Interindustry (Input-Output) Relationships and Export Success--Japan and Korea

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As a country develops, the empty (zero) cells in its Leontieff technology matrix (A) start to fill in and backward and forward linkages are forged between the individual sectors. The proposition which will be explored is that the dynamic development of comparative advantage is systematically associated with this process.

A. Theoretical Considerations

What sort of relationships might one expect to find? Let us set out a series of hypotheses:

1. Following classic trade theory, one can focus on the sectoral requirements for employment of the relatively abundant factor of production as an indicator, which should in an ex-ante sense predict success. Thus, if one knew, or posited, that physical or human capital were likely to become relatively abundant over time. One would seek out those industries which, at the initial period, intensely employed domestic physical or human capital.
2. Following development theory, several measures are suggested. If one can identify key sectors, in the sense of sectors with strong forward the backward linkages,[1] one may

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1 For examples of relevant literature here, see Schultz (1977), pp. 77-96 and also see Dewerah and Barnah (1978), PP. 440-444.

focus on such sectors,[2] which are expected to grow rapidly. This will provide a rapidly growing domestic market for its relatively important supplying sectors, and hence enable them to lower costs and heighten the probability of improving international competitiveness.

3. Alternatively, again stressing backward linkages. One could focus on those sectors which use inputs from key sectors intensely. Such key sectors could be certain raw materials which may be available cheaply domestically; or perhaps agriculture (following a Ranis-Fei dual-economy evolution, in which the "surplus" generated by agriculture is a key source of net capital formation); or perhaps the machine tool; or, more generally, the capital goods sector which in other contexts had proven to be of central importance in importing growth impulses in the past.[3]

4. It may be posited that high values on the diagonal may indicate a high probability of export success, especially in LDCs. This would indicate that the sector provides a high proportion of its own inputs, and such vertical integration should help assure standardized quality control and a relatively smooth flow of inputs. It would also probably be associated with experience (shared both by managements and labor force) in a wide range of techniques associated with various aspects of the industry or sector. This, in turn, would impart a dynamic (potential) flexibility to that sector which would allow it to respond to new production techniques and shifts in tastes (or new taste patterns as new export markets were penetrated).

5. Finally, large interfirm purchases within given sector may attest to a high degree of firm specialization (within the sector or industry), which, in turn, is typically associated (in classic models of comparative advantage) with export success.

B. An Application - Japan and Korea

This section will explore the empirical relevance of the several hypotheses sketched out in the previous table. The industry-

2 these would be industries with high values of u;$u = \frac{X_{ij}}{X_j}$, when X_{ij} is the input from i to j and X_j is the gross output of j.

3 See Rosenberg (1976).

sectoral data are from a series of 23 x 23 sector domestic interindustry input-output tables of Japan for the years 1960 and 1970, and for Korea 1963 and 1973.[4] The trade data are from a sample of 3-digit SITC categories drawn from the OECD *Trade by Commodities* (Series C).

1. The Export Variables

The approach in this section is to first define several measures of sectoral export success, and then to relate these to various measures of industry interdependence associated with the hypotheses outlined in the previous section.

The sample of 94 commodities, which encompassed over 99% of the value of manufactured exports for both countries, was allocated to the twelve tradable industry groups (sectors) available from the Input/Output tables. The commodity composition of each of the twelve sectors is in Appendix V-1.

Table 1

SECTORAL TRADE PERFORMANCE INDICATORS
(PERCENT)

	JAPAN		KOREA	
	World Share 1965	World Share 1977	World Share 1965	World Share 1978
Misc. Mfg.	12.0	16.5	0.14	2.90
Basic Metals	11.7	19.1	0.12	1.42
Textiles	18.2	15.3	0.42	6.32
Clothing	12.4	3.9	0.81	18.10
Transp. Equip.	9.1	21.6	0.01	1.03
Chemicals	5.3	6.6	0.00	0.52
Machinery	5.6	13.1	0.02	0.89
Paper	2.4	3.4	0.01	0.76
Petroleum	2.1	2.7	0.00	0.38
Rubber	13.7	15.8	0.12	4.34
Nonmetal Minerals	10.7	10.2	0.14	2.56
Wood Products	14.5	4.0	2.68	14.46

4 Poduval/Kubo (1979).

The three measures of export success which were calculated for each exporter for each product group were:

a. The market share in 1965 (relative to OECD).

b. The change in this share 1965-1970.

c. The change in this share 1970-77/78.

The sectoral market shares appear in Table 1.

2. The Input-Output Variables

All variables other than the capital/output ratios used in this study are associated with the direct domestic input inner matrix. The variables are:

a. *Capital/Labor ratios.* These are expressed in thousands of U.S dollars.

b. *Forward linkages.* These are tradable-sector sales to a key sector as a proportion of all domestic interindustry inputs purchased by the key sector. The larger this number, the more important is the tradable sector as a supplier to the key sector (relative to all other domestic suppliers).

c. *Backward linkages.* These are a tradable sector's purchases from a key sector as a proportion of all interindustry domestic inputs purchased by the tradable sector. The larger this number, the more important is the key sector (relative to all other domestic suppliers) to the tradable sector.

d. *Own purchases.* These are the numbers on the diagonal of the A matrix divided by all inter- and intra- industry purchases of the designated tradable sector. These may be interpreted as measures of vertical integration and indicators of interfirm (within sector) specialization.

The values of these variables will be presented below in their proper analytical context.

C. The Results - All Exports

1. Capital Intensity

The first analysis focuses on the capital/labor relationships.

Here the general hypothesis is that a country will tend to develop a (revealed) comparative advantage in those industries which are intensive users of that country's relatively abundant resource. The factor ratio we use is the classic ratio of physical capital per employee. It is difficult to say if Japan's initial (1965) situation is one of capital scarcity or abundance. Roughly one-half of its exports was directed to relatively less well endowed LDCs. In 1965, Japan was probably still relatively poor in capital endowments, relative to its industrialized (MDC) trade partners.[5] Thus, this hypothesis holds no certain inferences in this area for Japan. Korea, on the other hand, was clearly a capital poor country. Over two-thirds of its manufactured exports in 1965 (and over 80% in 1970) were to MDCs. Hence, support for this hypothesis would call for a negative relationship between sectoral market shares and capital/labor intensities.

A related hypothesis may be posited, that a country which is rapidly accumulating a given factor over time, relative to its trade partners, should develop a comparative advantage in commodities that intensively embody that factor. Applying this dynamic version of the classic theory to our two cases would lead us to expect to find Japan gaining a comparative advantage in capital intensive commodities, since its rate of physical capital accumulation per employee was clearly higher than that of its trade partners from 1965 to 1977. While Korea also maintained a respectable rate of capital formation, its population also grew rapidly into the 1970s, so that no clear inferences are obvious in her case. Table 2 presents the relevant capital/labor ratios.

It is clear from Table 2 that Japan's industry was relatively capital intensive in 1965 (relative to Korea's), and became more so during the 1970s. An interesting insight from these tables is that, by 1973, the capital/labor intensities in many of Korea's tradable sectors closely approximated those in Japan in 1960 for the relevant sectors (basis metals, clothing, transport equipment, chemicals, nonmetallic mineral products, and wood products). If, indeed, export competitiveness is related to relative factor endowments, it seems interesting to explore the thesis that the Korean competitiveness structure in the 1970s was similar to Japan's of a decade earlier. This is done in Section VI below.

Table 3 presents the correlation coefficients between the capital-intensity ratios (and changes in these ratios) and the

5 This was indicated by Hufbauer's rough calculations, summarized in Table 4, in Vernon ed., *The Technology Factor in International Trade*, NBER (1970), p. 157.

Table 2

CAPITAL/LABOR RATIOS

	Japan (000 yen)				Korea (000 won)		
	1960	1965	1970		1960	1965	1970
Misc. Mfg.	0.491	0.310	1.350	Misc. Mfg.	0.151	0.184	0.194
Basic Metals	1.417	2.461	4.004	Basic Metals	0.375	0.416	1.521
Textiles*	1.270	1.577	2.135	Textiles	0.335	0.721	0.340
Clothing*	0.466	0.463	0.385	Clothing	0.123	0.212	0.348
Transport Equip.	0.392	1.617	3.001	Transport Equip.	0.318	0.441	0.373
Chemicals	2.361	4.638	8.536	Chemicals	0.523	1.431	2.039
Machinery	0.536	0.999	1.436	Machinery	0.235	0.365	0.359
Paper Products	1.390	2.280	3.809	Papere Products	0.390	0.616	0.811
Petroleum Prods.	6.208	11.519	23.990	Petroleum Prods.	0.131	1.605	4.728
Rubber	0.664	1.257	2.421	Rubber	0.142	0.267	0.381
Nonmetal Minerals	1.031	1.696	2.536	Nonmetal Minerals	0.623	1.117	1.369
Wood Products	0.410	0.600	1.063	Wood Products	0.250	0.355	0.444
ALL ECONOMY	0.741	1.139	1.812	ALL ECONOMY	0.467	0.564	0.762

* The figure in "textiles and clothing" allocated to both in the same ratio as Korea's.

Source: Poduval/Kubo (1979).

Source: Ibid.

export-success indicators.

From Table 3, Japan's larger sectoral export market shares in 1965 were clearly in labor-intensive product groups. Those commodities in which Japan had relatively large market shares had relatively low capital/employee ratios in 1960 and 1970, and tended to gain capital/labor less rapidly in both percentage points and percentage terms. Since Japan occupied an intermediate position in capital/labor endowment, this finding neither supports nor contradicts the hypothesis. Japan is also found to have increased its shares in the 1970s in product groups which had (during the 1960s) most rapidly increased their capital/employee ratio in percentage terms ($r = 0.523$). This supports the dynamic version of the stated hypothesis.

Table 3

SIMPLE CORRELATION COEFFICIENTS BETWEEN EXPORT SUCCESS AND CAPITAL INTENSITY INDICATORS

	JAPAN			
Export by Source/ Capital Intensity	Capital / 1950	Labor 1970	Change 1960-1970	% Change 1960-1970
1965 Market Share	-.572*	-.598*	-.605*	-.564*
Change 56-70	-.138	-.132	-.130	.227
Change 70-77	.111	.133	.140	.523*

	KOREA			
	Capital / 1963	Labor 1973	Change 1963-1973	% Change
1965 Market Share	-.203	-.274	-.251	-.183
Change 1966-70	-.302	-.303	-.269	-.181
Change 1970-78	-.405	-.416	-.335	-.224

* Significant at 90% level.

As suggested by the hypothesis, Korea's 1965 market share is somewhat (though not significantly) associated with negative capital/labor ratios. During the 1970s. Korea's largest share gains were in relatively capital poor product groups.

2. Agriculture - A Key Sector

An influential group of theoretical studies dealing with the dualistic nature of LDC economies, formally summarized by the Lewis-Ranis-Fei model, focus on the key role of agriculture in promoting growth impulses to the modern, or manufacturing, sectors. On the one hand, agriculture provides the labor force and the real capital, or the "surplus," which fuels the growth of the modern manufacturing sector. On the other hand, the agricultural sector, due to its preponderant size, provides an important domestic market for the manufacturing sector.

It would follow that those manufacturing sectors which were linked (backward for raw materials, and forward as suppliers) to agriculture would tend to develop in a relatively rapid manner in a Ranis-Fei world, and should be expected to develop an early comparative advantage in external markets relative to exports from other exporting sectors within the economy.

Table 4A

THE FORWARD LINKAGES FROM THE TRADEABLE SECTORS TO AGRICULTURE (PERCENT)*

Supplying Tradable Sectors	JAPAN		KOREA	
	1960	1970	1963	1973
Misc. Mfg.	1.4	1.3	0.0	2.0
Basic Metals	1.4	1.1	2.3	1.5
Textiles	1.5	0.0	1.2	0.0
Clothing	6.4	4.0	4.7	3.6
Trans. Equip.	2.9	1.3	1.2	0.5
Chemicals	22.5	17.5	3.1	26.9
Machinery	2.2	2.6	1.2	0.5
Paper Products	0.7	2.9	0.0	0.5
Petroleum & Coal	5.3	6.9	0.0	4.6
Rubber Products	0.0	0.4	0.0	0.0
Nonmetal Minerals	0.7	1.1	1.2	0.5
Wood Products	1.4	0.7	3.5	1.0

* Percent of all intersectoral purchases of agriculture.

Table 4B

THE BACKWARD LINKAGES FROM THE TRADEABLE SECTORS TO AGRICULTURE (PERCENT)*

Purchasing Tradable Sectors	JAPAN		KOREA	
	1960	1970	1963	1973
Misc. Mfg.	5.2	1.2	20.0	2.4
Basic Metals	0.5	0.0	0.4	0.9
Textiles	22.5	10.4	23.4	17.2
Clothing	5.7	0.3	5.9	1.4
Transp. Equip.	0.0	0.0	0.3	0.0
Chemicals	12.3	4.9	7.4	2.5
Machinery	0.0	0.0	0.7	0.0
Paper Products	18.2	2.7	7.6	5.3
Petroleum & Coal	3.0	0.7	0.0	0.0
Rubber Products	22.0	4.5	0.0	0.3
Nonmetal Minerals	0.3	0.0	3.8	0.3
Wood Products	71.1	39.3	17.4	12.5

* Percent of all intersectoral purchases of tradable sectors.

There is little reason to expect this hypothesis to have any real applicability in the case of Japan in the early 1960s, since the agricultural sector provided only about 10% of the value of gross production (3.8% in 1970). By the 1960's, rural population pressures in Japan were hardly of the magnitude experienced in the developing world, and persistent subsidies to agriculture, as well as the intensive use of manufactured inputs such as chemicals by agriculture, countered the direction of intersectoral capital flows envisioned in the original model.

In terms of relative size, there is no a priori reason to reject the applicability of the model to Korea. In 1960, over 30% of Korea's gross output originated in agriculture. By 1970, that proportion was still 18.8%-higher than Japan's in 1935 (16.7%).

Tables 4A and 4B contain the linkage indicators relevant to agriculture for Japan and Korea, respectively. Table 4A presents the forward links from each of the twelve tradable sectors to

agriculture. An example will suffice to demonstrate the nature of these figures. In 1960, 1.4% of all Japan's agriculture purchases from other domestic sectors were from miscellaneous manufacturing. In Japan, the chemicals sector was clearly the most important domestic supplier to agriculture in both 1960 and 1970. Not much change is evident in the nature of the forward linkages to agriculture during the decade in Japan (the 1960 and 1970 linkages have a correlation coefficient of 0.972). In Korea, the domestic chemical industry played a relatively smaller role as an input to agriculture in 1963, but by 1973 closely approximated its respective role in Japan a decade earlier. In general, the structure of these forward linkages to agriculture underwent a more significant change in Korea (the forward linkages of 1963 and 1973 have a correlation of 0.806), and the Korean 1973 structure closely approximated Japan's of 1960 ($r = 0.982$). The patterns of backward linkages (Table 4B) are less similar across countries as Korea's 1973 and Japan's 1960 patterns have only a correlation of 0.704.

Table 5 presents the correlation between the linkages to agriculture and the export success indicators.

Table 5

SIMPLE CORRELATION COEFFICIENTS BETWEEN EXPORT SUCCESS INDICATORS AND INTERINDUSTRY LINKAGES WITH AGRICULTURE

	JAPAN			
	Forward Linkages		Backward Linkages	
	1963	1973	1963	1973
1965 Market Share	-.350	-.538*	.385	.405
Change 1965-70	-.023	.024	-.567*	-.543*
Change 1970-77	-.077	-.019	-.560*	-.634*
	KOREA			
	Forward Linkages		Backward Linkages	
	1960	1970	1960	1970
1965 Market Share	.267	-.147	.457*	.563*
Change 1965-70	.317	-.111	.433	.463*
Change 1970-77	.284	-.164	.243	.241

* At 90% significance level.

The results are fairly clear. In Japan, those sectors which were important suppliers to agriculture tended to have smaller export market shares. The export market shares of Japan were somewhat positively associated with the importance of domestic agricultural inputs, though not at the 90% significance level. What is statistically significant is that those Japanese sectors which tended to rely on agricultural inputs tended to lose market shares relative to those tradable sectors which did not. This was true in the late 1960s, and even truer in the 1970s.

No statistically significant relationship is found between the Korean sectors' export success and their forward linkages to agriculture during this period. However, it is evident from the significantly positive correlations that domestic agricultural inputs were relatively important for those Korean sectors which by 1965 had attained relatively large world export shares. Furthermore, in contrast to Japan, strong backward linkages to agriculture were associated with gains in market shares from 1965 to 1970, a period of exceptionally rapid growth of Korean exports. No significant relationship appears to connect further share gains in the 1970s with these links to agriculture (unlike Japan's quite negative relationship).

To summarize, the major relationships linking agriculture to export success in both countries is via the backward linkages, i.e., viewing agriculture as a supplier of raw materials. In Japan, agriculture tends to hurt, and in Korea to help export success. The fining for Korea supports expectations from a Lewis-type model entering its second and third phases, fueling its modernization with resources largely derived from a traditional sector which is shrinking.

3. Food Processing - A Key Sector

One rung above agriculture on the ladder of industrialization is food processing, and as such it is often identified as a key sector in LDC growth strategy. It would be expected, following the logic of the preceding discussion, that those sectors which are important suppliers to this key sector, or for whom food processing is in turn important as a supplier, should be found to be relatively competitive abroad. Tables 6A and 6B contain the relevant linkage measures. Table 7 contains the relevant correlation coefficients.

The results in Table 7, which tend to support the hypothesis, are fairly similar to those in Table 5, which relate to linkages with

Table 6A
THE FORWARD LINKAGES FROM THE TRADEABLE SECTORS TO FOOD PROCESSING
(PERCENT)

Supplying Sectors	JAPAN		KOREA	
	1960	1970	1963	1973
Misc. Mfg.	0.3	2.2	0.8	1.5
Basic Metals	1.1	3.4	1.0	1.3
Textiles	0.0	0.1	0.2	0.3
Clothing	0.2	0.2	3.1	1.3
Transp. Equip.	0.2	0.3	0.2	0.0
Chemicals	3.4	12.5	1.7	3.2
Machinery	0.5	0.9	1.5	0.6
Paper Products	1.1	2.8	1.5	2.3
Petroleum & Coal	0.6	1.9	0.2	1.3
Rubber Products	0.0	0.0	0.2	0.3
Nonmetal Minerals	1.2	4.1	1.0	2.9
Wood Products	0.6	0.9	1.3	0.6

Table 6B
THE BACKWARD LINKAGES FROM THE TRADEABLE SECTORS TO FOOD PROCESSING
(PERCENT)

Purchasing Sectors	JAPAN		KOREA	
	1960	1970	1963	1973
Misc. Mfg.	0.6	0.2	0.2	0.0
Basic Metals	0.0	0.0	0.0	0.0
Textiles	3.1	2.2	2.1	0.8
Clothing	4.2	0.0	2.8	0.0
Transp. Equip.	0.0	0.0	0.0	0.0
Chemicals	3.1	2.8	4.4	1.3
Machinery	0.0	0.0	0.0	0.0
Paper Products	0.2	0.3	2.7	1.7
Petroleum & Coal	0.0	0.0	0.0	0.0
Rubber Products	0.0	0.0	0.0	0.0
Nonmetal Minerals	0.0	0.0	0.0	0.0
Wood Products	0.0	0.2	1.5	4.7

agriculture. In Japan, sectors with relatively small shares in 1965 tended to be relatively important suppliers of raw materials to the food processing sector (especially in 1960), and a tendency existed

Table 7

SIMPLE CORRELATION COEFFICIENTS BETWEEN EXPORT SUCCESS INDICATORS AND INTERINDUSTRY LINKAGES WITH FOOD PROCESSING

	JAPAN			
	Forward Linkages		Backward Linkages	
	1960	1970	1960	1970
1965 Market Share	-.459*	-.393	0.309	0.111
Change 1965-70	0.109	0.149	-.279	0.011
Change 1970-77	0.005	0.029	-.477*	-.214
	KOREA			
	Forward Linkages		Backward Linkages	
	1963	1973	1963	1973
1965 Market Share	0.249	-.251	0.166	0.836*
Change 1965-70	0.394	-.217	0.216	0.767*
Change 1970-77	0.575*	-.212	0.307	0.089

* At 90% significance level.

for those sectors for whom purchases from food processing were relatively important (in 1960) to lose market shares in the 1970s, relative to other tradable sectors' shares.

As with agriculture, linkages with food processing in Korea are somewhat positively associated with export success. Those with relatively large forward linkages in 1963 gained relatively higher export shares during the 1970s ($r = 0.575$). Those for whom purchases from food processing were important had high export shares in 1965 ($r = 0.836$) and were especially successful in increasing their competitive shares during the mid to late 1960s ($r = 0.767$).

4. Heavy Industry - The Key Sectors

The heavy capital goods industries have been identified as key sectors in the (unbalanced) growth strategy in many places. This was a key issue in the industrialization debates in the USSR in the 1930s. It under lay the logic of the Mahalanobis model as incorporated in India's Second Five-Year Plan. Rosenberg posited that the capital goods sector and, in particular, the machine tool industry played a critical role in the modernization process during and following the Industrial Revolution.

Identifying (a priori) these key sectors as basic metals, machinery, and chemicals, we repeat the analysis performed in the last two sections. In this section, we focus on the backward linkages from the key sectors. We posit, as a working hypothesis, that in rapidly industrializing economies, such as those of Japan and Korea of the past two decades, those tradable sectors for whom inputs from the key sectors play a major role should tend to develop a

Table 8

BACKWARD LINKAGES TO KEY SECTORS - BASIC METALS, MACHINERY, AND CHEMICALS (1970-73)

Suppliers:	JAPAN			KOREA		
Purchasers:	Basic Metals	Machin-ery	Chemi-cals	Basic Metals	Machin-ery	Chemi-cals
Misc. Mfg.	3.9	3.7	41.0	9.3	1.5	51.1
Basic Metals	72.5*	5.6	4.4	68.3*	4.4	10.5
Textiles	1.9	1.5	68.4	0.4	0.8	50.4
Clothing	1.9	1.3	14.4	0.4	0.6	10.6
Transport Equip.	29.3	27.1	2.3	32.1	32.8	4.7
Chemicals	3.3	4.9	53.8*	3.2	2.5	44.3*
Machinery	42.4	46.2*	3.2	50.7	36.0*	11.0
Paper Products	0.7	1.3	11.4	2.9	1.2	16.2
Petroleum & Coal	2.6	5.3	4.6	2.0	2.0	2.9
Rubber Products	4.3	1.1	45.8	2.1	0.8	21.3
Nonmetal Minerals	5.3	4.2	4.2	8.5	1.8	5.3
Wood Products	10.2	1.1	5.9	14.7	1.6	15.3

* Denominator includes intrasectoral purchases.

competitive edge.

Talbes 8 and 9 contain the relevant linkage indicators and correlations between these and the selected export-competitiveness indicators.

The results from Table 9 support the proposition that the extraordinary competitive share gains made by Japan on the international market were aided by backward linkages (purchases) from

Table 9

SIMPLE CORRELATION COEFFICIENTS BETWEEN EXPORT SUCCESS INDICATORS AND INTERINDUSTRY BACKWARD LINKAGES WITH BASIC METALS, MACHINERY AND CHEMICALS

Suppliers:	JAPAN					
Export Success	Basic Metals		Machinery		Chemicals	
Indicators:	1960	1970	1960	1970	1960	1970
1965 Market Share	-.006	.007	-.275	-.313	.312	.415
Change 1965-70	.613*	.557*	.583*	.596*	-.191	.036
Change 1970-77	.567*	.560*	.607*	.576*	-.334	-.214
Suppliers:	KOREA					
Export Success	Basic Metals		Machinery		Chemicals	
Indicators:	1963	1973	1963	1973	1963	1973
1965 Market Share	-.174	-.109	-.179	-.233	.097	-.043
Change 1965-70	-.184	-.152	-.218	-.227	.050	-.052
Change 1970-78	-.374	-.328	-.272	-.312	-.348	-.010

basic metals and machinery, both from 1965 to 1970, and from 1970 to 1977. Though not in the table, increased shares from 1965 to 1970 were also positively correlated with forward links to machinery ($r = 0.517$). No support is found that linkages from heavy industry were especially conducive to competitiveness for Korea.

5. Economic Social Overhead infrastructure - Public Utilities, Transportation, and Communication - The Key Sectors

It is reasonable to posit that a precondition for sustained export

success is the existence of an adequate economic infrastructure of social overhead capital and a close (backward) linkage (as a purchaser) with this infrastructure. This is examined here.

The only statistically significant connections between export success and the relative importance of the domestic social overhead

Table 10

BACKWARD LINKAGES FROM TRADABLE SECTORS TO PUBLIC UTILITIES, TRANSPORTATION, AND COMMUNICATION

Supplying Sector:	JAPAN				KOREA			
Purchasing	Pub. Util.		Trans. & Comm.		Pub. Util.		Trans. & Comm.	
Sector:	1960	1970	1960	1970	1963	1973	1963	1973
Misc. Mfg.	2.1	1.9	14.5	13.6	2.5	0.7	14.3	10.5
Basic Metals	10.9	12.2	26.4	25.4	6.3	11.4	20.2	19.3
Textiles	7.6	4.4	28.3	19.1	7.1	3.3	20.5	14.3
Clothing	0.6	1.8	11.5	19.3	0.6	1.4	8.4	14.5
Transport Equip.	2.2	2.0	11.3	13.3	3.1	1.2	12.0	8.4
Chemicals	9.3	11.0	16.9	16.7	6.1	9.5	20.9	23.6
Machinery	2.3	2.2	12.8	19.6	2.2	2.1	12.7	13.7
Paper Products	13.1	11.1	15.3	18.2	8.0	6.9	29.0	17.9
Petroleum & Coal	2.3	4.0	3.4	15.9	1.0	1.5	28.7	12.4
Rubber Products	2.3	2.6	9.7	10.5	4.6	3.3	24.6	9.0
Nonmetal Minerals	9.6	7.5	13.8	18.5	7.5	7.3	23.5	22.9
Wood Products	1.0	2.5	10.0	19.7	2.6	2.1	25.6	26.3

capital infrastructure relate to purchases from transportation and communication. Japan's structure of competitive shares in 1965 was positively associated with backward linkages to transportation and communication in 1960. No similar relationship was found for Korea. Rather, high shares in 1965 and relatively large share increases from 1965 to 1970 were associated with backward links to that sector in 1973 (but not earlier).

6. Vertical Integration - Intensive Use of Own-Sector Input

As was argued earlier, one should expect to find international competitiveness associated with the degree of sectoral vertical in-

Table 11

SIMPLE CORRELATION COEFFICIENTS BETWEEN EXPORT SUCCESS INDICATORS AND SOCIAL OVERHEAD CAPITAL INFRASTRUCTURE BACKWARD LINKAGES TO PUBLIC UTILITIES, TRANSPORTATION, AND COMMUNICATION

	JAPAN			
	Public Utilities		Transport & Comm.	
	1960	1970	1960	1970
1965 Market Share	-.229	-.338	.462*	.065
Change 1965-70	.209	.166	.268	-.079
Change 1970-77	.110	.113	.030	-.237
	KOREA			
	Public Utilities		Transport & Comm.	
	1963	1973	1963	1973
1965 Market Share	-.269	-.259	.100	.304*
Change 1965-70	-.400	-.340	-.033	.438
Change 1970-77	-.349	-.333	-.409	.004

* At 90% significance level.

tegration as reflected by the "own purchase" linkage: i.e., the proportion of all domestic materials purchases which originate in one's own sector. The results of relevant statistics are in Table 12.

A glance at Table 13 suggests that the relative importance of own-sector purchases tended to be greater in Japan than in Korea. Over the decade of the 1960s, a greater structural transformation is evident for Korea, such that Korea's pattern of sectoral self-sufficiency came to approximate Japan's by the early 1970s. This is summarized in Table 13.

Especially notable here is that Korea's pattern of own-sector purchases in 1973 was more similar to Japan's than to its own-sector purchases one decade earlier.

Table 14 presents the relevant correlations.

The only statistically significant results relate to the changes

which took place in the own-purchase ratios in each country. Both in Japan and in Korea, those sectors with relatively high export market shares in 1965 experienced decreases in self reliance with respect to purchases of domestic inputs during the 1960s and early 1970s. In Korea (but not Japan), this trend continued into the

Table 12

OWN PURCHASE LINKAGES - THE PROPORTION OF DOMESTIC SECTORAL PURCHASES ORIGINATING IN OWN SECTOR (PERCENT)

Supplying Sectors	JAPAN 1960	JAPAN 1970	KOREA 1963	KOREA 1973
Misc. Mfg.	11.3	17.7	7.7	5.3
Basic Metals	69.9	72.5	37.2	68.3
Textiles	96.2*	76.8*	62.9	38.8
Clothing	11.6*	10.5*	7.3	5.3
Transp. Equip.	26.9	36.5	20.9	19.1
Chemicals	35.2	53.8	7.9	44.3
Machinery	34.1	46.2	27.8	36.0
Paper Products	46.5	55.8	45.9	48.4
Petroleum & Coal	10.5	16.1	0.1	6.3
Rubber Products	5.3	9.9	9.2	1.6
Nonmetal Minerals	11.8	18.1	14.5	14.1
Wood Products	18.6	23.5	34.6	14.8

* The Japanese sector "Textiles and Clothing" was distributed to each component sector using the Korean ratios.

Table 13

CORRELATION COEFFICIENT BETWEEN THE RELATIVE IMPORTANCE OF OWN-SECTOR PURCHASES

	Japan 1960	Japan 1970	Korea 1963	Korea 1973
Japan 1960	1			
Japan 1970	0.948	1		
Korea 1963	0.844	0.773	1	
Korea 1973	0.796	0.924	0.628	1

Table 14

CORRELATION COEFFICIENTS BETWEEN OWN-PURCHASE RATIO AND EXPORT SUCCESS INDICATORS

Proportion of Purchased Domestic Inputs Originating in Own Sector in:	JAPAN			KOREA		
Export Success Indicators:	1960	1070	1960-70	1963	1973	1963-73
1965 Market Share	.236	.013	-.682*	.200	-.223	-.488*
Change 1965-70	.266	.421	.297	.075	-.306	-.455*
Change 1970-77/78	.064	.200	.333	-.034	-.379	-.425

* At 90% significance level.

1970s as the self-reliant sectors of the 1960s lost relative market shares. The correlation between changing own-purchase ratios and 1977 export shares was even greater ($r = -0.497$) than with the initial 1965 share pattern.

These results contradict the stated hypothesis and lead one to view the relationship in quite a different light-export competitiveness tends to be hurt by high degrees of self-sufficiency (or vertical integration).

D. The Results - By Market

This section will discuss how the findings in Section III are modified when export-success within separate markets, rather than for the world as a whole, is examined.

1. Capital Intensity

It had been found in Section C.1 that Japan was especially competitive in 1965 and 1970 (as reflected by world market shares) in labor-intensive sectors. An examination of shares in separate markets reveals that this was true only in the MDC and USA markets. In the LDC market, Japan was found to gain market shares in the 1970s in sectors which were capital intensive in 1960 and in 1970.

Korea's export success indicators were not found to be statistically related to capital-intensity measures. This was true as well within each of the markets studied.

2. Linkages with Agriculture

Calculations corresponding to those presented in Table 5 were repeated for each market. In Table 5 it had been found that world market shares in 1965 and 1970 (not noted there) were negatively associated with forward linkages to agriculture in 1970. Purchases from agriculture both in 1960 and 1970 were associated with relatively decreasing shares throughout 1965 to 1977.

The negative association between market shares in 1965 and 1970 and forward linkages to agriculture in 1970 in Japan was found to hold for each individual market except OPEC, where the relationship was not significant.

The negative relationship between decreasing market shares and backward linkages was found to be true only in the MDC market. In the U.S. and LDC markets, the backward linkages were associated with decreasing shares only in the 1970s.

For Korea, backward linkages to agriculture were found (Table 5) to be associated with relatively large export shares in 1965, and in relatively increasing shares from 1965 to 1970. This was largely typical within each market, with the major exception of the LDC market, where none of these relationships were found to be true. Those to OPEC were quite significant.

3. Linkages to Food Processing

The calculations presented in Table 7 were repeated for each market. For Japan the two significant results noted there were a negative correlation between 1965 world market shares and forward linkages to food processing in 1960, and between backward linkages to that sector in 1960 and share increases during the 1970s. The first result was found not to apply within any one single market, while the second was replicated within every component market except the U.S.

For Korea, two significant results were found. The first was a positive relationship between a forward link to food processing in 1963 and gains in market shares from 1970 to 1978. The second, a positive relationship between large market shares and share gains

in the 1960s and large backward linkages to food processing. These results were representative of the MDC (and U.S.) markets. None were significant in the LDC or OPEC markets. On the other hand, a strongly positive correlation (.77) was found between 1973 backward links to food processing and increasing shares in the 1970s, as well as with 1977 market shares in the LDC markets.

4. Linkages to Heavy Industry

Calculations corresponding to those in Table 9 were repeated for each market. The four significant relationships found applicable to Japanese backward links to the machinery sector were found to reflect only exports to the MDC (and U.S.) markets. In LDC markets, share gains were not significantly associated with the linkages, while in OPEC, they were associated only with share gains in the 1970s. The four significant relationships between export success and Japanese links to the basic metal sector again held in the MDC market (though in the U.S. market, only for 1965-70), and also in the OPEC market. Again, no significance attached to these relationships for Japanese exports to the LDCs.

For Korea, the lack of significance indicated in Table 9 was found to be generally representative of each component market.

5. Linkages to Social Overhead Capital

The calculations underlying Table 11, related to sectoral purchases from public utilities and transportation and communications (T&C), were repeated for each market.

The results in Table 11 show that for both countries no statistically significant relationship related export success and purchases from the public utilities sector. For Japan, 1960 linkages to T&C were related to large world export shares in 1965 (and even more so with 1970 shares, with $r = 0.584$); while for Korea, 1965 market shares were positively associated with 1973 linkages to T&C.

The following are the cases in which relationships within individual markets were found to differ from those enumerated above.

a. Japanese backward linkages to public utilities, both in 1960 and (even more so) 1970, were positively associated with increases in OPEC market shares from 1965 to 1970.

b. The positive association between Japan's 1965 market shares and the 1973 linkages to T&C was found to be true only in the LDC market (not in the MDC, U.S., or OPEC).

c. For Korea, 1963 backward linkages to public utilities were found to be positively related to 1965 shares in the LDC market.

d. Korean 1977 world market shares were not significantly correlated with linkages to public utilities (not shown in Table 11). However, in the MDC and (especially) the U.S. markets, the correlation of these 1963 linkages with 1977 market shares are significantly negative.

e. The positive correlation between the size of the 1965 Korean market share and the 1973 linkages with T&C were found not to apply in the LDC or OPEC markets.

6. Vertical Integration - Own Purchase Ratios

The calculations discussed here were similar to those which underly Table 14. The negative relationship between the change from 1960 to 1970 in the Japanese own-purchase ratio (OP) and the 1965 market share was found to hold in every component market. It was most significant in the LDC market ($r = -.876$).

The two significant (negative) relationships found in the case of Korea were found to be significant only in the OPEC market. In the LDC market, the 1965 market share was not related to changes in OP. However, in the LDC (and in OPEC), the 1965 market share was positively associated with the 1963 OP ratios.

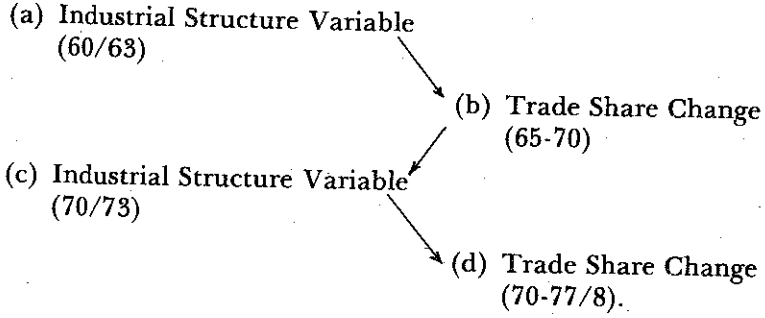
E. Directional Causality

Theoretically, it is quite possible that various structural patterns defining sectoral interrelationships, factor use, and degree of self-sufficiency may affect the degree of international competitiveness of the commodities provided in these sectors. This, indeed, is the general proposition explored in this chapter. However, it is possible that causality runs in the opposite direction. This is, a sector may attain a strong international competitive position, and thereupon having thus attained quality standards or economics of scale develop significant linkages with other domestic sectors.

Since our posited hypothesis assumes the causality to run from

economic structure to export competitiveness, it would be remiss not to test, albeit casually, the direction indicated by the findings. We employ a modified Sims test[6] procedure. If X_t is correlated with Y_{t+i}, but not with Y_{t-i}, then we will infer that causality runs from X to Y, rather than from Y to X.

We apply the test to the market shares for 1965, 1970, and 1977 on the one hand, and the various structural indicators related to 1960/63 and 1970/73, respectively. The chronological order of their appearance is:



The inferences can be drawn as follows:

Industrial Structure affects export success:
- if (b) is significantly correlated with (a), but not with (c);
- if (c) is correlated with (d), but not with (b);
- or if (a) is correlated with (d).

Trade patterns primarily affect industrial structure
- if (b) is correlated with (c), but not with (a)

Table 15 indicates by checks those relationships which are significantly correlated. Those cases in which no significant correlations were present were omitted. Unless otherwise noted, significance is at 90% level.

The results in Table 15 support the following inferences:

PROPOSITION A: *Industrial structure determines comparative advantage* in the following cases:
1. Japan - backward linkage to agriculture
   - backward linkage to basic metals
   - backward linkage to trade communication
2. Korea - forward linkage to food processing

6 Sims (1972).

Table 15

SIGNIFICANT CORRELATIONS BETWEEN EXPORT MARKET SHARES IN MDC MARKETS, AND ECONOMIC STRUCTURE INDICATORS*

	JAPAN			KOREA		
Trade Share Dates:	1965	1970	1977	1965	1970	1978
Structural Indicators:						
Capital/Labor (1960/63)	x	x	–	–	–	–
Capital/Labor (1970/73)	x	x	–	–	–	–
FLAG (1960/63)	–	–	–	–	–	–
FLAG (1970/73)	x	x	–	–	–	–
BLAG (1960/63)	x	x	–	–	–	–
BLAD (1970/73)	–	–	–	x	x	–
FLFP (1960/63)	–	–	–	–	–	x
FLFP (1970/73)	–	–	–	–	–	–
BLFP (1960/63)	–	–	–	–	–	–
BLFP (1970/73)	–	–	–	x	x	–
BLBM (1960/63)	–	–	x	–	–	–
BLBM (1970/73)	–	–	x	–	–	–
BLPU (1960/63)	–	–	–	–	–	–
BLPU (1970/73)	–	–	–	–	–	–
BLTC (1960/63)	x	–	–	–	–	–
BLTC (1970/73)	–	–	–	x	x	–

FL = Foreward linkage
BL = Backward linkage
AG = Agriculture
FP = Food processing
MA = Machinery
BM = Basic metals
PU = Public utilities
TC = Transportation & Communication
OP = Own purchase ratio
* Unless designated, significance at 90% level.

PROPOSITION B: *Comparative advantage primarily affects industrial structure* in the following cases:

1. Japan - forward linkage to agriculture
2. Korea - backward linkage to agriculture
   - backward linkage to food processing
   - backward linkage to trade and communication

Thus, if propositions A and B are viewed as logically mutually

exclusive, then neither can be accepted, since support was found in different cases for both.

If we accept the possibility that both may have validity, then the following conclusions may be drawn. For Japan the major causality is from economic structure to comparative advantage. The decreasing role of agriculture as a purchaser of domestic inputs in the early 1960s released resources which were successfully diverted to the foreign sector in the mid 1960s and early 1970s. Industries which tended to rely on inputs from the domestic basic-metals sector throughout the 1960s and early 1970s tended to develop international competitiveness in the late 1970s. This supports the view that the heavy industry sectors played a crucial role in the development process of Japan, which follows in the evolutionary footsteps of the U.K. and other pioneers of the Industrial Revolution. Finally Trade and Communication inputs in the early 1960s played significant roles in determining Japanese export success.

In Korea (unlike Japan), most cases indicated causality going from trade to economic structure. The emergent internationally competitive sectors tended to boost subsequent production of primary (agriculture), secondary (food processing), and tertiary (trade and communications) sectors as suppliers to the export sectors. The single indication of a feedback relationship, from economic structure to trade, was the growing role of the internationally competitive sectors as suppliers to the food processing sector.

A tentative hypothesis, which is suggested by the data of the late 1960s and 1970s, is that Japan's pattern of comparative advantage was largely a function of the structure of Japan's economy. On the other hand, Korea experienced "export driven growth" in the sense that domestic sector interrelationships were largely determined by the ex-ante establishment of international export competitiveness.

F. A Multivariate Regression Model

The scope of this exploratory project does not include specifying the model explaining export success. Nevertheless, it is interesting to note the ballpark range of how well these input-output structural considerations explain export success. Accordingly, least square estimates were made, utilizing no more than two explanatory variables in each equation (due to the small availability

of degrees of freedom). The variables were chosen from those which had significant correlations with the dependent variables. The results are:

JAPAN

1965 Share = 13.93 - 1.63 (1960 K/L) - 0.35 (Change in Own Purchase Ratio 1960-1970)
(1.2) (0.54) (0.09)

$\bar{R}^2 = 0.68$

(Change in Share) 1965-1970 = 0.62 - 0.04 (1960 BLAG) + 0.042 (1960 BLBM)
(0.70) (0.02) (0.022)

$\bar{R}^2 = 0.41$

(Change in Share) 1970-1979 = 4.03 - 0.16 (1960 BLAG) - 1.49 (1960 BLFP)
(3.29) (1.05) (0.60)

$\bar{R}^2 = 0.59$

KOREA

1965 Share = 0.10 + 0.42(1973 BLFP) - 0.011 (Change in Own Purchase Ratio 1963-1973)
(0.14) (0.09) (0.007)

$\bar{R}^2 = 0.71$

(Change in Share) 1965-1970 = 0.29 + 0.93 (1973 BLFP) - 0.026 (Change in Own Purchase Ratio 1963-1973)
(0.41) (0.28) (0.022)

$\bar{R}^2 = 0.57$

(Change in Share) (1970-1978) = 3.49 + 2.66 (1963 FLFP) - 10.19 (1963 K/L)
(2.41) (6.05)

$\bar{R}^2 = 0.38$

Figures in parentheses are standard errors of estimate.

The results are fairly encouraging. Roughly 70% of the in-

tersectoral differences in the 1965 market shares for each of the two countries is explained. Japan's international shares are seen to reflect a (positive) utilization of labor-intensive techniques and a positive degree of integration with other domestic sectors (rather than a high degree of enclave-like own-purchase vertical integration).

The latter factor somewhat explains Korea's relative competitive successes, as reflected by its 1965 sectoral international market shares. The former variable, capital (or labor)intensity, was not found to be significant in this context. However, a degree of economic integration, as a purchaser of materials, from a typically dynamic sector in rapidly developing LDCs—food processing—proved an important determinant of Korean internatioal competitiveness in the 1960s.

Changes in international competitiveness were also fairly well explained by this model. For both countries, between 40% and 60% of the intersector differences in the market share growth experienced was explained. For Japan, increased international competitiveness during the mid to late 1960s was negatively associated with earlier (1960) links to domestic agriculture, and positively associated with economic links to the domestic basic metals industry. During the 1970s, only the former, with a similar association with food processing, explained the changing international shares.

For Korea, the same domestic economic integration factors which explained the 1965 shares continued to explain share changes from 1965 to 1970, though the own-purchase variable was no longer statistically significant. Korea's changes in international competitiveness during the 1970s are seen to be, in part, a function of labor-intensive techniques—the same factor which helpd determine Japan's relatively dominant positions a decade earlier.

G. Summary

Competitive international market shares and changes in these shares were found to be statistically associated with various measures of capital intensity and intersectoral economic interdependence in both countries. Japan's competitive position in the 1960s was associated with labor-intensive techniques. Korea gained competitive shares primarily in the products of labor-intensive industries.

Various sectors were seen to play key roles in affecting the international competitiveness of the two countries, either as suppliers of materials or as providers of domestic outlets for the tradable sectors. Some important differences were noted, notably the role of food processing—a key industry in the process of economic development, as LDCs shift away from preponderant dependence on agriculture. Economic linkages to this key sector tended to give Korean export competitiveness a boost, while retarding that of Japanese exports.

It was noted that, by and large, export success was primarily affected by prior domestic economic structure linkages in Japan; whereas, in Korea, domestic structural transformation was more likely to be affected by prior success in attaining large international market shares.

Finally, it was found that a simple specification of the model was able to explain from a half to over two-thirds of the intersectoral export success in both countries.

H. Appendix V-1 - Concordance Between Twelve Import-Output Sectors, and Ninety-four SITC Commodity Codes

Miscellaneous Manufacture	812, 821, 831, 861, 864, 891, 892-5, 897, 899
Basic Metals	671-9, 681-9, 691-6, 698, 698
Textiles	651-7
Clothing	611-13, 841, 842, 851
Transportation Equipment	731-5
Chemicals	521-4, 531, 533, 541, 551, 553, 554, 561, 571, 581, 599
Machinery	711, 712, 714, 715, 717-9, 722-6, 729
Paper	641, 642
Petroleum and Coal Products	521
Rubber Products	629
Nonmetallic mineral products	661-6
Wood Products	631, 632

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