JAPAN'S DEPENDENCE ON EXPORTS IN CONTRAST WITH THAT OF SIX OTHER NATIONS

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I. *Introduction*

With special reference to Japan, it has been common practice to use the ratio of exports or imports to national income as a measure of a country's trade dependence. Hersey (1), in a report for the State Department published in 1946, measures retained imports and originated exports as a proportion of national income. To obtain either retained imports or originated exports he made various estimates of the import content of exports based primarily on the extent to which the principal raw material used in exports was of domestic or foreign origin. Lockwood (2) used Hersey's data to establish Japan's trade dependence in a slightly different sense than Hersey. The conceptual difficulties that arise, pointed out by Hollerman (3 and 4), center chiefly on the difference between a national income view of trade dependence and a technological view of trade dependence.

If measurement problems are not anticipated, a meaningful method of measuring trade dependence would be to compute a country's welfare in the absence of trade. With the same production possibilities set, opening the country to trade would enable the attainment of a higher level of welfare. This difference in community welfare divided by the welfare level prior to trade would provide a measure of trade dependence for a cross-sectional or intertemporal comparison. On a cross-sectional basis we would expect that for countries with extensive resource bases such as Canada, the U.S.S.R., and the U.S., trade dependence would be less than for smaller countries at approximately the same level of development such as Japan and the United Kingdom.

However, in practice it is almost impossible to measure hypothetical welfare without trade or even income without trade. When the measurements of the type carried out by Hersey are used as measures of trade dependence, the assumption is made either implicitly or explicitly that the domestic economy is dependent upon foreign demand. Retained imports as a proportion of national income represent an increment to consumption at constant terms of trade. Consequently, any increase in the flow of retained imports as a proportion of national income is equivalent to a real increase in income. Similarly, an increase in originated exports represents an increase in real income due to foreign demand implying that there are no alternative uses for these products at home.

While these measures are not valid as indicators of trade dependence, they do provide us

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with an interesting basis for an intercountry comparison of value added exported as a proportion of total value added. Taken in conjunction with the value added exported as a proportion of total exports, we will be able to discern the relative importance of exports to selected industrial nations. Since the comparison is made at a given point in time, institutions and the basis for trade are assumed fixed.

For this study the ratio of value added exported to *GNP* is computed for a cross-section of industrial nations. In order to obtain a measure of value added exported a method must be chosen such that the indirect as well as the direct import content of exports is deducted from the value of exports. While the most appropriate denominator might be national income or net national product, we have chosen *GNP* to avoid intercountry divergencies in the measurement of capital consumption allowances.

II. *The Model*

In order to carry out an empirical analysis of trade dependence as defined above, the indirect as well as the direct utilization of primary inputs must be accounted for explicitly. The most appropriate framework for this task is an open input-output general equilibrium model.

Suppose that the economy consists of n production sectors. Let X_i stand for the output of the i-th sector, X_{ij} for the output of the i-th sector delivered to the j-th sector for its production, and F_i for the output of the final demand for the ith sector. Then the following identity is obtained:

(1) $$X_i=\sum_{j=1}^{n} X_{ij}+F_i : i=1, n.$$

This equation states that the output of the ith sector is allocated as either an input into one or more production processes or as a component of final demand.

If we assume proportionality for each productive process, a fixed relationship is obtained between X_j and X_{ij}, or

(2) $$X_{ij}=a_{ij}X_j : \begin{matrix} i=1, n. \\ j=1, n. \end{matrix}$$

At any level of output the demand by the jth sector for the goods produced in the ith sector remains proportional to jth sector's output. Combining (2) with (1), we obtain:

(3) $$X_i=\sum_{j=1}^{n} a_{ij}X_j+F_i : i=1, n.$$

Or, in matrix notation:

(3)′ $X=AX+F$, where X is a vector of X_i, F is a vector of F_i, and A is a matrix of a_{ij}. Then,

(4) $$F=(I-A)X$$

or

(5) $$X=(I-A)^{-1}F.$$

Equation (5) provides us with the amount of output of the i-th sector necessary to produce the vector of final demand F_i. Each element of $(I-A)^{-1}$, A^{ij}, establishes the amount of production of ith sector *directly* and *indirectly* needed to produce one unit of output of jth sector. The assumption of proportionality for each production process also establishes a fixed relationship between imports and the output of the jth industry, X_j.

(6) $M_j = b_j X_j : j=1, n.$

In addition to proportionality, we assume that each process is a homogeneous process producing one commodity. Consequently, a_{ij} and b_j are the same regardless of the composition or destination of final demand for ith sector. This assumption permits the substitution of E_i, exports of the ith output for F_i in equation (3), and thus the following equation is obtained:

(7) $X=(I-A)^{-1}E$, where E is a vector of E_i.

By using equation (7) we can obtain the output for the ith sector, X_i, needed to produce the vector of E_i. Then, by substituting this X_i for the X_i in equation (6), we obtain:

(8) $M^* = \sum_{j=1}^{n} M_j = \sum_{j=1}^{n} b_j X_j$, where M^* is is the total imports used to produce the vector of E_i. Therefore,

(9) $E' = (E-M^*)$ is the amount of income exported or the value of exports which accrues to domestic factors of production. By dividing E' by total value added, we obtain the proportion of value added exported.

III. *Measurement*

Seven processes have been chosen which, by virtue of the assumptions of the model, must each be considered as being homogeneous processes producing seven different commodities. In practical applications of input-output analysis the assumption of a homogeneous process for each commodity is difficult to fulfill; in a highly aggregated economy of seven sectors this assumption is even more tenuous. Each commodity group is produced by a mixed process which consists of an average weighted by the output of different processes. If all of the individual processes were the same or if all were utilized in the same proportions, there would be no aggregation problem.

In this study each economy has been aggregated on the same basis into the seven sectors or processes, each of which is essentially an extension of Colin Clark's tripartite division of production. Corresponding to the primary sector, Group I consists of agricultural products, Group II of natural raw materials and products directly derived therefrom, and Group III consists of mineral fuels and products. The secondary sector corresponds to Group IV, chemicals; Group V, manufactures; and Group VI, machinery and transportation equipment. The tertiary sector is identical to Group VII, services. In each of these sectors, industries have been grouped according to the similarity of process in order to conform as closely as possible with the assumptions of the model. Table 1 shows the results of the calculations on the basis of the 1954 input output table for the United Kingdom, the 1955 input-output table for Japan, and the 1959 input-output table for Belgium, France, Germany, Italy, and the Netherlands. Since we want to compare the export dependency of different countries at the same point of time, ideally the same year should be selected for each country. The method of analysis has limited the choice of input-output tables to those with imports entered in a row

TABLE 1. $\frac{E'}{E}$

	I	II	III	IV	V	VI	VII	VIII	TOTAL	
									$\frac{E'}{E}$	$\frac{E'}{Y}$
Japan	.907	.872	.760	.836	.823	.896	.949	.915	.876	.1219
Belgium	.762	.624	.716	.669	.614	.644	.910		.683	.2450
France	.906	.944	.793	.856	.847	.906	.967		.888	.1146
Germany	.826	.907	.816	.821	.806	.863	.951		.860	.1595
Italy	.904	.914	.658	.780	.783	.861	.950		.851	.1028
Netherlands	.670	.838	.511	.566	.618	.667	.827		.691	.3695
United Kingdom	.838	.738	.699	.818	.782	.896	.951		.860	.1666

Sources: Japan: Sōrifū Tōkeikyoku, *Showa 30 nen Sangyō Renkanhyō* (Tokyo: 1961).
Common Market Countries: Statistisches Amt Der Europäischen Gemeinschaften, *Input-Output Tabellen für die Länder der Europäischen Wirtschaftsgemeinschaft* (*Zweite Fassung*), published as an appendix to the *Allgemeines Statisches Bulletin*, December, 1965.
United Kingdom: Board of Trade and Central Statistical Office, *Input-Output Tables for the United Kingdom, 1954* (London: Her Majesty's Stationary Office, 1961), Table A.

Note: Group I includes agriculture, forestry, fisheries, livestock and slaughtering, processed foods, beverages, and tobacco. Group II includes metallic ores and concentrates, non-metallic mineral mineral products, wood pulps, and pig iron. Group III includes coal, mineral tar, tar oils, crude chemicals from coal, natural gas, petroleum, and petroleum products. Group IV includes chemicals, intermediate chemical products, drugs, soaps, and explosives. Group V includes textiles, yarns, leather products, rubber products, ferrous and non-ferrous metals, non-mechanical metal products, housewares and miscellaneous manufactures. Group VI includes machinery, instruments, communications equipment, optical products, and transport equipment. Group VII includes all internal and external services. Group VIII applies only to Japan and includes miscellaneous items unallocated in the input-output table cited above.

as inputs into the productive process; the 1960 Japanese input-output table, for example, has imports entered as a negative component of final demand to emphasize the competitive nature of imports. While it is unfortunate that the lack of data has necessitated a comparison using different years, the results in general terms should be indicative of the relative importance of exports in generating income.

In Table 1 the proportion of value added exported varies from ten percent for Italy to thirty-seven percent for the Netherlands. The values for the Netherlands and Belgium are appreciably higher than for the other countries examined. This can be attributed to the degree of specialization of these economies due in part to institutional arrangements such as the Benelux Treaties, low tariff structures, and large overseas investments. Germany and the United Kingdom values are similar at about sixteen percent, while Italy, France, and Japan have values of between ten percent and twelve percent. There appears to be little correlation between the resource base of the countries considered and the percentage of value added exported. In Table 1 a ranking by countries according to a decreasing amount of value added as a proportion of total value added corresponds in general to a ranking of countries by an increasing amount of value added exported as a proportion of total exports. The major implication of these results is that trade is not so much predicated upon the raw material base of a country, but that for industrial nations trade is apparently a function of specialization.

The sector with the highest value added exported as a proportion of total exports is the services sector, Group VII, while the lowest values are found in the mineral fuel sector, Group III, as would be expected on an *a priori* basis. Japan's value added exported as a proportion of total exports in agriculture, chemicals, manufactures, and machinery is only exceeded by the values for France. The only sector for which $\frac{E'}{E}$ is less than eighty per-cent is in the export of mineral fuels. For Japan, the export of mineral fuels primarily consists of a small amount of gasoline in which the amount of value added domestically is small in relation to its total value.

If input-output tables were available for the years after 1955, we would be able to observe the direction of change in the importance of exports in the generation of income for Japan. Howeve, as noted above, the 1955 input-output table is the only Japanese table with imports entered as a row. In lieu of additional tables, we might want to assume that the technology matrix remained the same over a period of several years; however, for the economy of a country such as Japan which has been experiencing technological change, this assumption can not be justified. Although a perspective on the importance of exports in the long run cannot be obtained for Japan, it is possible to show the direction of change in value added exported as a proportion of *GNP* around the year 1955, by using the trade statistics with some additional assumptions.

First, we assume that the technology matrix remained the same between 1954 and 1955 and between 1955 and 1956. While this assumption is not strictly true, it may be considered as a close approximation to reality to the extent that the change in technological coefficients may not be too large over a one-year interval. Using this assumption, and if we differentiate X in equation (7) with respect to E, we obtain:

(7)′ $dX=(I-A)^{-1}\,dE$, which states that the change in production can be calculated by multiplying the change in exports (dE) by the inverse, $[(I-A)^{-1}]$. Secondly, and with the same justification as in the case of the technology matrix, we assume that the import coefficients, b_j, remain the same between 1954 and 1955 and between 1955 and 1956. Applying this second assumption to equation (8), we obtain:

(8)′ $dM^*=\sum_{j=1}^{n} b_j dX_j$, where dM^* is a vector representing the change in imports needed to produce a change in the vector of exports, dE_n. Then dE', or the change in exports originating in Japan, is equal to $(dE-dM^*)$.

The value added exported as a proportion of *GNP* can be written in terms of dE', the value for domestically originated exports, and *GNP* for the year in question as follows:

$$\frac{E_t'}{Y_t}=\frac{dE'+E'_{t-1}}{dY+Y_{t-1}}.$$

By using this expression, we obtain $\frac{E'}{Y}$ for 1954, $(t-1)$, in terms of $\frac{E'}{Y}$ for 1955, (t),

$$\frac{E'_{t-1}}{Y_{t-1}}=\left(1+\frac{dY}{Y_{t-1}}\right)\frac{E'_t}{Y_t}-\frac{dE'}{Y_{t-1}}. \tag{9}$$

Similarly, by using the same equation we can obtain $\frac{E'}{Y}$ for 1956, $(t+1)$, in terms of $\frac{E'}{Y}$ for 1955, (t),

TABLE 2

	1954	1955	1956
$\frac{dE'}{Y_t}$	.0207*	.0215*	
$\frac{dY}{Y_t}$	.0995*	.1276*	
$\frac{E'}{Y_t}$	.1134	.1219	.1274

Sources: Trade data was obtained from Okurasho, *Nihon Gaikoku Bōeki Nenpyō 1954, 1955, 1956* (Tokyo: Okurashō, n. d.); Nihon Ginko Tokeikyōku, *Hompō Keizai Tōkei, 1957* (Tokyo: Nihon Ginko, n.d.); Economic Planning Agency, *Japanese Economic Statistics, Bulletin nrs. 107-108, 117-118, 132-133* (Tokyo: Economic Planning Agency, n.d.). National income data were obtained from Sōrifū Tokeikyoku, *Nihon Tokei Nenkan, 1959* (Tokyo: Sōrifū Tokeikyoku, 1959).

Note: * indicates the change over the period 1954 to 1955 under 1954 and the change over the period 1955 to 1956 under 1955.

$$\frac{E'_{t+1}}{Y_{t+1}}=\left(\frac{1}{1+\frac{dY}{Y_t}}\right)\left(\frac{dE'}{Y_t}+\frac{E'_t}{Y_t}\right). \tag{10}$$

In order to obtain the vector dE, the Japanese trade data have been aggregated to conform with the seven sectors of the basic input-output model. The eighth, or unallocated sector of the Japanese input-output table, is comprised of the miscellaneous entry in the invisible trade accounts and unallocated special procurements.

In Table 2 the results of applying the trade data to equations (10) and (11) are shown.

The amount of value added exported as a proportion of GNP has been calculated using (9) and (10) for the years 1954 and 1956. The differences between 1954 and 1955 and between 1955 and 1956 are 0.0085 and 0.0055, indicating that the value added exported as a proportion of GNP declined from a 7.5 percent rate of growth to a 4.5 percent rate of growth per year. Unfortunately, we are unable to ascertain whether or not this decrease has continued since 1956.

IV. *Summary and Conclusion*

While no attempt has been made to calculate trade dependence as defined above, the export of value added as a proportion of GNP and the domestic content of exports has been calculated for seven industrial nations, which, by virtue of their resource base, degree of industrialization, and size, may be expected to have similar proportions of their income devoted to the production for export. However, we found that the export of value added as a proportion of GNP varied among the countries, with Japan having one of the lowest values for $\frac{E'}{Y}$ and one of the highest values for $\frac{E'}{E}$. In addition, the direction of change in value added exported as a proportion of GNP was calculated for the period 1954 to 1956 and was found to be increasing. Without suitably constructed input-outpt tables for the period after 1955, we are unable to know with certainty whether or not the increase in $\frac{E'}{Y}$ has continued.

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