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An Econometric Link System for the East and Southeast Asian Countries, Japan and the United States

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I Introduction

The East and Southeast Asian countries have close economic relationships with Japan and the United States through trade and capital movements. Economic interdependence within the East and Southeast Asian region has also been increasing steadily in recent years. Quantitative analyses of any national economy in this region, therefore, should allow for its relations with other economies. The econometric link system is a method of analysing individual economies focusing on this aspect of economic interdependence. The purpose of this paper is, first, to construct an econometric link system for the East and Southeast Asian countries, Japan and the United States including 10 individual national models,[1] and, then, to analyse the structure of the interdependence between these countries in the 1970s, in terms of elasticity-multipliers based on policy simulations. Our international linkage model is called the Asian Link System.

There are already quite a number of international linkage models which differ in scope, coverage and use. Project LINK (Ball [1973], Waelbroeck [1976], Sawyer [1979], etc.) is the first, pioneering effort to develop such a link system for the world

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1) The 10 country models and their constructors are:
- Japan Model.... M. Ezaki & C. Moriguchi (Kyoto Univ.)
- USA Model.... S. Hirai (Wakayama Univ.)
- Korea Model.... M. Cheong & Y. E. Kim (Bank of Korea)
- Taiwan Model.... Y. C. Chiu (DGBAS/ROC)
- Hong Kong Model.... T. B. Lin & W. C. Chou (Chinese Univ. of Hong Kong)
- Indonesia Model.... K. Kobayashi, H. Tampubolon & M. Ezaki (Kyoto Sangyo Univ., BAPPENAS & Kyoto Univ.)
- Malaysia Model.... S. Abe (Kyoto Sangyo Univ.)
- Philippines Model.... E. P. Zialcita, P. B. Lucas, F. R. Alfiler, W. C. Mañalac & S. Ichimura (Central Bank of the Philippines & Kyoto Univ.)
- Singapore Model.... M. Ezaki & S. Ichimura (Kyoto Univ.)
- Thailand Model.... S. Ganjarerndee (Bank of Thailand)

Most of the models were originally annual, with two exceptions: the Korea and Taiwan models (quarterly and semi-annual, respectively) for which annual versions are used in the link system here. For the details of the 10 country models, see M. Ezaki, S. Shibayama and S. Ichimura, "Structural Equations of the Asian Link System", Discussion Paper No. 119, the Center for Southeast Asian Studies, Kyoto University, April 1984.

economy. It has been followed by several other world models, such as the OECD International Linkage Model (OECD [1980], etc.), the EPA World Economic Model (Amano, Kurihara and Samuelson [1980], Amano [1982], etc.), the Tsukuba-FAIS World Econometric Model (Shishido [1983], etc.), Project FUGI (Kaya, Onishi and Suzuki [1983], etc.), and so on.[2] Almost all of the existing world models, however, do not pay any direct attention to the East and Southeast Asian countries. For example, Project LINK system consists of 20 models for individual countries (13 developed market economies and seven centrally planned socialist economies) and four regional models of developing areas (Africa, Latin America, the Middle East, and Southeast Asia). In other words, all the South, Southeast and East Asian countries are aggregated into a single region, for which only an aggregate regional model is constructed based on averages for the region.[3] The same is more or less true for most of the other world models, though the EPA system includes individual models for Korea as well as eight developed countries, while the Tsukuba-FAIS system includes nine major developing countries (Korea, Indonesia, the Philippines, Thailand, etc.) in addition to eight developed countries. The exception is the FUGI macroeconomic model which links 28 areas of the world, dealing separately with eight countries in the East and Southeast Asian region.[4] Our Asian Link System is similar to Project FUGI's macroeconomic model as far as coverage is concerned, but structure of the two models is quite different in that the FUGI macroeconomic model employs a recursive system based on a prototype model common to each area which aims at long-term projections.[5]

The Asian Link System is based on national models basically constructed in cooperation with econometricians in the East and Southeast Asian regions. The linkage part of the model employs a relatively simple structure with several limitations in scope and analysis. First, only linkages via trade relations are allowed for, i.e., no capital transactions are introduced. Second, trade linkage is based essentially on exports and imports

2) See Hickman [1983], in which 15 global international models are collected together with a cross section survey of the models. For the details of the EPA World Economic Model, see a series of discussion papers (No. 1-No. 14) published by the Economic Planning Agency of Japan, and Toyoda, Arai and Ohtani [1983].

3) See Waelbroeck [1976: 397-409], Klein and Su [1979], Filatov, Hickman and Klein [1983], etc.

4) See Kaya, Onishi and Suzuki [1983]. The whole system of Project FUGI comprises a global dynamic macroeconomic model, a static global input-output model and a set of global metal-resource models. FUGI is an abbreviation of 'Future of Global Interdependence'. As the name indicates, the FUGI model was originally designed to investigate the long-term future of the world economy and industry, but it has been used mainly to investigate the long-term future of the ESCAP economies in the last few years.

5) See, for example, Kaya and Onishi [1977: 65-68]. Project ELSA (Econometric Link System for ASEAN) is an on-going project at the Institute of Developing Economies in Japan, the contents of which are very close to our Asian Link System.

in total, while linkages through trade disaggregation by SITC numbers is only partial and not rigorous. Third, the linkage method is the naive one, i.e., the constant quantity shares approach. Fourth, regional models for the rest of the world (i.e., for other developed, other oil-exporting, and other LDC countries) are of the effective demand type, comprising of only a few equations. Fifth, centrally planned economies, including China, are treated as exogenous in the linkage model.[6] These limitations are caused to a great extent by data problems and the nature of the individual national models, but are also related to the purpose of the Asian Link System at this stage, i.e., to establish a workable linkage model applicable to the analysis of economic interdependence for the East and Southeast Asian countries and their major trading partners: Japan and the United States.

In Section 2, the components of the Asian Link System will be explained in detail. In Section 3, the traceability of the system will be tested for the period 1972-1980 by dynamic simulations. In Section 4, the system will be applied to policy simulations to investigate the structure of economic interdependence for the period 1976-1980.

II The Asian Link System

As shown in Table 1, the Asian Link System at this stage consists of 550 equa-

Table 1 Asian Link System (550 Equations)*

Linked Trade Model, Number of Equations		Linked Country Models, Number of Equations: Original	Interface, In+Out	Total	Unlinked Country Models, No. of Eqs.
34		413	72+31	516	
WLINK. TRADE	WLINK. JAPAN: J	56	3+2	61	57
	WLINK. USA: A	28	3+2	33	29
	WLINK. KOREA: K	31	3+2	36	29
	WLINK. TAIWN: F	29	7+2	38	32
	WLINK. H.K.: H	39	5+2	46	43
	WLINK. INDON: I	68	13+4	85	73
	WLINK. MALAY: M	46	12+4	62	46
	WLINK. PHILI: P	21	2+2	25	20
	WLINK. SINGA: S	36	11+2	49	36
	WLINK. THAIL: T	43	8+4	55	44
	WLINK. ROW: DOL	16	5+5	26	16

* WLINK is a file name in the computer program 'LINKSIM' (See Section 3 and Fig. 1). To each country model are attached a country name (abbreviated if necessary) and an appropriate initial. The initial F is taken from Formosa. ROW means the rest of the world, and D, O and L are the initials for three regions in the ROW sector (See Table 2). Differences in number between the linked (original) and the unlinked country models are explained in detail in Table 5. See Table 8 for the interface. Note that annual versions are used for the models of Korea and Taiwan in the linkage system here.

6) A model of China is not introduced into the linkage system partly due to problems in data consistency but mainly due to the time limitation.

tions in total, of which 516 are for country or regional models and 34 for the trade model, i. e., the linkage part. The system includes individual models for 10 countries (i. e., Japan, U. S. A., Korea, Taiwan, Hong Kong, Indonesia, Malaysia, the Philippines, Singapore and Thailand) and three aggregate regional models from the rest of the world (i. e., other developed countries (D), other oil-exporting countries (O) and other less developed countries (L)), treating all of the centrally planned economies as exogenous. Each model consists of equations of two kinds: original and interface. The original equations (except those of the regional models) are those of the unlinked country models with export functions, if any, deleted and export price equations, if none, added. The interface equations mainly adjust for differences in units, dimensions, concepts, coverage, etc., between the variables of the trade model and those of the country or regional models. They are classified into two groups, i. e., 'in' and 'out', from the point of view of causality. The 'in' equations mean the interface from the trade model to the country or regional models while the 'out' equations mean the interface in the other direction. We will discuss these major components of the Asian Link System (i. e., the trade model, country models, rest of the world models, and interface) in more detail below.

The Trade Model

The trade matrix framework is an essential linkage in most existing world models. There exist several alternative methods of generating the trade share matrix for linkage purposes: the constant value shares method (which assumes nominal import shares to be constant), the constant quantity shares method (which assumes real import shares to be constant), the Klein-Van Peeterssen method (based on the linear expenditure system), the Hickman-Lau method (based on import functions with constant elasticities of substitution), the Moriguchi method (which introduces supply capacity of exports into the import functions), the Samuelson-Kurihara method (which combines price effects with the constant quantity shares approach), and so on. No specific linkage method, however, can be said to be superior to the others in every respect in the light of their ex post predictive performance, and even the naive method of constant quantity shares has some merits compared with the others.[7] In one of our pilot studies [Ezaki 1979] which deals with only a few country models, we attempted to generate each cell of the trade matrix directly, estimating the import functions on a country-by-country basis. This linkage method, however, requires the estimation of a huge number of import functions when the number of countries and regions to be linked increases. We have adopted, for these reasons, the constant quantity shares approach to linkage in the Asian Link System at this stage.

7) See Gana, Hickman, Lau and Jacobson [1979], and Amano, Kurihara and Samuelson [1980], for the details of the alternative linkage methods and their comparisons in predictive performance.

The Asian Link System trade model is summarized in Tables 2, 3 and 4. It depends exclusively on United Nations'

Table 2 Regional Classification in the Trade Model*

Code Number	Initial	Country or Region Name	Code Number(s) in the UN Trade Matrix*
1	J	Japan	5
2	A	U. S. A.	7
3	K	Korea	51
4	F	Taiwan	48
5	H	Hong Kong	49
6	I	Indonesia	47
7	M	Malaysia	52
8	P	Philippines	54
9	S	Singapore	55
10	T	Thailand	56
11	D	Other Developed Countries	1-4, 6, 8-23
12	O	Other Oil-exporting Countries	28-31, 34-37, 41-45
13	C	Centrally Planned Economies	59-67
14	L	Other LDC's	all of the rest
15	W	World	68

* See Y. Nakamura and A. Ozbek [1983: Appendix 1] for the code numbers in the UN trade matrix.

Table 3 Trade Model: Notation

For Commodity Total (SITC 0 to 9):

XQ.. = quantity of commodity exports in constant 1975 prices (millions of US dollars).

PX.. = price index (deflator) for commodity exports (1975=1.0).

XQij = exports from region i to region j (i, j=1(J) ... 14(L)).

XQiW = $\sum_{j=1}^{14}$ XQij = total exports of region i.

XQWj = $\sum_{i=1}^{14}$ XQij = total imports of region j.

XQWW = $\sum_{i=1}^{14}$ XQiW = $\sum_{j=1}^{14}$ XQWj = total world exports.

SQij = XQij/XQWj = quantity share.

PXiW = export price index of region i (i=1(J) ... 14(L)).

PXWj = import price index of region j (j=1(J) ... 14(L)).

PXWW = world export price index.

PXij = average export price index of region i (i=11(D) ... 14(L)) in region j (j=1(J) ... 14(L)).

RPij = PXij/PXiW (i=11(D) ... 14(L)).

For Commodity Sub-groups (SITC 0+1, 2+4, 3 and 5 to 9):

XQk.. = exports of commodity k in constant 1975 prices (millions of US dollars) where k=01 for SITC 0+1, 24 for SITC 2+4, 33 for SITC 3, and 59 for SITC 5 to 9.

PXk.. = export price index for commodity k (1975=1.0).

XQkiW = total exports of commodity k by region i.

XQkWW = world total exports of commodity k.

SQkiW = XQkiW/XQkWW.

PXkiW = export price index for commodity k by region i.

PXkWW = world export price index for commodity k.

RPkiW = PXkiW/PXiW.

Table 4 Trade Model: Constant Quantity Shares Approach*

(1) $XQiW = \sum_{j=1}^{14} SQij^{\circ} * XQWj \quad [+AQi] \quad (i=1 \ldots 14)$

(2) $XQWW = \sum_{i=1}^{14} XQiW \quad (=\sum_{j=1}^{14} XQWj)$

(3) $PXWj = \sum_{i=1}^{10} SQij^{\circ} * PXiW + \sum_{i=11}^{14} SQij^{\circ} * RPij^{\circ} * PXiW \quad [*APj] \quad (j=1 \ldots 14)$

(4) $PXWW = \sum_{i=1}^{14} PXiW * XQiW/XQWW$

(5) $PXkWW = \sum_{i=1}^{14} SQkiW^{\circ} * RPkiW^{\circ} * PXiW \quad [*Ak] \quad (k=1 \ldots 4)$

* Superscript ° means the base year (1976 in the present case) for which shares (SQij's and SQkiW's) and ratios (RPij's and RPkiW's) are set to be constant parameters. AQi's, APj's and Ak's are adjustment factors to attain exact equalities. They are treated as exogenous, and their data are obtained by residuals. XQWj's and PXiW's are exogenous in the trade model but they are endogenized in the country models of the linked system.

trade matrix data [Nakamura and Ozbek 1983]. The UN data are prepared using both current and constant prices for the period 1965-1980 and cover five commodity categories: SITC 0 through 9, SITC 0 + SITC 1, SITC 2 + SITC 4, SITC 3, and SITC 5 through 8 (with an additional category corresponding to SITC 9 + estimation errors). The UN trade matrix disaggregates the world into 67 countries and regions, while the world in our trade model consists of 10 countries and four regions. Table 2 indicates the correspondence in regional classification between the two.

Our trade model includes five kinds of equations as shown in Table 4. The first four (i.e., (1)-(4) in Table 4) are concerned about commodity totals (i.e., SITC 0 through 9). Treating import shares and price ratios as constant, they determine (1) total exports in real terms for each of the 14 countries and regions (14 equations), (2) total world exports in real terms (one equation), (3) average import price for each of the 14 countries and regions (14 equations), and (4) average world export price (one equation). On the other hand, the fifth kind of equations (i.e., (5) in Table 4) refer to commodity sub-groups (i.e., SITC 0+1, SITC 2+4, SITC 3, and SITC 5 through 9).[8] Again treating import shares and price ratios as constant, it determines (5) average world export price for each of the four commodity categories (four equations). The import shares and the price ratios here are all fixed at 1976 levels, but they actually changed to a greater or lesser extent during the sample period. In order to mitigate the effects of the changes in these shares and ratios, we have introduced additive adjustment factors (AQi's) into quantity equations and multiplicative ones (APj's and Ak's) into price equations.[9]

Our trade model is neither theoretically rigorous nor complete as a linkage with respect to the commodity sub-groups because of the differences in commodity disaggregation between individual country models. Our trade model determines only the average world prices of four commodity categories, based on the price ratios RPkiW's, assuming proportional relationships between the export prices of individual commodities and the average export price of commodity totals in each country or region. These average world prices are fed back into country models with commodity breakdowns to determine their import prices. In other words, (a) import prices of commodity sub-groups in the country models with commodity breakdowns are functions of PXkWW's in the system. On the other hand, exports of commodity sub-groups in the country models with commodity breakdowns are determined by assuming similar proportional relationships for quantities: (b) XQkiW = RQkiW*XQiW, where the ratios (RQkiW's) are treated as

8) SITC 5 through 8 and SITC 9 + estimation errors in the UN trade matrix are aggregated into SITC 5 through 9 in the trade model here.

9) These adjustment factors, especially AQi's, seem to be explained by the price terms in other linkage methods of a more elaborate type.

Table 5 Revisions of the Original Country Models for Linkage and Corresponding Revised Equations[1]

Country Initial	Deleted	Changed	Added
J:	XR	-	-
A:	E	-	-
K:	-	-	BXC, PX
F:	XN, XK, XO	-	-
H:	DEC, EC, ES, WBC	-	-
I:	XOILD, QXOIL, QDOIL, QDROL, XNOSD, GDPRCP	GDPR, CPR, XNOSR, PGDP, PCG, PI, CP, PCP, GDP	SFMB[2]
M:	XR, XM, XO	-	KG,[2] KP,[2] PX
P:	-	-	PEX
S:	-	-	-
T:	XGAGR, XGNAR	GDPR, GDPNAR, WGRNA, PD	PMGS

Revised Equations: Changed and Added[3]

K: BXC	= 70.4307+0.9577 * K: PX * K: GXC (2.44) (171.12) 0.9996/57.2467/1.3362	1971–1980
K: PX	= 0.08786+0.4238 * K: PI+0.5039 * K: PXW * K: REX/484.0 (2.00) (3.03) (2.58) 0.9892/0.05247/1.8224	1971–1980
I: GDPR	= I: CR+I: IR+I: XR−I: MR	
LOG(I: CPR)	= −0.6679+0.6973 * LOG(I: GDPR) +0.3581 * LOG(I: CPR[1]) (3.29) (5.11) (2.65) 0.9956/0.01706/1.8414	1970–1980
I: XNOSR	= I: XNOSD * 415/I: PXNOS * (1/1000)	
I: PGDP	= I: GDP/I: GDPR	
I: PCG	= −0.1275+0.8542 * (I: CP+I: I)/(I: CPR+I: IR) +0.2976 * I: PCG[1] (2.48) (3.76) (1.26) 0.9966/0.05253/1.5359	1970–1980
LOG(I: PI)	= −4.4681+0.5017 * LOG(I: GDP) +0.1964 * LOG(I: PMI) (9.17) (8.76) (2.38) 0.9940/0.04285/1.9428	1970–1980
I: CP	= I: CPR * I: PCP	
LOG(I: PCP)	= −4.0925+0.4695 * LOG(I: GDP) +0.2156 * LOG(I: PCP[1]) (9.22) (9.54) (2.51) 0.9981/0.02218/0.9763	1970–1980
I: GDP	= I: CP+I: CG+I: I+I: X−I: M	
I: SFMB	= I: DD+I: TSD+I: FCD+I: BMAMB−I: RRMB	
M: KG	= M: IG+M: IG[1]+M: IG[2]+M: IG[3]+M: IG[4]+M: IG[5]	
M: KP	= M: IP+M: IP[1]+M: IP[2]+M: IP[3]+M: IP[4]+M: IP[5]	
M: PX	= 0.06631+0.6959 * M: PXR+0.2979 * M: PXM (0.81) (4.29) (2.93) 0.9857/0.06995/1.9106	1970–1980
P: PEX	= −0.3723+1.0767 * P: PGNP+0.3840 * P: PIM−0.6077 * P: DUMPEX (1.84) (2.23) (1.35) (5.27) 0.9883/0.08993/2.5252	1967–1980
GDPR	= CONHHR+IFXBPAGR+IFXBPNAR+INVBPR+ (CONGV+INXGV+ IFXBS)/PD+XGSR−MGSR	
GDPNAR	= GDPR−GDPAGR	
LOG(WGRNA)	= 1.1769+0.5716 * LOG(PD) +0.6060 * LOG(WGRNA[1]) (2.09) (2.33) (3.05) 0.9553/0.1031/1.8150	1962–1980

$$\mathrm{LOG(PD)} = \underset{(4.88)}{-2.6169} + \underset{(4.89)}{0.2188} * \mathrm{LOG(GDPR)} + \underset{(5.88)}{0.4293} * \mathrm{LOG(PMGS)} + \underset{(1.93)}{0.2587} * \mathrm{LOG(PD[1])}$$

0.9943/0.02750/1.2543 1962–1980

$$\mathrm{PMGS} = \mathrm{MGS/MGSR}$$

1) Note that variables in the model of Thailand do not have the initial T since their original names are generally too long to be stored with the initial T in the computer program 'LINKSIM' (which permits a maximum of eight characters for each variable name).
2) Introduced only for computational convenience.
3) The estimation method is OLS (except for identities). t-ratios are shown in brackets. The last line for each of the estimated equations indicates the adjusted coefficient of determination, standard deviations of the equation and the Durbin-Watson ratios, respectively.

exogenous to the system. The two relations for prices and quantities of commodity sub-groups ((a) and (b)) are introduced into the interface equations in the Asian Link System.

Country Models

The 10 country models employed here (see footnote 1) are diverse in many respects and without any standardization for linkage purposes. First, the size of the model (i.e., the number of equations) ranges from 20 for the model of the Philippines to 73 for the model of Indonesia. Second, the financial sector or the monetary aspect of the economy is explicitly allowed for in the models of Korea, Hong Kong, Indonesia, Malaysia, the Philippines and Singapore, but not in the others.[10] Third, industry is brokendown in the models of Malaysia (for agriculture, mining, manufacturing, and others) and Thailand (for agriculture and non-agriculture), but not in the others. Fourth, trade commodities are disaggregated in the models of Taiwan, Hong Kong, Indonesia, Malaysia, Singapore and Thailand but not in the others, though the mode of disaggregation does not always depend on the SITC numbers. Fifth, most of the 10 country models are of the effective demand type, focusing on the expenditure side of GDP, but the models of Indonesia, Malaysia and Thailand also give relatively heavy weighting to the production side or the supply capacity of the economy.

These 10 original country models are revised in two ways for linking with the trade model, as shown in Table 5. First, standard revisions ordinarily needed in the linkage process, i.e., deleting export functions if any and adding export price equations if none. Second, revisions related to the nature of the model specific to Thailand and Indonesia.

The Thai model uses a kind of general equilibrium framework. Regarding the GDP identity as the supply-demand equilibrium condition at the aggregate level, it determines the general price level (PD) by this equilibrium identity with the supply side explained by production functions for agriculture and non-agriculture and the demand side by demand functions for expenditure components. This sophisticated model of Thailand is very attractive

10) The Bank of Thailand model of the original version is a huge system consisting of 184 equations, of which 69 belong to the financial sector. See Chaipravat, Meesook and Ganjarerndee [1979].

from the theoretical point of view, but it causes difficulties from the operational one. It is unstable in simulation analyses both with shocks and without shocks, very often resulting in the non-convergence of iterative solutions. We have, therefore, changed the Thai model from a general equilibrium type to an effective demand type (mainly for non-agricultural products).

The Indonesian model, on the other hand, may be said to be a model of the supply-oriented type. It determines GDP from the supply side with an aggregate production function and explains the general price level (PGDP) with a kind of aggregate excess demand, i.e., potential or desired demand for GDP (GDPRCP) over GDP to be determined on the production side. It generates feed-back effects from the demand side (i.e., expenditures) to the supply side (i.e., productions) only with time lags. This supply-oriented model of Indonesia seems to be too specific in nature to be linked with other country models as well as with the trade model. For consistency, therefore, we have changed the Indonesian model from a supply-oriented type to an effective demand type.[11]

All of the revised equations are also listed in Table 5.

Rest of the World Models

The Asian Link System is a world model with a trade model and 10 country models as its core. Models for the rest of the world must be introduced to close the system and to make it possible, at least approximately, to allow for the feed-back effects of this sector. For this purpose, a simple prototype model of the effective demand type, as shown in Table 6, is used to construct regional models for three regions in the rest of the world: other developed countries (D), other oil-exporting countries (O), and other LDC's (L). The remaining region, i.e., the centrally planned economies, is treated as exogenous because of lack of data. The prototype model consists of six equations: two behavioral equations (CR and MR), one statistical equation (PX) and three identities (ZR, YR and PZ). The model describes the domestic multiplier process with respect to quantities (i.e., effective demand) in the

Table 6 A Simple Effective Demand Model for the Rest of the World (ROW)*

(1) $ZR=CR+\overline{AR}+\overline{XR}$ $(=YR+MR)$
(2) $YR=ZR-MR$
(3) $CR=f(YR, CR[1])$
(4) $MR=f(ZR, MR[1])$
(5) $PZ=(\overline{PY}*YR+\overline{PM}*MR)/(YR+MR)$
(6) $PX=f(PZ, PX[1])$

where
ZR = real total supply or real total demand
YR = real GDP or real income
CR = real private consumption expenditures
AR = real investment + real government expenditures
XR = real exports
MR = real imports
PZ = price index (deflator) of ZR
PY = price index (deflator) of YR
PX = price index (deflator) of XR
PM = price index (deflator) of MR

* Variables with super-bars are exogenous in the ROW model. XR and PM are endogenized in the link system through the trade model. f(...) means a function of....

11) We have not considered any changes in the Malaysian model since the model is well-balanced between the supply and demand sides.

ordinary way, through consumption and import functions and income identities. The domestic multiplier process with respect to prices, however, is incomplete in that no relationships between factor prices, output prices and import prices are introduced into the model, resulting in the exogenous treatment of the GDP deflator (PY). It must be noted, therefore, that the feed-back effects of the rest of the world sector, based on this prototype model, are only partial and insufficient with respect to prices.

Estimated results for three regional models are presented in Table 7. Note that price equations are omitted in the regional model of the oil-exporting countries because oil price is the dominant component of export prices (PX), so that PX is better treated as exogenous rather than endogenous in the regional model and the linkage system. The data source here is *World Tables* (The World Bank, available on magnetic tape). As the region-country identifications given in the footnote

Table 7 Models for Three Regions (D, O and L) in the Rest of the World*

D (Other Developed Countries):

No.	Equation	Period
D. 1	D: MR = −291626.9732 + 0.3172 * D: ZR	
	(11.97) (36.23)	
	0.9931/7162.7242/1.5756	1971–1980
D. 2	D: YR = D: ZR − D: MR	
D. 3	D: CR = 32113.2521 + 0.3143 * D: YR + 0.4594 * D: CR[1]	
	(0.81) (3.18) (3.09)	
	0.9961/7200.2579/1.9619	1971–1980
D. 4	D: ZR = D: CR + D: AR + D: XR	
D. 5	D: PZ = (D: PY * D: YR + D: PM * D: MR)/(D: YR + D: MR)	
D. 6	D: PX = 0.01100 + 0.9685 * D: PZ	
	(0.59) (56.75)	
	0.9972/0.01817/1.4065	1971–1980

O (Other Oil-exporting Countries):

No.	Equation	Period
O. 1	O: MR = −54859.6082 + 0.2744 * O: ZR + 0.3574 * O: MR[1]	
	(2.31) (2.68) (1.43)	
	0.9801/4657.9510/1.7153	1971–1980
O. 2	O: YR = O: ZR − O: MR	
O. 3	O: CR = −23685.6204 + 0.2449 * O: YR + 0.7053 * O: CR[1]	
	(1.96) (2.55) (5.41)	
	0.9956/2290.6209/2.3883	1971–1980
O. 4	O: ZR = O: CR + O: AR + O: XR	

L (Other LDC's):

No.	Equation	Period
L. 1	L: MR = −547.5895 + 0.1462 * L: ZR	
	(0.093) (13.37)	
	0.9518/2543.5687/1.7791	1971–1980
L. 2	L: YR = L: ZR − L: MR	
L. 3	L: CR = −4993.1161 + 0.2157 * L: YR + 0.7457 * L: CR[1]	
	(0.76) (1.55) (3.47)	
	0.9970/2505.1215/2.0437	1971–1980
L. 4	L: ZR = L: CR + L: AR + L: XR	
L. 5	L: PZ = (L: PY * L: YR + L: PM * L: MR)/(L: YR + L: MR)	
L. 6	L: PX = −0.1146 + 1.0688 * L: PZ	
	(1.90) (20.15)	
	0.9782/0.05385/1.0246	1971–1980

* The region of centrally planned economies (C) is treated as exogenous in the link system due to the lack of data. The data source here is the World Bank Data Tape, "Economic Data Sheet 1 —— Update 1982" (National accounts, prices, exchange rates and population for the period 1960–1981). The original data for individual countries on the tape are simply added to get aggregate data for the three regions D, O and L. In aggregating, individual countries are identified with each of the three regions in the following way:

D = 9, 10, 15, 30, 45, 54, 55, 61, 65, 77, 82, 83, 84, 98, 105, 115, 119, 123, 132, 147, 148, 156, 157, 167, 170, 181

O = 4, 48, 58, 80, 81, 92, 97, 109, 122, 140, 175

L = 6, 8, 13, 14, 17, 20, 21, 22, 26, 27, 29, 32, 34, 35, 38, 40, 41, 43, 47, 49, 50, 52, 59, 62, 69, 71, 73, 74, 78, 85, 86, 88, 89, 95, 96, 100, 101, 104, 106, 107, 108, 111, 112, 120, 121, 125, 129, 138, 141, 143, 146, 149, 153, 155, 158, 159, 162, 164, 166, 168, 172, 173, 179, 182, 183.

See *User Documentation* (April, 1983) for the country codes shown above. Many data are missing from the tape, especially for the countries of regions O and L, so that the country coverage in regions O and L is not exhaustive. There is almost no data for the countries of region C.

Table 8 Interface in the Asian Link System*

〈JAPAN〉		
1. J: XR	F	XQJW
2. J: PM	F	J: REX*PXWJ
3. J: PXW	F	PXWW
A. XQWJ	F	J: MR
B. PXJW	F	J: PX/J: REX
〈U. S. A.〉		
1. A: E	F	XQAW
2. A: PM	F	PXWA
3. A: PXW	F	PXWW
A. XQWA	F	A: M
B. PXAW	F	A: PE
〈KOREA〉		
1. K: GXC	F	XQKW
2. K: PM	F	K: REX*PXWK
3. K: PXW	F	PXWW
A. XQWK	F	K: GMC
B. PXKW	F	K: PX/K: REX
〈TAIWAN〉		
1. XQ01FW	=	RQ01FW*XQFW
2. XQ59FW	=	RQ59FW*XQFW
3. F: XN	F	XQ01FW, XQ59FW
4. F: XK	F	XQ59FW
5. F: PM	F	F: E*PXWF
6. F: POIL	F	F: E*PX33WW
7. F: PMO	F	F: E*PXWF
A. XQWF	F	F: MR+F: MCAP+F: MC
B. PXFW	F	F: P/F: E
〈HONG KONG〉		
1. H: EC	=	XQHW*H: ECXQHW
2. H: PM01	F	H: EX*PXWH
3. H: PM24	F	H: EX*PXWH
4. H: PM03	F	H: EX*PX33WW
5. H: PM59	F	H: EX*PX59WW
A. XQWH	F	H: M01+H: M24+H: M3 +H: M59
B. PXHW	F	H: PE/H: EX
〈INDONESIA〉		
1. XQ33IW	=	RQ33IW*XQIW
2. PX33IW	=	RPX33IW*PX33WW
3. XQ01IW	=	RQ01IW*XQIW
4. PX01IW	=	RPX01IWW*PX01WW
5. XQ24IW	=	RQ24IW*XQIW
6. PX24IW	=	RPX24IWW*PX24WW
7. XQ59IW	=	RQ59IW*XQIW
8. PX59IW	=	RPX59IWW*PX59WW
9. I: XOILD	F	PX33IW*XQ33IW
10. I: XNOSD	F	PX01IW*XQ01IW+ PX24IW*XQ24IW+ PX59IW*XQ59IW
11. I: PMCD	F	PXWI
12. I: PMID	F	PX59WW
13. I: PMRMD	F	PX24WW
A. I: PXOIL	F	PX33WW
B. I: PXNOS	F	PX24WW, PX59WW
C. XQWI	F	I: MR
D. PXIW	F	I: PX/I: RFEX
〈MALAYSIA〉		
1. XQ24MW	=	RQ24MW*XQMW
2. PX24MW	=	RPX24MWW*PX24WW
3. XQ33MW	=	RQ33MW*XQMW
4. PX33MW	=	RPX33MWW*PX33WW
5. XQ59MW	=	RQ59MW*XQMW
6. PX59MW	=	RPX59MWW*PX59WW
7. M: XR	F	M: REX*(PX24MW* XQ24MW+PX33MW* XQ33MW)
8. M: XM	F	M: REX*PX59MW* XQ59MW
9. M: XO	F	M: REX*PXMW* XQMW
10. M: PMR	F	M: REX*PX24WW, M: REX*PX33WW
11. M: PMM	F	M: REX*PX01WW
12. M: PMF	F	M: REX*PX01WW
A. M: PXR	F	M: REX*PX24WW
B. M: PXM	F	M: REX*PX59WW
C. XQWM *PXWM *M: REX	F	M: MR+M: MM+M: MF+M: MI+M: MO
D. PXMW	F	M: PX/M: REX
〈PHILIPPINES〉		
1. P: XR	F	XQPW
2. P: PIM	F	P: ER*PXWP
A. XQWP	F	P: MR
B. PXPW	F	P: PEX/P: ER
〈SINGAPORE〉		
1. XQ01SW	=	RQ01SW*XQSW
2. XQ24SW	=	RQ24SW*XQSW
3. XQ33SW	=	RQ33SW*XQSW
4. XQ59SW	=	RQ59SW*XQSW
5. S: EGP01R +S: EGD01R	F	XQ01SW
6. S: EGP24R +S: EGD01R	F	XQ24SW
7. S: EGD3R +S: EGP3R	F	XQ33SW
8. S: EGD59R +S: EGP59R	F	XQ59SW
9. S: PMG01	F	S: REX*PXWS
10. S: PMG3	F	S: REX*PX33WW
11. S: PM	F	S: REX*PXWS

A. XQWS	F	S: MG01R+S: MG24R +S: MG3R+S: MG59R	B. PXGAG	F	PXGAGD*ZXRD/20.913
B. PXSW	F	S: PE/S: REX	C. XQWT	F	MRMR+MCR+MKR
⟨THAILAND⟩			D. PXTW	F	PXGAG/ZXRD, PXGNA/ZXRD
1. XQ01TW	=	RQ01TW * XQTW	⟨ROW: DOL⟩		
2. XQ24TW	=	RQ24TW * XQTW	1. D: XR	=	D: RXRQ * XQDW
3. XQ59TW	=	RQ59TW * XQTW	2. D: PM	=	D: RPM * PXWD
4. XGAGR	F	XQ01TW+XQ24TW	A. PXDW	=	D: RPX * D: PX
5. XGNAR	F	XQ59TW	B. XQWD	=	D: RMQR * D: MR
6. PMRM	F	ZXRD * PX24WW, ZXRD * PX33WW	3. O: XR	=	O: RXRQ * XQOW
7. PMC	F	ZXRD * PX01WW, ZXRD * PX59WW	C. XQWO	=	O: RMQR * O: MR
8. PMK	F	ZXRD * PX59WW	4. L: XR	=	L: RXRQ * XQLW
A. PXGAGD	F	PX01WW	5. L: PM	=	L: RPM * PXWL
			D. PXLW	=	L: RPX * L: PX
			E. XQWL	=	L: RMQR * L: MR

* F means log-linear function while = means identity. The identities here are all based on the ratios which appear on the right-hand sides of equalities:
RQ01FW, RQ59FW, H: ECXQHW, RQ33IW, RPX33IW, RQ01IW, RPX01IWW, RQ24IW, RPX24IWW, RQ59IW, RPX59WW, RQ24MW, RPX24MWW, RQ33MW, RPX33MWW, RQ59MW, RPX59MWW, RQ01SW, RQ24SW, RQ33SW, RQ59SW, RQ01TW, RQ24TW, RQ59TW, D: RXRQ, D: RPM, D: RPX, D: RMQR, O: RXRQ, O: RMQR, L: RXRQ, L: RPM, L: RPX, and L: RMQR.
These ratios are treated as exogenous variables in the link system. Equations preceded by a numeral correspond to the interface from the trade model to the country models (i. e., the 'in' equations), while those preceded by a letter correspond to the interface from the country models to the trade model (i. e., the 'out' equations).

show, because of missing data the country coverage in the three regions is not exhaustive, especially for the regions O and L. Thus, there are some data discrepancies between the regional models and the trade model. This inconsistency is adjusted for by exogenous ratios at the interface in the Asian Link System.

Interface

The main role of the interface is to adjust for differences in units, dimensions, concepts, coverage, etc. between the trade model and the country and regional models. In the Asian Link System, these adjustments are made either by statistical equations (approximately) or by identities based on exogenous ratios without introducing precise relationships. Another role, which is specific to the Asian Link System, is to close the linkage system with respect to commodity sub-groups in trade as already explained in relation to the trade model.[12] The interface equations are presented in Table 8, where the 'in' equations from the trade model to each of the country or regional models are listed numerically, while the 'out' equations in the opposite direction are listed alphabetically. The log-linear form (denoted by F in the table) is adopted here to estimate all of the equations other than identities (denoted by = in the table). This is simply because

12) Note that, unlike the trade model, the ratios here are all treated as exogenous variables without being fixed in a specific base year.

the log-linear form is more convenient than the linear form in connecting variables which differ in units, dimensions and base years.[13]

III Traceability of the System: 1972–1980

The Asian Link System is a simultaneous system of 550 equations comprising one trade model and 13 country and regional models. To test its traceability in the sample period we used dynamic simulations. For this purpose (as well as for the policy simulations in the next section), we used a computer program, 'LINKSIM', developed by S. Yasuda, which is a general purpose simulation program designed especially for linkage models.[14]

As illustrated in Fig. 1, 'LINKSIM' consists of three basic files (i.e., DATA FILE, EQU FILE and SYS FILE) with a common file name for a specific linkage model (i.e., WLINK for the Asian Link

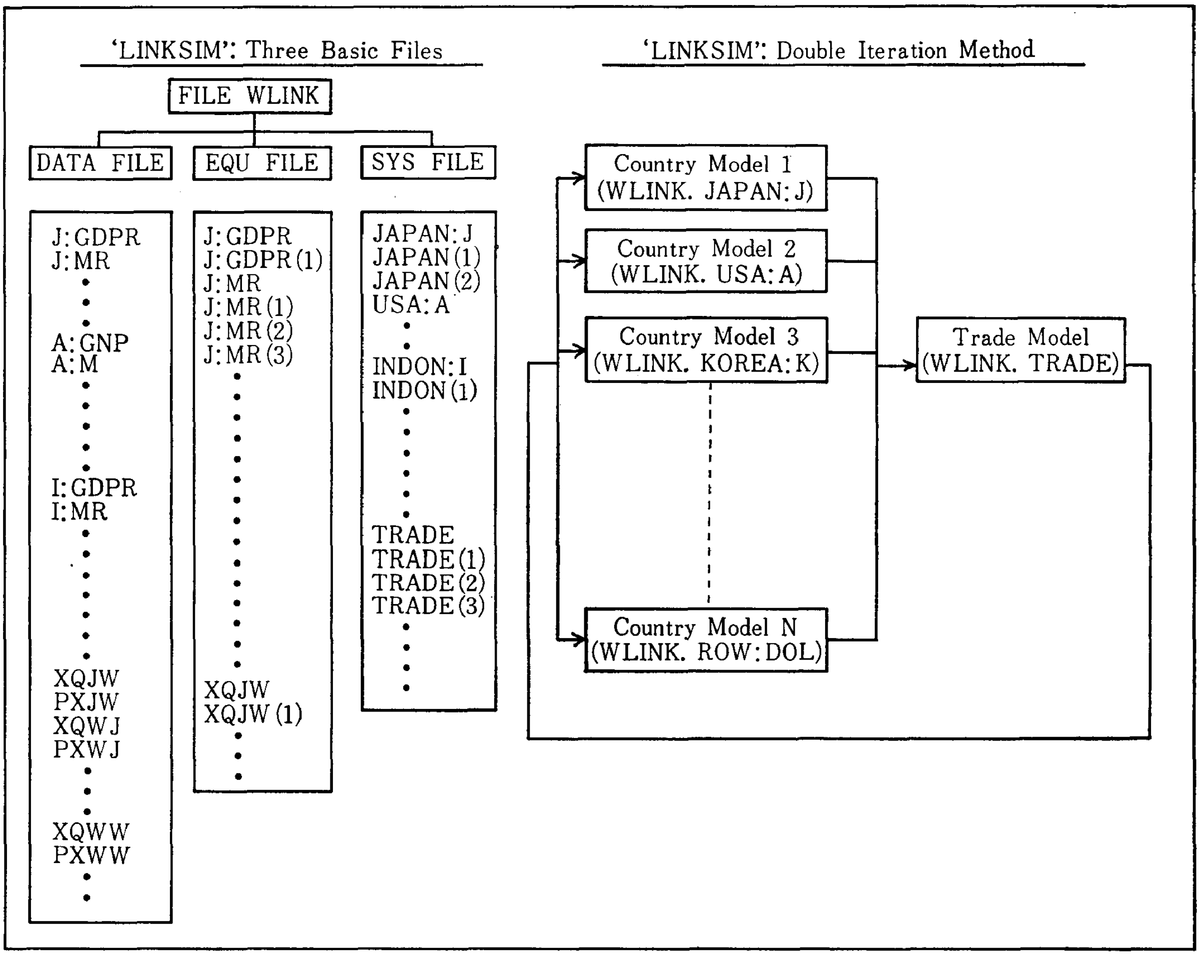

Fig. 1 A Brief Outline of the Linkage Program 'LINKSIM'

13) The coefficients of determination are very high for many of the estimated equations, exceeding 0.90 in almost all cases.

14) It was written closely in line with STS-System (Stochastic Simulation System) developed by S. Schleicher.

System). DATA FILE stores the data for all of the variables needed in the linkage model. Since each variable in DATA FILE must have a specific name, a specific initial was attached to each of the original variable names for the country and regional models, except for the country model of Thailand. Variables in the Thai model do not have the initial T since their original names are often of the maximum length (eight characters) permitted in 'LINKSIM'. EQU FILE, on the other hand, stores all of the equations, including alternative specifications, to be used in the linkage model. Again, each equation must have a specific name. SYS FILE, similarly, stores all of the component systems of the linkage model (i. e., country models, regional models and trade models including alternative specifications) with specific names distinguishable from each other.

As also indicated in Fig. 1, 'LINKSIM' employs a double iteration method in solving for a linkage model composed of a set of non-linear systems of equations.[15] In other words, each of the component country or regional models is first solved for by iteration based on the Gauss-Seidel method. Then, the trade model (i. e., the linkage part) is solved for by the same method, using the solutions for the country and regional models. This is the end of the first round of the double iteration process. The solutions for the trade model, then, are fed back into the country and regional models, and the second round starts. The double iteration process continues for several rounds until the solutions for all of the component systems converge. 'LINKSIM' makes it possible, among other things, to easily find which component systems are responsible when the linkage model as a whole does not converge.

Using the simulation program 'LINKSIM', we tested the traceability of the Asian Link System for the period 1972-1980. For each year of the simulation period, the whole system converges in the fourth or fifth round of the double iteration process.[16] In the first (whole system) round, the number of iterations required to attain convergence for the country models of Japan and Singapore was relatively large (around 50) compared to the others (about 10 to 20), but it decreased rapidly in subsequent rounds of the (whole model) iteration. The results of the final test are summarized in Table 9 in terms of the root-mean-square-percentage-errors (RMSPE's) for all of the 550 endogenous variables in the Asian Link System. Most of the RMSPE's are around 10% or less, while exceptionally high RMSPE's are all related to the variables with large fluctuations or with values close to zero in some years,[17] i. e., inventory investments (J: JPR, J: JP, K: II and F: J), statistical

15) Project LINK also employs a double iteration method. See Johnson and Van Peeterssen [1976].

16) The convergence criterion is 1/1000 here in the final test. For policy simulations in the next section, we adopt the convergence criterion of 1/100000 for which six or seven rounds of the double iteration process are necessary to get convergent solutions (See footnote 19).

17) Note that the RMSPE is a ratio which takes a large value when its denominator is close to zero only in some specific years.

Table 9 Final Test of the Link System: 1972–1980
(Root-Mean-Square-Percentage-Errors)　(×100)

XQJW	.021	XQAW	.014	XQKW	.043	XQFW	.035
XQHW	.022	XQIW	.048	XQMW	.033	XQPW	.032
XQSW	.024	XQTW	.047	XQDW	.009	XQOW	.021
XQCW	.005	XQLW	.015	XQWW	.012	PXWJ	.018
PXWA	.027	PXWK	.030	PXWF	.032	PXWH	.023
PXWI	.029	PXWM	.026	PXWP	.027	PXWS	.029
PXWT	.029	PXWD	.021	PXWO	.024	PXWC	.013
PXWL	.022	PXWW	.021	PX01WW	.027	PX24WW	.025
PX33WW	.010	PX59WW	.023	J: XR	.027	J: PM	.049
J: PXW	.016	J: YRH	.085	J: TP	.090	J: LS	.026
J: L	.010	J: Y	.059	J: H	.014	J: LW	.015
J: YS	.099	J: LF	.006	J: U	.246	J: RU	.249
J: PCG	.058	J: CGR	.064	J: PIG	.047	J: IGR	.050
J: TC	.138	J: YDIH	.070	J: PGDP	.050	J: MR	.093
J: M	.107	J: PX	.033	J: X	.054	J: JPR	1.372
J: JP	1.264	J: PIFP	.038	J: IFP	.158	J: IHP	.119
J: IP	.126	J: PCP	.060	J: CP	.050	J: GDP	.045
J: GNP	.045	J: YC	.127	J: YCA	.151	J: SC	.992
J: IFPR	.171	J: PWM	.030	J: PIHP	.050	J: IHPR	.095
J: IPR	.135	J: O	.093	J: ULC	.081	J: PW	.030
J: CPI	.063	J: W	.060	J: YW	.054	J: YP	.060
J: YPD	.060	J: CPR	.057	J: GDPR	.058	J: KFPR	.039
J: KJPR	.038	J: SP	.115	J: KSP	.044	J: TI	.040
J: DISC	10.450	XQWJ	.095	PXJW	.059	A: E	.021
A: PM	.041	A: PXW	.016	A: PE	.026	A: DIVDN	.056
A: YRIN	.035	A: YIN	.041	A: PGNP	.013	A: PIPR	.037
A: PIPF	.028	A: M	.029	A: IPR	.025	A: CPT	.011
A: GNP	.008	A: PRINDX	.017	A: IPF	.031	A: PCNDS	.019
A: YDNDS	.015	A: CPNDS	.009	A: PCD	.024	A: CPTN	.021
A: GNPN	.016	A: YN	.020	A: WPN	.015	A: YPN	.012
A: YDD	.024	A: CPD	.044	A: GKPF	.003	A: GKPR	.003
A: LFENA	.007	A: RTW	.010	XQWA	.045	PXAW	.029
K: GXC	.039	K: PM	.081	K: PXW	.016	K: G	.000
K: GX	.032	K: BMS	.097	K: GMS	.098	K: PC	.038
K: CU	.030	K: WI	.032	K: PI	.033	K: P	.029
K: BMC	.096	K: GMC	.057	K: GM	.047	K: IH	.131
K: INH	.135	K: I	.125	K: CON	.018	K: X	.024
K: XI	.030	K: II	1.013	K: KNH	.014	K: KH	.007
K: PX	.053	K: BXC	.082	K: BTI	1.663	K: BBC	5.558
K: CC	.062	K: DD	.069	K: DT	.055	K: NFAK	.800
K: M2	.051	K: MB	.170	XQWK	.058	PXKW	.055
XQ01FW	.035	XQ59FW	.035	F: XN	.042	F: XK	.087
F: PM	.043	F: POIL	.099	F: PMO	.062	F: Y	.027
F: X	.031	F: MCAP	.117	F: MC	.160	F: M	.084
F: J	2.689	F: IPO	.051	F: IPN	.138	F: IPK	.266
F: IP	.081	F: I	.045	F: CS	.062	F: CPI	.043
F: WPI	.063	F: P	.032	F: CD	.091	F: CN	.045
F: TGF	.161	F: TFG	.164	F: TD	.062	F: D	.066
F: TI	.033	F: NI	.031	F: YD	.034	F: CF	.022
F: CP	.015	F: GNP	.029	F: MR	.074	F: K	.016

XQWF	.105	PXFW	.060	H: EC	.022	H: PM01	.048
H: PM24	.061	H: PM03	.105	H: PM59	.069	H: GDPP1	.052
H: GDPP	.045	H: DD	.103	H: E	.018	H: MS	.042
H: M59	.048	H: M3	.077	H: M24	.061	H: CUR	.084
H: M1	.095	H: P	.072	H: MO1	.039	H: MC	.031
H: M	.028	H: IPBC	.093	H: IPPD	.090	H: CF	.025
H: TD	.086	H: GDPFC	.068	H: NDPFC	.075	H: Y	.073
H: CP	.068	H: GDPMP	.068	H: TI	.106	H: KPPD	.069
H: XM	.130	H: NIM	.090	H: NIMC	.008	H: XMC	.145
H: KP	.088	H: PRA	.060	H: PC	.061	H: WMF	.173
H: WBC	.080	H: PM	.047	H: PE	.083	H: DT	.098
H: DS	.088	H: KPBC	.031	XQWH	.043	PXHW	.066
XQ33IW	.048	PX33IW	.010	XQ01IW	.048	PX01IW	.027
XQ24IW	.048	PX24IW	.025	XQ59IW	.048	PX59IW	.023
I: XOILD	.083	I: XNOSD	.065	I: PMCD	.126	I: PMID	.173
I: PMRMD	.085	I: PMI	.173	I: XOIL	.083	I: XGAS	.0
I: XNOS	.065	I: X	.072	I: PMC	.126	I: PMRM	.085
I: PXOIL	.054	I: XOILR	.074	I: XGASR	.0	I: PXNOS	.074
I: XNOSR	.086	I: XR	.055	I: MR	.069	I: RPMB	.075
I: TSD	.081	I: MSDR	.489	I: MSD	.489	I: MRMR	.096
I: MRM	.095	I: MIR	.247	I: MI	.172	I: C	.072
I: PC	.055	I: MCR	.246	I: MC	.170	I: M	082
I: PI	.068	I: I	.082	I: PCG	.046	I: CG	.046
I: PCP	.058	I: CP	.078	I: GDP	.070	I: PGDP	.054
I: DD	.102	I: SFMB	.044	I: CRPMB	.084	I: CRPMS	.082
I: IPR	.086	I: IR	.046	I: CPR	.024	I: CR	.021
I: GDPR	.022	I: GNPR	.023	I: DEPR	.018	I: NNPR	.025
I: LABF	.005	I: EMP	.005	I: UNEM	.052	I: KR	.004
I: PCPI	.094	I: PX	.047	I: PM	.074	I: GNP	.073
I: DEP	.067	I: NNP	.077	I: BOP	.641	I: NFAMS	.364
I: CRGMS	.001	I: CROMS	.011	I: CMBMA	.0	I: RMB	.140
I: RMO	.141	I: NOIMS	.013	I: SMB	.164	I: NFAMB	1.132
I: NFAMA	.416	I: RM	.280	I: CUR	.413	XQWI	.120
PXIW	.053	XQ24MW	.033	PX24MW	.025	XQ33MW	.033
PX33MW	.010	XQ59MW	.033	PX59MW	.023	M: XR	.090
M: XM	.081	M: PXR	.112	M: PXM	.164	M: PX	.079
PXMW	.072	M: XO	.169	M: PMR	.042	M: PMM	.071
M: PMF	.074	M: PIP	.077	M: PIG	.076	M: IG	.077
M: KG	.027	M: XGSV	.079	M: LW1	.017	M: Y1	.041
M: LW2	.005	M: Y2	.067	M: PCPI	.045	M: NPOP	.003
M: LF	.018	M: LWO	.026	M: TY	.063	M: XGS	.059
M: TX	.079	M: MGS	.049	M: PCG	.039	M: CG	.038
M: S	10.327	M: CP	.030	M: CPV	.050	M: TM	.049
M: GRN	.033	M: GB	.121	M: MCG	.122	M: MM	.143
M: MR	.092	M: YO	.025	M: LW	.021	M: LW3	.111
M: KP	.042	M: Y3	.042	M: GDP	.019	M: PGDP	.048
M: PCP	.026	M: MF	.080	M: MGSV	.049	M: BPR	1.490
M: MER	.278	M: M2	.171	M: IP	.136	M: IPV	.100
M: GDPV	.065	M: TI	.065	XQWM	.071	P: XR	.032
P: PIM	.055	P: NDAMA	.981	P: RR	.145	P: CDMB	.778
P: RES	.200	P: DCKB	.102	P: NFADMB	.484	P: DINVR	.074
P: IPRR	.086	P: ITOTR	.057	P: MRS	.054	P: MR	.041

P: PEX	.068	P: NFA	2.873	P: NFAMA	1.032	P: RN	.281
P: TL	.023	P: PGNP	.022	P: PCER	.009	P: GNPR	.012
P: TN	.084	P: NCGMA	1.094	XQWP	.086	PXPW	.068
XQ01SW	.023	XQ24SW	.024	XQ33SW	.024	XQ59SW	.024
S: EGP01R	.068	S: EGP24R	.037	S: EGD3R	.116	S: EGD59R	.048
S: PMG01	.063	S: PMG3	.041	S: PM	.045	S: MG24R	.047
S: EGDR	.041	S: EGPR	.019	S: EGR	.025	S: ER	.017
S: MSR	.080	S: MG59R	.049	S: MG3R	.055	S: MG01R	.031
S: MGR	.036	S: MR	.027	S: MER	.439	S: JR	.367
S: ITER	.178	S: IMER	.086	S: ICONR	.075	S: IR	.036
S: RTSDD	.072	S: RCICD	.099	S: M2	.044	S: NCPF	.064
S: GCPF	.044	S: TD	.158	S: TI	.063	S: CPI	.079
S: LE	.017	S: W	.040	S: ULC	.050	S: P	.057
S: GDP	.045	S: Y	.048	S: CPR	.017	S: GDPR	.021
S: KJR	.062	S: PE	.051	S: M1	.026	XQWS	.036
PXSW	.056	XQ01TW	.047	XQ24TW	.047	XQ59TW	.047
XGAGR	.050	XGNAR	.082	PMRM	.031	PMC	.095
PMK	.073	UPAAG	.037	UHAAG	.041	YRTHHNA	.164
YINHHNA	.040	YKNHHNA	.061	TDRHH	.092	PXGAGD	.068
PXGAG	.068	TCYBPNA	.327	PMGS	.034	MGSR	.100
XGSR	.126	MSR	.129	MCR	.206	MKR	.176
TMNA	.091	PTXNA	.039	GDPNAR	.051	MRMR	.104
MGS	.089	XSR	.680	PXS	.060	PXGNA	.082
XGS	.139	KIVBPR	.062	INVBPR	.327	IFXTOR	.084
PGDNA	.037	YGPBPNA	.451	YRDBPNA	.480	IFXBPNAR	.128
KFXBPAGR	.009	IFXBPAGR	.111	PGDAG	.052	YLBNA	.095
YDSHHR	.078	CONHHR	.065	GDPR	.043	PD	.024
WGRNA	.082	NEMNA	.106	NEMAG	.036	GDPAGR	.060
PTXAG	.060	KFXBPNAR	.008	XQWT	.079	PXTW	.084
D: XR	.009	D: PM	.021	D: MR	.012	D: YR	.005
D: CR	.007	D: ZR	.004	D: PZ	.004	D: PX	.024
PXDW	.024	XQWD	.012	O: XR	.021	O: MR	.076
O: YR	.019	O: CR	.015	O: ZR	.011	XQWO	.076
L: XR	.015	L: PM	.021	L: MR	.033	L: YR	.007
L: CR	.010	L: ZR	.006	L: PZ	.003	L: PX	.053
PXLW	.053	XQWL	.033				

discrepancies (J: DISC and M: S), balance of payments (K: BTI, K: BBC and M: BPR), and net foreign assets or net domestic claims (I: NFAMB, P: NFA, P: NFAMA and P: NCGMA). It may be said, therefore, that the Asian Link System has shown a generally good traceability of the actual economy for the period 1972–1980.

IV Policy Simulations: 1976–1980

Many kinds of policy simulations are possible, not only in the sample period but also forecasts. Here we try only the most standard kind of policy simulations, giving external shocks to government expenditures in the sample period in order to clarify the structure of economic interdependence between the 10 countries under consideration from the viewpoint of the international transmission of economic impulses.

External shocks are given independently to each of the 10 countries in the form of increasing government expenditures by one percent of GDP or GNP for the period 1976-1980:

(J) J: CG+J: GDP/100*.53,
J: IG+J: GDP/100*.47
(A) A: G+A: GNP/100
(K) K: CG+K: X/100*.67,
K: GI+K: X/100*.33
(F) F: CG+F: GNP/100*.5
F: IPUB+F: GNP/100*.5
(H) H: CG+H: GDPMP/100*.55,
H: IG+H: GDPMP/100*.45
(I) I: CGR+I: GDPR/100*.5,
I: IGR+I: GDPR/100*.5
(M) M: IGV+M: GDPV/100
(P) P: CGER+P: GNPR/100*.55,
P: IPUR+P: GNPR/100*.45
(S) S: CGR+S: GDPR/100
(T) CONGV+GDPR*PD/100*.62,
IFGV+GDPR*PD/100*.27,
IFXBS+GDPR*PD/100*.11.

In the above specifications for external shocks, government expenditures are allocated between government consumption and investments using their approximate shares in 1976, except for the United States, Malaysia and Singapore.[18] Furthermore, the shocks are given basically to real government expenditures except for Japan, Malaysia and Thailand.[19] The simulation results under these external shocks are summarized in terms of the elasticity-multipliers in Tables 10 and 11 for several key variables in the Asian Link System.[20] The first matrix in Table 10 shows the elasticity-multipliers for real GDP or GNP, which are derived simply by averaging the annual results for 1976-1980 shown in Table 11. The other five matrices in Table 10, on the other hand, indicate average elasticities of a similar kind for GDP or GNP deflators, import quantities and prices, and export quantities and prices.

We can derive, from Tables 10 and 11, several quantitative implications for the structure of economic interdependence among the 10 countries under consideration. First, the own effects in terms of multipliers for real GDP or GNP (i.e., the diagonal elements in the first matrix of Table 10 and the diagonal columns in Table 11) are expected to be larger than those based on the unlinked country models due to the allowance for the feed-back effects in the link system. The differences between the two, however, do not seem large since the own elasticities for exports (i.e., the diagonal elements in the real

18) The US model does not break down government expenditures into consumption and investments. The Malaysia model endogenizes government consumption. The Singapore model does not separate government investments from other capital formation.

19) Nominal government expenditures are exogenous in the models of Japan, Malaysia and Thailand, while real ones are exogenous in the other models.

20) The convergence criterion in 'LINKSIM' here is 1/100000, for which six or seven rounds of the double iteration process are necessary to attain convergence of the whole system. The number of iterations required to attain convergence for the country model of Japan is especially large, exceeding 200 iterations in some rounds of some years. The convergence level of 1/100000 means that computational errors of about .001 may possibly be included in the figures in Tables 10 and 11.

Table 10 Average Elasticity-multipliers (1976–1980)*

Real GDP or GNP

To(From)	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
J: GDPR	1.502	0.218	0.024	0.015	0.008	0.013	0.001	0.012	0.001	0.007
A: GNP	0.045	1.809	0.010	0.007	0.003	0.005	0.001	0.006	0.001	0.002
K: X	0.211	0.429	1.271	0.013	0.016	0.008	0.001	0.008	0.002	0.004
F: GNP	0.118	0.228	0.008	0.583	0.013	0.007	0.001	0.007	0.002	0.005
H: GDPMP	0.143	0.856	0.015	0.024	0.805	0.012	0.004	0.017	0.006	0.009
I: GDPR	0.175	0.182	0.011	0.005	0.002	1.091	0.001	0.008	0.005	0.001
M: GDP	0.059	0.087	0.007	0.004	0.003	0.003	0.979	0.008	0.009	0.004
P: GNPR	0.104	0.258	0.008	0.006	0.004	0.004	0.000	1.022	0.002	0.002
S: GDPR	0.034	0.130	0.007	0.003	0.013	0.027	0.013	0.005	0.649	0.010
GDPR	0.075	0.072	0.005	0.002	0.006	0.013	0.002	0.005	0.002	0.869

Deflators of GDP or GNP

To(From)	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
J: PGDP	1.731	0.177	0.021	0.016	0.005	0.008	0.001	0.011	0.002	0.007
A: PGNP	0.016	1.245	0.007	0.002	0.002	0.004	0.000	0.004	0.001	0.001
K: P	0.248	0.159	0.499	0.011	0.006	0.004	0.000	0.005	0.001	0.003
F: P	0.301	0.420	0.016	1.074	0.024	0.014	0.002	0.015	0.004	0.012
H: P	0.016	0.043	0.001	0.003	0.051	0.001	0.000	0.001	0.000	0.001
I: PGDP	0.354	0.381	0.022	0.011	0.004	1.193	0.001	0.015	0.009	0.003
M: PGDP	0.152	0.092	0.010	0.013	0.003	0.004	0.014	0.012	0.007	0.004
P: PGNP	−0.007	−0.139	−0.003	0.000	−0.002	−0.002	−0.000	0.551	−0.001	−0.001
S: P	0.145	0.045	0.005	0.016	0.004	0.005	0.002	0.004	0.097	0.003
PD	0.075	0.034	0.004	0.006	0.003	0.006	0.001	0.003	0.002	0.243

Real Imports

To(From)	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
J: MR	2.026	0.267	0.029	0.015	0.010	0.017	0.001	0.015	0.002	0.010
A: M	0.060	2.570	0.014	0.009	0.004	0.007	0.001	0.008	0.001	0.003
K: GM	0.199	0.499	1.846	0.013	0.019	0.009	0.001	0.009	0.002	0.005
F: M	−0.050	0.488	0.010	1.859	0.029	0.015	0.003	0.013	0.004	0.012
H: M	0.097	0.890	0.012	0.018	0.960	0.011	0.004	0.017	0.007	0.010
I: MR	0.379	0.497	0.027	0.006	0.005	3.151	0.002	0.020	0.013	0.003
M: MGS	0.170	0.132	0.013	0.015	0.005	0.005	0.441	0.014	0.012	0.007
P: MR	−0.028	0.064	0.001	−0.002	0.001	0.001	0.000	2.410	0.000	0.000
S: MR	0.069	0.236	0.013	0.007	0.027	0.050	0.024	0.011	0.451	0.022
MGSR	0.052	0.093	0.005	−0.002	0.009	0.020	0.004	0.007	0.005	1.579

Real Exports

To(From)	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
XQJW	0.072	0.912	0.102	0.073	0.030	0.049	0.006	0.054	0.009	0.032
XQAW	0.233	0.247	0.045	0.033	0.013	0.022	0.003	0.027	0.004	0.009
XQKW	0.435	0.986	0.014	0.026	0.037	0.017	0.002	0.018	0.004	0.009
XQFW	0.291	1.153	0.031	0.007	0.065	0.034	0.006	0.033	0.009	0.028
XQHW	0.155	1.272	0.019	0.028	0.006	0.017	0.006	0.024	0.010	0.013
XQIW	0.817	0.975	0.054	0.017	0.010	0.013	0.003	0.038	0.024	0.007
XQMW	0.408	0.584	0.047	0.028	0.018	0.020	0.004	0.046	0.053	0.027
XQPW	0.448	1.096	0.033	0.025	0.017	0.016	0.002	0.008	0.007	0.008
XQSW	0.177	0.513	0.028	0.017	0.057	0.108	0.051	0.024	0.003	0.046
XQTW	0.541	0.515	0.035	0.010	0.048	0.096	0.020	0.035	0.023	0.006

Import Prices

To(From)	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
PXWJ	0.051	0.018	0.010	0.023	0.001	0.001	0.000	0.007	0.000	0.001
PXWA	0.222	0.042	0.010	0.030	0.003	0.002	−0.000	0.006	0.001	0.002
PXWK	0.533	0.081	0.010	0.021	0.002	0.003	−0.000	0.007	0.001	0.003
PXWF	0.569	0.084	0.014	0.012	0.003	0.003	−0.001	0.008	0.001	0.003
PXWH	0.382	0.084	0.018	0.083	0.003	0.003	−0.000	0.007	0.001	0.003
PXWI	0.478	0.080	0.011	0.037	0.003	0.003	−0.000	0.007	0.001	0.003
PXWM	0.347	0.062	0.008	0.035	0.003	0.002	−0.000	0.005	0.002	0.002
PXWP	0.445	0.073	0.010	0.030	0.003	0.003	−0.000	0.005	0.001	0.003
PXWS	0.296	0.053	0.008	0.032	0.003	0.002	−0.000	0.007	0.001	0.002
PXWT	0.497	0.084	0.011	0.046	0.003	0.003	−0.000	0.006	0.001	0.003

Export Prices

To(From)	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
PXJW	1.423	0.301	0.023	0.023	0.004	0.007	−0.001	0.012	0.003	0.008
PXAW	0.122	0.031	0.006	0.013	0.002	0.001	−0.000	0.004	0.000	0.001
PXKW	0.184	0.096	0.261	0.012	0.004	0.002	0.000	0.004	0.001	0.002
PXFW	0.281	0.392	0.015	4.002	0.023	0.013	0.002	0.014	0.004	0.011
PXHW	0.102	0.066	0.004	0.011	0.072	0.002	0.000	0.003	0.001	0.001
PXIW	0.111	0.033	0.005	0.009	0.002	0.001	0.000	0.005	0.001	0.001
PXMW	0.165	0.030	0.007	0.016	0.003	0.002	−0.000	0.009	0.000	0.001
PXPW	0.194	−0.100	0.002	0.014	−0.000	−0.000	−0.000	0.531	−0.000	0.000
PXSW	0.255	0.047	0.008	0.028	0.003	0.003	0.000	0.007	0.005	0.002
PXTW	0.058	0.015	0.004	0.015	0.001	0.001	0.000	0.006	0.000	0.006

* Government expenditures are increased by *one percent of GDP or GNP* in each of the 10 countries, for the period 1976–1980. Each column shows average *percentage* discrepancies of the solutions under the shocks from the control solutions without shocks. Note that diagonal elements of the first matrix for real GDP or GNP are multipliers while the others are kinds of elasticities. See Table 11 for annual results before averaging (though only for the case of real GDP or GNP), from which average results here are obtained.

exports matrix) are generally very small. Furthermore, the own effects for real GDP or GNP observed in Tables 10 and 11 are relatively small in the eight countries of East and Southeast Asia compared with Japan and the United States.[21] This is mainly due to the structure of each country model, but it may also be interpreted as an indication of the general characteristics common to the developing countries with high leakages in the process of effective demand spread.[22]

21) Also in the EPA World Economic Model, the own multiplier effects are relatively small for Korea compared with developed countries. See Amano [1982: Table 5.2].

22) The own multiplier effects for Taiwan are decreasing steadily as shown in Table 11. This exceptional result is caused by the specific structure of the Taiwan model (of the annual version used here). In other words, investment functions of the Taiwan model include real money supply (i. e., nominal money supply / GNP deflator) as one of the major explanatory variables. The nominal money supply, however, is treated as exogenous in the model, so that price increases caused by increases in government expenditures lead to decreases in private investments. It seems necessary to also give shocks to the nominal money supply in the Taiwan case but the difficulty arises in deciding the proper amount.

Table 11 Elasticity-multipliers (1976–1980): Real GDP or GNP*

WLINK　J: GDPR

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.877	0.072	0.011	0.006	0.004	0.008	0.001	0.008	0.001	0.005
1977	1.356	0.155	0.020	0.012	0.006	0.013	0.001	0.011	0.001	0.007
1978	1.666	0.228	0.027	0.015	0.009	0.015	0.001	0.013	0.002	0.008
1979	1.829	0.291	0.030	0.019	0.010	0.015	0.000	0.013	0.002	0.008
1980	1.783	0.343	0.030	0.023	0.012	0.016	0.000	0.014	0.002	0.008
Mean	1.502	0.218	0.024	0.015	0.008	0.013	0.001	0.012	0.001	0.007

WLINK　A: GNP

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.013	1.301	0.004	0.003	0.001	0.003	0.000	0.003	0.001	0.001
1977	0.027	1.542	0.007	0.004	0.002	0.004	0.000	0.005	0.001	0.001
1978	0.044	1.791	0.010	0.006	0.003	0.005	0.001	0.006	0.001	0.002
1979	0.062	2.073	0.013	0.008	0.003	0.006	0.001	0.007	0.001	0.002
1980	0.081	2.337	0.016	0.012	0.006	0.009	0.001	0.010	0.001	0.003
Mean	0.045	1.809	0.010	0.007	0.003	0.005	0.001	0.006	0.001	0.002

WLINK　K: X

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.077	0.177	0.957	0.005	0.008	0.004	0.000	0.005	0.001	0.003
1977	0.158	0.337	1.324	0.010	0.014	0.007	0.001	0.007	0.002	0.004
1978	0.229	0.447	1.412	0.013	0.017	0.008	0.001	0.008	0.002	0.004
1979	0.287	0.548	1.415	0.015	0.019	0.009	0.001	0.009	0.002	0.005
1980	0.305	0.635	1.245	0.019	0.023	0.011	0.001	0.012	0.002	0.005
Mean	0.211	0.429	1.271	0.013	0.016	0.008	0.001	0.008	0.002	0.004

WLINK　F: GNP

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.065	0.191	0.006	0.923	0.013	0.009	0.001	0.009	0.003	0.009
1977	0.118	0.253	0.008	0.714	0.015	0.008	0.001	0.008	0.002	0.006
1978	0.148	0.254	0.009	0.540	0.014	0.006	0.001	0.006	0.002	0.005
1979	0.145	0.227	0.007	0.413	0.011	0.004	0.001	0.005	0.001	0.003
1980	0.115	0.214	0.007	0.323	0.011	0.005	0.001	0.006	0.001	0.002
Mean	0.118	0.228	0.008	0.583	0.013	0.007	0.001	0.007	0.002	0.005

WLINK　H: GDPMP

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.053	0.408	0.006	0.012	0.874	0.008	0.002	0.012	0.005	0.008
1977	0.102	0.671	0.011	0.020	0.933	0.010	0.003	0.015	0.006	0.008
1978	0.176	1.044	0.017	0.029	0.848	0.014	0.005	0.019	0.007	0.010
1979	0.097	1.088	0.018	0.028	0.733	0.012	0.005	0.017	0.006	0.009
1980	0.188	1.069	0.022	0.032	0.637	0.016	0.004	0.021	0.006	0.008
Mean	0.143	0.856	0.015	0.024	0.805	0.012	0.004	0.017	0.006	0.009

WLINK I: GDPR

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.085	0.110	0.007	0.003	0.001	1.190	0.000	0.007	0.005	0.001
1977	0.152	0.161	0.010	0.005	0.002	1.080	0.001	0.008	0.005	0.001
1978	0.204	0.193	0.012	0.006	0.002	1.072	0.001	0.008	0.005	0.002
1979	0.230	0.230	0.013	0.006	0.002	1.109	0.001	0.008	0.005	0.001
1980	0.202	0.216	0.012	0.007	0.004	1.001	0.000	0.008	0.004	0.001
Mean	0.175	0.182	0.011	0.005	0.002	1.091	0.001	0.008	0.005	0.001

WLINK M: GDP

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.007	0.016	0.002	0.001	0.001	0.001	0.552	0.002	0.003	0.001
1977	0.024	0.042	0.004	0.002	0.001	0.002	0.791	0.005	0.006	0.003
1978	0.056	0.084	0.008	0.004	0.003	0.003	1.014	0.008	0.009	0.005
1979	0.082	0.116	0.010	0.005	0.004	0.004	1.241	0.010	0.011	0.006
1980	0.128	0.177	0.014	0.009	0.005	0.006	1.297	0.014	0.014	0.007
Mean	0.059	0.087	0.007	0.004	0.003	0.003	0.979	0.008	0.009	0.004

WLINK P: GNPR

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.039	0.116	0.004	0.003	0.002	0.002	0.000	0.888	0.001	0.001
1977	0.076	0.192	0.006	0.005	0.003	0.003	0.000	0.956	0.001	0.002
1978	0.116	0.268	0.008	0.006	0.004	0.004	0.000	1.047	0.002	0.002
1979	0.143	0.336	0.010	0.007	0.005	0.005	0.001	1.101	0.002	0.002
1980	0.146	0.378	0.011	0.009	0.007	0.006	0.001	1.116	0.002	0.002
Mean	0.104	0.258	0.008	0.006	0.004	0.004	0.000	1.022	0.002	0.002

WLINK S: GDPR

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.005	0.061	0.004	0.001	0.009	0.023	0.008	0.005	0.576	0.012
1977	0.019	0.101	0.006	0.002	0.013	0.028	0.012	0.006	0.639	0.011
1978	0.034	0.138	0.008	0.004	0.016	0.030	0.015	0.007	0.683	0.012
1979	0.051	0.166	0.008	0.004	0.013	0.028	0.016	0.006	0.680	0.007
1980	0.058	0.184	0.007	0.005	0.015	0.024	0.015	0.003	0.667	0.007
Mean	0.034	0.130	0.007	0.003	0.013	0.027	0.013	0.005	0.649	0.010

WLINK GDPR

Year	(J)	(A)	(K)	(F)	(H)	(I)	(M)	(P)	(S)	(T)
1976	0.035	0.038	0.003	0.000	0.004	0.014	0.001	0.005	0.002	1.009
1977	0.055	0.053	0.004	0.000	0.004	0.011	0.001	0.004	0.000	0.822
1978	0.084	0.075	0.006	0.002	0.007	0.013	0.003	0.005	0.002	0.887
1979	0.098	0.090	0.006	0.003	0.008	0.014	0.003	0.005	0.003	0.820
1980	0.101	0.107	0.007	0.004	0.009	0.015	0.003	0.007	0.003	0.809
Mean	0.075	0.072	0.005	0.002	0.006	0.013	0.002	0.005	0.002	0.869

* See footnote to Table 10.

Second, the cross effects, in terms of elasticities for real GDP or GNP (i. e., the off-diagonal elements in the first matrix of Table 10 and the off-diagonal columns in Table 11), indicate a strong asymmetry in the structure of the interdependence of the East and Southeast Asian countries vis-a-vis Japan and the United States. In other words, the growth of the former is heavily dependent on the growth of the latter, but not vice-versa, from the point of view of the international transmission of effective demand. The dependence of the East Asian NIC's on Japan and the United States is strong, while Indonesian dependence on Japan and Philippine dependence on the United States are also notable. As to the cross effects within the East and Southeast Asian region, the East Asian NIC's may be said to have a balanced relationship of mutual dependence with each other, while Singapore has an unbalanced relationship of one-way dependence with Indonesia and Malaysia. As to the cross effects between Japan and the United States, Japan may be said to be still in a position where it is influenced by the United States far more than it influences the United States.

Third, the cross effects for real GDP or GNP are closely related to those for real exports and real imports (i. e., the off-diagonal elements in the corresponding two matrices) though in offsetting directions in the case of real imports.[23] The effects on prices (i. e., GDP or GNP deflators, import prices and export prices), on the other hand, are more or less similar to the effects on quantities with respect to both own and cross effects. In the case of GDP or GNP deflators, for example, the own effects will probably not be much different from those based on the unlinked country models, while the cross effects again indicate an asymmetric relationship between the East and Southeast Asian countries and Japan and the United States.[24]

We can say generally, from these observations on the international transmission of effective demand and related economic impulses, that the interdependence among the 10 countries in the latter half of the 1970s was still weak and of a significantly one-way nature, with the United States at the center and Japan in next place, though local interdependence relationships are emerging within the East and Southeast Asian region and the influence of the East and Southeast Asian countries on the United States and Japan is no longer negligible, especially for the latter.

23) It is difficult to find any clear-cut reasons for the negative elasticities observed in the matrix for real imports.

24) Negative elasticities are observed in Table 10 for the cross effects on the Philippine GNP deflator (P: PGNP). This is due to the specific structure of the Philippine model, in which PGNP is determined partly by a kind of excess demand for money (i. e., total liquidity/ monetary base) with a positive coefficient estimate. In the model, the monetary base is affected positively by net foreign assets, which are affected positively by the balance of payments. Therefore, positive shocks on government expenditures in other countries may result in the negative changes in PGNP.

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