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Interindustry Linkages and Industrial Development

by

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Abstract

This paper compares the changing patterns of intermediate input use, the levels of overall and domestic industrial linkages, and import content of domestic final demand and exports among nine countries and over time, based on input-output data. A systematic shift in intermediate demand from primary to manufactured products was found to accompany economic development, and distinct differences in the overall linkages and import contents between Korea and Taiwan on the one hand and Turkey, Colombia, and Mexico on the other were pointed out, which were then attributed to the differences in export structure and in trade and industrial policies.

Interindustry Linkages and Industrial Development*

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I. Introduction

One of the central concerns of industrial development is the modernization and expansion of manufacturing production. Countries at an early stage of development are typically primary-oriented, and manufacturing production is limited to those using relatively simple or traditional technology. Industrial development aims at introducing and adopting more advanced modes of production that are offered by modern technology, thereby improving efficiency of producing existing goods or enabling production of commodities that could not formerly be produced domestically. Such an attempt requires, among other things, establishment of modern factories and firms, training of labor force for necessary skills, and fostering enterpreneurial and managerial skills for proper operation of new modes of production.

Much of the capital goods required for such a transition is usually not produced by countries at an average level of development, and their supply usually depends heavily on imports. Indeed, in an average developing

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country, imports of machinery and equipment constituted about 30% or more of total merchandise imports during the past two decades,[1] and the available data suggest that the proportion of imports in total domestic demand for capital goods is also very high.[2] The high import dependence of capital-goods supply is one of the major reasons for foreign exchange difficulty that many developing countries face.

Another important component of imports in developing countries is intermediate goods. The introduction of new modes of production carries with it the changes in the mix of material inputs in production. The structure of intermediate inputs required in a modern mode of production is inherently different from that in a more traditional one, the former requiring more refined and uniform materials of specific kinds in large quantity. Depending on the types of intermediate goods, developing countries depend heavily on imports of these products to sustain the new modes of production, until adequate domestic production of these goods is made possible in the course of industrialization. Available data indicate that imports of basic intermediate goods (defined as rubber and chemical products, nonmetallic minerals, coal and oil products and basic metals) account for 20% or more of total imports even in relatively successful developing countries, and that the proportion of imports in domestic demand for these products exceeds 20% in many cases.[3] Thus, along with capital-goods imports, intermediate imports constitute another important factor that exerts pressure on foreign exchange in many developing economies.

Intermediate goods have received relatively little attention in the development literature. However, the changes in intermediate-input use

capture an important aspect of changes in production technology and in domestic supply capability that accompany industrial development. In this paper, we shall examine the role of intermediate inputs in industrial development based on 30 input-output tables collected from nine economies: Republic of Korea, Taiwan Province, Turkey, Colombia, Mexico, Japan, Israel, Norway and Yugoslavia. The data were compiled as part of the World Bank research on the sources of industrial growth and structural change, which were aggregated to a comparable 14-sector classification in the present study.[4/] We shall first examine the changes in the structure of intermediate demand and in the intermediate input intensity of production. We shall then analyze the changes in interindustry linkages that result from intermediate-goods transactions and their differences across countries. In doing so, we shall introduce a measure of interindustry linkages that can bring out characteristic features of each input-output matrix. The measure is applied to input-output matrices both with and without the imported intermediates in order to examine the extent of domestic industrial base and the role of imported intermediate goods in the overall intermediate-input technology. The observed differences in linkages across countries are then related to the import contents of domestic and foreign demands and to the structure of exports with a hope to gain insights into the relationship between the development strategy adopted and the technological adjustments it requires.

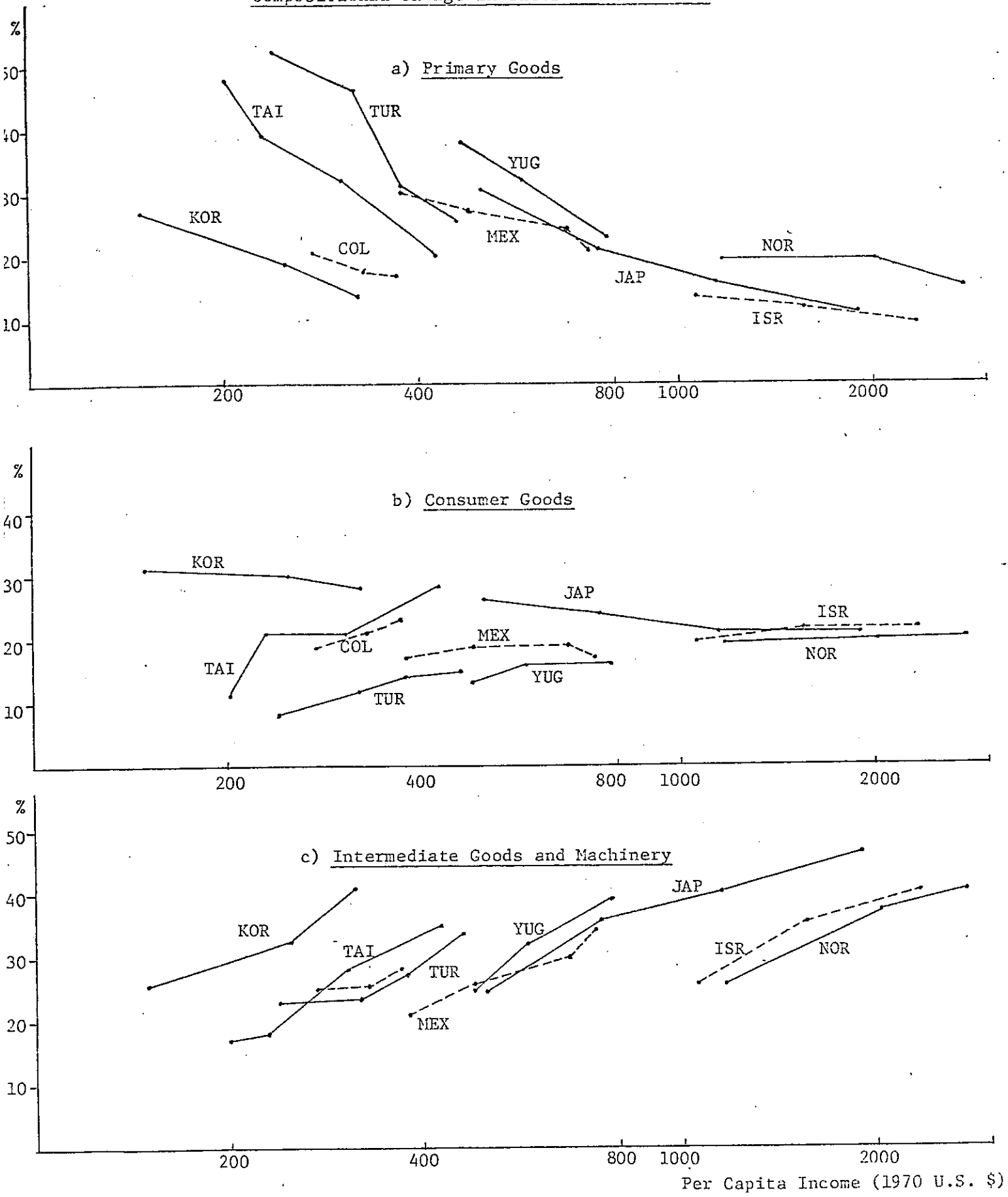
II. Changing Patterns of Intermediate Input Use

Recent comparative studies on industrial growth and structural change have produced a great deal of empirical evidences on the distinct shift of production from primary to manufacturing in the course of development.[5] A related set of studies has analyzed the forces underlying the observed change in terms of changing structures of domestic and foreign demands, import substitution, and changes in intermediate-input technology.[6] In these studies, much attention was paid to the role played by domestic demand growth, export expansion and import substitution, and consequently the importance of intermediate inputs was given only a limited focus.[7] In this section, we shall bring to the fore the patterns of changes in intermediate input use by examining the changes in the structure of intermediate demand and in the intermediate input intensity of production associated with rising income.

Based on the input-output data, the changing composition of intermediate demand is compared among the nine countries in Figure 1, grouping intermediate demand into three categories: primary goods, consumer goods, and intermediate goods and machinery.[8] Per capita income is measured in constant 1970 U.S. dollars.[9] A notable change in the structure of intermediate demand is observed in Figure 1. There is a distinct shift in the composition of intermediate demand from primary to manufacturing products. The proportion of intermediate goods originating in the primary sector declined steadily with income in all the nine countries. Of the manufactured intermediates, the part originating in the consumer-goods industry appears to stabilize at about 20% at higher income, although there is a wider variation at low income levels. Thus, the rapid rise

Figure 1

Compositional Change in Intermediate Demand



in the relative importance of manufactured intermediates is largely due to the increased use of other manufactured products as intermediates, such chemical products, basic metals, petroleum products, and machinery. In all countries except Colombia, the proportion of these products in total intermediate demand has risen to more than 30% by the last input-output benchmark year.

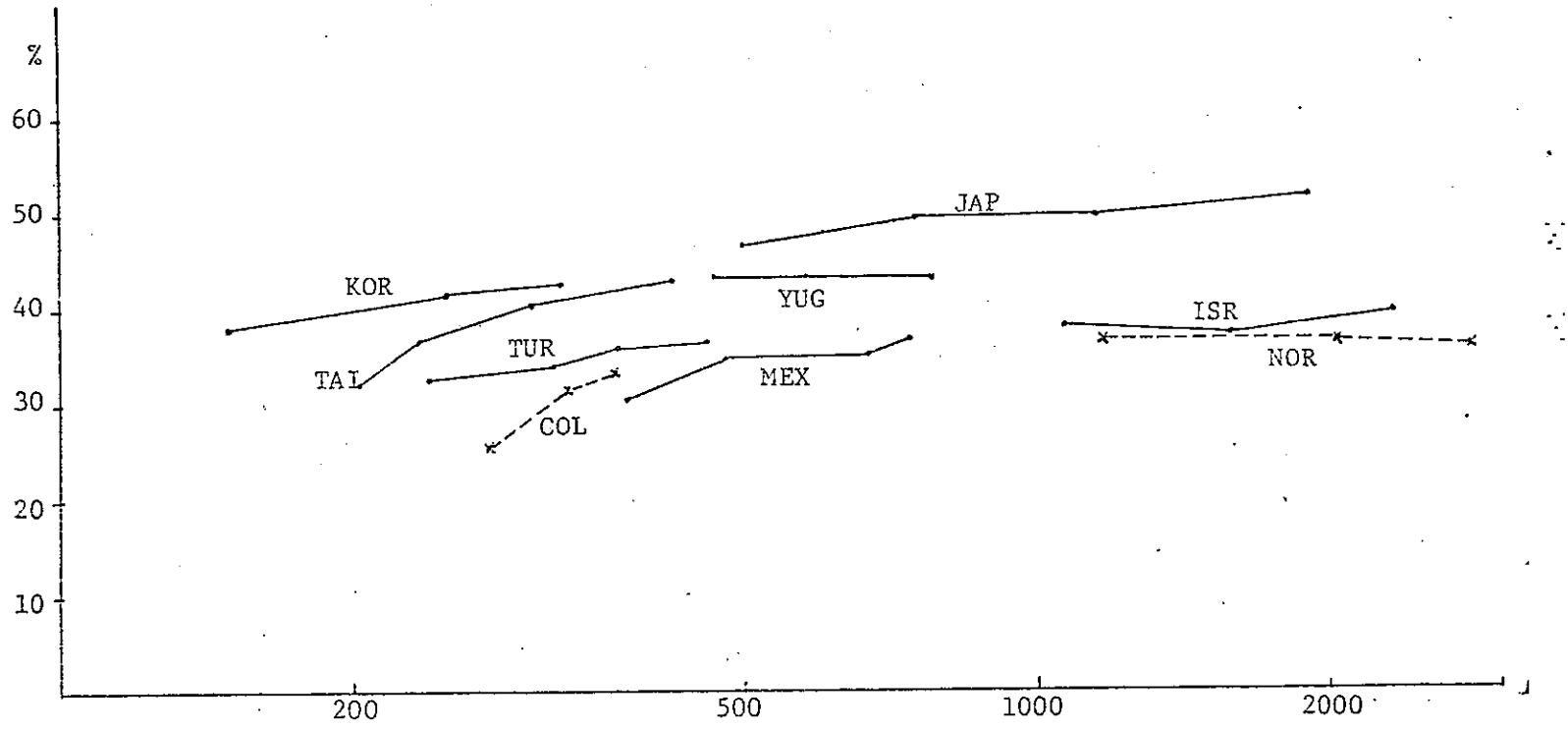
The observed trend in the composition of intermediate demand may be attributed to a number of factors. Newly introduced manufacturing technologies may require intermediate products of uniform quality in large quantities, which are typically supplied by manufacturing industries. There may be price substitution effects of replacing primary intermediates by manufactured products, as the relative price of primary and manufactured goods change as development proceeds. Furthermore, there is an increasing trend in manufacturing industries for subdividing production processes into specialized components, resulting in an increased flow of intermediate goods among them. Although these effects are difficult to separate, together they account for the rapid change in the structure of intermediate demand observed above.

The intermediate demand constitutes a substantial part of the total (intermediate plus final) demand in many countries. For the nine countries in our study, the ratio of intermediate to total demand[10/] ranged largely from 30-50% for the whole economy and 35-60% for manufacturing (Figure 2). Given the importance of intermediate demand, the distinct shift in the composition of intermediate demand shown in Figure 1 should be regarded as an important element behind the systematic shift in production from primary to manufacturing that is known to accompany economic

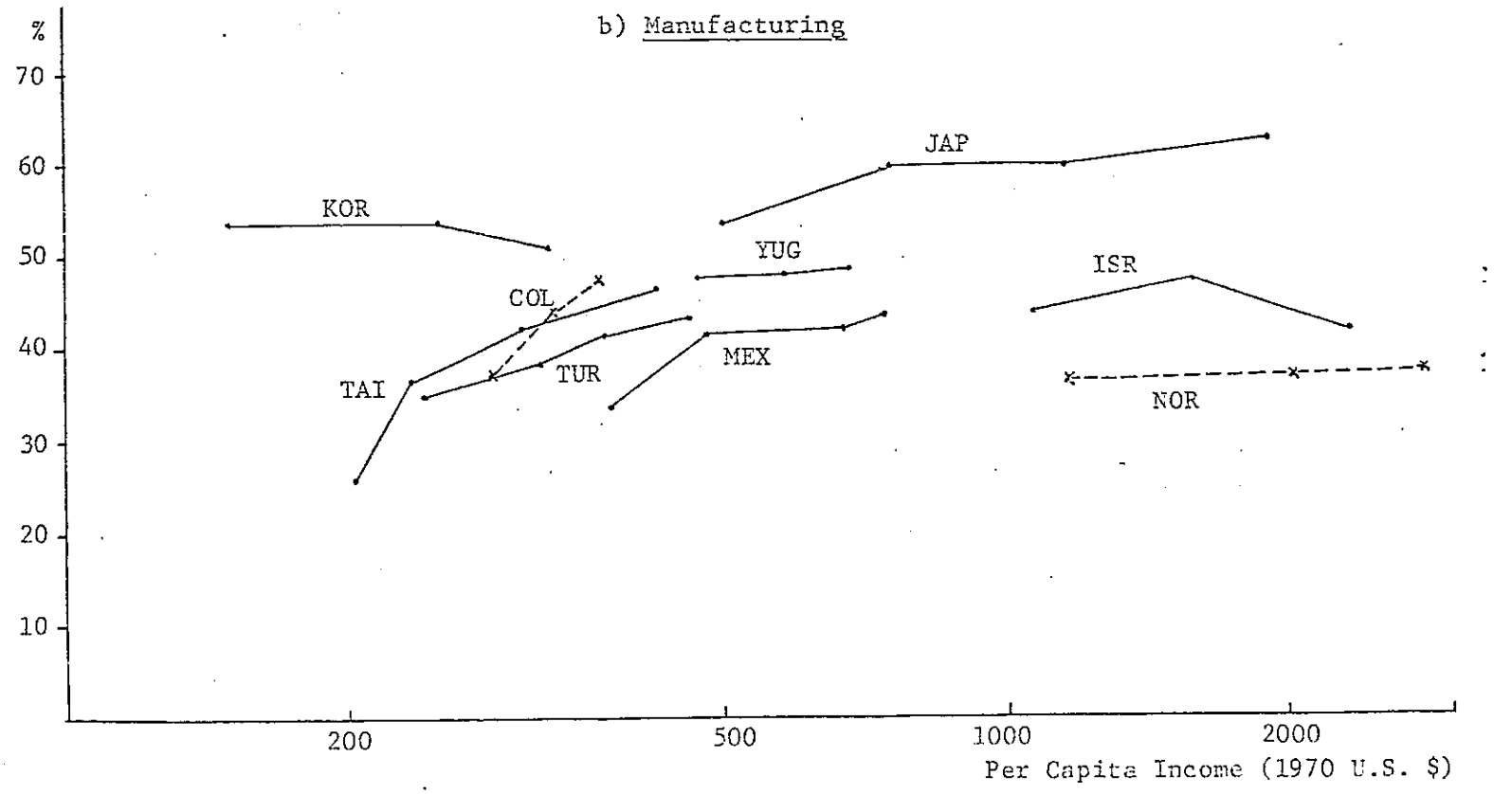
Figure 2

Intermediate Demand as Ratio to Total Demand

a) Economy



b) Manufacturing

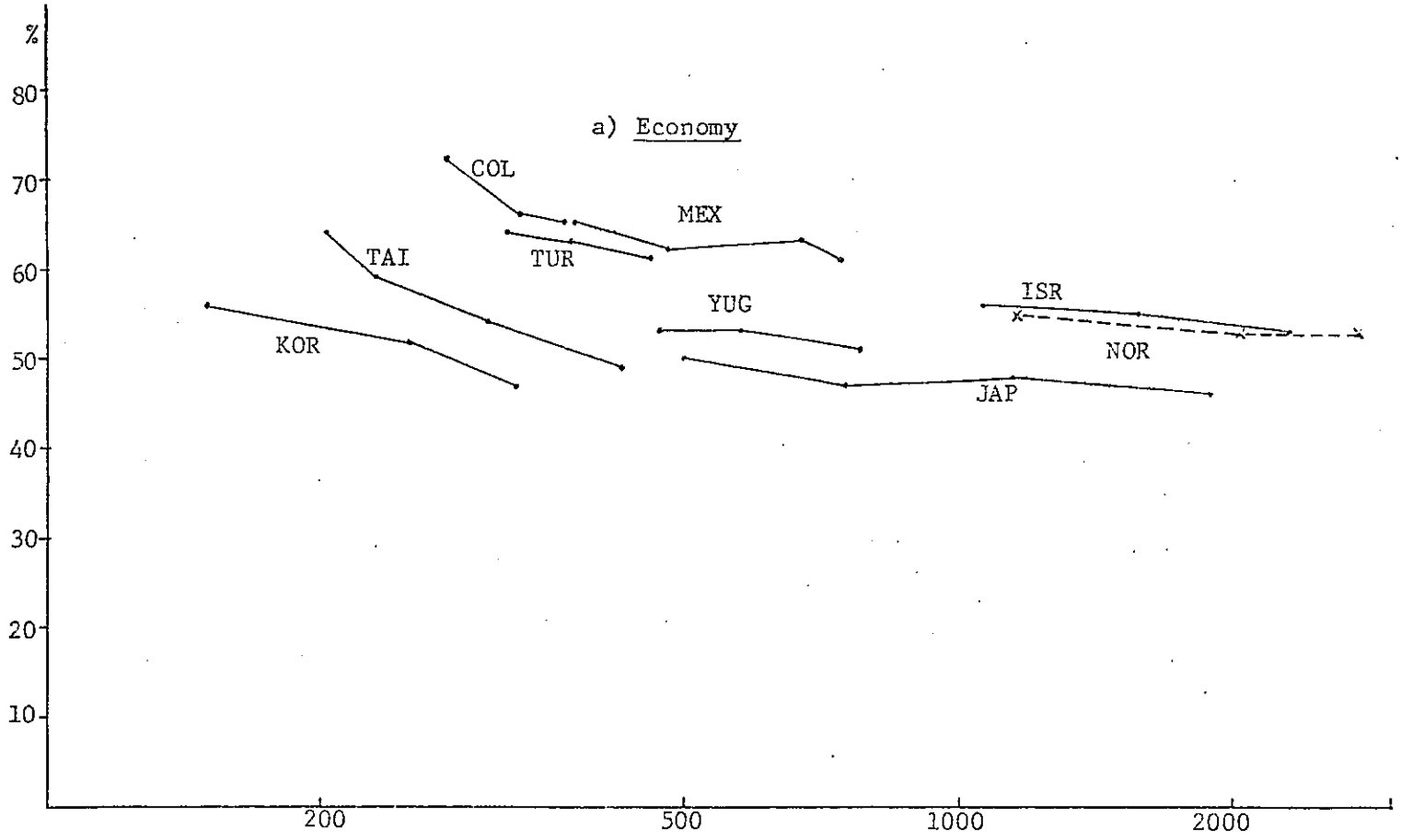


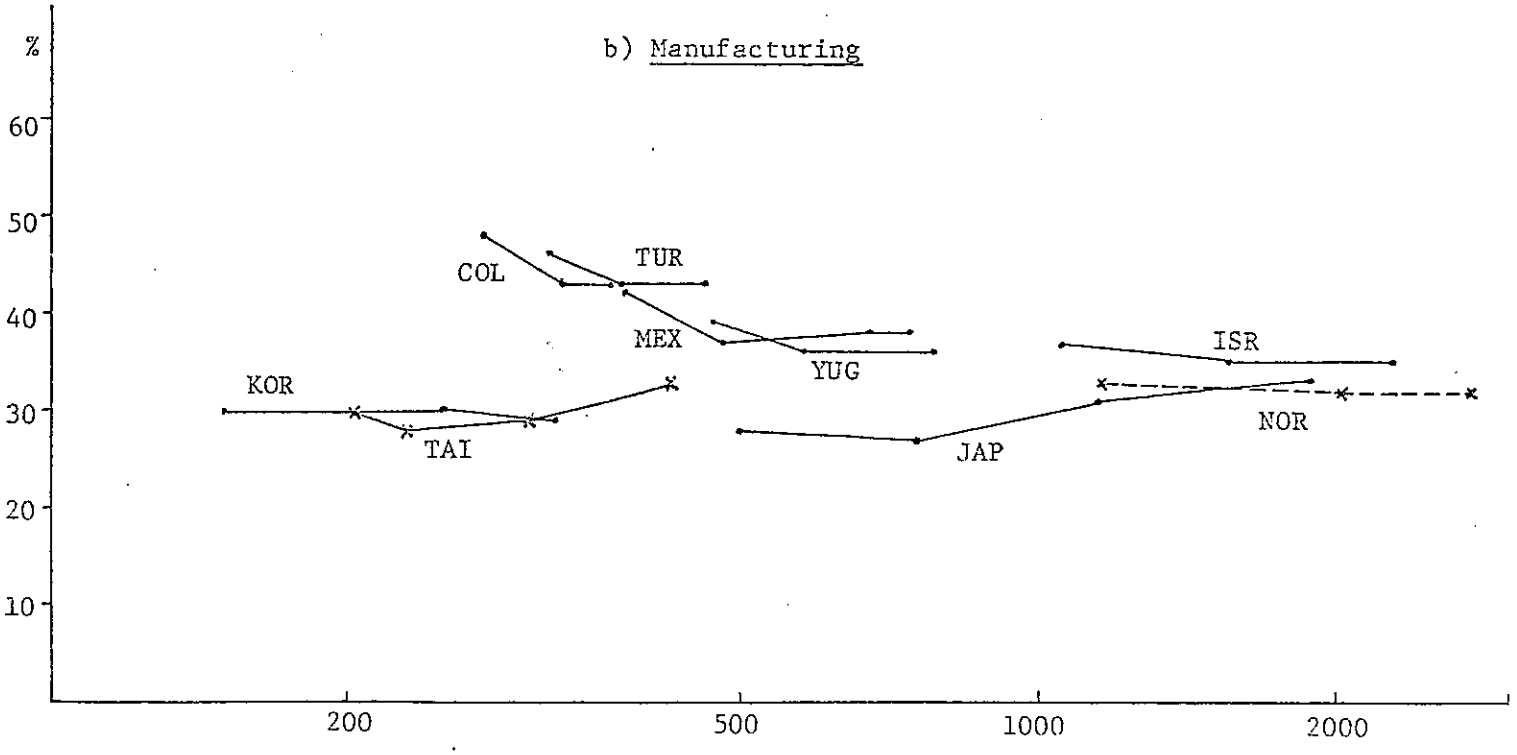
development.

An alternative way of looking at the changes in the pattern of intermediate input use is to examine the intermediate input intensity of production, or its counterpart, the value-added coefficient. In Figure 3, the value-added coefficients of the nine countries are compared for the whole economy and for the manufacturing industry. In all countries, the economy's value-added coefficient declined gradually with income, reflecting an increase in the intermediate-input intensity of production over time. Two main reasons are behind this trend. First, as Syrquin (1981) has pointed out, there is a systematic decline in the value-added coefficient of the agricultural sector which dominates the value-added coefficient of the primary sector. Second, the shift in the structure of production from primary to manufacturing results in a decline in the economy's value-added coefficeint. As shown in the second panel of Figure 3, the value-added coefficient for the manufacturing industry remains rather stable and ranges around 35% which is well below that of the entire economy. Since the value-added coefficients of the primary and the services sectors range between 50-80% for our sample countries, the increase in the share of manufacturing production necessarily results in a decline in the economy's value-added coefficient. In other words, the structural shift in production that accompanies development is characterized by a shift from high value-added sectors to low value-added sectors, resulting in higher intermediate input intensity for the whole economy.

Figure 3

Changes in Value Added Coefficients





III. Analysis of Interindustry Linkages

The general increase in the economy's intermediate input intensity and the compositional shift in intermediate demand from primary to manufactured products observed above indicate that the interdependence among industries increases with economic development. Such a trend is often referred to in the input-output literature as deepening and widening of interindustry relations, but the empirical validity of the phenominon over time and across countries have not yet been subjected to adequate scrutiny. In this section, we shall exploit 30 comparable input-output tables for the nine countries to gain some insights into the nature of changes in interindustry linkages over time and the differences across countries.

A. Linkage Measure

There is a bulk of literature on interindustry linkages. Most of the work has been stimulated by Hirschman's (1958) theory of unbalanced growth which emphasizes strategic development of industries having high linkage effects to other industries, and concentrated on identifying "key industries" that have greater possibilities of spreading growth impulses to other sectors of the economy. The typical measures of interindustry linkages used in these studies are: 1) Chenery and Watanabe's (1958) u and w coefficients, which are the ratio of a sector's (or the economy's) total intermediate input purchases to output and the ratio of intermediate demand to total demand for a sector's (or economy's) output, respectively; and Rasmussen's (1956) "power of dispersion", which is defined by the column sum of the Leontief inverse matrix divided by its average over all industries. A number of intercountry comparisons based

on these measured have been conducted, among the notable ones being Chenery and Watanabe (1958), Yotopoulos and Nugent (1973), Shultz (1976), and Martin and Rodoriguez (1979).

While interesting in its own right, the analysis of interindustry linkages focused on key industries failed to pay attention to the change in the extent of industrial linkages that takes place with industrial development or its differences among countries. Indeed, very little work has been done to compare the level of interindustry linkages across countries and over time. A few exceptions are: Robinson and Markandya (1973), who used the number of transactions required for the transmission of effects of a change in an input-output system as a measure of an economy's complexity and compared the results for six countries; and Syrquin (1981), who applied standardized output compositions to input-output matrices of nine countries to bring out the difference in intermediate input intensity among countries.

In this section, we take the denominator of Rasmussen's power of dispersion as a measure of economy's level of interindustry linkages. Letting A denote the input-output coefficient matrix of an economy and r_{ij} the elements of the Leontief inverse, $(I-A)^{-1}$, our linkage measure is expressed as

$$(1) \qquad L = \left(\sum_{i=1}^{n} \sum_{j=1}^{n} r_{ij} \right)/n,$$

where n is the number of sectors in the input-output classification. Each column of the Leontief inverse describes the amount of goods directly and indirectly required in all sectors in order that the sector in question deliver a unit of its product to final demand. Hence, the sum of

all elements of the Leontief inverse divided by the number of sectors shows the total value of products directly and indirectly required for the economy to cater to a unit of final demand distributed evenly over all sectors. The excess of this measure above unity corresponds to the intermediate demand created through interindustry linkages. Therefore, the higher the linkage measure, L, the stronger the industries will be inter-related through intermediate-goods transactions.

Partial justification for the above linkage measure is provided by its relationship to the Frobenius root of the input-output matrix.[11/] The Hawkins-Simon condition, or equivalently the nonnegative invertibility, of an input-output coefficient matrix, A, is necessary and sufficient for A to have a Frobenius root, λ^*, which is less than one. Let x^* be the characteristic vector associated with λ^*, which is nonnegative and nonzero.[12/] That is,

$$Ax^* = \lambda^* x^*, \text{ where } 0 \leq \lambda^* < 1, \text{ and } x^* \geq 0.$$

This relationship can be written as

$$(I-A)x^* = (1-\lambda^*)x^*,$$

which we solve for x^* on the left-hand side to yield

$$x^* = (1-\lambda^*)(I-A)^{-1}x^*.$$

Since $x^* \geq 0$, we can normalize x^* so that $\sum_{i=1}^{n} x_i^* = 1$. Hence, denoting the elements of $(I-A)^{-1}$ by r_{ij}, we derive

$$1 = \sum_{i=1}^{n} x_i^* = (1-\lambda^*) \sum_{i=1}^{n} \left(\sum_{j=1}^{n} r_{ij} x_j^* \right),$$

or

$$(2) \qquad \sum_{j=1}^{n} \left(\sum_{i=1}^{n} r_{ij} \right) x_j^* = \frac{1}{1-\lambda^*} .$$

Comparing the left-hand sides of (1) and (2), we see that the only differnce between the two is the weights used in averaging the column sums of the Leontief inverse. Moreover, both indexes are bounded by the same upper and lower bounds, $\max_j\{\sum_{i=1}^{n} r_{ij}\}$ and $\min_j\{\sum_{i=1}^{n} r_{ij}\}$.

Equation (2) shows that the weighted average of the column sums of the Leontief inverse is an increasing function of the Frobenius root, λ^*. The Frobenius Theorem states that, for two nonnegative matrices, A and B, if $A \geqq B$, then $\lambda^*(A) \geqq \lambda^*(B)$, where $\lambda^*(A)$ and $\lambda^*(B)$ are the Frobenius root of A and B, respectively.[13] Therefore, the wider and the denser the input-output matrix, the larger the properly weighted average of the elements of the Leontief inverse. The linkage measure (1) utilizes uniform weights rather than the composition of the characteristic vector associated with the Frobenius root, but we use the same weights for the input-output matrices to be compared largely because we wish to find the characteristic differences of input-output relations across countries and over time.

There are two alternative ways to calculate the above linkage measure for an economy's input-output matrix. If one uses the input-output matrix inclusive of imported intermediates, the resulting linkage estimate captures the extent of inter-link among industries implied by the underlying intermediate-input technology. We shall call the linkage index thus calculated as the overall linkages. In turn, if one uses the input-output matrix exclusive of the imported components the resulting figure shows the extent of interindustry linkages emanating from domestic industrial base alone. The linkage index thus calculated will be referred to as the domestic linkages. The difference between the two signifies

the role of imported intermediate inputs in production, which enables the use of technologies that cannot be sustained with domestic supplies of intermediate inputs alone.

B. Empirical Results

The above linkage measure was calculated for the nine countries and the results are shown in Table 1. A glance at Column 1, which shows the overall linkages based on domestic plus imported input-output coefficients, reveals an interesting difference among countries. Korea, Taiwan, Japan, and Yugoslavia exhibit the linkage values consistently exceeding 2.0, while Turkey, Colombia, and Mexico have the values less than 2.0 in all the years analyzed. Israel and Norway fall in between, with the values around 2.0. Thus, the interindustry linkages implied by the underlying production technology appear to be stronger in the three Asian economies and in Yugoslavia, and significantly lower in Turkey and Colombia, and to a lesser extent in Mexico.

The linkage measure in Column 1 ranges from a low of 1.6 to a high of 2.3, but the difference in the indirect requirements for intermediate goods generated through interindustry linkages is much larger than one might think. The indirect requirements corresponding to uniformly-distributed one-unit delivery to final demand are given by the excess of figures in Column 1 over unity. In Turkey and Colombia, this value is approximately 0.8, while that for Taiwan and Japan is about 1.2. Therefore, the latter countries generate 50% more indirect demand for intermediate goods for the same amount of uniformly distributed delivery to final demand than do the former group of countries. The difference is enormous if we consider the level of final demand in each country.

Table 1: Interindustry Linkages in Nine Economies

		Overall Linkages [1/]	Domestic Linkages [2/]
Korea	1963	2.1	1.7
	1970	2.1	1.7
	1973	2.2	1.7
Taiwan	1956	2.2	1.6
	1961	2.3	1.8
	1966	2.3	1.7
	1971	2.2	1.7
Turkey	1963	1.7	1.6
	1968	1.8	1.7
	1973	1.8	1.7
Colombia	1953	1.6	1.4
	1966	1.8	1.6
	1970	1.8	1.6
Mexico	1950	1.7	1.6
	1960	1.9	1.7
	1970	1.9	1.7
	1975	1.9	1.7
Japan	1955	2.3	2.1
	1960	2.3	2.1
	1965	2.2	2.0
	1970	2.3	2.0
Israel	1958	1.9	1.6
	1965	1.9	1.6
	1972	2.2	1.5
Norway	1953	1.8	1.5
	1961	2.0	1.5
	1969	2.0	1.5
Yugoslavia	1962	2.2	2.0
	1966	2.1	1.8
	1972	2.2	1.8

Source: Based on the input-output data of the "Sources of Industrial Growth and Structural Change" research project, World Bank.

[1/] Calculated as $\sum_i \sum_j r_{ij}$, where r_{ij} is an element of $(I-A)^{-1}$.

[2/] Calculated as $\sum_i \sum_j r^d_{ij}$, where r^d_{ij} is an element of $(I-\hat{u}A)^{-1}$ with $\hat{u}$ denoting a diagonal matrix of domestic supply ratios. See Note 14.

The second column of Table 1 shows the linkage measure based on the Leontief domestic inverse.[14/] A striking result emerges: the significant difference observed between Korea and Taiwan on the one hand and Turkey, Colombia, and Mexico on the other in the overall linkages disappears almost completely if we restrict our attention to domestic industrial linkages alone. All these countries show the domestic linkage measure of about 1.7, with Colombia showing slightly lower figures. In other words, these countries appear to have an essentially similar level of domestic industrial linkages although their sectoral distribution would of course differ from country to country. What is different between the two groups of countries is that the former group of countries achieved an interindustry linkage level comparable to that of a more developed country like Japan[15/] by supplementing the domestic intermediates substantially by imported intermediate goods. These countries achieved rapid economic growth through export expansion,[16/] and the growing foreign exchange earnings from exports enabled these countries to expand imports of capital and intermediate goods rapidly. Indeed, as shown in Table 2, the rapid increase in export earnings was almost completely absorbed in equally rapid increase in imports, and approximately 55-60% of their imports were comprised of imports of capital and intermediate goods.[17/] These facts strongly suggest that the rapid export expansion enabled these countries to introduce and maintain more advanced industrial technology relying heavily on imported capital and intermediate goods. In the early years in Korea and Taiwan, export earnings were not enough to sustain the import needs, but both countries benefitted significantly from a high level of foreign capital inflow which helped these countries

Table 2: Exports and Imports in Nine Countries

		Exports as % of GDP [1]	Imports as % of GDP [1]	Share in Total Imports [2] Capital Goods	Share in Total Imports [2] Intermediate Goods
Korea	1963	4.8%	16.4%	21.4%	34.3%
	1970	14.8	24.9	29.4	26.2
	1973	31.7	35.0	32.6	29.9
Taiwan	1955	8.3	12.6	(21.6)	(38.2)
	1961	12.8	19.9	32.7	23.3
	1966	20.6	21.5	31.4	29.1
	1971	36.8	34.2	32.5	26.2
Turkey	1963	5.5	10.3	38.8	27.2
	1968	5.3	7.5	39.1	36.2
	1970	7.6	9.1	35.6	43.2
Colombia	1955	12.4	14.3	(43.8)	(33.9)
	1966	12.1	15.1	28.9	32.8
	1970	14.2	15.8	35.7	33.4
Mexico	1950	14.1	13.9	44.6	27.2
	1960	11.3	12.8	50.9	26.5
	1970	8.1	10.1	54.9	21.5
	1975	7.7	10.9	55.7	21.9
Japan	1955	10.7	10.1	8.6	12.7
	1960	11.1	10.6	8.9	24.5
	1965	10.8	9.3	8.5	18.2
	1970	11.2	9.8	9.5	17.0
Israel	1955	11.5	32.8	(28.2)	(17.6)
	1965	18.9	31.9	26.6	20.5
	1972	28.3	40.1	27.9	39.4
Norway	1955	40.7	43.6	(26.5)	(19.9)
	1961	39.7	42.6	29.5	20.1
	1969	41.2	38.5	28.0	22.7
Yugoslavia	1962	16.0	17.1	48.3	20.0
	1966	19.5	20.5	39.4	25.5
	1972	22.0	24.1	36.7	30.1

Source: [1] World Tables 1976, World Bank.

[2] Based on the input-output data of the "Sources of Industrial Growth"research project, World Bank. The figures in parentheses correspond to the nearest input-output year to 1955 (1956 for Taiwan, 1953 for Colombia and Norway, and 1958 for Israel).

expand their industrial base at an early stage.

In Turkey, Colombia and Mexico, the domestic industrial linkages are not much different from the overall linkages. These countries emphasized import substitution without providing adequate incentives to exports during the most of the period considered. Thus, the export growth was not enough to meet the growing import needs, and imports had to be restricted to essential ones. Since the level of foreign capital inflow was also low in these countries, quantity restrictions and other import control measures were used to cope with the foreign exchange imbalances. As Table 2 shows, the ratio of total imports to GDP remained stable in these countries at a very low level (7-15%) or even declined, and the limited foreign exchange was directed more intensively towards imports of capital and intermediate goods (60-80% of total imports) than in Korea and Taiwan. Thus, in these countries, the inadequate growth of exports and the resulting shortage of foreign exchange appear to have forced the countries to resort mainly to the existing domestic industrial linkages, limiting the introduction of new technologies and reliance on imported intermediates to a minimal.

In Table 1, Japan stands out as having exceptionally strong domestic industrial linkages. Considering its low import dependence for most manufactured products, the small difference between domestic and overall linkages may not be surprising. However, the fact that the strong domestic linkages were well established already by the mid 1950s is revealing. Her income grew rapidly after 1960 but the interindustry structure of the early postwar period, as captured by the linkage measure, was already comparable to that of 1970. In turn, Yugoslavia follows

Japan in the level of domestic industrial linkages, which may reflect the effects of the basic-industry development strategy typical of many socialist countries, which aims at establishing broad industrial base at an early stage. In the late 1960s and early 1970s, the domestic linkages declined somewhat despite the stable level of the overall linkages, which points to the effects of import liberalization and devaluation that took place after 1965.

Finally, Israel and Norway exhibit one of the lowest level of domestic industrial linkages, although the overall linkages are not especially low. Two reasons may account for this fact: First, being particularly small countries having population of 3-4 million in 1973, the establishment of a wide domestic industrial base would probably not have been an appropriate strategy for their development, thus relying heavily on imports of some of the industrial necessities. Second, both countries, especially Norway, adopted increasingly liberal trade policies, reducing controls on imports. Thus, the relatively large discrepancy between domestic and overall linkages in these countries especially in the later years can be thought to reflect the effects of the policies chosen and of the country size.

The interindustry linkage measures shown in Table 1 exhibit surprisingly little variation over time in each country. In Korea, Turkey, Colombia, Israel, and Norway, there was a slight upward trend in overall linkages, while in others there was a minor fluctuation. Hence, it is not possible to draw any distinct conclusion on the over-time changes in interindustry linkages from the present data. One suspects that the coverage of 10-20 years is not adequate to observe a systematic change

in the interindustry linkages at the aggregate level. For example, to see how the Japanese industrial linkages were strengthened to the level observed in 1955 would require knowledge of the linkage level existed in the prewar years. The only inference that we can make at this point is that, within the time span of 10-20 years, the interindustry linkages viewed at the aggregate level remain surprisingly stable, although there is a slight indication that it slowly increases over time.

IV. The Pattern of Use of Imported Intermediate Goods

The intercountry differences in the overall and domestic industrial linkages shown in the previous section signify the differences in the role played by imported intermediate goods in production among countries. A question arises as regards to for what purposes the imported intermediates are mainly used. Are they used largely to cater to domestic demands, or to produce exportables? To answer this question, we shall examine the import content of domestic final demand and exports in this section.

The total (direct plus indirect) import content of domestic final demand and exports distributed according to country-specific compositions can be measured in the following manner: Let f and e be domestic final demand and export vectors normalized so that their elements add up to unity. The total requirements (inclusive of indirect requirements for intermediate inputs) for domestic production to meet these demands are given by

$$X^f = (I-A^d)^{-1} f,$$

and

$$X^e = (I-A^d)^{-1} e,$$

respectively, where A^d denotes the input-output coefficient matrix exclusive of imported intermediates. If A^m denotes the matrix of imported input-output coefficients, the total requirements for imported intermediate inputs associated with the final demand deliveries, f and e, are given by

$$M^f = A^m(I-A^d)^{-1} f,$$

and

$$M^e = A^m(I-A^d)^{-1} e,$$

respectively. Since f and e are normalized, the sums of the elements of M^f and M^e describe the proportion of the value of imported intermediates contained directly and indirectly in the deliveries to domestic final demand and exports with given compositions. In other words, the total import content of domestic final demand and exports can be measured by

$$(3) \qquad MC^f = \sum_{i=1}^{n} \sum_{j=1}^{n} a^m_{ij} \sum_{k=1}^{n} r^d_{jk} f_k$$

and

$$(4) \qquad MC^e = \sum_{i=1}^{n} \sum_{j=1}^{n} a^m_{ij} \sum_{k=1}^{n} r^d_{jk} e_k,$$

where a^m_{ij}, r^d_{jk}, f_k, and e_k denote elements of A^m, $(I-A^d)^{-1}$, f, and e, respectively.

The above measures of total import content were calculated for each input-output table of the nine countries[18/] and the results are presented in Table 3. A comparison between Korea and Taiwan on the one hand and Turkey, Colombia, and Mexico on the other brings out a distinct difference in the pattern of the use of imported intermediates. In the latter group

Table 3: Import Content of Domestic Final Demand and Exports (%)

		Import Content of Domestic Final Demand	Import Content of Exports
Korea	1963	11.2	15.8
	1970	14.8	18.7
	1973	17.9	25.5
Taiwan	1956	9.7	13.6
	1961	9.8	12.9
	1966	14.3	19.7
	1971	17.9	25.0
Turkey	1963	3.7	2.7
	1968	3.2	2.3
	1973	4.7	3.9
Colombia	1953	7.0	4.1
	1966	6.5	4.4
	1970	7.3	3.7
Mexico	1950	6.6	5.2
	1960	7.4	5.5
	1970	6.1	6.5
	1975	8.3	10.5
Japan	1955	4.2	6.6
	1960	5.8	9.3
	1965	6.5	9.6
	1970	8.5	10.0
Israel	1958	12.8	12.1
	1965	13.0	11.1
	1972	27.0	21.2
Norway	1953	18.7	16.3
	1961	22.5	18.8
	1969	23.4	21.9
Yugoslavia	1962	6.0	9.6
	1966	8.6	11.9
	1972	14.1	18.7

Source: Calculated from the input-output data of the "Sources of Industrial Growth and Structural Change" research project, World Bank.

of countries, import contents of both domestic final demand and exports are very low and the import content of domestic demand is slightly higher than that of exports in general. In contrast, in the former group, the import content is much higher for each category of demand and is increasing over time. Moreover, the import content of exports is substantially higher (about 30-40%) than that of domestic final demand. Indeed, in the early 1970s, a quarter of the value of these countries' exports was comprised of the value of imported intermediates used in their production.

The observed differences in the pattern of use of imported intermediates in the two groups of countries relate both to the structure of exports and to the trade and industrial policies adopted in each country. First, as shown in Table 4, the structure of exports in Korea and Taiwan is heavily and increasingly oriented toward non-food manufactured products (especially consumer goods and machinery[19]), which in general have higher import content than primary goods, while that in Turkey, Colombia, and Mexico is oriented heavily, though declining, toward primary products and processed food, which have low import content in these countries. Thus, a part of the difference in the import content of exports in the two groups of countries is explained by their export orientation. Second, Korea and Taiwan provided almost free access to imports of intermediate goods for producers of exportables at the same time discouraging the use of imported intermediates for production catering to domestic needs, while Turkey, Colombia, and Mexico limited the use of imported intermediates mainly to producers of import substitutes, giving little incentives for (or even discouraging) their use by

Table 4: Structure of Exports as Percent of Marchandize Exports [1]

		Primary Goods	Processed Food	Other Consumer Goods	Inter-mediate Goods	Machinery and trans-port Eq.	Non-Food Manufactured Exports [2]
Korea	1963	29.4	11.6	38.2	17.5	3.3	59.0
	1970	11.1	5.0	65.4	10.6	7.9	83.9
	1973	4.6	3.5	54.9	15.2	21.8	91.9
Taiwan	1956	7.0	76.7	6.4	9.6	0.3	16.3
	1961	8.5	59.2	20.3	10.3	1.7	32.3
	1966	11.6	34.7	28.2	16.8	8.7	53.7
	1971	5.6	14.2	41.4	15.4	23.4	80.2
Turkey	1963	82.9	7.7	4.0	5.4	0.0	9.4
	1968	66.8	26.2	2.5	4.5	0.0	7.0
	1973	44.1	32.5	12.3	10.3	0.8	23.4
Colombia	1953	97.8	0.0	0.9	1.3	0.1	2.2
	1966	85.3	2.6	4.9	6.5	0.7	12.1
	1970	90.2	3.2	4.4	1.6	0.6	6.6
Mexico	1950	65.4	23.1	9.7	1.2	0.6	11.5
	1960	59.5	27.8	7.3	4.8	0.6	12.7
	1970	52.7	14.5	7.8	11.5	13.5	32.8
	1975	41.3	11.3	10.2	16.0	21.2	47.4
Japan	1955	3.9	6.4	52.6	24.5	12.6	89.7
	1960	4.2	4.3	46.0	23.0	22.5	91.5
	1965	2.5	3.0	27.6	34.0	32.9	94.5
	1970	1.4	2.2	21.4	31.4	43.6	96.4
Israel	1958	32.7	6.9	44.2	13.3	2.9	60.4
	1965	23.9	5.6	52.2	16.4	1.7	70.5
	1972	17.1	12.0	46.8	17.2	6.9	70.9
Norway	1953	14.5	15.1	27.5	38.3	4.4	70.4
	1961	10.6	11.0	24.7	44.0	9.7	78.4
	1969	6.0	8.8	20.8	48.9	15.5	85.2
Yugoslavia	1962	18.6	11.1	23.3	16.8	30.2	70.3
	1966	21.5	6.7	23.5	18.1	30.2	71.8
	1972	14.6	7.3	25.8	22.9	29.4	78.1

Source: Input-output data of the "Sources of Industrial Growth and Structural Change" research project, World Bank.

[1] Commodity classification complies with that in Note 8.

[2] Sum of columns 3-5.

producers of non-traditional exports.[20/] There differences in policy are behind the higher import content of manufactured exports in Korea and Taiwan than in Turkey, Colombia, and Mexico, which account for the remaining differences in the import content of exports in these two groups.

The two distinct patterns of imported intermediate input use and the structure of exports point to a number of questions that are beyond the scope of the present study: why do Korea and Taiwan encourage exports having higher import contents which would generate smaller net foreign exchange earnings per unit than those having lower import contents? Does achieving higher overall linkages through the use of imported intermediate goods enhance a better growth performance of manufactured exports? Are the differences in the overall linkages and in the import contents in the two groups of countries primarily due to the fundamental differences in production technologies or are they due to the differences in the incentive systems provided by trade and industrial policies?

Among the remaining countries, Japan and Yugoslavia rank between the above two groups in the level of import content of domestic demand and exports, although resembling Korea and Taiwan in that their exports are more import intensive than domestic final demand. These countries' exports are largely composed of manufactured products as in Korea and Taiwan, so that the lower import content in these countries may reflect their ability to domestically supply a larger proportion of intermediate inputs needed for manufacturing production, which is based on wider and deeper domestic industrial base.

Finally, Israel and Norway show almost equal import content of both

domestic final demand and exports, which are among the highest in the nine countries and increasing over time. This trend may be the reflection of the balanced incentives given to producers of both exports and domestic supplies and of increasingly liberal trade policies that removed controls on imports over time.

V. Summary and Conclusion

In this paper, we concentrated on an intercountry comparison of the patterns of intermediate input use and of interindustry linkages based on input-output data of nine countries. We have first shown that there is a distinct shift in the composition of intermediate demand from primary to manufactured products, which pointed to the importance of the pattern of intermediate input use in accounting for the wellknown shift in the structure of production from primary to manufacturing in the course of development. We have then compared the levels of overall and domestic industrial linkages using a linkage measure based on the Leontief inverse. A sharp contrast emerged between the high overall linkages in Korea and Taiwan and the low overall linkages in Turkey, Colombia, and Mexico despite the similar level of domestic industrial linkages, which signified the differences in the role of imported intermediate inputs in production. Finally, the differences in the pattern of imported intermediate input use were examined by comparing total import content of domestic final demand and exports, which again brought out a significant difference between Korea and Taiwan on the one hand, exhibiting high and increasing import content of exports which is substantially

higher than that of domestic final demand, and Turkey, Colombia, and Mexico on the other, which had low import content of exports slightly less than that of domestic final demand. The difference was attributed to the differences in the structure of exports and the trade and industrial policies adopted in the two groups of countries.

The questions prompted by the distinct differences between these two groups of countries concern the choice of export items as the source of foreign exchange, the role of higher overall linkages enabled by imported intermediates in enhancing better export and growth performances, and the role of trade and industrial policies in the use of imported intermediates which would enable the use of technologies that cannot be sustained by domestic intermediate goods alone. These are questions that our static framework is not equipped to analyze, and require a dynamic framework which incorporates the relationships among production technology, the role of domestic and imported intermediate goods, export performances and impacts of trade and industrial policies. We hope that the present study might motivate further analyses on these questions.

Notes

1/ World Bank (1980), pp. 402-403.

2/ The input-output data from nine economics used in the present study show that the ratio of imports to domestic demand of capital goods (composed of machinery and transport equipment) ranges from 30-90% in all countries except Japan. See Kubo (1981), Table 1.

3/ See Kubo (1981), Table 1.

4/ "A comparative Study of the Sources of Industrial Growth and Structural Change" research project (RPO 671-32), World Bank. The original input-output data from the nine countries have been recompiled to unify definitions and classifications and deflated to constant domestic prices for each country. The table in Appendix shows the names and compositions of the 14 sectors in reference to the ISIC codes.

5/ See, for example, Chenery (1960), Kuznets (1966), Chenery and Taylor (1968), Chenery and Syrquin (1975), and Prakash and Robinson (1979) among others.

6/ See Chenery, Shishido and Watanabe (1962), Chenery and Syrquin (1979), Kubo and Robinson (1979), and Chenery (1980 a,b), among others.

7/ A notable exception is Syrquin (1981) who has pointed out the growing importance of manufactured intermediates in the course of development using slightly different indicators from those used in this section.

8/ Primary goods include agricultural and mining products; consumer goods include processed food, textiles and clothing, lumber and wood products, paper products and printing and miscellaneous manufacturing

products; the third category includes all other manufactured products.

9/ Taken from the data bank of the "Patterns of Industrial Development" research project, World Bank.

10/ This ratio corresponds to Chenery and Watanabe's (1958) "w" coefficient.

11/ I am indebted to Professor Yoshihiko Otani of University of Tsukuba for useful suggestions regarding this argument.

12/ Nikaido (1970), Theorem 17.1.

13/ Nikaido (1970), Theorem 17.1.

14/ The comparison is based on the domestic input-output coefficients approximated by $a^{d}_{ij} = u_i \, a_{ij}$, where a_{ij} is the total (domestic plus imported) input-output coefficient and u_i is the domestic supply ratio defined as $(X_i - E_i)/(D_i + W_i)$ with X_i, E_i, D_i, and W_i denoting output, exports, domestic final demand, and intermediate demand in sector i, respectively. The domestic linkage values that result from the use of actural domestic matrices are shown below for a few countires, which do not differ much from the approximated ones:

		Approximated	Actual			Approximated	Actual
Korea	1963	1.7	1.7	Japan	1955	2.1	2.1
	1970	1.7	1.6		1960	2.1	2.1
	1973	1.7	1.6		1965	2.0	2.0
					1970	2.0	2.0
Taiwan	1961	1.8	1.7	Mexico	1950	1.6	1.5
	1966	1.7	1.6		1960	1.7	1.6
	1971	1.7	1.6		1970	1.7	1.7
					1975	1.7	1.7

15/ It remains to be seen if the high overall linkage value is characteristic of devloped countries with relatively large size, although

I suspect it is. Robinson and Markandya (1973) ranks Japan as almost equally complex as U.S. already in the mid 1950s. A comparison of the above linkage values with those of U.S. and West European countries would help verify this conjecture.

16/ For a comparative study of sources of industrial growth and development strategies in most of the countries studied, see Kubo and Robinson (1979).

17/ Capital goods here consist of machinery and transport equipment, and intermediate goods include rubber and chemical products, coal and oil products, nonmetallic minerals and baisc metals.

18/ For the purpose of empirical comparison, the domestic and imported coefficient matrices were approximated by $A^d = \hat{u}A$ and $A^m = (I-\hat{u})A$, respectively, where $\hat{u}$ is a diagonal matrix of domestic supply ratios. See Note 14.

19/ The significant rise in machinery exports in Korea and Taiwan in the early 1970s is primarily due to the rapid expansion of electronics products, which then comprised about 80% of machinery output in there countries. See Kubo and Robinson (1979), p. 27.

20/ See de Melo (1981) for a comparison of trade and industrial policies in these countries.

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Appendix

Fourteen Sector Classification and Aggregation Code

14 sectors	24 sectors	ISIC Code
1. Agriculture	1. Agriculture, Forestry & Fishery	01, 02, 03, 04
2. Mining	2. Crude Oil	13
	3. Coal Mining	11
	4. Other Mining	12, 14, 19
3. Food Processing	5. Food Processing	20, 21, 22
4. Textiles, Clothing and Leather	6. Textiles	23
	7. Clothing and Leather Products	24, 29
5. Paper, Pulp and Printing	9. Paper & Pulp Products	27
	10. Printing & Publishing	28
6. Other Light Industry	8. Lumber and Wood Products	25, 26
	11. Miscellaneous Manufacturing	39
	12. Unallocated	—
7. Rubber and Chemicals	13. Rubber Products	30
	14. Chemicals	31
	15. Petroleum and Coal Products	32
8. Nonmetallic Products	16. Non-metallic Products	33
9. Basic Metals	17. Basic Metals	34, 35
10. Machinery and Transport Equipment	18. Machinery	36, 37
	19. Transport Equipment (including shipbuilding)	38
11. Construction	20. Construction	40
12. Public Utilities	21. Public Utilities	51, 52
13. Transport and Communication	22. Transport and Communication	71, 72, 73
14. Other Services	23. Trade	61
	24. Other Services (including real estate)	62, 63, 64, 81, 82, 83, 84, 90

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