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ECONOMIC INTERDEPENDENCE IN PACIFIC ASIA: AN INTERNATIONAL INPUT-OUTPUT ANALYSIS

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I. INTRODUCTION

IN the last two decades, developing countries in East and Southeast Asia have experienced high economic growth through industrialization. In the 1960s, the so-called newly industrializing countries (NICs) among them, Taiwan, the Republic of Korea, Singapore, and Hong Kong, launched their industrialization in the light manufacturing sectors, managed to achieve domestic production of previously imported labor-intensive goods ("import substitution"), and then started exporting these same goods. In the 1970s, development of heavy industry became one of the major economic objectives of these countries. Aside from Singapore, the other four ASEAN member countries[1] achieved import substitution of labor-intensive manufactures in the middle of the 1970s, at the same time also increasing exports of these products. The growth rates of the manufacturing sectors in these countries were 10 to 13 per cent per annum, though primary products still have a large share in their overall exports.

Rapid industrialization in East and Southeast Asian countries has had a tremendous impact on the international division of labor among the Pacific Asian countries, as well as on trade between them and the developed countries in the region. Both exports and imports of the regional LDCs have expanded rapidly, while the growth rates of exports and imports of such major trading partners as Japan and the United States were lower than or merely equal to the average growth rates for the world as a whole. This difference in growth rates between LDCs and developed countries which is characteristic of the international division

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[1] The Association of Southeast Asian Nations (ASEAN) at present has six member countries, i.e., Indonesia, Malaysia, Philippines, Singapore, Thailand, and Brunei. In this paper, however, ASEAN encompasses only the first five, as Brunei was not a member in 1975.

of labor in the region has brought on "trade conflicts," a phenomenon requiring the coordination of industrial policies.

In the markets of developed countries, the share of manufactures imported from East and Southeast Asian countries has rapidly increased, and "competition" between export industries in these countries and import-competing domestic industries in developed countries has been intensified. On the other hand, most of the capital and intermediate goods required in the process of industrialization and production for exports in the regional LDCs are supplied by developed countries. Thus, exports to the regional LDCs from the developed countries have grown faster than their domestic demand or exports to other regions. In this sense, industrialization in the LDCs has supported the economic growth of the developed countries to some extent. Here, then, we find "complementarity" between the two groups of countries. This "competition and complementarity" is the main feature of the international division of labor in the region.

Even over the long run, as these LDCs are further industrialized, substitution of present imports by domestic production proceeds, and exports of new goods increase, this type of relationship may continue to hold.

The intensified competition coupled with complementarity has brought about two types of trade conflicts. In developed countries, severe competition by imports from East and Southeast Asia has raised protectionistic sentiments. Direct measures aimed at countering intensified competition—such as restriction of imports from LDCs—will, however, result in a reduction of exports to these LDCs and thus to sluggish growth because of the complementarity relationship. In developing countries, on the other hand, heavy dependence on developed countries in terms of capital and intermediate goods has the tendency to cause balance-of-payments difficulties or bilateral account deficits with specific countries. Behind the criticism among regional LDCs against trade patterns with Japan lies such economic reasoning.

Separate, allopathic treatment of these two types of conflicts could result in contracted world trade. To avoid such an eventuality, it is necessary to prepare consistent and internationally coordinated policy measures, similar to the OECD's positive adjustment policies, based on the existing competitive and complementarity relationship.

This paper aims at a quantitative analysis of this complicated relationship. Section II presents the methodology and data used in this study, Section III outlines the trade and industrial interrelationships in the Pacific Asian region in 1975, and Section IV offers a simulation analysis of various international industrial adjustment policies. This substantive presentation is followed by short concluding remarks.

II. METHODOLOGY AND DATA

To study the "competitive and complementarity" relationship existing in the region, we used the international input-output table for 1975 which covers ASEAN

TABLE I

SELF-SUFFICIENCY RATIOS, 1975

(%)

	IDN	MYS	PHL	SGP	THA	KOR	JPN	USA
Private consumption:	97	88	95	75	96	99	98	96
Apparel	98	75	99	76	99	99	95	94
Electric machinery	77	53	71	54	61	97	98	90
Government consumption	99	98	99	93	98	97	100	97
Investment:	92	49	72	62	74	72	98	96
Industrial machinery	7	13	12	15	19	23	94	88
Electric machinery	67	38	55	64	34	57	98	90
Motor vehicles	93	38	80	43	50	83	99	85
Other transportation equipment	36	40	27	67	33	28	86	97
Precision equipment	1	67	4	13	11	20	86	90
Intermediate demand:								
Textiles	76	76	73	60	91	91	93	93
Apparel	85	64	87	63	89	87	96	90
Iron and steel	52	75	40	30	32	67	93	93
Industrial machinery	22	45	77	46	48	77	97	91
Motor vehicles	31	46	56	48	57	73	99	91

Note: IDN=Indonesia, MYS=Malaysia, PHL=Philippines, SGP=Singapore, THA=Thailand, KOR=Korea, JPN=Japan, USA=United States.

countries, plus Korea, Japan, and the United States.[2] Our analysis is thus limited to the relationships among these countries, though we consider it representative of the pattern of international division of labor in the region as a whole. The original table upon which we relied has fifty-six industrial sectors for each country, but we recompiled these into twenty-eight industrial sectors for convenience of analysis.

Conventional analytical methods for input-output tables are followed, though they are extended to multicountry cases, and some new concepts are introduced. The structure of an international input-output table and our analytical methods are given in Appendix.

III. COMPETITION AND COMPLEMENTARITY IN 1975

Korea and ASEAN member countries have achieved import substitution of consumption goods, but much of their supply of capital and intermediate goods still derives from developed countries. The self-sufficiency ratios (domestic supply/domestic demand) calculated from the international input-output table are presented in Table I. In LDCs in the region, the self-sufficiency ratio for final private consumption is quite high, around 90 per cent for apparel and 80

[2] See Institute of Developing Economies, *International Input-Output Table for ASEAN Countries, 1975*, I.D.E. Statistical Data Series No. 39 (Tokyo, 1982).

TABLE II

PRODUCTION INDUCEMENT COEFFICIENTS, 1975

	IDN	MYS	PHL	SGP	THA	KOR	JPN	USA
Textiles:								
Total	2.15	2.13	2.23	2.15	2.12	2.69	2.61	2.29
Domestic	1.68	1.68	1.74	1.73	1.91	2.30	2.53	2.26
Foreign	0.47	0.45	0.49	0.42	0.21	0.39	0.08	0.03
Apparel:								
Total	2.30	2.00	2.23	1.78	2.15	2.65	2.50	2.04
Domestic	1.93	1.58	1.93	1.52	1.96	2.22	2.44	2.00
Foreign	0.37	0.42	0.30	0.26	0.19	0.43	0.06	0.04
Iron and steel:								
Total	2.29	2.22	2.21	2.25	2.23	3.10	3.06	2.19
Domestic	1.55	1.87	1.41	1.03	1.69	2.17	2.98	2.14
Foreign	0.74	0.35	0.80	1.22	0.54	0.93	0.08	0.05
Industrial machinery:								
Total	1.85	1.81	2.21	2.00	2.00	2.50	2.50	1.92
Domestic	1.21	1.42	1.87	1.45	1.48	1.98	2.45	1.86
Foreign	0.64	0.41	0.34	0.55	0.52	0.52	0.05	0.06
Motor vehicles:								
Total	1.98	2.15	2.17	2.14	2.00	2.44	2.67	2.40
Domestic	1.29	1.62	1.62	1.52	1.66	1.92	2.63	2.31
Foreign	0.69	0.57	0.55	0.62	0.34	0.52	0.04	0.09

per cent for electric appliances. For investment goods, it is relatively low, except for automobiles, which are assembled in the countries under heavy protection. In Japan and the United States, both consumption and investment goods are mostly supplied domestically.

The self-sufficiency ratio for intermediate goods by industry (domestic input supply/total input demand) in ASEAN countries is around 60 per cent for textiles and 30 to 60 per cent for iron and steel, while in Japan and the United States it is around 90 per cent for most industries. In Korea, the ratios lie somewhere in between.

High intermediate dependence on imports is reflected in the share of intermediate goods imports in total imports—around 70 per cent for Korea and Singapore and 50 per cent for the other four ASEAN countries—which has important implications both for the industrialization process of LDCs in the region and the international division of labor there. With high rates of international intermediate goods transactions, production in one country induces production in other countries. If this inducement effect is high, we can say that a high degree of "complementarity" exists between two countries.

Table II portrays this relationship. To satisfy a unit of final demand in a given country, the industry concerned requires both domestic and foreign inputs, which in turn induce the necessary production. In the table, the ratios of both directly and indirectly induced production per unit of final demand, or the "inducement coefficient" are presented for major industries. The figures for the

TABLE III

VALUE-ADDED INDUCEMENT COEFFICIENTS, 1975

	IDN	MYS	PHL	SGP	THA	KOR	JPN	USA
Indonesia	0.8170	0.0038	0.0033	0.0178	0.0008	0.0063	0.0054	0.0014
Malaysia	0.0005	0.7060	0.0002	0.0209	0.0010	0.0020	0.0004	0.0003
Philippines	0.0003	0.0003	0.7826	0.0014	0.0005	0.0008	0.0016	0.0003
Singapore	0.0053	0.0095	0.0003	0.4661	0.0018	0.0003	0.0002	0.0002
Thailand	0.0007	0.0093	0.0019	0.0110	0.7696	0.0017	0.0011	0.0001
Korea	0.0008	0.0011	0.0004	0.0030	0.0011	0.7345	0.0020	0.0005
Japan	0.0460	0.0429	0.0415	0.0769	0.0410	0.0651	0.8830	0.0067
United States	0.0225	0.0266	0.0383	0.0907	0.0100	0.0626	0.0191	0.9142
Total	0.8931	0.7994	0.8685	0.6876	0.8258	0.8731	0.9129	0.9237
Foreign inducement	0.0761	0.0934	0.0859	0.2215	0.0562	0.1386	0.0279	0.0095

Indonesian textile industry, for example, indicate that one unit of final demand for domestic textile production in Indonesia induces, in money terms, 2.15 units of total production in the region, with 1.68 units of this in Indonesia, and the remaining 0.47 units in other countries in the region. In the United States and Japan, by contrast, the inducement effects on other countries are weak, that is, the foreign inducement effects are less than 0.1 in all the listed sectors. In the regional LDCs, generally, the coefficients are one-fourth to one-half, reflecting their weak industrial structures, and are even higher in heavy industries where import dependence for inputs is higher. In Korea, for example, one unit of final demand in the iron and steel industry induces almost one unit of production in other countries, mostly in Japan (0.67) and the United States (0.25). This relationship also holds for export demand, which is to say that even if Japan loses one unit of exports in competition with Korea in iron and steel production in a third country, Japan recovers 0.67 of a unit through Korean demand for imported inputs. This is a concrete example of what we mean by a "competition and complementarity" relationship.

Thus we can see that there exists an international division of labor such that each country produces not only for itself but for other countries so as to provide for intermediate as well as final demand through exports, while it also induces production in other countries through imports from them. The regional LDCs with which we are concerned have strong interests in such benefits as increases in income and employment derived from this relationship.

With the help of the international input-output table, this income effect can be quantitatively measured. The value-added inducement coefficient (VIC), or the value added induced by a unit of final demand at a given commodity composition ratio is a measure of this effect. The proportions of VIC which go to the domestic economy and to the economies of foreign countries differ by country. The domestic VIC is high for the United States (0.91) and Japan (0.88), but relatively low for the regional LDCs, especially for Singapore (0.47) (see Table III). The foreign VIC is, in turn, high for these countries, while it is low for

TABLE IV

MUTUAL INDUCEMENT RATIO, 1975

A	B							
	IDN	MYS	PHL	SGP	THA	KOR	JPN	USA
Indonesia	—	1.94	6.22	0.73	0.68	5.79	1.93	3.20
Malaysia	0.52	—	1.33	1.68	0.26	4.89	0.51	2.32
Philippines	0.16	0.75	—	1.80	0.28	2.83	1.13	0.67
Singapore	1.37	0.60	0.58	—	0.52	0.33	0.26	0.50
Thailand	1.47	3.80	3.56	1.92	—	1.85	0.72	0.92
Korea	0.17	0.20	0.35	3.00	0.54	—	0.69	0.58
Japan	0.52	1.98	0.89	3.88	1.40	1.45	—	1.06
United States	0.31	0.43	1.48	2.00	1.08	1.73	0.94	—

the United States and Japan. That is, the inducement effect is a one-way relationship, flowing from regional LDCs to developed countries. The difference between total VIC and unity represents the leakage of income to other regions through imports from countries outside the region.

The VIC is a normalized measure and is independent of differences in economic size. The GNPs of the United States and Japan are very big compared with those of Korea or ASEAN member countries. Therefore, actual values of the inducement effect must be adjusted for economic size for purposes of comparison. The actual induced values are obtained by multiplying the VICs of a country with the total value of the country's final demand. The mutual inducement ratio (MIR) is thus defined as

$$\text{MIR} = \frac{\text{A's value added induced by B}}{\text{B's value added induced by A}}.$$

The numerator and the denominator can be interpreted as analogous to A's exports to B and B's exports to A respectively (see Table IV). The MIRs of Japan and the United States vis-à-vis the regional LDCs are above unity, except with respect to resource-exporting countries, which means that Japan and the United States enjoy more benefits from the regional LDCs than vice versa. The changes in value added induced by Japan and the United States in the regional LDCs are much smaller than those induced in Japan and the United States by the regional LDCs. Korea and Singapore do not seem to be much benefitted in terms of income generation through their trade with other countries of the region. This imbalance of mutual inducement effects, resulting both from the economic size of the countries and patterns of international division of labor, is one of the characteristics of economic relations in the region.

We are not, of course, suggesting that MIRs should be kept to around unity. As in trade, balance should be sought for, not bilaterally but multilaterally. The imbalance of the inducement effects is parallel to the one in trade between Japan and the regional LDCs. Except for Indonesia, every country has a trade deficit, of which Japan's share is quite high. This analysis shows that imbalance exists

TABLE V

MUTUAL INDUCEMENT RATIO, 1990

A	B							
	IDN	MYS	PHL	SGP	THA	KOR	JPN	USA
Indonesia	—	1.69	4.00	0.80	0.80	8.57	1.34	1.68
Malaysia	0.59	—	1.33	2.05	0.38	10.35	0.44	1.55
Philippines	0.25	0.75	—	2.18	0.48	5.50	0.90	0.55
Singapore	1.24	0.49	0.46	—	0.68	0.49	0.15	0.22
Thailand	1.25	2.67	2.07	1.48	—	1.97	0.33	0.44
Korea	0.12	0.10	0.18	2.04	0.51	—	0.29	0.23
Japan	0.75	2.27	1.11	6.48	3.00	3.41	—	0.89
United States	0.59	0.64	2.20	4.46	2.26	4.29	1.13	—

between Japan and those countries not only in trade but also in employment and income generation. An input-output structure which brings about low self-sufficiency ratios for these countries is one of the reasons, but Japan's own high self-sufficiency ratio is another. That is why the common textbook assertion that bilateral balance is irrelevant is not easily accepted by LDCs. The United States had a similar pattern to Japan in 1975, but overall it could be said to give more benefits to other countries compared with those Japan gives to them.

IV. SIMULATION ANALYSIS OF INTERNATIONAL ADJUSTMENT POLICIES

Will the pattern of international division of labor prevalent in 1975 continue to hold throughout the 1980s? If the imbalance described above gets worse, then trade conflicts between developed and developing countries in the region might be exacerbated, and trade restricting measures might become unavoidable.

To determine the effects of changes in structural factors on such conflicts in the near future, we attempt to forecast the structure of the international division of labor for 1990. Using simple macroeconomic models, we first project the final demand for each country, by item (private and government consumption, gross fixed capital formation, changes in stocks, and exports to the rest of the world). The changes in composition of each final demand item by industrial sector are also estimated along with income increase, with the import shares of regional countries in final demand kept constant. The intermediate input coefficients, including import coefficients, are also held unchanged, since revision would involve the same volume of work as estimating a new international input-output table.

With this set of projected final demand data, we calculate the MIRs for 1990 (see the figures for the base case in Table V). The MIRs of Japan and the United States vis-à-vis the regional LDCs show an increase, with Japan's "surplus" vis-à-vis Singapore, Korea, and Thailand growing by some two times, and its "deficit" with Indonesia shrinking compared with 1975. This is mainly because the growth rates of Japan and the United States in the 1980s are projected at 2

TABLE VI

JAPAN'S MUTUAL INDUCEMENT RATIO

		IDN	MYS	PHL	SGP	THA	KOR	USA
1975		0.52	1.98	0.89	3.88	1.40	1.45	1.05
1990	BC	0.75	2.27	1.11	6.48	3.00	3.41	0.89
	S(a)	0.73	2.16	1.04	6.12	2.87	3.07	0.89
	S(b)	0.73	1.47	1.01	5.98	2.44	1.51	0.88
	S(d)	0.56	1.71	0.84	4.87	2.26	2.57	0.81
	S(e)	0.55	1.11	0.76	4.48	1.83	1.14	0.92

Note: BC refers to the base case simulation, and S(a) to S(e) refer to simulations based on scenarios (a) to (e).

TABLE VII

UNITED STATES' MUTUAL INDUCEMENT RATIO

		IDN	MYS	PHL	SGP	THA	JPN	USA
1975		0.31	0.43	1.48	2.00	1.08	1.73	0.94
1990	BC	0.59	0.64	2.02	4.46	2.26	4.29	1.13
	S(a)	0.59	0.60	1.89	4.00	2.19	4.13	1.13
	S(c)	0.52	0.40	0.64	2.77	1.00	1.22	1.09
	S(d)	0.44	0.48	1.51	3.34	1.70	3.22	1.12
	S(e)	0.39	0.30	0.48	2.07	0.75	0.91	1.09

Note: See note for Table VI.

to 4 percentage points lower than those of the other countries.

Such an expanded imbalance would most likely make the trade conflicts more severe, and bring about a contracted balance of trade through various trade restricting measures. To determine whether expanded imbalance, as represented by MIRs, could be curtailed, simulation analyses were carried out for five alternative scenarios, as follows:

(a) Regional LDCs raise their self-sufficiency ratios of final demand for investment goods. Thirty per cent of the imports in the base case are substituted by domestic production for Singapore and Korea, 20 per cent for Malaysia, the Philippines, and Thailand, and 10 per cent for Indonesia.

(b) Japan pursues import promotion policies for final consumption goods from the regional LDCs, which results in a decrease in Japan's self-sufficiency ratio of final demand by 10 per cent below the base case.

(c) The United States pursues the same policies as outlined for Japan in (b).

(d) The United States and Japan accelerate their annual economic growth rates by 2 percentage points above the base case.

(e) The conditions in scenarios (b), (c), and (d) occur simultaneously.

The simulation results of the MIRs under the alternative scenarios are separately given for Japan and the United States in Tables VI and VII.

Under scenario (a), where import substitution of investment goods proceeds, imbalance in the inducement effects is mitigated, but the extent of the amelioration

is limited. This is because the present structure in which intermediate goods needed for the production of investment goods are mainly supplied by developed countries is assumed to continue unchanged.

Under scenarios (b) and (c), where Japan and the United States promote imports of consumption goods from the LDCs, the MIR for Korea substantially improves, because Korea's share of supply was large compared with other countries in 1975. No significant improvement is apparent in the MIRs of the other developing countries. Given a continuation of the present circumstances, in which the other four ASEAN countries are expanding their share in the developed countries at the expense of the shares of the NICs, the benefits might be more equally distributed among regional LDCs. Under these two scenarios, (b) and (c), however, increased imports of production inputs from regional LDCs have the effect of slowing economic growth of Japan and the United States. Therefore, there is a tendency for balance to be recovered through contracted regional production.

Under scenario (d), the difference in growth rates between developed and developing countries is narrowed, and the MIRs for the latter improve slightly, but the imbalance persists since differences in growth rate continue, albeit on a smaller scale. Under scenario (e), which assumes that all the measures discussed above are taken simultaneously, the MIRs improve for developing countries, compared with the 1975 case.

V. CONCLUDING REMARKS

As the simulation results of the base case indicate, the causes of the current trade conflicts between developed countries in the region and the regional LDCs are worsening. Japan is already being criticized for its tariff and non-tariff barriers to light manufactured goods from ASEAN countries. The United States has imposed quotas on imports of textile products from Asian NICs and ASEAN countries. On the side of the regional LDCs, the import substitution of intermediate goods is gradually progressing, but the implications for an improvement of the present situation are rather small as we saw in the simulation results of scenario (a).

Thus, corrective action on the part of Japan and the United States is of growing importance. In 1983–84, a rapidly expanding United States economy resulted in increased imports from developing countries, and trade deficits were incurred with Asian NICs and ASEAN countries. The inclination toward protectionism to which this situation gave rise should be resisted so as to allow improvement in the global economic situation through macroeconomic adjustment and depreciation of the U.S. dollar against other currencies.

For Japan, which is "suffering" from huge trade surpluses, the two policy targets suggested by scenarios (b) and (d) are relatively easy to attain from the macroeconomic viewpoint. Acceleration of Japan's domestic economic growth would induce higher growth in the regional LDCs and further opening of the Japanese market to their exports would not seriously harm the domestic economy

because of the strong complementarity relationship existing between Japan and the regional LDCs. Furthermore, it seems likely that to strengthen the inter-industry relationship among countries and thus raise the complementarity still further, such measures as promoting the relocation of declining industries through foreign direct investment, technology transfer, and the expansion of intra-firm trade might be effective, though simulation analyses on these approaches were not carried out.

APPENDIX

INTERNATIONAL INPUT-OUTPUT ANALYSIS METHODS

The International Input-Output Table in Matrix Form

To illustrate the ASEAN international input-output table in matrix expression, we denote each cell or group of cells in the transaction tables as follows. First the intermediate and final demand transactions among countries in the region (hereafter, called endogenous countries) are respectively shown by

$$X_{ij}^{mn}\ (m, n=1, \cdots, k, \quad i, j=1, \cdots, s),$$

$$F_{il}^{mn}\ (m, n=1, \cdots, k, \quad i=1, \cdots, s, \quad l=1, \cdots, q),$$

where m denotes the producing country, n the consuming country, i the sector of production, j the sector of consumption, and l the final demand sector. Therefore, when $m=n$, X indicates a domestic transaction and, when $m \neq n$, an intercountry transaction among the endogenous countries. In the present paper, the original fifty-six-sector table was aggregated into a twenty-eight-industrial-sector table ($s=28$), there are eight endogenous countries ($k=8$), i.e., Korea, Japan, the United States, and the ASEAN countries excluding Brunei. The final demand sectors are private consumption, government consumption, fixed capital formation, and changes in inventory ($l=4$).

The exports of an endogenous country (m) to the rest of the world (r) are denoted by

$$E_i^{mr}\ (m=1, \cdots, k, \quad i=1, \cdots, s, \quad r=1).$$

The difference between the total output of each row (X_i^m) and the summation of consumption for the row is regarded as changes in in-transit stock, and is denoted by

$$S_i^m\ (m=1, \cdots, k, \quad i=1, \cdots, s).$$

The import for intermediate consumption of the j sector of an endogenous country (n) from the i sector of the rest of the world (r) is expressed by

$$X_{ij}^{rn}\ (n=1, \cdots, k, \quad i, j=1, \cdots, s, \quad r=1),$$

and the imports for final demand by

$$F_{il}^{rn}\ (r=1, \quad n=1, \cdots, k, \quad i=1, \cdots, s, \quad l=1, \cdots, q).$$

It should be noted that all these transactions within the region are valued at producers' prices of the producing country, and that imports from the rest of the world are valued at c.i.f. prices to the importing endogenous country. The difference between the producing country's f.o.b. price and the consuming country's landed price is composed of customs duties (including import sales tax) and international freight and insurance fees. Customs duties on imports for intermediate consumption and final demand are summed up for each column, and respectively expressed by

$$(DX)_j^n\ (n=1, \cdots, k, \quad j=1, \cdots, s),$$

$$(DF)_l^n\ (n=1, \cdots, k, \quad l=1, \cdots, q).$$

The international freight and insurance on trade among the endogenous countries are similarly denoted by

$$(BX)_j^n\ (n=1, \cdots, k, \quad j=1, \cdots, s),$$

$$(BF)_l^n\ (n=1, \cdots, k, \quad l=1, \cdots, q).$$

Finally, the value-added sectors are shown by

$$V_{tj}^n\ (n=1, \cdots, k, \quad j=1, \cdots, s, \quad t=1, \cdots, q),$$

where t is composed of four items: compensation to employees, operating surplus, indirect taxes (net), and depreciation.

For the sake of simplicity, we now redefine the group of matrices composed of the various elements illustrated so far as follows:

$X^{mn}=[X_{ij}^{mn}]$,
$F^{mn}=[F_{ij}^{mn}]$,
$E^{mr}=[E_i^{mr}]$,
$S^m=[S_i^m]$,
$X^{rn}=[X_{ij}^{rn}]$,
$F^{rn}=[F_{ij}^{rn}]$,
$(DX)^n=[(DX)_j^n]$, $(DF)^n=[(DF)_l^n]$,
$(BX)^n=[(BX)_j^n]$, $(BF)^n=[(BF)_l^n]$,
$V^n=[V_{ij}^n]$,
$X^m=X^n=[X_i^m]=[X_j^n]$.

The whole structure of the international input-output table can then be shown as in the following chart:

$X^{11}, \quad X^{12}, \cdots, X^{1k}$ $X^{21}, \quad X^{22}, \cdots, X^{2k}$ $\vdots \quad \vdots \quad \vdots$ $X^{k1}, \quad X^{k2}, \cdots, X^{kk}$	$F^{11}, \cdots, F^{1k}$ $F^{21}, \cdots, F^{2k}$ $\vdots \quad \vdots$ $F^{k1}, \cdots, F^{kk}$	$E^{1r}, \; S^1$ $E^{2r}, \; S^2$ $\vdots \quad \vdots$ $E^{kr}, \; S^k$	X^1 X^2 $\vdots$ X^k
$(BX)^1, (BX)^2, \cdots, (BX)^k$ $X^{r1}, \quad X^{r2}, \cdots, X^{rk}$ $(DX)^1, (DX)^2, \cdots, (DX)^k$	$(BF)^1, \cdots, (BF)^k$ $F^{r1}, \cdots, F^{rk}$ $(DF)^1, \cdots, (DF)^k$		
$V^1, \quad V^2, \cdots, V^k$			
$X^1, \quad X^2, \cdots, X^k$			

With matrices further grouped as follows,

$$\tilde{X}=\begin{bmatrix} X^{11} & \cdots & X^{1k} \\ \vdots & & \vdots \\ X^{1k} & \cdots & X^{kk} \end{bmatrix},$$

$$F^n=\begin{bmatrix} F^{1n} \\ F^{2n} \\ \vdots \\ F^{kn} \end{bmatrix}, \quad (n=1, \cdots, k)$$

$$E^r=\begin{bmatrix} E^{1r} \\ \vdots \\ E^{kr} \end{bmatrix}, \quad S=\begin{bmatrix} S^1 \\ \vdots \\ S^k \end{bmatrix}, \quad X=\begin{bmatrix} X^1 \\ \vdots \\ X^k \end{bmatrix},$$

we finally obtain an international input-output model similar to the single country input-output model,

$$\tilde{X}+(F^1+F^2+\cdots+F^k)+E^r+S=X. \tag{1}$$

We define the input coefficient matrix as

$$A=[A_{ij}^{mn}],$$

where

$$A_{ij}^{mn}=X_{ij}^{mn}/X_j^n.$$

Since $\tilde{X}=AX$, equation (1) can be rewritten by

$$AX+(F^1+F^2+\cdots+F^k)+E^r+S=X.$$

With the help of further algebra, the expression for the repercussion analysis is derived as

$$(I-A)X=(F^1+F^2+\cdots+F^k)+E^r+S,$$
$$X=(I-A)^{-1}[(F^1+F^2+\cdots+F^k)+E^r+S], \tag{2}$$

where $(I-A)^{-1}$ is the so-called Leontief inverse matrix. Equation (2) is the formula used to calculate the induced output (X) to satisfy a certain final demand for a given A matrix.

Standard International Input-Output Analyses

Static input-output analysis is based on an assumption of the stability of the input coefficients (A). In the analysis of a single country input-output table, the assumption seem to hold for several years around the reference year. However, in the case of an international input-output table, the A matrix is composed of domestic input coefficients $(A_{ij}^{mn}, m=n)$ and trade coefficients $(A_{ij}^{mn}, m\neq n)$ between endogenous countries. These trade coefficients are relatively unstable, and it should be noted that the stability of the A matrix is a very strong assumption in the international analysis.

However, just as with single country input-output data, it is possible to do several variants of a standard international input-output analysis. To calculate various repercussion effects, the following final demand matrix should be exogenously given based on the assumptions of repercussion analysis.

$$F=\begin{bmatrix} F^{11}\cdots F^{1k} & E^{1r} & S^1 \\ \vdots \quad \vdots & \vdots & \vdots \\ F^{k1}\cdots F^{kk} & E^{kr} & S^k \end{bmatrix}.$$

Production inducement coefficient (PIC). The corresponding production or output vector $(\hat{X})$ for a given final demand matrix $(\hat{F})$ is given by

$$\hat{X}=(I-A)^{-1}\hat{F},$$

and is equivalent to the value of induced production. The production inducement coefficient is used for comparison of the degree of induced production for various levels of $\hat{F}$, and is calculated by substituting $\hat{F}$ in the above equation by $\hat{\hat{F}}$ which is normalized so that the sum of the elements of $\hat{\hat{F}}$ equals unity.

Value-added inducement coefficient (VIC). The relationship between the overall value of production and the value added in each sector is fixed by the A matrix. So, denoting the value-added coefficient matrix by

$$V=\begin{bmatrix} V_1^1 & & & & & & \\ & V_2^1 & & & & 0 & \\ & & \ddots & & & & \\ & & & V_s^1 & & & \\ & & & & \ddots & & \\ & 0 & & & V_1^k & & \\ & & & & & \ddots & \\ & & & & & & V_s^k \end{bmatrix},$$

where $V_j^n = \sum_{i=1}^{g} V_{ij}^n / X_j^n$, the amount of induced value added ($\hat{V}$) for a given $\hat{F}$ is obtained by

$$\hat{V} = V(I-A)^{-1}\hat{F}.$$

The value-added inducement coefficient is calculated by substituting $\hat{F}$ in the above equation by a normalized $\hat{\bar{F}}$ as in the case of the production coefficient.

Mutual inducement ratio (MIR). This ratio is defined as between two endogenous countries, and shows the ratio of one country's value added induced by the partner country's final demand to the other country's induced value added. In other words, the ratio between country n and m, as seen from country n, is given by

$$\frac{\text{Sum of } V^n \text{ for a given } F^m}{\text{Sum of } V^m \text{ for a given } F^n}.$$