International Economic Policy

Theory and Evidence

EDITED BY

Rudiger Dornbusch

AND

Jacob A. Frenkel

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THIS BOOK IS DEDICATED

TO THE MEMORY OF

HARRY G. JOHNSON

Contents

	Preface	xi
One	Trade Policy and Development JAGDISH N. BHAGWATI AND T. N. SRINIVASAN	1
	Comment ROBERT E. BALDWIN	35
Two	International Cartels and Monopolies in International Trade RICHARD E. CAVES	39
	Comment ALAN V. DEARDORFF	73
Three	Trade and Direct Investment: Recent Policy Trends RACHEL MCCULLOCH	76
	Comment RONALD W. JONES	105
Four	Uncertainty and International Trade JOHN POMERY	112
	Comment WILFRED ETHIER	157
Five	Macroeconomic Interdependence and the Exchange Rate Regime MICHAEL MUSSA	160
	Comment ALEXANDER K. SWOBODA	204
Six	On Modeling the Economic Linkages among Countries RAY C. FAIR	209
	Comment FRANCO MODIGLIANI	239
	Comment J. DAVID RICHARDSON	242
Seven	On the Efficiency of Markets for Foreign Exchange RICHARD M. LEVICH	246
	Comment JOHN F. O. BILSON	267
Eight	Stabilization and Stagflation in a Semi-Industrialized Economy MICHAEL BRUNO	270
	Comment RONALD I. MCKINNON	289
Nine	Macroeconomic Strategy and Coordination under Alternative Exchange Rates KOICHI HAMADA	292

Ten Problems and Prospects for the World Economy: Round-Table RICHARD N. COOPER, RONALD I. McKINNON, FRANCO MODIGLIANI, ROBERT A. MUNDELL, AND HENRY C. WALLICH 325

Index of Names 337

Preface

This book brings together a collection of essays in the field of international economics. The essays share the common objective of assessing where trade and payments theory and policy stand after a proliferation of writing in recent years. Beyond that broad objective there are, of course, common themes. They include the special problems in trade and payments relations of developing countries, the implications for stabilization policy of world capital market integration, questions of exchange rate regimes, and the issues posed by monetary integration. While there is thus a considerable interdependence between the various contributions to this book, we have not tried to achieve an artificial coordination that would eliminate any overlap or force a synchronization of views or perspectives. On the contrary, each of the essays stands as a reasonably independent statement of a problem area and represents a scholar's critical assessment of where the field has come and where the frontiers of research lie.

In the first chapter, Jagdish N. Bhagwati and T. N. Srinivasan review some of the major issues that international trade poses for economic development. Their essay concentrates mainly on two sets of analyses that have been the focus of recent policy discussions, both theoretical and empirical. The first deals with the question of optimal trade and developing strategy for a less-developed economy that plans to accelerate its rate of economic growth. The second deals with the complementary subject of how to define the various trade opportunities. Thus, rather than being an exhaustive guide to the literature on the subject of trade and development, Bhagwati and Srinivasan provide a selective review of the major policy issues associated with the topic of international trade and development policy.

The traditional analytical framework of international trade theory relies on the assumption of pure competition. Yet, frequently, imperfect competition is called to our attention in the context of international economic policy. In the second chapter, Richard E. Caves reviews the major issues that arise when industrial organization departs from pure competition. The

chapter summarizes the theory and empirical evidence relevant to governments' policy choices as exploiters of monopoly power and as enforcers of competition. Caves analyses in detail the economic considerations and the empirical evidence relevant to the creation and maintenance of international cartels. This essay also deals with the question of economic policies toward monopolies.

The third chapter, by Rachel McCulloch, is an essay on international trade and direct investment. The author identifies areas in which policy problems posed by trade and investment, or the solutions to these questions offered by international economists, have changed significantly in recent years. With this perspective, McCulloch deals with the relationships between domestic policies and international economic policy, tariffs and the distribution of income, as well as with various barriers to trade. The review of the major problems relating to direct investment deals with taxes and capital flows, with the transfer of technology, as well as with the effects of direct investment on employment and wages.

The fourth chapter, by John Pomery, is an essay on uncertainty and international trade. Pomery assesses some recent developments in the literature and integrates them into a unified conceptual framework. He classifies models according to the timing of production and trade decisions relative to the realization of random variables and according to the market structure of trade in commodities and in assets.

The essays by Bhagwati and Srinivasan, Caves, McCulloch, and Pomery cover topics that are usually classified as dealing with the "real" side of international trade. The following chapters deal with theoretical and empirical aspects of topics that deal with financial and macroeconomic issues of the open economy.

Michael Mussa, in chapter 5, reviews the theory of the transmission of macroeconomic disturbances under alternative exchange rate regimes. Mussa analyzes the extent to which monetary and fiscal policies adopted in one country generate disturbances in the rest of the world. He also examines the extent to which flexible exchange rates insulate an economy from disturbances in the rest of the world. Special attention is paid to the implications of the international mobility of capital for the transmission of disturbances and for the conduct of policy. Mussa reviews and interprets in his analysis recent developments in the field. These include exchange rate theory, the monetary approach to the balance of payments, the relationship between inflation and aggregate supply, and, finally, the special role that expectations play in the transmission of disturbances between national economics.

Side by side with the developments of the theory of interdependent economies, there has been progress in the econometric modeling of these linkages. In the sixth chapter, Ray C. Fair reviews and assesses the litera-

ture on econometric modeling. He provides a comparison of the quantitative properties of seven multicountry econometric models and presents a "quasi-empirical" two-country model. That model is constructed by linking Fair's econometric model of the United States to a second economy with assumed identical structure. One of the major limitations of the existing econometric models remains the treatment of capital flows and exchange rates that by and large are taken to be exogenous. Fair concludes his review by suggesting some econometric modeling improvements for a small, multicountry model.

The seventh chapter, by Richard M. Levich, is a review of the theory and empirical evidence on the efficiency of the markets for foreign exchange. Levich outlines the essential elements of the efficient market hypothesis and highlights some of the difficulties in the empirical testing of the hypothesis. His analysis covers both the spot and forward markets for foreign exchange.

Much of the theoretical and empirical literature on macroeconomics of the open economy deals with industrial developed economies. Some of the policy prescriptions that are appropriate for such countries, however, may be inappropriate when applied to a developing semi-industrialized economy. The eighth chapter, by Michael Bruno, contains a review of the major policy issues that are relevant for the analysis of stabilization policies for semi-industrialized economies. Among the major characteristics of such economies are low income per head, small economic size, high dependence on imports of machinery, large structural trade deficits, a fiscal base that is dominated by indirect taxation, and an underdeveloped system of financial intermediation. Bruno's analysis highlights the constraints imposed on various macroeconomic adjustment policies by their possible side effects on inflation and unemployment, and he demonstrates that the existence of a segmented credit market imposes a severe limitation on monetary management.

The increased degree of interdependence raises the important question of harmonization and coordination of macroeconomic policies among the various interdependent economies. In the ninth chapter, Koichi Hamada reviews and assesses the theoretical literature and the empirical evidence concerning the nature of international interdependence, the rationale for policy coordination, the various methods for coordination and policy interaction under fixed and flexible exchange rate regimes. Hamada concludes the chapter by extending the analytical framework to a regime of managed floating.

The various essays are followed by comments that extend, criticize, or complement the analysis. The last chapter contains statements by Richard N. Cooper, Ronald I. McKinnon, Franco Modigliani, Robert A. Mundell, and Henry C. Wallich, on Problems and Prospects for the World Economy.

In concluding, we have the pleasant task of thanking those who have made this book possible. We are indebted to the Johnson Foundation, our generous host at Wingspread, not only for an unrivaled atmosphere for the conference at which the papers were first presented but also for financial support. The Norman Wait Harris Foundation at the University of Chicago and the Center for International Economics at the Graduate School of Business of the University of Chicago provided generous grants that are gratefully acknowledged. We owe a special debt to Robert Z. Aliber and Bert Hoselitz of the University of Chicago and to Henry Halsted, Kay Mauer, and Leslie Paffrath of the Johnson Foundation for their interest in this project and their help in making it possible. Our final thanks go to Nancy Middleton Gallienne of the Johns Hopkins University Press and Melanie Lau for their help in the preparation of the book.

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CHAPTER SIX

On Modeling the Economic Linkages among Countries

RAY C. FAIR

I. INTRODUCTION

This chapter is concerned with modeling the economic linkages among countries. Although there are by now a number of multicountry macroeconometric models in existence, it seems safe to say with respect to the treatment of capital flows and exchange rates that econometric work has not kept pace with theoretical developments. Since Mundell's pioneering theoretical work (1968) in the 1960s, the potential empirical importance of capital flows among countries has been known, and yet in most multicountry econometric models capital flows are either ignored completely or else taken to be exogenous. This usually means that exchange rates are also taken to be exogenous, which in the present regime of floating exchange rates is clearly an important limitation. Econometric model-builders are not, of course, unaware of these limitations. For a number of reasons, econometric work in this area is difficult, and these difficulties have undoubtedly impeded progress. One difficulty is the lack of good data for a number of countries. Another is the sheer size of the task of linking a number of single-country models together. Dealing with hundreds or thousands of equations is painstaking, and there is a natural tendency in this type of work to be less concerned with theoretical purity than with the practical issue of getting the model running.

Theoretical work in this area has, on the other hand, ignored a number of important economic linkages among countries that are accounted for in multicountry econometric models. The two-country theoretical models of the type surveyed by Myhrman (1976) and Mussa (1978), for example,

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are too small to incorporate all the main features and links in the international economy, particularly with respect to price and wage behavior. There is thus currently a fairly wide gap in international economics between theoretical and econometric work, the former emphasizing capital flows and exchange rates at the expense of other features of the economy, and the latter emphasizing some of the other features of the economy at the expense of capital flows and exchange rates.

This chapter has three main purposes. The first is to present a comparison of the quantitative properties of seven multicountry econometric models; the second is to discuss briefly a quasiempirical model of the author's that has the detail of large-scale econometric models and yet also accounts for all capital flows and allows for the endogenous determination of the exchange rate; and the third is to suggest an approach for the future construction of multicountry econometric models.

The comparison of the quantitative properties of the seven models is presented in Section II. The evidence presented in this section should give one a general idea of the current range of estimated effects of U.S. actions on the economies of other countries. Given the diversity of the seven models, their quantitative properties are actually closer than one might have expected, although there are still some very large differences. With one exception, however, the results from the models are based on the assumption of exogenous capital flows and exchange rates, and this should be kept in mind in interpreting the results.

The quasiempirical model is discussed in Section III. This model, which will be called Model A, is a 180-equation two-country model. It was constructed by linking the 84-equation econometric model of the U.S. economy in Fair (1976) to itself. Model A is "quasiempirical" in that half of it is an actual empirical model of the United States and half is completely made up. This model accounts for all flows of funds between the two countries and allows for the endogenous determination of the exchange rate. It also has, of course, much more detail and many more links between the two countries than do the standard two-country theoretical models in the literature. Model A is an attempt to bridge, in part, the gap between theoretical and econometric work mentioned above. As will be seen, the properties of this model are quite sensitive to the treatment of capital flows and the exchange rate. This evidence, along with what is already known from the theoretical literature, rather strongly indicates that further work on making capital flows and exchange rates endogenous in multicountry econometric models is needed before much confidence can be placed in their properties.

The suggested approach for the future construction of multicountry econometric models is presented in Section IV. At the risk of some oversimplification, it will be useful to distinguish between two approaches to making capital flows and exchange rates endogenous in a multicountry

econometric model—a "large" approach and a "small" approach. The large approach is to take a model like LINK and modify the single-country models in it to account for all flows of funds among the domestic and foreign sectors.[1] The problem with this approach is, again, the size of the task. It is a tedious job to account for all flows of funds in a large single-country model,[2] and the amount of effort involved in doing this for all the single-country models in LINK, some of which currently have fairly weak monetary sectors, is enormous.

The small approach, which is the approach discussed in Section IV of this chapter, is to specify and estimate a relatively small, highly aggregated multicountry model, but a model in which all flows of funds among the countries are accounted for. The emphasis in this approach is on the determination of the key aggregate macroeconomic variables in the system (e.g., prices, interest rates, and exchange rates), and on accounting for all the aggregate flows of funds and goods among the countries. The aim of this approach is to end up with an econometric model that, within its aggregate framework, accounts for all the adding-up constraints and is relatively easy to estimate and analyze. The aim is also to end up with a model that can, if desired, be fairly easily disaggregated later without changing its basic structure. In short, then, the small approach is to start with a small model that accounts for all the aggregate flows of funds and get larger later, rather than, as with the large approach, to start with a large model that does not account for all the flows of funds and work later on accounting for them.[3]

II. A COMPARISON OF THE QUANTITATIVE PROPERTIES OF SEVEN MULTICOUNTRY MODELS

There is by now a considerable amount of evidence on the quantitative properties of various multicountry models. The purpose of this section is not, however, to review this evidence in detail, since a fairly extensive review is already contained in Deardorff and Stern (1977). The purpose is rather to take from this evidence results for a common experiment for each model and compare these results across models. The common experiment is

[1] Hickman (1974), p. 203, has stated that work is currently in progress on making capital movements endogenous in the LINK model.

[2] See the 84-equation model in Fair (1976) for an example of a single-country model in which all flows of funds are accounted for. See, in particular, Section 1.3 for a description of the linking (by sector) of the U.S. national income accounts with the flow-of-funds accounts.

[3] The approach of Berner et al. (1976), who are concerned with the specification and estimation of a five-country model, is perhaps somewhere in between the small and large approaches. There is an attempt in this approach to account for capital flows, although the proposed treatment of exchange-rate determination as described in Berner et al. (1976) is suspect. Their proposed single-country models are also much larger than the proposed single-country models in Section IV of this chapter.

Table 1. Percentage Income Change of Country Induced by a Sustained One Percent Autonomous Increase in U.S. Income

Model	Time Period (years)	Country					
		U.S.	Canada	Austria	Belgium	France	Germany
MM	1	1.56	.27				
LINK	1	1.18	.31	.05	.05	.02	.04
DS	1	2.00	.72	.13	.39	.13	.19
METEOR	1	2.42	.65		.23	.12	.19
LINK	2	1.87	.56	.11	.09	.04	.08
METEOR	2	2.86	1.29		.46	.30	.43
RDX2-MPS[a]	2	2.11	.10				
RDX2-MPS[b]	2	2.11	.10				
RDX2-MPS[c]	2	2.12	.19				
RDX2-MPS[d]	2	2.11	.21				
MM	Long Run	4.11	.93				
LINK	3	2.58	.86	.24	.15	.06	.14
METEOR	5	8.33	4.19		1.66	1.49	1.81
OECD	Long Run	2.00	.70				.50
RDX2-MPS[a]	6	1.65	.14				
RDX2-MPS[b]	6	2.02	−.21				
RDX2-MPS[c]	6	1.66	.01				
RDX2-MPS[d]	6	1.99	.09				
RDX2-MPS[a]	8	−.83	−.29				
RDX2-MPS[b]	8	−.95	−1.06				
RDX2-MPS[c]	8	−.85	−.83				
RDX2-MPS[d]	8	−.92	−.80				

[a] Migration and all capital flows suppressed; fixed exchange rate.
[b] Migration and all capital flows suppressed; flexible exchange rate.

an autonomous increase in U.S. income of one percent. Some adjustment of the results for some models had to be made in order to make them comparable and, even given these adjustments, it should be stressed that the results are only approximately comparable.[4] The present comparison should give one a general idea of the different properties of the models, but it is by no means a rigorous evaluation of the differences.

The seven models are: (1) the Morishima–Murata (MM) trade-multiplier model (1972), (2) the LINK model (Ball 1973), (3) the OECD model (Samuelson 1973), (4) one of the multiplier models in De Rosa and Smeal (DS) (1976), (5) the METEOR model of the Netherlands Central Planning Bureau (1975), (6) the price-linkage model Kwack (KWACK) (1975), and (7) the RDX2–MPS model of Canada and the United States

[4] For example, the properties of nonlinear models are different for different starting points, and the starting points were not all the same for the results presented in this section. The results also may be sensitive to what is assumed about monetary policy, although most of the models considered here have either no or a weak monetary sector. Finally, the properties of nonlinear models are different in absolute value for positive and negative changes, and for some of the results presented in this section the U.S. policy change was negative rather than positive. For present purposes, the signs of the effects were merely reversed when the U.S. policy change was negative.

Table 1 (Continued)

Model	Time Period (years)	Country: Italy	Sweden	U.K.	Japan	Australia	Nether-lands
MM	1			.14	.19		
LINK	1	.08	.10	.08	.13	.03	
DS	1	.15	.19	.19	.17	.12	.33
METEOR	1	.15		.19	.22		.17
LINK	2	.17	.19	.21	.27	.09	
METEOR	2	.34		.45	.45		.36
RDX2–MPS[a]	2						
RDX2–MPS[b]	2						
RDX2–MPS[c]	2						
RDX2–MPS[d]	2						
MM	Long Run			.14	.87		
LINK	3	.31	.33	.35	.40	.24	
METEOR	5	1.38		1.83	1.79		1.38
OECD	Long Run				.35		
RDX2–MPS[a]	6						
RDX2–MPS[b]	6						
RDX2–MPS[c]	6						
RDX2–MPS[d]	6						
RDX2–MPS[a]	8						
RDX2–MPS[b]	8						
RDX2–MPS[c]	8						
RDX2–MPS[d]	8						

[c] Full transmission; fixed exchange rate.
[d] Full transmission; flexible exchange rate.

(Helliwell 1974). The results presented in this section are taken from the following seven sources: Morishima and Murata (1972) for the MM model, Hickman (1974) for the LINK model, OECD (1975) for the OECD model, De Rosa and Smeal (1976) for the DS model, Deardorff and Stern (1977) for the METEOR model, Kwack (1975) for the KWACK model, and Helliwell (1974) for the RDX2–MPS model. The income effects from the autonomous increase in U.S. income are presented in Table 1, and the price effects are presented in Table 2. Table 3 contains a description of how the numbers in Tables 1 and 2 were obtained. The results in the two tables are fairly self-explanatory, and so only a brief discussion of them will be presented here.

Except for some of the results for RDX2–MPS, the income effects in Table 1 are all positive. For the one-year results, the DS effects are larger than the LINK effects, which is due in large part to the use in the DS model of larger expenditure multipliers than exist in the LINK model. The METEOR effects are also larger than the LINK effects, and except for Canada, the MM effects are slightly larger than the LINK effects. For the

Table 2. Percentage Price Change of Country Induced by a Sustained One Percent Autonomous Increase in U.S. Income

Model	Time Period (years)	Country					
		U.S.	Canada	Austria	Belgium	France	Germany
LINK	1	.310	.000	.010	.000	.010	.050
METEOR	1	-.084	-.029		.005	.006	-.000
KWACK	1	-.013	-.003	.000	.000		.000
LINK	2	.290	.170	.010	-.010	.000	.110
METEOR	2	.152	.040		.053	.035	.031
RDX2-MPS[a]	2	.210	-.060				
RDX2-MPS[b]	2	.210	-.050				
RDX2-MPS[c]	2	.210	-.020				
RDX2-MPS[d]	2	.210	-.010				
LINK	3	.690	.640	.040	-.010	.020	.230
METEOR	5	1.050	.916		.627	.453	.480
KWACK	6	.373	.267	.003	.027		.027
RDX2-MPS[a]	6	2.770	.450				
RDX2-MPS[b]	6	2.910	.220				
RDX2-MPS[c]	6	2.780	.440				
RDX2-MPS[d]	6	2.880	.540				
RDX2-MPS[a]	8	5.090	1.000				
RDX2-MPS[b]	8	5.640	.060				
RDX2-MPS[c]	8	5.110	1.140				
RDX2-MPS[d]	8	5.550	1.140				

Model	Time Period (years)	Country					
		Italy	Sweden	U.K.	Japan	Australia	Netherlands
LINK	1	-.010		.000	-.020	-.010	
METEOR	1	.009		.008	.003		.018
KWACK	1	.000	.000	.000	-.003	.000	.000
LINK	2	-.020		-.060	-.030	-.030	
METEOR	2	.053		.058	.041		.076
RDX2-MPS[a]	2						
RDX2-MPS[b]	2						
RDX2-MPS[c]	2						
RDX2-MPS[d]	2						
LINK	3	.010		.000	-.030	-.100	
METEOR	5	.565		.629	.509		.647
KWACK	6	.030	.023	.020	.107	.107	.047
RDX2-MPS[a]	6						
RDX2-MPS[b]	6						
RDX2-MPS[c]	6						
RDX2-MPS[d]	6						
RDX2-MPS[a]	8						
RDX2-MPS[b]	8						
RDX2-MPS[c]	8						
RDX2-MPS[d]	8						

[a] Migration and all capital flows suppressed; fixed exchange rate.
[b] Migration and all capital flows suppressed; flexible exchange rate.
[c] Full transmission; fixed exchange rate.
[d] Full transmission; flexible exchange rate.

Table 3. Sources for the Results in Tables 1 and 2

Each number in Table 1 is $\Delta Y_j/Y_j \div \Delta A_i/Y_i$, and each number in Table 2 is $\Delta P_j/P_j \div \Delta A_i/Y_i$, where

ΔA_i = autonomous change in U.S. real income,
ΔY_j = induced change in the real income of country j,
Y_j = level of real income of country j,
ΔP_j = induced change in the price level of country j,
P_j = price level of country j.
(country j may be the U.S.)

Model	Source	Discussion
MM	Morishima–Murata (1972)	One-year values of $\Delta Y_j/\Delta A_i$ taken from Table 5 (p. 325); long-run values of $\Delta Y_j/\Delta A_i$ taken from Table 6 (p. 325); and values of Y_j taken from Table 8 (p. 328). Model is linear, so starting point does not matter. Values of Y_j are for 1964.
LINK	Hickman (1974)	Numbers in Table 1 taken directly from Tables 2–4 (pp. 211–13), and numbers in Table 2 taken directly from Tables 6–8 (pp. 218–20). Starting point was 1973.
DS	DeRosa–Smeal (1976)	The numbers in Table 1 are the numbers in Table 9 (p. 10*a*) multiplied by 2.0, the U.S. expenditure multiplier. The results are based on the following assumptions: use of Houthakker–Magee (1969) estimated income elasticities of the demand for imports in each country; use of a U.S. expenditure multiplier of 2.0; and use of an expenditure multiplier for each of the other countries of 1.5. The year was 1974.
METEOR	Deardorff–Stern (1977)	Numbers in Table 1 taken directly from Table 28 (p. 96), and numbers in Table 2 taken directly from Table 29 (p. 97).
OECD	(1975)	Numbers in Table 1 taken directly from Table 8B (p. 34). The effects are assumed here to be long-run, although no time period is given in OECD (1975).
RDX2–MPS	Helliwell (1974)	Full transmission numbers in Tables 1 and 2 taken directly from Table 1–A (p. 259), with signs reversed, and numbers in Tables 1 and 2, when migration and all capital flows are suppressed, taken directly from Table 5–A (p. 273), with signs reversed. Starting point was 1963.
KWACK	Kwack (1975)	The numbers in Table 2 are the numbers in Table 9 (p. 27) divided by −3.0. The effects in Table 9 are for a one percentage point increase in the unemployment rate; and from the Okun's Law equation for the United States in Table 6 (p. 20), a one percentage point increase in the unemployment rate corresponds roughly to a three percent decrease in real output. Starting point was 1968.

two-year results, the METEOR effects are again larger than the LINK effects. For Canada, the RDX2–MPS effects are considerably smaller than both the LINK and METEOR effects. For the three-year or more results, the METEOR effects are quite large relative to the others. The MM, LINK, and OECD effects for Canada are fairly close, as are the LINK and OECD effects for Japan. The RDX2–MPS effects for Canada are small for the six-year period, but fairly large and negative for the eight-year period. In general, the results for the RDX2–MPS model show evidence of a considerable amount of cycling.

For the one-year results in Table 2, the price effects are all fairly small, except perhaps for the LINK effect for the United States. This is also true for the two-year results. For the three-year or more results, on the other hand, the METEOR and RDX2–MPS effects are fairly large, as are the LINK effects for the United States and Canada. The KWACK effects are still small, and the three-year LINK effects for Belgium, Japan, and Australia are still negative.

To conclude, it is partly a matter of judgment whether one feels that the differences in Tables 1 and 2 are large or small. Clearly, however, the five-year METEOR results are quite different from the others, as are the RDX2–MPS results for Canada in Table 1. On the other hand, the MM and LINK differences in Table 1 seem fairly small, and many of the differences for the one-year results in Table 1 are also small.

With respect to the possible sensitivity of a model's properties to the treatment of capital flows and exchange rates, it should be noted that for the RDX2–MPS model the two- and six-year results in Tables 1 and 2 are not very sensitive to the treatment of capital flows and the exchange rate, but the eight-year results are. For the case in which migration and capital flows are suppressed, the eight-year income effect for Canada is -0.29 in the fixed-exchange-rate case and -1.06 in the flexible-exchange-rate case. The corresponding price effects are 1.000 and 0.060. For the case in which migration and capital flows are not suppressed, the eight-year effects are not sensitive to the treatment of the exchange rate. The income effect is 1.140 in both the fixed- and flexible-exchange-rate cases, and the price effect is -0.83 in the fixed-exchange-rate case and -0.80 in the flexible-exchange-rate case. The overall results for the RDX2–MPS model are thus somewhat mixed with respect to the sensitivity question.

III. A QUASIEMPIRICAL TWO-COUNTRY MODEL

As mentioned in the Introduction, the model discussed in this section (Model A) is an attempt to bridge in part the current gap between theoretical and econometric work in international economics. The fact that the properties of Model A turn out to be quite sensitive to the treatment of

capital flows and the exchange rate casts some doubt on the reliability of the results presented in Section II. The properties of Model A also cast some doubt on the reliability of the results from the standard two-country theoretical models in the literature. In particular, the price links among countries that these standard models ignore appear to be important, at least as reflected in Model A.

Model A is a special case of a more general theoretical model of the balance of payments that is presented and discussed in Fair (1978*b*). Since Model A was constructed by linking the 84-equation U.S. econometric model in Fair (1976) to itself, the United States is half of the world in the model. Space limitations prevent a detailed description of Model A here. It is also discussed in Fair (1978*b*), and an appendix to this paper is available that contains a complete list of the 180 equations. The following is a brief discussion of some of its key features.

There are four sectors for each of the two countries in the model: household, firm, bank, and government. All flows of funds among the eight sectors are accounted for. This means that any financial saving or dissaving of a sector in a period results in the change in at least one of its assets or liabilities, that any financial asset of one sector is a corresponding liability of some other sector, and that the government budget constraints of the two countries are accounted for. The model is one in which stock and flow effects are completely integrated. The exchange rate, for example, has an effect on both stock and flow variables, and in the flexible-exchange-rate case it is simultaneously determined along with the other endogenous variables. As discussed in Fair (1978*b*), this integration of stock and flow effects is not true of other approaches to the balance of payments and is one of the main distinctions between Model A and other models.

Each country specializes in the production of one good, and the goods are traded. In addition to the obvious links between the two countries with respect to capital and goods flows, there are important price links between the two countries: in each country the price of the imported good has an effect on the price of the home-produced good. In other words, a price change in one country has a direct effect on the price change in the other country and vice versa. Wages are also endogenous in the model, and prices affect wages as well as vice versa.

One important feature of the model with respect to prices is that prices have, other things being equal, a negative effect on demand. One would expect, for the usual microeconomic reasons, the demand for a good to be a negative function of its price, and this is in fact the case in the U.S. econometric model upon which Model A is based. Although this may seem to be an obvious characteristic for a model to have, in most macroeconometric models consumption is not a direct function of prices, but only of income terms and the like. The consumption equations in Model A differ from the usual consumption equations in macroeconometric models in

having explanatory variables that are consistent with microeconomic theory.[5]

In the more general theoretical model of the balance of payments in Fair (1978*b*), expectations of future exchange rates have an effect on the decisions of the private sector in each country. In the special case of Model A, however, this is not true because exchange-rate expectations were not explicitly taken into account in the 84-equation U.S. econometric model upon which Model A is based. This is clearly an important limitation of Model A, and it should be kept in mind in interpreting the following results. The treatment of exchange-rate expectations in multicountry models is discussed in the next section.

In Fair (1978*b*) the properties of Model A were analyzed in four different regimes: the regimes of (1) zero capital mobility and a fixed exchange rate, (2) zero capital mobility and a flexible exchange rate, (3) perfect capital mobility and a fixed exchange rate, and (4) perfect capital mobility and a flexible exchange rate. For the perfect mobility regimes it was necessary to make some assumption about exchange-rate expectations in order to link together the interest rates in the two countries, and for this purpose exchange-rate expectations were assumed to be static. This means that the interest rates in the two countries are always the same in the perfect mobility regimes in Model A.

A summary of the results from the analysis of Model A's properties is presented in Table 4. Two basic experiments were performed for these results: a monetary policy experiment and a fiscal policy experiment. For the monetary policy experiment, the amount of government securities outstanding of country 1 was decreased, a standard expansionary open-market operation on the part of the monetary authorities of country 1.[6] For the fiscal policy experiment, the value of goods purchased by the government of country 1 was increased. For this latter experiment, no change in the amount of government securities outstanding was made, which means that any government deficit that results from the increase in purchases is financed by an increase in nonborrowed reserves (high-powered

[5] See Section 1.1 in Fair (1976) for a discussion of the differences between the consumption equations in the 84-equation U.S. econometric model (and thus in Model A) and the consumption equations in other macroeconometric models. One of the three main features of the theoretical model in Fair (1974), upon which the econometric model in Fair (1976) is based, is the derivation of the decisions of the individual agents in the economy from the assumption of maximizing behavior. The other two main features of this model are an explicit treatment of possible disequilibrium effects and the accounting of all flows of funds in the system.

[6] The experiment in Fair (1978*b*) was actually one in which the amount of government securities outstanding was increased (a contractionary action) rather than decreased. All the results in this earlier paper are in fact for contractionary monetary and fiscal actions. Given the results in Section II of this chapter, it seemed best in the present section to talk about expansionary rather than contractionary actions, and so for purposes of the discussion in this section all the signs in Fair (1978*b*) have been reversed.

Table 4. Results for Model A: Effects after Three-Quarters

I. Monetary Policy Experiment (Decrease in government securities outstanding of country 1 of 1.25.)

Changes are *not* in percentage terms.

Real Output Change

Capital Mobility	Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2	No Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2
Zero	0.94	0.20	1.39	−0.18	0.86	0.25	0.63	0.41
Perfect	0.62	0.59	−0.41	1.68	0.63	0.59	0.51	0.74

Price Level Change

Capital Mobility	Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2	No Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2
Zero	−0.001	−0.016	−0.159	0.173	0.016	−0.026	0.117	−0.165
Perfect	−0.015	−0.014	0.867	−0.904	−0.015	−0.014	0.158	−0.185

II. Fiscal Policy Experiment (Money-financed increase in government purchases of goods of country 1 of 1.25.) These results are comparable to those in Tables 1 and 2.

Changes are in percentage terms.

Real Output Change

Capital Mobility	Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2	No Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2
Zero	1.90	0.33	2.80	−0.58	1.89	0.34	1.50	0.63
Perfect	1.80	0.46	0.92	1.35	1.82	0.44	1.81	0.47

Price Level Change

Capital Mobility	Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2	No Price Lags in Import Equations, Fixed: Country 1	Fixed: Country 2	Flexible: Country 1	Flexible: Country 2
Zero	0.053	−0.001	−0.523	0.599	0.066	−0.006	0.494	−0.475
Perfect	0.041	0.009	0.953	−0.910	0.043	0.011	0.247	−0.190

(*Table 4 Notes*)

Notes:

1. The monetary policy results are taken from Fair (1978*b*), and the fiscal policy results are taken from an earlier version of the paper: "A Model of the World Economy," Cowles Foundation Discussion Paper No. 430, April 27, 1976.

2. The results for the monetary policy experiment have not been adjusted except for the change in sign discussed in footnote 6 and for multiplication of the price level changes by 100. The numbers are merely the total induced changes in real income after three quarters and the total induced changes in the price level after three quarters (ΔY_j and ΔP_j in the notation in Table 3).

3. The results for the fiscal policy experiment have been adjusted and are as in Tables 1 and 2. The real output changes are $\Delta Y_j/Y_j \div \Delta A_i/Y_i$ and the price level changes are $\Delta P_j/P_j \div \Delta A_i/Y_i$, where the value of ΔA_i is -1.25. For these calculations the values for Y_i and Y_j were taken to be 169.4, the actual U.S. value in 1971IV, and the values for P_i and P_j were taken to be 1.26, also the actual U.S. value in 1971IV.

4. The starting quarter for the experiments was 1971I, a quarter that is at or near the bottom of a contraction.

money). In other words, this latter experiment is a money-financed fiscal policy change. The effects of these two experiments after three quarters are presented in Table 4 for two variables for each country, real output and the domestic price level.

Results are also presented in Table 4 for two versions of the import-demand equations. The first version is the actual estimated equation for the demand for imports in the U.S. econometric model in Fair (1976). In this version there are price lags: prices affect the demand for imports with a lag of one or two quarters. In the second version these lags have been eliminated: imports respond in the current quarter to a change in prices.

The following is a brief discussion of some of the main features of the results in Table 4. Space limitations again prevent an extensive discussion here, and the reader is referred to Fair (1978*b*) for more detail. It should be stressed that the following discussion is somewhat loose. Reference is sometimes made to a change in one endogenous variable "causing," "leading to," or "resulting in" a change in another endogenous variable or variables. This discussion, while useful pedagogically, is loose because the model is simultaneous. Strictly speaking, each endogenous variable in the model affects and is affected by all the other endogenous variables. It should also be stressed that the effects in Table 4 are effects after only three quarters; they are of the nature of short-run effects. It is particularly important to keep this in mind when comparing the price-lag and no-price-lag cases. While the results for these two cases are sometimes quite different in Table 4, these differences are likely to lessen as the length of the period after the change increases.

Consider first in Table 4 the monetary policy experiment. In the fixed/perfect regime the monetary policy change has almost identical effects on the two countries. In this regime it makes no difference with respect to the aggregate effects in which country the open-market operation takes

place. Therefore, since the two countries in the model are virtually the same, the effects on the two countries are virtually the same. In the fixed/zero regime, on the other hand, the effects on output in country 1 are greater than they are in country 2. This is because in this regime the monetary policy change lowers the interest rate more in country 1 than in country 2.

In the two fixed-exchange-rate regimes the results are not sensitive to whether or not there are price lags in the import equations. In these two regimes the changes in prices are not very large, and so the results are not very sensitive to what one assumes about the price responsiveness of imports.

In the flexible/perfect regime the expansionary monetary policy in country 1 actually has a negative effect on country 1's real output in the case in which there are price lags in the import equations. The reason for this is as follows. The expansionary monetary policy results in this case in a depreciation of country 1's currency (which is needed to keep the interest rates in the two countries the same[7]). This then results in a higher domestic price level in country 1 (since the price of country 1's imports is higher) and a lower domestic price level in country 2 (since the price of country 2's imports is lower). As mentioned above, a higher price level in a country has, other things being equal, a negative effect on demand. It turned out in this experiment that the negative effect on output from the increase in the price level in country 1 was large enough to offset the positive effects induced by the policy change, so that there was a net contraction in output in country 1. In country 2, on the other hand, the positive effect on output from the decrease in its price level and the other positive effects induced by the policy change resulted in an expansion in output.

Remember that the results just cited are for the case in which there are price lags in the import equations. Because of these lags, the depreciation of country 1's currency has no direct immediate effect on decreasing its demand for imports or on increasing country 2's demand for country 1's exports. In the no-price-lag case, on the other hand, this channel is open and, in this case, as can be seen in Table 4, there is no longer a contraction in country 1's output in the flexible/perfect regime. The output increase is, however, smaller in country 1 than in country 2, and this is again due to the negative effect (through the price level) of the devaluation of country 1's currency on country 1's output.

The flexible/zero regime is unusual and probably not very realistic. In the price-lag case in this regime the expansionary monetary policy in country 1 actually leads to a contraction in country 2's output. The reason for this

[7] Remember that exchange-rate expectations are assumed to be static for the experiments, and so the interest rates in the two countries are the same in the perfect capital mobility regimes.

result is as follows. In the flexible/zero regime the financial saving of country 1 (its balance of payments on current account) cannot change, since there is no capital mobility and no change in international reserve holdings. If imports do not respond to current price changes, as is true in the price-lag case, then the adjustment to the expansionary monetary policy must take place through a terms-of-trade effect. Country 1's currency must appreciate to turn the terms of trade in favor of country 1 to offset the decrease in its balance of payments on current account that would otherwise have taken place as a result of country 1's expansionary monetary policy. The depreciation of country 2's currency leads to an increase in its price level, which is, other things being equal, contractionary. This contractionary effect was strong enough in the present experiment so as to lead to a net contraction in country 2's output.

In the no-price-lag case in the flexible/zero regime, real output in country 2 expands rather than contracts. In this case country 1's currency depreciates rather than appreciates, which results, other things being equal, in a decrease in its imports and an increase in its exports. The offset to the decrease in country 1's balance of payments on current account that would otherwise have taken place as a result of its expansionary monetary policy occurs in the no-price-lag case through a change in imports and exports rather than through a change in the terms of trade. There is thus no depreciation of country 2's currency and so no contractionary effect on its output from this source.

One further point about the results for the monetary policy experiment in Table 4 should be noted, which is that in the fixed-exchange-rate regimes the expansionary monetary policy leads to a slight decrease in the price levels in both countries. This is explained by the fact that interest rates have, other things being equal, a positive effect on prices in the model.[8] An expansionary monetary policy leads to a decrease in interest rates and thus from this source to a decrease in prices. An expansionary monetary policy also has positive effects on prices through other sources, but the net effect on prices after three quarters is still negative for the results in Table 4.

The fiscal policy experiment reported in Table 4 is a combination of a direct increase in the sales of country 1's good and of an expansionary monetary policy. Since the monetary-policy effects have already been discussed, the further effects from the increase in sales will not be discussed here.[9]

[8] See footnote 1 in the Appendix for an explanation of this.

[9] The fiscal policy results in Table 4 are directly comparable in terms of units to the results in Tables 1 and 2. It should be kept in mind in comparing these results, however, that fiscal policy effects in Model A are sensitive to what one assumes about monetary policy (see Fair [1978*a*]). Quite different fiscal policy effects would have been obtained for the results in Table 4 had something different been assumed about monetary policy. This sensitivity is, of course, not necessarily true of the models considered in Section II, since, as mentioned in footnote 4, many of these models have either no monetary sector or a weak one.

This completes the discussion of the results in Table 4. It is clear that the properties of Model A are sensitive to the choice of regime, which, as mentioned in the Introduction, indicates the need to make capital flows and exchange rates endogenous in multicountry econometric models before much confidence can be placed in their properties.

The discussion of the results in Table 4 also shows the importance of price effects in the model in the flexible-exchange-rate regimes, something which is generally ignored or treated very lightly in small-scale theoretical models. In Model A import prices influence domestic prices, and prices in general influence demand. These price effects can be quantitatively quite important. To give one example where they are important, consider Model A versus Mundell's two-country model (1968, Appendix to Chapter 18) in the perfect/flexible regime. In Mundell's model in this regime an expansionary monetary policy has a positive effect on the output of the home country and a negative effect on the output of the other country. For Model A this result is either completely reversed (in the price-lag case) or else substantially modified (in the no-price-lag case). As discussed above, the depreciation of country 1's currency that the expansionary monetary policy causes in this case leads in Model A to a higher domestic price level in country 1, and then either an actual contraction in country 1's real output or else an expansion that is smaller than the expansion in country 2. It thus appears from the results in this section that Mundell's model and models of this type have omitted some potentially important price links between countries.

IV. A SUGGESTED WAY OF MODELING THE ECONOMIC LINKAGES AMONG COUNTRIES: A SMALL APPROACH

One possible way of constructing a multicountry macroeconometric model with endogenous capital flows and exchange rates would be to estimate for each country a model as in Fair (1976), in which all flows of funds among the sectors are accounted for, and then link these models together. The resulting overall model would be like Model A, only it would be completely empirical and for more than two countries. Since, as discussed in the Introduction, this is an enormous task, it may be better to start with a somewhat smaller approach. The purpose of this section is to propose such an approach. The model described in this section requires that only five or six equations be estimated per country, but it accounts for all the main economic links among the countries and allows for the endogenous determination of the exchange rates.

Although the model that is outlined in this section is for three countries, the generalization to more than three countries is straightforward. The model in this section is a simplified version of the three-country model in the Appendix, and the reader is assumed to have mastered the model in the Appendix before reading this section. The model in the Appendix is a

three-country version of the two-country model of the balance of payments in Fair (1978*b*). The reason for separating the model in this section from the model in the Appendix is to make clear the simplifications that are being proposed in this section.

The six or seven equations to be estimated per country for the model in this section are equations explaining (1) the demand for imports, (2) the demand for foreign securities, (3) the demand for domestic money, (4) the price of domestic goods, (5) the demand for domestic goods, (6) the forward price of the country's currency (except for the *numéraire* country), and possibly (7) the domestic interest rate. The overall model consists of twenty-one equations per country. The notation used in this section is presented in Table 5. All domestic goods in each country are aggregated into one good X, and all domestic financial securities (except money) in each country are aggregated into one security B. (Liabilities correspond to negative values of B.) There is therefore only one domestic price and one domestic interest rate per country. Any possible effects on behavior of capital gains and losses on securities are ignored.

For those who would like to skip or skim the equations, a brief outline of them is as follows. Equations (1.1)–(1.5) and (1.7)–(1.11) are definitions: (1.1) and (1.2) define the financial savings of the private and government sectors; (1.3) and (1.4) define the budget constraints of the two sectors; (1.5) and (1.7)–(1.9) are adding-up constraints; and (1.10) and (1.11) define price and covered interest-rate indices. Equation (1.6) explains bank reserves, and equations (1.12)–(1.17) and (1.22)–(1.23) are the equations to be estimated. Finally, equations (1.18)–(1.21) determine the allocation of goods and securities among countries.

With respect to the equations, consider first for country 1 the aggregation of the household, firm, and bank sectors in the model in the Appendix into one private sector (denoted by a subscript p).[10] Adding the private saving equations, (13), (27), and (31), yields:

$$(1.1)\quad S_{1p} = P_1(X_{1f} - X^1{}_{1p}) - e_2P_2X^1{}_{2p} - e_3P_3X^1{}_{3p} + R_1B^1{}_{1p} + e_2R_2B^1{}_{2p} + e_3R_3B^1{}_{3p} - V_{1p} - RD_1BO_1. \text{ [saving of the private sector]}$$

The government saving equation, (33), remains unchanged except to note that $V_{1h} + V_{1f} = V_{1p}$.

$$(1.2)\quad S_{1g} = V_{1p} + RD_1BO_1 - P_1X^1{}_{1g} - e_2P_2X^1{}_{2g} - e_3P_3X^1{}_{3g} + R_1B^1{}_{1g} + e_2R_2B^1{}_{2g} + e_3R_3B^1{}_{3g}. \text{ [saving of the government sector]}$$

[10] With the exception of X_{1f} and M_{1b}, all the h, f, and b subscripts in the Appendix have been changed in this section to p, even when a variable in the Appendix pertains to only one or two of the three individual sectors. As examples of the change of notation, $B^1{}_{1p} = B^1{}_{1h} + B^1{}_{1f} + B^1{}_{1b}$, $X^1{}_{1p} = X^1{}_{1h} + X^1{}_{1f}$, and $M^1{}_{1p} = M^1{}_{1h}$. Also, government purchase of labor (L_{ig}) has been dropped as an explicit variable in the model and has instead been taken to be part of the good of country i. In other words, W_iL_{ig} has been taken to be part of $P_iX^i{}_{ig}$.

Table 5. Variables for the Model in Section III (i, j = 1, 2, 3)

Number of Variables			
Endogenous	Exogenous		
3[a] $(i = j)$	6	B^i_{ig}	= amount of country i's securities held by the government of country j in units of country i's currency (negative values are liabilities).
9		B^i_{ip}	= amount of country i's securities held by the private sector of country j in units of country i's currency (negative values are liabilities).
3		B^i_{mp}	= index of the total foreign security holdings of the private sector of country i.
	3	BO_i	= bank borrowing from the government in country i.
3		BR_i	= bank reserves in country i.
1[b]		e_2	= price of country *2*'s currency in terms of country *1*'s currency.
1[b]		e_3	= price of country *3*'s currency in terms of country *1*'s currency.
1		e^*_2	= forward price of country *2*'s currency in terms of country *1*'s currency.
1		e^*_3	= forward price of country *3*'s currency in terms of country *1*'s currency.
	9	M^i_{ig}	= amount of country i's money held by the private sector of country j in units of country i's currency.
3 $(i = j)$	6	M^i_{ip}	= amount of country i's money held by the private sector of country j in units of country i's currency.
3		M_{ib}	= total money supply in country i (total deposits in the bank sector of country i).
3		P_i	= price of the good of country i in units of country i's currency.
3		P^i_m	= price index of the total imports of country i in units of country i's currency.
1	2[c]	Q_i	= amount of the international reserve held by country i (price = 1.0).
3		R_i	= interest rate for country i's securities.
3		R^i_m	= covered interest rate index for the total foreign security holdings of country i.
	3	RD_i	= discount rate in country i.
	3	RR_i	= reserve requirement ratio in country i.
3		S_{ig}	= financial saving of the government of country i.
3		S_{ip}	= financial saving of the private sector of country i.
	3	V_{ip}	= taxes paid by the private sector of country i.
	9	X^i_{ig}	= real value of the good of country i purchased by the government of country j.
9		X^i_{ip}	= real value of the good of country i purchased by the private sector of country j.
3		X^i_{mp}	= index of the total real value of imports of the private sector of country i.
3		X_{if}	= total real value of sales of the good of country i.
62	44		

[a] Exogenous if no reaction functions of the monetary authorities are specified (equations [1.17], [1.17]′, [1.17]″).
[b] Exogenous in fixed-exchange-rate regime.
[c] Endogenous in fixed-exchange-rate regime.

Adding the private budget-constraint equations, (14), (28), and (32), yields:

(1.3) $O = S_{1p} + \Delta(M_{1b} - M^1{}_{1p}) - e_2\Delta M^1{}_{2p} - e_3\Delta M^1{}_{3p} - \Delta B^1{}_{1p} - e_2\Delta B^1{}_{2p} - e_3\Delta B^1{}_{3p} - \Delta(BR_1 - BO_1)$. [private sector budget constraint]

The government budget-constraint equation, (34), remains unchanged:

(1.4) $O = S_{1g} + \Delta(BR_1 - BO_1) - \Delta M^1{}_{1g} - e_2\Delta M^1{}_{2g} - e_3\Delta M^1{}_{3g} - \Delta B^1{}_{1g} - e_2\Delta B^1{}_{2g} - e_3\Delta B^1{}_{3g} - \Delta Q_1$. [government sector budget constraint]

Equation (35) also remains unchanged except for the replacement of h by p:

(1.5) $M_{1b} = M^1{}_{1p} + M^1{}_{1g} + M^2{}_{1p} + M^2{}_{1g} + M^3{}_{1p} + M^3{}_{1g}$. [total deposits in the bank sector]

Equation (30) remains the same:

(1.6) $BR_1 = RR_1\, M_{1b}$. [bank reserves]

Equation (36) in the new notation is

(1.7) $O = B^1{}_{1p} + B^1{}_{1g} + B^2{}_{1p} + B^2{}_{1g} + B^3{}_{1p} + B^3{}_{1g}$. [supply of the bond of country 1 equals the demand for it]

Equation (109) remains unchanged:

(1.8) $O = \Delta Q_1 + \Delta Q_2 + \Delta Q_3$. [no change in total world reserves]

Equation (24) in the new notation is

(1.9) $X_{1f} = X^1{}_{1p} + X^1{}_{1g} + X^2{}_{1p} + X^2{}_{1g} + X^3{}_{1p} + X^3{}_{1g}$. [total sales of the good of country 1]

Let $X^1{}_{mp}$ denote an index of the total imports of country 1's private sector from countries 2 and 3, i.e., some weighted average of $X^1{}_{2p}$ and $X^1{}_{3p}$; and let $B^1{}_{mp}$ denote an index of the total foreign security holdings of country 1's private sector, i.e., some weighted average of $B^1{}_{2p}$ and $B^1{}_{3p}$. Also, let $P^1{}_m$ be a price index of the total imports of country 1 in the units of country 1's currency:

(1.10) $P^1{}_m = \alpha^1{}_1 e_2 P_2 + \alpha^1{}_2 e_3 P_3$, [price index of the total imports of country 1]

where $\alpha^1{}_1$ and $\alpha^1{}_2$ are some appropriately chosen weights. Similarly, let $R^1{}_m$ be a covered interest-rate index for the total foreign security holdings of

country 1:

$$(1.11)\quad R^1{}_m = \beta^1{}_1\left[\frac{e_2}{e^*{}_2}(1 + R_2) - 1\right] + \beta^1{}_2\left[\frac{e_3}{e^*{}_3}(1 + R_3) - 1\right],$$

[covered interest-rate index for the total foreign security holdings of country 1]

where the expressions in brackets are the covered interest rates on the securities of countries 2 and 3, respectively, and where $\beta^1{}_1$ and $\beta^1{}_2$ are also some appropriately chosen weights.

The stage is now set for explaining the equations to be estimated for country 1. In what follows, Z_1 denotes a vector of all the exogenous and lagged endogenous variables that help explain the LHS variable in the equation. The variables in Z_1 may, of course, differ for different equations. The following six equations are meant to be approximations to the equations that would be estimated were the complete model in the Appendix being estimated:

(1.12) $X^1{}_{mp} = f_{12}\,(P_1, P^1{}_m, X_{1f}, Z_1)$, [demand for imports by the private sector of country 1]

(1.13) $B^1{}_{mp} = f_{13}\,(R_1, R^1{}_m, Z_1)$, [demand for foreign securities by the private sector of country 1]

(1.14) $M^1{}_{1p} = f_{14}\,(R_1, P_1, X_{1f}, Z_1)$, [demand for domestic money by the private sector of country 1]

(1.15) $P_1 = f_{15}\,(P^1{}_m, R_1, X_{1f}, Z_1)$, [price of the good of country 1]

(1.16) $X^1{}_{1p} = f_{16}\,(P_1, P^1{}_m, X_{1f}, R_1, Z_1)$, [demand for the good of country 1 by the private sector of country 1]

(1.17) $R_1 = f_{17}\,(R^1{}_m, P_1, X_{1f}, Z_1)$. [reaction function of the monetary authorities of country 1]

The total level of sales of the good of country 1, X_{1f}, is used as the aggregate real income or activity variable of country 1 in equations (1.12) and (1.14)–(1.17). Equation (1.12) explains the demand for imports as a function of the two prices, real income, and other (nonendogenous) variables. This equation is an approximation to equations (3), (4), (18), and (19) in the Appendix. Equation (1.13) explains the demand for foreign securities as a function of the two interest rates and other variables. It is an approximation to equations (9) and (10) in the Appendix.

Equation (1.14) explains the demand for domestic money as a function of the interest rate, price level, real income, and other variables. It is an approximation to equation (5) in the Appendix. Equation (1.15) explains the price of domestic goods as a function of the import price index, the interest rate, aggregate real activity, and other variables. It is an approximation to equation (15) in the Appendix. The price of domestic goods is assumed to be set by the firm sector.[11] Equation (1.16) is a combination of the consumption and investment demands for domestic goods for country 1; it is an approximation to equations (2) and (17) in the Appendix. In this equation, the demand for the good of country 1 by country 1's private sector is a function of the two prices, real income, the interest rate, and other variables. Finally, equation (1.17) explains the interest rate of country 1; it is a reaction function of the monetary authorities of country 1. As discussed at the end of the Appendix, this is an optional equation. If it is specified, then $B^1{}_{1g}$ is endogenous; if it is not, then $B^1{}_{1g}$ is exogenous.

Equations (1.12)–(1.17) are the key behavioral equations of the model for country 1, and these are the equations where it is suggested that most of the estimation work be focused. Regarding equations (1.12) and (1.13), however, it is still necessary once $X^1{}_{mp}$ and $B^1{}_{mp}$ have been explained to explain the division of these variables into $X^1{}_{2p}$, $X^1{}_{3p}$, $B^1{}_{2p}$, and $B^1{}_{3p}$. This can be done by the following "share" equations:

(1.18) $$\frac{X^1{}_{2p}}{X^1{}_{mp}} = f_{18}\left(\frac{e_2P_2}{e_3P_3}, Z_1\right),$$ [share of the imports of country 1's private sector from country 2]

(1.19) $$\frac{X^1{}_{3p}}{X^1{}_{mp}} = f_{19}\left(\frac{e_2P_2}{e_3P_3}, Z_1\right),$$ [share of the imports of country 1's private sector from country 3]

(1.20) $$\frac{B^1{}_{2p}}{B^1{}_{mp}} = f_{20}\left(\left[\frac{e_2}{e^*{}_2}(1+R_2) - 1\right] \Big/ \left[\frac{e_3}{e^*{}_3}(1+R_3) - 1\right], Z_1\right),$$

[share of country 2's securities in the foreign security holdings of country 1's private sector]

(1.21) $$\frac{B^1{}_{3p}}{B^1{}_{mp}} = f_{21}\left(\left[\frac{e_2}{e^*{}_2}(1+R_2) - 1\right] \Big/ \left[\frac{e_3}{e^*{}_3}(1+R_3) - 1\right], Z_1\right).$$

[share of country 3's securities in the foreign security holdings of country 1's private sector]

The lagged value of the share in each equation is an obvious variable to include in Z_1. These share equations should probably be estimated directly, although with a large number of countries this is tedious, and one may

[11] Again, see footnote 1 in the Appendix for a discussion of the inclusion of the interest rate in the price equation.

instead want to assign parameter values to many of these equations without direct estimation.[12]

This completes the outline of the basic model for country 1. Equations (1.1)–(1.7) and (1.9)–(1.21) also hold for countries 2 and 3, with appropriate change of notation. Also, equations explaining the forward exchange rates are needed for countries 2 and 3:

(1.22) $e^*_2 = f_{22}(\cdots)$, [forward price of country 2's currency]

(1.23) $e^*_3 = f_{23}(\cdots)$, [forward price of country 3's currency]

As in the Appendix, the determinants of the forward prices can be left unspecified for present purposes.

Except for equations (1.22) and (1.23), let a single prime denote the equations for country 2, and let a double prime denote the equations for country 3. This then gives sixty-three equations in the model, one of which is redundant. As in the Appendix, it will be convenient to drop equation (1.8). The remaining equations for which there are no obvious LHS variables are (1.3), (1.4), (1.7), and the corresponding equations for countries 2 and 3. To equations (1.3), (1.3)′, and (1.3)″ can be matched $B^1{}_{1p}$, $B^2{}_{2p}$, and $B^3{}_{3p}$. To the government budget-constraint equations, (1.4), (1.4)′, and (1.4)″, can be matched either R_1, R_2, and R_3, if no reaction functions of the monetary authorities are specified, or $B^1{}_{1g}$, $B^2{}_{2g}$, and $B^3{}_{3g}$, if such functions are specified. Finally, to equation (1.7) can be matched Q_1, and to equations (1.7)′ and (1.7)″ can be matched either e_2 and e_3 or Q_2 and Q_3, depending on whether there are flexible or fixed exchange rates.

To summarize, if a model like the one outlined in this section were estimated, it would account for the main economic linkages among countries. In addition to the obvious capital-flow and exchange-rate linkages, there are linkages through the price equations (1.10), (1.10)′, (1.10)″, (1.15), (1.15)′, (1.15)″, through the interest-rate equations (when reaction functions of the monetary authorities are specified) (1.11), (1.11)′, (1.11)″, (1.17), (1.17)′, (1.17)″, and through the total-sales equations (1.9), (1.9)′, (1.9)″.

A few further points about this model should be noted. First, if for a given country a reaction function of the monetary authorities is not specified, then the interest rate for that country is implicitly determined. The solution value of the interest rate is, speaking loosely, the rate that makes equation (1.4), the government budget constraint, hold. If the interest rate is instead explained by a reaction function, then $B^1{}_{1g}$, the (negative of) the amount of government securities outstanding, is taken to

[12] There are clearly a number of ways in which one can model the allocations of goods and securities among countries. The present model is not restricted to one particular way. See Hickman (1973) for a discussion of the allocation of goods among the various countries in the LINK model.

be endogenous. In this case the solution value of $B^1{}_{1g}$ is, again speaking loosely, the value that makes equation (1.4) hold.

Second, in the regime of flexible exchange rates, the exchange rates are also implicitly determined. In the above discussion, e_2 and e_3 were matched to equations (1.7)′ and (1.7)″, the equations that equate the supply of securities of countries 2 and 3 to the demand for them. In the regime of fixed exchange rates, the international reserve holdings of the countries are implicitly determined. In this case, Q_2 and Q_3 are the variables matched to equations (1.7)′ and (1.7)″. It is also possible, if desired, to add equations explaining e_2 and/or e_3 to the model and interpret these equations as reaction functions of some particular government authority or authorities. If this is done, then Q_2 and/or Q_3 must be taken to be endogenous. This procedure is analogous to the procedure of estimating equations explaining R_1, R_2, and R_3; interpreting these equations as reaction functions of the monetary authorities; and taking $B^1{}_{1g}$, $B^2{}_{2g}$, and $B^3{}_{3g}$ to be endogenous.

Third, if the bonds of the three countries are perfect substitutes, then equations (1.13), (1.13)′, and (1.13)″ drop out of the model, and the above matching of variables and equations must be modified. This case is considered in detail in Fair (1978*b*) for the two-country model. It will not be discussed further here except to note that if the bonds are perfect substitutes, then it is not logically consistent to postulate reaction functions of the government authorities with respect to both a country's interest rate and its exchange rate.

Fourth, even though the present model is relatively small, it is not an easy task to collect the necessary data for it. The data first of all must satisfy equations (1.1)–(1.9), which requires for each country linking its national-income and flow-of-funds accounts. For the United States this is fairly straightforward to do, as described in Fair (1976), but for countries that have poorer data than does the United States, some data may have to be made up. Also, for most pairs of countries, data on $B^j{}_{ig}$ and $B^j{}_{ip}$ do not exist, although it is generally possible to get data on a country's total foreign security holdings. The same holds true for $M^j{}_{ig}$ and $M^j{}_{ip}$. Much of the data on the allocation of a country's total holdings of foreign securities and foreign money among the individual foreign countries will thus have to be made up.

Finally, it should be noted that one important feature of the single-country model in Fair (1976) that is lost in the model in this section is an explicit treatment of disequilibrium effects. Disequilibrium effects are present in the model in this section in that the price of the good of each country is assumed to be set by its firm sector (equations [1.15], [1.15]′, and [1.15]″), rather than being such as to clear the goods markets each period. Also, the use of the aggregate activity variables, X_{1f}, X_{2f}, and X_{3f}, in equations (1.16), (1.16)′, and (1.16)″, respectively, can be assumed in part to be accounting for disequilibrium effects. Nevertheless, it should be

clear from comparing the model in Fair (1976) to the model in this section that disequilibrium effects are only crudely accounted for here, and this is probably one of the first restrictions that should be relaxed if the model in this section is expanded. Within the present model one can include in the Z_1 vector variables that may pick up disequilibrium effects, but any variables so included must be taken to be exogenous.

It is, of course, a matter of judgment whether or not one wants to restrict the model in the Appendix in the ways proposed in this section, and, if desired, it is fairly straightforward to lessen some or all of these restrictions. It is clearly an open question whether an estimated version of the model in this section would be a more accurate representation of the economic linkages among countries than, say, some future version of the LINK model. Given, however, the enormous task of accounting for all the flows of funds in the LINK model or in a similar model, it does seem worthwhile to try the small approach suggested in this paper. After the model proposed in this section has been estimated and analyzed, one can then be concerned, within the context of this basic model, with further disaggregation.[13]

APPENDIX: A THREE-COUNTRY MODEL OF THE BALANCE OF PAYMENTS

The model presented in this Appendix is a three-country version of the two-country model of the balance of payments in Fair (1978*b*). Different versions of the two-country model were considered, and the one used for present purposes is the one in which there is a bank sector and in which the labor and goods markets are not always in equilibrium. The notation used here differs from the notation in Fair (1978*b*), because of the need to keep track of three countries rather than two. The countries are numbered 1, 2, and 3. A subscript number for a variable denotes that the variable pertains to the particular country, and a superscript number for a variable denotes that the variable is held or purchased by the particular country. There are four sectors per country: household, firm, bank, and government. Subscripts h, f, b, and g will be used to denote these sectors, respectively. Each country specializes in the production of one good (X). Labor (L) is homogeneous within a country, and there is no labor mobility among countries. Each country has its own money (M), which takes the form of demand deposits in the bank sector, and its own bond (B). The bonds are one-period securities. If a sector is a debtor with respect to a bond (i.e.,

[13] At this point, further disaggregation and expansion could include 1) disaggregation of goods by type; 2) disaggregation of securities by type and maturity; 3) accounting more explicitly for disequilibrium effects; 4) accounting for the effects of capital gains and losses on behavior; and 5) generally making more variables endogenous. Except for 1) and 2), Model A is expanded in this way.

a supplier of the bond), then the value of B for this sector is negative. The bank sector of each country holds bank reserves with its government (BR), some of which are borrowed (BO). The reserve-requirement ratio is RR, and the discount rate is RD. Prices, wage rates, and interest rates are denoted P, W, and R, respectively. e_2 is the price of country 2's currency in terms of country 1's currency, and e_3 is the price of country 3's currency in terms of country 1's currency. e^*_2 is the (one-period) forward price of country 2's currency in terms of country 1's currency, and e^*_3 is the forward price of country 3's currency in terms of country 1's currency. The government of each country holds a positive amount of the international reserve (Q), whose price is 1.0, and it taxes its citizens using a vector (T) of tax parameters.

Consider country 1. The household sector is assumed to determine jointly its labor supply and its demand for the three goods, the three monies, and the three bonds. It takes as given the wage rate, the three prices, the three interest rates, the tax parameters, the two exchange rates, the two forward rates, and all lagged values. The vector of all relevant lagged values will be denoted as Z_{1h}. These decisions are assumed to be derived from a multiperiod maximization problem. Expectations of various future values, which are needed for such problems, are assumed to be a function of current and lagged values. The equations representing the decisions for the current period will be written as:

(1) $L_{1h} = f_1(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [labor supply]

(2) $X^1_{1h} = f_2(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [demand for the good of country 1]

(3) $X^1_{2h} = f_3(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [demand for the good of country 2]

(4) $X^1_{3h} = f_4(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [demand for the good of country 3]

(5) $M^1_{1h} = f_5(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [demand for the money of country 1]

(6) $M^1_{2h} = f_6(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [demand for the money of country 2]

(7) $M^1_{3h} = f_7(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [demand for the money of country 3]

(8) $B^1_{1h} = f_8(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [supply of (−) or demand for the bond of country 1]

(9) $B^1_{2h} = f_9(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$ [demand for the bond of country 2]

(10) $B^1_{3h} = f_{10}(W_1, P_1, P_2, P_3, R_1, R_2, R_3, T_1, e_2, e_3, e^*_2, e^*_3, Z_{1h})$. [demand for the bond of country 3]

These ten equations are not independent, since they must satisfy a budget constraint. This constraint is as follows. First, the taxable income of the household sector (Y_{1h}) is assumed to be

(11) $Y_{1h} = W_1 L_{1h} + R_1 B^1_{1h} + e_2 R_2 B^1_{2h} + e_3 R_3 B^1_{3h}$, [taxable income]

where the first term on the RHS is wage income, the second term is interest income or interest payments on the domestic bond, and the third and fourth terms are interest income on foreign bonds. Second, net taxes paid by the household sector (V_{1h}) is assumed to be a function of Y_{1h} and T_1:

(12) $V_{1h} = f_{12}(Y_{1h}, T_1)$. [net taxes paid]

The financial saving of the household sector (S_{1h}) is then

(13) $S_{1h} = Y_{1h} - V_{1h} - P_1 X^1_{1h} - e_2 P_2 X^1_{2h} - e_3 P_3 X^1_{3h}$, [saving of the household sector]

where the last three terms are expenditures on goods. Finally, the budget constraint is

(14) $O = S_{1h} - \Delta M^1_{1h} - e_2 \Delta M^1_{2h} - e_3 \Delta M^1_{3h} - \Delta B^1_{1h} - e_2 \Delta B^1_{2h} - e_3 \Delta B^1_{3h}$, [household sector budget constraint]

which says that any nonzero level of saving of the household sector must result in the change in at least one of its assets or liabilities.

Before discussing the firm sector it will be useful to consider briefly the case in which the bonds of the three countries are perfect substitutes. From country 1's perspective the covered interest rate on the bond of country 2, say R^1_2, is $(e_2/e^*_2)(1 + R_2) - 1$. Similarly, the covered interest rate on the bond of country 3, say R^1_3, is $(e_3/e^*_3)(1 + R_3) - 1$. If for $R_1 = R^1_2 = R^1_3$ people are indifferent as to which bond they hold, then the bonds are defined to be perfect substitutes. In this case, equations (9) and (10) drop out of the model, and $R_1 = R^1_2 = R^1_3$ always. It is unnecessary for present purposes to consider this case in any detail. A complete discussion of the perfect-substitution case in the two-country model is contained in Fair (1978*b*). Note that the "perfect mobility" regimes for Model A in Section III of this paper are regimes in which the bonds in the two countries are perfect substitutes *and* in which the forward rate is always assumed to be equal to the spot rate. Note also that in the nonperfect-substitution case in this appendix the covered interest rates are implicit in equations (9) and (10), since R_2, R_3, e_2, e_3, e^*_2, and e^*_3 all enter as arguments in these equations.

For simplicity, the firm sector is assumed to hold no foreign bonds and no money. It is assumed to determine jointly its price (P_1), its production (X^*_{1f}), its demand for the three goods for investment purposes (X^1_{1f}, X^1_{2f}, X^1_{3f}), its wage rate (W_1), the maximum amount of labor that it will employ in the period (L_{1f}), and its supply of (−) or demand for the bond of country 1 (B^1_{1f}). It takes as given R_1, T_1, P_2, P_3, e_2, e_3, and all lagged values (Z_{1f}). These decisions are also assumed to be derived from a multiperiod maximization problem, with the equations representing the decisions for the current period written as:[1]

(15) $P_1 = f_{15}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$ [price of the good of country 1]

(16) $X^*_{1f} = f_{16}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$ [production of the good of country 1]

(17) $X^1_{1f} = f_{17}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$ [demand for the good of country 1]

(18) $X^1_{2f} = f_{18}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$ [demand for the good of country 2]

(19) $X^1_{3f} = f_{19}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$ [demand for the good of country 3]

(20) $W_1 = f_{20}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$ [wage rate of country 1]

(21) $L_{1f} = f_{21}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$ [maximum amount of labor that the firm sector will employ in the period]

(22) $B^1_{1f} = f_{22}(R_1, T_1, P_2, P_3, e_2, e_3, Z_{1f})$. [supply of (−) or demand for the bond of country 1]

Disequilibrium in the labor market is handled as follows. First, note that $L_{1f} + L_{1g}$ is the maximum amount that the household sector can work in the period, where L_{1g} is the amount of labor employed by the government. (The bank sector is assumed to employ no labor.) It is assumed that the firm and government sectors make their decisions regarding L_{1f} and L_{1g}

[1] See Chapter 3 in Fair (1974) for a detailed discussion and analysis of this type of model of firm behavior. For present purposes, the production-function constraint on the firm sector should be assumed to be incorporated into the decision equations (15)–(22). For the model in Fair (1974), a production function was postulated explicitly, and the possibility that it may at times be optimal for a firm to hold excess labor and excess capital was considered.

It should also be noted that in the theoretical model in Fair (1974) the interest rate has a positive effect on the price that a firm sets, and so R_1 is included as an explanatory variable in equation (15). In the empirical work in Fair (1976) the bond rate did have a significant and positive effect on the price variable of the firm sector.

before the household sector makes its decisions, and that the household sector takes this possible labor constraint into account in making its decisions. Equations (1)–(10) are thus assumed to represent the household sector's decisions that incorporate this possible labor constraint, so that L_{1h} in (1) is always less than or equal to $L_{1f} + L_{1g}$.

Consider now the firm sector's adjustment to disequilibrium in the labor market. If L_{1h} is strictly less than $L_{1f} + L_{1g}$, then the firm sector is assumed to get only the amount $L_{1h} - L_{1g}$ of labor in the period. Call this amount L'_{1f}:

(23) $L'_{1f} = L_{1h} - L_{1g}$. [actual amount of labor employed by the firm sector in the period. $L'_{1f} \leq L_{1f}$.]

In the case in which $L'_{1f} < L_{1f}$, the firm sector is assumed to change its production decision during the period, and so equation (16) should be interpreted as reflecting this fact.

With respect to the goods market, the total amount of sales of the firm sector (X_{1f}) is

(24) $X_{1f} = X^1_{1h} + X^1_{1f} + X^1_{1g} + X^2_{1h} + X^2_{1f} + X^2_{1g} + X^3_{1h} + X^3_{1f} + X^3_{1g}$. [total sales of the good of country 1]

The firm sector is assumed to hold inventories of the good (I_{1f}), so that any difference between production and sales in the period results in a change in inventories:

(25) $\Delta I_{1f} = X^*_{1f} - X_{1f}$. [change in inventories of the good of country 1]

The lagged value of inventories (I_{1f-1}) is one of the variables in Z_{1f} that affects the firm sector's current decisions.

The equations for the firm sector also must satisfy a budget constraint. The value of taxes paid by the firm sector (V_{1f}) is assumed to be a function of T_1 and of variables that determine profits:

(26) $V_{1f} = f_{26}(T_1, P_1, X^*_{1f}, X^1_{1f}, X^1_{2f}, X^1_{3f}, W_1, B^1_{1f}, L'_{1f}, R_1, P_2, P_3, e_2, e_3, Z_{1h})$. [taxes paid]

The financial saving of the firm sector (S_{1f}) is

(27) $S_{1f} = P_1X_{1f} - P_1X^1_{1f} - e_2P_2X^1_{2f} - e_3P_3X^1_{3f} - W_1L'_{1f} + R_1B^1_{1f} - V_{1f}$, [saving of the firm sector]

and its budget constraint is

(28) $O = S_{1f} - \Delta B^1_{1f}$. [firm sector budget constraint]

The main characteristic of the bank sector is that it takes in deposits (M_{1b}) and makes loans (B^1_{1b}). The bank sector is assumed for simplicity to

employ no labor, buy no goods, pay no taxes, and hold no foreign bonds and monies. Its borrowing from the government is assumed to be a function of R_1 and the discount rate (RD_1):

(29) $BO_1 = f_{29}(R_1, RD_1)$. [bank-borrowing from the government]

The bank sector is assumed to hold no excess reserves, so that bank reserves are determined as

(30) $BR_1 = RR_1 \, M_{1b}$, [bank reserves]

where RR_1 is the reserve requirement ratio. The financial saving of the bank sector (S_{1b}) is

(31) $S_{1b} = R_1 \, B^1_{1b} - RD_1 \, BO_1$, [saving of the bank sector]

and its budget constraint is

(32) $O = S_{1b} - \Delta B^1_{1b} + \Delta M_{1b} - \Delta(BR_1 - BO_1)$. [bank sector budget constraint]

Equation (31) states that the saving of the bank sector equals the difference between the interest revenue on its loans and the interest payments to the government on its borrowing. Equation (32) states that the change in bank loans plus unborrowed reserves $(\Delta B^1_{1b} + \Delta(BR_1 - BO_1))$ equals saving plus the change in deposits $(S_{1b} + \Delta M_{1b})$.

The government is assumed to purchase labor from its own citizens (L_{1g}) and all three goods $(X^1_{1g}, X^1_{2g}, X^1_{3g})$. It also holds the three monies $(M^1_{1g}, M^1_{2g}, M^1_{3g})$ and the three bonds $(B^1_{1g}, B^1_{2g}, B^1_{3g})$, in addition to the international reserve (Q_1). Its financial saving (S_{1g}) is

(33) $S_{1g} = V_{1h} + V_{1f} - W_1 L_{1g} - P_1 X^1_{1g} - e_2 P_2 X^1_{2g} - e_3 P_3 X^1_{3g} + R_1 B^1_{1g} + e_2 R_2 B^1_{2g} + e_3 R_3 B^1_{3g}$, [saving of the government sector]

and its budget constraint is

(34) $O = S_{1g} + \Delta(BR_1 - BO_1) - \Delta M^1_{1g} - e_2 \Delta M^1_{2g} - e_3 \Delta M^1_{3g} - \Delta B^1_{1g} - e_2 \Delta B^1_{2g} - e_3 \Delta B^1_{3g} - \Delta Q_1$. [government sector budget constraint]

The first two terms on the RHS of (33) are tax revenue, the next four terms are purchases of labor and goods, and the last three terms are interest income or payments. Equation (34) states that any nonzero value of government saving must result in the change in at least one of the government's assets or liabilities.

Two further equations complete the model for country 1. The total

amount of deposits in the bank sector (M_{1b}) is:

(35) $M_{1b} = M^1{}_{1h} + M^1{}_{1g} + M^2{}_{1h} + M^2{}_{1g} + M^3{}_{1h} + M^3{}_{1g}$, [total deposits in the bank sector]

and the supply of the bond of country 1 equals the demand for it:

(36) $O = B^1{}_{1h} + B^1{}_{1f} + B^1{}_{1b} + B^1{}_{1g} + B^2{}_{1h} + B^2{}_{1g} + B^3{}_{1h} + B^3{}_{1g}$. [supply of the bond of country 1 equals the demand for it]

Equations (1)–(36) also hold for countries 2 and 3, with appropriate changes of numerical subscripts and superscripts and with appropriate modifications of e_2 and e_3. Call these equations (1)′–(36)′ and (1)″–(36)″. The overall model is then closed by the following three equations:

(109) $O = \Delta Q_1 + \Delta Q_2 + \Delta Q_3$, [no change in total world reserves]

(110) $e^*_2 = f_{110}(\cdots)$, [forward price of country 2's currency]

(111) $e^*_3 = f_{111}(\cdots)$. [forward price of country 3's currency]

For present purposes the determinants of the two forward prices can be left unspecified, although this is admittedly side stepping a difficult problem. Estimating equations (110) and (111) would clearly be an important and difficult part of any modeling effort.

Of the 111 equations, 7 are redundant. The redundant equations are: one from the household equations (1)–(14), one from the firm equations (15)–(28), the same for countries 2 and 3, and one because the savings of all sectors sum to zero: $S_{1h} + S_{1f} + S_{1b} + S_{1g} + e_2(S_{2h} + S_{2f} + S_{2b} + S_{2g}) + e_3(S_{3h} + S_{3f} + S_{3b} + S_{3g}) = 0$. It will be convenient to drop (8), (22), the same for countries 2 and 3, and (109). This leaves 104 equations. If all the government variables (i.e., all the variables with subscript g) except S_{1g}, S_{2g}, and S_{3g} are taken to be exogenous and if all lagged values are taken to be predetermined, then there are 106 variables left. Therefore, two further variables must be taken to be exogenous in order for the model to be determined. These variables are e_2 and e_3 in the fixed-exchange-rate regime and Q_2 and Q_3 in the flexible-exchange-rate regime.

It may be helpful to consider the matching of variables and equations to see that all variables are accounted for. The equations for which there are no obvious LHS variables are (14), (28), (32), (34), (36), and the corresponding equations for countries 2 and 3. To the three budget-constraint equations, (14), (28), and (32), can be matched $B^1{}_{1h}$, $B^1{}_{1f}$, and $B^1{}_{1b}$, and similarly for countries 2 and 3. To the three government-budget-constraint equations, (34), (34)′, and (34)″, can be matched R_1, R_2, and R_3. To (36) can be matched Q_1, which then leaves (36)′ and (36)″ to be matched to e_2 and e_3 or Q_2 and Q_3.

In the model as just outlined the interest rates are matched to the

government budget constraints and therefore implicitly determined. Another possibility is to 1) assume that the monetary authority of each country behaves by controlling the domestic interest rate; 2) estimate a "reaction function" for each monetary authority with the domestic interest rate as the LHS variable; and 3) close the model by taking each government's holdings of domestic securities ($B^1{}_{1g}$, $B^2{}_{2g}$, and $B^3{}_{3g}$) to be endogenous. This was done in Fair (1978*a*) for the single-country model in Fair (1976), and the properties of this version of the model were compared to the properties of the version without the reaction function.

It should finally be noted that the above matching of variables and equations has to be changed in the case in which the bonds of the three countries are perfect substitutes. Again, see Fair (1978*b*) for a complete discussion of this case for the two-country model.

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Comment

FRANCO MODIGLIANI

One can hardly disagree with Fair's premise that the nature of linkages between countries is likely to be profoundly affected by exchange regimes and by the extent of mobility of capital across national boundaries, and that econometric analysis in this area has so far made limited progress. I also agree with his diagnosis that endeavors to secure empirical estimates of linkages so far have paid insufficient systematic attention to the exchange regime and financial aspects, while the empirical work focusing on the latter mechanisms has tended to rely on *ad hoc* models giving insufficient attention to other aspects of the economy. In his paper, Fair first endeavors to provide some "empirical" and "quasi empirical" evidence of the importance of capital flows and exchange regimes and then proposes a fresh attack on the problem.

Unfortunately, the "empirical" evidence, relying on a number of existing econometric models, is not very impressive. The only results that really bear on the issue are those relating to RDX2-MPS in Tables 1 and 2. It is apparent that for up to six years the differential impact is, on the whole,

rather puny, and anyone familiar with model simulations and their reliability cannot be much impressed by significant differences developing in the seventh or eighth year after the shock!

On the other hand, the "quasi evidence" embodied in Table 4 is quite valuable and fascinating, both because of the highly ingenious methodology employed and because the results are in good part counterintuitive and inconsistent with currently prevailing paradigms. Fair's results seem to depend crucially on three elements. (i) His model incorporates mechanisms that have apparently been neglected, among them primarily the effect of devaluation on the real money supply and, hence, finally on real variables, via prices. (ii) He assumes that exchange rate expectations are static. This assumption greatly simplifies matters but is unwarranted, especially in a model concerned with short-run adjustment paths and considering also that the model itself implies that, in response to a shock, exchange rates keep changing for quite a while. (iii) His model labeled "price lags" is characterized by a very strong J-effect: real imports do not respond at all to current prices and hence to devaluation, and even the short-run elasticity for exports is presumably small. Accordingly, in the initial periods the sum of the elasticities is distinctly below unity, i.e., the Marshall–Lerner conditions fail to hold.

All of these elements are relevant in understanding the results, sometimes weird, reported in the left-hand block. Fair attributes these results to some special feature of his model that recognizes "that prices have, other things being equal, a negative effect on demand"; but, as far as I can see, the results are really accounted for by the interaction of the above three elements of which only the first is relatively new. Take, for instance, the weirdest of his results—those for flexible exchanges and perfect capital mobility. Because of assumption (ii), the interest rates must at all times remain equal in the two countries; this is apparently achieved in large part through a sizable devaluation of country 1's currency and mechanism (i): the devaluation by raising prices, cushions the rise in real money supply and hence the decline in interest rates; correspondingly, the revaluation of country 2's currency, by lowering prices, leads to a lower interest rate. Because of assumption (iii), the devaluation substantially worsens the current account balance of country 1, with well-known deflationary effects outweighing any possible short-run expansionary effect of lower interest rates. Hence, the final result is a fall in real income. At the same time, in country 2's currency, by lowering prices, leads to a lower interest rate. both contribute to expanding income.

On the other hand, when capital is completely immobile, and thus interest rates do not have to be equalized, the expansionary effect of a lower interest rate in country 1 leads to an incipient deterioration in the current balance, which, in view of the failure of the Marshall–Lerner conditions, can be offset only by an *appreciation* of the exchange. This further

boosts the income of 1 and reduces that of 2. One can only concur with Fair's judgment that this result is not very "realistic." But I would suggest that the same is true of the perfect mobility case, and, in both cases, not because of the extreme assumptions about capital mobility but primarily because of assumption (ii) interacting with (iii). Once we allow for exchange expectations and forward exchange markets, so that the equality of interest rates is replaced by interest parity, the path of adjustment in the presence of J-effects can be expected to look quite different.

The results for the case of a fiscal shock, reported in Part II of the table, strike me as less enlightening, since in Fair's experiment the increased expenditure is entirely financed by money—and in fact by high-powered money. As a consequence, his results appear to be swayed by the monetary effect—or at any rate, this is what I would infer from the table. In my view, it would be more enlightening to run the simulation with the money supply kept constant, because the government expenditure shock can be seen as a prototype of a large variety of demand shocks.

One can presumably obtain a rough approximation of the pure effect of a demand shock by subtracting from the entries of Part II the corresponding ones of Part I. If one relies on this somewhat perilous approach, one finds again some strange results. For instance, under flexible exchanges and perfect mobility, the shock appears to raise the income of country 1 by about 1.3, and to *lower* that of country 2 by some —.3. Both multipliers, and especially the second, are not in line with what one would expect from the received paradigms, and the reason appears to be, again, primarily in the failure of the Marshall–Lerner conditions: the appreciation of currency 1 due to the (incipient) higher interest rate *deteriorates* the balance of country 2, as well as raises its price level and interest rate with depressing effects on both accounts. I submit that these results again are not very "realistic"—though admittedly a good model of exchange market dynamics in the face of strong J-effects is still missing.

With this background I turn to a few comments on the programmatic Section IV. I find myself in full sympathy with the spirit of that program, and the critical remarks that follow are meant to contribute to it in a constructive spirit.

I have first a question of basic strategy: there clearly are advantages in moving away from the LINK format toward a stripped-down, standardized model for all countries. But how far should one go? That depends in part on the purpose of the exercise. If it is primarily to serve analytical purposes and each of the countries is but a prototype, then the case for standardization is strongest. But then one might ask why not push further Fair's earlier design of coupling the United States with many other United States, each multiplied by suitable scale factors and with judgmental variations in a few crucial parameters? Before doing so, the U.S. model might well be stripped down to the format of the "small approach."

If, on the other hand, one aims at actual forecasting for individual countries, be it unconditional or conditional on alternative policies, then one *must* take into account specific features of each economy and, especially, of its capital markets. As I have concluded elsewhere,[1] the working of the monetary mechanism is significantly affected by the composition of both firms' and households' balance sheets and the extent of rationing in the bank credit and bond markets. And this mechanism, in turn, will play an important role in the linkage through capital movements.

In the light of the above considerations, there seems to be little point in commenting on the individual equations of the "small" model proposed by Fair. I will limit myself to calling attention to two shortcomings, which in my view are so basic that they would have to be taken care of in order to obtain "realistic" results, independently of the specific countries to be "linked." The most serious one is the failure, noted earier, to model the forward exchange market and exchange rate expectations affecting the demand for foreign "bonds," and, probably, the related one of not distinguishing between long- and short-term markets and capital movements (including the possibility of short-term borrowing and lending abroad by firms). The other shortcoming is the failure to distinguish between real and nominal rates (or to allow appropriately for expectations of inflation). Both defects are, of course, remediable, though the first clearly presents a serious challenge.

Comment

J. DAVID RICHARDSON

I think that the first part of Ray Fair's paper documents very nicely the need for the second. Whether the quantitative predictions in Part I from the seven extant international linkage models are "closer than one might have expected" or notably divergent, explanations for any divergence at all are uncomfortably speculative. The large size of the seven models precludes definitive comparisons of behavior and structure (although, see, Deardorff and Stern 1977). Better for purposes of interpretation that a small, synthetic, and flexible model be constructed and employed—one that can be parametrically transformed to cover a large sample of alternative structures among several popular extremes. Part II does exactly that and pinpoints (reasonably to my mind) the extent of international capital mobility and of policy determination of exchange rates as the key reasons for divergent model predictions.

Many aspects of the Fair International Linkage Model (FILM?) deserve favorable mention, because macroeconometric work that follows should

[1] See Mattioli lectures, Milan, Italy, October 1977, forthcoming.

emulate them. One is the meticulous attention to stock-flow consistency, adding-up properties, and flow-of-funds precision (the analytical antecedent to Fair's econometric analysis is Mundell's [1963, 1964] meticulous and classic work). Another feature is the promising approach to disequilibrium dynamics proposed in the appendix, although regrettably not in the text (the analytical roots being the closed-economy work of Clower 1965, Patinkin 1965, Barro and Grossman 1976, Malinvaud 1977, and the econometric roots being presumably Fair and Jaffee 1972). A third feature is the restoration of supply-side macroeconometric influences through rational behavior of firms toward employment needs and inventory (also in the appendix but not in the text), and also through the impact of import prices, exchange rates, and interest rates on costs of production.

But other aspects of the work detract somewhat from its appeal. After outfitting his model in Mundell's (1963, 1964) familiar extreme regimes (rigidly fixed/cleanly floating exchange rates; no international capital mobility/perfect international capital mobility), Fair obscures the comparison of his quantitative results to Mundell's qualitative conclusions: Fair's fiscal expansion is financed by money creation; Mundell's by government borrowing. It would have been preferable to be able to observe more directly how much quantitative difference Mundell's categorizations really make.

Second, Fair's treatment of international linkages through capital movements would be measurably more compelling if he had included forward premia/discounts as one of the determinants of stock demands for bonds and cash balances. They are as important as interest rates in determining rates of return and borrowing costs. In excluding them by appeal (presumably) to stable exchange rate expectations (footnote 7 of the text and footnote 1 of the appendix), Fair has surrendered to the most convenient, tempting, inelastic, and nonrational of expectations mechanisms—that expected exchange rate changes remain exogenously stable, even in the face of endogenously flexible and variable exchange rates. Having turned frequently to this palliative myself, I do not want to sound too harsh. But I conjecture that important capital account linkages among nations would be revealed if exchange rate expectations were modeled rationally and endogenously, and if asset preference depended, as it should, on comparative *covered* rates of return. A closely related, and perhaps equally valuable, addition to asset preference would be the incorporation of exchange-rate-related capital gains and losses in stock-demand behavior.

Third, I wish that Fair had highlighted better the role that debt service may be playing in his model. He is to be commended for including it, but the inclusion sets up the possibility for J-curve responses of the combined capital and services account to rate-of-return changes, responses that generate many of the same counterintuitive predictions as J-curve responses of the merchandise trade account to exchange rate changes. A rise in

domestic rates of return leads to temporarily increased capital inflows and permanently increased debt-service outflows (see, especially, Willett and Forte 1968). With zero capital mobility, in fact, debt service (on existing stocks) is all that remains, and a rise in domestic rates of return *weakens* domestic currency in the foreign exchange market, short run and long, *ceteris paribus*. With certain model structures and parameters, including debt service can furthermore imply unstable equilibria. Fair says little about the stability properties of his model. One place where they might have helped is in explaining why expansionary domestic monetary policy causes foreign recession under flexible exchange rates with zero capital mobility (p. 221). He twists and turns to arrive at an explanation that has no foundation in the microeconomic behavior of economic agents. I suspect, by contrast, a locally unstable equilibrium.

Attention to these quarrels notwithstanding, I have great respect and enthusiasm for this paper. It sets its feet firmly in theory, with precise attention to the consistency of its behavioral specification, and then carefully avoids building a body so intricate and obese that vision of the theory is obscured totally by clouds of equations. Since theory, by its nature, is designed to pose refutable generalizations (as Mundell [1964, pp. 421–22] impatiently reminded McLeod), empirical work that loses clear sight of theory is handicapped in its usefulness. Fair is to be commended, by contrast, for econometric work that illuminates theory and promises to interpret reality as well.

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