Stability in The International Economy: The LINK Experience

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National Economic Stability — The Single Country Case

The response mechanism of an economic model under imposed disturbance is an insightful way of looking at the stability properties of the system being modeled. It should show the quantitative magnitude of fluctuations or movements that are generated by the shock and might also indicate policies that would serve to reduce the severity of the fluctuations. In the case of national models, there has been an extensive application of simulation under shock and some analytical techniques for studying the associated problems of stability.

Given a model of an economy, stability is examined through calculation of multipliers, simulation under general changes in exogenous inputs, or parametric change, dynamic simulation over long periods of time from given initial conditions, and dynamic stochastic simulation. Most of these studies could be in parallel: (1) by numerical simulation calculation, (2) by analytic formula evaluation. The second method is generally applicable only in the linear case.

An abstract model of an economy can be written as

$$F(y'_t, y'_{t-1}, \ldots y'_{t-p}, x'_t, \theta') = u_t$$

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where

F is a vector of functions $(f_1, f_2, \ldots, f_n)'$

y'_t is a vector of dependent variables $(y_{1t}, y_{2t}, \ldots, y_{nt})$

x'_t is a vector of independent variables $(x_{1t}, x_{2t}, \ldots, x_{mt})$

θ' is a vector of parameters $(\theta_1, \theta_2, \ldots, \theta_r)$

u_t is a vector of random disturbances $(u_{1t}, u_{2t}, \ldots, u_{nt})'$

For given initial values of $y_{t-1}, \ldots, y_{t-p}$; given simulation period values of x_t; given parameter values (estimates) $\hat{\theta}$; and assumed random errors (usually at mean values = 0); the system can be solved dynamically at successive values of t. This is called a simulation, and if u_t is set at its zero mean, it is called a "deterministic" simulation.

The response characteristics of the system are studied by examining behavior of the simulation for changes in input values of x_t, θ, and u_t. If a component of x_t is changed to $x_{it} + \delta_{it}$, we get the multiplier effect of x_{it} by comparing a standard simulation with that obtained by using $x_{it} + \delta_{it}$ as input. A sustained change in x_{it} would be obtained by making δ_{it} a constant, an impulse change by assigning a non-zero value to δ_{it} for one period and changing it back to zero for subsequent periods. In this case, we should cumulate the differences between the shocked and the standard simulation.

Both x_t and $\hat{\theta}$ are input values for simulation. Some economic policy simulations are associated with changes in exogenous variables (e.g., changes in government spending), but others are associated with changes in parameter values (e.g., changes in tax rates). Simulation studies of the response mechanism consider both types of change. The changes can also be generalized in the sense that several x_t and $\hat{\theta}$ components can be changed simultaneously and that the changes need not be uniform over time; they can be turned "off" or "on" for different time periods. Finally, random numbers can be drawn for u_t in the study of stochastic simulations.

All these ways of simulating dynamic systems lead to understanding of their stability properties. In dynamic stochastic simulations we can look at the oscillatory properties of systems and ascertain whether they tend to be damped, explosive, or maintained in limit cycles. The periodicity of oscillation tells about duration of recession and recovery. The multiplier values of a system show how different policy instruments change performance towards more or less stable values. By changing parameter estimates we can see the effectiveness of built-in stabilizers for modern economies. A simulation without such built-in features ought to be less stable in some sense than an economy with such features.

In extensive simulation calculations with models of the American economy, the following facts are emerging:

(i) The postwar economy is strongly damped. If models are temporarily disturbed from standard growth simulations, they return quickly to the standard path after the disturbance is removed.

(ii) The automatic stabilizers appear to be doing their job in dampening fluctuations in the U.S. economy.

(iii) The postwar cycle has been moderate in amplitude and duration.

(iv) Longer-run implications of energy shortage are strongly unsettling to the U.S. trade balance.

(i) In their pioneering study of stochastic simulation, Adelman and Adelman found that a single-period exogenous change in defense spending deflected a U.S. model from its simulated growth path for a very short period.[1] The system showed great resilience in returning to the standard path. Similar results have been found in simulated post-Vietnam disarmament solutions and in general shocked simulations.[2]

(ii) In the aftermath of 1929, the American economy together with most of the rest of the world fell to pieces in a most unstable way, leading to the introduction of numerous automatic stabilizers, such as a progressive tax system, cyclically sensitive transfer systems, deposit insurance schemes, and price support levels. In simulations of U.S. models under modern conditions, with the full range of automatic stabilizers, it has been found virtually impossible to duplicate the 1929 kind of cumulative decline.[3]

(iii) Adelman and Adelman found evidence of a moderate postwar cycle of approximately four years' duration. The actual cycle has peaked in 1948, 1953, 1957, 1960, 1969, and 1973. None of the fluctuations has been cumulative. On prewar standards, they were mild cycles, and the classical Juglar oscillation of 8-10 years does not seem to be characteristic of the present system.

(iv) Long before the energy problem became an acute crisis, Preston had been simulating one of the Wharton models of the U.S. economy under conditions of large scale oil imports at rising prices.[4] The price rises

[1] I. and F. Adelman, "The Dynamic Properties of the Klein-Goldberger Model," *Econometrica* 27 (Oct., 1959): 596-625.

[2] L.R. Klein and Kei Mori, "The Impact of Disarmament on Aggregate Economic Activity: An Econometric Analysis," in *The Economic Consequences of Reduced Military Spending*, edited by B. Udis (Lexington, Mass.: D.C. Heath, 1973).

E.P. Howrey and L.R. Klein, "Dynamic Properties of Nonlinear Econometric Models," *International Economic Review, 13 (Oct., 1972):599-618.*

[3] L.R. Klein, "On the Possibility of Another '29", *The Economic Outlook for 1967*, (Ann Arbor: Department of Economics, University of Michigan, 1967).

[4] R.S. Preston. *The Wharton Annual and Industry Model* (Philadelphia: Economics Research Unit, Universtiy of Pennsylvania, 1972).

were probably too mild, at least in the special conditions of 1973-74, but the large volume of imports foreseen were fully expected to be unsettling for the U.S. balance of trade. All the gains of devaluation in 1971-73 were expected to be overcome by oil imports some time after mid-decade, according to his simulations. This suggests a shift in mix of imports towards low elasticity items, weakness of exchange depreciation policy, and tendencies towards external instability.

The very simple mathematics of multiplier theory for the individual economy can be derived as follows,

$$Y = d(1 - t)Y + G + E - mY$$

$$\frac{dY}{dG} = \frac{dY}{dE} = \frac{1}{1 - d(1 - t) + m}$$

Y = real output

d = marginal propensity to spend $\quad 0 < d < 1$

t = tax rate $\quad 0 < t < 1$

m = marginal propensity to import $\quad 0 < m < 1$

G = real public spending

E = real exports

The response of real output to exogenous changes in G or E varies directly with d, inversely with t, and inversely with m. It is assumed, for stability, that

$$0 < d(1 - t) - m < 1$$

In relation to simulation of large dynamic systems, as outlined in general terms above, changes in G or E correspond to changes in x_{it}, x_{jt}; while changes in d, t, or m correspond to changes in $\hat{\theta}_k$, $\hat{\theta}_1$,$\hat{\theta}_m$. The simple mathematics are worked out for expository purposes, for the linear, static case. The parameter t is a stabilizer because it reduces, by the fraction (1 — t), the influence of d on the multiplier. Similarly, imports for the open economy are another source of "leakage" in that addition of m to the denominator offsets in part the effect of -d(1 — t).

This application of simple multiplier analysis is best for the small country case because it can more safely be assumed that exports are exogenous and largely independent of the response dY in the world economy. Even in the largest of economies, however, the feedback influence of Y on world trade or world production and own exports is usually neglected in calculations to a first approximation.

If taxes are progressive so that t varies directly with income, we find even more built-in stability and reduced multiplier responses. Similarly, if m is large and positively associated with Y, as is often the case in small countries, we find even stronger leakages and smaller multiplier responses. If 2.0 is a rough figure for a large, relatively closed economy, the corresponding figure would be 0.5 to 1.0 for a small open economy.[5]

This simplified model has no supply side, i.e., no mechanism of domestic price determination. The multiplier mathematics lose their simplicity in this case, but numerical simulation shows that a given shift in the *endogenous* export equation may have a larger multiplier than a corresponding *exogenous shift* in the volume of public expenditures. This difference comes about because exports depend on relative prices; they are positively related to the ratio of world to home prices and because there is usually a time build-up in the adjustment of exports to shifting demand. If the increase in productivity usually associated with output expansion leads to relatively lower or stable home prices, there may be an induced expansion in exports, which becomes progressively larger as time lags work out their effects. If the expansion comes at a point of full capacity utilization, however, it may lead to relatively higher domestic prices which would restrain the export expansion.

These cases would have to be worked out in numerical simulations by changing the component of x_t representing G_t, in one case, and by adding a shift parameter to the component of F representing the export function, in the other case. In early multiplier simulations of the Wharton Model (1966-68 version) export multipliers appear to be quite strong in comparison with government expenditure multipliers. The real multiplier arising from a change in G quickly rose, in that model, to approximately 2.0 and oscillated in a narrow range about the average.[6] This is different from the present version of the Wharton Model because the standard expenditure multiplier falls in subsequent quarters after peaking at about 2.9 in three to four years. The export multiplier exceeded the real government expenditure multiplier in the older version of the Wharton Model. It settled down at about 3.5 after growing for three to four years. In that system exports were in a distributed lag relation; therefore, the initial impact was compounded in the dynamic solution. If this effect is eliminated, the long-run multiplier would be only about 2.1. It should be slightly larger than a domestic expenditure multiplier because it has a *direct* and immediate impact on private output and because it may cause less of an increase in domestic prices than other changes in exogenous spending.

[5]An extreme case with high values for m is shown in the models of the Dutch economy. For small multiplier values associated with large values of m see, J. J. Post and P. J. Verdoorn, "Capacity and Short-term Multipliers," in *Economic Analysis for National Economic Planning*, edited by Hart, Mills and Whitaker. (London: Butterworths, 1964.)

[6]L. R. Klein and M. K. Evans, *The Wharton Econometric Forecasting Model*, 2nd enl. ed. (Philadelphia: Economics Research Unit, University of Pennsylvania, 1968)

Perhaps more is known about the stability and dynamic response properties of various U.S. models because there have been more coordinated simulation studies;[7] nevertheless, other individual participant models in the LINK system have been put through a number of simulation calculations or stability analyses. In this respect, Canadian results with TRACE are important in showing the stabilizing effects of alternative exchange rate policies.[8] The Canadian model is unique in having a significant statistical sample of both floating (1951-60) and fixed (1961-69) exchange rates. Also, the model includes a comprehensive balance-of-payments sector. The exchange rate is a variable in the trading, pricing, and capital flow equations of the model.

At the level of partial equilibrium analysis, the TRACE model satisfies the Marshall-Lerner condition. Nominal exports fall and nominal imports rise when the exchange rate (Can. $ per U.S. $) falls, *cet. par.* The balance-of-payments surplus falls at the same time the exchange rate falls; thus it is possible to program a rule in TRACE to vary the exchange rates for solutions that show balance-of-payments disequilibrium and solve for an equilibrating exchange rate.

This is not a full stability condition, however, because exchange rate changes induce changes in income levels, price levels, and interest rates. The total effect on the system for changing exchange rates shows that, on average, a change in the rate by 1 cent, induces a change (in the same direction) of the payments balance by $300 million in the short run. The long-run effect is lower.

In simulations of TRACE under floating and fixed rates, it is found that expansionary policies (public expenditure increases, tax cuts, easier money) work better under floating than under fixed rates as far as increasing output, and lowering unemployment are concerned. There tends to be somewhat more inflation under the floating system when an expansionary policy is followed, and, of course, the balance of payments is closer to an equilibrium value than under fixed rates.

These are suggestive and promising results in favor of stabilization for the single country case; there is no similar experience for other countries, either individually or linked.

Prior to the 1971 revaluations, simulation of the German (Bonn) and Japanese (Japan Economic Research Center) LINK models were individually and separately made for different levels of DM or ¥ exchange rates in order to see if there would be movements toward equilibrium as a

[7]B. Hickman, ed., *Econometric Models of Cyclical Behavior*, (N.Y.: Columbia University Press for NBER, 1972); O. Eckstein, ed., *Econometrics of Price Determination*, (Washington D.C.: Federal Reserve Board, 1972); G. Fromm and L.R. Klein, "A Comparison of Eleven Econometric Models of the United States," *American Economic Review*, (May, 1973).

[8]J.L. Carr and J.A. Sawyer, "The Balance of International Payments and the Foreign Exchange Rate in TRACE Mark IIIR," University of Toronto, August 1973, memo. See also the paper by John Helliwell in this volume.

result of devaluation. The German results produced the pessimistic conclusions that unilateral up-valuations would reduce their trade surplus in the very short run, but in a few years time the surplus would re-appear unless some compensatory fiscal or other stimulative policy were pursued to maintain domestic activity at a level that would be conducive to strong import demand. Revaluation, therefore, would be stabilizing for the world economy provided it was accompanied by complementary domestic policy.

In the case of Japan, 10 percent ¥ up-valuation with ¥ 90 billion additional public expenditure almost doubles the simulated drop in the current account balance, adds 300 basis points to the real growth rate and 100 basis points to the rate of rise in real wage rates. In a sense, what appears to be good for the nation is also good for the world. These Japanese simulations of 1970 and early 1971 did not foresee the enormous inflation that is associated with the present decline in the Japanese real growth rate, but this is because extremely high import prices for oil and other basic materials were not introduced at that time into the Japanese model solution.

International Economic Stability — The Multi-Country Case

The analysis takes on a new dimension if we consider the inter-relatedness of national economies in the world system. The two-country analysis formulated many years ago by Lloyd Metzler provides an indicative starting point.[9] This again proceeds by the simple mathematics of multiplier analysis. Let there be two (look-alike) economies (one country and the rest-of-the-world, e.g.):

$$Y_1 = d_1(1 - t_1)Y_1 + G_1 + e_1Y_2 - e_2Y_1$$

$$Y_2 = d_2(1 - t_2)Y_2 + G_2 + e_2Y_1 - e_1Y_2$$

Following the Metzler model, we assume that one's exports depend on two's output level and that one's imports depend on its own output level. Corresponding switches are introduced in the relations for two's exports and imports.

The world economy reduced forms are

$$Y_1 = \frac{1}{1 - d_1(1 - t_1) + e_2 - \dfrac{e_1e_2}{1 - d_2(1 - t_2) + e_1}} \left[G_1 + \frac{e_1}{1 - d_2(1 - t_2) + e_1} G_2 \right]$$

[9]Lloyd Metzler, "Underemployment Equilibrium in International Trade," *Econometrica* X (1942):97-112. Graphical results for the two-country case are worked out in a highly informative way by Romney Robinson, "A Graphical Analysis of the Foreign Trade Multiplier," *Economic Journal*, LXII (Sept., 1952): 546-64.

$$Y_2 = \frac{1}{1 - d_2(1 - t_2) + e_1 - \dfrac{e_1 e_2}{1 - d_1(1 - t_1) + e_2}} \left[G_2 + \frac{e_2}{1 - d_1(1 - t_1) + e_2} G_1 \right]$$

Looking at country one by itself with a change in G_1 alone, we see that the multiplier has been increased over the single country analysis by the subtraction of

$$\frac{e_1 e_2}{1 - d_2(1 - t_2) + e_1}$$

in the denominator, again assuming that all values satisfy standard stability conditions. The increment to the multiplier depends positively on one's marginal propensity to export (two's marginal propensity to import), and on two's ordinary multiplier. Essentially, the added term offsets the dampening effect of one's marginal propensity to import by having

$$e_2\left(1 - \frac{e_1}{1 - d_2(1 - t_2) + e_1}\right)$$

in place of

$$e_2$$

alone, that would be used in the single country analysis.

In addition, the *multiplicand* as well as the *multiplier* can be a reinforcing factor in the multi-country case. If two's public expenditure changes in the same direction as one's, the *multiplicand* changes from

$$dG_1$$

to

$$dG_1 + \frac{e_1}{1 - d_2(1 - t_2) + e_1} dG_2$$

Of course it would be possible for countries to offset one another in the sense that negative values for dG_2 could reduce the positive multiplicand contribution of dG_1.

In the simple single country case, we analyze a domestic multiplier for dG by assuming that exports are fixed ($dE = 0$). This cannot be assumed to be the case in the multi-country case because exports are undergoing

induced change and thus affect the multiplier; in addition policy changes in other countries can affect the size of the multiplicand. There is no basis for assuming that one country acts alone.

It is evident that the two country models can be extended, without price effects, readily to a general n-country analysis, but few qualitative results would be affected. The introduction of prices turns the simple problem into a more complicated one; therefore, we shall rely on LINK simulations in the next section to study these effects.

In the business cycle history of the period since World War II, we may make the following rough chronicle:

1950-60 In the early part of the decade, there was reconstruction and recovery on a general upward trend in most countries except North America. There was a post-Korean recession in the United States. In 1957-58, there was a synchronized recession throughout the world — the United States, Canada Europe, Japan.

1960-70 There were nonsynchronized recessions,

United States	1960-61,1969-70
Italy	1963-64,1969
France	1963,1968
Germany	1963,1967
United Kingdom	1962
Japan	1962,1964-65

1970- After the U.S. recession of 1969-70, there was a delayed recession in Europe and Japan 1971-72. In 1973-74 there was a synchronized recession in the United States and Europe, aggravated by the energy crisis.

As any traffic manager knows, staggered office hours for opening and closing times are conducive to a smoother flow than is the case with completely uniform hours. The latter tends to cause jams. This is like the effect of business cycle crises brought about by common reinforcing fiscal policies. Offsetting policies ought to be properly coordinated to help to smooth the flow of traffic.

Associated with the usual assumption that export volume or factors determining export volume, such as world trade and production, is exogenous to the single economy, is the assumption that world prices are also external. Import prices or competing export prices are assumed to be given to the national economy. The effect of these prices on domestic inflation is well recognized, but the feed-back effect of countries' own inflation on world prices is usually not taken into account. If two-country or multi-country models are constructed with real trade flows and prices as separate variables, they become so complicated that simple analytical study does not appear to be feasible. We shall study the effects in the next

section of world inflationary pressures in numerical simulation exercise. At this time, we simply note, in a general way, some aspects of inflation for the single country and the world.

A typical equation for a country model expresses price in a mark-up relation with unit costs — unit wage costs. In some industries unit capital cost is equally important, and in others unit material costs should be entered. For countries importing capital goods, import costs will be expressed through unit capital costs. For countries importing materials, inflation transmittal will occur through a mark-up on unit material costs. The only special note to make in this instance is that the dependent price variable should not be a value-added price, such as the price of GNP (GDP); it should be a gross output price such as a wholesale price index or a deflator of total domestic spending, measured as GNP plus imports.[10] But just as domestic activity can affect trade and thereby world trade with an induced feedback effect, so can domestic inflation affect world price level and an induced feedback on the domestic inflation rate.

World inflation has been a fact of life since World War II, sometimes stronger than at other times and rarely moving in reverse, except during the simultaneous business cycle downturn of 1957-58 when basic material prices fell. The latest round of world inflation received something of a step upwards in the mid-60s when heavy U.S. purchases for Vietnam stimulated many commodity booms. General world expansion contributed to strong overall demand, but large Soviet-Sino grain purchases intensified increases in food prices in 1972. This inflated import costs in a large part of the world, including the major exporting country, the United States. An unusual jolt was added by the October (1973) War in the Middle East and the related increases in oil prices. Prices of food, fuel, and other basic commodities in the import bills of several nations have risen on an inflationary path in the latest world round. It will be an objective of the LINK analysis that follows to analyze the world inflation problem as well as world fluctuations in real output.

Some LINK Results

By analytical methods, we have seen how and why a single country's response is different from a system's response, where many countries are linked multilaterally in the system. These points can be illustrated on a larger scale by comparing national solutions for models in Project LINK with the fully linked system solution for these same countries. These are known as pre- and post-linkage simulations.[11] In pre-linkage calculations,

[10]The price index of gross domestic spending is often used in the Dutch Model, where imports comprise a large fraction of total spending. For the relevant model calculus on this point, see the paper by B.G. Hickman in this volume.

[11]See R. J. Ball, ed., *International Linkage of National Economic Models*, (Amsterdam: North-Holland, 1973). A compact statement of the present form of the model is given by K. Johnson and L. Klein, "LINK Model Simulations of International Trade: An Evaluation of the Effects of Currency Realignment," *Journal of Finance, Papers and Proceedings*, XXIX (May, 1974):617-30.

Table 1

Effects of Linkage 1973

	Real Exports			Import Price Index			Real GDP (GNP)		
	Pre-linkage	Post-Jan. rates	Post-73 rates	Pre-linkage	Post-Jan. rates	Post-73 rates	Pre-linkage	Post-Jan. rates	Post-73 rates
Australia	$59x10^8$ $A	63	61	105	112	109	311	316	313
Austria	$128x10^9$ AS	134	124	132	136	129	357	364	353
Belgium	$548x10^9$ BF	568	561	133	140	134	1074	1087	1079
Canada	$238x10^8$ $C	209	214	124	132	134	749	742	753
France	$116x10^9$ F	118	115	130	140	134	631	627	628
Germany	$190x10^9$ DM	208	184	88	95	88	621	623	618
Italy	$132x10^{11}$ L	134	135	128	131	135	486	490	493
Japan	$110x10^{11}$ ¥	101	98	136	120	114	741	728	722
The Netherlands	$52x10^{12}$ DFL	52	52	120	122	117	92	91	92
Sweden	$334x10^{11}$ SK	341	331	—	—	—	1076	1081	1072
United Kingdom	$103x10^{11}$ £	101	101	88	90	89	366	364	364
United States	$63x10^{12}$ $US	63	66	143	148	152	834	834	839

Pre-linkage results determined by national model builders at various times during 1973.
Post-linkage results — January rates, computed using $ exchange rates effective January, 1973.
Post-linkage results — 73 rates, computed using average of monthly $ exchange rates prevailing during 1973.

each specialist model builder solves his own system in advance on the basis of his expert judgment about domestic input values and his personal appraisal of the world economy. These national solutions are assembled with all input values set by the national model builders except those relating to world trade and prices; these are endogenously generated by the algorithm solving the LINK system. In particular, exports (or world trade), import prices, and competing export prices are assumed given at particular values as inputs for solution of each national model. Assumed values for these variables are used only in a starting iteration of the LINK solution, and generated values are developed on successive iterations. A general result of such calculations in today's environment is that the linkage process induces higher inflation rates and lower export values for most countries than are assumed for separate national calculations. In the process of scaling down trade or scaling up inflation rates, the multiplier effects of simultaneous movement in the same direction among countries gets amplified. Before we look at amplification, let us look at the effects of the linkage.

In Table 1, there are summary results for selected countries before and after the linkage algorithm is used for simulating 1973. Pre-linkage results are individual country projections provided by each model builder without having been put through the LINK system calculation. These results came to the central LINK files at different times during 1973; they do not, therefore, represent a given set of exchange rates. This reduces the overall meaning of the intended comparison, but the results are, nevertheless, strongly indicative of the effects being discussed. Results are shown only for those countries submitting independently considered projections. We have to make our own initial assumptions for all other models in LINK in order to start the iterative solution algorithm, but our assumed values would not show anything interesting about the effects of linkage.

In order to study exchange rate changes, we made a "control" solution, assuming that January, 1973, exchange rates (U.S. cents per unit of foreign currency) would be in effect for the whole year. This solution provides the entries for the second set of columns: Post-linkage — January rates. Finally, actual rates were averaged by months over the year. This gives rise to the solution, Post-linkage — 1973 rates. For the present analysis, this is an ex-post calculation. Solutions like this were being made on different occasions during 1973, and estimated rates had to be used ex-ante. Similar calculations for 1974 and 1975 used estimated rates. It was assumed that exchange rate changes of 1973 would be "passed through" to foreign trade prices by two-thirds of the amount of the rate change.

The strongest result in Table 1 is that import prices are higher for most countries listed in one or both of the linked solutions than in the individual country, unlinked solution. The principal exception to this general rule is Japan, where yen prices of imports fall markedly. In this inflationary environment linkage induced some inflation. In a strongly

Table 2

Effects of Linkage 1975

	Real Exports		Import Price Index		Real GDP (GNP)	
	Pre-linkage	Post-end 73 rates	Pre-linkage	Post-end 73 rates	Pre-linkage	Post-end 73 rates
Australia	66	71	111	119	316	324
Austria	153	134	144	140	418	388
Belgium	647	649	142	143	1174	1170
Canada	293	252	130	146	867	856
France	140	123	135	143	694	675
Germany	243	181	69	83	695	650
Italy	152	147	136	153	525	531
Japan	129	115	174	120	851	889
The Netherlands	55	58	128	121	94	98
Sweden	388	387	—	—	1159	1159
United Kingdom	118	111	116	124	385	374
United States	74	85	155	169	864	885

Post-linkage results — end 73 rates are computed using November 1973 rates for 1974-75.

deflationary environment, it may well work the other way. It indicates that when prices are going up all round, individual model builders may fail to take account of the full impact of inflation, though this need not be the case, and the LINK method of world simulation will catch the added inflationary impact. It is not that linkage is, in itself, an inflationary process. It is just a way of taking account of fuller international effects of inflation and making sure that a world market environment will be represented in each model even if the initial single country simulations fail to reflect it properly.

LINK solution exports will generally be different from individual country export assumptions based on separate appraisals of world economic prospects. Less striking than the underestimate of inflation is the tendency to overestimate exports. More often than not the post-linkage exports with 1973 exchange rates are smaller than those used in the pre-LINK solution. When linked exports are lower than assumed exports GDP tends to be lower and vice versa if the linkage process raises export volume above the assumed values used in individual model solution.

One impression to be obtained from Table 1 is that the LINK system calculation modifies values for each country within a year's time, but not very much. GDP change, as a result of linkage alone, is usually not as large as 1.0 percent in Table 1.

By 1975, in a three-year simulation, the approximate effects of linkage are much larger. In Table 2, we compare the pre-linkage solution with post-linkage using 1973 rates. In this tabulation we omit the Control solution with January 1973 rates because these rates are strongly outdated, as of 1975. The rates used for the post-linkage simulations in 1975 are the rates in effect during November 1973 but with an assumed full (3/3) pass-through of exchange rate changes to export prices.

In comparison with Table 1, we see that differences between pre-linkage and fully linked solutions build up to much larger amounts over a three-year period. Not all the differences are larger but many are. Instead of saying that usual difference in GNP is less than 1.0 percent as in Table 1, it becomes as large as 3 percent or more, frequently in Table 2. The import price differences are much larger in Table 2 than in Table 1, but the full effects of oil shortages, high oil prices, and high prices for other basic materials are not strongly built into these linked solutions. There is an allowance for the oil price rise that occurred in 1973, but the 1975 price implicit in the linked solution does not reflect the effective tripling of this price expected in a year-over-year comparison of 1974 or 1975 and 1973. A solution that contains higher (more realistic) oil and basic material prices will be presented in a later table that tries to interpret the "oil crisis."

At this date, the entire LINK system has not been simulated for periods as long as 5-10 years. In principle, it can be extrapolated for an indefinite period as long as input values are provided, but such a large amount of input information is required that it is no easy task to make longer-run

simulations. At this stage we can only conclude that there is a tendency for buildup of discrepancy between unlinked and linked simulations.

Given that linkage has some effect, although moderate, on the functioning of the world economy, what can we learn about international stability from linked results of estimated effects of major disturbances? The first disturbance that we shall study is the series of currency rate changes that took place in early 1973 as a sequel to the Smithsonian rates of December 1971. On many occasions, the LINK system was used to try to interpret the U.S. New Economic Policy of August 15, 1971, and the Smithsonian exchange rate realignment. The statistical equation system has changed so much, by a process of evolution, since that period, that we shall not concern ourselves here with 1971-72 simulations, but will start with 1973 and the present version of LINK.[12]

Lacking a complete set of balance-of-payments equations for each LINK model, this system is now only an international trade system that can be solved for given exchange rates. The solutions for different exchange rate configurations 1973-75 will be studied in two parts. The first will be a static comparison for 1973 under two separate assumptions for exchange rates:

(i) The rates of January 1973 are assumed to prevail for the whole year.

(ii) The rates are average for the different months of 1973 and assumed to be passed through by a factor of two-thirds.

The only difference between these two solutions will be an assumed change in exchange rates. All other input values for 1973 are left unchanged.

The second analysis will be dynamic, tracing the effects of the exchange rate changes through time, 1973-75, under the assumption that the pass-through is two-thirds in 1973-74 and three-thirds in 1975.

In Table 1, we can already see some of the static (one-year) effects on GDP, exports, and import prices by looking at the second and third columns tabulated for each variable. The usual pattern is for exports to be reduced for upvaluing countries and to be increased for devaluing countries. Generally speaking, higher exports stimulate higher growth. These comparisons do not indicate whether growth will be present or absent or whether it will be absolutely strong or weak for any country; it shows simply whether the exchange rate change will induce a *different* growth rate for exports or production. According to Table 1, the exchange rate changes would restrain Japanese and German real GDP by somewhat less than 1 percent and add a slightly smaller percentage amount to the U.S.

[12]For some retrospective interpretations of former LINK solutions for 1971-72 see L.R. Klein, "Five-Year Experience of Linking National Econometric Models and of Forecasting International Trade," International Colloquium, Namur, January 31 — February 1, 1974.

Table 3

Inflation and Exchange Rates

	January Rates		Average Rates 1973	
	Exchange	Price Index	Exchange	Price Index
Australia	1.27160	144.3	1.35740	145.0
Austria	.04320	154.7	.04992	153.0
Belgium	.02266	163.1	.02524	161.3
Canada	1.00710	150.6	.99990	151.1
France	.19671	160.9	.21864	157.6
Germany	.31288	150.9	.36145	148.1
Italy	.00171	162.4	.00172	162.4
Japan	.00331	151.1	.00359	151.3
The Netherlands	.31084	180.4	.34454	174.3
Sweden	.21092	—	.22671	—
United Kingdom	2.35620	168.3	2.44487	168.3
United States	1.00000	153.9	1.00000	154.0

level. Canada, which is strongly tied to the U.S. economy would be expected to put on more GDP (in percentage terms) than the United States. Similarly, Austria, which is closely associated with Germany, would lose more in percentage terms than the latter. Most of the GDP changes are small. Australia does not show a strong sympathetic movement with Japan. Import price changes between the two solutions are estimated to be positive for the United States, Canada, and Italy. They are put at negative values for the other countries in Table 1. The changes in import prices as a result of the revaluation, with the assumed rates of pass-through, work their way through to final prices. Estimates of the GDP deflators for the two solutions, together with exchange rate values for each case are shown in Table 3. Mostly, the upvaluing countries show a lower domestic price level, and the devaluing countries a higher domestic price level, but the U.S. change, for a devaluing country, is almost negligible.

Oddly enough, inflation was more serious in many of the upvaluing countries than in the United States, but the LINK calculations in Table 3 suggest that the inflation rates in Western Europe would have been even worse if it had not been for the devaluation.

A calculation for the whole world economy covering the developing countries, the CMEA countries, and the rest of the developed world has been made for the change in trade balances associated with revaluation. To do this wider calculation, we valued each country's trade flows in U.S. dollars and constructed models (structural and reduced form) for each of these areas in U.S. dollar units.

The largest single anticipated gainer from the 1973 revaluation turns out to be the United States in this calculation and this is actually an understatement. The U.S. improvement is at the simulated expense of France, Germany and a variety of other compensatory changes. The widespread distribution of adjustment is favourable for the preservation of stability in the face of exchange rate changes, for the 1973 changes were of significant magnitude.

Ever since the imposition of the Smithsonian rate structure, LINK model simulations have been showing that dollar devaluation, to reduce imbalances like those with Germany and Japan, tended to reduce the estimated volume of world trade and this result holds for the 1973 calculations of the effect of the second wave of revaluations. The value of non-socialist world exports in 1963 prices is estimated to be reduced by $1-2 billion as a result of the revaluations. The reason for the drop is that the effect of the change is to shift world activity away from some of the faster growing (in output and trade) areas to somewhat slower areas. This brings about an overall reduction in real world demand. It does not mean that world demand is expected to fall on a year-to-year basis; it means that the growth path is lowered at the point of revaluation. This, however, is only a short-run effect because after three years (see below) the simulated LINK growth path under revaluation shows a full recovery to the path that was estimated to have prevailed under old exchange rates.

Table 4

Estimated Change in Trade Balances, 1973 Exchange Rate Changes

(trade balance with 1973 rates less that estimated with January, 1973 rates)

Australia	0.19
Austria	-0.17
Belgium	-0.23
Canada	0.17
France	-0.64
Germany	-0.89
Italy	0.17
Japan	0.29
The Netherlands	0.46
Sweden	-0.03
United Kingdom	0.52
United States	1.66
Africa	-0.12
Asia	0.05
Middle East	-0.27
Latin America	-0.40
Denmark	-0.08
Finland	-0.01
Greece	-0.08
Iceland	0.00
Ireland	-0.01
New Zealand	0.02
Norway	0.00
Portugal	-0.10
South Africa	-0.07
Spain	-0.09
Switzerland	-0.16
Turkey	-0.04
Yugoslavia	-0.04
CMEA[1]	0.08
ROW[2]	-0.19

[1]CMEA is the Council for Mutual Economic Assistance which includes

Bulgaria
Cuba
Czechoslavakia
German Democratic Republic
Hungary
Mongolian Peoples Republic
Poland
Romania
USSR

[2]ROW is the rest of the world.

The exchange rate changes introduced in 1973 were in effect for only part of the year, and there were changes within the year. When we look at 1974 and 1973 together, we see that there is further adjustment in a year-over-year comparison if the rates prevailing at the end of 1973 are continued throughout 1974 at a two-thirds pass-through level. We have assumed a further change by virtue of a full three-thirds pass-through by 1975. Another way of studying stability is to look at the change in the simulation over a three-year span. This particular time interval was never thought to be an ordinary one even before the serious disturbances associated with the oil crisis and longer-run energy problems became apparent. There was an expected slowdown in growth during 1974 to fight the strong inflationary pressures that set in during 1973. An interesting aspect of this expected growth slowdown was that several countries lined up together for a simultaneous slowdown. In 1969-70 the United States experienced a recession first; then a year or more later there was a transmission in the form of reduced growth rates. The point of interest in 1974 has been a convergence of slow growth rates among many leading industrial countries.

As a projection, the three-year movement under the impetus of exchange revaluation looks quite stable. There is a projected slowdown for 1974, not categorized as a recession but possibly as a "growth recession" and a mild recovery in 1975. There is comparatively little evidence of expected cooling of inflation, except in the United States and Japan.

Trade balance effects of the revaluation simulation over three years are shown for all countries including those for which we have area models or simple reduced form models.

Without a sudden rise in the price of oil, it already appeared that the Middle East producers were on the path towards accumulation of an unusually large trade surplus. This amount is so large that it appears to be unsustainable in a stable trading world. There is some indicated progress in the adjustment of the German surplus, but not much in the Japanese surplus. In fact, the Japanese surplus fell drastically in 1973 but shows indication of recovering some in 1974. The seriousness of the U.K. deficit and its failure to improve is another omen of instability in this exchange rate configuration. To a lesser extent this is also the case for Italy. The chronic persistent deficits for Latin America and Asia are not as destabilizing because these countries have traditionally had to cover negative merchandise balances with services and capital flows. We are much less confident about the results for individual countries obtained from reduced-form trade models, but the estimated deterioration of the Spanish balance is possibly a sign of economic weakness.

The serious deterioration in the external position of the United Kingdom after a good performance in 1972 was attributed to high import costs for materials in 1973. An expected decline in world commodity prices has not yet occurred in 1974. In addition domestic economic difficulties further impeded growth in production and exports. The precarious position

of the United Kingdom with compounded world energy difficulties in early 1974, did not spread to its trading partners in large degree. Domestic instability did not become a major source of international instability.

The energy problem was already foreshadowed in what turns out retrospectively to have been moderate price increases for crude petroleum and very large trade surpluses in primary producing areas. But the oil crisis came as a major disturbance to the world economy, with price tripling and supply reduction. These events are additive to the general policy-induced-slowdowns that we could observe in 1974 simulations. The modest recoveries projected for 1975 rounded out the picture. Although the oil crisis never held in its most extreme form, it was enough of a disturbance, especially with the higher prices that do seem to show signs of holding at levels well above early 1973 crude oil prices, that its analysis should tell us something informative about world economic stability. Does the slowdown brought about by simultaneous coordination of anti-inflation policies become a genuine world recession under the impact of this large disturbance? This is a question of some interest to investigate with the LINK system in a hypothetical simulation of the oil crisis, assuming that embargoes and price increases would be strictly adhered to.

During the height of the oil crisis (November-December, 1973), the main troublesome point of interpretation was how to incorporate supply restrictions in demand-oriented models? That is an interesting question in itself and will not be taken up in detail at this time, but a specific technique for approximating an answer to this question was worked out and led to some interesting LINK simulations that have a bearing on world stability.[13]

The initial reactions of most LINK model proprietors were that the restrictions and shortfalls being discussed in October and November, 1973, would reduce real growth rates, in some cases by direct limitation and in others by indirect effect on close partner countries. The level of information was unusually sparse and sometimes mysterious; nevertheless a similar reaction came from most countries in Western Europe, United Kingdom, Japan, Canada and United States. A significant common difficulty was the question of treating a supply problem in a demand-oriented system. Decreases of imports of oil coupled with domestic restraints on final consumption were, in many cases, offsetting adjustments in the identity of most demand models.

$$GDP = C + I + G + E - M$$

The offsetting changes were to reductions in both C and M. The key to obtaining a net impact as a result of supply limitation is through negative changes in inventory investment, a component of I. This makes sense because inventory change is the difference between supply and demand. If

[13]See L. R. Klein, "Supply Constraints in Demand Oriented Systems: An Interpretation of the Oil Crisis," *Zeitschrift fur Nationalökonomie* 34 (1974): 45-46.

Table 5

Estimated Dynamic Effects of Exchange Rate Changes, 1973-75

(% changes)

	GDP			Inflation			Real Exports			Real Imports			Effective Exchange Rates ($/foreign currency)		
	1973	1974	1975	1973	1974	1975	1973	1974	1975	1973	1974	1975	1973	1974	1975
Australia	7.3	3.5	-0.1	10.9	7.2	7.2	5.8	9.0	7.3	20.3	7.0	0.0	1.35740	1.37053	1.42000
Austria	4.9	6.7	2.9	9.1	9.1	7.8	8.6	4.3	3.3	16.0	10.7	2.2	0.04992	0.05353	0.05870
Belgium	5.1	3.6	4.7	5.8	5.9	5.6	9.8	7.3	7.7	7.6	8.5	7.0	0.02524	0.02630	0.02812
Canada	6.6	6.2	7.0	5.1	5.2	5.3	11.5	8.1	9.1	12.9	6.2	8.0	0.99990	0.99950	0.99890
France	4.6	3.9	3.5	6.1	6.6	6.4	9.8	4.0	3.5	10.1	6.8	6.2	0.21864	0.22784	0.24340
Germany	6.3	2.4	2.6	5.4	6.9	5.8	8.2	0.1	-2.0	15.0	8.6	9.0	0.36145	0.38865	0.42640
Italy	6.0	3.3	4.2	10.0	6.6	7.7	9.1	3.8	4.5	8.6	5.5	5.7	0.00172	0.00173	0.00174
Japan	10.5	8.3	13.6	9.5	7.4	4.3	3.4	10.8	5.9	27.0	6.4	11.3	0.00359	0.00363	0.00379
The Netherlands	4.1	4.7	1.9	8.1	5.0	6.9	9.5	6.5	4.2	8.0	6.5	7.7	0.34454	0.36186	0.38710
Sweden	4.9	4.3	3.7	—	—	—	8.8	8.6	7.6	4.6	6.0	5.4	0.22671	0.23544	0.24770
United Kingdom	6.9	1.7	1.1	7.3	9.2	7.2	9.8	4.3	5.0	10.0	3.7	4.2	2.44487	2.45987	2.51170
United States	6.5	1.3	4.1	5.5	4.9	3.3	9.9	11.2	15.5	7.3	5.7	6.8	1.00000	1.00000	1.00000

Table 6

Merchandise Trade Balances for Exchange Rate Changes, 1973-75
(billions of U. S. dollars)

	1973	1974	1975
Australia	0.69	0.68	1.42
Austria	-2.13	-2.99	-3.21
Belgium	1.07	0.61	0.30
Canada	1.53	2.14	3.28
France	1.03	0.41	-0.18
Germany	12.17	11.36	9.51
Italy	-1.21	-1.09	-0.75
Japan	5.52	6.41	6.11
The Netherlands	-0.97	-1.26	-2.00
Sweden	1.13	1.37	1.78
United Kingdom	-4.79	-4.96	-4.41
United States	-2.36	0.38	3.03
Africa	0.70	-0.22	0.25
Asia	-7.43	-7.47	-7.53
Middle East	12.81	14.79	16.77
Latin America	-7.03	-6.14	-6.00
Denmark	-0.82	-1.33	-1.81
Finland	-0.08	-0.12	-0.17
Greece	-1.67	-2.13	-2.66
Iceland	-0.02	-0.04	-0.06
Ireland	-0.49	-0.73	-0.96
New Zealand	0.53	0.40	0.32
Norway	-0.94	-1.33	-1.67
Portugal	-0.73	-0.96	-1.24
South Africa	-1.24	-1.71	-2.20
Spain	-2.98	-3.87	-4.81
Switzerland	-0.98	-0.92	-0.76
Turkey	-0.62	-0.81	-1.01
Yugoslavia	-1.02	-1.58	-2.20
CMEA	0.38	0.52	0.69
ROW	-0.06	0.59	0.19

The major target of the 1973 revaluation was the U.S. $, and the American trade balance does respond strongly to this second wave of devaluation, added to the Smithsonian changes of 1971-1972. The balance figure for 1973 is a distinct improvement over 1972, the disastrous year that stimulated a second wave of $ devaluation, but not as large in simulation as actually occurred. The whole set of calculations in Table 6 should be considered more for the year-to-year movement than for the realism of any one year. This is particularly so because the simulation values of Table 6 do not use contemporary values for oil prices. It is interesting to note that Canada improves right along with the United States in the three-year simulation.

supply is to be restricted, it should show up as an inventory decrease — not an actual decrease, but decrease below the levels that would be implied by the normal working of an inventory equation. In any event, an inventory decrease will bring the required net effect after taking account of offsetting movements between C and M.

A full interpretation of the oil crisis would require other changes. Import prices must be raised; specific types of consumption must be reduced; consumer purchases of complementary items should undergo temporary structural shifts (cars, travel); compensatory monetary and fiscal policies must be introduced; etc.

We noticed that almost all LINK model proprietors were estimating that their growth rates in GDP would be reduced by 100-200 basis points as a result of the crisis. The base rates were the 1974 values in the GDP group of columns in Table 5. Some unusual cases outside this general range were Japan and the Netherlands, the former because of an unusual dependence on Persian Gulf crude and the latter because of being an outstanding target for the embargo.

We posed the following hypothetical question: What would happen to world trade and activity levels in individual countries if there were a synchronized decline in real GDP in each of the major industrial countries? Accordingly, we lowered the inventory equation or made similar adjustment in each LINK model by an amount that would lower its 1974 growth rate by 100 basis points. These calculations were all done as separate unlinked simulations, country-by-country. Trial and error methods were used until each country model came down in its *unlinked* simulated growth rate for 1974 by the given amount. It was essentially a process of finding the appropriate multiplier for each model.

The interesting result for the world economy is that most growth rates fell in a fully linked solution by a larger amount than in the unlinked simulation. An interesting way to look at the results in Table 7 is to compare the two pre-linkage solutions first. By design the shocked solutions are approximately 100 basis points lower than the original solution before the shocks are applied. In some cases the drop is only 80 basis points, and some times it reaches 110, but the differences are always close to 100 points except for the Netherlands where the model was not responding to the impulse and Australia, where we introduced no changes. Similarly, we can compare the two linked solutions and notice that they fell by (absolute) amounts that are approximately 1 1/2 times as large as the fall in the pre-linkage solutions. We tentatively conclude that international linkage introduces an amplification factor of 50 percent if there is complete synchronization. To many people, this kind of calculation indicated great stability in the world economy. A moderate synchronized movement, assuming that 100 basis points was reasonably indicative of the realistic situation in the world economy, did not develop in the short run into a world recession. The linked simulation reduced growth rates but did not make any of them negative.

Table 7

Effects of Synchronized Declines in Real Growth Rate
(% change)

	Pre-Linkage		Post-Linkage	
	Before Shock	After Shock	Before Shock	After Shock
Australia	3.7	3.7	3.5	3.2
Austria	9.0	8.2	6.7	5.5
Belgium	4.1	3.3	3.6	2.2
Canada	8.1	7.1	6.2	4.8
France	5.1	4.0	3.9	2.5
Germany	6.7	5.9	2.4	1.3
Italy	3.8	2.9	3.3	1.8
Japan	5.6	4.7	8.3	7.1
The Netherlands	3.8	4.2	4.7	4.4
Sweden	4.7	3.7	4.3	2.6
United Kingdom	3.4	2.4	1.7	0.3
United States	0.7	-0.1	1.3	0.1

Table 8

Effects of Synchronized Declines in Trade
(% change)

	Pre-Linkage				Post-Linkage			
	Before Shock		After Shock		Before Shock		After Shock	
	Real Exports	Real Imports	Real Exports	Real Imports	Real Exports	Real Imports	Real Exports	Real Imports
Australia	11.6	8.6	11.6	8.6	9.0	7.0	7.8	6.9
Austria	9.5	14.3	9.5	12.4	4.3	10.7	3.1	8.3
Belgium	9.1	10.0	9.1	8.9	7.3	8.5	4.9	5.7
Canada	14.0	12.0	14.2	10.3	8.1	6.2	7.0	3.8
France	9.4	9.7	9.4	7.6	4.0	6.8	2.5	4.0
Germany	13.1	20.9	13.0	18.8	0.1	8.6	-1.4	6.0
Italy	7.2	6.1	7.2	5.1	3.8	5.5	1.9	3.8
Japan	6.2	4.4	6.2	3.6	10.8	6.4	9.7	5.4
The Netherlands	5.9	6.4	6.1	4.2	6.5	6.5	4.8	2.8
Sweden	10.6	6.5	10.6	6.5	8.6	6.0	6.5	3.4
United Kingdom	8.3	6.1	8.3	5.0	4.3	3.7	2.9	2.1
United States	7.8	6.4	7.7	5.7	11.2	5.7	8.9	4.9

This is a *real* calculation. There were induced effects on prices but no disturbed price changes for direct increases in oil prices. There were no direct monetary or fiscal changes. It is a calculation that shows something about international stability but was not intended to be a realistic interpretation of the actual crisis.

Every part of the world economy is not shocked in the simulations for Table 7. No changes were made for Australia, developing countries, CMEA countries, or the rest of the developed world (except for import changes in simple reduced form models for Portugal and South Africa). These varied and selected changes, though hypothetical, reflected the overall pattern of the oil cutbacks imposed by the Arab nations.

Although no changes are introduced in the Australian model, it shows the consequence of secondary effects. The Middle East model for developing countries shows a lower growth rate between the two linked solutions because it has sharply lower real exports as a result of the oil cutbacks. This is not indicative of export earnings, only export volume.

The slowing down of the main economies of the world, apart from effects of oil cutbacks, is apparent in the projected growth rate for real world trade (non-socialist) of only 6.0 percent. A notable result of the multiplier calculation demonstrated here is to reduce this estimated growth rate to 4.4 percent; herein lies the main source of the amplification factor because exports depend on world trade. In Table 8 the growth rates of real exports and imports for each country show that without linkage a decline in growth can be brought about by simulation with almost every major country remaining nearly steady in its export trade position. Imports are generally lower because of the induced decline in real growth. The discrepancies between the movements of exports and imports are naturally not taken into account in the pre-linked national model solutions. The linkage of these solutions induced a set of downward trade adjustments that intensify the decline in real output, country-by-country, but not to the point of world recession in this particular simulation.

The primary (imposed) and secondary (induced) effects of this international multiplier-type calculation are large enough to show up as changes in real output and trade growth rates, as indicated in Tables 7-8; moreover, the changes are realistic in magnitude, yet there are not clearly discernible changes in other variables (interest rates, prices, unemployment rates) as a result of the small changes involved. This is, in a sense, an indication of international stability inherent in the LINK system.

The principal thing that is missing from these calculations, as far as the transmission effects of the oil crisis are concerned, is the price effect, manifesting itself as a world inflationary movement caused by sharply higher fuel prices.

We have undertaken a more realistic analysis of the oil crisis with LINK, incorporating these higher fuel prices. This analysis, is mainly a complicated and technical forecast exercise. More suitable for the comparative simulation and stability analysis stressed in this paper is the

Table 9

Effects of Price Increase of Developing Nations' Exports

		%ΔGNP	%ΔPGNP	%ΔPC	%ΔX	%ΔPX	%ΔM	%ΔPM	ΔBAL
Australia	1974	+2.0%	-1.1%	-0.3%	+5.7%	0.0%	+0.1%	+4.5%	+0.24
	1975	+3.6	-2.0	-0.8	+6.6	0.0	+1.5	+5.1	+0.08
Austria	1974	+1.2	+0.4	NA	+2.2	+0.2	+1.4	+1.9	-0.06
	1975	+1.7	+0.3	NA	+2.5	+0.2	+3.0	+2.1	-0.28
Belgium	1974	+0.1	+0.9	NA	-0.9	+4.9	-0.2	+4.4	+0.24
	1975	-0.4	+1.4	NA	-1.6	+5.2	-0.9	+4.4	+0.41
Canada	1974	+1.2	+1.3	+1.6	+3.9	+0.9	+1.3	+1.3	+0.87
	1975	+0.7	+2.7	+2.8	+3.8	+0.9	+1.5	+1.5	+1.29
Finland	1974	+2.2	+0.2	NA	+4.6	+0.2	+2.3	+2.8	+0.01
	1975	+4.2	+1.2	NA	+4.8	+0.2	+4.5	+3.6	-0.12
France	1974	-1.0	+2.6	+3.3	-0.3	+3.8	-1.7	+5.8	-0.18
	1975	-1.5	+3.7	+3.5	-0.5	+3.8	-2.8	+6.0	+0.16
Germany	1974	-0.4	+0.3	NA	+3.9	+0.1	-1.3	+6.0	-0.19
	1975	+0.4	+0.7	NA	+4.0	+0.2	-3.3	+6.2	+0.86
Italy	1974	-0.7	0.0	-0.2	-1.6	+5.7	+0.1	+9.0	-1.91
	1975	-0.8	-0.3	-0.3	-3.4	+6.8	-0.8	+9.1	-2.05
Japan	1974	-0.1	+0.1	+1.0	+0.5	+2.2	-1.7	+9.5	-1.67
	1975	-1.2	+2.0	+1.9	-1.2	+4.1	-2.3	+9.6	-1.36
The Netherlands	1974	-1.7	+4.6	NA	-0.1	+4.2	+3.7	+2.0	-0.48
	1975	-1.3	+4.9	NA	+1.0	+2.5	+3.2	+2.3	-0.68
Sweden	1974	+1.3	NA	+0.5	+4.1	+0.2	+1.1	+5.0	-0.01
	1975	+2.0	NA	+0.9	+4.1	+0.2	+2.0	+5.4	-0.19

Table 9 (cont.)

United Kingdom*	1974	0.0	0.0	+1.5	+1.7	+2.5	-0.4	+7.7	-1.27
	1975	0.0	0.0	+1.6	+1.8	+2.7	0.0	+7.9	-1.55
United States	1974	+0.5	0.0	+0.2	+5.1	+0.8	-0.2	+4.8	-0.49
	1975	+0.5	0.0	+0.3	+4.8	+0.9	+0.1	+5.7	-2.36
Developing**	1974	-1.5	+0.8	NA	-15.9	+26.0	-2.4	+5.2	+5.90
	1975	-2.0	+1.2	NA	-17.7	+28.2	-3.3	+5.8	+6.96
ROW**	1974	—	—	—	-0.1	+2.9	+0.1	+3.4	-0.73
	1975	—	—	—	-1.7	+4.9	-0.8	+4.1	-0.67
CMEA	1974	—	—	—	—	—	—	—	-0.26
	1975	—	—	—	—	—	—	—	-0.19

World Trade Statistics:

		Volume Growth	Price Inflation
SITC 0 — 4	1974	-2.0%	+11.2 %
	1975	-2.7	+11.6
SITC 5 — 9	1974	+1.2	+ 2.7
	1975	+0.8	+ 3.1
All Goods	1974	+0.1	+ 5.6
	1975	-0.4	+ 6.0

For specification of shocks and further description of entries, see text.

*Note that the U. K. output is supply constrained in 1974 and 1975 under these circumstances.

**Averages

GNP = real GNP (GDP)
PGNP = implicit deflator of GNP (GDP)
PC = consumer price index
X = real exports
PX = export price index
M = real imports
PM = import price index
BAL = FOB trade balance, US$

consideration of higher world raw materials prices, in isolation, as a companion to the preceding multiplier-type analysis. Moreover, this is just one form of world inflation. A second interesting companion to the preceding study of synchronized real shocks is a study of synchronized wage-rate shocks, an analysis which also enables us to focus on world inflation originating in domestic labor markets.

Unfortunately, it is a well recognized fact that the component models which make up LINK are better specified in terms of real demands than in terms of prices. More than half of the models fail, as yet, to incorporate endogenous monetary sectors to explain money supply and interest rates; also the monetary influences on the price level are sometimes weak or absent. As a consequence, there are not yet any linkages on the monetary or balance-of-payments accounts. Also, export price disaggregation by commodities is not yet complete, but imminent. We have, for example, three new sets of disaggregated export price equations which are not yet programmed into the model. Current research is underway in LINK on the monetary and balance-of-payments modelling/linkages as well as commodity market modelling/linkages. At this point, however, the predictive performance regarding prices, which has been poor relative to the real side, as well as the incomplete specifications on the price side, make the following calculations more tentative than the preceding.

In Table 9 may be found a comparison of two alternative LINK simulations where the distinction between the two is that one assumes substantially higher food, raw material, and fuel prices than the other. The control solution for this comparison is calculated in terms of Spring, 1974 LINK forecasts, and so already exhibits a somewhat different picture than was anticipated in November and December, 1973. Since this control is not exactly the same as the results already discussed, we hope to avoid confusion by reporting in Table 9 the differences between the "shocked" path less the control path, as a percentage of the control solution (except for the goods trade balance). It is understood, however, that response characteristics must be treated with some care in a non-linear system as they will depend on the values of the control solution.

In the control solution, the price of Middle Eastern exports — virtually all oil products — is assumed to increase 1974 over 1973 by 100 percent and further 1975 over 1974 by about 15 percent. The price of exports of other developing nations is forecast to increase 1974 over 1973 by about 30 percent and further 1975 over 1974 by slightly less than 10 percent. These other exports include some fuels (Venezuela, Nigeria, etc.) representing about 10 percent of the total in value, foodstuffs and raw materials representing about 25 percent each, and the balance manufactures. In the shocked simulation, we assume that Middle East fuel prices are increased by an incremental 100 percent in 1974 (so that the 1974 total change is 200 percent and the 1975 change 9 percent), and also we shock export prices of the other area models by an incremental 20 percent in 1974 with no further change or offset in 1975. This is, as already noted, a

hypothetical calculation; for example, no changes are introduced to the prices of non-manufactured products exported by developed economies. Nevertheless, the changes are broadly plausible and perhaps indicative of what may obtain if cartels such as the OPEC were to become widespread.

The first interesting aspect of these calculations may be seen in the effect on growth of real world trade and its price deflator. While export prices of developing countries increase by an average 26 percent, total world primary goods prices increase by 11.2 percent in 1974. Also the price of world manufactures trade increases by almost 3 percent in 1974. A small fraction (perhaps as much as 80-90 basis points) may be attributable to imposed shocks to prices of manufactured goods exported from developing areas, but the bulk of this effect arises from raw material prices feeding through to manufactured goods prices. Corresponding to this change in relative prices, we see a change in the volume of trade when distinguished by commodity. Real trade increases in manufactures and falls in primary goods. Part of this substitution may be attributable to substitution in production, but it is likely that a more important reason is a demand shift away from goods with high raw material or fuel content into products which are more labor and/or capital intensive. It may also be seen that the substitution elasticity implicit in these comparisons increases from 1974 to 1975. Disappointingly, there appears to be little lagged price impact, however. The differences between the control and shocked path of world trade prices is only slightly higher in 1975 than 1974. While this conclusion is indicative of a dynamically stable system following this type of price impulse, one might view this result as being perhaps too strong.

Turning now to the country-by-country impacts, it is easy to verify that the channels of price transmission which do exist today in the LINK system are clearly operative. First, import prices increase in every country. The impact is as much as 8 — 10 percent in such primary products importers as Japan, Italy, and the United Kingdom. The impact is much smaller in Canada which imports few primary products (on a percentage basis). Second, export prices of the various countries increase rather noticeably and often by much more than may be accounted for by import content of exports.[14] In open economies like Belgium and the Netherlands, the impact on export prices actually exceeds that on import prices. Clearly, the changes in export prices not accounted for by import content represent either competitive adjustments by exporters or indirect

[14]Exceptions are Australia, Austria, Finland, and Sweden where export prices are exogenous. This fact accounts for the rather different results for these countries in real growth also, but is not necessarily representative of actual real-world responses. The Australia results are, in one sense, more counter-intuitive in that the GNP deflator actually declines. Mechanically, this result follows from the definition of PGNP as a value-added deflator with import prices subtracted out. Hence, an increase in import prices may have a negative impact on the GNP deflator; however, such a feature also indicates an inadequate specification of price transmission. For example as just noted, export prices are implicitly assumed to be constant, and this fact contributed to the unexpected fall in GNP prices.

Table 10

Effects of Price Increases of Developing Nations' Exports on Domestic Labor Market

	1974				1975			
	%ΔGNP	ΔUR	%ΔPC	%ΔWR	%ΔGNP	ΔUR	%ΔPC	%ΔWR
Australia	+2.0	-0.1	-0.3	+0.2	+3.6	-0.2	-0.8	+0.3
Austria	+1.2	-0.1	+0.4*	+0.5	+1.7	-0.1	+0.3*	+1.0
Belgium	+0.1	NA	+0.9*	0.0	-0.4	NA	+1.4*	0.0
Canada	+1.2	-0.5	+1.6	+1.9	+0.7	-0.5	+2.8	+3.3
Finland	+2.2	-0.3	+0.2*	NA	+4.2	-1.0	+1.2*	NA
France	-1.0	NA	+3.3	+1.8	-1.5	NA	+3.5	+2.0
Germany	-0.4	+0.1	+0.3*	-0.2	+0.4	-0.2	+0.7*	+0.3
Italy	-0.7	+0.0**	-0.2	-0.2	-0.8	+0.3	-0.3	-0.5
Japan	-0.1	+0.0**	+1.0	+0.5	-1.2	+0.0**	+1.9	+1.2
The Netherlands	-1.7	-0.4	+4.6*	+1.2	-1.3	-0.6	+4.9*	+2.3
Sweden	+1.3	NA	+0.5	NA	+2.0	NA	+0.9	NA
United Kingdom	0.0	0.0	+1.5	0.0	0.0	0.0	+1.6	0.0
United States	+0.5	-0.1	+0.2	+0.1	+0.5	-0.2	+0.3	+0.3

*GNP deflator instead of consumption deflator

**Positive but less than 0.1%

UR = unemployment rate
WR = wage rate
Other variables are defined in Table 9.

effects through domestic prices or wages. Wage rates may vary in two ways: in response to increased costs of living, particularly where wage rates are indexed, and where output prices change, in response to changing marginal value products or different profit margins. Also, wages, and therefore prices, may move along a Phillips curve if the unemployment rate varies as a result of different real output demands. It cannot be seen in Table 9, but each of these mechanisms is operative in this exercise; we transfer some columns from Table 9 and append the impacts on unemployment and wage rates in Table 10 to describe the details. Very simplified theory (i.e., ignoring substitution of capital for labor and assuming a stable Phillips curve) suggests that the impact on GNP and unemployment should be of opposite sign and also that the impact on wage rates should be in the same direction as consumption and prices and opposite to the movement in the unemployment rate. With the sole exception of the Netherlands' real output and employment movements, Table 10 is in accord with these results. Moreover, the size of the whole of these various impacts may hardly be judged negligible.

Referring back again to Table 9, a final observation may be made about trade balances. The final change will, of course, follow from a large number of partially or wholly offsetting effects. Import prices will be larger, but so, too, will export prices and possibly even more so. Real exports may increase or decline, as relative competitiveness is quite different in some cases and also because of different changes in various import markets. For example, the relative competitiveness factor is clearly important for Australia, Austria, Finland, and Sweden where (unrealistically) export prices are exogenous, but also for Canada, Germany, and the United States as opposed to Belgium, France, Italy, the Netherlands, and the United Kingdom. Also France, Japan, the United Kingdom and the United States are affected by the high proportion of their exports which are traditionally sold to developing regions which, in this exercise, sharply curtail imports. The real import effect is less varied, but still real imports are sharply down in Germany, for example, contributing to an improvement in the trade balance. The stability of the trade balances generally is somewhat surprising; it is evidence of the stability of a fixed-exchange rate world where the Keynesian adjustment mechanism along with rather important relative price shifts are responsible for external balance. The large improvements in Canada and Germany as well as the declines in Italy, Japan, the United Kingdom and the United States (while perhaps underestimated) suggest that such an adjustment mechanism may act to eliminate extreme disequilibria, but weaken in effectiveness for small shocks or when nearing balance again.

An interesting counterpart is provided by the case where the stimulus to world inflation arises from domestic origins, in particular from increased wage demands. In order to examine this possibility, we use a control solution essentially the same as above, and let the wage rate equation be disturbed in each country model. Now we are interested primarily in

Table 11

Pre-Linkage Effects of Sustained Synchronized Wage Shocks

		%ΔWR	%ΔPGNP	%ΔGNP	%ΔX	%ΔPX	%ΔM	%ΔPM	ΔBAL
Australia	1973	+5.1	+2.3	+0.3	0.0	0.0	+1.0	0.0	-0.05
	1974	+4.9	+3.1	0.0	0.0	0.0	+0.9	0.0	-0.06
	1975	+4.6	+3.3	-0.6	0.0	0.0	+0.1	0.0	0.00
Belgium	1973	+7.8	+1.9	+0.4	-5.7	+1.0	-2.0	-0.1	-0.55
	1974	+8.1	+3.3	+0.3	-7.5	+0.9	-2.3	0.0	-0.98
	1975	+8.2	+3.7	-0.2	-7.6	+0.9	-3.3	0.0	-0.98
Canada	1973	+4.3	+2.1	-1.1	-1.7	+0.3	-0.1	+0.1	+0.08
	1974	+4.5	+2.7	-1.1	-2.2	+0.3	+0.4	+0.1	-0.12
	1975	+5.1	+2.5	-1.4	-2.0	+0.2	-0.3	+0.1	+0.08
Finland	1973	+4.0	+2.0	+0.4	0.0	0.0	+0.8	0.0	-0.03
	1974	+4.2	+2.1	+0.9	0.0	0.0	+1.4	0.0	-0.06
	1975	+4.8	+2.5	+1.2	0.0	0.0	+1.9	0.0	-0.10
France	1973	+5.5	+2.1	0.0	-0.6	+1.6	+0.1	0.0	+0.26
	1974	+5.5	+2.1	-0.2	-0.6	+1.7	-0.4	0.0	+0.43
	1975	+5.5	+2.2	-0.2	-0.6	+1.9	-0.4	0.0	+0.49
Germany	1973	+2.6	+1.8	-1.1	-0.2	+0.2	-2.6	-0.1	+1.14
	1974	+4.6	+3.1	-2.2	-0.3	+0.3	-3.8	-0.2	+2.24
	1975	+5.4	+4.0	-2.9	-0.4	+0.4	-4.3	-0.2	+3.04

Table 11 (cont.)

Italy	1973	+13.4	+2.1	-0.9	-0.5	+0.6	-1.1	0.0	+0.31
	1974	+13.5	+3.3	-2.7	-1.2	+1.7	-4.1	+0.1	+1.73
	1975	+9.9	+5.0	-4.5	-1.5	+2.1	-6.9	+0.1	+2.35
Japan	1973	+10.8	+2.2	+0.4	-1.3	+0.9	+1.4	+0.1	-0.51
	1974	+11.0	+2.9	+1.1	-3.1	+1.5	+3.5	0.0	-2.21
	1975	+9.9	+3.3	-0.4	-3.4	+1.6	+2.2	0.0	-1.84
The Netherlands	1973	+2.7	+2.1	-0.5	-1.3	+1.0	+1.1	+0.1	-0.31
	1974	+3.0	+2.2	-0.7	-2.6	+0.9	-0.2	-0.2	-0.28
	1975	+3.1	+2.3	-0.8	-2.9	+0.8	-0.3	-0.3	-0.23
Sweden	1973	+5.0	+3.0	+0.8	0.0	0.0	+1.4	0.0	-0.15
	1974	+5.6	+5.2	+0.9	0.0	0.0	+2.1	-0.1	-0.22
	1975	+5.0	+5.5	+0.5	0.0	0.0	+1.5	-0.1	-0.19
United Kingdom	1973	+3.8	+2.3	+0.1	-0.3	+1.3	+0.4	0.0	+0.20
	1974	+3.7	+3.3	-0.1	-1.0	+1.8	+0.3	0.0	+0.22
	1975	+3.4	+3.6	-0.7	-1.6	+1.8	-0.4	0.0	+0.26
United States	1973	+6.9	+2.4	+0.2	-0.7	+2.4	+1.7	+0.2	-0.61
	1974	+7.2	+3.7	-1.3	-1.3	+3.7	+1.3	0.0	+0.47
	1975	+8.0	+5.0	-2.5	-1.8	+4.9	+0.3	-0.1	+2.16

For specification of shocks and further description of entries, see text.

Table 12

Post-Linkage: Effects of Sustained Synchronized Wage Shocks

		%ΔWR	%ΔPGNP	%ΔGNP	%ΔX	%ΔPX	%ΔM	%ΔPM	ΔBAL
Australia	1973	+5.1	+1.8	+0.8	+1.3	0.0	+0.9	+1.4	-0.01
	1974	+4.9	+2.4	+1.2	+2.2	0.0	+1.2	+2.4	-0.03
	1975	+4.6	+2.3	+0.8	+1.7	0.0	+0.6	+2.8	-0.11
Austria	1973	+0.1	+0.1	+0.2	+0.3	0.0	+0.2	-0.5	-0.03
	1974	+0.2	+0.1	+0.2	0.0	-0.1	+0.3	+1.0	-0.12
	1975	+0.3	+0.1	+0.1	-0.5	-0.1	+0.2	+1.1	-0.23
Belgium	1973	+7.9	+2.2	+1.4	-1.7	+2.6	+1.0	+1.2	-0.25
	1974	+8.3	+3.5	+1.4	-2.7	+3.3	+1.3	+2.5	-0.68
	1975	+8.5	+3.8	+0.5	-4.4	+3.5	-0.8	+2.8	-0.56
Canada	1973	+6.2	+3.3	-0.8	-0.3	+0.9	-0.6	+1.1	+0.46
	1974	+7.9	+5.0	-0.8	-1.9	+0.8	-0.3	+1.7	+0.17
	1975	+8.3	+5.6	-1.7	-3.4	+0.6	-1.8	+2.1	+0.15
Finland	1973	(+4.0)	+2.1	+0.9	+1.0	+0.1	+1.3	+0.9	-0.02
	1974	(+4.2)	+2.2	+2.0	+1.2	+0.2	+2.5	+1.4	-0.10
	1975	(+4.8)	+2.6	+1.7	+1.3	+0.2	+1.5	+0.7	-0.08
France	1973	+4.8	+2.5	-0.2	-1.3	+2.0	-0.6	+1.0	+0.06
	1974	+5.2	+3.0	-0.7	-2.2	+2.5	-1.7	+1.7	+0.06
	1975	+5.4	+3.3	-1.0	-3.5	+2.5	-2.3	+1.8	-0.30
Germany	1973	+2.8	+2.0	-1.1	+1.3	+0.2	-2.5	+1.1	+1.47
	1974	+4.8	+3.2	-2.2	+1.2	+0.4	-4.8	+2.1	+2.35
	1975	+5.5	+4.0	-2.7	-0.2	+0.5	-6.4	+2.4	+2.50
Italy	1973	+13.5	+2.0	-0.8	-0.5	+1.4	-1.3	+0.7	+0.29
	1974	+13.7	+3.2	-3.8	-2.8	+3.2	-6.7	+1.7	+2.17
	1975	+9.5	+4.0	-6.3	-5.1	+3.7	-12.0	+2.0	+4.39

Table 12 (cont.)

Japan	1973	+10.9	+2.2	+0.8	+0.4	+1.4	+1.6	+1.4	-0.05
	1974	+11.4	+3.1	+1.8	-0.8	+2.4	+4.1	+2.4	-1.40
	1975	+10.7	+3.9	0.0	-1.3	+2.8	+2.8	+2.6	-1.29
The Netherlands	1973	+2.9	+2.4	-0.5	-1.3	+1.9	+1.6	+1.2	-0.46
	1974	+4.6	+6.9	-3.3	-5.6	+5.8	+1.3	+1.8	-0.70
	1975	+6.3	+8.6	-4.7	-7.5	+6.4	-0.6	+1.9	-0.64
Sweden	1973	(5.0)	3.2	+1.1	+1.0	0.0	+1.7	+0.6	-0.14
	1974	(5.6)	5.3	+1.3	+1.2	0.0	+2.3	+1.3	-0.39
	1975	(5.0)	5.9	+0.7	+0.5	0.0	+1.6	+1.5	-0.48
United Kingdom	1973	+3.8	+2.2	+0.1	-0.2	+2.0	+0.4	+1.3	-0.09
	1974	+3.8	+3.2	0.0	-0.7	+2.8	+0.3	+1.9	-0.03
	1975	+3.8	+3.3	0.0	-2.0	+2.8	-0.9	+2.0	-0.46
United States	1973	+6.9	+2.3	+0.2	-1.2	+2.4	+1.4	+1.0	-1.26
	1974	+7.1	+3.7	-1.3	-1.7	+3.7	+0.6	+1.2	-0.48
	1975	+7.8	+5.0	-2.6	-3.2	+5.0	-0.7	+1.3	-0.61
Developing	1973	—	+0.2	+0.4	+1.3	+0.4	-0.1	+1.2	-0.29
	1974	—	+0.4	+0.5	+1.3	+0.4	-0.4	+2.0	-0.27
	1975	—	+0.4	+0.4	+0.4	+0.2	-0.7	+2.3	-2.02
ROW	1973	—	—	—	+0.1	+0.6	-0.3	+1.3	+0.19
	1974	—	—	—	-0.7	+2.2	-0.7	+1.7	+0.33
	1975	—	—	—	-1.4	+3.1	-1.7	+3.0	+0.09
CMEA	1973	—	—	—	—	—	—	—	-0.04
	1974	—	—	—	—	—	—	—	-0.23
	1975	—	—	—	—	—	—	—	-0.49
World Trade	1973				+0.3	+1.0			
	1974				-1.1	+1.8			
	1975				-1.4	+2.1			

For further specification of shocks and further description of entries, see text.

two aspects of the system: (a) How and to what extent is price inflation stemming from wage pressures in developed countries transmitted in comparison with inflation resulting from increases in prices of non-manufactures supplied by the developing areas? (b) How does the "amplification" phenomenon caused by synchronized impulses behave on the price side in comparison with the same feature discussed previously on the real side?

To cope with the second issue, we require some uniformity (across models) of the shock as measured in prices, and the price we employ is the GNP (or GDP) deflator. Therefore we initially alter the wage-rate equation or equations in each model sufficiently to increase the GNP deflator by approximately 200 basis points.[15] While this is a rather arbitrary magnitude, it is not far from what many countries have been experiencing as a consequence of disturbances in 1973-1974.

The differences produced by these impulses are collected in Table 11, which contains pre-linkage changes, with the component models standing alone, and in Table 12, which contains post-linkage changes, with the entire system solved as a whole.

The wage shocks produce an interesting set of responses in the models even without linkage; however, in this paper we only briefly and broadly discuss the detailed changes. First, it is apparent from Table 11 that a given (percentage) shock to the wage rate will result in varying impacts on the GNP deflator in different models. This finding follows from prices generally being more or less responsive to wage changes (because labor is of different importance relative to capital or materials in production) and with longer or shorter lag structures. Second, a given shock to wage rates clearly has varying effects on real growth. A superficial presupposition would be that real output would drop since an increase in domestic prices relative to the price of internationally traded goods (both import prices and competing export prices) would depress exports and stimulate imports. To be sure, real imports may not increase if the income effect overwhelms the relative price effect, but in any case the net result must be to retard real output. In some models, however, real growth fails to drop: Belgium, France, Japan, the United Kingdom and the United States.[16] The reason is that wages may increase relative to other factor prices, in particular, to capital costs, stimulating substitution effects which, in Japan for example, strongly accelerate fixed investment. Another reason is that wage increases tend to squeeze profits and, because of different marginal propensities to consume from wage compared to capital income, real demands may increase for a short time. In the United States, for example, profits fall in 1974 between the two simulations by almost 15 percent. The longer-run impact on real growth is more uniform. By 1975, real output is below the control path except where exports are exogenous.

[15]No changes were made for Austria, the developing models, ROW, or CMEA.

[16]Also in Australia, Finland, and Sweden, but here real exports are exogenous pre-linkage. Still since real imports increase in these models, the above analysis applies, but the effects noted need not be nearly as powerful.

By comparing Tables 11 and 12 we may again examine the strength of international transmission of prices. Qualitatively, the transmission effects are obviously similar to those resulting from an external shock to prices of primary commodities. Import prices, constant in Table 11, are up by about 1 percent in Table 12 in 1973 increasing to about a 2 percent difference by 1975. That this occurs is hardly surprising, since an identity determines import from export prices, post-linkage. Also, export prices increase more rapidly when international linkage channels are opened; as before the differences are smaller for insulated economies like Germany and the United States (and of course where export prices are exogenous) but substantial for Belgium and the Netherlands, possibly also for Canada, Italy, and Japan.

The changes to GNP deflators in the post-linkage computation as compared to the changes to GNP deflators in the pre-linkage computation may be viewed as a price-side "amplifier" to be compared to the real amplifiers discussed before. By comparing Tables 11 and 12, it may be verified that the shocks to PGNP are only slightly higher with internationally synchronized wage-rate impulses as opposed to results from the models standing alone for most countries. In Japan, for example, the difference between the shocked and control paths of PGNP before linkage is +2.2 percent in 1973, +2.9 percent in 1974, and +3.3 percent in 1975. The same differences with full linkage are +2.2 percent, +3.1 percent, and +3.9 percent. However, a further result is that there is much less uniformity of impacts of synchronized wage shocks than impacts of real expenditure shocks. In the latter case, the amplifier ratio was very nearly 1 1/2 for all economies; whereas here in the case of synchronized inflation Canada, France, and especially the Netherlands show a much larger impact with full linkage as compared to pre-linkage.

The impact of increased primary commodity prices on domestic GNP deflators (Table 9) are uniformly greater than the impact of wage inflation in the rest of the world on domestic GNP deflators (i.e., comparing Table 12 with Table 11). This finding arises not so much from system response multipliers — which remain an open question — but rather from different sizes of multiplicands. In other words, the shock represented by the increase of primary commodity prices by 25 percent can surely be regarded as a more severe shock than that represented by the increased wage demands considered here. However, and this is the point, both of these impulses may be viewed as reasonable possibilities in the context of current economic conditions and so are comparable in that sense.

Each of these two analyses of transmission of price inflation across national boundaries suggest that, while the appropriate channels are clearly open, and pass-through as well as feedback properties are significant, there is no strong evidence of instability or runaway inflation dynamically. The time horizon on which this conclusion is based is only two or three years. Also, if countries adopted fiscal policy to combat these inflationary tendencies, then we would return to the previously considered case of

synchronized real recessionary changes. Moreover, we emphasize again that the LINK system is less complete regarding interdependencies among prices (both domestically and internationally). Even so the results are informative and suggest numerous possible directions of further analysis.

Some Policy Considerations

Many more LINK simulations are being planned to investigate hypothetical policy changes that may lead to a more stable world economy. At present, we have mainly a large collection of simulations that were done for other purposes and are trying to distill some information from them. To a large extent, these simulations are passive; they examine the effect on the world economy of particular input assumptions and are not specifically designed to search for policy solutions to world problems.

Policies for international stabilization may be classified as follows:

1. Exchange rate policies
2. Other trade policies
3. Domestic fiscal policies
4. Domestic monetary policies.

In simulating the series of exchange rate changes that have taken place since December 1971 (Smithsonian rates) LINK estimates have consistently been that the effects would be in the direction of stabilization by increasing the balance of deficit nations and decreasing the balance of surplus nations. We have generally found that the policy changes were too small to wipe out the main imbalances fully. This is because of lagged response, world business cycle conditions, and world energy needs. All LINK models combine income and price effects, probably less satisfactorily for the latter, but world business cycle developments in 1972 clearly worked against the success of the Smithsonian rates and in 1973 worked for the rates established in the second wave of devaluation. U.S. oil imports on a large and increasing scale have been used in LINK simulations for some years, and were cited as a factor working against stability of Smithsonian or 1973 rates. Now this problem is transformed into a new scale of effects of the world energy shortage with high prices. This is a strongly destabilizing result. There are no LINK simulations to show how to deal with this form of instability, short of a longer-run solution to energy problems, enabling industrial countries to have abundant fuel sources at nonescalating prices.

Other external effects such as armament deliveries, and large bilateral trade agreements have been programmed into the various simulations with different exchange rates, and they generally show expected and stabilizing effects in that they have helped to restore balance where large surpluses or deficits existed.

The changed world currency rates in LINK simulations have not, together with other input changes, shown improvement for the U.K. deficit

position. This is a persistent aspect of world instability found in our calculations.

A problem that has not been systematically investigated yet with the LINK system but that could probably be treated in its framework is the search for a set of exchange rates that would define international equilibrium.

As far as other trade policy is concerned, the LINK calculations, as noted above, have taken account of bilateral agreements and the particular ones studied have been favourable for closing trade gaps. The U.S.-Soviet wheat agreement may have had the destabilizing effect of stimulating domestic inflation in the United States, but it contributed significantly towards reduction of the U.S. deficit. Liberalization policy would generally improve price sensitivities of the flows of trade. Low price elasticities have worked against establishment of international equilibrium under changed exchange rates; therefore liberalization of trade ought to lead to more quickly and sharply stabilizing results from exchange revaluations.

Individual LINK models have strong income effects on imports. These have played important roles in estimating effects of currency realignments. If an upvaluing country does not adopt compensatory stimulative policies, the slowing down of activity levels can work against reductions of surpluses. Individual simulations of Japanese and German LINK models showed the need for compensatory fiscal policies to accompany revaluations in order that imports were maintained. On a broader scale fiscal policies should be coordinated with international policies so that the two are not operating in opposite directions.

A more important consideration for policy coordination, however, is that countries should try to avoid strongly synchronized movements in which all are inflating or deflating together. LINK calculations of world amplifier effects suggest that they are not disastrous in particular episodes, but they are nevertheless present. It is in the interests of international stability to stagger timing of policies among countries. This is easier said than done, but it is a way of reducing amplitude in international fluctuations. Developing nations would benefit from a strongly growing volume of world trade. The simulated world slowdowns that we examined with LINK held back world trade growth by large amounts. A stable economic environment in the developed nations would undoubtedly work to the advantage of growth for the developing nations.

Monetary policies, like fiscal policies, have significant impacts on domestic economic performance. In the "Oil Crisis" simulations, there were unusually high interest rates for Japan, the United States, Canada, Italy, Belgium, and especially the United Kingdom (more than 11.0 percent). These were parts of domestic anti-inflationary policies adopted on a world-wide scale and formed a base pattern of slowdown upon which the shortages of fuel were superimposed. Monetary policies, like fiscal policies, if they all come together at the same time tend to accentuate international fluctuations. Many individual LINK models have estimates of

capital movements in response to interest-rate differentials. While these partial estimates all generate capital flows in response to differentials in a way that appears to be stabilizing, the LINK system is not yet able to provide complete world solutions for capital flows in the same way that it has functioned for estimates of trade flows.

Monetary policies have been used domestically to fight inflation, although evidence does not suggest that they have been successful. An interesting issue arises in this connection, whether individual countries should intensify monetary stringency to fight inflation that is brought about by rising oil and other basic commodity prices. If these could be accepted as one-shot price rounds in the developed countries, then they would be well advised to pursue stimulative fiscal and monetary policies together in order to arrest recessionary tendencies that have developed as a result of shortages. But there is little evidence to suggest that these rounds of inflation — grain/beef in 1972-73; oil in 1973-74 — are one-shot affairs. They have spread significantly to other related sectors of the economies concerned and they are reinforced by rising prices in nonferrous metals and other commodities. The LINK evidence is stronger that movements in the real world economy are stable than that world inflation rates are stable. Given a high degree of uncertainty about the mechanism of the world inflationary process, it may be preferable for the countries concerned to ease fiscal burdens to arrest recessionary tendencies but to keep tight monetary policies to try to hold inflation in check.

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Discussion

Anton Barten

The LINK experience is unique in the area of macro-economic model construction. Attempts have been made before to engage a large number of specialists to design parts of a greater model, but the LINK effort is the first to result in an operational global model. The intellectual and organizational talents required for coordination deserve the deepest respect of the profession.

The LINK project links together country or area models of different kinds (and of differing quality). In a number of cases these models were not specifically designed for use in the LINK project. The advantages of using existing models are several. It has saved considerable time for the whole project. Several of the models have been used for some time in the past and their advantages and weaknesses are known. As far as the models are more or less "official" models, one avoids discussions with the "officials" about the validity of results.

There are also some disadvantages associated with the use of dissimilar country or area models. It is very difficult for a relative outsider to form an idea about the mechanism by which external effects are transformed into internal effects to be again exported. Since the eventual magnifying or reducing takes place within the country models, it is difficult to understand the nature of the (de)stabilizing effect of international trade and to suggest policy measures to cope with undesirable consequences.

Before beginning with the comments on the paper itself I would like to underline the significance of the LINK project. It provides an operational instrument to analyze and predict consequences of policy measures. It also enables the operators of the national models to obtain a sharper picture of the international context of their own economy. This could lead to more rational economic policies. Some parts of the model may not be quite adequate. Experimentation reveals such shortcomings, which can then be overcome. Modelbuilding has no natural end, but the fastest death for a model comes from not being used. Let us now turn to the use made of the LINK project in connection with the topic of this conference: International stability.

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In the Johnson-Klein paper two different concepts of (in)stability are used. One of them is well known from dynamics: A system is stable if the effects of an initial disturbance are a non-increasing function of the distance in time from the moment of the disturbance. The other concept is related to the scope of the model. Multipliers change in value when variables, initially taken as exogenous, are made dependent on endogenous variables of the system. If the multipliers of the new system are smaller than those of the original one, the extension of the system is said to have a stabilizing effect. For example, if the introduction of a system of progressive income taxes reduces the value of certain multipliers, progressive income taxes are considered to be stabilizing. It is clear that the two concepts can be combined by comparing time paths of multiplier values. However, since the Johnson-Klein paper deals both with the process of linking national models, i.e., a process of making initially exogenous variables (international trade variables) endogenous and with the analysis of lagged effects of "disturbances," it is good to keep the distinction between the two concepts of stability in mind.

The evaluation by Johnson and Klein of the LINK experience discusses two different issues, as already mentioned: a) the effect of integrating a set of national models into a global one and b) the effects of changes in the "conditions" of international trade, like changes in exchange rates, restrictions on the supply of oil, changes in raw material prices and changes in domestic wage rates. In the paper the discussion of the two issues is somewhat interwoven. This is perhaps due to the procedures used in the LINK project, where one starts with a set of unlinked control solutions for the national models and then searches for a solution of the integrated system. In theory, of course, one could have proceeded directly to the solution of the integrated system.

As far as the "*linking*" itself is concerned, the authors present a theoretical argument and illustrate it empirically. The theory is straightforward. The authors are well aware of modifications due to capacity constraints and price effects. I would like to make two comments on the theoretical argumentation. First, the question may be asked how the multipliers are affected by an increase in exports and imports, relative to real output of a country. If they increase with international trade, more of the latter adds to possibly destabilizing effects. Some algebra can be used to verify that under the condition of maintaining equilibrium on the trade balance $\partial Y_1/\partial G_1$ decreases and $\partial Y_1/\partial G_2$ increases as the exchange of commodities goes up. In other words, one becomes more sensitive to what happens elsewhere and the effectiveness of domestic policy measures decreases. To benefit from an increased international division of labor, one has to pay the price of reduced control, hence increased instability. Somewhere, there exists an optimal relative size of international trade.

A second comment concerns the comparison of large versus small economies. Among the 10 major traders in the world there are three small ones, both small in population and in the ratio of output to exports,

namely Canada, the Netherlands, and Belgium. Such small economies have a strong initial response to an increase in exports, but rather soon reach capacity limits and then the expansion becomes more one of prices than of volume, which eventually might even decrease again. For the larger countries the initial effect is weak but can be sustained for a long time before running into capacity problems, and hence price increases. It would be of interest to verify this by way of an experiment with LINK.

Turning now to the empirical evidence on the effect of linking as presented by the authors, it seems to me that comparing the pre-link solutions with the post-link solutions does not reveal much about the increase in feedback because of the linking process. It does show the ability of the country operators to assess world trade developments. Assume that these operators would have done their job perfectly, then the linking would not have resulted in modifications. In fact, participation in the LINK project might educate the country operators to improve their appraisals of world trade as relevant for their country so that the actual linkage will be less and less important for unconditional predictions. The results of Table 7 are much more adequate to illustrate the consequences of linkage. In my opinion these results contradict the authors' statement of "the world economy as being quite stable in terms of its transmission effect." Also a comparison of Tables 11 and 12 reveals that for countries like Canada and the Netherlands a substantial lagged increase in wage rates results from linking. These economies are both relatively open economies. If other countries tend to become more internationally oriented, could one not expect a more universal explosive effect?

Part of the experiments with the integrated model concerns *exchange rate* adjustments. Before commenting on the presented results it may be conjectured that changes in the exchange rates are not very effective in correcting trade balance problems in the long run. First, a considerable part of, say, a revaluation is absorbed by a decrease in the export price in domestic currency, while importers do not hand on the full decrease of the prices of imported goods to their customers. The reduced profits of the exporters are compensated by the increased profits of the importers. Hence the income effect of a revaluation is small. The absorption is caused by competitive price-setting behavior. What is left of an increase in the export price in dollar terms causes import prices of the trading partners to go up, causing domestic inflation, while a direct competitive effect will increase their export prices in dollar terms. Relative export prices have not changed very much and the net reduction in the surplus on the trade balance will be minor. Domestic price inflation in the revaluing country is reduced somewhat but the continued pressure of external demand prevents it from being spectacular. This script is, for example, more or less confirmed by experiments with the COMET model, the model for the European Economic Community.

It would be of interest to analyze the long-run responses to exchange rate modifications by means of the LINK project, since this project takes

into account the additional effect of changes in total world trade. Unfortunately, Tables 5 and 6 of the paper do not represent the pure effect of exchange-rate changes but give simply the expected time path. Only short-run effects can be extracted from the paper. From Table 3 it appears that the German mark was revalued on average by about 16 percent with respect to the U.S. dollar in the course of 1973. Other major traders had a smaller revaluation. The results for 1973 only are summarized in the table below for Germany and the United States.

Effects of 1973 Exchange Rate Changes

	Germany	U.S.	Source
Real Exports	-11%	+5%	Table 1
GDP	- 1%	+6%	Table 1
Import Prices	- 7%	+5%	Table 1
Price Index	- 2%	+1%	Table 3
Trade balance	-0.89×10^9\$	$+1.66 \times 10^9$\$	Table 4

The effect of the German trade balance is very small, if at all significant. According to Table 6 this balance is \$12.17 billion. The actual figure is close to \$15 billion. Also according to Table 6 further effective revaluations of the D mark do not result in drastically lower surpluses. The stronger effect for the United States is small compared to its volume of international trade but, of course, large compared to its small balance in absolute value. It is puzzling that a decline of 11 percent in exports produces less than a 1 percent decrease in German GDP while exports represent about 30 percent of GDP or roughly 20 percent of total final demand. It would indicate a rather low instantaneous export multiplier. Import prices have declined by less than the exchange rate because exporting countries in part also revalued and in part increased prices in their own currency. The decrease in the German domestic price index seems to be too strong to be realistic. The results for the United States appear in general acceptable.

It seems difficult to believe that following through the consequences over a longer period than one year will indicate a greater sensitivity to exchange rate changes. On the contrary, one might expect a smaller lasting effect. Apparently, exchange rate modifications are not very effective in restoring balances except when they are applied in isolation, which could only be the case for small traders.

To comment more adequately on the presented results one would have liked additional information, like export prices. However, one cannot blame the authors for being miserly in producing arrays of results! In

presenting results of simulation there is always a problem of what to select among the flood of numbers flowing from the computer.

The part of the paper dealing with the "oil crisis" is reassuring. The authors do not predict a major recession, they only suggest smaller real growth rates. In their discussion, they point towards the "international stability inherent in the LINK system." Does it mean that the LINK system is more stable than reality, or that reality, as well as possible described by LINK, is more stable than some pessimists have assumed, or that an internationally open system is hardly less stable than a world economy consisting of more or less autarchic national economies? Only the last meaning has significance, but is difficult to accept.

The last two major experiments are related to the problem of worldwide inflation. Rather than trying out the effects of an impulse originating in a single country, the authors have selected as impulses an increase in the prices of raw materials and a synchronized wage increase in the industrialized countries. Are these types of impulses really the most probable causes of world inflation?

As appears from Table 9 an average of a 26 percent increase in the prices of raw materials has a noticeable effect on import and export prices, but usually a weak effect on the consumption price, which is the most relevant indicator of inflation. The number of NAs reveals that some models are not really adequate in describing the relation between international and domestic prices. To study problems of inflation these defects should be remedied. Still, for some countries one might expect a type of independent development of international and domestic prices. In the 15 years before 1969 import and export prices moved up and down in a rather narrow interval, while domestic prices moved up almost monotonously. The reverse could then also be true. Consider as an example of an extreme nature the Curacao economy. The main economic activity of this tiny island off the coast of Venezuela consists in refining crude oil. An increase in the price of crude oil will have its effect on the prices of refinery products, hence increases in Curacao import and export prices, but why should domestic prices be affected? Only in the longer run, when prices of consumable imports go up, the Curacao consumption prices will start moving. Not all economies are like the Curacao one, but many of the smaller open ones resemble it to a certain degree. Anyway, the experiments of Johnson and Klein appear to confirm the impression that an increase in the prices of several products cannot be a major factor of the present rate of inflation.

Turning now to the other candidate: Synchronized wage increases. It is unfortunate that the effects on consumption prices are not reported. Again it appears that in the LINK project the direct relation between domestic prices and export prices is weak. Only after linkage, i.e., by introducing indirect effects, does the effect on international prices become noticeable.[1] Still the amplifying effect of linkage as far as wage increases

[1] Are the results for Italy to be believed? The solution for its balance-of-payments problem would be a substantial wage increase!

are concerned is negligible if at all positive. Apparently, synchronized wage increases can explain synchronized inflation, but the synchronization would be accidental and not essential.

In this connection it may be useful to quote a result from an as yet unpublished paper by one of my Louvain colleagues, Guy Carrin. He applied spectral analysis to quarterly data on price and wage increases for eight E.E.C. countries. It turned out that in the short run there is hardly any coherence, which becomes only significant for small frequencies, corresponding with a period of four years and more. This result points towards a rather slow process of mutual adjustment.

These experiments first of all show that the LINK project is operational. This is in itself an important achievement for which the participants, and more in particular the coordinators, deserve warm congratulations. The experiments also show rather moderate transfers of domestic shocks to other economies, certainly when these shocks are applied to prices. They do not point to an obvious cure for the present problem of inflation.

Today's world economy is characterized by strongly increasing international trade, wildly fluctuating exchange rates, and widespread inflation. The situation cannot be called steady or stable. Exchange-rate changes can have reduced the amplitude somewhat, but have not basically solved our problems. National governments, many of them already politically weak, feel powerless because the source of the problems lies allegedly "abroad," outside their control. International agreements turn out to be very unstable if it comes to cutbacks. Are we going to repeat the experience of the thirties, when a temporary closing-off allowed national governments to put the house in order? There are some indications for this tendency. Even if such a return to introversion would be at all possible, it might entail a high price in terms of welfare losses and increased nationalism.

Discussion

Alan Peacock

A conference run by the International Seminar on Public Sector Economics presumably allows one to enquire about the role played by the public sector in international linkage models. The example given by Mr. Hickman of a simulation exercise, it is true, involves the public sector at the outset. All linked economies are in equilibrium and then an exogenous change is made in government expenditure on goods and services in several economies and the effects of this change are traced through the linkage system. The subsequent role of the public sector seems to me to be obscure so, in the absence of presentation of the particular model used in each linked economy, let me speculate on the way in which assumptions about the public sector's role may affect the outcome of the exercise.

Let me begin by assuming that once exogenously determined G is changed, there are no changes either in constant terms or in parameters in whatever sets of public budget equations are used. Subsequent effects of the public sector on the economy will then crucially depend on the type of model used. A simple Keynesian type model for an open economy will illustrate the way in which "fiscal drag" will reduce the multiplier effect of the change in G, depending on the progressivity of the tax and transfer system. The linkage effect will be shown in the influence of the change in tax yields (after allowing for negative tax changes) on the level of expenditure and therefore on the demand for imports. However, if we expand the model to include price and wage equations, we are bound to examine the effect of changes in prices and wages on the supply of exports and demand for imports. Expenditure changes which raise prices and wages will induce substitution effects depending on the relation between domestic and overseas price levels. Furthermore, prices may depend not only on expenditure but also cost changes, and particularly wage changes. If, as in some recent attempts to improve the explanatory power of macro-models, unions are assumed to base their wage claims on disposable income, then even with no change in the tax parameters, growing fiscal drag may promote "wage retaliation" in response to the fall in the

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growth rate of disposable income, with consequential effects on prices, employment, and, given our interest in linkage effects, on the supply price of exports and the demand for imports.

However, let us stick to a linked system of the kind illustrated by Messrs. Johnson and Klein, which is a set of simple Keynesian-type models with recursive properties, which can be readily extended to embody price equations. How do we decide whether or not to assume that policy variables should be treated as endogenous or exogenous? There seem to me to be three approaches one can adopt:

(a) *Analytical Convenience*

This is the only approach which can be identified in the papers presented to us. Thus the treatment of the monetary sector is a function of the development of the national models, with money supply and interest rates variables endogenous in some countries and exogenous in others. On the other hand, the exchange rate is treated as exogenous. How budgetary variables are treated is not explained, but it clearly makes a difference to the results of simulation if, for example, government expenditure is made a function of tax yields. It has been reported that this treatment of G as an endogenous variable is what is assumed in the case of W. Germany, and this may explain why that country appears to originate disturbances which are "strong and diffuse" (Hickman). While it is good to know that a LINK system can incorporate quite complex relationships, analytical convenience clearly hampers the extent to which our knowledge of international transmission of fluctuations is enhanced by model-building pyrotechnics.

(b) *No Exogenous Changes*

Such an approach implies the answer to the question: what happens in LINK if there is some exogenous change, as illustrated in the Hickman analysis, and the government takes no corrective action? The answer is a conditional prediction which may be of interest to policy-makers for it indicates how dependent variables of policy interest (e.g., employment) will move as a result of the initial change. The identification of the (unchanged) exogenous variables which are within the control of the public sector or, rather, which the public sector specifically can and wishes to control, clearly depends on special knowledge of the institutions in each member of the LINK and there is no reason to suppose that a list of such variables will be uniform for each member.

(c) *Unchanged Public Sector Policies*

This approach is a much more ambitious one and would entail the introduction of changes in public sector policy parameters in order to influence one or more target variables. In the kind of exercise described by Mr. Hickman, it would be interesting to study the effects of some given corrective action by the public sector in those LINK countries faced with

balance-of-payments deficits without taking on the enormous task of predicting how policy-makers would actually behave if committed to avoiding such deficits. I can imagine that LINK pundits will groan at this suggestion but the development of LINK projects in a form which will arouse the interest and support of policy-makers clearly calls for an approach along these lines.

Reply to Mr. Peacock's Discussion

Hickman, Johnson, and Klein

The purpose of Mr. Peacock's comment is to query the role of the public sector in simulations of the LINK system. He stresses that the multiplier responses to an exogenous shock will depend on the assumptions made about endogenous or exogenous policy actions in the various national models. This is, of course, entirely correct, and explains why we took pains in our papers to note some crucial features of the fiscal and monetary sectors of the various national models insofar as they affect the multiplier results.

The questions raised by Mr. Peacock concerning public policies are relevant, interesting, and important. They were not, however, within the purview of the topics we were asked to analyze for the conference. The contribution by Hickman is concerned with the international transmission mechanism. Such induced domestic policy responses as are built into the national models form part of that mechanism, but discretionary policies do not. It is true that government expenditure was chosen as the variable to be shocked in the simulations, but this was done for the sake of uniformity — government spending is exogenous in most of the models — rather than as a realistic exercise in policy analysis.

The Johnson-Klein simulations deal with *hypothetical* change to a system that is finely tuned to estimate the current realistic state of the world economy. The hypothetical disturbances in wages, raw material prices, or autonomous expenditures are designed to throw light on stability properties and the transmission mechanism; they are not designed to show the consequences of the kinds of public sector policies that interest Peacock. The LINK system and numerical methods of analysis that we have designed are general enough so that policy analysis suggested by Peacock could, in principle, be undertaken.

It is worth mentioning also that the linked economies are not in equilibrium and are not assumed to be. The LINK system is solved and simulated as realistically as possible. That means comparing disturbed solutions with a realistic baseline case for 1973-75. These years are anything but equilibrium situations for the world economy in any of the cases we consider. The models have a solution but with imbalances that are serious departures from equilibrium.

Space limitations prevented more than a brief description of the structures of the national models entering the linked simulations presented in our papers. More details are available in the volume edited by Ball and cited by Hickman, and the complete models will soon be published in a volume edited by Waelbroeck. Generally speaking, however, the various models contain all of the features discussed in Mr. Peacock's second paragraph, including wage and price equations. The actual LINK system is not limited to the simple Keynesian models. These simple models were used by Johnson and Klein purely to illustrate some theoretical issues in an expository way. Their simulations, and those by Hickman, are based on the larger national models actually embodied in the LINK system, and used regularly in individual countries for forecasting with extensive policy analysis.

We are in complete agreement with the suggestion made by Mr. Peacock that it would be interesting to study the effects of unchanged public sector policies in pursuit of one or more target variables, and such studies are high on the LINK research agenda. It will be most welcome if these studies arouse the interest and support of policy-makers in our approach to world modelling through a linked system of national models incorporating important policy instruments and targets. It should be stressed that there is nothing inherent in the structure of the LINK system to prevent our carrying out the kinds of calculations needed to take up Peacock's lines of research; it is only a matter of time involved in our getting round to the precise set of calculations implied.