Properties of a Multicountry Econometric Model

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A general description of my multicountry econometric model is presented in this paper. A two-country theoretical model is presented first. This model is then used to motivate the specification of the econometric model, especially the specification of the interest rate and exchange rate equations. The properties of the econometric model are then examined by performing a number of numerical experiments.

I. INTRODUCTION

This paper discusses the properties of my multicountry econometric model. The theoretical structure of the model is explained in Section II; the econometric specifications are discussed in Section III; and the properties of the model are examined in Section IV.

I began work on the model in the late 1970s, and the complete version of it was presented in Fair (1984). The model has changed very little from this version, and so this reference is still useful. I have, however, tried to make the present paper self-contained for those who want a general idea of the structure and properties of the model but not necessarily a complete list of its estimated equations and variables. The notation in this paper is simpler than, and thus differs from, the notation in Fair (1984).

II. THE THEORETICAL STRUCTURE[1]

The main features of the econometric model can be seen by analyzing a two-country model.[2] In particular, the two-country model can be

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[1]Some of the discussion of the theoretical model in this section and the next section is the same as the discussion in Section II in Fair (1986b).

[2]The following model is similar to the model in Fair (1979), although the present model is simpler. In the earlier model, household and firm sectors were considered separately, a labor market was introduced, and each country was allowed to hold the other country's money. It is unnecessary to introduce these features into the present theoretical model for purposes of understanding the structure of the econometric model.

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used to see how interest rates and exchanges rates are determined. Capital letters will denote variables for country 1, lower case letters will denote variables for country 2, and an asterisk (*) on a variable will denote the other country's holdings or purchase of the variable. There are three sectors per country: private nonfinancial (p), financial (b), and government (g). The private nonfinancial sector includes both households and firms. It will be called the "private sector." Members of the financial sector will be called "banks." Each country specializes in the production of one good (X,x). Each country has its own money (M,m) and its own bond (B,b). Only the private sector of the given country holds the money of the country. The bonds are one-period securities. If the 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. The interest rate on B is R and on b is r. The price of X is P and of x is p. e is the price of country 2's currency in terms of country 1's currency, so that, for example, an increase in e is a depreciation of country 1's currency. The government of each country holds a positive amount of the international reserve (Q,q), which is denominated in the units of country 1's currency. The government of a country does not hold the bond of the other country and does not buy the good of the other country. Y denotes real GNP of country 1, and y denotes real GNP of country 2.

There are 17 equations per country and one redundant equation. The equations for country 1 are as follows (the sign above an explanatory variable indicates the expected effect of the variable on the left-hand side variable): The demands for the two goods by the private sector of country 1 are

$$X_p = f_1 (\overset{-}{P}, \overset{+}{e \cdot p}, \overset{-}{R}, \overset{+}{Y}), \tag{1}$$

$$x_p^* = f_2 (\overset{+}{P}, \overset{-}{e \cdot p}, \overset{-}{R}, \overset{+}{Y}). \tag{2}$$

The demands are a function of the two prices, the interest rate, and income as measured by GNP. X_p is the purchase of country 1's good by the private sector of country 1, and x_p^* is the purchase of country 2's good by the private sector of country 1. The domestic price level is assumed to be a function of demand pressure as measured by Y and of the level of import prices, $e \cdot p$:

$$P = f_3 (\overset{+}{Y}, \overset{+}{e \cdot p}). \tag{3}$$

There is assumed to be no inventory investment, so that production is equal to sales:

$$Y = X_p + X_g + X_p^*, \tag{4}$$

where X_g is the purchase of country 1's good by its government and X_p^* is the purchase of country 1's good by country 2. Taxes paid to the government are

$$T_p = TX \cdot Y, \tag{5}$$

where TX is the tax rate.

The demand for money is assumed to be a function of the interest rate and income:

$$M_p/P = f_6(\overset{-}{R}, \overset{+}{Y}). \tag{6}$$

Borrowing by the banks from the monetary authority (BO) is assumed to be a function of R and of the discount rate RD:

$$\text{BO} = f_7(\overset{+}{R}, \overset{-}{RD}). \tag{7}$$

Since the private sector is assumed to be the only sector holding money,

$$M_b = M_p, \tag{8}$$

where M_b is the money held in banks. Equation (8) simply says that all money is held in banks. Banks are assumed to hold no excess reserves, so that

$$\text{BR} = \text{RR} \cdot M_b, \tag{9}$$

where BR is the level of bank reserves and RR is the reserve requirement rate.

The expected (one-period) return on the bond of country 2 is $(e^e_{+1}/e)(1 + r) - 1$, where e^e_{+1} is the expected exchange rate for the next period based on information available in the current period and r is the interest rate on the bond of country 2. The demand for country 2's bond is assumed to be a function of R and of the expected return on country 2's bond:

$$b_p^* = f_{10}[\overset{+}{R}, \overset{-}{(e^e_{+1}/e)(1 + r) - 1}]. \tag{10}$$

b_p^* is the amount of country 2's bond held by country 1. If capital mobility is high, large changes in b_p^* will result from small changes in the difference between R and the expected return on country 2's bond. If capital mobility is perfect, R is always equal to the expected return on country 2's bond, and Equation (10) drops out. It is assumed here that capital mobility is not perfect.

The next three equations determine the financial saving of each sector:

$$S_p = P{\cdot}X_g + P{\cdot}X_p^* - e{\cdot}p{\cdot}x_p^* - T_p + R{\cdot}B_p + e{\cdot}r{\cdot}b_p^*, \quad (11)$$

$$S_b = R{\cdot}B_b - \mathrm{RD{\cdot}BO}, \quad (12)$$

$$S_g = T_p - P{\cdot}X_g + R{\cdot}B_g + \mathrm{RD{\cdot}BO}. \quad (13)$$

Equation (11) states that the saving of the private sector is equal to revenue from the sale of goods to the government plus export revenue minus import costs minus taxes paid plus interest received (or minus interest paid) on the holdings of country 1's bond and plus interest received on the holdings of country 2's bond. If the private sector is a net debtor with respect to the bond of country 1, then B_p is negative and $R{\cdot}B_p$ measures interest payments. Remember that the private sector (p) is a combination of households and firms, and so transactions between households and firms net out of Equation (11). Equation (12) states that the saving of banks is equal to interest revenue on bond holdings (assuming B_b is positive) minus interest payments on borrowings from the monetary authority. Equation (13) determines the government's surplus or deficit. It states that the saving of the government is equal to tax revenue minus expenditures on goods minus interest costs (assuming B_g is negative) and plus interest received on loans to banks.

The next three equations are the budget constraints facing each sector:

$$0 = S_p - \Delta M_p - \Delta B_p - e{\cdot}\Delta b_p^*, \quad (14)$$

$$0 = S_b - \Delta B_b + \Delta M_b - \Delta(\mathrm{BR} - \mathrm{BO}), \quad (15)$$

$$0 = S_g - \Delta \mathrm{B}_g + \Delta(\mathrm{BR} - \mathrm{BO}) - \Delta \mathrm{Q}. \quad (16)$$

Equation (14) states that any nonzero value of saving of the private sector must result in the change in its money or bond holdings. Equation (15) states that any nonzero value of saving of the financial sector must result in the change in bond holdings, money deposits (which are a liability to banks), or nonborrowed reserves. Equation (16) states that any nonzero value of saving of the government must result in the change in bond holdings, nonborrowed reserves (which are a liability to the government), or international reserve holdings.

There is also a constraint across all sectors, which says that someone's asset is someone else's liability with respect to the bond of country 1:

$$0 = B_p + B_b + B_g + B_p^*. \tag{17}$$

These same 17 equations are assumed to hold for country 2, with lower case and upper case letters reversed except for Q and with $1/e$ replacing e. Q is replaced by q/e [Equations (18)–(34)]. (Remember that Q and q are in the units of country 1's currency.) The last equation of the model is

$$0 = \Delta Q + \Delta q, \tag{35}$$

which says that the change in reserves across countries is zero. Equation (35) is implied by Equations (11)–(17) and the equivalent equations for country 2, and so it is redundant. There are thus 34 independent equations in the model.

The following variables for country 1 are taken to be exogenous: X_g, government purchases of goods; TX, the tax rate; RD, the discount rate; and RR, the reserve requirement rate. The same is true for country 2. Not counting these variables, there are 38 variables in the model: B_b, B_g, B_p, B_p^*, BO, BR, M_b, M_p, P, Q, R, S_b, S_g, S_p, T_p, X_p, X_p^*, Y, these same 18 variables for country 2, e, and $e^e{}_{+1}$. In order to close the model, one needs to make an assumption about how $e^e{}_{+1}$ is determined and to take three other variables as exogenous.

Assume for now that exchange rate expectations are static in the sense that $e^e_{+1} = e$ always. The model can then be closed by taking B_g, b_g, and Q as exogenous. These are the three main tools of the monetary authorities. Instead of taking the three tools to be exogenous, however, one can assume that the monetary authorities use the tools to manipulate R, r, and e. (Remember that it is assumed here that capital mobility is not perfect, which implies that the monetary authorities can in principle achieve any target values of R, r, and e that they want.) Another way of putting this is that one can take R, r, and e to be exogenous in the model if B_g, b_g, and Q are taken to be endogenous. The solution values of B_g, b_g, and Q will be whatever is needed to have the exogenously chosen values of R, r, and e be met. It will be seen below that the econometric model is based on the assumption that the monetary authorities manipulate R, r, and e.

In order to help in understanding the properties of the model, it will be useful to consider two equations that can be derived from the others. Let S denote the financial saving of country 1, which is the sum of the saving of the three sectors: $S = S_p + S_b + S_g$. S is the balance of payments on current account of country 1. Summing equations (14)–(16) and using (17) yields

$$0 = S + \Delta B_p^* - e\cdot\Delta b_p^* - \Delta Q. \tag{36}$$

This equation simply says that any nonzero value of saving of country 1 must result in the change in at least one of the following three: country 2's holdings of country 1's bond, country 1's holding of country 2's bond, and country 1's holding of the international reserve. The derived equation for S can be obtained by summing Equations (11)–(13) and using (17):

$$S = P\cdot X_p^* - e\cdot p\cdot x_p^* - R\cdot B_p^* + e\cdot r\cdot b_p^*. \tag{37}$$

This equation says that the saving of country 1 is equal to export revenue minus import costs minus interest paid to country 2 plus interest received from country 2.

This completes the presentation of the theoretical model. In the next section the model will be used to help explain the econometric specifications.

III. ECONOMETRIC SPECIFICATIONS

One of the main uses of the above theoretical model is to allow one to see clearly the assumptions behind the determination of interest rates and exchange rates in the econometric model. It will help to put the present approach to interest rate and exchange rate determination in perspective to consider an alternative approach that could in principle be used to estimate the model. If all the equations in the theoretical model that are not identities were estimated, one could solve the model for R, r, and e by taking B_g, b_g, and Q as exogenous. R, r, and e would thus be determined without having to estimate any direct equations for them. In doing this, however, one would be making the rather extreme assumption that the monetary authorities' choices of B_g, b_g, and Q are never influenced by the state of the economy, i.e., are always exogenous. It seems likely that monetary authorities intervene at least some of the time in the financial markets.

If one believes that monetary authorities do intervene, there are essentially two options open. One is to estimate equations with B_g, b_g, and Q on the left-hand side, and the other is to estimate equations with R, r, and e on the left-hand side. If the first option is followed, the B_g, b_g, and Q equations are added to the model, and the model is solved for R, r, and e. If the second option is followed, the R, r, and e equations are added to the model and the model is solved for B_g, b_g, and Q. The first option is awkward because one does not typically think of the monetary authorities having target values of the tools themselves. It is more natural to think of them having target values of interest rates (or money supplies[3]) and exchange rates, and this is the assumption upon which the econometric work is based. Exchange rate and interest rate "reaction functions" are estimated for the econometric model, where the explanatory variables in these equations are assumed to be variables that affect the monetary authorities' decisions.

The key question, of course, is what variables affect the monetary authorities' decisions. If capital mobility is high, it will take large changes in the three tools to achieve values of R, r, and e much different from what the market would otherwise achieve. Since the monetary authorities are likely to want to avoid large changes in the tools, they are likely to be sensitive to and influenced by the market forces. In short, they are likely to take market forces into account in setting their target values of R, r, and e. Therefore, one needs to know the market forces that affect R, r, and e in the model in order to guide the choice of explanatory variables in the reaction functions, and this is where the theoretical model can be of some help.

Before considering the market forces on R, r, and e in the theoretical model, it should be noted that there is also a practical reason for estimating equations for R, r, and e rather than taking B_g, b_g, and Q as exogenous or estimating equations for them. If B_g, b_g, and Q are taken to be exogenous or equations estimated for them, the entire model must be estimated in order to solve for R, r, and e. In practice it is very difficult to estimate equations like (10), which determine the bilateral demands for securities. One of the main problems is that data on bilateral holdings of securities either do not exist or are not very good. If equations for interest rates and exchange rates are estimated instead, one can avoid estimating equations like (10) in order to determine interest rates and exchange rates if one is willing to give up determining B_g, b_g, and Q. This is what is done in the econometric model. For many applications one can get by without knowing the amounts of government bonds outstanding and government reserve

[3]It is in the spirit of the present approach to estimate money supply reaction functions rather than interest rate reaction functions. In either case B_g is endogenous. No attempt has been made in the econometric work to estimate money supply reaction functions. The econometric model is based on the implicit assumption that interest rate reaction functions provide a better approximation of the way monetary authorities behave than do money supply reaction functions.

holdings. One can simply keep in mind that the values of these variables are whatever is needed to have the interest rate and exchange rate values be met.

Market Forces in the Theoretical Model

In order to examine the market forces on R, r, and e in the theoretical model, a "simulation" version of the model was analyzed. Particular functional forms and coefficients were chosen for Equations (1)–(3), (6), (7), and (10) and the equivalent equations for country 2, and the model was then analyzed using numerical techniques. This work is described in Fair (1986b). A set of "base" values was chosen for the exogenous variables, and the model was solved for the endogenous variables. These solution values of the endogenous variables are then their base values. The model is analyzed by changing something in it and solving it again. The difference between the new solution value for an endogenous variable and the old solution value (i.e., the base value) is the amount by which the change has affected the endogenous variable.

The following experiments give an idea of the market forces affecting R, r, and e in the model. Unless otherwise noted, the experiments are based on the assumption that $e^e_{+1} = e$. This means from Equation (10) and the equivalent equation for country 2 that b^*_p and B^*_p are simply a function of R and r. In all but the last experiment e is endogenous and Q is exogenous. Taking Q to be exogenous means that the monetary authorities are not manipulating e. This is a way of examining the market forces on e. The solution value of e for each experiment is the value that would pertain if the monetary authorities did not intervene at all in the foreign exchange market in response to whatever change was made for the experiment. B_g and b_g are always endogenous for the experiments because all the experiments either have R and r exogenous or M_b and m_b exogenous. In other words, it is always assumed that the monetary authorities either keep interest rates or money supplies unchanged in response to whatever change was made for the experiment. When R and r are exogenous, M_b and m_b are endogenous, and vice versa. All shocks in the experiments are for country 1.

EXPERIMENT 1: R EXOGENOUS AND LOWERED, r EXOGENOUS AND UNCHANGED

For this experiment the interest rate for country 1 was lowered (from its base value) and the interest rate for country 2 was assumed to remain unchanged. This change resulted in a depreciation of country 1's currency. The fall in R relative to r led to an increase in the demand for the bond of country 2 by country 1 (b_p^* increased) and a decrease in the demand for the bond of country 1 by country 2 (B_p^* decreased). From Equation (36) it can be seen that this must result in an increase in S, country 1's balance of payments, since Q is exogenous and unchanged. S is increased by increasing country 1's exports and decreasing its imports—Equation (37)—which is accomplished by a depreciation. Another way of looking at this is that the fall in R relative to r led to a decreased demand for country 1's currency because of the capital outflow, which resulted in a depreciation of country 1's currency. GNP for country 1 increased because of the lower interest rate and the depreciation, and the demand for money increased because of the lower interest rate and the higher level of income. The monetary authority of country 1 bought bonds to achieve the reduction in R (B_g increased).

Experiments with alternative coefficients in the equations explaining b_p^*—Equation (10) and the equivalent equation for country 2—showed that the more sensitive the demands for the foreign bonds to the interest rate differential, the larger the depreciation of the exchange rate and the larger the increase in B_g for the same drop in R. In other words, the higher the degree of capital mobility, the larger the size of open market operations that is needed to achieve a given target value of the interest rate.

Remember that the above experiment is for the case in which exchange rate expectations are static, i.e., where $e^e_{+1} = e$. If instead expectations are formed in such a way that e^e_{+1} turns out to be less than e, which means that the exchange rate is expected to appreciate in the next period (i.e., reverse at least some of the depreciation in the current period), then the depreciation in the current period is less. This is because if e^e_{+1} is less than e, the expected return on country 2's bond falls. The differential between R and the expected return on country 2's bond thus falls less as a result of the decrease in R, which leads to a smaller increase in b_p^* and a smaller decrease in B_p^*. There is thus less downward pressure on country 1's currency and thus a smaller depreciation. If expectations are formed in such a way that $e^e{}_{+1}$ turns out to be greater than e, which means that the exchange rate is expected to depreciate further in the next period, there is more of a depreciation in the current period. The expected return on country 2's bond rises, which leads to greater downward pressure on country 1's exchange rate.

EXPERIMENT 2: POSITIVE PRICE SHOCK, *R* AND *r* EXOGENOUS AND UNCHANGED

For this experiment the price equation for country 1 was shocked positively. The monetary authorities were assumed to respond to this by keeping interest rates unchanged. The positive price shock resulted in a depreciation of country 1's currency. A positive price shock leads to a decrease in the demand for exports and an increase in the demand for imports, which puts downward pressure on S. If, however, interest rates are unchanged, b_p^* and B_p^* do not change, which means from Equation (36) that S cannot change. Therefore, a depreciation must take place to decrease export demand and increase import demand enough to offset the effects of the price shock. Put another way, a positive price shock leads to a decreased demand for country 1's currency because of the increased import demand and the decreased export demand, which puts downward pressure on the price of the currency.

EXPERIMENT 3: POSITIVE PRICE SHOCK, M_b AND m_b EXOGENOUS AND UNCHANGED

This experiment is the same as experiment 2 except that the money supplies are kept unchanged rather than the interest rates. The positive price shock with the money supplies unchanged led to an increase in R, both absolutely and relative to r. Even though R increased relative to r, country 1's currency depreciated. The negative effects of the price shock (though decreased export demand and increased import demand) offset the positive effects of the interest rate changes.

EXPERIMENT 4: *R* EXOGENOUS AND LOWERED, *r* EXOGENOUS AND UNCHANGED, *e* EXOGENOUS AND UNCHANGED

This experiment is the same as experiment 1 except that e rather than Q is exogenous. In this case the monetary authorities choose B_g, b_g, and Q so as to lower R and keep r and e unchanged. One of the key differences between the results for this experiment and the results for experiment 1 is that the balance of payments, S, decreases rather than increases. In experiment 1, S had to increase because of the increase in the demand for country 2's bond by country 1 and the decrease in the demand for country 1's bond by country 2. In this case S must increase because Q is exogenous—Equation (36). The increase in S is accomplished by a depreciation. In the present experiment there is still an increase in the demand for country 2's bond and a decrease in the demand for country 1's bond—because R falls relative to r—but S does not necessarily have to increase because Q can change. The net effect is that S decreases (and thus Q decreases). The reason for the decrease is fairly simple. The decrease in R is an expansionary action in country 1, and among other things it increases the country's demand for imports. This then worsens the balance of payments. There is no offsetting effect from a depreciation of the currency to reverse this movement.

The Econometric Model

The above experiments should give one a fairly good idea of the properties of the theoretical model. The specification of the equations in the econometric model can now be discussed.

The econometric model is quarterly. Quarterly data bases have been constructed for all the countries. When only annual data were available, quarterly data were constructed using interpolation procedures. The trade matrix contains data for 63 countries plus a rest of the world category. Not counting the trade share equations, there are estimated equations for 37 countries. There are 1874 estimated trade share equations. The basic estimation period is 1958 I–1986 I. For equations that are relevant only when exchange rates are flexible, the basic estimation period is 1972 II–1986 I. Most of the equations have been estimated by two-stage least squares. The model used for the results in this paper has been updated from the version in Fair (1984), where the estimation periods ended in 1982 II.

My U.S. model is used as the U.S. part of the multicountry model. Small models have been estimated for each of the other 36 countries for which there are estimated equations. There are up to 11 estimated equations per country, and there are 10 identities per country. The trade share equations and a number of others are used to link the countries together.

The Estimated Interest Rate and Exchange Rate Equations

The general form of the interest rate equation is[4]

[4]The equations of the econometric model are numbered with brackets rather than with parentheses to distinguish them from the equations of the theoretical model.

$$R = g_1(\overset{+}{\dot{P}}_{-1}, \overset{+}{D}, \overset{-}{A}_{-1}, \overset{+}{A}_{-2}, \overset{+}{\dot{M}}_{-1}, \overset{+}{R}_{US}, \overset{+}{R}_{GE}, \overset{+}{R}_{-1}), \quad [1]$$

where R is the country's short term interest rate, $\dot{P}$ is the rate of inflation, D is a measure of demand pressure, A is the real net asset position of the country relative to the rest of the world as a percent of a measure of full employment GNP of the country, $\dot{M}$ is the rate of growth of the per capital money supply, R_{US} is the U.S. short term interest rate, and R_{GE} is the German short-term interest rate. This choice of explanatory variables will now be explained.

The rate of inflation is assumed to have a positive effect on the interest rate target. Monetary authorities are assumed to tighten up as inflation rises. This is consistent with market-force effects in the theoretical model, where a positive price shock with the money supply unchanged led to an increase in the interest rate. The demand pressure variable is included in the interest rate equation to pick up possible inflation effects not captured in the inflation variable itself. It may be a better signal for the monetary authorities regarding future inflation than is the inflation variable itself, and it may thus be used by the authorities in setting interest rates.

The asset variable A is the normalized real net asset position of the country relative to the rest of the world. The *change* in A is the real value of the balance of payments except for the normalization by full employment GNP.[5] If the balance of payments of the country is weak, the monetary authorities may tighten up, and, if the balance of payments is strong, the authorities may feel they have room to loosen up. Experiment 4 shows that in the theoretical model with the exchange rate unchanged a decrease in the interest rate expands the economy and worsens the balance of payments.[6] (The theoretical model is

[5]The nominal net asset position of each country relative to the rest of the world is obtained by summing past values of the balance of payments. The real value of net assets is equal to the nominal value divided by the domestic price index. A is then the real value of net assets divided by the full employment measure of real GNP. The creation of the full employment measure of real GNP is explained in Fair (1984, p. 162).

[6]The use of experiment 4 to justify using A_{-1} and A_{-2} in the interest rate equation is not quite right. In experiment 4 the exchange rate was taken to be unchanged. In the estimated exchange rate equation below, on the other hand, the interest rate has an effect on the exchange rate. Therefore, according to the estimated equations, the monetary authorities know that if they change the interest rate this will affect the exchange rate, which is contrary to the assumption of experiment 4. What needs to be assumed here is that the exchange rate movement from a change in R is not so large as to reverse the results of experiment 4 regarding the effects on S.

roughly symmetric, so that an increase in the interest rate contracts the economy and improves the balance of payments.) The authorities may be thus more likely to lower the interest rate when the balance of payments is strong (and suffer the consequences of some fall in the balance of payments) than when it is weak. In the estimation work the coefficients on A_{-1} and A_{-2} were not constrained to be equal in absolute value and of opposite signs. This constraint was not imposed because there may be both level and rate of change effects.

The lagged money growth variable is added to the equation because a rapid growth of the money supply may lead the monetary authority to raise interest rates in the future in an attempt to lessen the growth. The past growth rate of the money supply may thus have a positive effect on the current value of the interest rate. If monetary authorities are interested in both money supply growth and interest rate values, one way of trying to capture this is to add the lagged growth of the money supply to the interest rate equation.

The U.S. interest rate is in the equation to account for the possibility that the monetary policies of other countries are influenced by U.S. monetary policy. Similarly, the German interest rate is included in the European equations to account for the possibility that the monetary policies of other European countries are influenced by German monetary policy.

The lagged dependent variable is included in the equations for the usual reasons. Monetary authorities are likely to dislike large short run changes in interest rates and thus try to avoid them, and one way of trying to capture this effect is by the use of the lagged dependent variable. The lagged dependent variable may also be picking up expectational effects.[7]

The general form of the exchange rate equation is

$$e = g_2(\overset{+}{P/P_{US}},\ \overset{-}{(1+R)/(1+R_{US})},\ \overset{+}{e_{GE}},\ \overset{+}{e_{-1}}), \qquad [2]$$

where e is the country's exchange rate relative to the U.S. dollar, P/P_{US} is the country's aggregate price level relative to the price level of

[7]Lagged dependent variables are freely used in the econometric model with the aim of accounting for partial adjustment and/or expectational effects. This "traditional" procedure was tested in Fair (1986a) using my U.S. model against a procedure that allows expectations to be formed in more sophisticated ways, including formed rationally. The results provide no strong support for the more sophisticated hypothesis. Both the traditional procedure and the more sophisticated one lead to very similar results, including results about policy properties. This is thus some justification for the use of the present approach.

the United States, $(1+R)/(1+R_{US})$ is one plus the country's interest rate relative to the same variable for the United States, and e_{GE} is the German exchange rate relative to the U.S. dollar. The equation is estimated in log form.

Regarding the price variable, in the theoretical model a positive price shock led to a depreciation, and so one expects a positive coefficient for the country's relative price level. In other words, a relative price increase in a country is likely to put downward pressure on the country's currency relative to the U.S. dollar, and the monetary authorities may go along with this. Regarding the interest rate variable, in the theoretical model a decrease in the domestic interest rate led to a depreciation, and so one expects a negative coefficient for the relative interest rate variable.

The monetary authorities of other European countries may be influenced by the German exchange rate in deciding on their own exchange rate targets, and this is the reason for including the German rate in the European equations. The use of the German rate is also an attempt to capture some of the effects of the European Monetary System (EMS). Under the assumption that Germany is the dominate country in the EMS, the German rate will pick up some of the effects of the EMS agreement.

The lagged dependent variable is included in the exchange rate equation for the same reasons that it was included in the interest rate equations, namely to pick up partial adjustment and expectational effects.

Before considering the other estimated equations, it will be useful to review what has been done regarding interest rates and exchange rates. The monetary authorities are assumed to use their tools—B_g, b_g, and Q—to manipulate R, r, and e. They are assumed to take market forces into account in this manipulation, which the estimated interest rate and exchange rate equations are trying in part to account for. This approach does not require that equations like (10) of the theoretical model—bilateral security demand equations—be estimated in order to determine interest rates and exchange rates. It does mean, however, that one loses the ability to determine variables like B_g, b_g, Q, B_p^*, and b_p^*.

If variables like B_g, b_g, Q, B_p^*, and b_p^* cannot be determined in the model, what can? What can be determined is the net asset position of the country relative to the rest of the world. The variable A in the interest rate equation above is the real net asset position normalized by a measure of full employment GNP. An asset variable also appears in the import and consumption equations below, which is the real net asset position normalized by population. Let A' denote the net asset position of the country before being divided by anything. (A' is thus in nominal terms.) In terms of the variables in the theoretical model, $\Delta A'$ in the econometric model is equal to $-\ \Delta B_p^* + e{\cdot}\Delta b_p^* + \Delta Q$, so that Equation (36) in the econometric model becomes $0 = S - \Delta A'$. A' is then determined as $A'_{-1} + \Delta A'$. S is determined by a definition like (37). The present approach thus allows A' to be determined, but it does not allow a disaggregation of A' into various components. With respect to the B_g, b_g, and Q components, one should thus remember that the values of these variables are whatever is needed to have the interest rate and exchange rate values that are predicted by the estimated interest rate and exchange rate equations be met.

It should also be noted that the interest rate and exchange rate equations have the characteristic that the exchange rate equation has the interest rate in it, but not vice versa. Implicit in this treatment is the assumption that the monetary authorities make decisions sequentially. It is assumed that they first decide on their interest rate target as a function of a number of variables (not including the exchange rate). They then decide on their exchange rate target, given the interest rate value and their knowledge of the market forces on the exchange rate that this value implies. It may be, of course, that the exchange rate affects the interest rate as well as vice versa. This can be tested by simply adding the exchange rate to the interest rate equation for each country. The results of this test are reported in Fair (1986c), and they are not supportive of the hypothesis that the exchange rate directly affects the interest rate.

Other Estimated Equations

The other estimated equations will now be discussed. The general form of the import equation—Equation (2) in the theoretical model—is

$$\mathrm{IM} = g_3\,(\overset{+}{P},\ \overset{-}{\mathrm{PIM}},\ \overset{-}{\mathrm{R}},\ \overset{+}{\mathrm{Y}},\ \overset{+}{A}_{-1},\ \overset{+}{\mathrm{IM}}_{-1}), \qquad [3]$$

where the new notation is IM for the total imports of the country and PIM for the import price deflator. The demand for imports is a function of the prices of domestic and foreign goods, the interest rate, income, and wealth. Y is real GNP, and P is the GNP deflator. The wealth variable in this equation and in Equation [4] below is the real net asset position of the country divided by population rather than by a measure of full employment GNP, which is done for the wealth variable in the interest rate equation above. For simplicity the letter A is used to denote both variables in the present discussion.

In the theoretical model the demand for domestic goods is determined by Equation (1). In the econometric model separate consumption and fixed investment equations are estimated, where the data on consumption and investment include both domestic and imported goods. The general form of the consumption equation is

$$C = g_4(\overset{-}{R}, \overset{+}{Y}, \overset{+}{A}_{-1}, \overset{+}{C}_{-1}), \qquad [4]$$

where the new notation is C for consumption. Consumption is a function of the interest rate, income, and wealth. The general form of the investment equation is

$$I = g_5(\overset{+}{Y}, \overset{+\text{or}-}{Y_{-1}}, \cdots, \overset{+\text{or}-}{Y_{-5}}, \overset{+}{I_{-1}}), \qquad [5]$$

where the new notation is I for investment. Investment is determined by an accelerator type of equation. Investment is a function of current and past values of output.

There is also an inventory investment equation in the econometric model, which was not true in the theoretical model. A production smoothing equation is estimated, where the general form of the equation is

$$Y = g_6(\overset{+}{X}, \overset{-}{V}_{-1} \ \overset{+}{Y}_{-1}), \qquad [6]$$

where the new notation is X for total sales and V for the end-of-period inventory stock. Production is a function of sales, the lagged stock of inventories, and lagged production. X is determined by an identity:

$$X = C + I + X_g + \text{EX} - \text{IM}, \qquad [7]$$

where the new notation is EX for total exports of the country. This equation is the equivalent of Equation (4) in the theoretical model. Imports are subtracted from the other items in this equation because C, I, and X_g include domestic and well as imported goods. X is just the level of sales of domestic goods. By definition inventory investment is equal to production minus sales:

$$\Delta V = Y - X, \qquad [8]$$

and V is determined as

$$V = V_{-1} + \Delta V. \qquad [9]$$

The general form of the price equation—Equation (3) in the theoretical model—is

$$P = g_{10}(\overset{+}{D}, \overset{+}{\text{PIM}}, \overset{+}{P_{-1}}), \qquad [10]$$

where D is the measure of demand pressure that is also used in the interest rate equation. The GNP deflator is a function of demand pressure and the price of imports.

The last major equation to be determined is the demand for money equation—Equation (6) in the theoretical model. The demand for money needs to be determined because the growth rate of the money supply appears as an explanatory variable in the interest rate equation. (Money supply is assumed to be equal to money demand in the model, i.e., the money market is assumed to clear.) The general form of the demand for money equation is

$$M/P = g_{11}(\overset{+}{Y}, \overset{-}{R}, \overset{+}{M_{-1}/P_{-1}} \text{ or } \overset{+}{M_{-1}/P}). \qquad [11]$$

Whether M_{-1}/P_{-1} or M_{-1}/P belongs in the equation depends on whether the adjustment of actual to desired money holdings is in real or nominal terms. Tests of the real versus nominal hypothesis for the various countries are carried out in Fair (1987). In nearly all the cases the nominal adjustment hypothesis was accepted over the real adjustment hypothesis, which means that M_{-1}/P belongs in the equation. Otherwise, Equation [11] is a standard demand for money equation in income and the interest rate.

There is a standard term structure equation in the model for each country, which determines the long term rate as function of current and lagged short term rates. For many countries the long term rate rather than the short term rate appears in the import and consumption equations. There is also an equation that determines the forward exchange rate, although this equation is not important because the forward rate is not an explanatory variable in any of the equations.

The final stochastic equation in the model for each country is an equation determining the price of exports. The general form of the export price equation is

$$\text{PEX} = g_{12}(\overset{+}{P}, \overset{+}{e \cdot \text{PW\$}}), \qquad [12]$$

where PEX is the export price index and PW$ is an index of all countries export prices in U.S. dollars. This equation states that a country's export price index is a function of its domestic price level and a world price index. If the country were a complete price taker, then *P* would not enter the equation, and if the country produced only one good and were a monopolist in the good, then the world price index would not enter. Equation [12] is an attempt to approximate the in between case.

The Trade Share and Other Linkage Equations

As noted at the beginning of this section, the trade share matrix is 64 by 64. Data permitting, a trade share equation was estimated for each pair of countries. For each equation, the left-hand side variable is the share of country *i*'s imports imported from country *j*. This share is taken to be a function of the price of *j*'s exports relative to a weighted average of all other countries' export prices. There is also the lagged dependent variable in the equation, which is meant to pick up any partial adjustment of the trade share to a change in relative prices.

There is an equation in the model that states that the sum of world imports equals the sum of world exports. The import price index for each country (PIM) is determined as a weighted average of the export prices (PEXs) of all the other countries. A country's level of exports (EX) is equal to the sum of the other countries' imports from it. Country *i*'s level of imports from country *j* is equal to country *i*'s total imports (IM) times the relevant trade share, i.e., times the share of country *i*'s imports imported from *j*.

The Solution of the Model

The model is solved in the following way. Given values of the price of imports (PIM), the level of exports (EX), and the world price index (PW$), an individual country's model can be solved. (The solutions for most countries also require values of the U.S. interest rate, price level, and real GNP because of the interest rate and exchange rate equations. Similarly, the solutions for the European countries require values of the German interest rate and the German exchange rate.) This solution results among other things in values of the country's imports (IM), price of exports (PEX), and exchange rate (*e*). Given PEX and *e* for all countries, the trade share equations can be solved. The trade share values and the values of the IM then allow EX to be computed for each country. The values of PEX and *e* also allow PIM and PW$ to be computed for each country. (PW$ differs slightly from country to country because the given country is not in the index.) These new values of PIM, EX, and PW$ can then be used to solve the individual country models again, and the process can be repeated. Convergence is reached when the change in the solution value for each variable from one iteration to the next is within some prescribed tolerance level (in absolute value).

Testing the Model

All the stochastic equations in the model are estimated over historical data using either two stage least squares or ordinary least squares (mostly two-stage least squares). None of the parameters of the model have been made up or "calibrated." The model, in other words, is a standard econometric model, which means that standard test procedures can be used to evaluate it.

Space limitations prevent the discussion of any tests here. Some early tests are presented in Fair (1984). More recent tests include tests of the money demand equations in Fair (1987) and tests of the interest rate and exchange rate equations in Fair (1986b). I am in the process of doing more tests. Until more is known about how good or bad an approximation the model is of the world economy, the results of analyzing its properties must be interpreted with considerably caution.

IV. PROPERTIES OF THE ECONOMETRIC MODEL

A number of the properties of the model can be described without performing any numerical experiments, and these will be discussed first.

Trade Effects among Countries

There is a standard trade multiplier effect in the model. An autonomous increase in GNP in country i increases its demand for imports, which increases the exports of other countries and thus their GNP and demand for imports, which then increases the exports of country i and thus its GNP. In short, imports affect exports and vice versa.

Price Effects among Countries

There is also a price multiplier effect in the model. An autonomous increase in country i's domestic price level increases its export price index, which increases the import price indices of other countries, which increases their domestic price levels, including their export price indices, which then increases country i's import price index and thus its domestic price level and export price index. In short, export prices affect import prices and vice versa.

Effects on the Exchange Rate of an Autonomous Change in GNP

Consider an autonomous decrease in GNP in a country. This has a negative effect on demand pressure and thus on the domestic price level. This in turn has a negative effect on the exchange rate (an appreciation) through the exchange rate equation. The contraction of the economy, on the other hand, has a negative effect on the interest rate through the interest rate equation, which in turn has a positive effect on the exchange rate (a depreciation). The effect of an autonomous decrease in GNP on the exchange rate is thus ambiguous. The price effect calls for an appreciation, and the interest rate effect calls for a depreciation. It will be seen below that the net effect is positive for some countries and negative for others.

Effects of the Exchange Rate on GNP

Consider an autonomous depreciation of the exchange rate. This lowers the country's export prices denominated in other currencies, which increases its exports through the trade share equations. The depreciation also raises the country's import prices denominated in its own currency, which results in a substitution away from imports to domestic goods within the country. The increase in exports and domestic demand for domestic goods has a positive effect on GNP. The increase in import prices also leads to an increase in domestic prices, which in turn has a positive effect on the short term interest rate through the interest rate equation. An increase in the interest rate has a negative effect on GNP through the consumption equation. It could be that the negative interest rate effect dominates the positive export and substitution effect and thus that a depreciation leads to a fall in GNP. For none of the experiments below, however, is this true. The net effect of a depreciation is an increase in GNP.

Effects of the Exchange Rate on the Balance of Payments

Again, consider an autonomous depreciation of the exchange rate. The resulting increase in exports and decrease in imports have a positive effect on the balance of payments. The decrease in export prices and the increase in import prices, on the other hand, have a negative effect. The net effect could thus go either way. It is generally felt that there is a "*J* curve" effect, which means that the negative effect dominates initially, but that after a few quarters the positive effect dominates. The *J* curve effect is examined in the experiments below.

The Experiments

The experiments were performed for the 1978 I–1981 IV period (16 quarters). A perfect tracking solution was first generated for this period by adding the estimated residuals to the stochastic equations. The residuals were then taken to be exogenous for all the experiments. This means that when the model is solved using the actual values of the exogenous variables, the predicted values of the endogenous variables are simple the actual values. For the first experiment U.S. government spending was lowered by 1% of U.S. GNP from the base (i.e., the historical) path (in real terms). The model was then solved dynamically for the 16 quarters.[8] The difference between the predicted value of an endogenous variable for a quarter and its actual value is the estimated effect of the spending change for that variable and quarter. Results for selected variables are presented in Table 1. The variables are real GNP, the GNP deflator, the short term interest rate, the exchange rate, and the balance of payments. Results are presented for the first eight quarters and for quarters 12 and 16. For real GNP, the GNP deflator, and the exchange rate, the units in the tables are percentage changes (from the base path) in percentage points. For the short term interest rate, the units are changes in percentage points, and for the balance of payments, the units are changes in millions of U.S. dollars.

Consider now the results in Table 1. The decrease in U.S. government spending led to a fall in U.S. GNP, a fall in the GNP deflator, a fall in the interest rate (through the U.S. interest rate reaction function), and an increase in the balance of payments. Although not shown, the U.S. demand for imports fell, which generally led to a fall in the exports of other countries. For most countries real GNP was lower, the GNP deflator was lower, the short term interest was lower, and the balance of payments was lower. For nearly all countries the exchange rate appreciated (relative to the U.S. dollar). The two exceptions are Canada after six quarters and Australia after one quarter. A relative fall in the U.S. interest rate, which occurred for most countries, leads to an appreciation of other countries' currencies, but a relative fall in the U.S. price level, which also occurred for most countries, leads to a depreciation. The present results show that the net effect is almost always for an appreciation. Interest rates for the other countries fell because the monetary authorities are assumed through the interest

[8]One 16-quarter solution of the model, which is one experiment, takes about an hour of CPU time on a VAX 730.

Table 1: Effects of a Sustained Decrease in U.S. Government Spending of 1% of U.S. GNP[a]

Country	Quarters Ahead 1	2	3	4	5	6	7	8	12	16
					Real GNP					
U.S.	–0.97	–1.21	–1.28	–1.27	–1.24	–1.20	–1.15	–1.10	–0.99	–1.00
Canada	–0.08	–0.13	–0.12	–0.11	–0.10	–0.06	0.00	0.03	0.17	0.26
Japan	–0.02	–0.04	–0.06	–0.07	–0.09	–0.10	–0.11	–0.11	–0.08	–0.05
Austria	0.02	0.02	0.01	0.00	–0.03	–0.03	–0.03	–0.04	0.00	0.05
Belgium	–0.02	–0.04	–0.07	–0.09	–0.11	–0.13	–0.13	–0.12	–0.05	0.03
Denmark	–0.01	–0.03	–0.05	–0.07	–0.10	–0.12	–0.12	–0.13	–0.07	–0.02
France	–0.01	–0.01	–0.02	–0.01	0.00	0.01	0.03	0.05	0.16	0.25
Germany	–0.01	–0.03	–0.06	–0.10	–0.14	–0.17	–0.18	–0.18	–0.06	0.09
Italy	0.00	–0.01	0.00	0.00	0.01	0.02	0.03	0.03	0.10	0.15
Netherlands	0.00	–0.01	–0.01	–0.01	–0.02	0.00	0.02	0.03	0.18	0.31
Norway	–0.01	–0.03	–0.04	–0.07	–0.13	–0.14	–0.15	–0.19	–0.18	–0.21
Sweden	–0.01	–0.03	–0.04	–0.05	–0.05	–0.05	–0.05	–0.04	0.03	0.09
Switzerland	0.00	–0.01	–0.03	–0.05	–0.05	–0.06	–0.07	–0.08	–0.03	0.02
U.K.	–0.01	–0.04	–0.04	–0.04	–0.04	–0.04	–0.03	–0.01	0.07	0.13
Finland	–0.01	–0.02	–0.02	–0.03	–0.06	–0.05	–0.03	–0.02	0.00	0.01
Greece	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.00	–0.01	–0.01
Ireland	–0.02	–0.05	–0.08	–0.11	–0.12	–0.13	–0.14	–0.14	–0.08	–0.04
Portugal	–0.01	–0.02	–0.03	–0.04	–0.05	–0.06	–0.05	–0.05	0.02	0.09
Spain	–0.01	–0.02	–0.01	0.00	0.02	0.05	0.07	0.11	0.17	0.11
Turkey	0.00	0.00	0.01	0.02	0.02	0.04	0.05	0.06	0.04	0.00
Yugoslavia	–0.01	–0.01	–0.02	–0.01	0.00	0.01	0.02	0.04	0.06	0.05
Australia	–0.01	–0.02	–0.02	–0.01	–0.02	–0.01	0.01	0.01	0.05	0.11
New Zealand	–0.02	–0.04	–0.03	–0.03	–0.05	–0.05	–0.03	–0.03	–0.01	–0.01
South Africa	–0.03	–0.03	–0.05	–0.07	–0.04	–0.04	–0.05	0.00	0.15	0.39

Saudi Arabia	0.00	0.02	–0.17	–0.17	–0.16	–0.10	–0.09	–0.04	0.99	–0.04
Venezuela	–0.10	–0.14	–0.15	–0.13	–0.21	–0.18	–0.18	–0.16	0.00	–0.03
Colombia	–0.03	–0.07	–0.09	–0.10	–0.12	–0.12	–0.10	–0.06	0.03	0.00
Mexico	–0.04	–0.07	–0.11	–0.17	–0.10	–0.08	–0.05	0.00	–0.09	–0.09
Peru	0.00	0.00	0.01	0.01	0.02	0.04	0.05	0.06	–0.05	–0.03
Jordan	0.00	0.02	0.04	0.06	0.11	0.12	0.12	0.13	0.07	0.00
Syria	–0.02	–0.02	–0.01	0.01	0.03	0.00	0.00	0.00	0.02	–0.02
India	–0.01	–0.01	–0.02	–0.01	–0.02	–0.02	–0.02	–0.01	0.00	0.00
Korea	–0.07	–0.09	–0.09	–0.04	–0.07	–0.05	–0.05	–0.03	–0.05	–0.05
Malaysia	–0.08	–0.12	–0.11	–0.14	–0.22	–0.14	–0.14	–0.12	–0.07	–0.03
Pakistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	–0.01	–0.01
Philippines	–0.04	–0.07	–0.13	–0.11	–0.11	–0.10	–0.11	–0.10	–0.08	–0.08
Thailand	–0.02	–0.01	–0.02	–0.01	–0.02	–0.01	–0.01	–0.02	–0.05	–0.05
					GNP Deflator					
U.S.	0.04	–0.01	–0.06	–0.11	–0.19	–0.22	–0.24	–0.36	–0.53	–0.66
Canada	0.00	–0.01	–0.03	–0.05	–0.07	–0.08	–0.08	–0.08	–0.01	0.11
Japan	0.00	–0.01	–0.02	–0.03	–0.04	–0.06	–0.08	–0.10	–0.16	–0.19
Austria	0.00	0.01	–0.01	–0.04	–0.07	–0.09	–0.12	–0.14	–0.17	–0.15
Belgium	0.00	–0.01	–0.02	–0.05	–0.07	–0.10	–0.14	–0.17	–0.28	–0.32
Denmark	0.00	0.00	0.00	–0.01	–0.02	–0.03	–0.05	–0.06	–0.11	–0.14
France	0.00	0.00	–0.01	–0.02	–0.03	–0.04	–0.05	–0.05	0.02	0.21
Germany	0.00	0.00	–0.01	–0.02	–0.04	–0.06	–0.09	–0.12	–0.20	–0.19
Italy	0.00	–0.01	–0.02	–0.03	–0.04	–0.06	–0.06	–0.07	–0.04	0.04
Netherlands	0.00	0.00	–0.01	–0.02	–0.04	–0.06	–0.07	–0.09	–0.09	–0.01
Norway	0.00	0.00	–0.01	–0.02	–0.03	–0.05	–0.06	–0.08	–0.14	–0.20
Sweden	0.00	–0.01	–0.02	–0.02	–0.02	–0.02	–0.02	–0.02	0.06	0.18
Switzerland	0.00	0.00	–0.01	–0.02	–0.04	–0.05	–0.07	–0.09	–0.13	–0.15
U.K.	0.00	0.00	–0.02	–0.05	–0.08	–0.10	–0.14	–0.17	–0.26	–0.28
Finland	0.00	0.00	–0.01	–0.02	–0.03	–0.05	–0.07	–0.09	–0.14	–0.18
Greece	0.00	0.01	0.02	0.03	0.04	0.06	0.06	0.07	0.07	0.05

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Country	Quarters Ahead 1	2	3	4	5	6	7	8	12	16
Ireland	0.00	0.00	−0.01	−0.03	−0.05	−0.07	−0.09	−0.11	−0.15	−0.16
Portugal	0.00	0.00	−0.01	−0.03	−0.04	−0.06	−0.07	−0.09	−0.07	0.02
Turkey	0.00	0.01	0.03	0.04	0.06	0.07	0.08	0.08	0.03	−0.01
Australia	0.00	0.00	0.00	−0.01	0.00	−0.01	0.00	0.00	0.04	0.11
New Zealand	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.01	−0.04
South Africa	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.05	0.01
Colombia	0.00	0.00	−0.01	−0.01	−0.01	−0.02	−0.03	−0.03	−0.02	−0.03
Jordan	0.00	0.01	0.02	0.03	0.05	0.05	0.04	0.04	0.00	−0.02
Syria	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.06	0.04	0.01
India	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Korea	0.00	−0.01	−0.02	−0.03	−0.02	−0.03	−0.03	−0.04	−0.07	−0.11
Malaysia	−0.03	−0.06	−0.09	−0.12	−0.17	−0.18	−0.18	−0.19	−0.17	−0.12
Pakistan	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.01	−0.01
Philippines	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	−0.02	−0.07
Thailand	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	−0.01	−0.04
					Short Term Interest Rate					
U.S.	−0.36	−0.45	−0.50	−0.51	−0.52	−0.53	−0.52	−0.48	−0.46	−0.52
Canada	−0.23	−0.39	−0.48	−0.52	−0.53	−0.55	−0.56	−0.53	−0.52	−0.57
Japan	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	−0.03	−0.05
Austria	−0.06	−0.11	−0.16	−0.19	−0.22	−0.24	−0.25	−0.26	−0.27	−0.30
Belgium	−0.07	−0.14	−0.20	−0.25	−0.29	−0.32	−0.35	−0.36	−0.37	−0.37
Denmark	0.00	−0.01	−0.03	−0.06	−0.10	−0.12	−0.15	−0.18	−0.20	−0.16
France	−0.11	−0.24	−0.33	−0.39	−0.44	−0.48	−0.49	−0.49	−0.38	−0.19
Germany	−0.06	−0.13	−0.19	−0.25	−0.30	−0.34	−0.38	−0.40	−0.39	−0.30
Italy	−0.07	−0.13	−0.17	−0.20	−0.21	−0.23	−0.23	−0.22	−0.19	−0.15

Netherlands	−0.14	−0.28	−0.38	−0.45	−0.50	−0.54	−0.57	−0.57	−0.55	−0.53
Norway	−0.08	−0.15	−0.21	−0.26	−0.29	−0.32	−0.33	−0.33	−0.33	−0.35
Sweden	−0.02	−0.06	−0.10	−0.14	−0.16	−0.19	−0.20	−0.21	−0.17	−0.07
Switzerland	−0.07	−0.12	−0.16	−0.18	−0.20	−0.20	−0.21	−0.20	−0.18	−0.18
U.K.	−0.08	−0.18	−0.26	−0.32	−0.37	−0.42	−0.44	−0.45	−0.43	−0.42
Finland	−0.02	−0.05	−0.08	−0.10	−0.12	−0.15	−0.16	−0.18	−0.23	−0.28
Ireland	−0.09	−0.18	−0.25	−0.31	−0.35	−0.38	−0.40	−0.40	−0.37	−0.38
Portugal	0.00	0.00	0.00	0.00	−0.01	−0.01	−0.01	−0.01	−0.02	0.00
Australia	−0.03	−0.06	−0.09	−0.11	−0.14	−0.16	−0.17	−0.18	−0.17	−0.11
South Africa	−0.06	−0.14	−0.22	−0.29	−0.36	−0.43	−0.49	−0.54	−0.69	−0.79
Korea	−0.01	−0.01	−0.02	−0.02	−0.03	−0.03	−0.04	−0.04	−0.05	−0.06
Pakistan	−0.01	−0.01	−0.02	−0.02	−0.02	−0.03	−0.03	−0.03	−0.03	−0.03
					Exchange Rate[b]					
U.S.	0.03	0.17	0.28	0.36	0.40	0.41	0.42	0.40	0.17	0.02
Canada	−0.03	−0.05	−0.05	−0.04	−0.02	0.01	0.03	0.08	0.33	0.68
Japan	−0.01	−0.13	−0.21	−0.25	−0.24	−0.24	−0.24	−0.20	−0.06	0.03
Austria	−0.09	−0.28	−0.46	−0.59	−0.68	−0.73	−0.76	−0.73	−0.54	−0.54
Belgium	−0.05	−0.23	−0.41	−0.56	−0.66	−0.72	−0.75	−0.75	−0.58	−0.60
Denmark	0.00	−0.18	−0.36	−0.50	−0.59	−0.64	−0.68	−0.67	−0.51	−0.52
France	0.00	−0.20	−0.34	−0.43	−0.48	−0.45	−0.44	−0.42	0.15	0.64
Germany	0.00	−0.19	−0.38	−0.53	−0.63	−0.69	−0.72	−0.72	−0.55	−0.57
Italy	0.00	−0.22	−0.39	−0.50	−0.56	−0.56	−0.56	−0.56	−0.20	0.03
Netherlands	0.00	−0.20	−0.38	−0.51	−0.60	−0.65	−0.68	−0.68	−0.52	−0.53
Norway	−0.05	−0.19	−0.34	−0.45	−0.53	−0.57	−0.59	−0.59	−0.43	−0.43
Sweden	−0.13	−0.25	−0.35	−0.40	−0.36	−0.34	−0.34	−0.14	0.47	0.93
Switzerland	−0.03	−0.29	−0.45	−0.56	−0.59	−0.62	−0.66	−0.57	−0.32	−0.24
U.K.	−0.15	−0.30	−0.44	−0.56	−0.64	−0.70	−0.75	−0.74	−0.58	−0.49
Finland	0.00	−0.12	−0.25	−0.36	−0.44	−0.48	−0.51	−0.52	−0.40	−0.41
Ireland	−0.01	−0.22	−0.36	−0.45	−0.48	−0.52	−0.54	−0.49	−0.31	−0.28
Portugal	0.00	−0.14	−0.26	−0.36	−0.41	−0.40	−0.40	−0.40	0.03	0.36
Australia	−0.01	0.00	0.01	0.02	0.06	0.09	0.13	0.19	0.47	0.82

Table 1: Effects of a Sustained Decrease in U.S. Government Spending of 1% of U.S. GNP[a]

Country	Quarters Ahead									
	1	2	3	4	5	6	7	8	12	16
	Balance of Payments (in U.S. Dollars)									
U.S.	192.2	273.0	344.2	379.9	391.1	418.4	432.7	434.4	441.9	480.0
Canada	−38.0	−54.0	−61.6	−69.2	−93.2	−93.4	−93.1	−96.1	−109.8	−136.0
Japan	−40.6	−54.8	−62.8	−56.0	−62.9	−59.6	−61.6	−51.8	−79.8	−125.7
Austria	−2.5	−0.8	−3.6	−7.1	−10.7	−10.4	−13.7	−15.2	−13.0	−11.8
Belgium	−6.1	−0.1	4.0	8.1	6.7	14.4	19.1	25.5	27.9	18.6
Denmark	−0.9	−1.2	0.2	2.1	1.0	2.5	3.6	6.1	5.5	7.7
France	−5.6	−6.0	−5.2	−7.5	−21.1	−34.5	−38.3	−47.8	−129.3	−195.1
Germany	−13.9	−10.9	10.4	17.6	16.6	44.9	71.6	58.8	17.2	−14.1
Italy	−5.1	−8.0	−10.1	−8.3	−12.1	−20.8	−28.3	−15.8	−31.0	−47.4
Netherlands	−2.5	−3.4	−1.7	−3.2	−11.1	−12.8	−12.2	−16.6	−40.7	−56.4
Norway	−2.1	−3.7	−4.7	−6.5	−9.8	−12.0	−15.1	−17.9	−25.0	−25.6
Sweden	−3.4	−0.1	−0.9	−2.8	−9.4	−10.7	−9.2	−21.2	−39.8	−58.8
Switzerland	−3.2	−1.3	−5.8	−9.1	−12.0	−9.5	−9.8	−14.8	−17.7	−18.7
U.K.	−19.3	22.3	29.3	36.7	29.3	47.5	50.2	50.4	−26.5	−31.1
Finland	−0.7	−2.2	−2.0	−2.6	−4.1	−3.7	−2.1	−0.4	0.6	2.8
Greece	−0.2	−1.2	−1.3	−2.2	−2.4	−1.8	−2.1	−3.1	−1.0	−1.4
Ireland	−0.4	−0.7	−0.4	−0.7	0.0	0.5	0.1	−0.6	−0.7	−0.8
Portugal	−0.2	0.2	0.8	1.3	2.3	2.5	3.5	3.8	−0.1	−7.1
Spain	−1.8	−5.7	−5.5	−5.3	−5.4	−2.0	−0.4	−0.8	−3.6	−3.2
Turkey	−0.2	−0.8	−0.8	−0.2	−1.9	−0.7	0.0	0.6	1.3	0.6
Yugoslavia	−0.6	−2.7	−4.1	−5.3	−7.4	−5.8	−5.0	−3.1	1.1	−3.7
Australia	−1.9	−5.4	−6.3	−6.7	−10.1	−8.9	−7.3	−6.7	−15.2	−32.4
New Zealand	−0.6	−1.8	−2.0	−1.9	−2.6	−2.5	−1.4	−0.7	2.0	3.8
South Africa	−2.3	−4.5	−7.0	−8.0	−5.1	−7.2	−8.0	−2.3	0.1	1.1

Saudi Arabia	0.2	-4.6	-26.7	-33.6	-33.2	-23.6	-20.0	-8.9	29.4	36.1
Venezuela	-5.6	-8.8	-8.9	-6.7	-11.6	-9.1	-10.4	-7.3	16.0	17.2
Colombia	-1.3	-2.1	-2.5	-2.0	-2.9	-2.0	-2.0	-0.5	3.8	4.9
Mexico	-4.9	-7.9	-9.8	-12.3	4.2	9.6	11.5	15.5	9.2	19.5
Peru	0.0	-0.3	-0.5	-0.9	-2.4	-1.5	-2.3	-2.4	-5.6	-6.5
Jordan	0.0	-0.3	-0.4	-0.7	-1.1	-0.9	-0.7	-0.6	0.5	1.0
Syria	-0.2	-0.7	-1.3	-1.3	-1.4	-2.3	-1.4	-1.7	0.2	0.2
India	-1.6	-2.0	-2.9	-2.4	-3.4	-3.7	-2.6	0.1	-0.3	0.0
Korea	-4.2	-5.8	-4.1	-2.2	-2.9	-0.3	0.9	2.7	1.4	-0.6
Malaysia	-1.4	-1.4	0.3	0.7	0.0	0.7	-0.7	-0.3	-1.3	0.3
Pakistan	-0.1	-0.4	-0.4	-0.5	-0.7	-0.6	-0.3	-0.4	0.0	0.2
Philippines	-1.4	-2.4	-3.4	-2.6	-2.7	-2.1	-2.4	-0.6	0.2	0.4
Thailand	-0.6	-0.6	-0.5	0.0	-0.3	0.1	0.8	1.4	-0.3	0.1

[a]In this table the values for real GNP, the GNP deflator, and the exchange rate are percentage deviations from the base values in percentage points. For the short term interest rate the values are deviations from the base values in percentage points. For the balance of payments the values are deviations from the base values in millions of U.S. dollars.

[b]The exchange rate for the United States is a weighted exchange rate. A positive value means a depreciation of the dollar.

rate reaction functions to react to the U.S. interest rate. The GNP deflators are lower in part because of the contractionary economies and in part because of the appreciation of the currencies.

For the second experiment the U.S. interest rate reaction function was dropped from the model and the U.S. short term interest rate was taken to be exogenous. The experiment corresponded to a sustained increase in the interest rate of 1.0 percentage points. The results are presented in Table 2.

The increase in the U.S. interest rate led to a contraction and a deflation in the United States. In all cases except for Canada after four quarters, there was a depreciation of the other countries' exchange rates. This is because of the rise in the U.S. interest rate relative to the other countries' interest rates. The interest rates of the other countries rose in response to the increase in the U.S. rate, but not by as much as the U.S. rate (except for Canada). For a number of countries the depreciation resulted in an increase in the GNP deflator. GNP fell for almost all countries, which is due primarily to the higher interest rates and the decrease in the demand for imports from the United States. The U.S. balance of payments increased, and the balance of payments of the other countries mostly decreased.

Shocks to countries other than the United States will now be considered. As noted above, the effect of a positive demand shock on a country's exchange rate is ambiguous. A positive demand shock leads to an increase in the country's interest rate, which has a negative effect on e (an appreciation). The shock also leads to an increase in the domestic price level, which has a positive effect on e (a depreciation). The results in Table 3 provide estimates of the net effect of a demand shock on the exchange rate for 14 countries. The results in Table 3 are based on 14 different experiments. For each experiment government spending of the given country was lowered by 1% of the country's GNP. Each of these experiments is like the experiment in Table 1 for the United States. To save space, only the results for the own country are presented in Table 3: the effects on the other countries are not presented. The experiment for the United States in Table 3 is the same as the one in Table 1. The exchange rate results in Table 3 are for the country's exchange rate relative to the U.S. dollar except for the United States itself. For the United States the exchange rate is a weighted average of the other country's exchange rates.

The results in Table 3 show that for some countries the negative demand shock led to an appreciation and for some it led to a depreciation. For all countries except Germany GNP is lower, with an estimated fall after eight quarters of between 0.68% and 1.98%. For

Table 2: Effects of a Sustained Increase in the U.S. Short Term Interest Rate of One Percentage Point[a]

	Quarters Ahead									
Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
					Real GNP					
U.S.	–0.03	–0.13	–0.23	–0.35	–0.45	–0.55	–0.61	–0.68	–0.75	–0.69
Canada	–0.07	–0.19	–0.37	–0.53	–0.75	–0.90	–1.08	–1.24	–1.80	–2.32
Japan	0.00	–0.02	–0.03	–0.06	–0.09	–0.13	–0.19	–0.24	–0.45	–0.62
Austria	–0.06	–0.07	–0.08	–0.08	–0.06	–0.07	–0.09	–0.09	–0.18	–0.34
Belgium	0.01	0.01	0.00	–0.01	–0.04	–0.08	–0.13	–0.16	–0.33	–0.68
Denmark	–0.01	–0.03	–0.03	–0.03	–0.05	–0.08	–0.10	–0.16	–0.40	–0.63
France	–0.01	–0.03	–0.05	–0.07	–0.09	–0.12	–0.14	–0.16	–0.23	–0.35
Germany	–0.01	–0.02	–0.03	–0.03	–0.06	–0.10	–0.13	–0.19	–0.41	–0.78
Italy	–0.03	–0.07	–0.12	–0.17	–0.23	–0.29	–0.36	–0.39	–0.56	–0.86
Netherlands	–0.05	–0.09	–0.14	–0.19	–0.28	–0.34	–0.43	–0.47	–0.79	–1.18
Norway	–0.04	–0.05	–0.05	0.00	–0.01	–0.01	0.00	0.05	–0.02	–0.06
Sweden	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	–0.08
Switzerland	–0.05	–0.07	–0.06	–0.05	–0.08	–0.08	–0.10	–0.11	–0.17	–0.32
U.K.	0.01	–0.01	–0.06	–0.11	–0.17	–0.24	–0.31	–0.38	–0.66	–0.87
Finland	–0.03	–0.05	–0.05	–0.06	–0.09	–0.14	–0.13	–0.15	–0.18	–0.34
Greece	–0.01	–0.02	–0.05	–0.10	–0.12	–0.14	–0.15	–0.20	–0.23	–0.30
Ireland	–0.02	0.01	0.03	0.03	0.03	0.00	–0.07	–0.12	–0.33	–0.64
Portugal	0.00	–0.01	–0.02	–0.03	–0.06	–0.07	–0.07	–0.08	–0.07	0.01
Spain	0.00	–0.05	–0.13	–0.28	–0.47	–0.71	–0.94	–1.26	–2.24	–3.10
Turkey	0.00	–0.02	–0.06	–0.13	–0.15	–0.19	–0.23	–0.30	–0.46	–0.73
Yugoslavia	0.00	–0.01	–0.03	–0.04	–0.07	–0.10	–0.13	–0.16	–0.22	–0.29
Australia	0.00	–0.04	–0.08	–0.13	–0.19	–0.25	–0.28	–0.32	–0.44	–0.47
New Zealand	–0.01	–0.04	–0.07	–0.10	–0.15	–0.18	–0.18	–0.22	–0.28	–0.30
South Africa	–0.03	–0.08	–0.17	–0.30	–0.38	–0.58	–0.81	–0.95	–1.72	–2.46

Table 2: Effects of a Sustained Increase in the U.S. Short Term Interest Rate of One Percentage Point[a]

	Quarters Ahead									
Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
Saudi Arabia	0.01	–0.06	–0.35	–0.63	–0.85	–1.02	–1.29	–1.49	–2.20	–2.43
Venezuela	–0.01	–0.09	–0.19	–0.26	–0.50	–0.60	–0.73	–0.84	–0.07	–0.16
Colombia	–0.01	–0.04	–0.10	–0.16	–0.27	–0.33	–0.36	–0.32	0.12	0.04
Mexico	0.00	–0.02	–0.07	–0.16	–0.10	–0.10	–0.10	–0.08	–1.13	–1.16
Peru	0.00	–0.01	–0.02	–0.03	–0.05	–0.07	–0.09	–0.10	–0.68	–0.82
Jordan	0.01	–0.06	–0.16	–0.27	–0.44	–0.55	–0.66	–0.79	–1.12	–1.93
Syria	0.00	–0.05	–0.10	–0.16	–0.22	–0.37	–0.48	–0.57	–0.61	–0.88
India	–0.01	–0.02	–0.03	–0.04	–0.06	–0.07	–0.08	–0.08	–0.11	0.00
Korea	–0.02	–0.08	–0.14	–0.13	–0.22	–0.25	–0.27	–0.19	–0.24	–0.23
Malaysia	–0.06	–0.08	–0.05	–0.05	–0.08	–0.02	–0.03	0.01	0.12	0.11
Pakistan	–0.01	–0.02	–0.03	–0.03	–0.04	–0.06	–0.06	–0.07	–0.10	–0.14
Philippines	–0.02	–0.06	–0.14	–0.17	–0.21	–0.28	–0.37	–0.41	–0.58	–0.69
Thailand	–0.01	–0.07	–0.13	–0.20	–0.29	–0.36	–0.36	–0.44	–0.60	–0.84
					GNP Deflator					
U.S.	0.00	–0.02	–0.05	–0.09	–0.14	–0.19	–0.23	–0.33	–0.57	–0.84
Canada	0.00	–0.01	–0.04	–0.10	–0.18	–0.30	–0.44	–0.60	–1.38	–2.35
Japan	0.00	0.00	0.01	0.01	0.00	–0.01	–0.02	–0.05	–0.23	–0.53
Austria	–0.01	0.01	0.04	0.06	0.08	0.10	0.11	0.12	0.11	0.02
Belgium	0.01	0.02	0.04	0.05	0.07	0.08	0.09	0.09	0.03	–0.15
Denmark	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.01	–0.06
France	0.00	0.00	0.00	0.00	0.02	0.03	0.06	0.08	0.26	0.48
Germany	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	–0.09	–0.30
Italy	0.00	0.00	0.00	0.00	–0.01	–0.03	–0.05	–0.08	–0.22	–0.48
Netherlands	0.00	–0.01	–0.01	–0.01	–0.02	–0.04	–0.07	–0.11	–0.31	–0.67

Norway	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.02	–0.02	–0.12
Sweden	0.01	0.03	0.06	0.09	0.13	0.18	0.24	0.30	0.64	1.07
Switzerland	0.00	–0.01	0.00	0.02	0.04	0.05	0.07	0.09	0.16	0.19
U.K.	0.00	0.03	0.06	0.08	0.10	0.11	0.12	0.13	0.14	0.07
Finland	0.00	–0.01	–0.02	–0.04	–0.06	–0.08	–0.12	–0.15	–0.31	–0.61
Greece	0.00	–0.01	–0.05	–0.10	–0.15	–0.21	–0.27	–0.33	–0.59	–0.91
Ireland	0.00	–0.01	0.02	0.04	0.06	0.08	0.09	0.10	0.02	0.16
Portugal	0.00	0.00	0.02	0.05	0.09	0.15	0.22	0.30	0.77	1.42
Turkey	0.00	–0.02	–0.09	–0.15	–0.21	–0.28	–0.33	–0.37	–0.44	–0.53
Australia	0.00	0.00	–0.02	–0.04	–0.07	–0.11	–0.16	–0.22	–0.51	–0.85
New Zealand	0.00	0.00	–0.01	–0.04	–0.06	–0.09	–0.12	–0.16	–0.28	–0.43
South Africa	0.00	–0.02	–0.06	–0.10	–0.15	–0.20	–0.25	–0.31	–0.52	–0.75
Colombia	0.00	0.00	–0.02	–0.04	–0.06	–0.09	–0.12	–0.16	–0.15	–0.17
Jordan	0.00	–0.03	–0.07	–0.12	–0.17	–0.20	–0.23	–0.26	–0.38	–0.53
Syria	0.00	–0.02	–0.05	–0.10	–0.15	–0.19	–0.24	–0.27	–0.45	–0.55
India	0.00	0.00	0.00	–0.01	–0.01	–0.02	–0.02	–0.03	–0.04	0.00
Korea	0.00	–0.01	–0.05	–0.10	–0.15	–0.21	–0.26	–0.30	–0.45	–0.59
Malaysia	–0.02	–0.05	–0.07	–0.10	–0.12	–0.13	–0.12	–0.12	–0.09	–0.15
Pakistan	0.00	–0.01	–0.02	–0.04	–0.06	–0.08	–0.10	–0.12	–0.19	–0.26
Philippines	0.00	–0.01	–0.04	–0.08	–0.12	–0.16	–0.19	–0.23	–0.39	–0.58
Thailand	0.00	–0.01	–0.04	–0.08	–0.12	–0.15	–0.18	–0.22	–0.34	–0.51
					Short Term Interest Rate					
U.S.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Canada	0.75	1.08	1.21	1.28	1.33	1.36	1.39	1.41	1.39	1.34
Japan	0.00	0.00	0.02	0.03	0.05	0.07	0.08	0.10	0.06	–0.15
Austria	0.16	0.28	0.36	0.41	0.44	0.47	0.49	0.51	0.55	0.58
Belgium	0.21	0.35	0.44	0.50	0.54	0.57	0.58	0.59	0.58	0.47
Denmark	0.01	0.03	0.07	0.10	0.12	0.12	0.11	0.08	–0.03	–0.21
France	0.36	0.58	0.70	0.79	0.85	0.89	0.93	0.95	1.06	1.10
Germany	0.17	0.29	0.37	0.42	0.46	0.48	0.49	0.49	0.42	0.25

Table 2: Effects of a Sustained Increase in the U.S. Short Term Interest Rate of One Percentage Point[a]

	Quarters Ahead									
Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
Italy	0.20	0.31	0.38	0.42	0.44	0.46	0.46	0.47	0.49	0.49
Netherlands	0.44	0.67	0.78	0.84	0.87	0.87	0.87	0.86	0.77	0.62
Norway	0.22	0.37	0.47	0.55	0.60	0.63	0.65	0.67	0.70	0.70
Sweden	0.08	0.15	0.21	0.26	0.30	0.34	0.38	0.42	0.55	0.63
Switzerland	0.19	0.29	0.35	0.38	0.39	0.39	0.40	0.40	0.40	0.39
U.K.	0.25	0.43	0.57	0.66	0.72	0.76	0.78	0.79	0.74	0.65
Finland	0.06	0.12	0.17	0.22	0.26	0.30	0.33	0.37	0.47	0.53
Ireland	0.25	0.41	0.53	0.61	0.66	0.69	0.70	0.70	0.64	0.54
Portugal	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.12	0.23
Australia	0.06	0.11	0.14	0.51	0.41	0.12	0.09	0.06	−0.14	−0.35
South Africa	0.18	0.34	0.49	0.62	0.75	0.85	0.95	1.04	1.24	1.29
Korea	0.00	−0.01	−0.02	−0.03	−0.05	−0.07	−0.10	−0.11	−0.17	−0.22
Pakistan	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07
					Exchange Rate[b]					
U.S.	−0.06	−0.42	−0.69	−0.90	−1.06	−1.18	−1.29	−1.40	−1.78	−2.16
Canada	0.05	0.04	0.00	−0.06	−0.12	−0.21	−0.31	−0.41	−0.99	−1.79
Japan	0.00	0.35	0.54	0.63	0.68	0.72	0.73	0.76	0.81	0.87
Austria	0.23	0.73	1.11	1.39	1.61	1.77	1.91	2.03	2.45	2.91
Belgium	0.13	0.60	1.00	1.30	1.51	1.68	1.82	1.94	2.35	2.82
Denmark	0.00	0.51	0.89	1.17	1.38	1.54	1.67	1.79	2.18	2.61
France	0.00	0.42	0.83	1.21	1.52	1.82	2.07	2.31	3.45	4.70
Germany	0.00	0.54	0.94	1.23	1.45	1.61	1.74	1.86	2.26	2.70
Italy	0.00	0.54	0.93	1.22	1.45	1.65	1.80	1.93	2.45	2.82
Netherlands	0.00	0.57	0.92	1.19	1.39	1.54	1.67	1.79	2.19	2.62

Norway	0.14	0.50	0.81	1.05	1.24	1.38	1.50	1.60	1.97	2.35
Sweden	0.25	0.67	1.12	1.52	1.89	2.23	2.54	2.92	4.41	6.17
Switzerland	–0.01	0.85	1.22	1.50	1.74	1.94	2.10	2.31	2.94	3.59
U.K.	0.38	0.73	1.05	1.35	1.61	1.84	2.06	2.27	3.06	3.83
Finland	0.00	0.33	0.62	0.84	1.01	1.13	1.23	1.32	1.61	1.92
Ireland	0.00	0.64	0.93	1.13	1.30	1.43	1.54	1.67	2.04	2.43
Portugal	0.00	0.30	0.66	1.01	1.32	1.63	1.92	2.20	3.60	5.28
Australia	0.00	0.00	0.01	0.01	0.03	0.04	0.05	0.06	0.10	0.08

Balance of Payments (in U.S. Dollars)

U.S.	–22.3	114.2	325.7	451.6	626.0	809.1	1073.2	1266.4	1998.4	2450.3
Canada	2.0	13.4	16.4	28.2	12.1	5.6	–6.0	4.6	44.4	81.2
Japan	–10.9	–82.8	–158.2	–223.9	–284.3	–352.6	–470.3	–534.4	–909.5	–1369.3
Austria	–6.2	0.4	7.7	14.2	16.5	16.1	20.6	24.2	22.6	19.9
Belgium	–7.5	–9.9	–14.2	–16.5	–18.9	–22.3	–29.2	–28.7	–20.7	19.2
Denmark	0.2	–3.5	–2.9	–4.1	–3.0	–1.6	–0.9	–0.9	1.4	6.4
France	–9.1	–16.7	–34.1	–51.8	–62.2	–82.0	–103.3	–117.7	–245.1	–250.9
Germany	–21.9	–69.4	–95.6	–112.6	–123.6	–162.0	–193.5	–187.6	–170.2	–227.3
Italy	–3.9	–13.6	–20.6	–47.0	–49.2	–49.5	–56.5	–91.7	–109.1	–143.5
Netherlands	–1.8	–7.3	–9.0	–6.3	–0.9	1.2	–1.3	2.3	0.7	21.7
Norway	0.0	5.2	8.1	14.7	19.2	23.6	28.5	41.7	63.1	69.7
Sweden	–10.4	–13.9	–17.3	–29.1	–41.0	–56.8	–69.5	–104.1	–176.7	–252.8
Switzerland	3.9	–9.3	2.5	7.9	6.0	3.7	7.7	3.9	11.4	2.5
U.K.	–72.9	–85.7	–91.9	–107.7	–120.2	–159.0	–194.0	–215.9	–226.4	–233.5
Finland	0.4	1.2	1.6	2.4	4.1	4.0	2.6	1.9	11.0	17.4
Greece	–0.8	2.3	2.2	4.3	3.2	2.7	6.2	4.1	–1.9	11.0
Ireland	2.1	–2.0	–1.4	0.1	–1.5	–0.9	0.2	1.3	11.8	11.1
Portugal	–0.3	–0.9	–2.6	–5.2	–10.0	–13.2	–18.6	–20.6	–51.7	–86.4
Spain	–1.8	5.5	4.3	0.7	1.7	1.1	9.8	32.2	159.6	245.8
Turkey	–0.3	1.4	1.5	1.5	2.5	3.2	0.8	–0.5	1.6	3.8
Yugoslavia	–0.3	3.8	5.9	9.6	15.2	13.1	12.0	9.4	–1.9	–41.5

Table 2: Effects of a Sustained Increase in the U.S. Short Term Interest Rate of One Percentage Point[a]

	Quarters Ahead									
Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
Australia	–0.8	2.7	6.2	6.2	2.0	0.8	3.6	0.7	17.5	75.2
New Zealand	0.0	–0.2	1.3	0.1	–2.9	–2.2	–0.8	–2.4	–4.1	2.6
South Africa	–0.8	–0.4	–2.2	–8.2	–9.6	–17.9	–30.5	–30.8	15.9	65.2
Saudi Arabia	–1.8	15.4	5.4	22.0	–3.5	–17.9	–64.4	–123.5	–318.5	–160.5
Venezuela	–1.7	0.6	2.5	3.7	–8.3	–16.7	–32.8	–40.2	56.6	67.5
Colombia	–0.4	–0.6	–2.1	–3.3	–3.7	–7.0	–10.0	–4.9	14.7	20.6
Mexico	–1.7	1.6	2.0	0.5	24.8	31.5	40.4	48.6	–31.0	30.1
Peru	0.0	0.9	1.5	2.1	3.9	2.9	5.5	3.7	–1.6	6.8
Jordan	–0.1	1.0	1.6	2.9	3.5	4.1	5.7	5.9	7.3	15.4
Syria	–0.2	0.9	3.2	3.9	4.0	5.3	2.5	5.6	6.8	15.3
India	–0.7	–2.7	–5.4	–5.6	–11.9	–14.2	–15.0	–15.4	–19.0	0.0
Korea	–2.2	–8.7	–15.7	–24.4	–23.2	–31.7	–39.4	–45.4	–58.6	–63.7
Malaysia	–0.5	–4.5	–9.7	–14.8	–20.4	–22.7	–25.9	–27.9	–21.5	–9.4
Pakistan	–0.4	0.3	0.8	1.1	0.8	0.9	1.0	0.3	–0.8	0.0
Philippines	–0.5	–1.5	–4.1	–5.6	–8.0	–10.0	–15.2	–16.2	–22.9	–17.1
Thailand	–0.8	–1.6	–3.2	–5.7	–8.8	–9.2	–7.6	–13.1	–14.9	–13.3

[a]See note to Table 1.
[b]The exchange rate for the United States is a weighted exchange rate. A negative value means an appreciation of the dollar.

Table 3: Effects of a Sustained Decrease in the Own Country's Government Spending of 1% of the Own Country's GNP[a]

Country	Quarters Ahead 1	2	3	4	5	6	7	8	12	16
					Real GNP					
U.S.	−0.97	−1.21	−1.28	−1.27	−1.20	−1.20	−1.15	−1.10	−0.99	−1.00
Canada	−0.88	−0.84	−0.92	−0.89	−0.90	−0.90	−0.95	−0.95	−1.03	−1.12
Japan	−1.05	−1.22	−1.42	−1.68	−1.76	−1.82	−1.85	−1.83	−1.68	−1.47
Austria	−1.13	−1.06	−1.03	−0.98	−0.89	−0.90	−0.94	−0.96	−1.09	−1.20
Belgium	−0.78	−0.77	−0.84	−0.80	−0.77	−0.75	−0.83	−0.68	−0.59	−.59
Denmark	−1.44	−1.67	−1.86	−1.93	−2.08	−2.09	−2.08	−1.98	−1.71	−1.37
France	−1.16	−1.32	−1.41	−1.38	−1.39	−1.42	−1.48	−1.44	−1.46	−1.50
Germany	−1.20	−1.70	−2.02	−2.25	−2.24	−2.00	−1.63	−1.14	0.65	0.34
Italy	−1.20	−1.31	−1.49	−1.44	−1.65	−1.68	−1.77	−1.59	−1.55	−1.44
Netherlands	−1.19	−1.26	−1.41	−1.42	−1.49	−1.45	−1.50	−1.34	−1.33	−1.39
Norway	−1.68	−1.41	−1.52	−1.18	−1.11	−1.10	−1.19	−1.05	−1.07	−1.03
Sweden	−0.88	−0.88	−0.97	−0.95	−0.95	−0.93	−0.95	−0.89	−0.88	−0.85
Switzerland	−1.00	−1.02	−1.20	−1.30	−1.39	−1.43	−1.51	−1.51	−1.67	−1.72
U.K.	−1.08	−1.34	−1.45	−1.53	−1.67	−1.61	−1.60	−1.52	−1.27	−0.91
					Exchange Rate					
U.S.	0.03	0.17	0.28	0.36	0.40	0.41	0.42	0.40	0.17	0.02
Canada	0.03	0.06	0.08	0.08	0.07	0.04	0.00	−0.05	−0.38	−0.87
Japan	0.00	−0.06	−0.16	−0.28	−0.42	−0.57	−0.74	−0.90	−1.58	−2.18
Austria	−0.03	−0.04	−0.04	−0.04	−0.03	−0.01	−0.01	−0.01	−0.04	−0.12
Belgium	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.31	0.28
Denmark	0.00	0.01	0.03	0.06	0.07	0.09	0.10	0.11	0.09	0.03
France	0.00	−0.18	−0.40	−0.65	−0.90	−1.15	−1.40	−1.67	−2.98	−4.81
Germany	0.00	0.20	0.61	1.21	1.97	2.82	3.66	4.40	5.19	3.05

Table 3: Effects of a Sustained Decrease in the Own Country's Government Spending of 1% of the Own Country's GNP[a]

	Quarters Ahead									
Country	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
Italy	0.00	−0.09	−0.20	−0.33	−0.46	−0.60	−0.75	−0.91	−1.58	−2.22
Netherlands	0.00	0.03	0.06	0.08	0.10	0.13	0.16	0.19	0.23	0.12
Norway	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00
Sweden	0.06	0.14	0.22	0.30	0.37	0.44	0.50	0.55	0.74	0.89
Switzerland	−0.07	−0.11	−0.15	−0.20	−0.24	−0.29	−0.36	−0.41	−0.74	−1.18
U.K.	0.08	0.18	0.28	0.37	0.45	0.51	0.54	0.56	0.45	0.15

[a]Values are percentage deviations from the base values in percentage points.
[b]The exchange rate for the United States is a weighted exchange rate. A positive value means a depreciation of the dollar.

Germany a cycle has been generated, where by quarter 12 GNP is higher rather than lower. Germany's exchange rate depreciated by a fairly large amount (5.19% by quarter 12), which is one of the reasons for the increase in GNP.

Whether there was an appreciation or a depreciation of the exchange rate in response to the demand shock for a given country can in part be traced back to the estimated exchange rate equation for the country. For some countries the relative interest rate variable dominates the relative price variable in the sense of having a higher *t* statistic, and for other countries the reverse is true. For the first group of countries there is generally a depreciation of the exchange rate in response to a negative demand shock, and for the second group there is generally an appreciation.

The *J* curve effect is examined in Table 4. Like Table 3, Table 4 includes results for 14 different experiments. For each experiment the exchange rate equation for the country was dropped and the exchange rate was depreciated by 10%. The exchange rate equations for the other countries were left in the model. For all countries except the United States the exchange rate was depreciated relative to the U.S. dollar. For the United States the exchange rate was depreciated relative to the 17 countries for which there are estimated equations (the 13 countries in Table 4 plus Finland, Ireland, Portugal, and Australia). The U.S. depreciation is thus not nearly as extensive as are the others. For the U.S. experiment all 17 of the exchange rate equations were dropped from the model and each exchange rate was appreciated relative to the U.S. dollar by 10%.

The results in Table 4 show clearly that a depreciation is expansionary. GNP is higher for all countries except for the United States after four quarters and the United Kingdom after 16 quarters. (Remember that the U.S. depreciation is less extensive than the others.) The results for the balance of payments, on the other hand, vary considerably across countries. The following countries exhibit *J* curves, with the switch from negative to positive indicated: the United States at eight quarters, Canada at seven quarters, Denmark at 13 quarters, France at 11 quarters, the Netherlands at 13 quarters, Norway at two quarters, Switzerland at 14 quarters, and the United Kingdom at 11 quarters. For Japan and Germany the effect on the balance of payments is positive from the very beginning. For Italy the effect is positive for the first four quarters and then becomes negative. For Austria, Belgium, and Sweden the effect is still negative after 16 quarters. There is thus evidence of a *J* curve for eight of the 14 countries, but there is far from a uniform pattern across countries.

Table 4. Effects of a Sustained 10% Depreciation of the Own Country's Currency[a]

Country	Quarters Ahead 1	2	3	4	5	6	7	8	12	16
					Real GNP[b]					
U.S.	0.21	0.19	0.10	–0.03	–0.19	–0.32	–0.44	–0.55	–0.73	–0.73
Canada	1.71	1.83	2.24	2.58	2.59	2.56	2.50	2.50	2.54	2.41
Japan	0.92	1.02	1.14	1.32	1.32	1.39	1.47	1.51	1.51	1.30
Austria	2.07	2.35	2.07	2.02	1.99	1.86	1.75	1.76	1.78	2.20
Belgium	4.58	4.66	4.53	4.81	4.68	4.37	4.12	3.94	3.37	3.20
Denmark	2.46	3.45	3.66	4.06	4.40	4.22	3.76	3.70	2.85	2.35
France	1.76	1.97	1.73	1.81	1.80	1.76	1.54	1.63	1.50	1.39
Germany	2.06	2.86	3.25	3.72	3.84	3.67	3.27	2.77	0.67	1.12
Italy	1.43	1.66	1.51	2.00	1.67	1.65	1.55	1.53	0.81	0.72
Netherlands	4.09	4.11	4.15	4.21	4.49	4.04	3.74	3.40	2.96	2.71
Norway	3.48	4.62	3.49	3.30	3.10	2.48	1.90	1.93	1.43	1.00
Sweden	2.87	1.91	1.78	2.19	1.98	2.07	1.85	2.14	1.93	2.06
Switzerland	2.58	3.11	3.36	3.76	3.72	3.77	3.72	3.81	3.44	3.20
U.K.	1.63	2.00	1.91	1.93	1.82	1.85	1.59	1.38	0.45	–0.03
					Balance of Payments (in U.S. Dollars)[c]					
U.S.	–1204.7	–1237.1	–900.8	–571.2	–509.8	–348.4	–53.4	81.7	874.8	416.1
Canada	–319.0	–473.7	–131.8	–186.0	–129.8	–70.0	28.7	–8.4	94.0	69.8
Japan	732.2	681.0	663.7	482.5	75.8	81.9	151.7	227.8	1240.3	1487.0
Austria	–129.9	–113.6	–104.8	–135.4	–114.8	–137.6	–127.0	–203.8	–203.1	–169.1
Belgium	–123.5	–307.3	–383.8	–438.5	–448.2	–447.0	–453.8	–454.7	–336.9	–65.6
Denmark[d]	–120.0	–90.9	–110.7	–134.4	–125.8	–113.2	–125.0	–103.9	–10.9	–39.0
France[e]	–65.8	–83.6	–224.4	–164.5	–147.6	–24.5	–194.3	–26.0	78.8	173.1
Germany	536.8	387.2	91.0	230.4	181.6	211.6	161.4	550.0	1182.4	1606.5

Why are the balance of payments results in Table 4 so variable? One possibility is that the model is simply a poor approximation of the structure of the world economy and that if the truth were known the results would be less variable. The balance of payments for each country is a residual in the model, and variables determined in this way are in many cases more sensitive to misspecification of the model (for example, of the trade share equations) than are variables determined by estimated equations.

If misspecification is not the complete answer, one needs to look more closely at the model. Because the balance of payments is residually determined, it has many forces acting on it, some positive and some negative. For example, the depreciation in Table 4 led to an increase in GNP, and, other things being equal, an increase in GNP has a negative effect on the balance of payments. This effect is offsetting at least some of the effect of the change in relative prices, and it may be the dominant effect in some cases. A depreciation also leads to an increase in the domestic price level (through the price of import effect), which then has a positive effect on the country's export price index. The country's export price index thus does not fall as much (in terms of the other countries' currencies) as would be the case if this domestic price effect were not operating. Again, this effect could be fairly large for some countries. In short, the different balance of payments responses across countries may be due to the (correct) differential responses that countries have to a variety of variables. Given the many forces affecting the balance of payments, there is no necessary reason for countries to exhibit a *J* curve in response to a depreciation of the exchange rate.

V. CONCLUSION

One way of looking at the results of the experiments is to ask which effects seem to be robust across countries and which do not. The robust results are the following: (1) A negative demand shock leads to a fall in GNP. Although shown in Table 1 for the United States but not in Table 3 for the other countries, a negative demand shock also leads to a fall in the GNP deflator, a fall in the short term interest rate, and an increase in the balance of payments. (2) An increase in the short term interest rate leads to a fall in GNP and an appreciation of the exchange rate. This is shown in Table 2 for the United States, but it is also true for the other countries. (3) An autonomous depreciation of the exchange rate leads to a rise in GNP.[9]

[9]The policy properties of the model are roughly symmetric, and so these conclusions about

Italy	165.4	172.7	109.2	133.1	−126.4	−53.5	70.5	−303.3	−178.5	−29.7
Netherlands[f]	98.5	−162.8	−322.8	−316.2	−333.4	−363.0	−466.3	−376.6	−48.7	306.2
Norway	−33.3	32.2	18.3	7.4	55.8	53.3	60.1	73.7	171.2	144.1
Sweden	−120.1	−142.6	−204.6	−214.7	−237.6	−268.1	−332.2	−330.9	−233.8	−232.3
Switzerland[g]	−175.2	−180.0	−169.9	−195.9	−249.7	−210.2	−265.7	−225.1	−54.5	158.8
U.K.[h]	−735.1	−875.4	−857.2	−821.5	−807.2	−640.6	−553.5	−554.3	255.0	245.6

[a]Results presented for the own country only.
[b]Values for real GNP are percentage deviations from the base values in percentage points.
[c]Values for the balance of payments are deviations from the base values in millions of U.S. dollars.
[d]Positive values in quarters 13 and 14.
[e]Positive values beginning in quarter 11.
[f]Positive values beginning in quarter 13.
[g]Positive values beginning in quarter 14.
[h]Positive values beginning in quarter 11.

The two main effects that are not robust are the following: (1) The effect of a negative demand shock on the exchange rate can be either positive or negative. (2) The effect of a depreciation on the balance of payments can be either positive or negative, both in the first quarter and over time. For some countries there are *J* curves, and for others there are not. More tests of the model are needed before one knows whether the lack of robustness that currently exists in the model accurately reflects the situation in the real world or is simply due to misspecification of the model.

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robustness also hold for positive demand shocks, a decrease in the short term interest rate, and an autonomous appreciation of the exchange rate.