What Have We Learned from Linked Econometric Models? A Comparison of Fiscal-policy Simulations*

As part of a larger study of international economic interdependence — see Deardorff and Stern (1977) — we had occasion to examine a number of simulations based upon various econometric models that link two or more submodels of individual countries. While we were initially impressed with these simulation efforts, it was evident that the models had by no means reached a consensus in their attempts to quantify economic interdependence. In the end, we were able to do little more than provide a tabulation of their results without drawing any firm conclusions. Rather than let the matter rest, we decided to take a further look at some of these simulation results, with the objective of evaluating the contribution that they have made to our understanding of the international economy. Specifically, in this paper, we compare the linked simulation results with a set of very simple calculations that we have made of the international transmission effects of fiscal policy.

The subject of fiscal-policy transmission provides an ideal focus for our purpose. First, every one of the linked models has been used to study it, and on fairly comparable terms. To the extent that they all ask the same questions, we can compare their answers.[1] Indeed

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[1] Unfortunately, however, we cannot be sure that the assumptions made in all of the simulations were identical, and, as we point out below, at least one of the simulations used a different exogenous shock than the others. It would have been preferable, for the comparisons we make here, if the model builders themselves could have agreed beforehand on exactly what their simulations were intended to represent. One would want, for example, for all simulations to initiate the spending

this seems to be the only issue that all of the model builders have addressed in common. Second, the basic theoretical mechanism of fiscal-policy transmission is well understood, at least under fixed exchange rates.[2] Thus, one can feel confident that the econometric model builders share a common starting point for their efforts.

Our own analysis proceeds as follows. In Section I, we provide a brief explanation of the familiar mechanism of fiscal-policy transmission. The mechanism will be interpreted so as to motivate a simple calculation of the transmission effect that will be used as a basis for comparing results of the more complicated econometric models. In Section II, each of the linked models is introduced and the simulations based upon them are described. In Section III, the linked-simulation results are reproduced, alongside our own simpler calculations, and the two are compared. In Section IV, we look briefly at some of the price effects generated by the simulations. And, in Section V, we conclude with an attempt to evaluate, in more general terms, the progress that has been made in the effort to model the international macroeconomy.

Before proceeding, we should point out a limitation of our analysis. To anticipate our findings, we conclude that the linked econometric models, *as a group*, do not add appreciably to our knowledge about fiscal-policy transmission beyond what is suggested by our calculations using a simple and relatively naive model. This does *not* mean that any *one* of the larger models might not in fact be much more accurate than the naive model. It may be that the builders of one of the models could argue convincingly that their model is superior in comparison to others. Our analysis does not provide the basis for such an argument. All we can suggest is that some choice among the models may have to be made, since collectively their contribution has been somewhat limited to date.

We should also acknowledge that our comparison of fiscal-policy multipliers leaves open the question of whether the linked models can provide useful information on other issues. One could argue that

increase on the same date, since nonlinearities in the models make results depend on the initial position. Such coordinated simulations have been done with domestic econometric models in the U.S., Canada, and the U.K. We were unfortunately not in a position to attain such coordination among the linked-model simulations that are the object of our present inquiry.

[2] All of the simulations to be considered do assume fixed exchange rates.

the usefulness of an econometric model lies in its ability to deal with issues that cannot be addressed with simpler models. However, it is beyond the scope of our paper to evaluate the models from this perspective.

I. The Mechanism of Fiscal-Policy Transmission

Our purpose in this section is to provide a simple means of calculating the effects of fiscal policy on incomes. This will be used solely as a benchmark for comparing the results of the more elaborate simulations, and, because of this, we derive our calculation from the simplest of models. We do not try to capture any of the complications that might arise from dynamic considerations or from simultaneous interaction of several markets. Rather, we focus exclusively on the two most fundamental implications of international trade for the Keynesian theory of income determination, as developed in the classic works by Metzler (1942) and Machlup (1943).

The first implication was that the multiplier, relating income to autonomous expenditure, would be smaller in an open economy than in a closed economy due to the leakage of expenditure in the form of imports. The second implication was that an increase in expenditure in one country would stimulate income abroad as well as at home, as increased imports would constitute an increase in demand for the products of the expanding country's trading partners and would thus initiate a multiplier expansion of their incomes as well.

All of this has become such a standard part of received macroeconomic doctrine that there is little need to elaborate it further here. However, it is useful to lay out the simple model that yields these results so as to specify our notation and the exact form of our later calculations. Let Y_i, C_i, X_i, and M_i be, respectively, income, consumption, exports, and imports of country i, and let A_i° represent all autonomous components of expenditure in country i, including the level of government spending.

Then equilibrium in country i requires that

$$[1] \qquad Y_i = C_i(Y_i) + A_i^\circ + X_i - M_i(Y_i)$$

where we have specified both consumption and imports as functions

of income. Taking exports as exogenous and differentiating, this leads immediately to the following "own-country multiplier" for fiscal policy

$$[2] \qquad Z_i \equiv \frac{dY_i}{dA_i^\circ} = \frac{1}{1-c_i+m_i}$$

where c_i and m_i are, respectively, the marginal propensities to consume and import of country i.

The transmission effects of fiscal policy can also be found once we note that one country's imports are another's exports, and that exports play exactly the same role in equation [1] as autonomous expenditure. Thus the "cross-country multiplier" relating the change in income in any other country j to autonomous expenditure in country i will be

$$[3] \qquad Z_{ij} \equiv \frac{dY_j}{dA_i^\circ} = \frac{dY_j}{dX_j}\,\frac{dX_j}{dY_i}\,\frac{dY_i}{dA_i^\circ} = Z_j\, m_{ij}\, Z_i$$

There, in writing m_{ij}, we are breaking down country i's marginal propensity to import into separate propensities to import from each other country j. Thus, to get the effect of fiscal policy in country i on income in country j, we first use country i's own multiplier to obtain the effect on its own income, then multiply by its propensity to import from country j to get the change in j's exports, and finally multiply this by country j's own multiplier to get the change in its income.

While all of this is intuitively quite plausible, what we have done is actually very naive since we have ignored several considerations that should be taken into account in any respectable macroeconomic model. First, we have been internally inconsistent in deriving equation [2] with exports as exogenous, even though they must rise when the change in foreign income indicated by equation [3] occurs. In other words we have missed the essence of "foreign repercussions", which are as familiar in basic textbooks as the foreign-trade multiplier itself.

Even more seriously, we have omitted from the model all variables, other than income, which could affect behavior and could also respond themselves to changes in income, expenditure, or international payments in ways that would alter the multipliers derived above. Interest rates, for example, have been ignored even though

they should affect investment and themselves change with income through the money market. Prices, both absolute levels and relative prices among countries, have also been ignored in spite of their importance for net trade and their tendency to respond on the supply side of the economy. And finally, capital flows and exchange rates are absent from the model, in spite of recent developments both in the theoretical literature and in the real world that indicate their importance.

But our purpose was not to construct a theoretically sophisticated model of the transmission process. Rather, we wished merely to capture the most elementary features of that process in order to construct a measure of fiscal-policy transmission that could be easily calculated. In this respect, the expressions in equations [2] and [3] serve admirably.

In order to calculate the multipliers, only one additional assumption is needed, which is that all marginal propensities may be approximated by their corresponding average propensities. With that assumption, the results become

$$[2'] \qquad Z_i' = \frac{Y_i}{Y_i-C_i+M_i}$$

and

$$[3'] \qquad Z_{ij} = Z_i\,\frac{M_{ij}}{Y_i}\,Z_i$$

where M_{ij} are the total imports of country i from country j.

One final modification is necessary before we proceed. It has become customary in analyzing international transmission via simulation to report results in percentage rather than absolute form. What has come to be called an "elasticity multiplier" relates the percentage change of income in one country to the change in expenditure *as a percent of income* in another. Thus we will compute

$$[4] \qquad E_{ij} = \frac{dY_j/Y_j}{dA_i^\circ/Y_i} = \frac{Y_i}{Y_j}\,Z_{ij}$$

While to call this an elasticity is to use the term rather loosely, this formulation is much easier to interpret as it normalizes for country size.

The naive model just presented is a static model. It predicts

changes in variables, such as income, without saying anything about how long it will take for those changes to occur. Implicitly, the changes require that enough time elapse for income to adjust to goods-market equilibrium, but that not enough time elapse for changes in prices, wages, and various stocks (capital, wealth, etc.) to be significant. Since it is unlikely that these two requirements can be satisfied at the same time, this underscores the naivete of the model. One would hope that the simulation results can shed more light on the timing of the effect of expenditure shocks on income.

Readers of earlier versions of this paper have noted this timelessness of the static model, as well as many other of its limitations, and have suggested that we complicate the calculations in a variety of ways to make them more realistic.[3] We have not done so because, as will be seen shortly, the naive model already yields results that are representative of the econometric simulations. In this context, it is the very naivete of our model that serves as the basis of comparison with the simulations. Thus, if the simulations do not provide answers that are systematically different from those given by the naive model, in spite of all of its obvious flaws, then the contribution of the simulations to our understanding will not be altogether clear.

II. Linked Econometric Simulations

Calculations of both own- and cross-country elasticity multipliers based on the results of fiscal-policy simulations have been reported in the literature for several linked econometric models. These models differ considerably in terms of the countries that they include, so that comparison of results for all possible country combinations is impossible. But there is nonetheless enough overlap among the models for some meaningful comparisons to be made. The models differ also in a number of other ways that we will now note briefly.[4]

[3] The following are some of the suggestions we received: [1] marginal propensities to import and consume should be estimated by simple regressions, rather than assuming them equal to the corresponding average propensities; [2] the multipliers should be derived from a full n-country model taking all foreign repercussions into account; [3] dynamic multipliers should be derived that account for the effects of income on spending in successive periods; [4] investment should be considered as depending on changes in income, thus building an accelerator mechanism into the model; and [5] a price equation should be added to the model. All of these suggestions, if followed conscientiously, would lead to a model just about as complicated as the linked model with which it is to be compared. It is not clear what that comparison would then tell us.

Project LINK

The system developed by Project LINK covers the entire world by combining separate national models for many countries and regional models for groups of countries. Since most of these models existed prior to their incorporation in LINK, there are differences among them arising from varying definitions of autonomous expenditures and from problems in modeling monetary feedbacks. As a result, elasticity multipliers calculated from LINK simulations are not entirely comparable. Still, the LINK system provides a more comprehensive set of such multipliers than would be possible with a more limited model. And the differences among its component models presumably also reflect a most intensive modeling effort in at least the major countries that are included. Simulations of "income shocks" — which appear to be analogous to the changes in autonomous expenditure discussed here — have been done with the LINK system and are reported in Hickman (1974) and in Hickman and Schleicher (1978).

The Mini-METEOR Model

The Mini-METEOR model, like Project LINK, covers the whole world. But it includes a smaller number of submodels as a result of aggregating countries into regions to a greater extent than is done in the LINK system. In addition, it has the important feature that its component models share a common structure. It has been used to simulate the effects of autonomous expenditure changes, and results are reported in elasticity-multiplier form by the Centraal Planbureau (1975).

[4] More complete description of the models can be found in Deardorff and Stern (1977), as well, of course, as in the individual original sources.

DESMOS

The DESMOS model encompasses only the countries of the European Community. Like the mini-METEOR model, it imposes a uniform structure on each country. However, the differences in country coverage may be a source of disagreement between the two models. Elasticity multipliers have again been calculated from DESMOS simulations for five of the major EC countries that were also covered in the LINK and mini-METEOR simulations already mentioned. They are reported by Waelbroeck and Dramais (1974).

COMET

The COMET model also covers only the European Community. While simulations of fiscal-policy transmission are not available in published form, one simulation reported in Barten et al. (1976) seems to be relevant. This involved an exogenous increase by 10 per cent in German investment in fixed assets from 1973 onward. Since, in the short run, investment plays the same theoretical role as any other component of demand, we include the results for the first year of the simulation with the other results to be presented here. Longer-run results are also available but are not presented here since the effects of investment on capital accumulation must surely distinguish it from fiscal policy after more than a year or so.[5] Elasticity multipliers were not reported for the COMET simulation. We therefore used the 1973 values of German gross domestic product and gross fixed capital formation to convert the reported results to elasticity-multiplier form.

The Linked RDX2 and MPS Models

The final linked model we consider combines the well-known RDX2 and MPS models of Canada and the U.S. While the country coverage is limited and does not overlap at all with several of the models discussed earlier, this model is nonetheless noteworthy for its relatively advanced treatment of monetary influences, capital flows,

[5] Even in the short run, investment is not exactly comparable to fiscal policy, inasmuch as the two categories of expenditure have different import components.

and exchange rates. Helliwell (1974) has reported the results of fiscal-policy simulations in both countries under a variety of assumptions. Of these, the most appropriate for our comparison with the results of other models seem to be the simulations under fixed exchange rates with "migration and capital flows suppressed". These are the assumptions made implicitly in the more primitive structures of the other models.[6]

III. Comparison of Results

In Table 1, we present elasticity multipliers for the effect of fiscal policy on income in and between each of eight countries. All of the entries in each cell of the table represent the effect of a fiscal expansion by the country listed on the left on income of the country listed at the top.

The first entry in each cell, enclosed in parentheses to distinguish it from the others, is our own calculation from the naive model of equations [2'], [3'], and [4'].[7] These are then followed, in separate columns within each cell, by the elasticity multipliers obtained from the various linked econometric simulations mentioned earlier. We report these results, where available, for the first, second, third, and fifth years of the simulations.[8] The names of the models are represented by initials at the top of the table.

The greatest overlap among the models occurred for the five EC countries appearing in the upper left portion of the table. The reader may therefore wish to direct the most attention to this part of the table, at least initially. Here most of the country pairs are repre-

[6] Helliwell's simulations also differ from the others in assuming a fiscal *contraction* rather than expansion. This may make a difference in view of the nonlinearity of the models.

[7] Own-country multipliers were calculated first from [2'] using 1973 data on gross domestic product [Y_i], private final consumption expenditure [C_i], and imports of goods and services [M_i] as reported in current local currency in United Nations (1974). Bilateral imports, M_{ij}, were calculated by first finding the fraction of each country's imports coming from each other country, based on 1973 data contained in OECD (1975). This fraction was then multiplied by total imports, M_i, found earlier, and the result used to calculate Z_{ij} from equation [3']. Finally, the local currency data on GDP were converted to U.S. dollars using 1973 period-average exchange rates taken from IMF (1977) and the results used for the elasticity calculation in equation [4].

[8] The fourth year of the simulation is reported in square brackets in the place of the fifth year for the RDX2-MPS simulations.

INTERNATIONAL ELASTICITY MULTIPLIERS I
(in parenthesis), LINK (L), MINI-METEOR (
(Percentage income change of country in row induc

COME. A COMPARISON OF NAIVE MODEL
SMOS (D), COMET (C), AND RDX2-MPS (R)
r unit percentage income change of country in column).

TABLE 1

Country	Year	Belgium			France			Germany			
		L	M	D	L	M	D	L	M	D	C
Belgium			(1.171)			(.237)			(.268)		
	1	1.10	1.01	1.41	.08	.28	.13	.18	.38	.16	.32
	2	.98	.95		.07	.31		.35	.43		
	3	.86		1.39	.08		.15	.66		.28	
	5		.85			.67			.85		
France			(.032)			(1.722)			(.096)		
	1	.01	.05	.01	1.21	1.78	1.46	.08	.16	.08	.16
	2	.01	.06		1.19	1.16		.16	.29		
	3	.01		.03	1.22		1.61	.21		.14	
	5		.13			2.76			.75		
Germany			(.026)			(.077)			(1.494)		
	1	.01	.05	.03	.04	.14	.07	.98	1.75	1.25	1.29
	2	.01	.06		.05	.23		1.38	1.06		
	3	.02		.03	.06		.09	1.20		1.56	
	5		.13			.59			2.48		
Italy			(.011)			(.088)			(.127)		
	1	.01	.02	.01	.07	.11	.05	.19	.17	.08	.24
	2	.02	.04		.08	.18		.42	.27		
	3	.02		.02	.11		.08	.81		.16	
	5		.08			.45			.62		
U.K.			(.015)			(.034)			(.034)		
	1	.01	.02	.01	.04	.07	.03	.10	.09	.04	.08
	2	.02	.04		.05	.15		.25	.20		
	3	.02		.01	.04		.04	.53		.08	
	5		.09			.42			.54		
Japan			(.001)			(.005)			(.011)		
	1	.00	.01		.01	.03		.04	.04		
	2	.01	.02		.01	.06		.09	.09		
	3	.01			.00			.18			
	5		.05			.23			.31		
Canada			(.003)			(.009)			(.015)		
	1	.00	.01		.02	.03		.05	.04		
	2	.01	.03		.01	.08		.10	.13		
	3	.00			.00			.35			
	5		.08			.35			.48		
U.S.			(.002)			(.011)			(.015)		
	1	.00	.01		.01	.04		.04	.05		
	2	.01	.03		.02	.09		.11	.13		
	3	.01			.01			.26			
	5		.11			.49			.66		

Italy		U.K.			Japan	Canada		U.S.		
L	D	L	M	D	L	L	R	L	M	R
(.057)			(.053)		(.009)	(.005)			(.098)	
.03	.05	.03	.10	.04	.01	.02		.05	.23	
.04		.05	.17		.02	.02		.09	.46	
.05	.10	.05		.07	.02	.02		.15		
			.34						1.66	
(.057)			(.031)		(.007)	(.004)			(.034)	
.02	.04	.01	.06	.02	.00	.01		.02	.12	
.03		.02	.12		.01	.01		.04	.30	
.04	.08	.02		.03	.01	.01		.06		
			.36						1.49	
(.047)			(.027)		(.009)	(.005)			(.067)	
.02	.05	.02	.07	.02	.01	.02		.04	.19	
.03		.03	.15		.01	.03		.08	.43	
.05	.09	.04		.04	.02	.03		.14		
			.38						1.81	
(1.699)			(.029)		(.007)	(.005)			(.072)	
1.30	1.69	.03	.05	.02	.01	.03		.08	.15	
1.51		.06	.11		.02	.05		.17	.34	
1.80	2.37	.08		.04	.03	.06		.31		
			.28						1.38	
(.017)			(1.574)		(.013)	(.017)			(.098)	
.03	.03	1.24	1.55	1.19	.02	.05		.08	.19	
.06		1.69	1.23		.04	.09		.21	.45	
.08	.05	1.51		1.29	.06	.08		.35		
			2.33						1.83	
(.003)			(.008)		(1.689)	(.008)			(.118)	
.01		.01	.03		1.18	.02		.13	.22	
.02		.03	.07		1.50	.05		.27	.45	
.03		.03			1.50	.04		.40		
			.22						1.79	
(.009)			(.042)		(.046)	(1.498)			(.646)	
.02		.03	.08		.02	1.15		.31	.65	
.02		.06	.16		.04	1.15	.94	.56	1.29	.08
.03		.05			.04	.79		.86		
			.44				[−.03]		4.19	[.04]
(.008)			(.013)		(.029)	(.052)			(2.236)	
.01		.01	.04		.02	.08		1.18	2.42	
.03		.04	.11		.04	.12	.04	1.87	2.86	2.02
.05		.05			.06	.13		2.58		
			.49				[.02]		8.33	[.94]

Sources: Adapted from HICKMAN (1974, pp. 211-13), CENTRAAL PLANBUREAU (1975, p. 33), WAELBROECK and DRAMAIS (19
p. 315), BARTEN *et al.* (1976, p. 104), and HELLIWELL (1974, pp. 273-4).

sented in three, and sometimes four, separate simulations, so that there is a good deal of evidence to be compared. We have also included the less abundant results for Japan, Canada, and the U.S. due to the importance of these countries.

Finally, one should notice the substantial difference between the diagonal and off-diagonal cells of the table. The diagonal cells contain own-country multipliers and are therefore substantially larger than the cross-country elasticity multipliers in the off-diagonal cells.

Having reported all of these results, we must consider how to interpret them. In the absence of formal statistical criteria for assessing the information content of such an array of estimates, we had to confine ourselves to a more casual inspection of the table itself. We first sought to determine whether the simulations gave us a distinctly different set of answers than our naive calculation. Here, at least for the impact effects reported as the first year of each simulation, the answer is negative. To see why, we have tabulated in Table 2 the number of cases in which the naive estimate lies outside of the range of the simulation estimates, higher or lower, and the number of cases, where instead, the naive estimate lies between the extremes of the simulation estimates. This is done separately for each period of simulation. In addition, we distinguish the results involving only EC members from those involving at least one non-EC member, and we tabulate own and cross-country multipliers separately.[9]

It is evident from the upper part of Table 2 that, for all categories compared in the first year of simulation, well over half of the cases included simulation estimates that spanned the naive estimate. This tendency is strongest for the cross-country multipliers within the EC, where 16 of a possible 20 naive estimates fall in between the simulation extremes while the remaining 4 are split evenly between lowest and highest. For comparisons involving non-EC countries, the naive estimate falls between the simulation extremes in a majority of cases, though now all of the remaining cases lie on the low side of the comparison. It is not clear to us why the EC and non-EC results should differ, except perhaps for a slight ten-

[9] We should note that these results are not perfectly accurate, due to the rounding of the reported econometric estimates to two decimal places. We carried our own calculations out to three decimal places in order to reduce the number of ties in these comparisons.

TABLE 2

SUMMARY OF TABLE 1 COMPARING NAIVE AND SIMULATION ESTIMATES

Year	Countries Covered	Multipliers	Cells of Table 1 with more than 1 estimate	Cells of Table 1 in which naive estimate is:		
				Lowest	Between	Highest
1	Intra-EC	Own	5		3 = 60%	2 = 40%
		Cross	20	2 = 10%	16 = 80%	2 = 10%
		Total	25	2 = 8%	19 = 76%	4 = 16%
	Non-Intra-EC	Own	1		1 = 100%	
		Cross	19	8 = 42%	11 = 58%	
		Total	20	8 = 40%	12 = 60%	
	All	Own	6		4 = 67%	2 = 33%
		Cross	39	10 = 26%	27 = 69%	2 = 5%
		Total	45	10 = 22%	31 = 69%	4 = 9%
2	Intra-EC	Own	4		1 = 25%	3 = 75%
		Cross	16	9 = 56%	7 = 44%	
		Total	20	9 = 45%	8 = 40%	3 = 15%
	Non-Intra-EC	Own	2		1 = 50%	1 = 50%
		Cross	19	17 = 89%	2 = 11%	
		Total	21	17 = 81%	3 = 14%	1 = 5%
	All	Own	6		2 = 33%	4 = 67%
		Cross	35	26 = 74%	9 = 26%	
		Total	41	26 = 63%	11 = 27%	4 = 10%
3	Intra-EC (= All)	Own	5	1 = 20%	2 = 40%	2 = 40%
		Cross	20	11 = 55%	6 = 30%	3 = 15%
		Total	25	12 = 48%	8 = 32%	5 = 20%

dency of the DESMOS model, which includes only the EC, to produce smaller estimates than the other models.

As we move on to the later years of the simulations, our conclusion with respect to the naive estimates no longer stands out as clearly. This is because the linked models give some evidence of systematic dynamic response to fiscal policy that our naive static model cannot capture. Thus, while there are numerous exceptions to this pattern in Table 1, there does seem to be a tendency for the elasticity multipliers to grow over time. This is most evident for the cross-country cells, where the naive calculation yields the lowest estimate in the majority of cases in the second and third years. But the reader can see by inspecting Table 1 that even this pattern is far

TABLE 3

DESMOS (D), METEOR (M), AND LINK (L) PATTERNS OF PRICE INTERDEPENDENCE: A COMPARISON
(Percentage price change of country in column induced per unit percentage income shock of country in row)

Country	Year	Germany			Belgium			France			Italy		United Kingdom		
		D	M	L	D	M	L	D	M	L	D	L	D	M	L
Germany	1	0.12	−0.08	1.10	0.02	−0.01	−0.02	0.05	−0.00	0.01	0.01	−0.03	0.00	0.00	0.02
	3	0.63		2.38	0.10		−0.29	0.06		0.10	−0.14	0.00	0.03		−0.05
	5		0.69			0.36			0.25					0.22	
Belgium	1	0.00	−0.00	0.02	0.11	−0.04	0.07	0.02	−0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	0.01		0.03	0.43		0.09	0.02		0.00	0.01	0.00	0.01		0.00
	5		0.04			0.19			0.05					0.04	
France	1	0.01	−0.00	0.05	0.05	−0.01	−0.01	0.87	−0.08	−0.08	0.01	−0.01	0.00	0.00	−0.01
	3	0.03		0.08	0.08		0.03	0.87		−1.73	0.03	0.04	0.02		0.02
	5		0.18			0.27			0.76					0.17	
Italy	1	0.00		0.03	0.01		0.00	0.02		0.00	0.32	0.08	0.00		−0.01
	3	0.02		0.09	0.03		−0.01	0.03		−0.01	1.29	0.38	0.02		0.01
United Kingdom	1	0.00	0.00	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	−0.01	0.08	−0.07	−0.36
	3	0.01		0.11	0.04		−0.01	0.01		0.01	0.01	0.01	0.95		0.63
	5		0.14			0.18			0.14					0.64	

Source: Adapted from CENTRAAL PLANBUREAU (1975, p. 35) and WAELBROECK and DRAMAIS (1974, p. 316).

from uniform. There are many cases in which the multipliers fail to grow with time or show cyclical behavior. And there is far from perfect agreement among the models as to which these cases are.

For what it is worth, one difference among the models does seem to stand out, which is that the LINK and DESMOS models typically generate lower elasticity estimates than the mini-METEOR and COMET models. This difference accounts for much of the variance around the naive estimates. Thus, if one could somehow ignore either of these pairs of models, the comparison of the remaining models to the naive estimates would be somewhat more favorable to the former. However, such a choice of models would have been required *before* the present results were observed in order for such comparisons to be meaningful.

So far the main conclusion seems to be that the linked-multi-country-multipliers tend to become larger over time. However, if we consider the evidence from the RDX2-MPS simulations,[10] which appear in the lower corner of Table 1, it appears that both the own and cross-country multipliers become smaller over time. These multipliers also show the most marked departure from our naive calculations, being noticeably smaller even before the decline over time takes place. While the RDX2 and MPS models are of course limited in their country coverage, these models are considerably more sophisticated than the multicountry models in a number of respects. Although greater sophistication does not necessarily mean more accuracy, the differences in the simulation results are certainly noteworthy.

[10] This evidence is included in the tabulation of Table 2 for non-intra-EC cases, but involves such a small number of cells that it has little effect on the results.

IV. Effects on Prices

In addition to the results displayed in Table 1, all of which concern the *income* effects of fiscal policies, the simulations have all generated results for prices as well. By focusing only on the income multipliers, we have perhaps not done full justice to the model builders. For here, one would think the econometric models must be an improvement over our naive model which does not contain prices at all. Nor can we readily modify our simple model to permit calculations of price effects. It would be easy enough to add an aggregate supply curve, but there is no obvious way to estimate its slope.

A selection of the price results from three of the linked models is presented in Table 3. One very notable feature of these results is the large number of negative entries that appear in the table. These tend to appear in the first year of a simulation, though negative entries occasionally appear in the third year as well. Such negative price effects apparently stem from the initial effect of increased demand upon productivity, which is said to be characteristic of the mini-METEOR model as well as some of the national models included in the LINK system.

Interesting as this effect may be, it is clear from Table 3 that the models do not agree on its importance. Thus, while the econometric models can tell us that fiscal policy will cause prices to change, the models are somewhat ambiguous as to the direction of change.

V. Qualifications and Conclusions

Let us return to the question with which we began this paper: what have we learned from the linked econometric models? From the evidence presented here, the contributions of the linked-multicountry models seem to be rather limited. When we compared the elasticity-multiplier estimates obtained from those models with the results of a naive calculation, we found the former to be spread remarkably evenly around the latter if we consider only first-year simulation results. There was somewhat greater agreement regarding the dynamic characteristics of these multipliers, which is that they become larger over time. But this conclusion was not borne out by the simulations done with the linked RDX2-MPS models. Finally,

the results reported for transmission effects on prices disagreed noticeably even as to direction.

It would be an interesting next step to investigate the divergence of results that we have noted. One possibility would be to subject the various linked models to some coordinated package of simulation experiments. An attempt could then be made to pinpoint the reasons for the divergences as stemming from differences in the theoretical and/or empirical specification of individual models. Until this is done, our results suggest an appropriate degree of caution in using the linked simulations based upon the existing models.

As work on the linked models proceeds, the model builders will obviously seek to correct the more important theoretical deficiencies of their models. We have already noted the careful modeling of monetary phenomena in the RDX2-MPS model and the apparent effect of these phenomena on the simulation results. While not reported here, the RDX2-MPS results were modified still further when migration, capital flows, and exchange-rate flexibility were taken into account.[11] In all of these areas, the larger linked models could benefit from further work, and efforts are no doubt being made accordingly.[12]

However, it is no accident that the economically most sophisticated linked model looked at here covers only two countries, Canada and the U.S. It will not be easy to model economic linkages among many countries in capital and exchange markets in addition to the linkage already done for trade. Indeed, one might argue that the approaches taken to international linked modeling may well have been misdirected. In this regard, is it really desirable to approach international modeling by first building large econometric models of individual countries, and then linking the models together in whatever ways are feasible? Perhaps a better research strategy would be to have the models focused upon the complete set of international interactions from the start, adding individual country detail only as it becomes necessary to provide an adequate representation of country behavior. Such an approach has been suggested by Fair (1979), who also provides the beginning of such a model. While this approach

[11] See HELLIWELL (1974, pp. 259-60, 273-74).

[12] A promising recent development is the multicountry model being constructed by the Quantitative Studies Section of the Federal Reserve, reported in BERNER *et al.* (1977). The model includes both trade and capital flows among five countries and determines exchange rates endogenously.

might sacrifice a certain amount of accuracy at the country level, the improvement in terms of modeling international interactions could more than compensate for this loss of accuracy.

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