THE KOREAN ECONOMIC REVIEW
Volume 17, Number 2, Winter 2001

AN INTERINDUSTRY ANALYSIS OF PRODUCTION BETWEEN KOREA AND JAPAN (THROUGH THE FOREIGN TRADE)

BYUNG HYUN KIM*

This study examines the interdependence of production between Korea and Japan through the foreign trade. The approach undertaken in this production analysis is to set up an input-output model in which the outputs of all producing sectors in both Korea and Japan are considered as variables. The study verifies the traditional theory that Korea is far more sensitive to relative growth in Japan, than is Japan to relative Korean growth. It also points to a conclusion that is perhaps not so well recognized: Japan is much more sensitive to changes in Korean economic activity than is Korea to changes in Japanese economic activity in absolute magnitude.

JEL Classification: F14, P52
Keywords: Interindustry Analysis, Sensitivity, Dependence, Vulnerability, Competitive and Non-Competitive Imports

I. INTRODUCTION

The flow of goods and services over the Korean-Japanese border is no less important than that over any other international boundary in the world. Indeed, Korea and Japan is the greatest trading partnership in East Asia. The objective of this study is to examine and analyse the resulting interdependence of the two economies.

The range and extent of Japanese influence in the Korean economy is a subject guaranteed to stimulate heated debate in Korea. Each year brings forth its impressive quota of technical research and editorial opinion devoted to the "vulnerability" of the Korean economy and on its "growing dependence" on

Received for publication: July 1, 1999. *Revision accepted:* Sep. 10, 2001.

* Department of Economics, Hallym University, 1 Okchon-dong, Chunchon, Kangwondo, Korea 200-702. E-mail: bhkim1@sun.hallym.ac.kr. The author would like to acknowledge the financial support of the Hallym Academy of Sciences, Hallym University made in the program year of 1998.

Japan. This is perhaps the one subject on which all Koreans have a very decided opinion.

This "vulnerability" is a many sided issue. The aspect most frequently emphasized in popular discussion is growing Japanese investment in Korea. The use of foreign resources as a percentage of gross capital formation in Korea between 1985 - 1990 was about 14% on the average, and the corresponding figure for the period 1991 - 1995 was about 19% on the average. Most of this imported capital has come from Japan. The confidence of Japanese citizens in the Korean economy has been one of the key factors in Korea's rapid expansion since 1961.

The second source of Korean vulnerability lies in the fact that the Korean economy is so largely dependent on foreign trade; moreover of this foreign trade, that with Japan is playing an increasingly dominant role. The Korean economy has been viewed as a structure, complete with external connections and supports. The degree to which the Korean economy leans on such external supports is illustrated by the fact that foreign trade traditionally accounts for 60% - 80% of Korea's Gross National Product. Moreover Korea's trade is becoming increasingly centered in Japan. These close economic ties between the two countries are of great importance to Japan as well. The foreign trade between the two countries has a very great quantitative and strategic significance to them.

These important lines of trading dependence between the two countries ensure that changed production levels in one will result in changed activity levels in the other. Indeed one may regard the dependence of production levels in the two countries as simply a crucial indicator of the importance of these import and export trading relationships. And while it is of course quite true that the growing pattern of Japanese investment in Korea has also had substantial production effects, attention in this particular study is focussed almost exclusively on the implications of the international trade flows between the two countries. The method is not an examination of the movement of large aggregates over time. Instead, the binding relationship of the two economies at one point of time will be spotlighted and examined.

The approach undertaken in this production analysis is to set up a model in which the outputs of all producing sectors in both Korea and Japan are considered as variables. This involves estimating the relationship of each sector to all other producing sectors in both countries. Such estimates require a wealth of empirical information; the 1990 Table of Interindustry Flows for Korea will be used in conjunction with the 1990 Interindustry Table for Japan and appropriate figures on international trade (BOK-IDE, 1996).

The analysis will take the general form better known as the input-output approach. The appropriate models are theoretically developed in Chapter Ⅱ. Chapter Ⅲ is designed to formulate the Korean-Japanese model, and whenever necessary, modifications are made in order to allow the model to apply better to the problem at hand. Also, an extensive empirical implementation of the model is undertaken in Chapter IV and the empirical results will be provided in Chapter V.

II. INPUT-OUTPUT AND INTERNATIONAL TRADE

There are major advantages of approaching the problem of Korean and Japanese interdependence by an input-output analysis. Traditional analyses have examined the interaction of the two economies by relating their large aggregative indicators, for example, national income, exports and imports. An input-output model, on the other hand, is capable of describing the links between the two economies in more specific and concrete terms. Each industry or producing sector in one economy may be linked to all other sectors in both economies. Explicit recognition is given not only to aggregate trade flows, but to their physical composition as well. An input-output analysis provides a means of specifying how trade in particular products (e. g. iron ore) may be expected to behave under certain specified conditions (Isard, 1951).

By the aggregation of all these individual trade flows the input-output model will of course, like other trade models, yield estimates of how exports or imports in the aggregate may be expected to behave (Leontief, 1946). But it gives more information. Since account is taken of the physical composition of trade, this model can throw light on the differential impact of trade flows which are of the same dimension in value terms, but not in physical terms. For example, an increased Korean export of 1 million won of wheat to Japan will have a markedly different impact on the Korean economy than an increased Korean export of 1 million won of nickel.

The direct impact of an export from the Korean base metals sector is that this sector would expand its output and employment. But there are indirect effects as well. To support its expansion this sector will draw on additional supplies from both Korean and Japanese producers; for example, Japanese production of mining machinery may be increased to satisfy the new demand of the expanding Korean base metals sector. In turn the expansion of this Japanese industry may draw upon increased supplies of Korean iron ore, and so on.

In this manner, the effect of expansion in any one producing sector is transmitted throughout the entire Korean-Japanese economy by an increase in the output of all the industries which either directly or indirectly supply it. Analysing all the direct effects individually becomes an impossible task. The major advantage of an input-output approach to such a problem is that its solution provides a means whereby the sum of all such direct and indirect effects on every sector can at once be estimated (Dorfman, 1954).

Let us now turn our attention to alternate methods of formulating an input-output model for handling problems of international trade. The balance of this chapter is devoted to a discussion of models suggested by Leontief (1951), Isard (1951) and Moses (1955).

Strictly speaking, these models were formulated as intrerregional models, i.e. models in which a nation is divided into separate producing and consuming regions. The regional distribution of economic activities within a nation is studied within this framework. However, the application of these models to an international study is obvious, and requires only a translation of the model into the context of a slightly different problem. Whereas an interregional analysis involves the study of a nation by focusing attention on its regions, an international analysis involves the study of the world, or some international sphere, by focusing attention on the nations of which it is composed.

1. The Leontief Model

The first interregional input-output model was suggested by the initiator of the input-output approach, Professor Wassily Leontief. Leontief (1951) conceived the nation as being composed of n regions. Each region produces m goods of two types, the first h being "regional," the last m-h being "national." The former are consumed only within the region in which they are produced; the latter are traded between regions. The structure of the system is determined by two sets of constants:

1) $a_{ik}=\dfrac{\textit{consumption of good i by industry it k}}{\textit{total output of industry k}} \quad (i,k=1,\ldots,m)$

a matrix of technical input coefficients describing production in each region, and

2) ${}_jr_g(j=1,\ldots,n;g=h+1,\ldots,m),$

the proportion of national commodity g produced in region j.
In addition ${}_jY_i\,(j=1,\ldots,n;i=1,\ldots,m)$, the final demands in each region j for each good i are given.

The objective is to determine the outputs of both national and regional commodities in each region. The analysis involves 3 steps.

Step 1. The total final demand by the nation as a whole for good i (Y_i) is computed by summing the final demand for good i in all regions, that is

$$Y_i=\sum_{j=1}^{n}{}_jY_i\ (i=1,\ldots,m) \tag{1}$$

These values are then used in conjunction with the parameters a_{ik} to set up m equations of the typical input-output form

$$x_i-\sum_{k=1}^{m}a_{ik}\,x_k=Y_i\ (i=1,\ldots,m) \tag{2}$$

in which x_i denotes the output of good i for the nation as a whole. These m equations are sufficient to determine the m unknowns, the x_i. The total national output of all goods of both types is now known.

Step 2. The trade coefficients determine the output of national good g in region j , as follows

$$_jx_g = {_jr_g}\, x_g \,(j=1,\ldots,n; g=h+1,\ldots,m) \quad (3)$$

in which $_jx_g$ denotes the output of national good g in region j. The regional production of national goods is now known.

Step 3. The final step is to compute regional outputs of regional goods. Since the matrix of technical input coefficients is assumed to describe production in each region, the outputs of regional goods in the j^{th} region may be computed by the following h equations:

$$_jx_f - \sum_{i=1}^{m} a_{fi}\; {_jx_i} = {_jY_f}\,(f=1,\ldots,h) \quad (4)$$

in which $_jx_i$ is the production in region j of regional good f. Now since this system contains all the $_jx_i$ the outputs of all m goods in this j^{th} region, it appears that there are only h equations in m unknowns. But the m-h outputs of the national goods in this j^{th} region have been determined in Step 2 above. Consequently this system of h equations contains only h unknowns - the outputs in this j^{th} region of the h regional goods. Thus the production in this region of regional goods is determined. In a similar fashion the production of regional goods is determined in each of the other regions.

The level and location of all outputs in the system have now been determined.

Given the structure of the system as defined by the technical input coefficients (a_{ik}), and the trade coefficients ($_jr_g$), all outputs in the system are uniquely determined by the final demands in all regions for all goods ($_jY_i$). Moreover, since the trade pattern of national goods is known, the balance of trade of a region vis-a-vis the rest of the nation is easily derived. Thus the impact of changes in final demand on the outputs of every producing sector in each region, and on the balance of trade of each region can be computed.

Our problem is: "Would such an analysis be appropriate for an examination of the interrelation of the Korean and Japanese economies?" There appear to be no insurmountable conceptual difficulties involved in reading into the above analysis "international" instead of "national," and "local" instead of "regional." International goods could be defined as those substantially taking part in the international trade between Korea and Japan; local goods as those not entering such trade. The analysis could proceed by first determining the production in

Korea and Japan of international goods, then the production in each country of local goods.

The advantage of this type of analysis is that it would be easier to handle computationally than alternative input-output models designed for trade analysis. However, a strict interpretation of the Leontief system would require a "composite" matrix of technical input coefficients describing the structure of production in the entire international sphere under study, that is, in both Korea and Japan taken together. Such a composite matrix would be assumed to apply to both the structure of production in Korea alone and the structure of production in Japan alone. In fact there is no such composite matrix. Instead there are too distinctly different matrices available, one pertaining to the Korean structure of production, the other to the Japanese structure of production.

Given this information, an obvious strategy would be to aggregate the two national matrices into a composite matrix describing production in the joint Korean-Japanese economy. This matrix, along with a set of trade coefficients, could be used to determine the level and location of the output of every international good. Then the Korean matrix could be used to determine the production of local goods in Korea.[1]

One of the problems involved in the construction of such a composite matrix, would be that the aggregation would compel assigning weights to Japanese activities and weights to Korean activities. The composite matrix would apply only so long as these relative weights were maintained. Once patterns of production changed (for example, as a result of relative changes in final demand in the two countries) the weighting on which the composite matrix was based would no longer apply, and the use of this matrix would introduce an error into the analysis.

The same problem may be stated in another way. In the final step of the solution, the Korean production of local goods would be computed on the basis of the Korean matrix, and the Japanese production of local goods would be computed on the basis of the Japanese matrix. Summing these two sets of outputs will yield a set of total outputs (in both economies) of local goods. But these same total outputs of local goods would have already been computed in the very first step of the analysis, on the basis of the composite matrix. There is no reason why these two sets of outputs of local goods should agree, although definitionally they are identical. An unfortunate inconsistency would be introduced.[2]

Another difficulty involved in any unmodified application of the Leontief model is that the supply patterns of international goods (the ${}_j r_g$) are frozen into

---

[1] The equations determining the outputs of these local goods would be those in (4) above, with the a_{fi} of course being drawn from the Korean matrix.

[2] This inconsistency was not encountered by Leontief (1951) because his composite matrix was always identical to his local matrices.

the analysis. However, if better information is available as to how supply patterns change as various levels of production are reached in certain sectors, this could be built into the analysis, and would in fact only involve a minor addition to the computational burden in Step 2.

In conclusion, the Leontief approach to this problem would be most appropriate if the only matrix of input coefficients available, was a composite matrix describing production in both Korea and Japan together. However, such a matrix does not exist. Instead there are two separate and distinct matrices at hand, one of the Korean economy, the other of the Japanese economy. Consequently it is advisable to employ an analysis that may more readily and directly use this additional information.

2. The Isard Model

Isard (1951) was the first to suggest an input-output model capable of utilizing two distinct technical matrices, each applying to a different area. He suggested combining these two matrices with two trade matrices into a larger matrix capable of relating production in any sector to activity levels in all other sectors in the two-area economy. Each commodity is considered distinct from the same commodity in the other area; for this reason the coefficients in each trade matrix have their own special meaning and represent specific trade flows.

3. The Moses Model

The next advance in this research came when Moses (1955) suggested an effective method of making this model practical. In his interregional study of the U.S., he found that insufficient data was available to provide trade matrices of the type suggested by Isard (1951). Specifically no records were available to indicate which industries consumes an imported good. He resolved the problem by assuming similarity of the imported and domestically-produced good. On this basis he was able to distribute the imported good to consuming industries in the manner in which the domestically-produced equivalent was distributed. By applying the limited data available on trading flows to the technical matrices for each area, he was thus able to derive the trade matrices he required.

The trade models discussed in this chapter were not designed to be international, but interregional models. Nevertheless, the Isard and Moses models provide a highly useful first approach to international trade problems. Indeed, in the next chapter we will describe a Korean-Japanese model which is along the lines suggested by these authors. For this reason they are not discussed here in greater detail.

Ⅲ. FORMULATION OF THE KOREAN-JAPANESE MODEL

1. Theoretical Fusion of the Two Economies

The Korean and Japanese economies are each divided into sectors. A system of accounts is then set up to show the flow of output from each sector to every other sector in both economies. Such an accounting yields the input-output table shown in Table 1, in which

${}_kx_{ij}$ = value (in Korean won) of output of Korean sector i consumed by Korean sector j.
${}_pt_{ij}$ = value (in Korean won) of output of Korean sector i consumed by Japanese sector j.
${}_kt_{ij}$ = value (in Japanese yen) of output of Japanese sector i consumed by Korean sector j.
${}_px_{ij}$ = value (in Japanese yen) of output of Japanese sector i consumed by Japanese sector j.
${}_ky_i$ = value (in Korean won) of output of Korean sector i consumed by Korean final demand sector
${}_py_i$ = value (in Korean won) of output of Korean sector i consumed by Japanese final demand sector.
${}_kz_i$ = value (in Japanese yen) of output of Japanese sector i consumed by Korean final demand sector.
${}_pz_i$ = value (in Japanese yen) of output of Japanese sector i consumed by Japanese final demand sector.

Now the output of industry i is distributed along row i to users in both Korea and Japan; its inputs from both Korea and Japan may be read down column i.[3] Note that the first n (Korean) rows in this table of accounts are value figures expressed in Korean won. The last n (Japanese) rows are value figures expressed in Japanese yen.

The final demand sector in this table must be interpreted carefully. As might be expected, it is comprised of subsectors including consumption, investment and exports. However, the export subsector has a special meaning. To avoid double counting it must be defined as exports to countries other than Korea or Japan.

Now let the total output (in Korean won) of the i^{th} Korean industry be denoted by ${}_kx_i (i=1, \ldots, n)$. Similarly let the total output (in Japanese yen) of the i^{th} Japanese industry be denoted by ${}_px_i (i=1, \ldots, n)$. The accounting data in Table 1 may be expressed in equation form as follows:

[3] Not all inputs are present in this table. For example, labor inputs do not appear.

[Table 1] Interindustry Flow Table, Korea and Japan

		Korean Consuming Sectors 1	2	··· n	Japanese Consuming Sectors 1	2	··· n	Korean Final Demand	Japanese Final Demand
Korean Producing Sectors	1	${}_k x_{11}$	${}_k x_{12}$	${}_k x_{1n}$	${}_p t_{11}$	${}_p t_{12}$	${}_p t_{1n}$	${}_k y_1$	${}_p y_1$
	2	${}_k x_{21}$	${}_k x_{22}$	${}_k x_{2n}$	${}_p t_{21}$	${}_p t_{22}$	${}_p t_{2n}$	${}_k y_2$	${}_p y_2$
	⋮								
	n	${}_k x_{n1}$	${}_k x_{n2}$	${}_k x_{nn}$	${}_p t_{n1}$	${}_p t_{n2}$	${}_p t_{nn}$	${}_k y_n$	${}_p y_n$
Japanese Producing Sectors	1	${}_k t_{11}$	${}_k t_{12}$	${}_k t_{1n}$	${}_p x_{11}$	${}_p x_{12}$	${}_p x_{1n}$	${}_k z_1$	${}_p z_1$
	2	${}_k t_{21}$	${}_k t_{22}$	${}_k t_{2n}$	${}_p x_{21}$	${}_p x_{22}$	${}_p x_{2n}$	${}_k z_2$	${}_p z_2$
	⋮								
	n	${}_k t_{n1}$	${}_k t_{n2}$	${}_k t_{nn}$	${}_p x_{n1}$	${}_p x_{n2}$	${}_p x_{nn}$	${}_k z_n$	${}_p z_n$

$$
\begin{array}{l}
{}_k x_1 - {}_k x_{11} - {}_k x_{12} \cdots - {}_k x_{1n} - {}_p t_{11} - {}_p t_{12} \cdots - {}_p t_{1n} = {}_k y_1 + {}_p y_1 \\
{}_k x_2 - {}_k x_{21} - {}_k x_{22} \cdots - {}_k x_{2n} - {}_p t_{21} - {}_p t_{22} \cdots - {}_p t_{2n} = {}_k y_2 + {}_p y_2 \\
\quad \vdots \\
{}_k x_n - {}_k x_{n1} - {}_k x_{n2} \cdots - {}_k x_{nn} - {}_p t_{n1} - {}_p t_{n2} \cdots - {}_p t_{nn} = {}_k y_n + {}_p y_n \\
{}_p x_1 - {}_k t_{11} - {}_k t_{12} \cdots - {}_k t_{1n} - {}_p x_{11} - {}_p x_{12} \cdots - {}_p x_{1n} = {}_k z_1 + {}_p z_1 \\
{}_p x_2 - {}_k t_{21} - {}_k t_{22} \cdots - {}_k t_{2n} - {}_p x_{21} - {}_p x_{22} \cdots - {}_p x_{2n} = {}_k z_2 + {}_p z_2 \\
\quad \vdots \\
{}_p x_n - {}_k t_{n1} - {}_k t_{n2} \cdots - {}_k t_{nn} - {}_p x_{n1} - {}_p x_{n2} \cdots - {}_p x_{nn} = {}_k z_n + {}_p z_n
\end{array}
\qquad (5)
$$

Now express each input of an industry as a proportion of the total output of that industry. Let

$$
{}_k a_{ij} = \frac{{}_k x_{ij}}{{}_k x_j} = \frac{\text{input of Korean good } i \text{ used by Korean industry } j}{\text{total value of output of Korean industry } j}
$$

$$
{}_p m_{ij} = \frac{{}_p t_{ij}}{{}_p x_j} = \frac{\text{input of Korean-produced } i \text{ used by Japanese industry } j}{\text{total value of output of Japanese industry } j}
$$

$$_{k}m_{ij} = \frac{_{k}t_{ij}}{_{k}x_j} = \frac{\text{input of Japanese-produced } i \text{ used by Korean industry } j}{\text{total value of output of Korean industry } j} \tag{6}$$

$$_{p}a_{ij} = \frac{_{p}x_{ij}}{_{p}x_j} = \frac{\text{input of Japanese good } i \text{ used by Japanese industry } j}{\text{total value of output of Japanese industry } j}$$

Now (5) may be expressed as (7)

$$\begin{array}{l}
(1 - {_k a_{11}})\,{_k x_1} - {_k a_{12}}\,{_k x_2} \cdots - {_k a_{1n}}\,{_k x_n} - {_p m_{11}}\,{_p x_1} - {_p m_{12}}\,{_p x_2} \cdots {_p m_{1n}}\,{_p x_n} = {_k y_1} + {_p y_1} \\
- {_k a_{21}}\,{_k x_1} + (1 - {_k a_{22}})\,{_k x_2} \cdots - {_k a_{2n}}\,{_k x_n} - {_p m_{21}}\,{_p x_1} - {_p m_{22}}\,{_p x_2} \cdots - {_p m_{2n}}\,{_p x_n} = {_k y_2} + {_p y_2} \\
\quad \cdot \qquad\qquad \cdot \qquad \cdot \qquad\qquad \cdot \qquad \cdot \\
\quad \cdot \qquad\qquad \cdot \qquad \cdot \qquad\qquad \cdot \qquad \cdot \\
\quad \cdot \qquad\qquad \cdot \qquad \cdot \qquad\qquad \cdot \qquad \cdot \\
- {_k a_{n1}}\,{_k x_1} - {_k a_{n2}}\,{_k x_2} \cdots + (1 - {_k a_{nn}})\,{_k x_n} - {_p m_{n1}}\,{_p x_1} - {_p m_{n2}}\,{_p x_2} \cdots - {_p m_{nn}}\,{_p x_n} = {_k y_n} + {_p y_n} \\
- {_k m_{11}}\,{_k x_1} - {_k m_{12}}\,{_k x_2} \cdots - {_k m_{1n}}\,{_k x_n} + (1 - {_p a_{11}})\,{_p x_1} - {_p a_{12}}\,{_p x_2} \cdots - {_p a_{1n}}\,{_p x_n} = {_k z_1} + {_p z_1} \\
- {_k m_{21}}\,{_k x_1} - {_k m_{22}} - {_k x_2} \cdots - {_k m_{2n}}\,{_k x_n} - {_p a_{21}}\,{_p x_1} + (1 - {_p a_{22}})\,{_p x_2} \cdots - {_p a_{2n}}\,{_p x_n} = {_k z_2} + {_p z_2} \\
\quad \cdot \qquad\qquad \cdot \qquad \cdot \qquad\qquad \cdot \qquad \cdot \\
\quad \cdot \qquad\qquad \cdot \qquad \cdot \qquad\qquad \cdot \qquad \cdot \\
\quad \cdot \qquad\qquad \cdot \qquad \cdot \qquad\qquad \cdot \qquad \cdot \\
- {_k m_{n1}}\,{_k x_1} - {_k m_{n2}}\,{_k x_2} \cdots - {_k m_{nn}}\,{_k x_n} - {_p a_{n1}}\,{_p x_1} - {_p a_{n2}}\,{_p x_2} \cdots + (1 - {_p a_{nn}})\,{_p x_n} = {_k z_n} + {_p z_n}
\end{array} \tag{7}$$

In matrix notation this is

$$\begin{bmatrix} (\mathrm{I} - [{_k a_{ij}}]) - [{_p m_{ij}}] \\ -[{_k m_{ij}}] \; (\mathrm{I} - [{_p a_{ij}}]) \end{bmatrix} \begin{bmatrix} [{_k x_j}] \\ [{_p x_j}] \end{bmatrix} = \begin{bmatrix} [{_k y_i}] + [{_p y_i}] \\ [{_k z_i}] + [{_p z_i}] \end{bmatrix} \quad (i,\ j = 1, \ldots, n) \tag{8}$$

in which I is an identity matrix of order n. For simplicity's sake the left-hand matrix in (8) may in future be referred to as the "α" matrix.

Now all that has really been done in (8) is to express the accounting information in Table 1 in an altered form. However, system (8) becomes a powerful tool of analysis if the $_{k}x_j$ and the $_{p}x_j$ are considered as unknowns and the coefficients in (8) are interpreted as constant production relationships, assumed to hold for any values of $_{k}x_j$ and $_{p}x_j$. Then the parameters in α define the structure of economic activity in the two countries. Given a particular set of final demand items (i.e., the $_{k}y_i$, $_{p}y_i$, $_{k}z_i$, $_{p}z_i$) the 2n equations in (8) uniquely determine the 2n unknowns, the $_{k}x_j$ and $_{p}x_j$. More generally, the system (8) can be solved for the $_{k}x_j$ and $_{p}x_j$ in terms of any set of final demand items, thus

$$\begin{bmatrix} [{}_kx_j] \\ [{}_px_j] \end{bmatrix} = \begin{bmatrix} (\mathrm{I} - [{}_ka_{ij}]) - [{}_pm_{ij}] \\ -[{}_km_{ij}] \; (\mathrm{I} - [{}_pa_{ij}]) \end{bmatrix}^{-1} \begin{bmatrix} [{}_ky_i] + [{}_py_i] \\ [{}_kz_i] + [{}_pz_i] \end{bmatrix} \quad (9)$$

Since the α matrix appearing in (8) has all the desirable properties of a Leontief matrix, its inverse, α^{-1} in (9), does in fact exist and has all positive elements. Thus the output of any industry or producing sector in either country becomes a function of the final demands for all goods in both countries.

By changing final demands imposed on the system, changes in required output levels throughout both economies can be estimated from the equations in (9). Thus estimates can be made of the impact of changes in final demand in either country on outputs of all sectors in both countries. Such results of course will be first approximations and entirely conditional on the assumptions involved in fixing the structural elements in α.

Let us pause now a moment to consider the implications of fixing the parameters of this system, that is, of assuming the coefficients in the α matrix are constant. This involves the assertion that the relations in (6) hold for any level of the ${}_kx_j$ or ${}_px_j$, that is, that all inputs of any industry or sector vary in direct proportion to its output. Each industry, it is assumed, will operate under conditions of constant returns to scale. The answers yielded by this analysis will of course be highly useful and enlightening if this assumption is a good approximation to reality. To the extent that it is not, the answers become less useful and enlightening.

The constancy of the technical input coefficients (the ${}_ka_{ij}$ and ${}_pa_{ij}$) has been debated at great length, and no attempt will be made to enlarge on that discussion. Instead let us turn attention to a critical evaluation of the use of constant trade coefficients (the ${}_km_{ij}$ and ${}_pm_{ij}$).

2. The Import Problem

Consider the Japanese industry j. It has been assumed that, if the output of this industry increases by 10%, then its consumption of all inputs also increases by precisely 10%. It now consumes 10% more input from the Japanese base metals sector, and 10% more input from the Korean base metals sector. Why should not these latter inputs be substitutable? Why should the Japanese industry j draw on Korean and Japanese suppliers of essentially the same good in some fixed ratio? At first such trade coefficients seem far more tenuous and unreliable than technical input coefficients.

To throw light on this problem consider the characteristics of Korean imports from Japan. They may readily be divided into two categories - competitive and non-competitive (Arrow, 1954). Each of these two categories should be considered separately.

(1) Non-Competitive Imports

Such imports are commonly defined as imports for which there is no equivalent good produced domestically. An example of a Korean non-competitive import from Japan is crude salt. If the only import by the Korean nonmetallic minerals sector from the Japanese quarrying sector is crude salt, then freezing this particular trade coefficient involves exactly the same assumptions that are involved in fixing the Korean technical input coefficients, the ${}_k a_{ij}$. Either involves the assumption that the production process of a particular industry, in this case Korean nonmetallic minerals production, involves the use in fixed proportions of different physical inputs. Its use of Korean quarrying produce is one distinct physical input. Its use of crude salt (an import from Japanese quarrying) is another distinctly different physical input. To fix this trade coefficient is to fix another technical input coefficient - no more, no less.

Extending this reasoning it is clear that if all foreign trade between the two countries is in non-competitive goods, all trade coefficients may be fixed in the same sense that technical input coefficients are fixed. It is appropriate to think of the 2-nation economy then as an economy with 2n distinctly different sectors producing 2n distinctly different goods. To define the trade relationship between these two nations requires two complete trade matrices, each with n^2 coefficients. Each coefficient has its own special and distinct economic meaning.

This is a direct application of the model developed by Isard (1951).

(2) Competitive Imports

Such imports are defined as imports for which there is an equivalent good produced domestically. An example of a Korean competitive import from Japan is iron ore. Suppose that all Korean imports are of this competitive type. In this case there seems little sense in examining the use of Japan-produced iron ore by a particular Korean industry. There is more significance in determining how the total Japanese supply of iron ore to Korea fluctuates with the Korean production of iron ore. This is the relationship which most writers on this subject have examined.

This approach allows the trade relationship of the two countries to be described by only 2n trade coefficients; n of these trade coefficients are of the form

$$ {}_k s_i = \frac{{}_k t_i}{{}_k x_i} = \frac{\text{total Korean import from Japan of good } i}{\text{total Korean production of good } i} $$

While the other n coefficients are of the form

$$ {}_p s_i = \frac{{}_p t_i}{{}_p x_i} = \frac{\text{total Japanese import from Korea of good } i}{\text{total Japanese production of good } i} $$

If all imports are of a competitive character, these import coefficients are the only structural trade relationships in the system that are considered constant. No specification is made as to how the Japanese import of good j is consumed by individual Japanese industries. These imports of good j are simply thrown on the Japanese market, where they become indistinguishable from the comparable Japanese product. Which Japanese industry consumes the import and which Japanese industry consumes the domestic equivalent is of no interest or consequence.

It can be shown nevertheless that the precise solution to this problem may be derived by assuming that each Japanese industry consumes the imported and domestically-produced good in the same fixed proportion $({}_p s_i)$ that this good is imported. Interpreted literally this is an unwarranted and highly restrictive assumption. However, it may be useful as a purely artificial device for deriving a solution to the less restrictive problem in which the only assumption is that a certain proportion of total consumption is satisfied by imports.

This was the method first introduced by Moses (1955) and it is in fact the method used in handling competitive imports in this study. The requirement is that trade between Korea and Japan be characterized by two full matrices of n^2 coefficients each, namely

$$\begin{aligned} [{}_k m_{ij}] &= [{}_k s_i \quad {}_k a_{ij}] \\ [{}_p m_{ij}] &= [{}_p s_i \quad {}_p a_{ij}] \end{aligned} \qquad (i, j = 1, \ldots, n)$$

In conclusion, if imports are non-competitive, trade must (if possible) be characterized by two full matrices of n^2 fixed coefficients each. If imports are competitive, trade may be artificially characterized by two full matrices of n^2 fixed coefficients each. Consequently throughout this analysis the ${}_k m_{ij}$ and ${}_p m_{ij}$ of the basic system (8) are considered to be matrices of n^2 fixed trade coefficients each.

3. The Exchange Rate

Any constant trade coefficient ${}_p m_{ij}$ represents a requirement of a fixed number of physical units of Korean good i for every physical unit increase in Japanese production of good j.

Physical units of Korean output are defined in terms of Korean prices in a base year, and physical units of Japanese output are defined in terms of Japanese prices in the same year. Clearly under these assumptions the Japanese requirements for imports from Korea (in physical terms, or Korean won) vary with Japanese outputs (in physical terms, or Japanese yen) and do not vary with the exchange rate.

It is important to make this assumption clear and always keep it in mind. It is of course no issue if the analysis pertains to a period in which the exchange rate was fixed. It becomes more debatable if it pertains to a period in which the exchange rate varied. The use of fixed trade coefficients is only valid in that case so long as physical trade flows are independent of the exchange rate.

If physical trade varies with the exchange rate, then trading coefficients can no longer be considered constant. The ${}_k m_{ij}$ and ${}_p m_{ij}$ become functions of the exchange rate. As a result the equations in (8) contain quadratic terms (terms in two unknowns - the exchange rate and the output level of a producing sector). Not only does the solution of such a system +involve serious computational difficulties, but the equations involved are of a form which cannot be guaranteed to yield a unique solution with all positive terms.

Ⅳ. EMPIRICAL IMPLEMENTATION OF THE KOREAN-JAPANESE MODEL[4]

Several major difficulties were confronted when the model developed in Chapter Ⅲ was employed to analyze the interdependence of Korea and Japan.

1. Price Adjustments

Korean and Japanese products in the table could be valued at producers' prices (computed at point of shipment) or purchasers' prices (computed at point of delivery, and thus included transportation costs and trade margins). Korean and Japanese products in this study are valued at producers' prices.[5] Accordingly, all import items must be adjusted to exclude not only international freight and insurance premiums incurred in the transactions between Korea and Japan, but also custom duties and import sales taxes levied on trade between two countries.

2. Sector Classifications

The basic classification of the International Input-Output Table, Korea-Japan, 1990 is composed of 274 intermediate sectors, 5 final demand items and 5 value added items. Each sector or item corresponds to at least one sector or item in the national input-output tables for Korea and Japan. Except for the Korean producing sector "Field Crops for Sugar" which does not have a counterpart in the Korean national input-output table. The effort has been made to make the basic classification of the table as consistent as possible with that of the preceding International Input-Output Table, Korea-Japan, 1985.

---

[4] Sections 2, 3, and 4 of this chapter have been fully quoted from The Report of International Input-Output Table, Korea-Japan, 1990, BOK-IDE.

[5] The other respect in which the Korean and Japanese matrices do not correspond is that secondary products are accounted differently. Ideally, therefore, one of the matrices should have been transformed to make both sets of accounts comparable in this respect as well.

In addition to the basic classification, two aggregated tables, one with 58

[Table 2] Number of Sectors (Basic Classification)

	Korea Table 1990	Japan Table 1990	Bilateral Table 1990	Bilateral Table 1985	Bilateral Table 1975
Agriculture, Forestry and Fishery	34	33	28	25	35
Mining	16	10	8	8	17
Manufacturing	267	247	173	158	95
Electricity, Gas and Water Supply, and Construction	24	23	16	15	7
Service	61	94	46	45	10
Dummy Sector	3	5	3	3	3
Intermediate Sector	405	412	274	254	167

intermediate sectors and the other with 11 intermediate sectors, were established, which correspond to aggregated classifications of the International Input-Output Table, Korea-Japan, 1985, which further correspond, respectively, to the 57 sector and 10 sector aggregated classifications of the International Input-Output Table, Korea-Japan, 1975, with the exception of the sector "Business Consumption."

3. The Exchange Rate

All figures in the table are measured in units of one thousand U.S. dollars. The exchange rates used for the conversion from the Korean won to the U.S. dollar and from the Japanese yen to the U.S. dollar are, respectively, 707.97 (₩/$) and 144.79(¥/$), which are the averages of the respective monthly rates in 1990. The data source of the former is the Exchange Rates Statistics of the Bank of Korea and that of the latter is the International Financial Statistics of the IMF.

4. Special Treatment

(1) Scrap and By-Products

Some producers and consumers supply scrap and by-products to the markets. Special care has been taken in recording these secondary products in the table. In the actual recording process, there are four methods which can be employed; i.e., (1) the lump-sum method. (2) the transfer method, (3) the separation method, and (4) the R. Stone method.

As shown in Table 3, the Japanese table treats most scrap and by-products in the same manner as the Korean table. Therefore, the International Input-Output

[Table 3] Treatment of Scrap and By-Products

Method	Scrap & By-Products	
	Korean Table	Japanese Table
(1) Lump-Sum Method	Rice Straw Fur and Hide of Livestock Poultry Manure etc.	Barnyard Manure etc.
(2) Transfer Method	Advertisements in Newspapers, Magazines and Broadcast Media etc.	Advertisements in Newspapers, Magazines and Broadcast Media etc.
(3) Separation Method	Sulfuric Acid Made by Metal Ore Industry etc.	None
(4) R. Stone Method	All Scrap Other By-Products	All Scrap Other By-Products

Table, Korea-Japan, 1990 has been compiled without any adjustment or conversion for the treatment of scrap and by-products.

(2) Non-Profit Organization Sectors

The gross outputs of non-profit organization sectors such as Public Administration, Private Non-Profit Institutions serving Households (comprising religious organizations, labor unions and so forth), etc. are defined as the total current expenditures for their activities. The amounts of deficits of public organizations are recorded mainly in the Government Consumption Expenditures column and those of private non-profit institutions generally in the column of Private Consumption Expenditures.

(3) Imputed Values

The gross outputs of the banking and insurance sectors are composed of (1) imputed values for service charges and (2) other service charges. The former is given as the interest received by financial institutions over and above the interest paid to their depositors.

Imputed values for house rents of owner-occupied dwellings are estimated at market rents and included in the gross output of the Real Estate and House Rent sector.

(4) Value Added Tax and Consumption Tax

The value added tax (VAT) in Korea and the consumption tax (COT) in

Japan are indirect taxes which are essentially levied on the value added at each stage of the production of goods and services. They are collected by enterprises but are ultimately borne by the final consumers of goods and services. In order to value the commodity flows in the Korean national input-output table, a system called the "net system" is introduced, while in the Japanese national input-output table, the "gross system" is employed.

The differences are as follows:

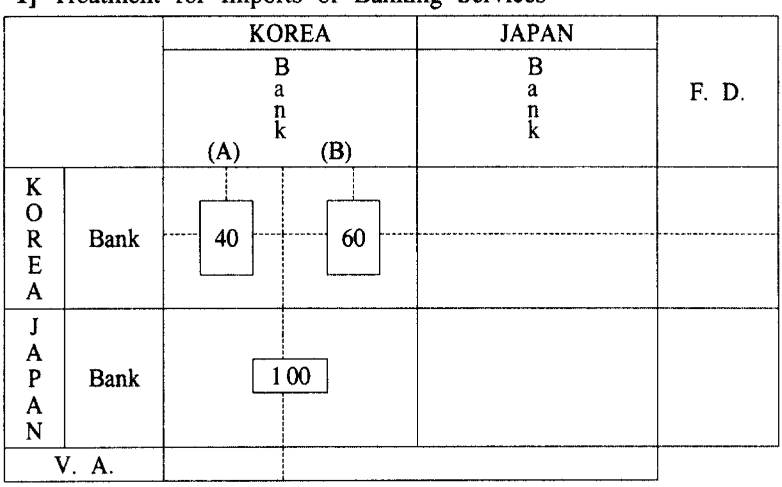
1) Output is valued excluding VAT as invoiced by the producers. (Korean I-O Table)
   Output is valued including COT. (Japanese I-O Table)
2) Imports are valued excluding invoiced VAT on imports. (Korean I-O Table) Imports are valued including COT. (Japanese I-O Table)
3) Intermediate inputs are valued excluding deductible VAT. (Korean I-O Table) Intermediate inputs are valued including COT. (Japanese I-O Table)
4) Final consumption is valued including VAT/COT. (both Korean and Japanese I-O Tables)
5) Gross capital formation is valued excluding deductible VAT. (Korean I-O Table) Gross capital formation is valued including COT. (Japanese I-O Table)
6) Exports are valued excluding VAT/COT. (both Korean and Japanese I-O Tables)

The International Input-Output Table, Korea-Japan, 1990 has been compiled without any adjustment or conversion of the treatment of VAT and COT. Hence the net system is applied for VAT in the Korean parts of the table and the gross system for COT in the Japanese parts.

(5) Imports of Financial, Postal and Telecommunication Services

In the International Input-Output Table, Korea-Japan, 1990, imports of banking,

[Figure 1] Treatment for Imports of Banking Services



insurance, postal and telecommunication services are treated using a method similar to the transfer method explained at the beginning of this section. Figure 1 shows how the table treats an example where Korean establishments in Sectors A and B, respectively, input 40 and 60 units of Japanese banking services. In this case, the total amount of imports (100) is recorded in the column for the Korean banking service sector, and the amounts purchased by Sectors A and B (40 and 60) are treated as Korean domestic products.

(6) Dummy Sectors

The International Input-Output Table, Korea-Japan, 1990 has three dummy sectors; i.e., 1) Office Supplies, 2) Business Consumption, and 3) Activities Not Elsewhere Classified. These sectors are introduced for the convenience of compilation although there is no such actual product in the economy. The Office Supplies sector records expenses for each establishment's supplies, such as notebooks, writing pads, stationery, and so forth. The Business Consumption sector covers expenses on business travel, employee welfare expenditures, and other special business expenses. The sector for Activities Not Elsewhere Classified is mainly used, in the process of compiling national tables, to balance the row and column totals.

V. EMPIRICAL RESULTS

The results provided by this model are of a qualified nature. They are the answers to economic problems that were formulated in mathematical terms. This formulation required a number of restrictive assumptions about the behavior of the economic units involved. Although the results given in this chapter may have complete mathematical precision, they should always be interpreted as being conditional on the economic assumptions from which they were developed, and therefore approximations of economic reality.

Let us now proceed to examine the results obtained. First of all consider α^{-1} the inverse in (9). If final demand for Japanese autos increased by 1 unit, the direct and indirect effects on all Korean and Japanese industries can be estimated by reading down the Japanese motor vehicles column (48) in this inverse.[6] For example, Korean non-ferrous metal ore mining will expand as a result by 0.000005 units, and Japanese leather and leather products by 0.000850 units. Similarly, the direct and indirect effects on any sector in either economy of 1 unit increase in final demand for Korean autos can be estimated by examining the Korean motor vehicles column (48) in this inverse.

This inverse[7] may be divided into four quadrants.

[6] The original version of this paper includes the table for this inverse. Editorial considerations of space have persuaded me to omit the table from the article to be published, but interested readers can be provided this material by asking the author.

[7] Note that this inverse has not been transposed, as is commonly done.

Quadrant I provides estimates of the dependence of Korean producing sectors on final demand for Korean goods. This quadrant is very similar to a typical input-output inverse yielded by a study of Korea in which only domestic output levels are considered as variables and all activities outside of Korea are assumed constant. However, Quadrant I is superior to

		Korean Final Demand 1 2 · · · · · · · · · · · · · · n	Japanese Final Demand 1 2 · · · · · · · · · · · · n
Korean Producing Sectors	1 2 · · n	QUADRANT I Effects of Changes in Final Demand for Korean Goods on Korean Economic Activity	QUADRANT II Effects of Changes in Final Demand for Japanese Goods on Korean Economic Activity
Japanese Producing Sectors	1 2 · · n	QUADRANT III Effects of Changes in Final Demand for Korean Goods on Japanese Economic Activity	QUADRANT IV Effects of Changes in Final Demand for Japanese Goods on Japanese Economic Activity

such a typical inverse, for this quadrant is the result of an analysis which recognizes that Japanese as well as Korean output levels are variable. Therefore, it alone is capable of estimating the effects of those changes in Korean demand which, although they do affect Korean outputs, do so only through their impact on Japanese economic activity.

Quadrant II provides estimates of Korean dependence on Japan, and Quadrant III Japanese dependence on Korea. Let us now turn to a careful evaluation of the information in these two quadrants.

1. Korean Dependence on Japan

Each additional unit of final demand for Japanese goods results in increased production in all sectors in both Korea and Japan. For example, assume final demand for Japanese unmilled rice increases by 1 unit. The total impact on all outputs in both economies may be estimated by summing all the effects shown in the first Japanese final demand column in α^{-1} the inverse matrix. This sum (1.514606) is shown in column 1 of Table 4 along with similar figures resulting from changes of 1 unit in the final demand for all other Japanese goods. Similarly a partial column sum (0.002259), including only those items corresponding to Korean outputs (i.e., only those items of the first Japanese column in α^{-1} appearing in Quadrant II) was computed; such a set of partial sums is shown in column 2 of Table 4.

Now in this table column 1 represents the total impact on both economies of given changes in final demand for Japanese goods; column 2 represents the impact on Korea alone of these changes. Column 3, which gives the ratios of all items in their first two columns, gives a rough indication of the extent to which any given change in Japanese demand may be expected to express itself in activity in Korea - that is, the extent to which such changes in Japanese demand translate themselves into international, as opposed to purely domestic effects. An examination of column 3 shows that four Japanese industries are outstanding for their international effect - industries 26 (leather and leather products), 25 (wearing apparel and other made-up textile goods), 43 (other metal and metal products) and 42 (iron and steel).

Suppose final demand for particular Japanese goods increases, not by a constant absolute amount, but by a constant relative amount, say 1%. Such effects are shown in column 4 of Table 4. These items are simply the items of column 2 multiplied respectively by 1% of final demand for each Japanese good in 1990. Whereas in absolute terms the Korean economy is most sensitive to changes in final demand in Japanese industries 26 (leather and leather products), 16 (slaughtering and meat preserving), 42 (iron and steel) and 23 (wearing and dyeing), on the other hand the Korean economy is most sensitive to relative changes in final demand in Japanese industries 52 (construction),[8] 56 (other services), 45 (electrical equipment and apparatus) and 53 (trade).

2. Japanese Dependence on Korea

Changes in final demands for Korean goods result in altered production levels in all sectors in both Korea and Japan. The total impact on production in both Korea and Japan of 1 unit increase in final demand in each Korean sector is shown in column 1 of Table 5 in which each item is the summation of a Korean final demand column in α^{-1}. The impact on Japanese production alone of this change is shown in column 2 of the same table, each figure in this case representing a partial sum of a Korean final demand column in α^{-1}, including only those items corresponding to Japanese outputs.

Column 1 represents the total impact on both economies of changes in Korea demand; column 2 represents the impact on the Japanese alone of these changes. The ratios of corresponding items in these two columns are given in column 3, and give an indication of the extent to which any given change in final demand for a Korean good expresses itself in activity in Japan - that is, the extent to which such changes in Korean demand translate themselves into international, as opposed to domestic effects. As examination of column 3 indicates that, in general, increased demands for Korean manufactured products (sectors 22 - 50) have the most pronounced international effect, and in particular increased demand for 45 (electrical equipment and apparatus), 46 (ships and boats), 31 (chemical

[8] Due to the fact that Japanese final demand is so largely centered in this industry.

fertilizer and pesticides) and 32 (synthetic rubber, resin and plastic materials).

In this table column 2 shows the absolute impact of 1 unit changes in final demand for various Korean goods. Column 4 shows the impact on Japan of a relative increase of 1% in final demand for each Korean good. While in absolute terms Japan is most sensitive to changes in final demand in Korean sectors 45 (electrical equipment and apparatus), 46 (ships and boats), 31 (chemical fertilizer and pesticides) and 32 (synthetic rubber, resin and plastic materials), in relative terms Japan is most sensitive to changes in final demand in Korean sectors 52 (construction), 45 (electrical equipment and apparatus), 48 (motor vehicles) and 56 (other services).

In summary, there is strong indication that Japan is particularly sensitive to one line of Korean economic activity. That is Korean demand for and production of electrical equipment and apparatus. This appears due to the fact that this Korean industry directly and indirectly draws on Japan for such large suppliers of semi-processed goods.

3. Korea Dependent on Japan or Vice-Versa ?

To throw light on this question, equal additions were made to final demand in each country. In each case the total effect on activity levels in the other country was studied.

One billion dollars was added to Korean demand, in such a way that the final demand for each Korean good was increased in proportion to its 1990 level. As a direct and indirect result, total production of all goods in Japan increased by approximately 71,757 (1,000 US$).

One billion dollars was added to Japanese demand in the same proportional fashion; as a direct and indirect result total Korean production increased by only 4,749 (1,000 US$).

At first glance this result seemed to indicate that any increase in Korean demand has approximately 15.1 times the impact on Japanese economic activity as has a similar increase in Japanese demand on Korean economic activity. Can it be concluded from this fact that Japan is many times as dependent on Korea as is Korea on Japan?

The answer is, of course, in the negative. The above argument is in terms of absolute increases in demand and production levels. Assume, however, that demand in each country is to be increased by some equal relative amount - for example, 1%. In absolute terms this requires increasing Japanese demand by many times the increase in Korean demand. In this case the impact on production in Japan is approximately 1.3 times as great as that in Korea in absolute terms.[9] But such an increase in the level of production has a much greater relative effect on Korean than on Japanese production, due to the

[9] In fact total production in Japan increases by about 173,861 (1,000 US$), in Korea by about 135,608 (1,000 US$).

comparative size of the two economies. The importance to Korea as compared to Japan of such a relative demand increase in the other country may be estimated as

$$\frac{\text{Increased Korean Production}}{\text{Total Korean Production}} \Big/ \frac{\text{Increased Japanese Production}}{\text{Total Japanese Production}}$$

$$= \frac{135{,}608\ (1{,}000\ \text{US\$})}{588{,}208{,}757\ (1{,}000\ \text{US\$})} \Big/ \frac{173{,}861\ (1{,}000\ \text{US\$})}{6{,}035{,}837{,}174\ (1{,}000\ \text{US\$})} = 7.965517 \text{ times}$$

In this sense Korea is about 8.0 times as sensitive to relative changes in Japanese demand as Japan is sensitive to relative changes in Korean demand even though in absolute terms the reverse is true.

This conclusion, of course, could have been established independently by a much simpler model. Moreover it follows for any example of a large and small country, so long as physical trade between 8 the two is roughly equal, and production and trading behavior can be characterized by linear relationships. In relative terms the large country has a much greater influence over its small partner, while in absolute terms the small partner exerts a much greater impact on the large nation.

Since most such questions are concerned with the impact of growth in one country on growth in another, this relative index is the one most widely used. However, the existence of such a reverse absolute index should be recognized for two reasons: first, in order that the term growth in such studies be more clearly and accurately defined, and second, because this absolute index itself may provide the answer to many questions which in the past have been misinterpreted.

Ⅵ. CONCLUDING REMARKS

We provided the results of a concentrated study into the pattern of production and trade in Korea and Japan. The two countries were regarded as being linked together in a common economic structure and the flow of goods and services between all producing sectors in both economies was examined. The specification of a general equilibrium input-output model on the basis of these trading flows has allowed a full tracing of both the direct and indirect effects of changed demand requirements in either economy on all producing sectors in both Korea and Japan.

Since the chief source of potential weakness in an input-output trade analysis is the assumption of frozen international trading patterns, a further objective of this study has been to arrive at a means of partially overcoming this difficulty. Given the nature of the assumptions about relative prices being constant and/or input-output coefficients that are insensitive to prices and technology changes, the input-output approach is best suited for short-range forecasting. However, given the amount of data that is required for this input-output approach, we could use a procedure that may be no more demanding in terms of data but offers more flexibility and less assumptions. In particular, econometric modelling offers more flexibility - one could at least include relative prices, and also forecast at least a medium range, if the structural parameters are sufficiently stable.

On the empirical level, the study indicated that Japan is particularly sensitive to one line of Korean economic activity. That is Korean demand for and production of electrical equipment and apparatus. In addition, the study highlights many other important lines of dependence between the two economies which are not reflected in trade statistics. In fact, it was concluded that trade statistics are usually relatively poor indicators of economic dependence.

In addition this study verified the traditional theory that Korea is far more sensitive to relative growth in Japan, than is Japan to relative Korean growth. It also pointed to a conclusion that is perhaps not so well recognized: Japan is much more sensitive to changes in Korean economic activity than is Korea to changes in Japanese economic activity in absolute magnitude.

Regarding our use of relative change rather than absolute change, we could point out that what might cause the increase in final demands is a change in income. If all sectors had a unitary income elasticity and income changed by 1%, there would be 1% increase in the final demand for each sector. A more interesting approach would be to use the income elasticity of each sector and assume 1% increase in income with prices held constant. A further study of the input-output model is required for this approach.

[Table 4] Effects of Changes in Final Demand in Specific Japanese Sectors

	Japanese Sector	(1)	(2)	(3)	(4)
1.	Unmilled Rice	1.514606	0.002259	0.001491	*
2.	Barley and Other Cereals	1.855088	0.003993	0.002152	*
3.	Other Food Crops	1.571902	0.002912	0.001853	581.119
4.	Industrial Crops	1.594685	0.002716	0.001703	*
5.	Missing Code	1.000000	0.000000	0.000000	0.000
6.	Other Crops	1.578269	0.003479	0.002204	93.985
7.	Livestock	2.350930	0.003672	0.001562	129.357
8.	Agricultural Services	1.797769	0.006343	0.003528	0.000
9.	Forestry	1.917127	0.002756	0.001438	15.006
10.	Fishery	1.807858	0.010972	0.006069	398.295
11.	Coal	1.995647	0.003570	0.001789	*
12.	Crude Petroleum and Natural Gas	1.544599	0.002092	0.001354	0.209
13.	Iron Ore Mining	1.944842	0.002092	0.001354	*
14.	Non-Ferrous Metal Ore Mining	1.692626	0.001807	0.001068	*
15.	Non-Metal Mining	1.994798	0.003853	0.001932	*
16.	Slaughtering and Meat Preserving	2.796421	0.017309	0.006190	2,430.374
17.	Food Processing	2.354429	0.011966	0.005082	4,711.277
18.	Oil and Fats	1.910189	0.003538	0.001852	39.587
19.	Grain Polishing and Manufacture of Flour	2.438403	0.002525	0.001036	512.328
20.	Food Preparations	2.140561	0.006623	0.003094	3,663.930
21.	Tobacco and Beverage	1.774685	0.003286	0.001852	1,573.389
22.	Spinning	2.037561	0.004214	0.002068	2.078
23.	Weaving and Dyeing	2.320733	0.016210	0.006985	168.454
24.	Knitted Products	2.267197	0.011447	0.005049	1,115.327
25.	Wearing Apparel and Other Made-Up Textile Goods	2.181554	0.015950	0.007311	6,211.090
26.	Leather and Leather Products	2.030372	0.026527	0.013065	1,878.801
27.	Wooden Products	2.040985	0.004455	0.002183	454.080
28.	Pulp and Paper	2.247893	0.003297	0.001467	57.737
29.	Printing and Publishing	2.092438	0.002468	0.001179	237.700
30.	Basic Industrial Chemicals	2.168887	0.009684	0.004465	3.012
31.	Chemical Fertilizer and Pesticides	2.078818	0.007326	0.003524	6.527
32.	Synthetic Rubber, Resin and Plastic Materials	2.431702	0.007889	0.003244	14.500
33.	Missing Code	1.000000	0.000000	0.000000	0.000

[Table 4] Effects of Changes in Final Demand in Specific Japanese Sectors (Cont'd)

34.	Paints and Other Chemical Products	2.091180	0.006754	0.003230	1,422.197
35.	Petroleum Refinery	1.195345	0.000992	0.000830	181.156
36.	Coal and Coaltar Products	1.584241	0.001544	0.000975	2.179
37.	Rubber Products	2.163347	0.008102	0.003745	77.244
38.	Plastic Products	2.431203	0.010117	0.004161	353.306
39.	Pottery and Glass Products	1.908219	0.004973	0.002606	38.988
40.	Cement and Cement Products	2.254801	0.007703	0.003416	10.599
41.	Non-Metallic Mineral Products	1.994198	0.006272	0.003145	113.624
42.	Iron and Steel	2.682500	0.018995	0.007081	*
43.	Other Metal and Metal Products	2.167872	0.015582	0.007188	2,159.447
44.	Industrial Machinery	2.306652	0.007795	0.003379	8,304.980
45.	Electrical Equipment and Apparatus	2.293298	0.010761	0.004692	12,273.641
46.	Ships and Boats	2.425995	0.010071	0.004151	262.480
47.	Railroad Cars	2.453392	0.007299	0.002975	145.133
48.	Motor Vehicles	2.817168	0.006373	0.002262	5,593.187
49.	Other Transport Equipment	2.447972	0.007645	0.003123	1,178.668
50.	Scientific Equipment and Other Manufactured Goods	2.185643	0.007676	0.003512	3,611.474
51.	Electricity, Gas and Water Supply	1.607681	0.002505	0.001558	962.338
52.	Construction	2.087408	0.006517	0.003122	37,069.875
53.	Trade	1.571436	0.002649	0.001686	9,039.660
54.	Hotel, Restaurant and Bar	1.932892	0.005237	0.002709	5,076.743
55.	Transport	1.689738	0.005736	0.003395	4,788.201
56.	Other Services	1.556847	0.001858	0.001193	18,644.329
57.	Business Consumption	2.784223	0.008787	0.003156	0.000
58.	Activity Not Elsewhere Classified	2.131738	0.004829	0.002265	0.000
	Total				135,607.590

(1) Production Generated in Korea and Japan by 1 Unit Increase in Final Demand in Specific Japanese Sectors

(2) Production Generated in Korea Alone by 1 Unit Increase in Final Demand in Specific Japanese Sectors

(3) Column (2) / Column (1)

(4) Production Generated in Korea by 1% Increase in Final Demand in Specific Japanese Sectors (1,000 US $)

* In 1990 Final Demand for the Output of This Sector Was Negative Due to Large Inventory Depletion.

[Table 5] Effects of Changes in Final Demand in Specific Korean Sectors

	Korean Sector	(1)	(2)	(3)	(4)
1.	Unmilled Rice	1.284203	0.014364	0.011185	12.209
2.	Barley and Other Cereals	1.668578	0.039687	0.023785	*
3.	Other Food Crops	1.404885	0.024278	0.017281	1,409.168
4.	Industrial Crops	1.336583	0.022638	0.016937	34.229
5.	Missing Code	1.000000	0.000000	0.000000	0.000
6.	Other Crops	1.403414	0.019016	0.013550	74.105
7.	Livestock	2.512467	0.035028	0.013942	245.196
8.	Agricultural Services	1.716698	0.017022	0.009916	0.000
9.	Forestry	1.223703	0.013893	0.011353	19.297
10.	Fishery	1.634075	0.069794	0.042712	1,464.069
11.	Coal	1.651514	0.030920	0.018722	6.277
12.	Crude Petroleum and Natural Gas	1.000000	0.000000	0.000000	0.000
13.	Iron Ore Mining	1.628414	0.038605	0.023707	0.618
14.	Non-Ferrous Metal Ore Mining	1.860180	0.042762	0.022988	0.898
15.	Non-Metal Mining	1.563339	0.026673	0.017062	*
16.	Slaughtering and Meat Preserving	3.199856	0.038771	0.012116	1,375.634
17.	Food Processing	2.535518	0.050176	0.019789	1,939.553
18.	Oil and Fats	1.983500	0.026925	0.013574	80.210
19.	Grain Polishing and Manufacture of Flour	2.223789	0.016577	0.007454	1,399.762
20.	Food Preparations	2.018422	0.040902	0.020264	1,757.600
21.	Tobacco and Beverage	1.669287	0.025586	0.015328	1,561.181
22.	Spinning	2.267215	0.176904	0.078027	*
23.	Weaving and Dyeing	2.426470	0.153806	0.063387	*
24.	Knitted Products	2.540175	0.127641	0.050249	2,694.374
25.	Wearing Apparel and Other Made-Up Textile Goods	2.406071	0.159005	0.066085	4,264.514
26.	Leather and Leather Products	2.031137	0.082360	0.040549	1,155.840
27.	Wooden Products	1.757125	0.042727	0.024316	721.232
28.	Pulp and Paper	2.039676	0.074235	0.036395	*
29.	Printing and Publishing	2.198875	0.075243	0.034219	901.938
30.	Basic Industrial Chemicals	2.040815	0.132978	0.065159	10.771
31.	Chemical Fertilizer and Pesticides	2.206354	0.247010	0.111954	*
32.	Synthetic Rubber, Resin and Plastic Materials	2.172319	0.220585	0.101544	*
33.	Missing Code	1.000000	0.000000	0.000000	0.000
34.	Paints and Other Chemical Products	2.007295	0.135231	0.067370	6,168.968

[Table 5] Effects of Changes in Final Demand in Specific Korean Sectors (Cont'd)

35.	Petroleum Refinery	1.199646	0.015526	0.012942	93.824
36.	Coal and Coaltar Products	1.880759	0.027674	0.014714	273.198
37.	Rubber Products	2.050939	0.156652	0.076381	78.796
38.	Plastic Products	2.262173	0.168199	0.074353	862.188
39.	Pottery and Glass Products	1.794638	0.075938	0.042314	*
40.	Cement and Cement Products	2.035855	0.035136	0.017259	*
41.	Non-Metallic Mineral Products	1.926928	0.054705	0.028390	*
42.	Iron and Steel	2.672774	0.124907	0.046733	*
43.	Other Metal and Metal Products	2.151052	0.134814	0.062674	2,662.981
44.	Industrial Machinery	2.315889	0.210382	0.090843	14,693.078
45.	Electrical Equipment and Apparatus	2.258418	0.314100	0.139080	28,898.142
46.	Ships and Boats	2.489809	0.282830	0.113595	2,389.631
47.	Railroad Cars	2.287747	0.173932	0.076028	427.177
48.	Motor Vehicles	2.389166	0.198568	0.083112	27,498.689
49.	Other Transport Equipment	2.184787	0.209104	0.095709	3,242.785
50.	Scientific Equipment and Other Manufactured Goods	2.218095	0.174288	0.078576	2,769.785
51.	Electricity, Gas and Water Supply	1.575941	0.031990	0.020299	690.600
52.	Construction	2.032149	0.059930	0.029491	33,500.270
53.	Trade	1.547536	0.017340	0.011205	3,079.411
54.	Hotel, Restaurant and Bar	1.632518	0.021997	0.013474	323.356
55.	Transport	1.645310	0.063086	0.038343	5,183.840
56.	Other Services	1.603048	0.028920	0.018041	19,895.195
57.	Business Consumption	2.883297	0.036606	0.012696	0.000
58.	Activity Not Elsewhere Classified	4.193306	0.128236	0.030581	*
	Total				173,860.560

(1) Production Generated in Korea and Japan by 1 Unit Increase in Final Demand in Specific Korean Sectors
(2) Production Generated in Japan Alone by 1 Unit Increase in Final Demand in Specific Korean Sectors
(3) Column (2) /Column (1)
(4) Production Generated in Japan by 1% Increase in Final Demand in Specific Korean Sectors(1,000 US $)
* In 1990 Final Demand for the Output of This Sector Was Negative Due to Large Inventory Depletion.

REFERENCES

Arrow, K. (1954), "Import Substitution in Leontief Models," *Econometrica*, XXII, 481-492.

BOK-IDE (1996), *International Input-Output Table, Korea-Japan, 1990*, I.D.E. Statistical Data Series No. 71.

Dorfman, R. (1954), "The Nature and Significance of Input-Output," *Review of Economics and Statistics*, XXXVI, 121-133.

Isard, W. (1951), "Interregional and Regional Input-Output Analysis: a Model of a Space Economy," *Review of Economics and Statistics*, XXXIII, 318-328.

Leontief, W. (1946), "Exports, Imports, Domestic Output and Employment," *Quarterly Journal of Economics*, LX, 171-193.

____________(1951), "Input-Output Economics," *Scientific American*, CLXXXV, 15-21.

Moses, L. (1955), "The Stability of Interregional Trading Patterns and Input-Output Analysis," *American Economic Review*, XLV, 803-832.