided trade regime and TCI was used instead of HCI and PCI to preserve degrees of freedom. The value of the F statistic increased. However, all factor intensity coefficients are statistically insignificant, whereas the dummy variable is highly significant (equations 7.2 and 7.3). The findings regarding capital intensities indicate that in 1980, Korea's comparative advantage was still in non–capital intensive, i.e. in unskilled labour–intensive, products. This result is similar to that of other studies.[42] However, the fact that PCI and HCI are not statistically significant might indicate the Korea was approaching the dividing line between comparative advantage in non–capital and capital intensive products. The negative coefficient obtained for the dummy variable indicates that the restriction of the free trade regime to only a few labour intensive direct export sectors has a negative impact on

[42]Lee (1986) and Noland (1986).

our static comparative advantage and export openness index. This does not necessarily imply that the coach–and–two–pattern of manufacturing growth in Korea is second–best compared to a free trade regime. Korea's record economic growth rates suggest that positive dynamic effects of dual manufacturing growth on economic development might be larger than those of a free trade regime. It may even be interpreted as a future oriented comparative advantage policy.[43]

Turning to the test of our hypothesis that purchased information services are a statistically significant determinant of comparative advantage and exports, our estimates indicate that although the *PISI* and *TPISI* coefficients are positive in the *CA* and *DER* equations, they are not statistically significant. Therefore, information services intensity does not seem to be a determinant of comparative advantage.[44] This reult is partly foreshadowed in Table 5, which shows that the main direct export sectors are not necessarily the sectors with highest information services input levels. In a sense, both Japan and Korea might still have been in the "pre–information age" in 1980. With the shift to more information intensive exports and the general increase in information intensity of production, we may expect different results in future studies.

However, purchased information services seem at least *indirectly* important for exports in Korea. When *TER* is used as dependent variable in the regressions, the *PISI* and *TPISI* coefficients are positive and statistically significant, i.e. information service intensity appears to be a determinant of total, i.e. direct plus indirect, export openness of sectors (see equations 8.3 and 8.4, Table 8). Because of the double logarithmic form of the equations in Table 8, the estimated factor intensity coefficients can be interpreted as elasticities. For example, equation 8.3 indicates that a 1 percent rise in *PISI* will result in a 0.945 percent rise in *TER*, whereas a 1 perent rise in *TCI* will reduce *TER* by 0.77 percent. However, it has to be emphasized that *TER* is an unconventional and much boarder

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[43]For a discussion of dynamic versus static comparative advantage policies, see, for example, Schydlowsky(1984). In general, the case for activist trade and industrial policies has become stronger in recent years with new developments in trade theory (Krugman ed. 1986).

[44]The critical reader might suspect our results to be partly due to the small number of observations in our data sample. However, at least the estimates for Japan (Table 7, equation 7.1) seem robust. A more extensive trade study, using a larger data sample and more sophisticated estimation techniques, produces very similar results(Engelbrecht, 1989).

TABLE 8
REGRESSION RESULTS FOR *TER* EQUATIONS

	Japan (1980)		Korea (1980)	
Eq. No.	8.1	8.2	8.3	8.4
Independent Variables				
PCI	−1.207[a]	−1.272[a]		
	(−2.837)	(−2.92)		
HCI	+2.418[a]	+2.422[a]		
	(2.206)	(2.307)		
TCI			−0.772[b]	−0.661
			(−1.39)	(−1.147)
PISI	+0.615		+0.945[a]	
	(1.091)		(1.815)	
TPISI		+0.677		+0.593[b]
		(1.231)		(1.431)
D			−0.784[a]	−0.714[b]
			(−1.95)	(−1.713)
Constant	−2.852[a]	−3.495[a]	0.97	0.113
	(−2.463)	(−4.473)	(1.092)	(0.18)
R^2 adjusted	0.403	0.418	0.381	0.321
F	4.144*	4.352*	3.866*	3.21**

Notes: 1. All equations are estimated in double-log form.
       2. For significance levels, see notes to Table 7.

measure of export involvement of a sector than *CA* or *DER*, taking into a account direct exports and export related forward linkages. It is therefore closer related to indices showing the importance of sectors in the domestic economy. Because we know that information services sectors have grown strongly in Korea from 1975 to 1980 and are fairly large (see Table 2), the estimates for equations 8.3 and 8.4 are not surprising. The dummy variable is still negative, i.e., in our static analysis, trade policy has a negative impact on the total export openness of the manufacturing sector. In case of Japan, the coefficients of the information services intensity variables are statistically insignificant (equations 8.1 and 8.2). The estimates in Table 8 seem to supplement the finding that purchased information services as a factor input in production are more underused in Korea than in Japan.[45]

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[45]Engelbrecht (forthcoming).

IV. Conclusion

The growth of information services sectors is one aspect of Japan's and Korea's development into information based economies. Although it is expected that in future these sectors will increasingly participate in direct trade, in the recent past their trade involvement has been largely indirect, i.e., their exports have been embodied in manufactured goods. This study shows that the amount of indirectly exported information services seems to increase with the level of economic development. Japan's exports embody a larger amount of information services than Korea's.

It has become popular amongst some analysts to argue that efficient service sectors are important, if not a prerequisite, for industrial development and comparative advantage in manufacturing. However, our attempt to establish the use of purchased information services as a statistically significant determinant of comparative advantage has not been successful, although it has been shown that such services are indirectly related to exports, at least in Korea. In that country, economic policies aimed at fostering the development and efficient production of information services are of increasing importance and should be seen as a natural extension of industrial and export-oriented policies.

It is important to conduct similar studies to the one presented here for other economies to assess whether Japan and Korea are special cases. Also, to overcome the probably most severe limitation of our study, i.e., the neglect of information services provided "in-house" by the private bureaucracies, a comprehensive measure of information services inputs used in manufacturing industries needs to be developed.[46]

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[46]The "in-house" provision and consumption of information services, being non-marketed, is difficult to measure, i.e., there is an inherent bias in published statistics to underestimate, even in purely quantitative terms, the production and consumption of information services.

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