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POLICY EFFECTS IN A MODEL OF THE BALANCE OF PAYMENTS

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POLICY EFFECTS IN A MODEL OF THE BALANCE OF PAYMENTS*

by

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I. *Introduction*

This paper is a sequel to [6]. In [6] a model of the balance of payments was developed. In this paper the effects of policy actions in one version of this model are analyzed. This version, which will be called Model A, was obtained by linking the 84-equation econometric model of the U.S. economy in [4] to the mirror image of itself. This exercise resulted, after the addition of a few equations to close the model, in a 180-equation two-country model. The effects of policy actions in this model are examined in this paper by means of simulation techniques.

The model of the balance of payments in [6] is one in which stock and flow effects are completely integrated. The exchange rate has an effect on both stock and flow variables, and it is simultaneously determined in the model along with the other endogenous variables. Model A also has this characteristic. One of the key features of the model that allows this integration to take place is that all flows of funds in the system are accounted for. This means that any saving or dissaving of a sector

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in a period results in the change in at least one of its assets or liabilities, that any 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. As discussed in [6], this integration of stock and flow effects is not true of the other approaches to the balance of payments and is one of the main distinctions between the present model and previous models.

Since, as discussed in [6], the inspiration for the balance of payments model came from my earlier work [3, 4] on developing a macroeconomic model for a single country, the single-country econometric model in [4] is an obvious model to use to construct a version of the balance of payments model. Model A differs from the basic model in Section II in [6] in four main ways: (1) it has a bank sector, (2) it accounts for possible disequilibrium effects in the labor and goods markets, (3) it has a more detailed specification of the firm sector, and (4) it accounts for the effects of some capital gains and losses on behavior. These issues are briefly discussed in Section III in [6].

The outline of this paper is as follows. In Section II some of the equations of Model A are presented. No attempt is made in this discussion to justify the particular specification of each equation, since this justification is already contained in [4]. In Section III the four regimes in which policy effects were examined are explained, and in Section IV the actual experiments that were performed are described. The results of these experiments are then presented and explained in Section V. Some further results are discussed in Section VI, and some concluding remarks are presented in Section VII.

II. Model A

Notation

The notation in this paper follows closely the notation in [6]. Capital letters will denote variables for country 1, lower case letters will denote variables for country 2, and an * on a variable will denote the other country's holdings or purchase of the variable. 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. For country 1, its good is X, its labor is L, its money is M, and its bond is B. The interest rate on B is R; the wage rate for L is W; and the price of X is P. The same is true for country 2, with lower case letters in place of capital letters. The exchange rate, the price of country 2's currency in terms of country 1's currency, is e. If a sector is a debtor with respect to a bond (i.e., a supplier of the bond), then the value of B or b for this sector is negative. It will sometimes be convenient in what follows to aggregate the four sectors of a country together. If no h, f, b, or g subscript occurs in the notation for a variable, then this variable represents the total holdings or purchase or saving of the country.

The above notation differs considerably from the notation for the U.S. econometric model in [4]. To avoid possible confusion for the meticulous reader between the variables in the present model and the variables in [4], the differences in notation will be explained in footnotes in the following discussion.

Some Equations

The complete list of the 180 equations of Model A will not be presented in this paper. A detailed description and analysis of the U.S. econometric model is contained in [4], and a description of the structure of the two-country model is contained in [6]. In addition, there is an appendix to this paper that contains a complete discussion of the construction of Model A and a list of the 180 equations. This appendix is available from the author upon request. The following is a discussion of some of the equations that relate to the linkages between the two countries.

Country 1's demand for the good of country 2 (x^*) is a function of the prices of the two goods (P and $e \cdot p$) and of the size of country 1 as measured by the total sales of its good (X'_f) .[1] The prices are lagged one and two quarters, respectively. The equation explaining x^* is

$$\text{(1)} \qquad \log \frac{x^*}{POP} = -1.60 + 1.62 \log P_{-1} - 0.43 \log(e \cdot p)_{-2} + 1.17 \log \frac{X'_f}{POP} + \text{strike dummies} ,$$

where POP is the population of country 1.[2] This equation was estimated using U.S. data for the 1954I-1974II period. The coefficient of $\log P_{-1}$ is about 3.8 times larger in absolute value than the coefficient of $\log(e \cdot p)_{-2}$, which means that the real value of U.S. imports is estimated

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[1] In this paper, X'_f denotes sales and X_f denotes production. This is the notation used in Section III in [6].

[2] Equation (1) is equation 24 in [4]. The notation in [4] is: $IM = x^*$, $PX = P$, $PIM = e \cdot p$, $X = X'_f$, and $POP = POP$.

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 domestically produced goods one quarter and the price of imports two quarters. An equation like (1) also explains country 2's demand for the good of country 1, with lower case letters and capital letters reversed and with $1/e$ replacing e .

The price of the good of country 1, which is assumed in the model to be set by the firm sector of country 1, is a function, among other things, of the price of the good of country 2:

$$\log P = 0.0795 \log(e \cdot p) + 0.739 \log P_{-1} + \text{other terms.} \qquad (2)$$

This equation was also estimated using U.S. data for the 1954I-1974II period.[3] The price of imports is estimated to have an effect on the price of domestically produced goods, with, for example, a one percent increase in the price of imports resulting, other things being equal, in a 0.0795 percent increase in the price of domestically produced goods in the current quarter. An equation like (2) also holds for country 2, again with lower case letters and capital letters reversed and with $1/e$ replacing e .

The financial saving of country 1 (denoted as S) is equal to the sum of the financial savings of its four sectors: $S = S_h + S_f + S_b + S_g$. It is also equal to the difference between receipts from and payments to country 2:

[3]Equation (2) is equation 9 in [4], where here $PF = P$ instead of $PX = P$. PF and PX are closely linked in the model, and so little is lost in the present discussion by treating them as the same variable.

(3) $$S = P \cdot X^* - e \cdot p \cdot x^* - A ,$$

where X^* is country 2's purchase of country 1's good and A is the value of net payments from country 1 to country 2 not included in the other two terms.[4] By definition $S = e \cdot s$, where s is the financial saving of country 2.

Any nonzero value of S in a quarter must result in the change in at least one of country 1's assets or liabilities. This "budget constraint" for country 1 is:

(4) $$0 = S + \Delta B^* + \Delta M^* - e \cdot \Delta b^* - e \cdot \Delta m^* - \Delta Q ,$$

where B^* and M^* are country 2's holdings of country 1's bond and money, respectively, and where b^* and m^* are country 1's holdings of country 2's bond and money, respectively. Country 1's holdings of the international reserve is Q , where the units of Q are chosen so that it has a price of 1.0.[5]

It will also be useful for future reference to write down the budget constraint for the government of country 1:

(5) $$0 = S_g + \Delta(BR - BO) - \Delta B_g - e \cdot \Delta m_g^* - e \cdot \Delta b_g^* - \Delta Q ,$$

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[4]Equation (3) is equation 65 in [4], where $SAVR = -S$, $EX = X^*$, and $A = HRTRP + GRTRP$. Also, $PEX = P$ instead of $PX = P$ or $PF = P$. Again, PEX is closely linked in the model to PX and PF , and so little is lost in the present discussion by treating these three as the same variable. It should also be noted that the payments and receipts that are involved in the definition of S include interest payments and receipts between the two countries. Finally, it should be noted that equation (3) is the sum of equations (10), (16), (18), and (53) in [6], where (18) is modified to include a bank sector.

[5]Equation (4) is equation 66 in [4], where $\Delta DDR = \Delta M^*$, $\Delta GFXG = \Delta Q$, and $\Delta SECR = \Delta B^* - e \cdot \Delta b^* - e \cdot \Delta m^*$. It is also the sum of equations (11), (17), (19), and (54) in [6], where (19) is modified to include a bank sector.

where $\Delta(BR - BO)$ is the change in nonborrowed reserves.[6] Equation (5) states that any nonzero value of the saving of country 1's government must result in the change in at least one of the following: nonborrowed reserves, its holdings of the bond of country 1, its holdings of the money of country 2, its holdings of the bond of country 2, and its holdings of the international reserve. (Remember that if country 1's government is a supplier of the bond of country 1, then B_g is negative.) An equation like (5) also holds for country 2's government, with lower case letters and capital letters reversed and with $1/e$ replacing e .

For all the simulation work in this paper, country 1's holdings of country 2's money is taken to be exogenous, and likewise for country 2's holdings of country 1's money. In other words, ΔM^* and Δm^* in (4) are taken to be exogenous (as well as Δm_g^* in (5)). For the model in [6] one of the decision variables of each household sector was its holdings of the money of the other country, but for the econometric model in [4] no equation explaining this variable was estimated. Therefore, for purposes of the simulation work with Model A, ΔM^* and Δm^* are taken to be exogenous.

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[6] Equation (5) is equation 69 in [4], where $SAVG = S_g$, $\Delta(BR\text{-}BORR) = \Delta(BR\text{-}BO)$, $\Delta VBG = -\Delta B_g^* - e \cdot \Delta m_g^* - e \cdot \Delta b_g^*$, $\Delta GFXG = \Delta Q$, and $\Delta CURR = 0$. It is also equation (19) in [6] as modified to include a bank sector.

III. *The Regimes*

Policy effects in Model A were analyzed in four different regimes. The regimes are:

(0,0) = zero capital mobility and a fixed exchange rate,

(∞,0) = perfect capital mobility and a fixed exchange rate,

(0,∞) = zero capital mobility and a flexible exchange rate,

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

Perfect capital mobility is defined to be the case in which the two bonds are perfect substitutes. Zero capital mobility is the case in which the two bonds are not exchanged between the countries. In the fixed exchange rate case e is exogenous and Q is endogenous, and in the flexible exchange rate case e is endogenous and Q is exogenous.

In the zero mobility case B^* and b^* are exogenous.[7] With respect to the perfect mobility case, if the two bonds are one-period securities and are perfect substitutes, then, as mentioned in [6], arbitrage will insure that $R = r+\rho$, where ρ is the expected one-period change in e . No equation explaining a variable like ρ was estimated in [4], however, and so for the simulation work in this paper, ρ was assumed to be zero. In other words, expectations regarding e were assumed to be static. There is thus only one (world) interest rate in the perfect mobility case in this paper: $R = r$. It is also true in this case, again as discussed in [6], that the model is underidentified with respect to B , B^* , b , and b^* . One of these variables must be taken to be exogenous, although it does not matter which one is chosen. For the work below, B^* was taken

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[7] In the zero mobility case equations (7) and (7)' in [6] drop out and b_h^* and B_h^* are taken to be exogenous.

to be the exogenous variable in the perfect mobility case. It should also be noted for future reference that in the zero mobility case the endogenous variables in equation (4) are S and e or Q and that in the perfect mobility case the endogenous variables are S , b^* , and e or Q .

Results for regimes in which capital mobility is in between zero and perfect are not presented in this paper. Some results for these regimes were in fact obtained in this study, regimes in which B^* and b^* were assumed to be a function of the difference between R and r . As expected, the results for these regimes were in between the results for the zero and perfect mobility regimes. The more responsive were B^* and b^* assumed to be to the difference between R and r , the closer were the results to the results for the perfect mobility regimes. Since these results contained no surprises or new insights into the properties of the model, there is little reason to present them here, and so this will not be done.

IV. The Experiments

The simulation experiments were performed as follows. For each regime, Model A was first simulated using the actual values of all the exogenous variables. The simulation was dynamic and began in 1971I. The length of the prediction period was four quarters. The predicted values of the endogenous variables from this simulation were recorded. A second simulation was then run in which the purchase of country 1's good by country 1's government (X_g) was decreased each quarter by an amount necessary to correspond roughly to a 1.25 decrease in nominal expenditures.[8] 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 X_g. Finally, a third simulation was run in which B_g was decreased each quarter by 1.25 (a sale of the bond of country 1 by country 1's government), and the predicted values from this simulation were compared to the predicted values from the base simulation.

IV. *The Results*

The results of the eight experiments are presented in Table 1. Each number in the table is the difference between the predicted value of the variable after the policy change and the predicted value of the variable before the change. Columns 1-4 correspond to the change in X_g in each of the four regimes, and columns 5-8 correspond to the change in B_g in each of the four regimes. Results for 20 variables for the first three quarters of the simulation period are presented in the table.[9] The rest of this section is a discussion of the results in Table 1. An attempt has been made in what follows to provide enough discussion of the results in each column so as to make the rest of the results in that column fairly self explanatory. In the following discussion, 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. It

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[8]For the econometric model in [4], the nominal unit is billions of dollars. For Model A, on the other hand, it is arbitrary what the nominal units for the two countries are called.

[9]The variables for country 1 in Table 1 in the notation in [4] are: $Y = X_f$, $RBILL = R$, $PEX = P$, $PIM = e \cdot p$, $IM = x^*$, $SAVR = -S$, $GFXG = Q$, $SAVG = S_g$, $BORR = BO$, and $BR = BR$. See also the definition of $\Delta SECR$ in footnote 5.

TABLE 1. RESULTS OF EIGHT EXPERIMENTS

Change in:	Quarter	Sustained 1.25 Decrease in X (Fiscal-Policy Contraction[g] in Country 1) Regime				Sustained 1.25 Decreased in B (Monetary-Policy Contraction[g] in Country 1) Regime			
		(0,0) (1)	(∞,0) (2)	(0,∞) (3)	(∞,∞) (4)	(0,0) (5)	(∞,0) (6)	(0,∞) (7)	(∞,∞) (8)
X_f (Output in Country 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
x_f (Output in Country 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
R (Interest Rate in Country 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
r (Interest rate in Country 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
$100 \cdot P$ (Domestic Price Level in Country 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
$100 \cdot p$ (Domestic Price Level in Country 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
$100 \cdot e \cdot p$ (Price of Imports of Country 1)	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
$100 \cdot P/e$ (Price of Imports of Country 2)	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
x^* (Imports of Country 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
X^* (Imports of Country 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
S (Saving of Country 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

TABLE 1 (continued)

Change in:	Quarter	Sustained 1.25 Decrease in X_g (Fiscal-Policy Contraction in Country 1) Regime				Sustained 1.25 Decrease in B_g (Monetary-Policy Contraction in Country 1) Regime			
		(0,0) (1)	(∞,0) (2)	(0,∞) (3)	(∞,∞) (4)	(0,0) (5)	(∞,0) (6)	(0,∞) (7)	(∞,∞) (8)
e (Exchange Rate, Price of Country 2's Currency in Terms of Country 1's Currency)	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
Q (Country 1's Holdings of the International Reserve)	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
b^* (Country 1's Holdings of Country 2's Securities)	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
S_g (Saving of Country 1's Government)	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
s_g (Saving of Country 2's Government)	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
BO (Bank Borrowing from the Government in Country 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
bo (Bank Borrowing from the Government in Country 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 (Level of Bank Reserves in Country 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
br (Level of Bank Reserves in Country 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

Notes:
1. Flow variables are at quarterly rates
2. Interest rates are in units of percentage points.
3. Initial price levels are approximately 1.3.
4. Initial value of e is 1.0.
5. Fiscal-policy contraction is a 1.25 decrease in nominal units.

should be realized that this discussion, while useful pedagogically, is not rigorous, since the model is simultaneous rather than recursive. Each endogenous variable in the model affects and is affected by all the other endogenous variables.

Regime (0,0)

Consider first the results in column 1 for quarter t. The decrease in X_g in this case led to a decrease in output in both countries and an increase in the interest rates in both countries. The interest rates increased because a decrease in X_g takes funds out of the system. Bank reserves fell in both countries. In the U.S. econometric model in [4], and thus in Model A, the interest rate has, other things being equal, a positive effect on the price level. In the present case the positive effects of the increase in the interest rates on the price levels were large enough to offset the negative effects due to the contractions in output, so that the price levels were higher in both countries. The decrease in X_g thus led to an initial increase in the price levels because of the higher interest rates that resulted from the decrease in X_g.

Because of the price lags in the import equations, a change 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 contractions in output. P increased more than did p and x^* decreased more than did X^*, which, as can be seen from equation (3) means an increase in the financial saving (S) of country 1. In the (0,0) regime, all the variables in equation (4), country 1's budget constraint, are exogenous except S and Q, and so the increase in S in this case resulted in an equal increase in country 1's reserves.

The saving of country 1's government increased by 0.66, which took the form of a 0.23 increase in bank borrowing, a 0.29 decrease in bank reserves, and a 0.15 increase in country 1's reserves. (These latter three numbers add to 0.67 instead of 0.66 because of rounding.) The saving of country 2's government decreased by 0.06, which took the form of a 0.05 increase in bank borrowing, a 0.04 decrease in bank reserves, and the 0.15 decrease in country 2's reserves. The saving of country 1's government did not increase by the full 1.25 decrease in its expenditures on goods because of a decrease in its tax revenues and an increase in some of its other expenditures caused by the economic contraction.

The economic contraction continued in both countries in quarters $t+1$ and $t+2$. The contraction continued to be more severe in country 1 than in country 2. This led to a continued fall in country 1's imports relative to country 2's imports and thus to a continued positive level of saving of country 1. The positive values of country 1's saving led to a continued accumulation by it of reserves. With respect to prices, the contraction led to a decrease in country 1's price level by quarter $t+2$ and, although not shown in the table, to a decrease in country 2's price level by quarter $t+3$.

Consider next the results in column 5 for quarter t . The decrease in B_g also led to a decrease in output and an increase in the interest rate in both countries. The contractions in output were somewhat smaller than the contractions in column 1, although the increases in the interest rates were larger. The larger increases in the interest rates led to larger initial increases in the price levels. The saving of country 1's government increased by 0.13 in quarter t , and this increase plus the 1.25 decrease in B_g was offset by a 0.67 increase in bank borrowing, a 0.60 decrease in bank reserves, and a 0.11 increase in country 1's reserves. Overall, the qualitative results in column 5 are very similar to the qualitative results in column 1.

Regime $(\infty, 0)$

In column 2 the increase in quarter t in the (world) interest rate was smaller than the increase in country 1's interest rate in column 1 and larger than the increase in country 2's interest rate in column 1. This led to a somewhat smaller contraction in country 1 and a somewhat larger contraction in country 2 in column 2 relative to column 1. The figure for b^* is negative in column 2, which means that there was a capital inflow into country 1. This inflow led to a larger accumulation of reserves by country 1 in column 2 than in column 1. The reason for the capital inflow is fairly clear. In the case of zero capital mobility in column 1, country 1's interest rate increased more than did country 2's interest rate. Therefore, to have the interest rate increases be the same in column 2, capital must flow into country 1. To put this another way, the decrease in X_g takes funds out of country 1's economy, and in order to prevent the interest rate from rising more in country 1 than in country 2, capital must flow into country 1.

The results in column 6 are interesting. The decrease in B_g had almost identical effects in the two countries. A decrease in B_g 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 two countries are virtually the same, taking funds out of the system in this case results in virtually identical effects in the two countries. The reason this result does not hold when X_g is decreased in this regime is that the decrease in X_g not only takes funds out of the system, but also has a direct effect on the sales of country 1's firm sector. This leads (in column 2) to greater output effects in country 1 than in country 2.

Regime $(0,\infty)$

The results for the two flexible exchange rate regimes are somewhat more difficult to explain. Consider first the results in column 3, which are for the regime of zero capital mobility and a flexible exchange rate. The decrease in X_g had opposite effects on the two countries regarding output and the interest rate: output decreased in country 1 and increased in country 2, and the interest rate increased in country 1 and decreased in country 2. The exchange rate increased (i.e., country 1's currency depreciated). It will help in understanding these results to realize that in the $(0,\infty)$ regime, the financial saving of each country cannot change, since there are no capital movements and no international reserve changes. In other words, the solution value for S when X_g or B_g is changed must be roughly[10] the same as the solution value for S in the base simu-

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[10]Because of the way in which the experiments were performed, the solution value for S after the change in the $(0,\infty)$ regime does not have to be exactly equal to the solution value before the change. This can be seen from equation (4). In the $(0,\infty)$ regime, the other endogenous variable in equation (4), aside from S, is e, where e multiplies the change in two exogenous variables (b^* and m^*). Treating b^* and m^* as exogenous means that the actual (historic) values of Δb^* and Δm^* were used in all the experiments for this regime. These values are not in general zero, and so e in general multiplies two nonzero variables in equation (4) in the $(0,\infty)$ regime. Therefore, with e endogenous, the solution value for S after the change can differ from the solution value before the change. This possible difference is, however, not important, and it is ignored in the discussion in the text.

lation. This is in fact the case in Table 1, where the changes in S are small in the two $(0,\infty)$ columns.

Consider now the reason for the increase in e in column 3. In the (0,0) regime in column 1, S increased, which means that e must adjust in column 3 in such a way as to offset this increase. A change in e has an important effect on the two import prices. A decrease in e, for example, decreases the price of country 1's imports $(e \cdot p)$ and increases the price of country 2's imports (P/e). 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 if did, then a decrease in e would have a direct positive effect on country 1's imports and a direct negative effect on country 2's imports and so would serve to lessen the increase in S. As it is, this channel is not open, and so the increase in S in column 1 must be lessened in some other way in column 3. This other way is for e to increase. The increase in $e \cdot p$ and the decrease in P/e that this causes has no direct effect on the real value of imports. It does, however, mean that country 1 pays more for its imports and receives less for its exports, and this has a negative effect on S. e thus increased in column 3 in order to turn the terms of trade against country 1 enough so as to offset the increase in S that would have otherwise taken place as a result of the decrease in X_g.

Consider next the reason for the increase in output in country 2. A decrease in the price of country 2's imports (P/e) has, other things being equal, a negative effect on country 2's domestic price level (p). This can be seen from equation (2), with capital and lower case letters reversed and with $1/e$ in place of e. In the U.S. econometric model in [4], and thus in Model A, a decrease in the price level is expansionary, because, among other things, it has a positive effect on the consumption of the household sector. The increase in e in column 3 and the resulting decrease in p thus led to an increase in output in country 2. The decrease in B_g in column 7 also resulted in an increase in e and an increase in the output of country 2.

Regime (∞,∞)

In column 4 the decrease in X_g resulted in a decrease in e (an appreciation of country 1's currency) and an increase in b^* (a capital outflow from country 1). The (world) interest rate increased in quarter t, and the output of both countries fell. The reason for the appreciation of country 1's currency and the capital outflow is as follows. The decrease in X_g takes funds out of the system. For the $(0,\infty)$ regime in column 3, this resulted in an increase in country 1's interest rate and a decrease in country 2's interest rate. This cannot happen for the (∞,∞) regime in column 4, however, since in this regime there is only one world interest rate. For the $(\infty,0)$ regime in column 2, the interest rates in the two countries were kept equal by having a capital inflow into country 1, which resulted in an accumulation of reserves by country 1. For the (∞,∞) regime, however, reserves are exogenous, and so any attempted capital inflow into country 1 to keep the interest rates the same results instead in an appreciation of country 1's currency.

The appreciation of country 1's currency is not, however, the end of the story. This appreciation decreases the price of country 1's imports and increases the price of country 2's imports: the terms of trade shift against country 2. 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 country 2 results in an increase in the saving of country 1. From equation (4), it can then be seen that an increase in S must be offset in the regime in which Q is exogenous by an increase in b^*, country 1's holdings of country 2's bond. The reason for the capital outflow from country 1 in column 4 is thus to compensate for the increase in the saving of country 1, the latter being caused by a shift in the terms of trade against country 2 due to the appreciation of country 1's currency. In short, what would have been a capital inflow into country 1 in the regime of perfect capital mobility and a fixed exchange rate $(\infty,0)$ has instead become a capital outflow in the regime of perfect capital mobility and a flexible exchange rate (∞,∞).[11]

In column 4 output fell more in quarters $t+1$ and $t+2$ in country 2 than it did in country 1. An appreciation of country 1's currency has a positive effect on country 2's price level, which in turn has a negative effect on country 2's output. This appreciation also has a negative effect on country 1's price level, which in turn has a positive effect on country 1's output. In column 4 these effects were large enough to cause the decrease in country 2's output to be larger than the decrease in country 1's output.

The decrease in B_g in column 8 also led to an appreciation of country 1's currency and a capital outflow. The reasons for this are the

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[11]The non rigorous nature of these last two paragraphs should be stressed. By telling the story in steps--first a decrease in e because of an attempted capital inflow and then a capital outflow because of an increase in S --it is hoped that some insights into the reasons for the results may be obtained, but this discussion is clearly not rigorous.

same as those for the results in column 4. The appreciation in column 8 was actually large enough to lead to an increase in country 1's output (through the negative effect on country 1's price level). In this case, a tighter monetary policy in country 1 resulted in a slight expansion in its economy as a result of the appreciation of its currency. The effects of this policy on country 2, were, on the other hand, contractionary. This conclusion is, however, reversed for output in nominal terms in the two countries. Although not shown in Table 1, for the experiment in column 8 nominal output in quarter t decreased in country 1 and increased in country 2.

A Summary

There are a number of ways in which the results in Table 1 can be summarized. One way is to compare the effectiveness of fiscal and monetary policies across regimes. The regime in which country 1's government has the least effect on the real output of country 1 (and the most effect on the real output of country 2) is the regime of perfect capital mobility and a flexible exchange rate (∞,∞). In this regime a contractionary policy results in an appreciation of country 1's currency and a decrease in country 1's price level because of the appreciation. A lower price level has, other things being equal, an expansionary effect in the model (through, among other things, the household sector's demand for goods), which tends to offset the initial contractionary effects. In the case of the monetary policy experiment in column 8, these offsetting effects were larger than the initial contractionary effects, so that real output increased in country 1 as a result of the monetary contraction. The appreciation of country 1's currency causes the price level in country 2 to rise, which, other things being equal, is contractionary in country 2.

The regime in which country 1's government has the most effect on the real output of country 1 (and the least effect on the real output of country 2) is the regime of zero capital mobility and a flexible exchange rate $(0,\infty)$. In this regime a contractionary policy results in a depreciation of country 1's currency and an increase in country 1's price level because of the depreciation. The higher price level thus causes more of a contractionary effect than there otherwise would be, as opposed to less of an effect in the (∞,∞) regime where the price level was lower.

The results for the two fixed exchange rate regimes are in between the results for the two flexible exchange rate regimes. Also, whether capital is mobile or not makes less difference in the fixed rate regimes than it does in the flexible rate regimes. Going from zero to perfect capital mobility in the case of a fixed exchange rate results in a larger increase in reserves in country 1, whereas in the case of a flexible exchange rate the result is a switch from a depreciation of country 1's currency to an appreciation. This latter result makes more of a difference to the economic system than does the former.

Another way of summarizing the results is to compare across regimes the response of S , the financial saving of country 1, to the policy changes. This response is again most in the (∞,∞) regime, least in the $(0,\infty)$ regime, and in between in the two fixed exchange rate regimes, $(0,0)$ and $(\infty,0)$. In the $(0,0)$ and $(\infty,0)$ regimes the response is positive because a contractionary policy in country 1 causes its imports to fall more than its exports.[12] In the $(0,\infty)$ regime, on the other hand,

[12]Except in column 6 in Table 1, where the monetary policy contraction in country 1 has essentially identical effects on the two countries.

the response is zero, since, from equation (4), S cannot change if there is no capital mobility and no change in country 1's reserves.[13] In this case S is prevented from rising by a depreciation of country 1's currency. The depreciation turns the terms of trade against country 1 so as to offset the increase in S that would otherwise have taken place as a result of the contractionary policy. In the (∞,∞) regime the increase in S is large, since in this case there is an appreciation of country 1's currency and thus a favorable terms of trade effect. The appreciation is the result of an attempted capital inflow into country 1 to equalize the interest rates in the two countries, i.e., to offset what would otherwise be a larger interest rate in country 1 as a result of the policy contraction in country 1.

A third way of summarizing the results is to compare across regimes capital movements and reserve changes. In the two fixed exchange rate regimes, the level of country 1's reserves increases in response to a policy contraction, since its saving increases. The increase in reserves is greater in the case of perfect capital mobility because there is a capital inflow into country 1. The capital inflow is needed to keep the interest rate from rising more in country 1 than in country 2. In the two flexible exchange rate regimes, the level of reserves is, of course, exogenous. With a flexible rate and perfect capital mobility, there is a capital outflow from country 1 in response to the policy contraction. The capital outflow is a result of the increase in country 1's saving, which in turn is a result of the appreciation of country 1's currency (and thus a favorable terms of trade effect).

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[13]Except for the qualification in footnote 10.

A final way in which the results in Table 1 could be summarized would be to compare them to results from other studies. This would, however, be a paper in itself, since it would require an extensive review of the literature to cover all the regimes. This type of review is beyond the scope of this paper, and so the present discussion will be restricted to the following two comments. First, in Mundell's model [8, Appendix to Chapter 18] in the (∞,∞) regime, a contractionary monetary policy has a negative effect on the output of the home country and a positive effect on the output of the other country. As discussed above, this is true in the present model in terms of nominal output, but in terms of real output the effects are reversed. Second, Niehans [9, p. 275] states for the case of flexible exchange rates that "we cannot even exclude the extreme possibility than an expansionary monetary policy may have a restrictive effect on output." This is in fact true of the present model in the (∞,∞) regime, where, as was seen above, the contractionary monetary policy in country 1 resulted in an increase in real output in country 1.

V. *Results When There Are No Price Lags in the Import Equations*

An important characteristic of Model A is that there are price lags in the import equation for each country. Price changes have no direct effects on the demand for imports in the current quarter of the policy changes, and so adjustments to policy changes must take place through such things as terms of trade effects. Although the U.S. data indicate, from the work in [4], that there are price lags in the import equations, it is of some interest to see what the response of the system would be if there were no lags. Therefore, the above experiments were performed with equation (1) replaced by

$$(1)' \qquad \log \frac{x^*}{POP} = -1.60 + 1.00 \log P - 1.00 \log(e \cdot p)$$

$$+ 1.17 \log \frac{X_f'}{POP} + \text{strike dummies} \ ,$$

and with country 2's version of equation (1) replaced by its version of (1)'. The coefficients on the two price terms are now equal in absolute value, and there are no lags.

In the no lag case the results for the two fixed exchange rate regimes were similar to the results in Table 1. The changes in $e \cdot p$ and P/e in columns 1, 2, 5, and 6 in Table 1 are not very large, and so the results are not very sensitive to what one assumes about the price responsiveness of imports. In the two flexible exchange rate regimes, on the other hand, the results were somewhat different, and these results are presented in Table 2. The following is a discussion of some of the differences between the results in Tables 1 and 2.

In Table 2 in the $(0,\infty)$ regime there is now an appreciation of country 1's currency rather than a depreciation. In this regime, as discussed above, S cannot change. In the price lag case, S was prevented from rising in response to the policy contraction by turning the terms of trade against country 1 through a depreciation of its currency. In the no lag case, on the other hand, S is prevented from rising primarily by changes in imports and exports. An appreciation of country 1's currency causes it *in the current quarter* to import more and export less than otherwise, both of which have a negative effect on S. The adjustment in the no lag case thus takes place through an appreciation rather than a depreciation of country 1's currency. This also means that some of the other responses are different in the no lag case in the $(0,\infty)$ regime. The

TABLE 2. RESULTS OF FOUR EXPERIMENTS (NO PRICE LAGS IN IMPORT EQUATIONS)

Change in:	Quarter	Sustained 1.25 Decrease in X_g (Fiscal-Policy Contraction in Country 1) Regime $(0,\infty)$ (1)	(∞,∞) (2)	Sustained 1.25 Decrease in B_g (Monetary-Policy Contraction in Country 1) Regime $(0,\infty)$ (3)	(∞,∞) (4)
X_f (Output in Country 1)	t	-1.42	-1.41	-0.70	-0.78
	$t+1$	-2.05	-2.05	-1.20	-0.70
	$t+2$	-1.87	-2.26	-0.63	-0.51
x_f (Output in Country 2)	t	-0.07	-0.08	-0.03	0.01
	$t+1$	-0.37	-0.50	-0.18	-0.88
	$t+2$	-0.79	-0.59	-0.41	-0.74
R (Interest Rate in Country 1)	t	0.48	0.45	2.02	1.16
	$t+1$	-0.18	0.03	-0.22	-0.09
	$t+2$	-0.45	-0.44	-0.83	-0.71
r (Interest Rate in Country 2)	t	0.40	0.45	0.17	1.16
	$t+1$	0.52	0.03	0.29	-0.09
	$t+2$	0.07	-0.44	-0.10	-0.71
$100 \cdot P$ (Domestic Price Level in Country 1)	t	0.024	-0.022	0.428	0.005
	$t+1$	-0.359	-0.098	-0.057	-0.036
	$t+2$	-0.459	-0.230	-0.117	-0.158
$100 \cdot p$ (Domestic Price Level in Country 2)	t	0.198	0.244	0.091	0.527
	$t+1$	0.409	0.240	0.214	0.300
	$t+2$	0.442	0.177	0.165	0.185
$100 \cdot e \cdot p$ (Price of Imports of Country 1)	t	-1.339	-1.594	-0.215	-3.156
	$t+1$	-2.098	-0.684	-1.038	0.605
	$t+2$	-1.457	-0.754	-0.154	-0.434
$100 \cdot P/e$ (Price of Imports of Country 2)	t	1.555	1.770	0.726	3.642
	$t+1$	2.458	0.854	1.348	-0.351
	$t+2$	1.517	0.694	0.208	0.457
x^* (Imports of Country 1)	t	0.01	0.03	0.00	0.24
	$t+1$	0.03	-0.10	0.01	-0.11
	$t+2$	-0.03	-0.11	-0.03	-0.01
X^* (Imports of Country 2)	t	-0.14	-0.17	-0.07	-0.32
	$t+1$	-0.21	-0.10	-0.11	-0.01
	$t+2$	-0.16	-0.09	-0.03	-0.08
S (Saving of Country 1)	t	-0.02	-0.05	-0.01	-0.31
	$t+1$	-0.07	0.06	-0.03	0.04
	$t+2$	-0.04	0.08	-0.00	-0.05

TABLE 2 (continued)

Change in:	Quarter	Sustained 1.25 Decrease in X_g (Fiscal-Policy Contraction in Country 1) Regime $(0,\infty)$ (1)	(∞,∞) (2)	Sustained 1.25 Decrease in B_g (Monetary-Policy Contraction in Country 1) Regime $(0,\infty)$ (3)	(∞,∞) (3)
e (Exchange Rate, Price of Country 2's Currency in Terms of Country 1's Currency	t	-0.0125	-0.0150	-0.0025	-0.0300
	$t+1$	-0.0200	-0.0075	-0.0100	0.0025
	$t+2$	-0.0150	-0.0075	-0.0025	-0.0050
Q (Country 1's Holdings of the International Reserve)	t	0.0	0.0	0.0	0.0
	$t+1$	0.0	0.0	0.0	0.0
	$t+2$	0.0	0.0	0.0	0.0
b^* (Country 1's Holdings of Country 2's Securities)	t	0.0	-0.02	0.0	-0.23
	$t+1$	0.0	0.07	0.0	-0.19
	$t+2$	0.0	0.21	0.0	-0.18
S_g (Saving of Country 1's Government)	t	0.39	0.35	0.03	-0.51
	$t+1$	-0.42	-0.10	-1.16	-0.54
	$t+2$	-0.09	-0.25	-0.46	-0.48
s_g (Saving of Country 2's Government)	t	0.24	0.29	0.11	0.72
	$t+1$	0.15	-0.16	0.10	-0.54
	$t+2$	-0.20	-0.25	-0.18	-0.39
BO (Bank Borrowing from the Government in Country 1)	t	0.17	0.16	0.71	0.41
	$t+1$	-0.07	0.01	-0.08	-0.03
	$t+2$	-0.16	-0.16	-0.30	-0.26
bo (Bank Borrowing from the Government in Country 2)	t	0.14	0.16	0.06	0.41
	$t+1$	0.18	0.01	0.10	-0.03
	$t+2$	0.02	-0.16	-0.04	-0.26
BR (Level of Bank Reserves in Country 1)	t	-0.21	-0.18	-0.57	-0.33
	$t+1$	-0.04	-0.22	-0.19	-0.23
	$t+2$	-0.02	-0.17	0.06	-0.02
br (Level of Bank Reserves in Country 2)	t	-0.10	-0.13	-0.05	-0.30
	$t+1$	-0.19	-0.12	-0.10	-0.19
	$t+2$	-0.17	-0.00	-0.06	0.01

Notes: See Table 1.

output in country 2, for example, is now lower rather than higher in response to the policy contraction in country 1, and the interest rate in country 2 is now higher rather than lower. (Compare columns 1 and 3 in Table 2 with columns 3 and 7 in Table 1.)

In Table 2 in the (∞,∞) regime there is now less of an appreciation of country 1's currency than there was in the price lag case. The fact that exports and imports respond to current changes in prices in the no lag case means that the exchange rate needs to change less to adjust to the policy contraction than it did before. In the price lag case the saving of country 1 increased because of the favorable terms of trade effect, and so there was a capital outflow. In the no lag case, on the other hand, the saving of country 1 fell slightly in quarter t because of the increase in imports and decrease in exports caused by the appreciation, and so there was a small capital inflow in quarter t. Also, it is no longer the case in the no lag case that a contractionary monetary policy results in an increase in real output in country 1 and a decrease in real output in country 2. Real output is lower in country 1 and, except for essentially no change in quarter t, lower in country 2. (Compare columns 2 and 4 in Table 2 with columns 4 and 8 in Table 1.)

VI. *Conclusion*

The main results of this study are summarized at the end of Section IV and in Section V, and this discussion will not be repeated here. It is obvious from the results in Tables 1 and 2 that many policy effects are sensitive to the type of regime in existence and to whether or not there are price lags in the import equations. The effects may also, of course, be sensitive to the properties of the econometric model that was used to construct Model A. Two important features of the model in this regard are the fact that a country's domestic price level is a function of the price of its imports and the fact that a lower price level, other things being equal, is expansionary in the country. Some effects would clearly have been different had the model not had these two features.

There are three main ways in which the work in this study might be extended, two theoretical and one empirical. One way would be to carry out more of the above kinds of simulation experiments. Different simulation models could be used[14] or Model A could be modified in various ways. In other words, one could examine the sensitivity of the results obtained in this study to alternative specifications of the single-country model. The second possible theoretical extension would be to see if the balance of payments model in [6] could be simplified enough (without changing its basic structure) to allow one to examine policy effects analytically or graphically. Some insights might be obtained from this work that one would not get from further simulation work. An important issue for further theoretical work of either kind is the treatment of expectations. In this study expectations of future exchange rates were assumed to be static, and it would clearly be of interest in future work to examine the sensitivity of policy effects to alternative assumptions about the formation of expectations.

The other possible extension would be to link the U.S. econometric

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[14]See Shafer [10] for another example of a simulation model, where the stress is on exchange-rate expectations. The basic structure of Shafer's model is different in a number of important ways from the basic structure of the balance of payments model in [6] and thus from the basic structure of Model A.

model in [4] to an actual econometric model (or set of models) of the rest of the world. If the half of Model A that is not empirical were replaced with an empirical version, then one would have a completely empirical model, whose properties could be analyzed by means of simulation techniques. Project LINK [1] is, of course, an attempt to construct an econometric model of the world.[15] Unfortunately, this project has not yet linked the financial sectors of the individual country models together. Capital movements are for the most part treated as exogenous, and the LINK model is still primarily a trade model. The results in this study indicate that the lack of completeness of a model like LINK with respect to capital flows is not a minor omission: policy effects can be quite sensitive to the behavior of capital movements. It is, of course, a large task either to replace the non-empirical part of Model A with an empirical version or to modify the LINK model so that it is closed with respect to all flows of funds, but as a long run goal this task is clearly of considerable interest and importance.

Finally, it should be noted that in future work one might want to relax the assumption in this study that the behavior of the governments is exogenous. In other words, one might want to specify reaction functions for some of the decision variables of the governments and add them to the model before examining the effects of changes in other government decision variables.[16]

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[15] See also the work of Berner *et al.* [2], which is concerned with linking together models of the United States, Canada, Japan, the United Kingdom, and West Germany, and the work of Helliwell [7], which is concerned with linking together the RDX2 model of Canada and the MPS model of the United States.

[16] See, for example, Fair [5] for an analysis of the addition of an equation explaining Fed behavior to the econometric model in [4].

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