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AT YALE UNIVERSITY

Box 2125, Yale Station
New Haven, Connecticut 06520

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A MODEL OF THE WORLD ECONOMY

Ray C. Fair

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by

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I. Introduction

A model of the world economy is developed and analyzed in this paper. The approach taken here differs from the two basic approaches that have been followed in previous work in the development of world economic models. One basic approach is to construct a two-country model of the world that is simple enough to be analyzed by standard analytic techniques. Examples of this approach are the studies of Mundell [6, Appendix to Chapter 18], Swoboda and Dornbusch [7], Allen [1], Henderson [5], and Dornbusch [3]. This approach is noneconometric in the sense that none of the equations in the models are estimated on the basis of actual data. The other basic approach is to link econometric models of different countries together into one large model of the world economy, where the resulting world model is then analyzed by means of simulation techniques. The main example of this approach is, of course, Project LINK [2].

Although the models developed under the first approach are relatively easy to analyze, their limitations are fairly obvious. They are too small to incorporate all of the main features of an economy, and none

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of them are empirically grounded. The problem with the approach of Project LINK, on the other hand, is one of feasibility. It is, for example, an enormous task to link the financial sectors of the individual econometric models together, and Project LINK has not yet done this. One of the key limitations of the current LINK model is the treatment of capital movements as exogenous. The model is not yet a complete model of the world economy; it is still primarily a trade model.

The approach taken here in the construction of a world economic model is somewhere in between the two previous approaches. It is an attempt to overcome many of the limitations of the first approach without at the same time sacrificing the feasibility of developing a complete model. This approach is as follows. I first began with my recent 84-equation econometric model of the U.S. economy [4]. I then assumed that the rest of the world (ROW) could be represented with slight modifications by the same 84-equation model. Combining these two models and adding a few extra equations that were necessary to close the overall model resulted in a 180-equation model of the world. This world model is thus partly empirically grounded and partly not. The U.S. part of the model is completely grounded, but the ROW part is completely made up. The ROW part of the model is empirically realistic only to the extent to which the economy of the rest of the world can be realistically approximated by a model of the U.S. economy.

An important feature of the U.S. model is that all flows of funds among the sectors are accounted for, including the flows of funds between the domestic sectors and the foreign sector. This feature is retained when the U.S. and ROW models are combined, which means that all international capital movements are accounted for. A trade deficit of the U.S., for example, results in the increase in at least one asset of the rest of the world. The model is complete in the sense that it accounts for flows of both goods and capital.

The model is used to examine the effects of U.S. monetary and fiscal policy actions on the world economy in four different regimes. The regimes are: (1) zero capital mobility and a fixed exchange rate (denoted at (0,R)), (2) perfect capital mobility and a fixed exchange rate (denoted as (∞,R)), (3) zero capital mobility and a flexible exchange rate (denoted as (0,e)), and (4) perfect capital mobility and a flexible exchange rate (denoted as (∞,e)). The questions examined here are thus standard ones in international economics, questions that have previously been examined by use of the models developed under the first approach.

The results of analyzing the model are presented and discussed in Section IV. The important conclusions of this analysis are summarized in Section V. Given that the model is only half empirically grounded, an important question is how the results in Section IV should be interpreted. Are the qualitative and quantitative properties of the model in a given regime good approximations to the actual properties of the world economy in that regime? Although it is obviously not possible to provide a definitive answer to this question, it does seem to me that the properties of the present model are more likely to be good approximations in this regard than are the properties of the models developed under the first approach. When the results of analyzing the present model differ from the results of analyzing these other models, I would argue that the present results are more to be trusted. The present model also has the advantage of allowing more detailed answers to be given to specific policy questions. Given that ProjectLINK has not advanced to the point where it has been able to analyze the kinds of questions considered in Section IV, it thus seems to me that the results in Section IV are of some interest and may have made some contribution toward improving our understanding of the actual properties of the world economy.

It is, needless to say, difficult to explain a 180-equation model in one paper, especially in a paper short enough to be acceptable to a professional journal. I have adopted the following strategy in explaining the model. In the next section a 17-equation model is presented that captures the essence of the complete model with respect to the treatment of the financial variables. This model is called Model T (T for tiny). It shows clearly the links between the saving of each sector and the changes in the sector's asset and liability variables. The complete model, called Model A (A for actual), is then briefly discussed in Section III. Only a few equations of Model A are presented in Section III, these being the ones that are most important for the discussion in Section IV.

The U.S. part of Model A (and thus also the ROW part) is described in detail in [4]. Although the results in Section IV are likely to be better understood if [4] (in particular Chapter 9 in [4]) has been read, I have tried to write this paper without assuming this. A detailed discussion of the construction of Model A and a list of all of the equations in the model are presented in an appendix to this paper, which is available from the author upon request. The discussion in the appendix assumes that [4] has already been read. In the main text of the paper I have tried to mention all of the properties of the model that are relevant for understanding the results in Section IV. I may not, however, have been completely successful at this. Any puzzlement that the reader may have regarding the results in Section IV and the general structure of Model A can either be blamed on me for failing to provide an adequate explanation or on the reader for failing to read [4] and the appendix to this paper first.

II. Model T

Model T is presented in Table 1. It consists of 17 equations. There are two sectors (private and government) and two securities (money and bonds) per country. Equations (1)-(4) determine the savings of the sectors. These four equations represent most of the equations in a typical macroeconometric model. It is unnecessary for purposes of this section to specify the variables that influence the saving of each sector, but these variables would include such obvious ones as prices, wage rates, interest rates, beginning-of-period assets and liabilities, government policy variables, the exchange rate, and expectations (somehow measured) of future values of various variables. Since a payment by one sector is a corresponding receipt to some other sector, the savings of all of the sectors sum to zero, as noted in Table 1. Payments between the two countries include payments for goods and services, interest payments, and transfer payments.

Equation (5) is a demand-for-money equation for country 1, and equation (7) equates the supply of money to the demand for money in country 1. Equations (6) and (8) are similar equations for country 2. It is again unnecessary for purposes of this section to specify the variables that explain the demand for money in each country; they may include for each country both interest rates as well as other variables.

TABLE 1. Model T

Two Countries: 1 and 2
Two Sectors per Country: Private (P) and Government (G)
Two Securities per Country: Money (M) and Bonds (B)

<u>Notation in Alphabetic Order</u> (subscript t refers to period t , stocks are end-of-period stocks):

BG_{it} = value of bonds issued by the government of country i , denominated in the currency of country i (i = 1, 2)

BP^{j}_{it} = value of the bonds of country j held by the private sector of country i , denominated in the currency of country j (i = 1, 2 ; j = 1, 2)

e_t = exchange rate, price of country 2's currency in terms of country 1's currency

MG_{it} = amount of money issued by the government of country i (i = 1, 2)

MP_{it} = amount of money held by the private sector of country i (i = 1, 2)

R_{it} = reserves of country i , denominated in some fixed unit (i = 1, 2)

r_{it} = interest rate on the bonds of country i (i = 1, 2)

SG_{it} = saving of the government of country i , denominated in the currency of country i (i = 1, 2)

SP_{it} = saving of the private sector of country i , denominated in the currency of country i (i = 1, 2)

z_t = price of a unit of reserves in terms of country 1's currency (assumed to remain unchanged over time)

<u>Equations of Model T</u>:

1. $SP_{1t} = f_1(\ldots)$
2. $SG_{1t} = f_2(\ldots)$
3. $SP_{2t} = f_3(\ldots)$
4. $SG_{2t} = f_4(\ldots)$

[The saving of each sector is a function of a number of variables. These four equations stand for most of the equations in a typical macro-econometric model. The savings of all sectors sum to zero: $SP_{1t} + SG_{1t} + e_t(SP_{2t}+SG_{2t}) = 0.$]

TABLE 1 (continued)

5.	$MP_{1t} = f_5(\ldots)$	[Demand-for-money equations in the two countries.]
6.	$MP_{2t} = f_6(\ldots)$	
7.	$MG_{1t} = MP_{1t}$	[Demand for money equals the supply of money in the two countries.]
8.	$MG_{2t} = MP_{2t}$	
9.	$0 = SP_{1t} - (BP^1_{1t}-BP^1_{1t-1}) - (MP_{1t}-MP_{1t-1}) - e_t(BP^2_{1t}-BP^2_{1t-1})$	[Equations linking the saving of each sector to the changes in its financial assets and liabilities.]
10.	$0 = SG_{1t} + (BG_{1t}-BG_{1t-1}) + (MG_{1t}-MG_{1t-1}) - z_t(R_{1t}-R_{1t-1})$	
11.	$0 = SP_{2t} - (BP^2_{2t}-BP^2_{2t-1}) - (MP_{2t}-MP_{2t-1}) - \frac{1}{e_t}(BP^1_{2t}-BP^1_{2t-1})$	
12.	$0 = SG_{2t} + (BG_{2t}-BG_{2t-1}) + (MG_{2t}-MG_{2t-1}) - \frac{z_t}{e_t}(R_{2t}-R_{2t-1})$	
13.	$BG_{1t} = BP^1_{1t} + BP^1_{2t}$	[Value of bonds issued by the government of each country equals the value of bonds held by the private sectors.]
14.	$BG_{2t} = BP^2_{2t} + BP^2_{1t}$	
15.	$R_{2t} - R_{2t-1} = -(R_{1t} - R_{1t-1})$	[No change in total world reserves.]
16.	$BP^2_{1t} = f_7(\ldots)$	[In the cases of zero and perfect capital mobility these equations drop out. In the zero mobility case both BP^2_{1t} and BP^1_{2t} must be taken to be exogenous, and in the perfect mobility case one of the two must be taken to be exogenous.]
17.	$BP^1_{2t} = f_8(\ldots)$	

Notes:

i) Because the savings of all sectors sum to zero, one of the 17 equations is redundant. There are thus 16 independent equations in the general case and 14 independent equations in the cases of zero and perfect capital mobility.

ii) In the case of perfect capital mobility there is only one interest rate ($r_{1t} = r_{2t}$ always).

iii) If BG_{1t} and BG_{2t} are taken to be exogenous, as is generally assumed, then the endogenous variables in the model are as follows:

TABLE 1 (continued)

General case (16 independent equations): SP_{1t}, SG_{1t}, SP_{2t}, SG_{2t}, MP_{1t}, MP_{2t}, MG_{1t}, MG_{2t}, BP^1_{1t}, BP^2_{1t}, BP^2_{2t}, BP^1_{2t}, R_{2t}, r_{1t}, r_{2t}, and either R_{1t} or e_t.

Zero capital mobility case (14 independent equations): Same as in the general case except that BP^2_{1t} and BP^1_{2t} are excluded from the list of endogenous variables.

Perfect capital mobility case (14 independent equations): Same as in the general case except that either BP^2_{1t} or BP^1_{2t} is excluded from the list of endogenous variables and $r_{1t} = r_{2t}$.

iv) The following assumptions are implicit in the model:

a) No labor mobility.
b) The sectors of country 1 do not hold any currency of country 2 and vice versa.
c) The government of country 1 does not hold any bonds of country 2 and vice versa.
d) Money in each country takes the form of currency, not demand deposits.
e) Bonds are one-period securities (since capital gains and losses on bonds due to interest rate changes are ignored).

Equations (9)-(12) link the saving of each sector to the changes in its assets and liabilities. Equations (10) and (12) are sometimes called government budget constraints. Equation (10), for example, states that any nonzero level of saving of the government of country 1 $(SG_{1t} \neq 0)$ must result in country 1 in the change in bonds outstanding (BG_{1t}), in the money supply (MG_{1t}), in reserves (R_{1t}), or in some combination of the three. For simplicity it is assumed that the sectors of country 1 do not hold any currency of country 2 and vice versa, that the government of country 1 does not hold any bonds of country 2 and vice versa, that money in each country takes the form of currency,[1] and that bonds are one-period securities (so that capital gains and losses on bonds due to interest rate changes can be ignored). It is also assumed that z_t, the price of a unit of reserves in terms of country 1's currency, does not change over time. The existence of equations (9)-(12) in the model means that all flows of funds are accounted for.

Equations (13) and (14) equate the supply of bonds from the two governments to the demand for bonds from the two private sectors. The private sectors are assumed to be net creditors with respect to the governments. Equation (15) states that the change in reserves for country 2 is minus the change in reserves for country 1: no change in total world reserves.[2]

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[1]It would be easy to modify Model T to include demand deposits as well as currency in the money supply. Model A does include both.

[2]If country 2 were assumed to hold the currency of country 1 (or vice versa), then the currency of country 1 could be taken to be the international reserve currency (or vice versa). In this case it would not be necessary to postulate the existence of R_{1t}, R_{2t}, and z_t in the model.

Equation (16) determines country 1's holdings of country 2's bonds (BP_{1t}^{2}), and equation (17) determines country 2's holdings of country 1's bonds (BP_{2t}^{1}). Consider BP_{1t}^{2} first. The three financial assets of the private sector of country 1 are its holdings of the bonds of the government of country 1 (BP_{1t}^{1}), its holdings of money (MP_{1t}), and its holdings of the bonds of the government of country 2 (BP_{1t}^{2}). Equation (9) links the change in these three assets to the saving of the private sector of country 1 (SP_{1t}). Given the asset values of the previous period and the current exchange rate and given three of the four values of BP_{1t}^{1}, MP_{1t}, BP_{1t}^{2}, and SP_{1t}, the other value is determined by equation (9). SP_{1t} is determined by equation (1) and MP_{1t} is determined by equation (5), which thus leaves either BP_{1t}^{1} or BP_{1t}^{2} to be determined by some other equation. Equation (16) is this other equation. It should be thought of as reflecting the decision of the private sector of country 1 regarding the allocation of its non-money assets between the bonds of the two countries. It is again unnecessary for purposes of this section to specify the exact set of variables that influence this decision, although two obvious variables that are likely to be important are the difference between the interest rates in the two countries and, since the bonds are one-period securities, expectations (somehow measured) of next period's exchange rate. Equation (17) is a similar equation for country 2 and reflects the decision of the private sector of country 2 regarding the allocation of its non-money assets between the bonds of the two countries.

In the case of zero capital mobility BP_{1t}^{2} and BP_{2t}^{1} must be taken to be exogenous. Their values can be considered to be equal either to zero or to values that existed before capital was restricted from moving between the two countries. In this case equations (16) and (17) drop out of the model.

If there are no restrictions on capital movements, if exchange-rate expectations are static, and if the private sectors are indifferent between which bonds they hold as long as the expected rates of return are equal, there will be only one world interest rate ($r_{1t} = r_{2t}$ always). This case will be called the case of perfect capital mobility.[3] In this case equations (16) and (17) drop out, since the private sectors are now indifferent as to how they allocate their non-money assets between the two types of bonds. It is also not possible in this case to determine both BP^2_{1t} and BP^1_{2t}. The model is underidentified with respect to these two variables, and one of them must be taken to be exogenous.[4]

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[3] If exchange-rate expectations are not static, but instead the exchange rate is expected (by everyone) to change by ρ_t percent in period t, then r_{1t} will equal $r_{2t} + \rho_t$ if there are no restrictions on capital movements and if the private sectors are indifferent between which bonds they hold as long as the expected rates of return are equal. For purposes of this section it is unnecessary to consider the case in which ρ_t is not zero.

[4] This indeterminancy is analogous to the indeterminancy that arises in, say, a two-consumer, two-firm model in which the two consumers are indifferent between the goods produced by the two firms. It is not possible in this model to determine the allocation of the two goods between the two consumers. To see this, let x_i denote the supply of the good of firm i $(i = 1, 2)$, let y_i denote the total demand for goods of consumer i $(i = 1, 2)$, let x^j_i denote the consumption of the good of firm i by consumer j $(i = 1, 2\ ;\ j = 1, 2)$, and let p denote the (one) price of the goods. Consider the following model:

(1) and (2) $\qquad x_i = f_i(p, \ldots)\ , \quad (i = 1, 2)\ ,$

(3) and (4) $\qquad y_i = g_i(p, \ldots)\ , \quad (i = 1, 2)\ ,$

(5) $\qquad y_1 = x^1_1 + x^1_2\ ,$

(footnote 4 continued on the next page)

This completes the discussion of Model T. Because the savings of all sectors sum to zero, one of the equations in the model is redundant. There are thus 16 independent equations in the general case and 14 independent equations in the cases of zero and perfect capital mobility. The endogenous variables in each case are listed in the notes to Table 1. If the exchange rate (e_t) is taken to be endogenous in the model, then reserves (R_{1t}) are exogenous, and vice versa.

III. Model A

Model A is similar in form to Model T, only much larger. In Model A there are four sectors (household, firm, financial, and government) and five securities (demand deposits and currency, bank reserves, bank borrowing, gold and SDRs, and an "all other" category) per country. The model consists of 180 equations, one of which is redundant. In combining the two 84-equation models in the construction of Model A, care had to be taken to insure that the sum of the savings of the eight sectors was zero. In other words, care had to be taken to insure that each payment by the U.S. to the ROW got counted as a receipt by the ROW from the U.S., and vice versa. Data on a few extra variables had to be collected in the

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(6) $$y_2 = x_1^2 + x_2^2 ,$$

(7) $$x_1 = x_1^1 + x_1^2 ,$$

(8) $$x_2 = x_2^1 + x_2^2 .$$

Equations (1) and (2) are supply equations, equations (3) and (4) are demand equations, and equations (5)-(8) are definitions. This model consists of 8 equations and 9 unknowns: x_1, x_2, y_1, y_2, x_1^1, x_2^1, x_1^2, x_2^2, and p. It is thus not possible to determine the allocation of the two goods between the two consumers. One of the x_i^j variables has to be taken as given.

process of constructing the model. For example, for the U.S. model in [4] only data on the net holdings (assets minus liabilities) of the "all other" category of securities of the foreign sector had to be collected, whereas for Model A data on the assets and liabilities of the foreign sector had to be collected separately.

The equations in Model A that are important for the discussion in the next section are presented in Table 3. All the variables that are referred to in the rest of this paper are defined in Table 2. The following is a brief discussion of Table 3. Equation (1) determines the real values of U.S. imports. The real per capita value of imports (IM_{1t}/POP_{1t}) is a function of the price of imports lagged two quarters (PIM_{1t-2}), of the price of domestically produced goods lagged one quarter (PX_{1t-1}), and of the real per capita value of domestically produced goods (X_{1t}/POP_{1t}). The estimate of the coefficient of log PX_{1t-1} is about 3.8 times larger in absolute value than the estimate of the coefficient of log PIM_{1t-2}, which means that the real value of imports is estimated to be more responsive to the price of domestically produced goods than it is to the price of imports. The best results in terms of goodness of fit for this equation were obtained by lagging the price of imports two quarters and the price of domestically produced goods one quarter. Equation (4) in Table 3 determines the real value of ROW imports; it is the same as equation (1) except for the use of ROW variables instead of U.S. variables.

Two important features of equations (1) and (4) are the larger estimated response to the price of domestically produced goods than to the price of imports and the use of nonzero lag lengths for the two price variables. In order to see how sensitive the results of analyzing the

TABLE 2. The Variables in Model A Referred to in This Paper

Subscript t denotes variable for quarter t . All flow variables are at quarterly rates. i = 1 for U.S. and i = 2 for ROW . Nominal U.S. variables are in billions of dollars, and nominal ROW variables are in billions of ROW currency. See Table 2-1 in [4] for a more complete description of the U.S. variables.

B^2_{1t} = total value (in ROW currency) of U.S. holdings of ROW securities (not counting ROW demand deposits and currency)

B^1_{2t} = total value (in dollars) of ROW holdings of U.S. securities (not counting U.S. demand deposits and currency)

$BORR_{it}$ = commercial bank borrowing at federal reserve banks of country i

BR_{it} = bank reserves of country i

$CURR_{it}$ = value of the currency of country i outstanding less the value of the demand deposits of country i held by the government sector of country i

$DISG_{it}$ = discrepancy of the government sector of country i

$DISR_{it}$ = discrepancy of the foreign sector of country i

e_t = exchange rate, dollar value of ROW currency

EX_{it} = real value of the exports of country i

IM_{it} = real value of the imports of country i

M^2_{1t} = total value (in ROW currency) of U.S. holdings of ROW demand deposits and currency

M^1_{2t} = total value (in dollars) of ROW holdings of U.S. demand deposits and currency

MG^2_{1t} = value (in ROW currency) of ROW demand deposits and currency held by the U.S. government sector

MG^1_{2t} = value (in dollars) of U.S. demand deposits and currency held by the ROW government sector

PEX_{it} = price of the exports of country i in the currency of country i

PIM_{it} = price of the imports of country i in the currency of country i

POP_{it} = total population 16 and over of country i

PX_{it} = price of domestically produced goods of country i in the currency of country i

TABLE 2 (continued)

R_{it} = value (in dollars) of gold and SDRs of the government sector of country i

$RBILL_{it}$ = three-month bill rate of country i in percentage points

SAV_{it} = total saving of country i

$SAVG_{it}$ = saving of the government sector of country i

TRP_{1t} = value (in dollars) of net transfer payments from the U.S. to the ROW

TRP_{2t} = value (in ROW currency) of net transfer payments from the U.S. to the ROW

VBG_{it} = value of securities outstanding of the government sector of country i

X_{it} = real value of the sales of domestically produced goods of country i

XG_{it} = real value of the purchases of goods of the government sector of country i

Y_{it} = real value of output of country i

z_t = dollar price of a unit of reserves (equals one for all t)

TABLE 3. Some of the Equations of Model A

1.	$\log\frac{IM_{1t}}{POP_{1t}} = -1.60 - 0.426 \log PIM_{1t-2} + 1.62 \log PX_{1t-1} + 1.17 \log\frac{X_{1t}}{POP_{1t}} + \text{strike dummies}$	[real value of U.S. imports]
2.	$\log PX_{1t} \approx 0.0795 \log PIM_{1t} + \text{other terms}$	[dollar price of U.S. domestically produced goods]
3.	$\log PEX_{1t} = \log PX_{1t} + \text{an exogenous term}$	[dollar price of U.S. exports]
4.	$\log\frac{IM_{2t}}{POP_{2t}} = -1.60 - 0.426 \log PIM_{2t-2} + 1.62 \log PX_{2t-1} + 1.17 \log\frac{X_{2t}}{POP_{2t}} + \text{strike dummies}$	[real value of ROW imports]
5.	$\log PX_{2t} \approx 0.0795 \log PIM_{2t} + \text{other terms}$	[price of ROW domestically produced goods in ROW currency]
6.	$\log PEX_{2t} = \log PX_{2t} + \text{an exogenous term}$	[price of ROW exports in ROW currency]
7.	$PIM_{1t} = e_t PEX_{2t}$	[dollar price of U.S. imports]
8.	$PIM_{2t} = \frac{1}{e_t} PEX_{1t}$	[price of ROW imports in ROW currency]
9.	$EX_{1t} = IM_{2t}$	[real value of U.S. exports]
10.	$EX_{2t} = IM_{1t}$	[real value of ROW exports]
11.	$TRP_{2t} = \frac{1}{e_t} TRP_{1t}$	[value of net transfer payments from the U.S. to the ROW in ROW currency]
12.	$SAV_{1t} = PEX_{1t}EX_{1t} - TRP_{1t} - PIM_{1t}IM_{1t}$	[total saving of U.S. in dollars]

TABLE 3 (continued)

13. $SAV_{2t} = PEX_{2t}EX_{2t} + TRP_{2t} - PIM_{2t}IM_{2t}$ [total saving of ROW in ROW currency]

14. $$0 = SAVG_{1t} + (VBG_{1t} - VBG_{1t-1}) + (CURR_{1t} - CURR_{1t-1}) + (BR_{1t} - BR_{1t-1}) - (BORR_{1t} - BORR_{1t-1}) - e_t(MG^2_{1t} - MG^2_{1t-1}) - z_t(R_{1t} - R_{1t-1}) - DISG_{1t}$$ [U.S. government budget constraint in dollars]

15. $$0 = SAVG_{2t} + (VBG_{2t} - VBG_{2t-1}) + (CURR_{2t} - CURR_{2t-1}) + (BR_{2t} - BR_{2t-1}) - (BORR_{2t} - BORR_{2t-1}) - \frac{1}{e_t}(MG^1_{2t} - MG^1_{2t-1}) - \frac{z_t}{e_t}(R_{2t} - R_{2t-1}) - DISG_{2t}$$ [ROW government budget constraint in ROW currency]

16. $R_{2t} - R_{2t-1} = -(R_{1t} - R_{1t-1})$ [no change in total world reserves]

17. $$0 = SAV_{1t} + (B^1_{2t} - B^1_{2t-1}) + (M^1_{2t} - M^1_{2t-1}) - e_t(B^2_{1t} - B^2_{1t-1}) - e_t(M^2_{1t} - M^2_{1t-1}) - z_t(R_{1t} - R_{1t-1}) + DISR_{1t}$$ [equation relating the total saving of the U.S. to the changes in the relevant asset and liability variables]

model are to these two features, an alternative pair of import equations was used for some of the simulation runs. This pair is:

$$(1)' \quad \log \frac{IM_{1t}}{POP_{1t}} = -1.60 - 1.00 \log PIM_{1t} + 1.00 \log PX_{1t} + 1.17 \log \frac{X_{1t}}{POP_{1t}} + \text{strike dummies} ,$$

$$(4)' \quad \log \frac{IM_{2t}}{POP_{2t}} = -1.60 - 1.00 \log PIM_{2t} + 1.00 \log PX_{2t} + 1.17 \log \frac{X_{2t}}{POP_{2t}} + \text{strike dummies} .$$

For this pair, the coefficients of the two price variables are equal in absolute value and the lag lengths are zero.

The results of analyzing the model may be particularly sensitive to the use of equations (1)' and (4)' instead of equations (1) and (4) in the flexible exchange rate regimes. Given the price lags in equations (1) and (4), any change in the price of imports of a country in a quarter, due, say, to a change in the exchange rate, has no direct effect on the real value of imports of the country in that quarter. The direct effect does not begin until two quarters later. When equations (1)' and (4)' are used instead, however, there is an immediate direct effect. The initial response of the system to a given policy change may thus be quite different in the two cases. Although the data for the U.S. indicate, from the work in [4], that there are price lags in the import equation, it is still of some interest to see what the response of the system would be if there were not.

Equation (2) in Table 3 states that the price of domestically produced goods is a function, among other things, of the price of imports. A 1.0 percent increase in the price of imports, for example, results approximately in a 0.0795 percent increase in the price of domestically produced goods in the current period, other things being equal. Equation

(2) is only approximate because of the treatment of the various price deflators in the model. PIM_{1t} affects another price deflator, which in turn affects PX_{1t}. For present purposes, however, it is sufficient to note that PIM_{1t} affects PX_{1t} in approximately the way indicated in equation (2). Equation (5) is a similar equation for the ROW.

Equation (3) links the price of exports to the price of domestically produced goods. The ratio of PEX_{1t} to PX_{1t} is taken to be exogenous in the model, which is what equation (3) says. Equation (6) is a similar equation for the ROW.

Equation (7) links the price of U.S. imports in dollars (PIM_{1t}) to the price of ROW exports in ROW currency (PEX_{2t}). e_t is the exchange rate, the dollar price of ROW currency.[5] Equation (8) links the price of ROW imports in ROW currency (PIM_{2t}) to the price of U.S. exports in dollars (PEX_{1t}). Equation (9) links U.S. exports to ROW imports, and equation (10) links ROW exports to U.S. imports. Equation (11) links net transfer payments from the U.S. to the ROW in ROW currency to the same thing in dollars.

Equation (12) defines the saving of the U.S. in dollars (SAV_{1t}). SAV_{1t} is analogous to $SP_{1t} + SG_{1t}$ in Table 2 for Model T, although for Model A it is the sum of the savings of four sectors rather than two. In equation (12), $PEX_{1t}EX_{1t}$ is the value of payments from the ROW to the U.S., and $TRP_{1t} + PIM_{1t}IM_{1t}$ is the value of payments from the U.S.

[5] Since the 84-equation model of the ROW is the same as the U.S. model, it is also in units of dollars. e_t is thus always equal to one in the fixed exchange rate regimes. In the flexible exchange rate regimes e_t, of course, changes, which means that the ROW currency is then no longer the dollar. In the rest of this paper the U.S. currency will be referred to as the dollar and the ROW currency will be referred to as merely the ROW currency.

to the ROW. Interest payments are included in these items. Equation (13) is a similar equation for the ROW. By definition, $SAV_{1t} + e_t SAV_{2t} = 0$.

Equation (14) is the U.S. government budget constraint in dollars. It is analogous to equation (10) in Table 2 for Model T. In equation (14), VBG_{1t} is the value of U.S. government securities outstanding, $CURR_{1t}$ is the value of U.S. currency outstanding less the value of U.S. demand deposits of the U.S. government, BR_{1t} is the value of U.S. bank reserves, $BORR_{1t}$ is the value of U.S. commercial bank borrowing from the U.S. federal reserve banks, MG^2_{1t} is the value of ROW currency and demand deposits held by the U.S. government, R_{1t} is the value of gold and SDR holdings of the U.S. government,[6] and $DISG_{1t}$ is a discrepancy variable that is needed to make the national income data consistent with the flow of funds data. Equation (14) states that any nonzero level of saving of the U.S. government $(SAVG_{1t} \neq 0)$ must result in the change in at least one other variable in the equation. In the model, VBG_{1t}, $CURR_{1t}$, MG^2_{1t}, z_t, and $DISG_{1t}$ are always taken to be exogenous, and $SAVG_{1t}$, BR_{1t}, and $BORR_{1t}$ are always taken to be endogenous. e_t and R_{1t} alternate between being endogenous and exogenous.

Equation (15) is the ROW government budget constraint in ROW currency. It is analogous to equation (12) in Table 2 for Model T. Equation (16) states that there is no change in total world reserves. It is

[6] The data on the gold and SDR holdings of the U.S. government are in dollars. z_t, the dollar price of R_{1t}, is thus always equal to one in the model. The data that were collected for R_{1t} are net of increases in the world's gold stock and the world's stock of SDRs. Equation (16) in Table 3 is thus consistent with the data. The model could be modified to incorporate changes in the world's supply of reserves. This would, however, have little effect on the properties of the model.

analogous to equation (15) in Table 2 for Model T.

Equation (17) is derived from a number of equations in Model A. It links the total saving of the U.S. to changes in the appropriate asset and liability variables. B_{2t}^{1} is the total value of ROW holdings of U.S. securities; B_{1t}^{2} is the total value of U.S. holdings of ROW securities; M_{2t}^{1} is the total value of ROW holdings of U.S. currency and demand deposits; M_{1t}^{2} is the total value of U.S. holdings of ROW currency and demand deposits; R_{1t} is, as before, the value of gold and SDR holdings of the U.S. government; and $DISR_{1t}$ is a discrepancy variable like $DISG_{1t}$ in equation (14). Equation (17) is analogous to the sum of equations (9) and (10) in Table 1 for Model T. In the case of zero capital mobility, B_{2t}^{1} and B_{1t}^{2} in equation (17) are exogenous. In the case of perfect capital mobility one of these two variables must be taken to be exogenous, and for the results in the next section B_{2t}^{1} was the one taken to be exogenous. In the case of perfect capital mobility the bill rates in the two countries ($RBILL_{1t}$ and $RBILL_{2t}$) are always equal to each other.

The following experiments were performed for the results in the next section. Consider first the (0,R) regime (zero capital mobility and a fixed exchange rate). In this regime B_{2t}^{1}, B_{1t}^{2}, and e_t are exogenous and R_{1t} is endogenous. Model A was first simulated under the assumptions of this regime using the historical values of all of the exogenous variables.[7] The simulation was dynamic and began in 1971I, a quarter at or near the bottom of a U.S. contraction. The length of the prediction

[7]This includes B_{1t}^{2} and B_{2t}^{1}. In other words, historical values of these two variables were used when the variables were exogenous, as opposed to, say, values of zero.

period was ten quarters. The predicted values of the endogenous variables from this simulation were recorded. A second simulation was then run in which the real value of goods purchased by the U.S. government (XG_1) was decreased each quarter by an amount necessary to correspond to a 1.25 billion dollar decrease in U.S. government expenditures on goods each quarter. (This is a 5.0 billion dollar decrease at an annual rate. The flow variables in Model A are at quarterly rates.) The predicted values of the endogenous variables from this simulation were then compared to the predicted values from the base simulation to see the effects of the decrease in XG_1 . Finally, a third simulation was run in which the value of U.S. government securities outstanding (VBG_1) was increased each quarter by 1.25 billion dollars, and the predicted values from this simulation were compared to the predicted values from the base simulation.

This procedure was repeated for the other three regimes. In the (∞,R) regime (perfect capital mobility and a fixed exchange rate) B^1_{2t} and e_t are exogenous and B^2_{1t} and R_{1t} are endogenous; in the $(0,e)$ regime (zero capital mobility and a flexible exchange rate) B^1_{2t} , B^2_{1t} , and R_{1t} are exogenous and e_t is endogenous; and in the (∞,e) regime (perfect capital mobility and a flexible exchange rate) B^1_{2t} and R_{1t} are exogenous and B^2_{1t} and e_t are endogenous. The above experiments were also carried out for each regime using the alternative pair of import equations discussed above. There were thus eight sets of experiments altogether, each set corresponding to a different base simulation.

When XG_1 was decreased for the experiments, no other exogenous variable in the model was changed. This means from equation (14) in Table 3 that any increase in the saving of the U.S. government that results from this action must result in either a change in U.S. bank reserves, in U.S.

bank borrowing from the U.S. federal reserve banks, in U.S. reserves (if R_{1t} is endogenous), in the exchange rate (if e_t is endogenous), or in some combination of the relevant three. Both a decrease in XG_1 and an increase VBG_1 mean that the U.S. government is taking funds out of the system.

It should be noted that in most macroeconometric models a variable like VBG_1 cannot be taken to be a direct policy variable of the government because the models are not closed with respect to the flows of funds in the system. Instead, these models must assume that the government has direct control over something like nonborrowed reserves. It is unnecessary to do this in the present case, however, because all flows of funds are accounted for. In fact, had the U.S. model in [4] not been closed with respect to the flows of funds, it would not have been possible to construct a model like Model A that accounts for all international capital movements.

No results are presented in the next section for regimes in which capital mobility is neither zero nor perfect, although results for these regimes were obtained in this study. In these regimes equations like (16) and (17) in Table 1 for Model T have to be specified, and for the work with Model A, equations determining B^2_{1t} and B^1_{2t} were specified in which each variable was assumed to be a function of the difference between the U.S. and ROW bill rates. Different pairs of equations were specified corresponding to different assumptions about the responsiveness of the two variables to the interest rate difference. Each pair of equations was added to Model A and the policy experiments performed. These results were, as expected, somewhere between the results for the cases of zero and perfect capital mobility. The greater was the assumed responsiveness to the interest rate difference, the closer were the results to the results for the case of perfect capital mobility. Since none of the equations determining B^2_{1t} and B^1_{2t} were empirically grounded and since the in between results contained no surprises, it seemed best not to take up space in the next section presenting these results.

The following are a few more comments on Model A. First, it should be noted that while interest payments are included in the payments between the two countries, no equations for them are specified. This means that interest payments between the two countries are exogenous in the model. These payments could have been made endogenous by taking, for example, the value of interest payments from the U.S. to the ROW in quarter t to be $RBILL_{1t}B^1_{2t}$. The problem with this term, however, is that B^1_{2t} is an aggregate of a number of different kinds of securities, some long term and some short term, and $RBILL_{1t}$ is not the appropriate interest rate for all of these securities. The term is thus not exactly the value of interest payments from the U.S. to the ROW . Because of this problem, the decision was made just to treat the interest payments between the two countries as exogenous. This treatment is not likely to have an important effect on the properties of the model.

There are two demand-for-money equations per country in Model A, one for the household sector of the country and one for the firm sector of the country. The demand for money of the U.S. household sector is a function of its income and of the U.S. bill rate, and the demand for money of the U.S. firm sector is a function of its sales and of the U.S. bill rate. "Money" in this case means U.S. demand deposits and currency. The U.S. household and firm sectors also hold some foreign demand deposits and currency, but these holdings are taken to be exogenous in the model.

Likewise, the ROW holdings of U.S. demand deposits and currency are taken to be exogenous. The demand for ROW money of the ROW household sector is a function of its income and of the ROW bill rate, and the demand for ROW money of the ROW firm sector is a function of its sales and of the ROW bill rate.

In the model U.S. (ROW) bank reserves are linked to U.S. (ROW) demand deposits, and U.S. (ROW) bank borrowing from the monetary authorities is a function of the difference between the U.S. (ROW) bill rate and the U.S. (ROW) discount rate. The discount rates, which by construction are the same in both countries, are taken to be exogenous. The money supplies in both countries are, of course, endogenous. The key exogenous monetary policy variables are the supplies of government securities outstanding (VBG_1 and VBG_2). It should be emphasized that when the U.S. policy variables were changed for the results in the next section, the ROW policy variables were not. Historical values of VBG_2, for example, were used for all of the experiments.

There are no direct effects of exchange-rate expectations on the decision variables of the various sectors in Model A. An attempt has been made in the model to capture expectational effects through the inclusion of lagged variables as explanatory variables in many of the equations, but no attempt has been made to be any more specific with respect to exchange-rate expectations. The main variables for which exchange-rate expectations are likely to be important are, of course, B^2_{1t} and B^1_{2t}. In the regimes of zero capital mobility these two variables are exogenous, so that not accounting in an explicit way for exchange-rate expectations is not likely to be very serious. This is also true in the fixed exchange rate regimes. Therefore, the only regime in which this omission may be important is the (∞,e) regime. The implicit assumption for this regime is that exchange-rate expectations are static, because otherwise it would not be the case that $RBILL_{1t} = RBILL_{2t}$ always. An attempt could have been made in this study to estimate exchange-rate expectations in some way and then adjust the relationship between the two bill rates accordingly (see footnote 3). It seemed unlikely, however, that this would make much difference to the basic results for this regime, and so no attempt of this sort was undertaken here.

Two important features of the model in [4], in addition to the fact that it accounts for all flows of funds in the system, are that it is based on solid microeconomic foundations and it accounts explicitly for disequilibrium effects. Although these two features have an important effect on the properties of the model, space limitations prevent any discussion of them here. These and other features of the model cause it to have a number of asymmetrical properties. The effects of various government policy actions, for example, differ depending on the state of the economy at the time the actions are made. The absolute values of the effects also differ depending on whether the actions are expansionary or contractionary. The results presented in the next section are for contractionary government actions in a contraction. Although the results would differ somewhat for expansionary government actions and for actions done in an expansion, the asymmetrical properties of the model are not so severe as to change the basic conclusions reached here. The asymmetrical properties of the U.S. model are examined in Chapter 9 in [4].

IV. The Results

The results of the eight sets of experiments are presented in Table 4. Each number in Table 4 is the difference between the predicted value of a variable after the change and the predicted value of the variable in the relevant base simulation. The first eight columns in the table are for the pair of import equations presented in Table 3, and the second eight columns are for the alternative pair. Columns 1-4 and 9-12 correspond to the change in XG_1 in each of the four regimes, and columns 5-8 and 13-16 correspond to the change in VBG_1 in each of the four regimes. Results for the first three quarters for 20 variables are presented in the table. The rest of this section is a discussion of the results in Table 4. An attempt has been made in what follows to provide enough discussion of the results in each of the sixteen columns to make the rest of the results in each column fairly self explanatory.

Consider column 1 in Table 4 first, and consider also the results for quarter t . The decrease in XG_{1t} in this (0,R) regime caused a decrease in output in both countries (Y_{1t} and Y_{2t}) and an increase in the interest rates in both countries ($RBILL_{1t}$ and $RBILL_{2t}$) . The bill rates increased in this case because the decrease in XG_{1t} took funds out of the system. Bank reserves fell in both countries (BR_{1t} and BR_{2t}) . In the model the bill rate has, other things being equal, a positive effect on the price level in each country, and in the present case the increase in the bill rates resulted in the price levels being higher in both countries (PEX_{1t} and PEX_{2t}) . The decrease in XG_{1t} thus led to an initial increase in the price levels because of the higher bill rates that resulted from the decrease in XG_{1t} . The levels of PEX_{1t} and PEX_{2t} are approximately 1.0, so that the numbers in Table 4 for PEX_1 and PEX_2 can be interpreted roughly as percentage points.

TABLE 4. The Results of Sixteen Experiments

Change in:		Price Lags in Import Equations: XG_1 Decrease				VBG_1 Increase			
		1 (0,R)	2 (∞,R)	3 (0,e)	4 (∞,e)	5 (0,R)	6 (∞,R)	7 (0,e)	8 (∞,e)
Y_1	t	-1.31	-1.21	-1.57	-0.89	-0.62	-0.37	-0.78	0.26
	t+1	-2.17	-1.96	-2.90	-1.08	-1.28	-0.76	-1.71	0.58
	t+2	-2.37	-2.25	-3.51	-1.15	-0.94	-0.62	-1.39	0.41
$RBILL_1$	t	0.63	0.43	1.07	0.47	1.90	1.12	2.23	1.18
	t+1	-0.03	0.04	0.21	0.04	-0.25	-0.08	-0.36	-0.08
	t+2	-0.66	-0.41	-0.60	-0.43	-1.13	-0.69	-1.47	-0.73
$100 \cdot PEX_1$	t	0.193	0.104	0.436	-0.203	0.478	0.260	0.631	-0.368
	t+1	0.085	0.065	0.430	-0.580	0.160	0.131	0.339	-0.742
	t+2	-0.049	-0.038	0.486	-0.886	0.001	0.015	0.159	-0.867
$100 \cdot PIM_1 = 100 \cdot e \cdot PEX_2$	t	0.040	0.109	1.665	-4.154	0.070	0.256	1.154	-8.292
	t+1	0.038	0.079	1.742	-5.119	0.055	0.129	0.515	-4.847
	t+2	0.001	-0.008	3.118	-4.459	0.016	0.014	1.056	-2.530
IM_1	t	-0.12	-0.11	-0.15	-0.08	-0.06	-0.03	-0.07	0.02
	t+1	-0.15	-0.14	-0.17	-0.12	-0.03	-0.02	-0.04	-0.01
	t+2	-0.17	-0.17	-0.29	-0.01	-0.04	-0.03	-0.10	0.27
$SAVG_1$	t	0.66	0.63	0.81	0.37	0.13	0.06	0.22	-0.48
	t+1	-0.09	0.09	-0.28	-0.12	-0.99	-0.53	-1.15	-0.56
	t+2	-0.20	-0.10	-0.44	-0.22	-0.65	-0.43	-0.84	-0.45
SAV_1	t	0.15	0.11	0.03	0.54	0.11	0.00	0.03	0.87
	t+1	0.16	0.14	0.06	0.66	0.04	0.00	0.03	0.51
	t+2	0.16	0.16	0.10	0.21	0.02	0.00	0.04	0.56
$BORR_1$	t	0.23	0.15	0.38	0.16	0.67	0.39	0.79	0.42
	t+1	-0.01	0.02	0.08	0.02	-0.08	-0.03	-0.13	-0.03
	t+2	-0.24	-0.15	-0.21	-0.16	-0.41	-0.25	-0.52	-0.26
BR_1	t	-0.29	-0.16	-0.43	-0.17	-0.60	-0.30	-0.68	-0.31
	t+1	-0.27	-0.21	-0.45	-0.19	-0.33	-0.20	-0.44	-0.17
	t+2	-0.15	-0.16	-0.34	-0.11	0.02	-0.00	-0.00	0.06
B_1^2	t	0.0	-0.21	0.0	0.56	0.0	-0.61	0.0	0.97
	t+1	0.0	-0.25	0.0	1.43	0.0	-0.61	0.0	1.67
	t+2	0.0	-0.20	0.0	1.85	0.0	-0.60	0.0	1.23
R_1	t	0.15	0.32	0.0	0.0	0.11	0.61	0.0	0.0
	t+1	0.31	0.50	0.0	0.0	0.15	0.61	0.0	0.0
	t+2	0.47	0.61	0.0	0.0	0.16	0.60	0.0	0.0
e	t	0.0	0.0	0.0150	-0.0375	0.0	0.0	0.0100	-0.0750
	t+1	0.0	0.0	0.0175	-0.0475	0.0	0.0	0.0050	-0.0475
	t+2	0.0	0.0	0.0300	-0.0425	0.0	0.0	0.0100	-0.0275

TABLE 4 (continued)

Change in:		Price Lags in Import Equations: XG_1 Decrease 1 (0,R)	2 (∞,R)	3 (0,e)	4 (∞,e)	VBG_1 Increase 5 (0,R)	6 (∞,R)	7 (0,e)	8 (∞,e)
Y_2	t	-0.19	-0.27	0.05	-0.59	-0.15	-0.36	0.01	-1.03
	t+1	-0.36	-0.56	0.40	-1.49	-0.24	-0.75	0.12	-2.19
	t+2	-0.41	-0.58	0.72	-1.69	-0.20	-0.59	0.18	-1.68
$RBILL_2$	t	0.15	0.43	-0.38	0.47	0.19	1.12	-0.17	1.18
	t+1	0.03	0.04	-0.16	0.04	-0.01	-0.08	-0.03	-0.08
	t+2	-0.13	-0.41	-0.26	-0.43	-0.18	-0.69	-0.12	-0.73
$100 \cdot PEX_2$	t	0.040	0.109	-0.182	0.429	0.070	0.256	-0.078	0.907
	t+1	0.038	0.079	-0.365	0.728	0.055	0.129	-0.089	1.014
	t+2	0.001	-0.008	-0.557	0.846	0.016	0.014	-0.173	0.904
$100 \cdot PIM_2 = 100 \frac{1}{e} PEX_1$	t	0.193	0.104	-1.417	4.111	0.478	0.260	-0.611	8.572
	t+1	0.085	0.065	-1.514	5.573	0.160	0.131	-0.235	5.403
	t+2	-0.049	-0.038	-2.980	4.609	0.001	0.015	-1.015	2.634
IM_2	t	-0.02	-0.03	0.00	-0.06	-0.01	-0.04	0.00	-0.10
	t+1	-0.02	-0.03	0.01	-0.06	-0.01	-0.02	-0.00	-0.03
	t+2	-0.04	-0.04	0.06	-0.21	-0.03	-0.03	0.03	-0.35
$SAVG_2$	t	-0.06	-0.03	-0.23	0.30	0.01	0.09	-0.11	0.75
	t+1	-0.18	-0.32	-0.09	-0.12	-0.12	-0.52	0.02	-0.51
	t+2	-0.25	-0.38	-0.04	-0.27	-0.12	-0.41	-0.05	-0.42
$BORR_2$	t	0.05	0.15	-0.13	0.16	0.07	0.39	-0.06	0.42
	t+1	0.01	0.02	-0.07	0.02	-0.00	-0.03	-0.01	-0.02
	t+2	-0.05	-0.15	-0.09	-0.16	-0.07	-0.25	-0.04	-0.26
BR_2	t	-0.04	-0.14	0.09	-0.15	-0.05	-0.31	0.04	-0.33
	t+1	-0.05	-0.13	0.23	-0.17	-0.04	-0.20	0.06	-0.26
	t+2	-0.03	-0.02	0.24	-0.08	0.00	-0.00	0.07	-0.07

TABLE 4 (continued)

Change in:		No Price Lags in Import Equations — XG_1 Decrease: 9 (0,R)	10 (∞,R)	11 (0,e)	12 (∞,e)	VBG_1 Increase: 13 (0,R)	14 (∞,R)	15 (0,e)	16 (∞,e)
Y_1	t	-1.36	-1.21	-1.42	-1.41	-0.71	-0.37	-0.70	-0.78
	t+1	-2.19	-1.98	-2.05	-2.05	-1.27	-0.77	-1.20	-0.70
	t+2	-2.36	-2.28	-1.87	-2.26	-0.86	-0.63	-0.63	-0.51
$RBILL_1$	t	0.66	0.44	0.48	0.45	1.98	1.13	2.02	1.16
	t+1	-0.05	0.03	-0.18	0.03	-0.29	-0.08	-0.22	-0.09
	t+2	-0.68	-0.42	-0.45	-0.44	-1.13	-0.69	-0.83	-0.71
$100 \cdot PEX_1$	t	0.196	0.105	0.024	-0.022	0.481	0.261	0.428	0.005
	t+1	0.079	0.065	-0.359	-0.098	0.146	0.133	-0.057	-0.036
	t+2	-0.061	-0.040	-0.459	-0.230	-0.016	0.015	-0.117	-0.158
$100 \cdot PIM_1 = 100 \cdot e \cdot PEX_2$	t	0.036	0.110	-1.339	-1.594	0.060	0.257	-0.215	-3.156
	t+1	0.042	0.079	-2.098	-0.684	0.067	0.131	-1.038	0.605
	t+2	0.006	-0.010	-1.457	-0.754	0.026	0.014	-0.154	-0.434
IM_1	t	-0.10	-0.11	0.01	0.03	-0.02	-0.03	0.00	0.24
	t+1	-0.16	-0.15	0.03	-0.10	-0.09	-0.06	0.01	-0.11
	t+2	-0.17	-0.16	-0.03	-0.11	-0.06	-0.04	-0.03	-0.01
$SAVG_1$	t	0.64	0.63	0.39	0.35	0.08	0.06	0.03	-0.51
	t+1	-0.11	0.08	-0.42	-0.10	-1.01	-0.53	-1.16	-0.54
	t+2	-0.20	-0.12	-0.09	-0.25	-0.62	-0.44	-0.46	-0.48
SAV_1	t	0.11	0.10	-0.02	-0.05	0.02	0.00	-0.01	-0.31
	t+1	0.16	0.13	-0.07	0.06	0.09	0.00	-0.03	0.04
	t+2	0.17	0.15	-0.04	0.08	0.05	0.00	-0.00	-0.05
$BORR_1$	t	0.24	0.16	0.17	0.16	0.70	0.40	0.71	0.41
	t+1	-0.01	0.02	-0.07	0.01	-0.10	-0.02	-0.08	-0.03
	t+2	-0.25	-0.15	-0.16	-0.16	-0.41	-0.25	-0.30	-0.26
BR_1	t	-0.29	-0.17	-0.21	-0.18	-0.61	-0.30	-0.57	-0.33
	t+1	-0.27	-0.21	-0.04	-0.22	-0.31	-0.21	-0.19	-0.23
	t+2	-0.13	-0.16	-0.02	-0.17	0.04	-0.00	0.06	-0.02
B_1^2	t	0.0	-0.21	0.0	-0.02	0.0	-0.61	0.0	-0.23
	t+1	0.0	-0.25	0.0	0.07	0.0	-0.60	0.0	-0.19
	t+2	0.0	-0.19	0.0	0.21	0.0	-0.59	0.0	-0.18
R_1	t	0.11	0.31	0.0	0.0	0.02	0.61	0.0	0.0
	t+1	0.28	0.48	0.0	0.0	0.11	0.60	0.0	0.0
	t+2	0.45	0.58	0.0	0.0	0.16	0.59	0.0	0.0
e	t	0.0	0.0	-0.0125	-0.0150	0.0	0.0	-0.0025	-0.0300
	t+1	0.0	0.0	-0.0200	-0.0075	0.0	0.0	-0.0100	0.0025
	t+2	0.0	0.0	-0.0150	-0.0075	0.0	0.0	-0.0025	-0.0050

TABLE 4 (continued)

Change in:		No Price Lags in Import Equations: XG_1 Decrease 9 (0,R)	10 (∞,R)	11 (0,e)	12 (∞,e)	VBG_1 Increase 13 (0,R)	14 (∞,R)	15 (0,e)	16 (∞,e)
Y_2	t	-0.15	-0.26	-0.07	-0.08	-0.05	-0.36	-0.03	0.01
	t+1	-0.34	-0.55	-0.37	-0.50	-0.23	-0.75	-0.18	-0.88
	t+2	-0.42	-0.55	-0.79	-0.59	-0.25	-0.59	-0.41	-0.74
$RBILL_2$	t	0.12	0.44	0.40	0.45	0.13	1.13	0.17	1.16
	t+1	0.05	0.03	0.52	0.03	0.05	-0.08	0.29	-0.09
	t+2	-0.11	-0.42	0.07	-0.44	-0.14	-0.69	-0.10	-0.71
$100 \cdot PEX_2$	t	0.036	0.110	0.198	0.244	0.060	0.257	0.091	0.527
	t+1	0.042	0.079	0.409	0.240	0.067	0.131	0.214	0.300
	t+2	0.006	-0.010	0.442	0.177	0.026	0.014	0.165	0.185
$100 \cdot PIM_2 = 100\frac{1}{e}PEX_1$	t	0.196	0.105	1.555	1.770	0.481	0.261	0.726	3.642
	t+1	0.079	0.065	2.458	0.854	0.146	0.133	1.348	-0.351
	t+2	-0.061	-0.040	1.517	0.694	-0.016	0.015	0.208	0.457
IM_2	t	-0.03	-0.02	-0.14	-0.17	-0.05	-0.03	-0.07	-0.32
	t+1	-0.03	-0.04	-0.21	-0.10	-0.03	-0.06	-0.11	-0.01
	t+2	-0.02	-0.04	-0.16	-0.09	-0.01	-0.04	-0.03	-0.08
$SAVG_2$	t	-0.04	-0.02	0.24	0.29	0.06	0.09	0.11	0.72
	t+1	-0.17	-0.32	0.15	-0.16	-0.09	-0.51	0.10	-0.54
	t+2	-0.25	-0.37	-0.20	-0.25	-0.15	-0.42	-0.18	-0.39
$BORR_2$	t	0.04	0.16	0.14	0.16	0.04	0.40	0.06	0.41
	t+1	0.02	0.01	0.18	0.01	0.02	-0.02	0.10	-0.03
	t+2	-0.04	-0.15	0.02	-0.16	-0.05	-0.25	-0.04	-0.26
BR_2	t	-0.03	-0.13	-0.10	-0.13	-0.03	-0.30	-0.05	-0.30
	t+1	-0.06	-0.13	-0.19	-0.12	-0.05	-0.20	-0.10	-0.19
	t+2	-0.03	-0.01	-0.17	-0.00	-0.02	0.00	-0.06	0.01

Notes: (0,R) = regime of zero capital mobility and a fixed exchange rate.

(∞,R) = regime of perfect capital mobility and a fixed exchange rate.

(0,e) = regime of zero capital mobility and a flexible exchange rate.

(∞,e) = regime of perfect capital mobility and a flexible exchange rate.

The 0.193 value for PEX_{1t}, for example, is an increase in PEX_{1t} of about 0.193 percent.

Because of the price lags in the import equations, an increase in prices in quarter t has no direct effect on the real value of imports in quarter t. The real value of imports decreased in both countries in quarter t because of the decrease in output. (Although not shown in the table, the decreases in Y_{1t} and Y_{2t} resulted in decreases in X_{1t} and X_{2t}, which from equations (1) and (4) in Table 3 resulted in decrease in IM_{1t} and IM_{2t}.) PEX_{1t} increased more than did PIM_{1t} and IM_{1t} decreased more than did IM_{2t}, both of which contributed the increase in the total saving of the U.S. (SAV_{1t}). This can be seen from equations (9) and (12) in Table 3. U.S. reserves (R_{1t}) increased by the increase in SAV_{1t}. This can be seen from equation (17) in Table 3. In the (0,R) regime the only endogenous variables in equation (17) are SAV_{1t} and R_{1t}, and so the variables must offset each other.

The saving of the U.S. government $(SAVG_{1t})$ increased by 0.66 billion dollars, which took the form of an 0.23 increase in U.S. bank borrowing $(BORR_{1t})$, an 0.29 decrease in U.S. bank reserves (BR_{1t}), and the 0.15 increase in U.S. reserves (R_{1t}). (These latter three numbers add to 0.67 instead of 0.66 because of rounding.) The saving of the ROW government $(SAVG_{2t})$ decreased by 0.06, which took the form of an 0.05 increase in ROW bank borrowing $(BORR_{2t})$, a 0.04 decrease in ROW bank reserves (BR_{2t}), and the 0.15 decrease in R_{2t} (corresponding to the 0.15 increase in R_{1t}). $SAVG_{1t}$ did not increase by the full 1.25 billion dollar decrease in expenditures on goods of the U.S. government sector because of a decrease in U.S. tax revenues and an increase in other endogenous U.S. government expenditures caused by the economic contraction.

The world economic contraction continued in quarters $t+1$ and t+2 . The contraction continued to be more severe in the U.S. than in the ROW . This led to U.S. imports continuing to fall more than ROW imports and thus to SAV_1 continuing to be positive. The positive values of SAV_1 thus led to the continued accumulation of reserves by the U.S. The contraction in the U.S. led to a decrease in the U.S. price level by quarter t+2 .

The results in column 9 for the alternative pair of import equations are quite similar to the results in column 1. Because of the existence of a fixed exchange rate, the import price changes are not very large in either currency. They are not large enough to make the results very sensitive to alternative assumptions about the effects of prices on imports. The effects on imports in this regime occur largely through the effects on real output.

Consider next the results in column 5 for quarter t . The increase in VBG_{1t} also led to a decrease in output and an increase in the bill rate in both countries. The contractions in output were somewhat smaller than the contractions in column 1, although the increases in the bill rates were larger. The larger increases in the bill rates led to larger initial increases in the price levels. The saving of the U.S. government increased by 0.13 in quarter t , and this increase plus the 1.25 increase in VBG_{1t} was offset by a 0.67 increase in U.S. bank borrowing, a 0.60 decrease in U.S. bank reserves, and a 0.11 increase in U.S. reserves. Overall, the qualitative results in column 5 are very similar to the qualitative results in column 1. The results in column 13 for the alternative pair of import equations are again similar to the results in column 5.

The results in column 2 are for the (∞,R) regime. The increase in quarter t in the (world) bill rate in this case was smaller than the increase in the U.S. bill rate in column 1 and larger than the increase in the ROW bill rate in column 1. This led to a somewhat smaller contraction in the U.S. and a somewhat larger contraction in the ROW in column 2 relative to column 1. The figure for B_{1t}^{2} is negative in column 2, which means that there was a U.S. capital inflow in this case. This inflow led to a larger accumulation of reserves (R_{1t}) by the U.S. in column 2 than in column 1. The reason for the capital inflow in this case is fairly clear. In the case of zero capital mobility in column 1 the U.S. bill rate increasedmore than did the ROW bill rate. Therefore, to have the bill-rate increases be the same in column 2, capital must flow into the U.S. To put this another way, the decrease in XG_{1t} takes funds out of the U.S. economy, and in order to prevent the bill rate from rising more in the U.S. than in the ROW , capital must flow into the U.S.

The results in column 6 for the (∞,R) regime are interesting. The increase in VBG_1 had almost identical effects on the two countries. An increase in VBG_1 has no other direct effects than to take funds out of the system. With perfect capital mobility and a fixed exchange rate, it makes no difference which country the funds are initially taken out of. Therefore, since the U.S. and ROW economies are virtually the same, taking funds out of the system in this case results in virtually identical effects on the two countries. The reason this result does not hold when XG_1 is decreased in the (∞,R) regime is that the decrease in XG_1 not only takes funds out of the system, but also has a direct effect on sales in the U.S. This leads (in column 2) to greater output effects in the U.S. than in the ROW .

The comparisons between columns 5 and 6 are similar to the comparisons between columns 1 and 2. The U.S. output contraction is less in column 6 than it is in column 5, and the ROW output contraction is greater in column 6 than it is in column 5. The comparisons between columns 10 and 2 and between columns 14 and 6 are similar to the comparisons between columns 9 and 1 and between columns 13 and 5. In the two fixed exchange rate regimes the results are not sensitive to the assumptions made about the response of imports to prices.

The results in column 3 are for the (0,e) regime. The decrease in XG_1 in this case resulted in quarter t in an increase in the U.S. bill rate, a decrease in U.S. output, a decrease in the ROW bill rate, an increase in ROW output, and an increase in e (a depreciation of the dollar). It will help in understanding these results to consider equation (17) in Table 3. In the (0,e) regime the only endogenous variables in this equation are SAV_{1t} and e_t . Since the terms that e_t multiplies in this equation are exogenous and generally fairly small, the solution value for SAV_{1t} when XG_{1t} or VBG_{1t} is changed must be roughly the same as the solution value for SAV_{1t} in the base simulation. This is in fact the case in Table 4, where the changes in SAV_1 are always small in the (0,e) columns.

Now, in the (0,R) regime in column 1, SAV_{1t} increased, which means that e_t must adjust in column 3 in such a way as to offset most of this increase. A change in e_t has an important effect on the two import prices. A decrease in e_t , for example, decreases the price of U.S. imports (PIM_{1t}) and increases the price of ROW imports (PIM_{2t}) . Because of the lags in the import equations, however, a change in import prices in quarter t does not have a direct effect on the real value of imports in quarter t . If it did, then a decrease in e_t would have a direct positive effect on U.S. imports and a direct negative effect on ROW imports and so would serve to lessen the increase in SAV_{1t} . As it is, this channel is not open, and so the increase in SAV_{1t} in column 1 must be lessened in some other way in column 3. This other way is for e_t to increase. The increase in PIM_{1t} and the decrease in PIM_{2t} that this causes has no direct effect on the real value of imports. It does, however, mean that the U.S. pays more for its imports and receives less for its exports, and this has a negative effect on SAV_{1t} . e_t thus increased in column 3 in order to turn the terms of trade against the U.S. enough so as to offset the increase in SAV_{1t} that would have otherwise taken place as a result of the decrease in XG_{1t} .

A decrease in PIM_{2t} has, other things being equal, a negative effect on the price level in the ROW (see equation (5) in Table 3). In the model a decrease in the price level in a country is, other things being equal, stimulative because, among other things, it has a positive effect on the consumption of the household sector in the country. The increase in e_t in column 3 and the resulting decrease in PIM_{2t} thus led to an increase in output in the ROW .

It is informative to compare the results in columns 3 and 11. In column 11, where there are no price lags in the import equations, e_t decreased rather than increased. This comes about, as alluded to above, from the fact that a decrease in e_t in this case has a negative effect on SAV_{1t} because it leads (through its effect on import prices) to an increase in U.S. imports and a decrease in ROW imports. The results in column 11 are thus quite different from the results in column 3. The output of the ROW , for example, decreased in column 11 rather than increased, and the ROW bill rate increased rather than decreased.

The increase in VBG_1 in the (0,e) regime in column 7 also resulted in an increase in e and an increase in the output of the ROW. In column 15, on the other hand, with the alternative pair of import equations, the increase in VBG_1 had the opposite effects. The reasons for this are the same as the reasons just given for the XG_1 experiments.

The results in column 4 are for the (∞,e) regime. The decrease in XG_{1t} in this case resulted in a decrease in e_t (an appreciation of the dollar) and an increase in B^2_{1t} (a U.S. capital outflow). The bill rate increased in quarter t, and the output of both countries fell. The reason for the dollar appreciation and the U.S. capital outflow is as follows. The decrease in XG_{1t} takes funds out of the U.S. economy. For the (0,e) regime in column 3 this resulted in an increase in the U.S. bill rate and a decrease in the ROW bill rate. This cannot happen for the (∞,e) regime in column 4, however, since in this regime there is only one world bill rate. For the (∞,R) regime in column 2 the bill rates in the two countries were kept equal by having a U.S. capital inflow. This led to an accumulation of reserves by the U.S. For the (∞,e) regime, however, reserves are exogenous, and so any attempted capital inflow into the U.S. to keep the bill rates the same results instead in an appreciation of the dollar.

The appreciation of the dollar is not the end of the story. The appreciation of the dollar decreases the price of U.S. imports and increases the price of ROW imports: the terms of trade shift against the ROW. Given the lags in the import equations, this has no direct effect on the real value of imports of either country. Therefore, the shift in the terms of trade against the ROW results in an increase in SAV_{1t} (see equation (12) in Table 3). Consider now equation (17) in Table 3. The endogenous variables in this equation in the (∞,e) regime are SAV_{1t}, B_{1t}^2, and e_t. Given an increase in SAV_{1t}, the main way in which this equation is satisfied is for B_{1t}^2 to increase. In other words, the main effect of an increase in the saving of the U.S. is an increase in the U.S. holdings of ROW securities. The reason for the U.S. capital outflow in column 4 is thus to compensate for the increase in SAV_{1t}, the latter being caused by a shift in the terms of trade against the ROW due to the appreciation of the dollar. In short, what would have been a U.S. capital inflow in the (∞,R) regime has instead become a U.S. capital outflow in the (∞,e) regime.

The results in column 12, where there are no price lags in the import equations, are considerably different from the results in column 4. In column 12 there is still an appreciation of the dollar (e_t decreased), but this now has an immediate effect on imports: a positive effect on U.S. imports and a negative effect on ROW imports. In quarter t in column 12 this effect actually dominated the terms of trade effect, and SAV_{1t} decreased rather than increased. There was thus a (small) U.S. capital inflow in quarter t in column 12, in contrast to the U.S. capital outflow in column 4.

In column 4 output fell more in quarters t+1 and t+2 in the ROW than it did in the U.S. An appreciation of the dollar has a positive effect on the ROW price level (through its effect on PIM_2), which in turn has a negative effect on ROW output. An appreciation of the dollar also has a negative effect on the U.S. price level (through its effect on PIM_1), which in turn has a positive effect on U.S. output. In column 4 these effects were large enough to cause the decrease in ROW output to be larger than the decrease in U.S. output. This is not the case in column 12, however, where the size of the dollar appreciation was smaller.

The increase in VBG_1 in column 8 also led to an appreciation of the dollar and a U.S. capital outflow. The reasons for this are the same as those for the results in column 4. The appreciation of the dollar in column 8 was actually large enough to lead to an increase in output in the U.S. (through the effect on the U.S. price level). In this case a tighter U.S. monetary policy resulted in a slight expansion in the U.S. as a result of the appreciation of the dollar. The effects of this policy on the ROW were, however, contractionary.

The comparisons between columns 8 and 16 are similar to the comparisons between columns 4 and 12. The dollar appreciated less in column 16, where there are no price lags in the import equations, than it did in column 8, and there was a U.S. capital inflow in column 16 as opposed to the U.S. capital outflow in column 8. The appreciation of the dollar was not large enough in column 16 to lead to a rise in U.S. output. U.S. output fell in column 16 in contrast to the rise in column 8.

This completes the discussion of the results in Table 4. The additional information contained in the results for quarters t+4 through t+9 did not appear to be important enough for present purposes to warrant their presentation here. The model does have a tendency to cycle somewhat, as can be seen for the U.S. model from the results presented in Tables 9-1 through 9-5 in [4]. There is little need here for a discussion of this issue. It is worth noting, however, that the differences between the results for the two pairs of import equations lessened over time. This is, of course, as expected, since the effects of the different lag lengths in the equations ought to be greatest for the first few quarters of the simulation period.

Before concluding this section it is of interest to note that some of the results obtained here can be compared to the properties of Mundell's model [6, Appendix to Chapter 18]. In the (∞,R) regime Mundell's model implies that a contractionary monetary policy has a negative effect on the output of both countries. This is true of the results obtained here. A contractionary fiscal policy, on the other hand, while having a negative effect on the output of the home country, may or may not have a negative effect on the output of the other country in Mundell's model. For the results here the decrease in XG_1 does have a negative effect on the output of both countries, although it is interesting to note that the negative effect on ROW output in this case is less than the negative effect on ROW output of an increase in VBG_1.

In the (∞,e) regime Mundell's model implies that a contractionary fiscal policy has a negative effect on the output of both countries, which is also true of the results obtained here. A contractionary monetary policy, on the other hand, while having a negative effect on the output of the home country, has a positive effect on the output of the other country in Mundell's model. The demand for money in each country in Mundell's model is a function of the world interest rate and the income of the country. A contraction of the money supply in one country results in an increase in the interest rate. With the money supply remaining unchanged in the other country, the only way the demand-for-money equation in the other country can hold with the higher interest rate is for the income of the other country to increase. Therefore, a contractionary monetary policy in one country has an expansionary effect on the income of the other country.

In the present model the demand for money in each country is also a function of the interest rate and income or sales, and so a similar effect holds. In the present case, however, one has to distinguish between real output and nominal output. For example, in column 8 in Table 4 the increase in VBG_1 had a positive effect on U.S. real output and a negative effect on ROW real output, both of which are contrary to Mundell's result. The effects on nominal output in the two countries are, however, consistent with Mundell's result. Although not shown in Table 4, for the experiment in column 8 nominal output in the U.S. decreased in quarter t and nominal output in the ROW increased in quarter t . The appreciation of the dollar in column 8 resulted in a decrease in the U.S. price level, which had a positive effect on U.S. real output. Real output was thus larger in this case, even though price times real output was smaller. The same considerations also apply to the results in column 16 in Table 4, although in this case both nominal and real output in the U.S. were lower and both nominal and real output in the ROW were higher for quarter t .

It should finally be noted that Mundell's result does not necessarily hold after quarter t in the present model because there is no necessary increase in the interest rate in quarters t+1 and beyond.

V. Conclusion

The following is a brief summary of the results in Table 4.

Regime	Effects of a decrease in U.S. government expenditures on goods (XG_1)
(0,R)	Output contraction in both countries; increase in reserves held by the U.S. Results not sensitive to whether or not there are price lags in the import equations.
(∞,R)	Same qualitative properties as (0,R) regime. Output contraction is now less in the U.S. and greater in the ROW . U.S. increase in reserves is now greater. A U.S. capital inflow.
(0,e)	When price lags in the import equations: output contraction in the U.S.; output expansion in the ROW ; depreciation of the dollar. When no price lags in the import equations: output contraction in both countries; appreciation of the dollar.
(∞,e)	Output contraction in both countries; appreciation of the dollar. When price lags in the import equations the appreciation of the dollar is greater and the output contraction in the ROW is greater than when no price lags. With price lags there is a U.S. capital outflow; with no price lags there is either a U.S. capital inflow or a much smaller outflow.
	Effects of an increase in U.S. government securities outstanding (VBG_1)
(0,R)	Same qualitative properties as XG_1 decrease in (0,R) regime.
(∞,R)	Same qualitative properties as XG_1 decrease in (∞,R) regime. Effects on the two countries are in this case virtually identical because of the identical nature of the countries.
(0,e)	Same qualitative properties as XG_1 decrease in (0,e) regime.
(∞,e)	Same qualitative properties as XG_1 decrease in (∞,e) regime, except that when there are price lags in the import equations there is an increase in U.S. output rather than a decrease.

The reasons for these results have been discussed in the previous section, and they will not be repeated here. It is obvious that there are important qualitative and quantitative differences across regimes and that some of the results are sensitive to whether or not there are price lags in the import equations. The overall results point out, among other things, the importance of accounting for capital flows in a world model and of obtaining fairly good estimates of the degree of capital mobility. The results indicate, in other words, that the lack of completeness of a model like LINK with respect to capital flows is not a minor omission.

There are a number of other experiments that could be performed with Model A. One experiment that might be of interest, for example, would be to have the two governments use VBG_1 and VBG_2 to achieve given target growth rates of their money supplies and see the effects that this set of policies has in the different regimes. The results in Table 4 do, however, give a good indication of the properties of the model, and no further results will be discussed in this paper. As mentioned in the Introduction, the results in Table 4 are presented here with the view that they may have made some contribution toward improving our understanding of the actual properties of the world economy.

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