Estimated Output, Price, Interest Rate, and Exchange Rate Linkages among Countries

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This article provides quantitative estimates from an econometric model of the output, price, interest rate, and exchange rate linkages among a number of countries. The linkages are examined by changing various policy variables and observing the resulting changes in the endogenous variables. The model is also used to estimate what is called the "exchange rate effect" on inflation. One of the ways in which monetary and fiscal policies may affect a country's inflation rate is by first influencing its exchange rate, which in turn influences import prices, which in turn influence domestic prices. The model allows this exchange rate effect on inflation to be estimated.

I. Introduction

This article provides quantitative estimates of the output, price, interest rate, and exchange rate linkages among a number of countries. The econometric model used for this purpose is described in Fair (1981*a*), and the present article is an extension of this work. The linkages are examined by changing various policy variables in the model and observing the resulting changes in the endogenous variables. The results of ten experiments are reported: (1) an increase in U.S. government spending, (2) an increase in the U.S. interest rate, (3) an increase in German government spending, (4) an increase in the German interest rate, (5) a depreciation of the German exchange rate, (6) an increase in U.K. government spending, (7) a depreciation

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of the U.K. exchange rate, (8) an increase in Japanese government spending, (9) a depreciation of the Japanese exchange rate, and (10) an increase in the price of exports of the oil-exporting countries.

The model is also used to estimate what will be called the "exchange rate effect" on inflation. One of the ways in which monetary and fiscal policies may affect a country's inflation rate is by first influencing its exchange rate, which in turn influences import prices, which in turn influence domestic prices. This is what is called the exchange rate effect on inflation. In order to estimate the size of this effect one needs a model linking monetary and fiscal policies to exchange rates, exchange rates to import prices, and import prices to domestic prices; the present model provides these links.

A complete list of the equations in the model, including all the estimated equations, is presented in Fair (1981*a*, 1981*b*). The first paper contains all the equations except for those explaining trade shares, and the second paper contains the trade-share equations. The model is reviewed in Sections II and III of this article. If the two discussion papers have been read, these two sections can be skipped. This article is concerned only with the flexible exchange rate period, though there is also a version of the model that pertains to the fixed exchange rate period. The testing of the model is discussed in the discussion papers, and no mention of this is made here. It perhaps goes without saying that the results in this article should be interpreted with caution. It is hoped that they provide some insights into the qualitative and quantitative linkages among countries, but further tests of the model are needed before the results can be considered anything other than preliminary. The results are based solely on estimated equations and definitions: No adjustments to any of the estimated equations have been made.

All exchange rates are in units of local currency per U.S. dollar. This means that an increase in a country's exchange rate is a depreciation. When the phrase "depreciation of the exchange rate" is used in this article, this refers to an increase in the exchange rate (and vice versa for appreciation). "Dollar" always refers to the U.S. dollar.

II. A Review of the Model

The model is quarterly and contains estimated equations for 44 countries. Most of the equations have been estimated by two-stage least squares. The basic estimation period is 1958I–1980I (89 observations). For equations that are relevant only when exchange rates are flexible, the basic estimation period is 1972II–1980I (32 observations). The trade matrix contains data for 64 countries. The list of countries is presented in the Appendix. The U.S. part of the model is the model described in Fair (1976, 1980).

The model differs from previous models in a number of ways: (1) Linkages among countries with respect to exchange rates, interest rates, and prices appear to be more important in the model than they are in previous models. (2) There is no natural distinction in the model between stock-market and flow-market determination of the exchange rate, a distinction that is important in recent discussions of the monetary approach to the balance of payments (see, e.g., Frenkel and Rodríguez 1975; Dornbusch 1976; Frenkel and Johnson 1976; and Kouri 1976). (3) The number of countries is larger than usual, and the data are all quarterly. Considerable work has gone into the construction of quarterly data bases for all the countries. (4) I alone have estimated small models for each country and then linked them together rather than, as Project LINK (see Ball 1973; Hickman 1974) has done, take models developed by others and link them together. The advantage of the LINK approach is that larger models for each country can be used. The advantage of the present approach is that the person constructing the individual models knows from the beginning that they are to be linked together, and this may lead to better specification of the linkages. It is unlikely, for example, that the specification of the exchange rate and interest rate linkages in the present model would develop from the LINK approach. Whether this possible gain in the linkage specification outweighs the loss of having to deal with small models of each country is an open question.

The basic theoretical model that has guided the empirical work is discussed in Fair (1974). Individual agents in this model derive their decisions from the solutions of multiperiod maximization problems. These problems require that agents form expectations of the future values of a number of variables. Even though the model is deterministic, agents make expectations errors. They do not know the complete model and must form their expectations on the basis of a limited set of information (usually only the past history of a few variables). These expectations errors lead at times to "disequilibrium" in the labor, goods, and financial markets, and much of the modeling is concerned with the effects of disequilibrium. Another important feature of the modeling is making sure that all flows of funds among the agents are accounted for. A two-country version of this model is presented in Fair (1979). The idea for this version came from considering how one would link the single-country model to a model just like it. Stock and flow effects are completely integrated in this model because of the accounting for all flows of funds. This is the reason there is no natural distinction between stock-market and flow-market determination of the exchange rate.

There are a number of versions of the two-country model. The version that was used as a basis for the empirical work is the one in which the bonds of the two countries are perfect substitutes, the

short-term interest rates of the countries and the exchange rate are determined by reaction functions, and the forward exchange rate is "passive." Whether this choice, which was partly dictated by data availability, provides an adequate basis for constructing an empirical model is an open question. No direct tests of the assumptions behind this choice have been attempted. The choice has been indirectly tested by examining how well the model explains the historical data.

Let R denote country 1's interest rate, r country 2's interest rate, e the exchange rate (the price of country 2's currency in terms of country 1's currency), and F the forward rate. The covered interest rate from country 1's perspective on the bond of country 2, say r', is $(e/F)(1 + r) - 1$. If for $R = r'$ people are indifferent as to which bond they hold, the bonds are defined to be perfect substitutes. In this case arbitrage will insure that $R = r'$, and so one of the equations in the model is

$$R = (e/F)(1 + r) - 1. \tag{1}$$

Write the reaction functions as

$$R = f_2(\ldots), \tag{2}$$

$$r = f_3(\ldots), \tag{3}$$

$$e = f_4(\ldots), \tag{4}$$

where the arguments in the functions are variables that affect the monetary authorities' decisions regarding the interest rates and the exchange rate.

The assumption that is most questionable in the choice of this version is probably the assumption that e is determined by a reaction function. The alternative assumption is that e is implicitly determined in the model, with reserves taken to be exogenous. In practice there is obviously some intervention of the monetary authorities in the exchange markets, and so this alternative assumption is also questionable. The assumption that e is determined by a reaction function may not be, however, as restrictive as it first sounds. The monetary authorities are likely to be aware of the market forces that are operating on e in the absence of intervention, and they may take these into account in setting their target each period. If some of the explanatory variables in the reaction function are in part measures of these forces, the estimated reaction function may provide a better explanation of e than one would otherwise have thought. Similar arguments apply to the assumption that R and r are determined by reaction functions.

The assumption that F is passive means that it is determined by equation (1): Given R, r, and e, F merely adjusts to insure that the arbitrage condition holds. In this case the forward market imposes no

"discipline" on the monetary authorities' choice of the exchange rate. Again, however, if the monetary authorities take into account market forces in the forward market operating on e and if the explanatory variables in the reaction function for e are in part measures of these forces, the estimated reaction function for e may not be too bad an approximation. Given the assumption that F is passive and given that F does not appear as an explanatory variable in any of the equations, F plays no role in the empirical model. For each country it is determined by an estimated version of the arbitrage condition, but the predictions from these equations have no effect on the predictions of any of the other variables in the model.

The U.S. model is much larger than the models for the other countries. The two key exogenous foreign sector variables are the import price deflator and the real value of exports. When the U.S. model is embedded in the overall model, these two variables become endogenous. Since the U.S. model is discussed in detail elsewhere, it will not be discussed here. All references to the econometric work in this section pertain only to the non-U.S. part of the model.

There are up to 11 estimated equations per country in the econometric model. These equations and their explanatory variables are in the table below. (The signs in parentheses are the expected signs of the coefficient estimates.)

Equation Number	Dependent Variable	Explanatory Variables
(1)	Merchandise imports	Short-term or long-term interest rate (−), GNP deflator (+), import price index (−), GNP (+), lagged net foreign assets (+), lagged dependent variable (+)
(2)	Consumption	Short-term or long-term interest rate (−), GNP (+), lagged net foreign assets (+), lagged dependent variable (+)
(3)	Change in investment	Changes in GNP—current, lagged once, lagged twice, lagged three times—(+), lagged level of investment (−)
(4)	GNP	Final sales (+), lagged stock of inventories (−), lagged dependent variable (+)
(5)	GNP deflator	Import price index (+), short-term or long-term interest rate (+), demand pressure variable (+), lagged dependent variable (+)
(6)	Nominal money supply	Short-term interest rate (−), nominal GNP (+), lagged dependent variable (+)
(7b)	Short-term interest rate	Lagged rate of inflation (+), lagged rate of growth of the money supply (+), demand pressure variable (+), change in net foreign assets (−), lagged rate of change in the import price index—four countries only—(+), exchange rate—three countries only—(+), lagged dependent variable (+)
(8)	Long-term interest rate	Short-term interest rates—current, lagged once, lagged twice—(+ or −), weighted average of current and past inflation rates (+), lagged dependent variable (+)

Equation Number	Dependent Variable	Explanatory Variables
(9b)	Exchange rate	GNP deflator (+), short-term interest rate (−), demand pressure variable (+), lagged change in net foreign assets (−)—all relative to the respective U.S. variables—lagged dependent variable (+)
(10b)	Forward rate	Exchange rate (+), short-term interest rate relative to the U.S. short-term interest rate (+)
(11)	Export price index	GNP deflator (+), world price index (+), exchange rate (+)

All expenditure variables are in real terms (1975 local currency). Many of the variables are on a per capita basis. A "b" after an equation number denotes that the equation was estimated only over observations in the flexible exchange rate period. Unless otherwise noted, "lagged" means lagged one quarter. Explanatory variables were dropped from the equations if they had coefficient estimates of the wrong expected sign. Both current and one-quarter lagged values were generally tried for the explanatory price and interest rate variables, and the values that gave the best results were used. Similarly, both the short-term and long-term interest rate variables were tried, and the variable that gave the best results was used. Data limitations prevented all the equations from being estimated for all countries and also required that shorter sample periods from the basic period be used for many countries.

Lagged dependent variables were used extensively to try to account for expectational and lagged adjustment effects. This procedure is consistent with the treatment of expectations in the theoretical model, where expectations are assumed to be formed on the basis of a limited set of information. All the equations except (10b) and (11) were estimated with a constant and three seasonal dummy variables. A time trend was also included in a number of equations. In most cases the functional form chosen was the log form. The demand pressure variable is a nonlinear function of GNP.

The specification of the equations is generally consistent with the theoretical model. An exception to this is the specification of the consumption function, where income (GNP) is used as an explanatory variable. If a household is choosing consumption and labor supply to maximize utility, income is not the appropriate variable to use. This procedure can be justified if households are always constrained in their labor supply decision, and this is what must be assumed here. Also, the investment equation is missing a variable that plays an important role in the theoretical model and in the U.S. model, namely, the amount of "excess" capital on hand. The transition from

the theoretical model to the U.S. model is discussed in Fair (1976), and this is a useful reference for the current transition as well.

Equation (7b) is the interest rate reaction function, and equation (9b) is the exchange rate reaction function. Although not noted above, the U.S. and German short-term interest rates are explanatory variables in a few of the interest rate reaction functions. Also, the German exchange rate is an explanatory variable in the exchange rate reaction functions of the other European countries.

There are nine definitions per country. The four most important are (1) final sales equals consumption plus investment plus government spending plus exports minus imports, (2) inventory investment equals GNP minus final sales, (3) the balance of payments equals the price of exports times exports minus the price of imports times imports plus net transfer payments, and (4) net foreign assets equals net foreign assets of the previous period plus the balance of payments (i.e., the change in net foreign assets equals the balance of payments).

Trade shares are a function of relative prices. A total of 64 trade-share equations were estimated, one per country, using a pooled time-series–cross-section technique. Quarterly data from 1971I through 1979IV were used for these estimates. The share of country i's imports from country j is a function of country j's export price relative to an index of all other countries' export prices.

III. Some Ceteris Paribus Effects in the Model

It is possible to get some idea of the properties of the model without performing simulation experiments. In what follows a variable is said to have a "direct" effect on another variable if it appears on the right-hand side of the equation (either a stochastic equation or a definition) explaining the other variable. Most endogenous variables have at least an indirect effect on the other endogenous variables—either contemporaneously or with a lag of one quarter. Because of this, it is difficult to explain the properties of the model in a very systematic way. The following discussion is designed to try to give a general idea of the properties without going into every possible indirect effect. It should also be kept in mind that not all of the effects operate for all countries. All interest rates referred to are short-term rates unless otherwise noted.

Trade Effects among Countries

There is a standard trade multiplier effect in the model. An autonomous increase in GNP in country i increases the 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, exports affect imports 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 prices, which increases the import prices of other countries, which increases their domestic prices, including their export prices, which then increases country i's import prices and thus its domestic and export prices. In short, export prices affect import prices and vice versa.

Direct Interest Rate and Exchange Rate Effects among Countries

As noted above, the U.S. and German short-term interest rates appear as explanatory variables in the interest rate reaction functions of a few countries. The U.S. and German interest rates thus directly affect these other countries' rates. The German exchange rate appears as an explanatory variable in the exchange rate reaction functions of the other European countries, and so it directly affects the other rates.

Direct Effects within a Country

The short-term interest rate directly affects the long-term rate in the term structure equation (eq. [8]). The short-term or long-term rate has a direct negative effect on imports and consumption (eqq. [1] and [2]) and a direct positive effect on the GNP deflator (eq. [5]). The short-term rate has a direct negative effect on the demand for money and the exchange rate (eqq. [6] and [9b]). (Remember that an increase in the exchange rate is a depreciation of the country's currency.)

The asset variable, which is the sum of past values of the balance of payments and is a measure of the net asset position of the country vis-à-vis the rest of the world, has a direct positive effect on imports and consumption (eqq. [1] and [2]) and a direct negative effect on the short-term interest rate and the exchange rate (eqq. [7b] and [9b]).

The exchange rate has a direct positive effect on the local currency price of exports (eq. [11]) and on the local currency price of imports (the equations involved in linking export and import prices). It also has a direct negative effect on the dollar price of exports (because the coefficient estimate of the exchange rate in eq. [11], which is in log form, is less than one). It has a direct positive effect on the short-term interest rate for three countries (eq. [7b]).

The price of imports has a direct negative effect on imports (eq.

[1]), a direct positive effect on the GNP deflator (eq. [5]), a direct negative effect on the asset variable (the balance-of-payments definition), and a direct positive effect on the short-term interest rate for four countries (eq. [7b]). The price of exports has a direct positive effect on the asset variable (balance-of-payments definition). The GNP deflator has direct positive effects on imports, the demand for money, the short-term and long-term interest rates, the exchange rate, and the price of exports (eqq. [1], [6], [7b], [8], [9b], and [11]).

The level of imports has a direct negative effect on final sales and the asset variable, and the level of exports has a direct positive effect on these two variables (the final-sales definition and the balance-of-payments definition). The level of final sales has a direct positive effect on GNP (eq. [4]). Any deviation of GNP from final sales in a period is absorbed by a change in inventories (inventory definition). The stock of inventories has a direct negative effect on GNP (eq. [4]).

The GNP or the demand pressure variable has a direct positive effect on imports, consumption, investment, the GNP deflator, the demand for money, the short-term interest rate, and the exchange rate.

Some Indirect Effects within a Country

It should be clear that there are very few unambiguous indirect effects in the model with respect to sign. The signs depend on the relative sizes of the coefficient estimates. It is useful, however, to consider the likely signs of some indirect effects, even though these signs are not necessarily logical consequences of the model.

Consider first the indirect effect of the exchange rate on GNP. The main direct effect of the exchange rate is on the price of imports, at least in the short run. The price of imports has a direct negative effect on imports, and the level of imports has a direct positive effect on GNP. In other words, an increase in the price of imports causes substitution from imports to domestically produced goods, which raises GNP. The exchange rate thus has an indirect positive effect on GNP through this channel (i.e., depreciation increases GNP).

Depreciation also lowers the dollar price of the country's exports, which through the trade-share equations has a positive effect on the other countries' demand for the given country's exports. Therefore, depreciation also increases GNP through this channel.

Depreciation is likely to have a negative indirect effect on GNP through a third channel. The likely initial effect of a depreciation on the balance of payments is negative. Depreciation raises the local currency price of imports more than it does the local currency price of exports, which, other things being equal, has a negative effect on the

balance of payments. Depreciation also lowers imports and raises exports, which has a positive effect on the balance of payments. This latter effect is, however, likely to be smaller initially than the price effect, and so the initial net effect is likely to be negative. (This is, of course, the "J-curve" effect.) A decrease in the balance of payments decreases net foreign assets, which directly decreases imports and consumption and directly increases the short-term interest rate. Although the decrease in imports raises GNP, the decrease in consumption and the increase in the interest rate lower GNP, and the net effect is likely to be negative. Depreciation is thus likely to have an initial indirect negative effect on GNP through this "asset" effect channel.

Depreciation has two main indirect effects on the GNP deflator, one positive and one ambiguous. The positive effect is through the price of imports, which has a direct positive effect on the GNP deflator. The second effect is through GNP. If the net effect of depreciation on GNP is positive, this will have a positive effect on the GNP deflator through the direct positive effect of the demand pressure variable on the GNP deflator. If the net effect of depreciation on GNP is negative, the indirect effect on the GNP deflator is negative.

There are three main effects of the short-term interest rate on GNP, one negative, one ambiguous, and one positive. The negative effect is through consumption. An increase in the short-term rate increases the long-term rate. An increase in the short-term rate or the long-term rate decreases consumption, which lowers GNP. The ambiguous effect is through the exchange rate. An increase in the short-term rate has a negative effect on the exchange rate (an appreciation), which has an ambiguous effect on GNP. The positive effect is through imports. An increase in the short-term or long-term rate lowers imports, which, other things being equal, raises GNP. The consumption effect is likely to be the dominant one, and so the net effect of the short-term rate on GNP is likely to be negative.

An increase in the short-term interest rate has three main effects on the GNP deflator, one positive and two negative. The positive effect is a direct one: The short-term or long-term rate appears as an explanatory variable in the price equation (eq. [5]). The first negative effect is the likely negative indirect effect of the short-term rate on GNP and thus on the demand pressure variable. The other negative effect is the effect on the exchange rate: The exchange rate appreciates, which lowers the price of imports, which lowers the GNP deflator.

IV. The Results of the Experiments

The results of the experiments are presented in tables 1 through 10. The experiments were performed as follows. The estimated residuals

were first added to the stochastic equations and treated as exogenous. This means that when the model is simulated using the actual values of the exogenous variables, a perfect tracking solution is obtained. Each experiment corresponds to changing one or more exogenous variables and running a dynamic simulation. The effect of this change on an endogenous variable is the difference between the predicted value of the variable from this simulation and the actual value. All experiments were for the 1976I–1977IV period.[1]

All of the 44 countries for which there are estimated equations were used for the experiments. The results for 15 countries and 13 variables per country are presented in the tables for the two-quarter-ahead and six-quarter-ahead predictions. Except for the numbers for the balance of payments, each number in the tables is the percentage change in the variable (in percentage points) divided by something. For the spending increases (tables 1, 3, 6, and 8) the divisor is the change in government spending as a percentage of GNP (in percentage points).[2] Each number in these tables is thus the percentage change in the variable induced by a 1 percent autonomous increase in GNP of the country in which the policy change was made. For the interest rate increases (tables 2 and 4) the divisor is the change in the interest rate (in percentage points). The actual change in the interest rates for the experiments was 2.0 percentage points, and so the divisor was 2.0. Each number in these tables is thus the percentage change in the variable induced by a 1.0 percentage point increase in the interest rate. For the exchange rate increases (tables 5, 7, and 9) the percentage change in the exchange rates was 10.0 percent and the divisor was 1.0. Each number in these tables is thus the percentage change in the variable induced by a 10.0 percent increase in the exchange rate. Finally, for the increase in the export prices (table 10) the percentage change in the prices was 50.0 percent and the divisor was 1.0. Each number in this table is thus the percentage change in the variable induced by a 50.0 percent increase in the export prices.

The numbers for the balance of payments are not in percentage terms and have not been divided by anything. They are merely the actual changes in the balance of payments corresponding to whatever policy change was made. The balance-of-payments variables are in units of nominal local currency, and so it is not readily apparent from the tables how one country's balance of payments changed relative to another's. For the most part it is unnecessary to know this to under-

[1] The model was solved using the Fair-Parke (1981) program. The approximate time on the IBM 379-158 at Yale for one eight-quarter simulation was 3.5 minutes.

[2] Each number in these tables is thus $[(\hat{y}_{it} - y_{it})/y_{it}]/(\Delta G_{it}/Y_{it})$, where $\hat{y}_{it}$ is the two- or six-quarter-ahead predicted value of y_{it} after the change, ΔG_{it} is the change in government spending in quarter t, and Y_{it} is the actual value of GNP in quarter t.

stand the rest of the results. When it is necessary, the relative change will be mentioned in the text. The main interest in the balance-of-payments results for a country is the sign of the changes.

The following discussion of the results is somewhat loose. Reference is sometimes made to a change in one endogenous variable "leading to" or "resulting in" a change in another endogenous variable. This is not, strictly speaking, correct because the model is simultaneous, but it does help give a general idea of the model's properties. Not all results in the tables are explained, and not every possible indirect effect is noted. Emphasis is placed on the main results and effects and, as the discussion progresses, on the results in a table that are different from the results in previous tables. In what follows, "GNP" and "income" are used interchangeably, interest rates are always short-term interest rates unless otherwise noted, and import and export prices are local currency prices unless otherwise noted.

United States Spending Increase (Table 1)

The results of an increase in U.S. government spending on U.S. goods are presented in table 1. The increase in spending increased U.S. income, which in turn increased U.S. imports. This increased other countries' exports, which in turn increased their income and imports. This is the trade multiplier effect. The increase in U.S. income and prices led to an increase in the U.S. interest rate through the U.S. interest rate reaction function. This offset some of the increase in U.S. income that would otherwise have occurred. It also led to an increase in some of the other countries' interest rates, which in turn offset some of the increase in their income that would otherwise have occurred from the pure trade multiplier effect.

There are four main effects of the U.S. spending increase on the exchange rates, three negative and one positive. The spending increase raised U.S. output and prices relative to those of the other countries, both of which have a negative effect on other countries' exchange rates (an appreciation). The U.S. balance of payments fell relative to those of the other countries (the balance of payments of other countries generally rose), and this also has a negative effect on exchange rates. The positive effect is the interest rate effect. The U.S. short-term interest rate rose relative to other countries' rates, and this has a positive effect on exchange rates (a depreciation). As can be seen in table 1, the net effect can go either way. For some countries, such as Germany, there is a depreciation after two quarters (the interest rate effect dominating) and then an appreciation after six quarters.

The changes in import prices are negative for countries whose

TABLE 1

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 1 PERCENT AUTONOMOUS INCREASE IN U.S. REAL GNP (Initial Change in 1976I)

Country	Real GNP		GNP Deflator		Short-Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	1.43	1.39	.17	.55	.56	.89	...	...	.06	.58	-.06	-.33	1.68	2.94
Canada	.18	.55	.05	.56	.22	.60	-.00	.01	.07	.51	-.16	-.90	.20	1.14
Japan	.04	.12	-.01	-.10	-.04	-.12	-.81	-3.32	-.75	-2.96	.02	.06	.11	1.04
Austria	.04	.12	.01	.17	-.00	.03	.44	-.71	.35	.07	.01	.13	.03	.16
Belgium	.02	.10	-.01	-.02	-.01	.16	.07	-1.01	.05	-.31	-.00	.00	.07	.30
Denmark	.03	.01	-.01	-.10	-.04	-.10	-.03	-1.05	-.14	-.42	.04	.03	.09	.32
France	.01	-.07	-.01	-.14	.16	.29	-.11	-1.89	-.15	-1.31	.02	-.24	.05	.25
Germany	.09	.14	.01	.10	.14	.41	.16	-1.11	.14	-.59	-.05	-.27	.08	-.06
Italy	.03	.21	-.01	-.27	-.04	-.42	-.10	-1.80	-.13	-1.23	.01	.17	.05	.43
Netherlands	.02	.03	-.00	.01	.44	.87	.15	-.95	.13	-.30	-.42	-.82	.03	.11
Norway	.05	.14	.03	.27	.05	.29	.22	-.01	.15	.66	.05	.31	.05	.10
Sweden	.09	.26	.02	.36	.10	.43	.54	-.07	.50	.59	.02	.20	.11	.11
Switzerland	.11	.23	.02	.09	.09	.13	.45	-1.18	.42	-.39	-.06	-.20	.07	.18
U.K.	.06	.10	.00	-.11	.00	.02	-.13	-2.23	-.13	-1.69	.02	.01	.08	.23
Finland	.05	.33	.03	.37	-.00	.00	.55	1.06	.42	1.71	.02	.51	.02	.24
U.S. Alone	1.43	1.36	.16	.45	.56	.86	...	...	.00	.00	-.07	-.33	1.68	3.01

Country	Consumption		Investment		Long-Term Interest Rate		Export Price		Exports		Balance of Payments*	
	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.30	-.01	2.36	5.25	.16	.41	.08	.42	.08	.65	-478.275	-974.289
Canada	-.00	.03	.15	.44	.07	.27	.04	.52	1.32	2.66	112.891	180.431
Japan	.02	.13	.01	.15	...	...	-.53	-2.23	.44	.92	23.349	34.381
Austria	.02	.07	.06	.15	...	...	.29	-.41	.15	.35	.123	-.335
Belgium	.02	.07	.02	.11	-.00	.02	.03	-.55	.13	.34	.609	-1.479
Denmark	.02	.01	.03	.01	-.01	-.03	-.08	-.50	.20	.40	.042	-.016
France	.00	-.05	.01	-.09	.04	.12	-.12	-.93	.13	.20	.126	.324
Germany	.01	-.04	.19	.29	.04	.16	.04	-.19	.19	.35	-.048	.574
Italy	.02	.19	.07	.52	-.01	-.11	-.12	-1.24	.19	.39	11.406	-16.737
Netherlands	-.03	-.18	.02	.04	.08	.26	.13	-.78	.12	.41	.070	-.124
Norway	.02	.05	...	...	.01	.06	.15	.01	.17	.59	.005	-.111
Sweden	.04	.15	.08	.21	.01	.10	.12	.15	.30	.56	-.048	-.028
Switzerland	-.00	.05	.25	.77	.03	.10	.07	-.27	.31	.34	.003	.018
U.K.	.04	.15	.04	.09	.00	-.00	-.06	-.76	.21	.20	14.092	108.099
Finland	.02	.23	.05	.37	...	...	.46	.99	.13	.51	9.962	-64.447
U.S. Alone	.31	.02	2.35	5.18	.16	.40	.07	.32	.00	.00	-461.178	-964.537

*Change is absolute change, not percentage change, in units of local currency.

exchange rate appreciated. For most of these countries the fall in import prices led to a fall in the GNP deflator. In other words, the U.S. expansion generally led to a fall in inflation rates in those countries whose exchange rates appreciated. This exchange rate effect on inflation (through import prices) tends to dominate the pure price multiplier effect that would exist if exchange rates were fixed.

The balance of payments fell for some countries. If a country's exchange rate depreciates in response to the U.S. expansion (the interest rate effect dominating), then, as noted above, the initial effect on the balance of payments is likely to be negative (the J-curve effect).

The results at the bottom of table 1 are for the U.S. model alone. In this case the rest of the world is exogenous. The results show that the

properties of the U.S. model are not very sensitive to the treatment of the rest of the world. The increase in the GNP deflator is somewhat less in this case, which is due to the fact that U.S. import prices did not rise. In the complete model U.S. import prices rose because of the general depreciation of the U.S. dollar.

United States Interest Rate Increase (Table 2)

For this experiment the U.S. interest rate reaction function is dropped and the U.S. interest rate is taken to be exogenous. The results of an increase in the U.S. interest rate are presented in table 2. This increase lowered U.S. income and imports and led to a general contraction in world income and exports (trade multiplier effect).

The interest rate increase also led to a depreciation of the other countries' exchange rates. The depreciation of the German exchange rate after six quarters, for example, was 3.63 percent. This depreciation was also due in part to the increase in the U.S. balance of payments relative to those of other countries. The depreciation led to an increase in other countries' import prices and then to their GNP deflators. The U.S. interest rate increase thus led to a general increase in other countries' inflation rates through the depreciation of their exchange rates. The U.S. inflation rate was little changed: The positive direct effect of interest rates on inflation was offset by the negative effects on inflation from the fall in U.S. import prices (due to the appreciation of the dollar) and the fall in U.S. income.

The balance of payments of some countries (other than the United States) increased. In these cases the change in export revenue (export price times exports) was greater than the change in import costs (import price times imports). In all cases export prices rose and exports fell, and in almost all cases import prices rose and imports fell.

The results at the bottom of table 2 for the United States alone again show that the properties of the U.S. model are not very sensitive to the treatment of the rest of the world. The increase in the GNP deflator is greater in this case because import prices did not fall.

German Spending Increase (Table 3)

This experiment corresponds to an increase in German government spending on German goods. As in the U.S. case, it led to a worldwide increase in exports and income. The increase in income led to a fairly large increase in the GNP deflator after six quarters (1.87 percent). This increase and the increase in income led to a large increase in the interest rate through the reaction function (3.02 percentage points after six quarters). The negative interest rate effect on the exchange

TABLE 2

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 1 PERCENTAGE POINT INCREASE IN THE U.S. SHORT-TERM INTEREST RATE (Initial Change in 1976I)

Country	Real GNP 2	Real GNP 6	GNP Deflator 2	GNP Deflator 6	Short-Term Interest Rate 2	Short-Term Interest Rate 6	Exchange Rate 2	Exchange Rate 6	Import Price 2	Import Price 6	Money Supply 2	Money Supply 6	Imports 2	Imports 6
U.S.	-.42	-1.61	.06	.04	1.00	1.00	...	...	-.15	-.60	-.48	-1.37	-.40	-2.11
Canada	-.09	-.66	.07	.15	.58	.88	.03	.08	-.01	-.16	-.55	-2.06	-.08	-.91
Japan	-.02	-.13	.00	.07	.01	.11	.34	2.59	.28	2.34	-.01	-.06	-.04	-.64
Austria	.07	-.04	.16	.68	.00	.00	1.84	4.12	.99	1.86	.06	.32	-.08	-.24
Belgium	.10	.06	.07	.38	.06	.07	1.12	3.01	.64	1.56	.01	.12	-.14	-.65
Denmark	-.05	-.39	-.01	-.02	-.06	-.26	.63	1.89	-.06	.24	.00	-.11	.02	-.14
France	.00	.01	.01	.19	.41	.85	.80	2.98	.31	1.59	-.09	-.41	-.09	-.65
Germany	.04	-.13	.03	.26	.24	.46	1.36	3.63	1.04	2.61	-.16	-.46	-.02	-.57
Italy	-.04	-.35	.01	.36	.06	.61	.56	2.84	.12	1.57	-.01	-.27	-.04	-.56
Netherlands	-.07	-.38	.02	.17	.77	.61	1.12	3.07	.68	1.66	-.87	-.78	-.20	-.89
Norway	-.04	-.20	.02	.09	.05	.02	.72	1.77	.12	.17	-.01	-.09	-.04	-.25
Sweden	.08	.13	.09	.83	.34	.81	1.73	3.40	1.25	1.92	.00	.23	.07	-.40
Switzerland	.25	.93	.07	.62	.23	.43	2.96	7.16	2.41	5.41	-.16	-.57	-.14	-.45
U.K.	-.03	-.12	.00	.16	-.00	-.01	.57	3.56	.25	2.60	-.01	.02	-.04	-.24
Finland	.02	-.01	.09	.67	-.01	-.03	1.72	5.34	1.00	3.45	.03	.49	-.13	-.49
U.S. Alone	-.41	-1.52	.07	.14	1.00	1.00	...	...	.00	.00	-.48	-1.34	-.40	-2.11

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-Term Interest Rate 2	Long-Term Interest Rate 6	Export Price 2	Export Price 6	Exports 2	Exports 6	Balance of Payments* 2	Balance of Payments* 6
U.S.	-.52	-1.59	-.55	-3.96	.24	.49	.05	.05	-.17	-.89	292.688	1619.244
Canada	-.11	-.56	-.07	-.53	.19	.40	.07	.15	-.40	-2.17	-47.515	-217.929
Japan	-.01	-.10	-.00	-.11	...	...	.22	1.71	-.19	-.89	-20.645	-94.284
Austria	.05	-.01	.06	.07	...	...	1.22	2.82	.00	-.48	.271	.728
Belgium	.05	.05	.07	.08	.01	.03	.62	1.72	-.07	-.65	.601	2.339
Denmark	-.03	-.29	-.06	-.53	-.01	-.06	.30	.92	-.09	-.63	.118	.150
France	-.01	-.06	-.00	.02	.10	.31	.38	1.46	-.07	-.45	.178	.174
Germany	-.04	-.27	.08	-.30	.07	.20	.28	.80	.14	-.08	-.848	-2.028
Italy	-.02	-.28	-.07	-.83	.01	.17	.36	1.94	-.16	-.69	28.986	96.506
Netherlands	-.13	-.48	-.08	-.41	.14	.26	.93	2.55	-.14	-.83	.231	.673
Norway	-.03	-.16	...	...	.01	.02	.63	1.55	-.16	-.81	.142	.394
Sweden	.04	.09	.07	.10	.05	.20	.45	1.17	.23	-.19	-.337	-.336
Switzerland	-.03	.15	.58	2.88	.08	.29	.85	2.24	.47	.50	-.172	-.482
U.K.	-.02	-.16	-.02	-.09	-.00	.01	.18	1.19	-.10	-.24	-21.137	-340.306
Finland	.01	.03	.02	.01	...	...	1.44	4.59	-.08	-.63	57.422	88.857
U.S. Alone	...	...	-.53	-3.77	.24	.49	.06	.15	.00	.00	290.646	1716.370

*Change is absolute change, not percentage change, in units of local currency.

was larger than the positive price and balance of payments effects in that the German exchange rate appreciated. The German exchange rate has a positive effect on the exchange rates of the other European countries, and this resulted in an appreciation of the other European rates. For a few countries, such as Italy, the appreciation resulted in a fall in the GNP deflator (through the fall in import prices).

German Interest Rate Increase (Table 4)

For this experiment the German interest rate reaction function was dropped and the German interest rate was taken to be exogenous. The results of an increase in the German rate are presented in table 4.

TABLE 3

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 1 PERCENT AUTONOMOUS INCREASE IN GERMAN REAL GNP (Initial Change in 1976I)

Country	Real GNP		GNP Deflator		Short-Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.02	.02	.01	.04	.01	.02	...	...	.10	.10	-.00	-.01	.01	.02
Canada	.02	.04	.00	.06	.00	.02	-.00	.00	.06	.07	-.00	-.01	.02	.07
Japan	.03	.08	-.00	-.02	-.01	-.02	-.00	.01	.04	.05	.01	.05	-.00	.04
Austria	.20	.37	-.02	.09	.01	.12	-.89	-.08	-.32	.36	.05	.22	.37	.42
Belgium	.36	.44	-.02	.13	.20	.50	-.68	.06	-.33	.34	.01	-.03	.60	.64
Denmark	.19	.40	.00	.11	.03	.26	-.48	.03	-.05	.39	.11	.22	.15	.15
France	.21	.42	-.01	-.07	.46	1.59	-.63	-.34	-.29	-.09	-.04	-.59	.18	.29
Germany	2.26	2.21	.29	1.87	1.29	3.02	-.95	-.05	-.77	.04	.58	.24	2.78	2.21
Italy	.19	.44	-.01	-.18	-.11	-.17	-.45	-.50	-.14	-.28	.05	.35	.21	.74
Netherlands	.51	.43	.01	.10	.50	.62	-.76	-.06	-.44	.20	-.10	-.18	.76	.86
Norway	.12	.14	.04	.40	.51	1.33	-.40	-.70	-.06	-.38	.09	.35	.04	-.41
Sweden	.09	.19	.01	.21	.23	.65	-.73	-.82	-.41	-.58	-.01	-.07	.06	-.18
Switzerland	.12	.31	.00	.05	-.01	.04	-.86	.07	-.46	.38	.01	-.01	.29	.67
U.K.	.10	.13	.00	-.03	.01	.03	-.40	-.49	-.20	-.34	.04	.06	.14	.27
Finland	.15	.24	.02	.07	.00	.01	-.37	-.41	.05	-.03	.06	.33	.20	.38

Country	Consumption		Investment		Long-Term Interest Rate		Export Price		Exports		Balance of Payments*	
	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.00	-.01	.03	.10	.00	.01	.01	.04	.29	.33	38.908	68.546
Canada	.00	.01	.02	.03	.00	.01	.00	.05	.13	.13	4.066	1.795
Japan	.01	.05	.01	.10	...	...	-.00	-.01	.20	.22	7.175	6.218
Austria	.12	.22	.27	.44	...	...	-.58	-.03	.87	.90	-.002	-.171
Belgium	.20	.26	.27	.48	.02	.11	-.38	.07	.97	.93	.525	-.472
Denmark	.13	.31	.21	.57	.01	.06	-.24	.03	.57	.56	-.009	-.048
France	.06	.17	.27	.79	.10	.54	-.31	-.17	.70	.70	.247	.212
Germany	.83	.87	5.10	4.31	.36	1.24	-.07	.71	.01	.13	-1.071	-.622
Italy	.07	.31	.38	1.24	-.02	-.08	-.30	-.37	.79	.69	14.832	-23.718
Netherlands	.25	.33	.57	.48	.09	.22	-.62	-.03	1.24	1.09	.039	-.041
Norway	.03	-.18	...	...	.06	.33	-.36	-.61	.54	.44	-.026	.075
Sweden	.04	.12	.08	.15	.04	.15	-.18	-.11	.35	.22	.096	.204
Switzerland	.05	.20	.28	.96	-.00	.02	-.25	.05	.52	.68	.022	-.046
U.K.	.06	.14	.06	.10	.00	.01	-.13	-.17	.37	.37	12.088	23.959
Finland	.07	.22	.13	.33	...	...	-.30	-.32	.46	.41	-15.995	-28.681

*Change is absolute change, not percentage change, in units of local currency.

This increase lowered German income and imports and led to a general contraction in world exports and income.

The relative increase in the German interest rate and balance of payments led to an appreciation of the mark, which led to an appreciation of the other European currencies. The price deflator of Germany and of most of the other European countries was lower because of the appreciation and of the fall in income.

German Exchange Rate Increase (Table 5)

For this experiment the German exchange rate reaction function was dropped and the German exchange rate was taken to be exogenous.

TABLE 4

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 1 PERCENTAGE POINT INCREASE IN THE GERMAN SHORT-TERM INTEREST RATE (Initial Change in 1976I)

Country	Real GNP		GNP Deflator		Short-Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.00	-.03	.02	.16	.00	.02	...	...	.19	.97	.00	.00	-.02	-.20
Canada	.01	.02	.00	.08	.01	.06	-.00	-.02	.10	.57	-.00	-.06	.00	-.05
Japan	.01	.04	.00	.01	.00	.02	-.02	-.21	.05	.18	.00	.03	-.01	-.04
Austria	-.14	-.49	-.10	-1.02	.00	-.07	-1.85	-6.94	-.83	-3.12	-.06	-.62	-.03	-.42
Belgium	-.35	-1.25	-.11	-.84	-.21	-.95	-1.55	-5.81	-.91	-3.26	-.02	-.27	-.03	-.31
Denmark	-.11	-.27	-.01	-.16	-.02	.21	-.98	-3.95	-.21	-1.06	-.06	-.53	-.03	-.40
France	-.13	-1.06	-.01	-.40	.41	.12	-1.23	-5.91	-.60	-3.50	-.12	-.70	.01	-.11
Germany	-.37	-.99	-.04	-.61	1.00	1.00	-1.91	-7.07	-1.54	-5.51	-1.26	-2.73	-.97	-2.76
Italy	-.03	-.11	-.02	-.53	-.06	-.80	-.83	-4.90	-.25	-2.63	-.00	.09	-.03	-.07
Netherlands	-.21	-.70	-.03	-.52	-.18	-.97	-1.57	-6.05	-.97	-3.63	-.00	-.03	-.09	-.46
Norway	.00	.07	.04	.31	.45	.73	-.65	-2.81	-.02	-.14	.01	.25	-.09	-.45
Sweden	-.06	-.28	.02	-.13	.19	-.01	-1.20	-4.33	-.60	-1.77	-.08	-.29	-.18	-.52
Switzerland	-.19	-1.25	-.03	-.47	-.03	-.25	-1.89	-8.02	-1.16	-5.28	.01	.17	-.23	-1.17
U.K.	-.04	-.32	-.01	-.30	-.00	-.05	-.82	-5.66	-.43	-4.14	-.01	-.28	-.05	-.46
Finland	-.00	-.12	.01	-.25	.01	.06	-.74	-4.76	.01	-1.77	.01	-.23	-.02	-.11

Country	Consumption		Investment		Long-Term Interest Rate		Export Price		Exports		Balance of Payments*	
	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-.00	-.06	.00	-.05	.00	.01	.02	.15	.05	.17	-95.370	-531.831
Canada	.00	-.01	.01	.01	.00	.02	.00	.07	.04	.04	-18.916	-133.422
Japan	.00	.01	.00	.03	...	...	-.01	-.13	.05	.19	-2.372	-14.143
Austria	-.08	-.34	-.21	-.61	...	...	-1.22	-4.84	-.34	-1.06	-.600	-1.954
Belgium	-.18	-.81	-.25	-1.19	-.02	-.19	-.87	-3.46	-.35	-1.04	-1.961	-8.078
Denmark	-.07	-.21	-.11	-.39	-.00	.05	-.48	-1.99	-.22	-.72	-.151	-.408
France	-.05	-.57	-.17	-1.70	.10	.11	-.59	-3.02	-.26	-1.03	-.404	-.544
Germany	-.45	-1.10	-.83	-2.10	.31	.49	-.40	-1.72	-.41	-1.57	2.037	6.211
Italy	-.00	.11	-.07	-.33	-.01	-.21	-.54	-3.40	-.17	-.63	-75.356	-346.601
Netherlands	-.09	-.52	-.24	-.76	-.03	-.29	-1.30	-5.13	-.30	-.80	-.363	-1.229
Norway	-.04	-.15	...	...	.06	.20	-.57	-2.47	-.02	-.03	-.167	-.728
Sweden	-.02	-.14	-.05	-.23	.04	.01	-.28	-1.13	-.29	-1.00	.111	.146
Switzerland	-.05	-.54	-.43	-3.55	-.01	-.12	-.55	-2.62	-.50	-1.97	.046	.377
U.K.	-.02	-.14	-.01	-.23	-.00	-.03	-.26	-2.02	-.13	-1.14	23.827	413.528
Finland	.00	-.11	-.00	-.13	...	...	-.61	-4.04	-.03	-.12	-90.883	-334.640

*Change is absolute change, not percentage change, in units of local currency.

The results in table 5 are for an increase in the exchange rate of 10 percent (a depreciation).

It was argued in Section III that the initial effect of a depreciation on the balance of payments is likely to be negative, and this is the case for Germany in table 5, even after six quarters. The depreciation led to an increase in GNP. As noted in Section III, the effect of a depreciation on GNP can go either way. In this case the negative effect from the fall in the balance of payments (the asset effect) was more than offset by the positive effects from the rise in the price of imports and the relative fall in the price of exports. The depreciation of the German exchange rate led to a decrease in the U.S. GNP

TABLE 5

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 10 PERCENT INCREASE IN THE GERMAN EXCHANGE RATE (Depreciation) (Initial Change in 1976I)

Country	Real GNP 2	Real GNP 6	GNP Deflator 2	GNP Deflator 6	Short-Term Interest Rate 2	Short-Term Interest Rate 6	Exchange Rate 2	Exchange Rate 6	Import Price 2	Import Price 6	Money Supply 2	Money Supply 6	Imports 2	Imports 6
U.S.	-.03	.05	-.12	-.36	-.04	-.05	.00	.00	-.96	-1.42	-.00	-.01	.12	.39
Canada	-.06	-.06	-.04	-.27	-.04	-.13	.01	.05	-.54	-.93	.02	.14	-.02	.06
Japan	-.07	-.17	.00	.00	.01	-.00	.14	.33	-.25	-.25	-.03	-.12	.04	.02
Austria	.40	-.02	.92	2.10	.01	.05	9.81	9.90	4.25	4.07	.34	1.19	-.16	.04
Belgium	1.15	.65	.70	1.73	.85	.60	8.13	7.94	4.55	3.74	.15	.68	-.60	-.73
Denmark	.31	-.50	.16	.36	.18	-.85	5.34	5.57	1.41	1.20	.16	.73	-.28	.49
France	.48	1.63	.15	1.36	.75	1.82	7.38	10.77	4.02	6.92	-.07	.26	-.62	-.84
Germany	.72	.20	.37	1.63	.58	1.28	10.00	10.00	7.79	7.13	.21	.07	.91	-.52
Italy	-.13	-.68	.19	2.27	.67	2.68	5.32	10.74	2.25	7.12	-.06	-1.14	-.20	-1.57
Netherlands	.34	.06	.29	1.15	.30	.45	8.49	8.57	5.21	4.63	.17	.50	-.47	-.66
Norway	-.18	-.32	-.10	.03	-.14	-.04	3.05	4.08	-.07	.16	-.19	-.23	-.15	-.12
Sweden	.12	.31	.09	1.02	.35	.88	5.16	6.27	1.91	2.19	.02	.40	.14	-.24
Switzerland	.83	2.13	.21	1.37	.28	.56	10.83	13.45	6.67	8.36	-.13	-.56	.49	.87
U.K.	.08	.25	.05	1.20	-.00	.10	5.36	13.89	3.35	11.38	.03	.74	.08	.22
Finland	-.16	-.05	.03	1.04	-.04	-.11	4.80	10.57	1.04	5.76	-.16	.63	-.35	-.51

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-Term Interest Rate 2	Long-Term Interest Rate 6	Export Price 2	Export Price 6	Exports 2	Exports 6	Balance of Payments* 2	Balance of Payments* 6
U.S.	.03	.15	-.05	.04	-.02	-.05	-.11	-.35	-.57	-.72	121.244	146.629
Canada	-.00	.02	-.05	-.04	-.01	-.06	-.03	-.25	-.29	-.14	39.711	85.448
Japan	-.02	-.08	-.03	-.19	...	...	.09	.21	-.47	-.53	-4.703	-.282
Austria	.28	.03	.33	-.09	...	...	6.48	6.89	.33	-.43	1.280	1.180
Belgium	.66	.56	.88	.69	.12	.23	4.52	4.75	.25	-.51	3.194	6.367
Denmark	.19	-.32	.32	-.54	.03	-.20	2.60	2.72	.19	-.28	.281	.160
France	.14	.83	.63	2.92	.17	.67	3.54	5.36	.41	.28	.353	-.604
Germany	.23	-.39	1.62	.25	.16	.56	2.05	2.54	1.46	1.03	-3.517	-2.246
Italy	-.14	-1.01	-.27	-1.67	.13	.87	3.51	7.60	-.24	-.27	101.246	248.632
Netherlands	.21	.33	.39	.07	.07	.30	7.00	7.27	-.22	-1.07	.749	.817
Norway	-.10	-.23	.00	.00	-.02	-.01	2.68	3.57	-.67	-.91	.421	.544
Sweden	.05	.19	.11	.25	.05	.23	1.25	1.93	.39	.29	-.117	.027
Switzerland	.20	.96	1.94	6.92	.08	.35	3.04	4.32	1.62	1.48	-.194	-.350
U.K.	.03	-.28	.01	.22	.00	.11	1.69	4.90	.32	1.71	-152.676	-671.156
Finland	-.09	.03	-.15	-.08	...	...	3.96	9.00	-.56	-.70	186.903	184.915

*Change is absolute change, not percentage change, in units of local currency.

deflator. This was due to the fall in the U.S. price of imports, which was due to the general appreciation of the dollar.

United Kingdom Spending Increase (Table 6)

This experiment corresponds to an increase in U.K. government spending on U.K. goods. In the German case in table 3 the increase in spending led to an appreciation of the mark because of the large relative increase in the German interest rate. In the U.K. case in table 6 the increase in spending led to a depreciation of the pound. The U.K. interest rate did rise in response to the U.K. expansion, but the negative interest rate effect on the exchange rate was dominated by the positive price and balance-of-payments effects.

TABLE 6

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 1 PERCENT AUTONOMOUS INCREASE IN U.K. REAL GNP (Initial Change in 1976I)

Country	Real GNP		GNP Deflator		Short-Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.01	.03	-.00	-.01	.00	.01	...	...	-.02	-.07	-.00	-.00	.01	.06
Canada	.02	.05	.00	.02	-.00	-.00	.00	.01	-.01	-.05	.01	.03	.02	.12
Japan	.01	.04	-.00	-.01	-.01	-.02	.00	.07	.00	.05	.00	.02	.00	.02
Austria	.05	.07	.01	-.02	.00	.02	-.04	-.22	-.04	-.17	.02	.04	.08	.14
Belgium	.11	.10	.00	-.01	.06	.07	-.04	-.18	-.06	-.27	.00	.01	.16	.33
Denmark	.25	.01	.01	-.05	.02	-.17	-.04	-.16	-.08	-.33	.15	.17	.18	.52
France	.09	.15	.00	-.02	.00	.02	-.03	-.17	-.04	-.22	.01	.07	.07	.27
Germany	.09	.14	.01	.07	.04	.13	-.05	-.22	-.06	-.28	.02	.04	.10	.18
Italy	.05	.12	-.00	-.06	-.03	-.06	-.02	-.15	-.02	-.16	.01	.09	.05	.23
Netherlands	.15	.13	.01	.02	.15	.19	-.04	-.18	-.05	-.28	-.03	-.06	.21	.32
Norway	.22	.20	-.01	-.04	.02	-.00	-.01	-.07	-.04	-.20	.14	.13	.25	.46
Sweden	.12	.14	-.00	-.05	-.01	-.08	.00	-.04	-.03	-.22	.04	.19	.16	.33
Switzerland	.08	.10	.01	.02	.00	-.01	-.03	-.15	-.06	-.36	.00	.02	.15	.33
U.K.	1.65	1.25	.06	.58	.16	.43	.70	3.26	.70	3.27	.68	1.08	2.54	2.30
Finland	.15	.23	.00	.01	-.00	-.01	-.01	-.07	-.04	-.26	.06	.27	.23	.53

Country	Consumption		Investment		Long-Term Interest Rate		Export Price		Exports		Balance of Payments*	
	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.00	.01	.02	.08	.00	.00	-.00	-.01	.16	.24	48.079	79.524
Canada	.00	.03	.02	.04	-.00	-.00	.00	.02	.17	.18	16.692	18.694
Japan	.00	.03	.00	.04	...	...	.00	.04	.09	.15	3.941	6.157
Austria	.03	.04	.07	.09	...	...	-.03	-.14	.21	.25	.033	.037
Belgium	.06	.10	.08	.11	.01	.02	-.02	-.10	.26	.36	.375	.704
Denmark	.16	.04	.27	.07	.01	-.04	-.02	-.08	.64	.55	.068	.040
France	.03	.10	.12	.29	.00	.01	-.01	-.09	.26	.30	.151	.130
Germany	.03	.08	.20	.28	.01	.05	-.01	-.02	.21	.25	.108	.245
Italy	.02	.08	.10	.32	-.01	-.03	-.01	-.11	.21	.27	11.219	5.291
Netherlands	.07	.12	.17	.15	.03	.07	-.03	-.14	.34	.38	.035	.053
Norway	.13	.18	...	...	.00	.00	-.01	-.06	.92	1.00	.068	.075
Sweden	.05	.11	.10	.11	-.00	-.02	.00	-.03	.45	.52	.065	.089
Switzerland	.03	.10	.18	.33	.00	-.00	-.00	-.04	.23	.26	.013	.029
U.K.	1.08	.62	1.41	.91	.03	.19	.26	1.35	.27	.90	-218.788	-382.145
Finland	.07	.22	.13	.32	...	...	-.00	-.06	.50	.52	17.573	16.685

*Change is absolute change, not percentage change, in units of local currency.

The other European exchange rates appreciated relative to the dollar, though only slightly. This is due primarily to the balance-of-payments effect on the exchange rate. The European countries benefited more from the U.K. expansion than did the United States with respect to the increase in exports, and so their balance of payments improved more.

United Kingdom Exchange Rate Increase (Table 7)

For this experiment the U.K. exchange rate reaction function was dropped and the U.K. exchange rate was taken to be exogenous. The results in table 7 are for an increase in the exchange rate of 10 percent (a depreciation).

TABLE 7

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 10 PERCENT INCREASE IN THE U.K. EXCHANGE RATE (Depreciation) (Initial Change in 1976I)

Country	Real GNP		GNP Deflator		Short-Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.00	.02	-.04	-.09	-.01	-.01	.00	.00	-.30	-.29	-.00	-.00	.06	.11
Canada	-.01	-.00	-.02	-.08	-.02	-.03	.00	.01	-.23	-.24	.01	.05	.02	.07
Japan	-.02	-.02	.00	-.00	.00	-.00	.06	.08	-.04	-.02	-.01	-.02	.01	-.00
Austria	-.06	-.09	-.07	-.18	-.01	-.03	.02	.01	-.27	-.26	-.04	-.13	-.02	-.01
Belgium	-.16	-.14	-.09	-.24	-.21	-.29	-.04	-.02	-.57	-.53	-.02	.05	.05	.15
Denmark	-.21	-.73	-.10	-.40	-.34	-.60	-.13	-.19	-.92	-.94	.04	-.40	.30	.33
France	-.08	-.21	-.03	-.11	-.07	-.12	.03	-.06	-.36	-.43	-.01	-.09	.04	-.06
Germany	-.06	-.06	-.02	-.08	-.04	-.10	.05	.02	-.26	-.30	-.01	-.00	-.07	-.03
Italy	-.04	-.10	-.04	-.13	-.05	-.06	.02	-.03	-.27	-.29	-.01	-.03	-.02	-.03
Netherlands	-.06	-.05	-.03	-.12	-.08	-.11	.02	.01	-.42	-.51	.00	-.03	-.02	.01
Norway	.03	-.12	-.17	-.28	-.15	-.20	.05	.09	-.58	-.51	-.09	-.31	.08	.09
Sweden	-.00	-.12	-.07	-.39	-.25	-.42	.27	.24	-.48	-.48	.02	-.11	.03	.16
Switzerland	-.07	-.27	-.03	-.17	-.06	-.12	-.02	-.13	-.80	-.98	.03	.14	.04	.08
U.K.	.62	-.15	.48	2.13	.07	.15	10.00	10.00	9.96	9.95	.39	1.24	.88	-.66
Finland	-.06	-.17	-.10	-.28	-.01	-.02	-.01	-.11	-.75	-.90	-.08	-.36	.08	.00

Country	Consumption		Investment		Long-Term Interest Rate		Export Price		Exports		Balance of Payments*	
	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.01	.04	-.00	.05	-.00	-.01	-.04	-.08	-.07	-.09	60.629	23.397
Canada	.00	.02	-.01	-.00	-.01	-.02	-.02	-.08	.00	.00	27.579	18.121
Japan	-.01	-.01	-.01	-.03	...	...	.04	.05	-.09	-.06	-.737	.970
Austria	-.04	-.04	-.04	-.08	...	...	-.01	-.04	-.10	-.14	.147	.167
Belgium	-.06	.12	-.12	-.13	-.02	-.07	-.05	-.08	-.09	-.16	1.776	1.227
Denmark	-.12	-.56	-.21	-1.04	-.06	-.15	-.08	-.15	.02	-.25	.136	.102
France	-.03	-.12	-.11	-.39	-.01	-.04	-.01	-.09	-.07	-.14	.263	.354
Germany	-.02	-.00	-.12	-.11	-.01	-.04	-.00	-.03	-.09	-.14	.170	.112
Italy	-.01	-.03	-.08	-.28	-.01	-.03	-.01	-.08	-.10	-.13	22.333	16.989
Netherlands	-.03	.07	-.07	-.05	-.02	-.05	.01	-.02	-.06	-.16	.136	.152
Norway	.03	-.01	.00	.00	-.02	-.06	.04	.06	.17	-.33	.133	.081
Sweden	-.01	-.06	-.01	-.11	-.04	-.10	.02	-.14	.06	-.07	.137	.057
Switzerland	-.00	-.05	-.17	-.85	-.02	-.08	-.03	-.15	-.08	-.14	.073	.087
U.K.	.27	-1.10	.56	-.15	.03	.21	3.33	4.29	2.11	1.77	-602.759	-481.566
Finland	-.03	-.11	-.05	-.21	...	...	-.04	-.18	.00	-.18	48.812	58.345

*Change is absolute change, not percentage change, in units of local currency.

In this case the depreciation led to an initial rise in GNP and then to a fall after six quarters. This is contrary to the German case in table 5, where there was still a slight rise after six quarters. Unlike in the German case, the effects on the other European exchange rates were slight. The depreciation led, as in the German case, to a decrease in the U.S. GNP deflator, though the effects in the U.K. case were smaller.

Japanese Spending Increase (Table 8)

This experiment corresponds to an increase in Japanese government spending on Japanese goods. The interesting result in this case is that the increase had only a small effect on the rest of the world. The

TABLE 8

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 1 PERCENT AUTONOMOUS INCREASE IN JAPANESE REAL GNP (Initial Change in 1976I)

Country	Real GNP 2	Real GNP 6	GNP Deflator 2	GNP Deflator 6	Short-Term Interest Rate 2	Short-Term Interest Rate 6	Exchange Rate 2	Exchange Rate 6	Import Price 2	Import Price 6	Money Supply 2	Money Supply 6	Imports 2	Imports 6
U.S.	.00	.01	-.00	-.01	-.00	.00	...	...	-.01	-.07	-.00	-.00	.01	.03
Canada	.00	.01	-.00	-.00	-.00	-.00	.00	.01	-.01	-.02	.00	.00	.00	.03
Japan	1.18	2.34	.01	.11	.02	.16	.25	1.11	.25	1.10	.51	1.78	.24	.69
Austria	-.00	-.00	-.00	-.00	-.00	-.00	.00	.07	-.00	.01	-.00	-.00	.00	-.00
Belgium	-.00	.01	-.00	-.00	-.00	-.00	.00	.06	-.00	.01	-.00	.00	-.00	.01
Denmark	-.00	.00	-.00	-.00	-.00	-.01	.00	.05	-.00	-.00	.00	.00	.00	.01
France	.00	.01	-.00	-.00	-.00	.01	.00	.09	-.00	.05	-.00	-.00	.00	-.00
Germany	-.00	.01	-.00	.00	.00	.01	.00	.09	-.00	.05	-.00	.00	-.00	.01
Italy	-.00	.00	-.00	.00	-.00	.01	.00	.08	-.00	.04	-.00	.00	.00	.00
Netherlands	-.00	.00	-.00	-.00	-.00	.01	.00	.06	-.00	.01	-.00	-.01	-.00	.00
Norway	-.00	.00	-.01	-.01	-.00	-.01	.00	.03	-.01	-.05	-.00	-.01	.00	.01
Sweden	-.00	.01	-.00	-.00	-.00	-.00	.00	.07	-.00	.03	-.00	.00	.00	.01
Switzerland	.00	.02	.00	.00	-.00	.00	.00	.11	-.00	.06	-.00	-.00	.00	.03
U.K.	-.00	.01	-.00	-.00	-.00	.00	.00	.06	-.00	.03	-.00	.00	-.00	.02
Finland	-.00	.00	-.00	-.00	-.00	-.00	.00	.06	-.00	.01	-.00	-.00	.00	-.00

Country	Consumption 2	Consumption 6	Investment 2	Investment 6	Long-Term Interest Rate 2	Long-Term Interest Rate 6	Export Price 2	Export Price 6	Exports 2	Exports 6	Balance of Payments* 2	Balance of Payments* 6
U.S.	.00	.01	.00	.03	-.00	.00	-.00	-.01	.02	.08	18.418	40.624
Canada	.00	.00	.00	.01	-.00	-.00	-.00	.00	.02	.07	2.576	9.527
Japan	.32	1.10	.51	2.87	...	...	.17	.80	.03	.12	-10.984	-37.917
Austria	-.00	-.00	-.00	-.01	...	...	.00	.05	.00	.01	.002	.027
Belgium	-.00	.01	-.00	.00	-.00	-.00	.00	.03	.00	.01	.021	.116
Denmark	.00	-.00	.00	.00	-.00	-.00	-.00	.02	.01	.02	.002	.006
France	.00	.00	.00	.01	-.00	.00	-.00	.03	.00	.02	.002	.020
Germany	-.00	.00	.00	.02	-.00	.00	.00	.02	.00	.03	.004	-.001
Italy	.00	-.00	.00	.00	-.00	.00	-.00	.04	.00	.01	.212	3.155
Netherlands	-.00	.00	-.00	.00	-.00	.00	.00	.05	.00	.00	.002	.013
Norway	.00	.00	...	...	-.00	-.00	.00	.02	.00	.01	.006	.015
Sweden	.00	.00	.00	.01	-.00	-.00	.00	.01	.00	.03	.001	.004
Switzerland	.00	.01	.00	.04	-.00	.00	.00	.02	.01	.04	.001	.001
U.K.	-.00	.01	-.00	.01	-.00	.00	-.00	.02	.00	.03	.621	.607
Finland	-.00	-.00	-.00	-.00	...	...	-.00	.05	.00	.01	.248	3.956

*Change is absolute change, not percentage change, in units of local currency.

increase in Japanese imports was fairly small, and so there was a small trade multiplier effect. The increase in imports was small in part because of the increase in the price of Japanese imports relative to the GNP deflator. This led to a substitution away from imported goods. The increase in the price of imports was due to the depreciation of the yen. Unlike the German case (but like the U.K. case), the exchange rate depreciated in response to the expansion: In this case the positive balance-of-payments effect dominated.

Japanese Exchange Rate Increase (Table 9)

For this experiment the Japanese exchange rate reaction function was dropped and the Japanese exchange rate was taken to be exogenous.

TABLE 9

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 10 PERCENT INCREASE IN THE JAPANESE EXCHANGE RATE (Depreciation) (Initial Change in 1976I)

Country	Real GNP		GNP Deflator		Short-Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-.01	.01	-.07	-.19	-.02	-.03	...	...	-.57	-.70	-.00	-.00	.09	.17
Canada	-.04	-.07	-.02	-.12	-.01	-.04	.01	.03	-.19	-.30	.00	.03	-.02	-.07
Japan	.30	.98	.07	.08	.15	-.04	10.00	10.00	9.97	9.91	.13	.73	-1.90	-3.87
Austria	-.03	-.06	-.01	-.04	-.00	-.02	.13	.57	-.04	.10	-.01	-.05	-.03	-.05
Belgium	-.05	-.06	-.01	-.04	-.05	-.13	.12	.42	-.04	.04	-.00	.03	-.05	-.03
Denmark	-.07	-.15	-.01	-.05	-.03	-.12	.12	.36	-.08	-.06	-.03	-.07	-.02	-.01
France	-.03	-.02	-.00	.02	-.00	.02	.18	.72	.05	.39	-.01	-.02	-.02	-.12
Germany	-.04	-.03	-.01	-.02	-.02	-.04	.20	.64	.04	.31	-.01	.00	-.05	-.03
Italy	-.03	-.07	-.00	.07	.02	.13	.15	.64	.02	.33	-.01	-.08	-.03	-.12
Netherlands	-.05	-.04	-.01	-.02	-.06	-.08	.11	.49	-.06	.11	.02	.03	-.06	-.08
Norway	-.03	-.06	-.10	-.19	-.08	-.14	.05	.24	-.42	-.43	-.09	-.19	-.02	.02
Sweden	-.03	-.04	-.01	-.05	-.03	-.05	.14	.53	-.03	.14	-.01	-.05	-.04	-.03
Switzerland	-.05	-.08	-.01	-.03	-.01	-.03	.19	.70	-.01	.26	.00	.02	-.08	-.14
U.K.	-.04	-.04	-.01	-.01	-.00	-.01	.09	.56	-.06	.23	-.02	-.03	-.07	-.07
Finland	-.04	-.09	-.02	-.04	-.00	-.01	.06	.44	-.13	.01	-.02	-.12	-.04	-.11

Country	Consumption		Investment		Long-Term Interest Rate		Export Price		Exports		Balance of Payments*	
	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	.02	.07	-.02	-.02	-.01	-.03	-.07	-.19	-.31	-.59	76.804	-1.875
Canada	-.00	-.01	-.03	-.06	-.00	-.02	-.01	-.11	-.21	-.29	5.691	5.811
Japan	.02	.39	.10	1.03	...	...	6.40	6.40	.87	.78	-50.505	62.755
Austria	-.01	-.03	-.03	-.07	...	...	.07	.35	-.10	-.14	.048	.220
Belgium	-.03	.03	-.04	-.06	-.01	-.03	.06	.21	-.10	-.15	.319	1.095
Denmark	-.05	-.12	-.08	-.21	-.01	-.03	.04	.12	-.15	-.20	.011	.039
France	-.01	-.02	-.05	-.05	-.00	.00	.06	.28	-.09	-.08	.004	.088
Germany	-.01	-.01	-.08	-.06	-.01	-.02	.02	.11	-.08	-.08	-.000	-.127
Italy	-.01	-.07	-.05	-.17	.00	.04	.08	.39	-.12	-.15	1.078	18.909
Netherlands	-.02	.02	-.05	-.04	-.01	-.03	.09	.40	-.11	-.18	.041	.122
Norway	-.01	-.01	...	...	-.01	-.04	.04	.18	-.15	-.20	.082	.121
Sweden	-.01	-.03	-.03	-.03	-.00	-.01	.02	.08	-.11	-.11	.008	-.008
Switzerland	-.02	-.05	-.12	-.29	-.00	-.02	.03	.13	-.13	-.14	.006	.011
U.K.	-.03	-.03	-.04	-.03	-.00	-.01	.02	.15	-.15	-.15	5.127	-7.114
Finland	-.02	-.07	-.04	-.11	...	...	.04	.35	-.12	-.19	8.333	27.991

*Change is absolute change, not percentage change, in units of local currency.

The results in table 9 are for an increase in the exchange rate of 10 percent (a depreciation).

In this case, as in the German case, the depreciation led to an increase in GNP. The dominant effect on GNP in the Japanese case was the substitution away from imported goods due to the increase in the price of imports relative to the GNP deflator. Japan is the only main country in the model for which the import price index is not an explanatory variable in the equation for the GNP deflator (eq. [5]). No effects of import prices on domestic prices could be found in the Japanese case. An increase in the price of imports in Japan thus corresponds to a larger increase in the relative price of imports than is

TABLE 10

PERCENTAGE CHANGE IN THE VARIABLE AFTER TWO AND SIX QUARTERS INDUCED BY A SUSTAINED 50 PERCENT INCREASE IN THE PRICE OF EXPORTS OF THE OIL-EXPORTING COUNTRIES (Initial Change in 1976I)

	Real GNP		GNP Deflator		Short-Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports	
Country	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-.30	-1.16	1.22	2.96	.25	.02	...	...	9.98	10.80	.03	.21	-1.89	-4.53
Canada	-.19	-1.12	.33	1.10	.44	.80	-.16	-.71	4.42	3.59	-.37	-1.76	-.75	-3.48
Japan	.03	.41	.81	2.91	1.91	2.39	1.47	5.05	22.84	28.58	.06	1.53	-4.31	-12.88
Austria	.02	-.07	.50	.44	.04	.07	-1.37	-6.29	1.65	-.83	.12	.29	-.42	-.53
Belgium	-.04	-.59	.26	.58	.41	.65	-1.12	-4.80	2.08	1.25	.04	-.53	-.99	-2.17
Denmark	.13	.70	.19	.47	.72	1.54	-1.32	-4.47	.91	1.01	-.27	-.40	-.82	-1.83
France	.47	.94	.46	1.89	.91	.79	-1.69	-5.26	6.91	4.18	.10	.72	-1.47	-1.08
Germany	-.40	-.51	.10	.08	-.02	-.21	-1.47	-6.30	3.68	-.61	-.15	-.33	-.44	-1.19
Italy	-.24	.51	1.33	5.06	2.44	2.31	-.40	-1.60	9.79	11.32	-.31	-1.05	-1.40	-4.25
Netherlands	.13	-1.24	.43	1.26	.32	-.88	-1.21	-5.28	6.96	3.63	.10	.77	-1.02	-2.65
Norway	-.13	-.17	.78	1.40	.58	.90	-.50	-2.43	3.11	2.42	.42	.94	-.29	-1.57
Sweden	-.17	-.20	.14	.51	.58	.39	-2.25	-6.70	1.31	-1.74	-.11	-.10	-.33	-.95
Switzerland	-.27	-.71	-.03	-.44	.04	-.25	-2.91	-10.18	-1.11	-6.24	-.02	.11	-.48	-.18
U.K.	-.30	-.71	.32	1.30	-.01	-.12	-.94	-5.51	7.15	2.34	-.01	.38	-.51	-2.05
Finland	.10	.22	.45	1.08	.06	.17	-.84	-5.10	3.96	2.03	.20	1.12	-.68	-1.14

	Consumption		Investment		Long-Term Interest Rate		Export Price		Exports		Balance of Payments*	
Country	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-.45	-1.44	-.42	-2.91	.11	.22	1.10	2.85	-.83	-.79	-3043.052	-2213.703
Canada	-.12	-.95	-.15	-.90	.15	.40	.28	.91	-1.89	-4.99	-680.620	-612.397
Japan	-.61	-1.69	.01	.21	...	...	1.56	5.44	-.73	-.00	-1019.925	-615.189
Austria	.00	-.12	-.05	-.18	...	...	-.74	-3.96	-.51	-.54	-1.476	-1.931
Belgium	-.15	-1.61	-.03	-.58	.03	.17	-.53	-2.44	-.90	-1.01	-10.627	-14.010
Denmark	.06	.48	.12	.89	.13	.37	-.64	-2.16	-.70	-1.26	-.281	-.567
France	.17	.55	.64	1.84	.19	.39	-.73	-2.18	-.64	-.80	-6.471	-6.887
Germany	-.18	-.68	-.93	-1.00	-.01	-.06	-.25	-1.24	-.77	-.21	-3.079	-.154
Italy	-.50	-.85	-.51	.82	.53	1.22	.12	.39	-.64	.67	-960.986	-869.974
Netherlands	-.08	-2.58	.13	-1.35	.08	.04	-.90	-4.09	-.73	-.92	-2.546	-2.301
Norway	-.12	-.44	...	...	.08	.28	-.44	-2.12	-.63	-1.77	-.751	-.950
Sweden	-.06	-.13	-.14	-.15	.09	.14	-.48	-1.41	-.70	-1.16	-.527	.027
Switzerland	-.11	-.41	-.62	-2.29	.01	-.10	-.84	-3.15	-.75	-.17	-.023	.295
U.K.	-.37	-1.89	-.16	-.62	.01	.07	-.12	-1.04	-.62	.39	-725.363	-204.003
Finland	.05	-.01	.09	.27	...	...	-.56	-3.91	-.48	-.46	-326.593	-471.727

*Change is absolute change, not percentage change, in units of local currency.

the case in other countries. This is the main reason for the larger Japanese substitution response. The effect on the Japanese balance of payments was initially negative, as expected, but by six quarters the effect was positive. This is also due primarily to the Japanese substitution away from imported goods. The depreciation led, as in the German and U.K. cases, to a decrease in the U.S. GNP deflator.

Increase in the Price of Exports of the Oil-Exporting Countries (Table 10)

The oil-exporting countries in the model are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates,

and Venezuela. The price of exports is exogenous for these countries. The experiment corresponded to a 50 percent increase in the price of exports of all these countries.

This experiment approaches, if not exceeds, the aggregation limits of the model. There is no specific treatment of oil in the model other than the fact that almost all of the exports of the oil-exporting countries are oil. If the ability of countries to substitute away from oil is less than it is for other goods, the model has not adequately captured the effects of oil price changes. In particular, the degree of substitution implicit in the trade-share equations may be too high for oil. The trade-share equations were thus not used for this experiment, and the shares were taken to be exogenous. This may underestimate the degree of substitution possible, but it is probably closer to the truth than is the other case. At any rate, because of this problem, the results of this experiment should be interpreted with considerable caution.

Different countries were affected quite differently in this experiment. The exchange rates of all countries except Japan appreciated relative to the dollar. This is due in large part to the generally larger decrease in the U.S. balance of payments relative to the decreases for the other countries. The price of imports rose for most countries, as expected, though part of the increase that would otherwise have occurred was offset by the appreciation of the exchange rates. The increase in import prices led to an increase in the GNP deflators, and so there was a general worldwide increase in inflation.

The GNP fell for many countries. This was due in part to the increase in the interest rate in many countries (because of the increase in inflation and the decrease in the balance of payments) and in part to the decrease in net foreign assets (because of the decrease in the balance of payments). There was, in other words, both a negative interest rate effect and a negative asset effect on GNP. Imports fell for all countries because of the increase in the price of imports relative to the GNP deflator. For some countries this substitution effect was large enough to lead to an increase in GNP.

Although not shown in the table, the balance of payments of the oil-exporting countries rose substantially, as expected. This increase in net foreign assets then led to an increase in imports of the countries for which there are import equations (Iran, Libya, Nigeria, Saudi Arabia, and Venezuela). In some cases these increases were quite large. The six-quarter-ahead increases for Iran, Nigeria, and Saudi Arabia, for example, were 28.6, 27.6, and 56.9 percent, respectively. These increases were not, of course, large enough to offset completely the increases in the balance of payments of these countries (and thus the decreases in the balance of payments of the oil-importing countries).

TABLE 11
ESTIMATED EFFECTS OF MONETARY AND FISCAL POLICIES ON INFLATION THROUGH THEIR EFFECTS ON EXCHANGE RATES (Results Are for the Country Initiating the Policy)

	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV	1976 I	1976 II	1976 III	1976 IV	1977 I	1977 II	1977 III	1977 IV
	U.S. Spending Increase (Table 1)								U.S. Interest Rate Increase (Table 2)							
GNP deflator:																
a	.07	.17	.28	.38	.46	.55	.63	.70	.04	.06	.05	.05	.05	.04	.00	-.03
b	.07	.16	.26	.34	.41	.47	.52	.57	.05	.07	.09	.11	.13	.15	.16	.18
c	.00	.01	.02	.04	.05	.08	.11	.14	-.01	-.01	-.04	-.06	-.08	-.11	-.16	-.21
Price of imports:																
a	-.01	.06	.17	.19	.42	.58	.72	.86	-.09	-.15	-.24	-.34	-.45	-.60	-.77	-1.01
b	.00	.01	.03	.05	.09	.13	.15	.19	.01	.02	.03	.04	.05	.05	.05	.05
c	-.01	.05	.14	.24	.33	.45	.57	.67	-.10	-.17	-.27	-.38	-.50	-.65	-.82	-1.06
Real GNP:																
a	1.02	1.43	1.61	1.67	1.59	1.39	1.17	.97	-.13	-.42	-.70	-1.02	-1.34	-1.61	-1.85	-2.08
b	1.02	1.43	1.61	1.66	1.59	1.38	1.17	.97	-.13	-.42	-.69	-1.00	-1.32	-1.59	-1.83	-2.06
c	.00	.00	.00	.01	.00	.01	.00	.00	.00	.00	-.01	-.02	-.02	-.02	-.02	-.02
	German Spending Increase (Table 3)								German Interest Rate Increase (Table 4)							
GNP Deflator:																
a	.00	.29	.66	1.06	1.46	1.87	2.24	2.58	.00	-.04	-.12	-.24	-.40	-.61	-.87	-1.16
b	.00	.31	.72	1.15	1.57	2.00	2.36	2.67	.00	-.00	-.01	-.00	-.00	-.00	-.00	-.00
c	.00	-.02	-.06	-.09	-.11	-.13	-.12	-.09	.00	-.04	-.11	-.24	-.40	-.61	-.87	-1.16
Price of imports:																
a	-.53	-.77	-.71	-.55	-.30	.04	.45	.94	-.81	-1.54	-2.42	-3.38	-4.39	-5.51	-6.65	-8.01
b	.00	.00	.01	.01	.02	.03	.03	.04	-.00	.00	-.00	-.00	-.00	-.00	-.00	-.00
c	-.53	-.77	-.72	-.56	-.32	.01	.42	.90	-.81	-1.54	-2.42	-3.38	-4.39	-5.51	-6.65	-8.01
Real GNP:																
a	1.78	2.26	2.36	2.33	2.31	2.21	2.10	1.94	-.25	-.37	-.49	-.64	-.81	-.99	-1.16	-1.33
b	1.82	2.33	2.43	2.38	2.33	2.20	2.04	1.79	-.17	-.19	-.20	-.21	-.26	-.29	-.33	-.32
c	-.04	-.07	-.07	-.05	-.02	.01	.06	.15	-.08	-.18	-.29	-.43	-.55	-.70	-.83	-1.01
Exchange rate:																
a	-.64	-.95	-.91	-.74	-.46	-.05	.46	1.11	-.99	-1.91	-3.00	-4.21	-5.61	-7.07	-8.63	-10.43
	U.K. Spending Increase (Table 6)								Japanese Spending Increase (Table 8)							
GNP Deflator:																
a	.03	.06	.14	.26	.40	.58	.78	.98	.00	.01	.02	.04	.07	.11	.15	.19
b	.03	.06	.10	.16	.21	.26	.32	.37	.00	.01	.02	.04	.07	.11	.14	.19
c	.00	.00	.04	.10	.19	.32	.46	.61	.00	.00	.00	.00	.00	.00	.01	.00
Price of imports:																
a	.01	.70	1.27	2.01	2.81	3.27	3.48	3.68	.10	.25	.42	.62	.85	1.10	1.32	1.52
b	.00	.00	.00	.01	.01	.01	.02	.02	.00	.00	.00	.00	.00	.00	.01	.01
c	.01	.70	1.27	2.00	2.80	3.26	3.46	3.66	.10	.25	.42	.62	.85	1.10	1.31	1.51
Real GNP:																
a	1.28	1.65	1.69	1.63	1.46	1.25	1.16	1.07	.78	1.18	1.51	1.85	2.12	2.34	2.56	2.72
b	1.28	1.61	1.62	1.52	1.32	1.12	1.09	1.06	.78	1.17	1.49	1.82	2.07	2.27	2.47	2.60
c	.00	.04	.07	.11	.14	.13	.07	.01	.00	.01	.02	.03	.05	.07	.09	.12
Exchange rate:																
a	.01	.70	1.27	2.01	2.80	3.26	3.46	3.66	.10	.25	.43	.62	.86	1.11	1.33	1.53

Note.--a = exchange rates endogenous, b = exchange rates exogenous, c = a - b.

V. Estimates of the Exchange Rate Effect on Inflation (Table 11)

Exchange rates have an effect on domestic inflation in the model through their effects on import prices. The 10.0 percent depreciation of the mark in table 5 resulted in an increase in the German GNP deflator of 1.63 percent after six quarters. For the U.K. results in table 7 the increase was 2.13 percent. In the case of Japan, as noted above, the price of imports does not directly affect the GNP deflator, and so for the Japanese results in table 9 there was little change in the GNP deflator.

The question considered in this section is how much of the change in inflation that results from a monetary or fiscal policy change can be attributed to the change in the exchange rate that results from the policy change. Estimates of this exchange rate effect on inflation are presented in table 11. The results in the a rows are from the experiments discussed in the previous section. The results for all eight quarters of the prediction period are presented in table 11 for the particular variables. For the results in the b rows the same experiments were performed except that all exchange rates were taken to be exogenous. Exchange rates, in other words, were assumed to be fixed. The difference in the two rows for a given quarter for the GNP deflator is an estimate of the exchange rate effect on inflation for the quarter. The differences are presented in the c rows.

The estimates in table 11 vary considerably across countries. Consider, for example, the effect of the spending increases after eight quarters and consider the ratio of the c-row value to the a-row value. This ratio is .20 for the United States (.14/.70), −.03 for Germany (−.09/2.58), .62 for the United Kingdom (.61/.98), and .00 for Japan (.00/.19). The effect for the United Kingdom is large because the pound depreciated more than did the mark and the yen. The mark, as noted in the previous section, actually appreciated for the first six quarters. The initial sign of the exchange rate effect for Germany is thus negative (although the size of the effect is small). The size of the effect for Japan is small because of the lack of a direct effect of import prices on domestic prices.

The exchange rate effect for the interest rate increases is much larger. All of the fall of the GNP deflator for Germany is attributed to the exchange rate effect. When exchange rates are exogenous, there is essentially no effect on the GNP deflator of the German interest rate increase, whereas when exchange rates are endogenous, the effect after eight quarters is −1.16 percentage points. For the United States the effect after eight quarters is .18 in the exogenous case and −.03 in the endogenous case, for a difference of −.21.

VI. Conclusion

The results in this article give a fairly good indication of the properties of the model. It is clear that the linkages among countries are complicated and that there are few unambiguous effects with respect to sign. This is true not just in principle but also in fact. Depreciation, for example, increases GNP for Germany and Japan but decreases it for the United Kingdom after six quarters (tables 5, 7, and 9). Also, a

spending increase leads to an appreciation in Germany but to a depreciation in the United Kingdom and Japan (tables 3, 6, and 8). A spending increase in the United States has noticeably different effects on different countries (table 1). It should also be noted that the exchange rate reaction functions have much more importance for the transmission of price and interest rate shocks than of spending shocks.

The results in general show the importance of the price, interest rate, and exchange rate linkages among countries as well as the usual trade and output linkages. They thus suggest that models that are primarily trade linkage models are not likely to be very realistic.

Appendix

COUNTRIES IN THE MODEL

Country	Local Currency	Country	Local Currency
1. United States	U.S. dollars (mil)	34. United Arab Emirates*	Dirham (mil)
2. Canada	Canadian dollars (mil)	35. Venezuela	Bolivares (mil)
3. Japan	Yen (bil)	36. Argentina	Argentine pesos (bil)
4. Austria	Schillings (bil)	37. Brazil	Cruzeiros (bil)
5. Belgium	Belgian francs (bil)	38. Chile	Chilean pesos (mil)
6. Denmark	Danish kroner (bil)	39. Colombia	Colombian pesos (mil)
7. France	French francs (bil)	40. Mexico	Mexican pesos (bil)
8. Germany	Deutsche marks (bil)	41. Peru	Soles (bil)
9. Italy	Lire (bil)	42. Egypt	Egyptian pounds (mil)
10. Netherlands	Guilders (bil)	43. Israel	Israeli pounds (mil)
11. Norway	Norwegian kroner (bil)	44. Jordan	Jordanian dinars (mil)
12. Sweden	Swedish kroner (bil)	45. Lebanon*	Lebanese pounds (mil)
13. Switzerland	Swiss francs (bil)	46. Syria	Syrian pounds (mil)
14. United Kingdom	U.K. pounds (mil)	47. Bangladesh*	Taka (mil)
15. Finland	Markkas (mil)	48. Republic of China (Taiwan)†	NT dollars (bil)
16. Greece	Drachmas (bil)	49. Hong Kong*	Hong Kong dollars (bil)
17. Ireland	Irish pounds (mil)	50. India*	Indian rupees (bil)
18. Portugal	Escudos (bil)	51. Korea	Won (bil)
19. Romania*	Lei	52. Malaysia	Ringgit (mil)
20. Spain	Pesetas (bil)	53. Pakistan	Pakistani rupees (mil)
21. Turkey*	Liras (bil)	54. Philippines	Philippine pesos (mil)
22. Yugoslavia	Dinars (bil)	55. Singapore*	Singapore dollars (mil)
23. Australia	Australian dollars (mil)	56. Thailand	Baht (bil)
24. New Zealand	New Zealand dollars (mil)	57. Bulgaria‡	. . .
25. South Africa	Rand (mil)	58. China (Mainland)‡	. . .
26. Algeria*	Algerian dinars (mil)	59. Cuba‡	. . .
27. Indonesia*	Rupiahs (bil)	60. Czechoslovakia‡	. . .
28. Iran	Rials (bil)	61. East Germany‡	. . .
29. Iraq*	Iraq dinars (mil)	62. Hungary‡	. . .
30. Kuwait*	Kuwaiti dinars (mil)	63. Poland‡	. . .
31. Libya	Libyan dinars (mil)	64. USSR‡	. . .
32. Nigeria	Naira (mil)		
33. Saudi Arabia	Riyals (bil)		

NOTE.—mil = millions, bil = billions.
* No estimated equations for this country.
† Recently eliminated from the IMF data tapes.
‡ No estimated equations for this country and only direction of trade data available.

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