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ESTIMATED OUTPUT, PRICE, INTEREST RATE,
AND EXCHANGE RATE LINKAGES AMONG COUNTRIES

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Estimated Output, Price, Interest Rate,
And Exchange Rate Linkages Among Countries

ABSTRACT

This paper provides quantitative estimates of the output, price, interest rate, and exchange rate linkages among a number of countries. The econometric model that is used for this purpose is described in Fair (1981), and the present paper is an extension of this work. The linkages are examined by changing various policy variables and observing the resulting change 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 influences domestic prices. The model allows this exchange rate effect on inflation to be estimated.

The results in the paper give a good indication of the properties of the model. The linkages among countries are complicated and 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 Japan, but decreases it for Germany and the U.K. A spending increase leads to a depreciation in Japan, but to an appreciation in Germany and the U.K. A spending increase in the U.S. has noticeably different effects on different countries. The results also show the importance of price, interest rate, and exchange rate linkages among countries as well as the usual trade linkages.

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by

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I. Introduction

This paper provides quantitative estimates of the output, price,
interest rate, and exchange rate linkages among a number of countries.
The econometric model that is used for this purpose is described in Fair
(1981), and the present paper is an extension of this work. The linkages
are examined by changing various policy variables in the model and ob-
serving 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 of the U.K. exchange rate,

8. An increase in Japanese government spending,

9. A depreciation of the Japanese exchange rate,

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 influences 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, and 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). The model is reviewed in Sections II and III of the present paper. If the earlier paper has been read, these two sections can be skipped. This paper is concerned only with the flexible exchange rate period, although 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 earlier paper, and no mention of this is made here. It perhaps goes without saying that the results in this paper 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 paper, 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 coun-

tries. 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 Table A-1 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.[1] (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 coun-

tries. (4) I alone have estimated small models for each country and then

linked them together, rather than, as Project LINK[2] 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 advan-

tage of the present approach is that the person constructing the individual

models knows from the beginning that they are to be linked together, and

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[1]See, for example, Frenkel and Johnson (1976), Dornbusch (1976), Frenkel
and Rodriguez (1975), and Kouri (1976).

[2]See Ball (1973) and Hickman (1974).

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 $(e/F)(1+r)$. If for $R = r'$ people are indifferent as to which bond they hold, then 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:

$$(1) \qquad R = (e/F)(1+r) \ .$$

Write the reaction functions as:

$$(2) \qquad R = f_2(\ldots) \ ,$$

$$(3) \qquad r = f_3(\ldots) \ ,$$

$$(4) \qquad e = f_4(\ldots) \ ,$$

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, then 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, then 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 as follows. The signs in parentheses are the expected signs of the coefficient estimates.

	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 (+).

Dependent Variable	Explanatory Variables
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 (+).
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 the 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 con-
sumption function, where income (GNP) is used as an explanatory variable.
If a household is choosing consumption and labor supply to maximize utility,
then 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 theo-
retical 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 ex-
change rate is an explanatory·variable in the exchange rate reaction
functions of the other European countries.

There are 9 definitions per country. The four most important are:
(1) Final sales equals consumption plus investment plus government spend-
ing 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 pay-

ments, and (4) net foreign assets equals net foreign assets of the pre-
vious period plus the balance of payments (i.e., the change in net
foreign assets equals the balance of payments).

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 contempor-
aneously 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 auton-
omous 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 (equation 8). The short term or long term
rate has a direct negative effect on imports and consumption (equations
1 and 2) and a direct positive effect on the GNP deflator (equation 5).
The short term rate has a direct negative effect on the demand for money
and the exchange rate (equations 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-a-vis the rest of the world, has a direct positive effect on imports
and consumption (equations 1 and 2) and a direct negative effect on the
short term interest rate and the exchange rate (equations 7b and 9b).

The exchange rate has a direct positive effect on the local currency
price of exports (equation 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 equation 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 (equation 7b).

The price of imports has a direct negative effect on imports (equation 1), a direct positive effect on the GNP deflator (equation 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 (equation 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 (equations 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 (equation 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 (equation 4).

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 sub-
stitution 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 exports, which lowers
the import price indices of countries that import from the given country,
which in turn increases the 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 in- direct 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 explana- tory variable in the price equation (equation 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.[3]

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 9) the divisor is the change in government
spending as a percentage of GNP (in percentage points).[4] Each number

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

[4]Each number in these tables is thus $[(\hat{y}_{jt} - y_{jt})/y_{jt}]/[\Delta G_{it}/Y_{it}]$, where
$\hat{y}_{jt}$ is the two- or six-quarter-ahead predicted value of y_{jt} 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 .

in these tables is thus the percentage change in the variable induced by
a one 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 per-
centage 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 understand 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.

U.S. Spending Increase (Table 1)[5]

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 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,

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[5]This experiment is also discussed in Fair (1981), and the present discussion can be skipped if the earlier paper has been read.

TABLE 1. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained One Percent Autonomous Increase in U.S. 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	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[a] 2	Balance of Payments[a] 6
U.S.	1.43	1.39	0.17	0.54	0.56	0.89	--	--	0.05	0.55	-0.07	-0.33	1.68	2.95	0.31	-0.01	2.36	5.26	0.16	0.41	0.08	0.41	0.09	0.60	-452.807	-985.274
Canada	0.18	0.55	0.05	0.56	0.22	0.60	-0.00	0.01	0.07	0.50	-0.16	-0.89	0.20	1.14	-0.00	0.04	0.15	0.44	0.07	0.27	0.04	0.51	1.32	2.67	114.732	182.173
Japan	0.06	0.13	-0.02	-0.12	-0.04	-0.14	-0.80	-3.42	-0.74	-3.08	0.02	0.06	0.12	1.12	0.03	0.17	0.02	0.22	--	--	-0.53	-2.31	0.51	1.09	30.555	41.713
Austria	0.04	0.10	0.01	0.22	0.00	0.03	0.44	-0.52	0.35	0.15	0.01	0.15	-0.00	0.11	0.02	0.06	0.07	0.14	0.00	0.03	0.29	-0.27	0.39	0.27	-0.016	-0.308
Belgium	0.06	0.09	0.00	0.01	0.01	0.14	0.07	-0.87	0.06	-0.25	-0.00	-0.01	0.06	0.24	0.04	0.04	0.04	0.10	-0.01	-0.03	0.04	-0.47	0.11	0.31	0.117	-1.245
Denmark	0.04	-0.01	-0.01	-0.09	-0.04	-0.11	-0.04	-0.95	-0.13	-0.41	0.04	0.04	0.09	0.32	0.03	-0.00	0.04	-0.01	0.04	0.12	-0.02	-0.46	0.17	0.39	0.036	-0.013
France	0.03	0.01	-0.01	-0.12	0.15	0.30	-0.11	-1.71	-0.15	-1.21	-0.02	-0.20	0.05	0.30	0.01	-0.01	0.04	0.04	0.03	0.16	-0.05	-0.84	0.12	0.32	0.138	0.358
Germany	0.05	0.19	0.01	0.10	0.12	0.43	0.17	-0.94	0.18	-0.46	-0.06	-0.25	0.04	0.00	-0.00	-0.02	0.11	0.41	-0.01	-0.11	-0.04	-0.15	0.15	0.46	-0.007	0.546
Italy	0.04	0.19	-0.01	-0.27	-0.05	-0.40	-0.10	-1.68	-0.12	-1.18	0.01	0.17	0.05	0.42	0.02	0.18	0.08	0.46	0.08	0.25	-0.07	-1.16	0.17	0.40	16.022	-11.398
Netherlands	0.03	-0.03	-0.00	0.03	0.44	0.82	0.15	-0.79	0.14	-0.21	-0.43	-0.80	0.02	0.01	-0.03	-0.23	0.03	-0.02	0.00	0.06	0.12	-0.64	0.10	0.30	0.019	-0.107
Norway	0.03	0.11	0.03	0.26	0.04	0.28	0.22	0.07	0.16	0.67	0.04	0.28	0.03	0.01	0.02	0.03	--	--	0.02	0.10	0.19	0.08	0.14	0.44	0.012	-0.111
Sweden	0.04	0.21	0.02	0.36	0.11	0.44	0.52	0.05	0.51	0.64	0.00	0.13	0.04	0.01	0.02	0.11	0.04	0.17	0.03	0.10	0.14	0.18	0.15	0.41	-0.069	-0.042
Switzerland	0.07	0.26	0.02	0.11	0.09	0.13	0.43	-0.97	0.42	-0.27	-0.06	-0.21	-0.02	0.17	-0.02	0.04	0.16	0.84	0.00	0.00	0.13	-0.21	0.17	0.45	-0.008	0.024
U.K.	0.07	0.21	0.00	-0.09	0.00	0.04	-0.13	-2.04	-0.12	-1.54	0.03	0.07	0.10	0.40	0.04	0.23	0.04	0.16	--	--	-0.04	-0.69	0.23	0.53	16.041	110.961
Finland	0.05	0.24	0.03	0.37	-0.00	0.00	0.55	1.21	0.44	1.77	0.02	0.45	0.00	0.09	0.02	0.18	0.04	0.28	--	--	0.46	1.11	0.09	0.29	5.837	-64.815
U.S. Alone	1.43	1.36	0.16	0.45	0.56	0.86	--	--	0.00	0.00	-0.07	-0.33	1.68	3.01	0.31	0.02	2.35	5.18	0.16	0.40	0.07	0.32	0.00	0.00	-461.178	-964.537

[a] Change is absolute change, not percentage change, in units of local currency.

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 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.

U.S. 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 4.5 percent. This depreciation was also due in part to the increase in the U.S. balance of payments relative to those of other countries. This depreciation led to an increase in other countries' import prices and then to the 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 U.S.) increased. In these cases the change in export revenue (exports 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 U.S. 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.

TABLE 2. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained One Percentage Point Increase in the U.S. Short Term Interest Rate. Initial Change in 1976I.

	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-0.41	-1.57	0.06	0.02	1.00	1.00	--	--	-0.16	-0.69	-0.48	-1.36	-0.39	-2.04	-0.52	-1.57	-0.53	-3.86	0.24	0.48	0.05	0.04	-0.08	-0.62	347.634	1812.287
Canada	-0.08	-0.61	0.07	0.16	0.57	0.87	0.03	0.09	-0.01	-0.21	-0.54	-2.02	-0.07	-0.80	-0.11	-0.54	-0.06	-0.49	0.19	0.39	0.07	0.16	-0.32	-1.91	-32.861	-162.398
Japan	-0.01	-0.12	0.00	0.07	0.01	0.10	0.34	2.65	0.28	2.36	-0.00	-0.05	-0.04	-0.64	-0.01	-0.09	-0.00	-0.10	--	--	0.22	1.74	-0.15	-0.88	-16.536	-92.506
Austria	0.04	-0.09	0.16	0.75	0.00	-0.01	1.95	4.99	1.03	2.22	0.05	0.31	-0.14	-0.37	0.03	-0.04	0.03	-0.13	--	--	1.29	3.38	-0.12	-0.73	-0.247	0.869
Belgium	0.07	0.03	0.08	0.44	0.05	0.05	1.20	3.71	0.69	1.94	0.01	0.14	-0.19	-0.88	0.04	0.03	0.05	0.04	0.01	0.03	0.67	2.10	-0.14	-0.89	0.413	2.554
Denmark	-0.06	-0.43	-0.01	0.00	-0.06	-0.27	0.69	2.36	-0.03	0.38	-0.00	-0.12	0.01	-0.21	-0.04	-0.32	-0.06	-0.58	-0.01	-0.07	0.34	1.14	-0.12	-0.75	0.116	0.166
France	-0.01	-0.09	0.01	0.23	0.39	0.79	0.87	3.69	0.35	2.00	-0.08	-0.41	-0.11	-0.85	-0.01	-0.11	-0.02	-0.14	0.09	0.29	0.42	0.80	-0.13	-0.73	0.121	-0.103
Germany	-0.09	-0.50	0.02	0.15	0.18	0.19	1.48	4.50	1.13	3.28	-0.20	-0.57	-0.16	-1.02	-0.08	-0.45	-0.07	-1.08	0.05	0.10	0.30	0.92	-0.13	-0.74	-1.134	-3.218
Italy	-0.03	-0.40	0.01	0.42	0.06	0.74	0.60	3.43	0.13	1.90	-0.01	-0.30	-0.03	-0.64	-0.02	-0.32	-0.07	-0.94	0.01	0.20	0.39	2.34	-0.14	-0.80	32.848	111.573
Netherlands	-0.07	-0.36	0.02	0.21	0.78	0.64	1.21	3.79	0.73	2.09	-0.87	-0.77	-0.20	-0.95	-0.13	-0.47	-0.07	-0.40	0.15	0.26	1.00	3.14	-0.14	-0.89	0.239	0.799
Norway	-0.02	-0.19	0.02	0.07	0.03	-0.12	0.75	2.09	0.12	0.20	-0.00	-0.09	-0.02	-0.16	-0.01	-0.12	--	--	0.00	-0.01	0.66	1.83	-0.09	-0.71	0.159	0.475
Sweden	-0.01	-0.02	0.09	0.84	0.34	0.80	1.78	3.92	1.27	2.14	-0.04	0.10	-0.07	-0.65	-0.00	-0.00	-0.01	-0.01	0.05	0.20	0.46	1.30	-0.10	-0.67	-0.420	-0.489
Switzerland	0.05	0.37	0.05	0.50	0.23	0.41	3.05	7.84	2.45	5.70	-0.17	-0.59	-0.54	-1.72	-0.11	-0.22	0.11	1.16	0.08	0.28	0.86	2.35	-0.12	-0.75	-0.213	-0.496
U.K.	-0.04	-0.30	0.00	0.18	-0.00	-0.03	0.61	4.12	0.27	2.98	-0.01	-0.06	-0.05	-0.52	-0.02	-0.30	-0.02	-0.22	-0.00	0.00	0.19	1.37	-0.13	-0.77	-25.656	-425.593
Finland	0.03	-0.01	0.09	0.69	-0.01	-0.04	1.75	5.87	1.00	3.62	0.03	0.50	-0.13	-0.49	0.01	0.04	0.02	0.02	--	--	1.47	5.03	-0.08	-0.62	61.612	130.696
U.S. Alone	-0.41	-1.52	0.07	0.14	1.00	1.00	--	--	0.00	0.00	-0.48	-1.34	-0.40	-2.11	--	--	-0.53	-3.77	0.24	0.49	0.06	0.15	0.00	0.00	290.646	1716.370

[a]Change is absolute change, not percentage change, in units of local currency.

German Spending Increase (Table 3)

This experiment is 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 (1.96 percent). This increase and the
increase in income led to a large increase in the interest rate through
the reaction function (3.17 percentage points after six quarters). The
negative interest rate effect on the exchange 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 ex-
change 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 re-
sults of an increase in the German rate are presented in Table 4. This
increase lowered German income and imports and led to a general contrac-
tion 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 Eueopean 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.

TABLE 3. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained One 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		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments [a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	0.02	0.02	0.01	0.04	0.01	0.02	—	---	0.11	0.14	-0.00	-0.00	0.01	0.00	0.00	-0.01	0.02	0.09	0.00	0.01	0.01	0.04	0.24	0.32	30.738	43.597
Canada	0.01	0.03	0.00	0.05	0.00	0.02	-0.00	-0.00	0.06	0.10	-0.00	-0.02	0.01	0.05	0.00	0.01	0.01	0.02	0.00	0.01	0.00	0.04	0.09	0.11	1.053	-3.038
Japan	0.02	0.06	-0.00	-0.02	-0.01	-0.02	-0.00	-0.01	0.04	0.05	0.01	0.04	-0.00	0.03	0.01	0.04	0.00	0.08	—	—	-0.00	-0.02	0.15	0.18	4.772	4.053
Austria	0.21	0.38	-0.02	0.05	0.01	0.12	-1.01	-0.41	-0.38	0.25	0.06	0.21	0.39	0.44	0.13	0.23	0.28	0.46	—	—	-0.66	-0.25	0.92	0.95	0.003	-0.258
Belgium	0.38	0.42	-0.03	0.08	0.22	0.48	-0.78	-0.25	-0.39	0.17	0.01	-0.04	0.67	0.71	0.21	0.27	0.29	0.46	0.03	0.10	-0.43	-0.11	1.03	0.98	0.759	-0.911
Denmark	0.23	0.33	0.00	0.07	0.04	0.19	-0.55	-0.15	-0.07	0.36	0.13	0.21	0.17	0.24	0.16	0.27	0.25	0.50	0.01	0.05	-0.26	-0.05	0.60	0.59	0.015	-0.081
France	0.25	0.46	-0.01	-0.10	0.48	1.63	-0.70	-0.67	-0.33	-0.29	-0.04	-0.58	0.21	0.42	0.08	0.21	0.32	0.90	0.11	0.55	-0.33	-0.32	0.76	0.77	0.350	0.153
Germany	2.36	2.36	0.29	1.96	1.34	3.17	-1.05	-0.39	-0.84	-0.21	0.60	0.30	2.89	2.42	0.87	0.96	5.33	4.62	0.37	1.30	-0.10	0.68	0.25	0.39	-0.861	-0.428
Italy	0.20	0.48	-0.01	-0.25	-0.13	-0.23	-0.50	-0.81	-0.15	-0.47	0.05	0.41	0.22	0.85	0.08	0.36	0.40	1.35	-0.03	-0.10	-0.32	-0.58	0.79	0.75	24.561	-37.654
Netherlands	0.53	0.44	0.01	0.09	0.51	0.63	-0.86	-0.34	-0.51	0.05	-0.10	-0.19	0.79	0.92	0.26	0.34	0.59	0.50	0.09	0.23	-0.71	-0.26	1.26	1.16	0.040	-0.087
Norway	0.13	0.17	0.02	0.41	0.53	1.40	-0.44	-0.85	-0.05	-0.38	0.09	0.38	0.05	-0.38	0.03	-0.17	—	—	0.06	0.34	-0.38	-0.73	0.50	0.50	-0.009	0.056
Sweden	0.15	0.28	0.01	0.21	0.23	0.67	-0.79	-1.04	-0.43	-0.66	-0.00	0.03	0.12	0.00	0.05	0.19	0.12	0.23	0.04	0.15	-0.18	-0.16	0.48	0.48	0.133	0.239
Switzerland	0.20	0.33	0.01	0.05	-0.01	0.04	-0.96	-0.30	-0.51	0.18	0.01	0.01	0.46	0.87	0.08	0.27	0.48	1.12	-0.00	0.01	-0.26	-0.04	0.67	0.70	0.039	-0.061
U.K.	0.12	0.17	0.00	-0.05	0.01	0.04	-0.45	-0.78	-0.22	-0.55	0.04	0.07	0.16	0.36	0.07	0.20	0.07	0.14	0.00	0.01	-0.14	-0.27	0.40	0.47	20.986	32.065
Finland	0.13	0.24	0.02	0.03	0.00	0.01	-0.41	-0.67	0.05	-0.13	0.05	0.29	0.18	0.39	0.06	0.21	0.11	0.32	—	—	-0.34	-0.55	0.42	0.46	-13.504	-39.019

[a] Change is absolute change, not percentage change, in units of local currency.

Table 4. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained One 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		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-0.01	-0.06	0.02	0.16	0.00	0.01	--	--	0.19	0.96	0.00	0.01	-0.02	-0.26	-0.01	-0.07	-0.01	-0.13	0.00	0.01	0.02	0.15	-0.05	-0.21	-149.702	-726.417
Canada	-0.00	-0.05	0.00	0.06	0.01	0.06	-0.00	-0.03	0.10	0.55	-0.01	-0.08	-0.01	-0.17	-0.00	-0.04	-0.00	-0.04	0.00	0.03	0.00	0.05	-0.04	-0.27	-33.392	-184.442
Japan	-0.01	-0.05	0.00	0.04	0.01	0.05	-0.02	-0.22	0.05	0.16	-0.00	-0.02	-0.01	-0.10	-0.00	-0.04	-0.00	-0.04	--	--	-0.01	-0.11	-0.05	-0.23	-11.286	-51.075
Austria	-0.11	-0.31	-0.10	-0.95	0.00	-0.04	-1.88	-6.71	-0.84	-2.96	-0.05	-0.53	0.01	-0.18	-0.07	-0.23	-0.17	-0.38	--	--	-1.25	-4.67	-0.23	-0.47	-0.577	-1.801
Belgium	-0.29	-0.91	-0.11	-0.78	-0.18	-0.70	-1.58	-5.60	-0.92	-3.07	-0.02	-0.25	0.04	0.11	-0.15	-0.60	-0.21	-0.89	-0.02	-0.15	-0.89	-3.33	-0.23	-0.39	-1.690	-7.127
Denmark	-0.08	-0.10	-0.01	-0.14	-0.02	0.25	-1.01	-3.82	-0.22	-0.97	-0.05	-0.41	-0.02	-0.27	-0.05	-0.09	-0.09	-0.17	-0.00	0.06	-0.49	-1.92	-0.16	-0.33	-0.142	-0.358
France	-0.10	-0.71	-0.01	-0.40	0.41	0.09	-1.26	-5.78	-0.61	-3.42	-0.11	-0.58	0.03	0.21	-0.04	-0.40	-0.12	-1.16	0.10	0.10	-0.61	-2.96	-0.16	-0.30	-0.300	0.064
Germany	-0.17	-0.10	-0.03	-0.38	1.00	1.00	-1.95	-6.82	-1.57	-5.30	-1.15	-1.86	-0.75	-1.37	-0.37	-0.53	-0.39	-0.18	0.31	0.49	-0.40	-1.58	-0.02	-0.07	2.339	6.707
Italy	-0.04	-0.02	-0.02	-0.54	-0.06	-0.84	-0.85	-4.84	-0.26	-2.62	-0.01	0.12	-0.09	0.04	-0.00	0.15	-0.08	-0.13	-0.01	-0.22	-0.56	-3.36	-0.17	-0.33	-76.632	-305.773
Netherlands	-0.20	-0.55	-0.03	-0.50	-0.18	-0.83	-1.59	-5.84	-0.99	-3.44	-0.00	-0.03	-0.09	-0.28	-0.09	-0.44	-0.24	-0.61	-0.03	-0.26	-1.32	-4.95	-0.28	-0.50	-0.365	-1.186
Norway	-0.02	0.02	0.04	0.31	0.45	0.73	-0.66	-2.75	-0.02	-0.12	-0.01	0.22	-0.12	-0.54	-0.05	-0.19	--	--	0.06	0.20	-0.58	-2.42	-0.13	-0.22	-0.183	-0.734
Sweden	-0.01	-0.08	0.02	-0.13	0.19	-0.03	-1.21	-4.20	-0.59	-1.68	-0.06	-0.15	-0.11	-0.20	-0.00	-0.04	-0.01	-0.06	0.04	0.01	-0.28	-1.10	-0.11	-0.32	0.153	0.269
Switzerland	-0.07	-0.58	-0.02	-0.36	-0.03	-0.21	-1.92	-7.61	-1.18	-4.89	0.01	0.18	-0.02	0.22	-0.01	-0.16	-0.17	-1.65	-0.01	-0.11	-0.55	-2.43	-0.15	-0.32	0.074	0.396
U.K.	-0.03	-0.02	-0.01	-0.29	-0.00	-0.02	-0.83	-5.51	-0.44	-4.01	-0.01	-0.15	-0.03	0.00	-0.01	0.07	-0.01	-0.02	-0.00	-0.02	-0.26	-1.96	-0.08	-0.23	28.208	465.805
Finland	-0.03	-0.18	0.01	-0.27	0.01	0.06	-0.76	-4.70	0.01	-1.78	0.00	-0.29	-0.06	-0.22	-0.01	-0.16	-0.02	-0.21	--	--	-0.62	-3.99	-0.12	-0.27	-97.398	-329.486

[a]Change is absolute change, not percentage change, in units of local currency.

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

It was argued above that the initial effect of a depreciation on the balance of payments is likely to be negative, and this is the case in Table 5, even after six quarters. The depreciation also led to a decrease in GNP. As noted above, 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) and the negative effect from the rise in the interest rate dominated. (The rise in the interest rate was due in part to the increase in the rate of inflation that resulted from the depreciation.)

The depreciation of the German exchange rate led to a decrease in the U.S. GNP deflator and an increase in U.S. GNP. The decrease in the deflator was due to the fall in the U.S. price of imports, which was due to the general appreciation of the dollar. The increase in GNP was due in part to the increase in assets from the increase in the balance of payments and in part to the fall in the interest rate from the fall in the rate of inflation.

U.K. Spending Increase (Table 6)

This experiment is 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

TABLE 5. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained Ten Percent Increase in the German Exchange Rate (Depreciation). Initial Change in 1976I.

Country	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	0.02	0.11	-0.12	-0.35	-0.03	-0.02	—	—	-0.93	-1.40	-0.00	-0.02	0.18	0.50	0.04	0.16	0.03	0.25	-0.01	-0.03	-0.11	-0.33	-0.07	-0.08	254.072	314.577
Canada	0.01	0.07	-0.03	-0.18	-0.04	-0.12	0.02	0.08	-0.51	-0.87	0.04	0.19	0.06	0.36	0.01	0.09	0.01	0.06	-0.02	-0.06	-0.03	-0.16	0.11	0.34	74.722	116.422
Japan	0.01	0.05	-0.02	-0.07	-0.03	-0.07	0.18	0.50	-0.19	-0.06	-0.00	0.00	0.06	0.15	0.01	0.06	0.00	0.04	—	—	0.10	0.27	0.03	0.15	17.367	24.744
Austria	0.27	-0.12	0.91	2.06	-0.00	-0.01	9.82	9.95	4.27	4.05	0.29	1.09	-0.37	-0.11	0.20	-0.03	0.23	-0.18	—	—	6.48	6.91	-0.16	-0.74	1.200	1.188
Belgium	0.90	0.47	0.68	1.63	0.71	0.40	8.04	7.82	4.49	3.65	0.14	0.66	-0.94	-1.02	0.51	0.42	0.69	0.50	0.10	0.18	4.47	4.66	-0.34	-0.96	2.648	6.112
Denmark	0.20	-0.65	0.16	0.31	0.18	-0.88	5.27	5.45	1.35	1.09	0.09	0.58	-0.37	0.33	0.12	-0.44	0.21	-0.76	0.03	-0.21	2.56	2.65	-0.12	-0.65	0.266	0.160
France	0.27	1.02	0.15	1.35	0.59	1.35	7.40	10.78	4.06	6.93	-0.06	0.20	-0.75	-1.45	0.08	0.49	0.35	1.81	0.13	0.50	3.52	5.34	-0.22	-0.71	0.014	-0.844
Germany	-0.16	-0.63	0.26	0.95	0.13	0.28	10.00	10.00	7.80	7.18	-0.05	-0.16	-0.17	-1.45	-0.11	-0.83	-0.38	-1.34	0.03	0.14	2.01	2.28	-0.31	-0.52	-4.038	-2.964
Italy	-0.10	-0.78	0.18	2.27	0.66	2.71	5.28	10.69	2.25	7.10	-0.04	-1.19	-0.13	-1.72	-0.12	-1.05	-0.18	-1.89	0.13	0.88	3.46	7.54	-0.26	-0.64	96.470	232.282
Netherlands	0.34	0.10	0.30	1.16	0.32	0.52	8.49	8.57	5.29	4.68	0.15	0.48	-0.48	-0.62	0.21	0.32	0.38	0.11	0.08	0.31	7.00	7.27	-0.34	-1.04	0.715	0.828
Norway	-0.04	-0.27	-0.09	-0.06	-0.28	-0.46	3.10	4.28	-0.01	0.35	-0.08	-0.24	0.07	0.24	0.01	-0.08	—	—	-0.04	-0.10	2.73	3.77	-0.13	-0.64	0.445	0.512
Sweden	-0.03	0.09	0.10	1.00	0.31	0.76	5.26	6.50	2.03	2.45	-0.01	0.25	-0.05	-0.53	-0.01	0.05	-0.02	0.08	0.04	0.20	1.29	1.99	-0.18	-0.38	-0.220	-0.114
Switzerland	0.20	0.94	0.15	1.00	0.28	0.41	10.65	12.43	6.51	7.38	-0.14	-0.52	-0.78	-1.41	-0.06	0.14	0.46	3.09	0.09	0.28	2.95	3.85	-0.19	-0.61	-0.234	-0.252
U.K.	-0.04	-0.41	0.05	1.13	-0.00	-0.01	5.34	13.32	3.34	10.83	0.00	0.38	-0.06	-0.94	-0.03	-0.82	-0.02	-0.30	0.00	0.08	1.68	4.68	-0.18	-0.32	-171.311	-685.638
Finland	-0.01	0.08	0.04	1.09	-0.05	-0.11	4.84	10.70	1.08	5.89	-0.04	0.83	-0.08	-0.25	-0.00	0.17	-0.01	0.10	—	—	3.99	9.12	-0.12	-0.50	200.580	184.543

[a]Change is absolute change, not percentage change, in units of local currency.

TABLE 6. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained One 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		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments*	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	0.01	0.03	-0.00	-0.01	0.00	0.01	--	--	-0.02	-0.05	-0.00	-0.00	0.02	0.06	0.00	0.01	0.02	0.08	0.00	0.00	-0.00	-0.01	0.17	0.26	49.175	75.318
Canada	0.02	0.05	0.00	0.02	-0.00	-0.00	0.00	0.01	-0.01	-0.04	0.01	0.02	0.02	0.12	0.00	0.03	0.02	0.04	-0.00	-0.00	0.00	0.02	0.17	0.19	16.866	17.391
Japan	0.01	0.05	-0.00	-0.02	-0.01	-0.02	0.00	0.07	0.00	0.05	0.00	0.02	0.00	0.02	0.00	0.03	0.00	0.05	--	--	0.00	0.03	0.09	0.16	4.220	6.329
Austria	0.05	0.09	0.01	-0.01	0.00	0.03	-0.05	-0.31	-0.04	-0.21	0.02	0.05	0.08	0.17	0.03	0.05	0.07	0.10	--	--	-0.03	-0.21	0.23	0.31	0.033	0.017
Belgium	0.11	0.12	0.00	-0.01	0.07	0.08	-0.04	-0.25	-0.06	-0.30	0.00	0.01	0.16	0.36	0.06	0.11	0.08	0.13	0.01	0.02	-0.02	-0.14	0.28	0.40	0.379	0.595
Denmark	0.25	0.02	0.01	-0.05	0.02	-0.16	-0.04	-0.21	-0.08	-0.33	0.15	0.17	0.18	0.52	0.17	0.04	0.27	0.08	0.01	-0.04	-0.02	-0.10	0.64	0.55	0.068	0.034
France	0.09	0.18	0.00	-0.03	0.01	0.04	-0.04	-0.24	-0.04	-0.26	0.01	0.08	0.07	0.30	0.03	0.12	0.12	0.34	0.00	0.01	-0.01	-0.12	0.28	0.34	0.157	0.138
Germany	0.10	0.18	0.01	0.08	0.04	0.17	-0.05	-0.31	-0.06	-0.34	0.03	0.05	0.11	0.24	0.03	0.10	0.22	0.38	0.01	0.06	-0.01	-0.03	0.23	0.34	0.120	0.312
Italy	0.05	0.14	-0.00	-0.06	-0.03	-0.08	-0.02	-0.20	-0.02	-0.19	0.01	0.11	0.06	0.26	0.02	0.10	0.10	0.38	-0.01	-0.03	-0.01	-0.15	0.22	0.31	11.681	3.907
Netherlands	0.15	0.14	0.01	0.02	0.15	0.20	-0.04	-0.26	-0.05	-0.32	-0.03	-0.06	0.21	0.34	0.08	0.12	0.17	0.16	0.03	0.07	-0.03	-0.21	0.35	0.42	0.035	0.039
Norway	0.22	0.17	-0.01	-0.04	0.02	0.02	-0.01	-0.11	-0.04	-0.19	0.14	0.11	0.25	0.41	0.13	0.12	0.17	--	0.09	0.01	-0.01	-0.08	0.92	0.89	0.067	0.059
Sweden	0.12	0.14	-0.00	-0.04	-0.01	-0.06	0.00	-0.11	-0.03	-0.24	0.04	0.18	0.16	0.32	0.13	0.16	--	0.10	0.09	0.01	-0.01	-0.04	0.45	0.51	0.064	5.088
Switzerland	0.08	0.13	0.01	0.02	0.00	-0.01	-0.03	-0.24	-0.06	-0.40	0.00	0.02	0.15	0.41	0.05	0.11	0.19	0.46	0.00	-0.00	-0.00	-0.05	0.25	0.32	0.014	0.027
U.K.	1.61	1.04	0.06	0.56	0.16	0.40	0.70	3.12	0.70	3.16	0.67	0.96	2.49	1.92	1.06	0.44	1.40	0.74	0.03	0.18	0.25	1.29	0.12	0.27	-224.831	-393.341
Finland	0.15	0.22	0.00	0.01	-0.00	-0.01	-0.01	-0.12	-0.04	-0.25	0.06	0.27	0.23	0.50	0.07	0.21	0.13	0.31	--	--	-0.00	-0.10	0.50	0.51	17.428	11.755

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

the exchange rate was dominated by the positive price and balance of payments effects.

The other European exchange rates appreciated relative to the dollar, although 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 U.S. with respect to the increase in exports, and so their balance of payments improved more.

U.K. 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 ten percent (a depreciation).

As in the German case, the depreciation led to a fall in GNP. 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 and an increase in U.S. GNP, although the effects in the U.K. case were smaller.

Japanese Spending Increase (Table 8)

This experiment is 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 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 in the German and U.K. cases, the exchange rate depreciated in response to the expansion:

TABLE 7. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained Ten 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		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	0.01	0.03	-0.04	-0.08	-0.01	-0.00	—	—	-0.28	-0.27	-0.00	-0.01	0.07	0.12	0.01	0.04	0.01	0.07	-0.00	-0.01	-0.04	-0.08	0.02	-0.02	76.500	37.399
Canada	0.00	0.00	-0.01	-0.07	-0.02	-0.03	0.00	0.01	-0.22	-0.24	0.02	0.05	0.03	0.09	0.00	0.03	0.00	0.00	-0.01	-0.02	-0.01	-0.06	0.05	0.03	28.046	19.710
Japan	0.00	0.01	-0.00	-0.02	-0.01	-0.02	0.00	-0.02	-0.09	-0.12	0.00	-0.00	0.02	0.08	0.00	0.01	-0.00	0.01	—	—	-0.00	-0.03	0.03	0.04	5.179	3.959
Austria	-0.02	-0.64	-0.06	-0.15	-0.00	-0.01	-0.01	-0.03	-0.27	-0.27	-0.02	-0.09	0.04	0.04	-0.01	-0.02	-0.01	-0.04	-0.02	-0.06	-0.02	-0.06	0.02	-0.03	0.136	0.163
Belgium	-0.09	-0.11	-0.07	-0.20	-0.16	-0.24	-0.01	-0.05	-0.50	-0.54	-0.01	0.04	0.11	0.19	-0.02	0.12	-0.01	-0.09	-0.06	-0.14	-0.03	-0.09	0.03	-0.09	1.582	1.286
Denmark	-0.20	-0.65	-0.10	-0.34	-0.33	-0.56	-0.04	-0.20	-0.78	-0.92	0.04	-0.34	0.29	0.30	-0.12	-0.50	-0.20	-0.93	-0.01	-0.03	-0.03	-0.14	-0.02	-0.27	0.110	0.103
France	-0.04	-0.13	-0.03	-0.11	-0.06	-0.08	-0.01	-0.08	-0.38	-0.43	-0.01	-0.06	0.08	0.04	-0.01	-0.07	-0.05	-0.22	-0.00	-0.01	-0.02	-0.09	0.02	-0.07	0.287	0.335
Germany	0.01	0.00	-0.01	-0.04	-0.01	-0.03	0.01	-0.00	-0.29	-0.31	0.00	0.01	0.01	0.04	0.01	0.03	0.02	-0.00	-0.01	-0.03	-0.00	-0.02	0.04	-0.02	0.215	0.178
Italy	0.00	-0.03	-0.04	-0.14	-0.07	-0.07	-0.02	-0.07	-0.29	-0.31	0.01	0.02	0.03	0.08	0.01	0.01	-0.01	-0.10	-0.01	-0.03	-0.02	-0.10	0.03	-0.04	25.972	14.941
Netherlands	-0.03	-0.02	-0.03	-0.10	-0.04	-0.06	-0.00	-0.02	-0.41	-0.52	-0.01	-0.04	0.03	0.06	-0.01	0.08	-0.04	-0.02	-0.01	-0.03	-0.01	-0.04	0.02	-0.08	0.122	0.148
Norway	-0.02	-0.18	-0.16	-0.26	-0.13	-0.16	0.04	0.07	-0.55	-0.50	-0.11	-0.34	0.02	-0.05	0.01	-0.07	—	—	-0.02	-0.05	0.02	0.05	-0.03	-0.62	0.112	0.067
Sweden	-0.01	-0.14	-0.08	-0.39	-0.25	-0.40	0.23	0.19	-0.50	-0.51	0.03	-0.15	0.04	0.11	-0.00	-0.08	-0.01	-0.12	-0.04	-0.10	-0.00	-0.14	0.04	-0.16	0.139	0.050
Switzerland	-0.03	-0.17	-0.02	-0.12	-0.06	-0.10	0.07	-0.09	-0.65	-0.92	0.03	0.12	0.12	0.19	0.02	0.01	-0.07	-0.52	-0.02	-0.06	0.01	-0.11	0.02	-0.05	0.060	0.085
U.K.	-0.09	-0.07	0.45	2.02	0.00	-0.03	10.00	10.00	9.97	9.97	0.10	0.83	-0.22	-1.81	-0.23	-1.68	-0.03	-0.54	0.02	0.14	3.32	4.22	0.05	0.07	-652.246	-525.555
Finland	-0.05	-0.19	-0.10	-0.27	-0.01	-0.02	-0.03	-0.12	-0.73	-0.88	-0.06	-0.36	0.08	-0.03	-0.02	-0.12	-0.04	-0.22	—	—	-0.06	-0.18	0.00	-0.23	43.665	54.954

[a]Change is absolute change, not percentage change, in units of local currency.

TABLE 8. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained One Percent Autonomous Increase in Japanese Real GNP. Initial Change in 1976I.

Country	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	0.00	0.01	-0.00	-0.01	-0.00	0.00	--	--	-0.01	-0.07	-0.00	-0.00	0.01	0.03	0.00	0.01	0.00	0.03	0.00	0.00	-0.00	-0.01	0.03	0.10	19.893	47.618
Canada	0.00	0.02	0.00	0.00	-0.00	-0.00	0.00	0.01	-0.01	-0.02	0.00	0.00	0.00	0.04	0.00	0.01	0.00	0.01	-0.00	-0.00	0.00	0.00	0.02	0.08	3.499	11.076
Japan	1.17	2.32	0.01	0.12	0.03	0.17	0.25	1.21	0.25	1.20	0.51	1.77	0.24	0.65	0.31	1.08	0.51	2.84	--	--	0.17	0.87	0.01	0.04	-14.041	-41.777
Austria	0.00	0.00	-0.00	0.00	-0.00	-0.00	0.00	0.08	-0.00	0.01	-0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	--	--	0.00	0.05	0.00	0.02	0.003	0.029
Belgium	-0.00	0.01	-0.00	0.00	-0.00	0.00	0.00	0.06	-0.00	0.01	-0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	-0.00	-0.00	0.00	0.04	0.00	0.02	0.026	0.131
Denmark	0.00	0.00	-0.00	-0.00	-0.00	-0.01	0.00	0.06	-0.00	-0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	0.02	0.01	0.03	0.003	0.008
France	0.00	0.01	-0.00	0.00	-0.00	0.01	0.00	0.10	-0.00	0.05	-0.00	-0.00	0.00	-0.00	-0.00	0.00	-0.00	0.01	0.00	0.00	-0.00	0.04	0.00	0.03	0.005	0.023
Germany	0.00	0.01	-0.00	0.00	-0.00	0.01	0.00	0.11	-0.00	0.06	-0.00	0.00	-0.00	0.01	-0.00	0.00	-0.00	0.01	0.00	0.00	-0.00	0.02	0.00	0.02	0.006	-0.001
Italy	0.00	0.00	-0.00	0.00	-0.00	0.01	0.00	0.09	-0.00	0.05	-0.00	0.00	0.00	0.00	0.00	0.01	-0.00	-0.00	-0.00	0.00	-0.00	0.05	0.00	0.03	0.652	3.974
Netherlands	0.00	0.01	-0.00	0.00	-0.00	0.02	0.00	0.07	-0.00	0.02	-0.00	-0.01	0.00	0.01	0.00	0.00	-0.00	0.01	-0.00	-0.00	0.00	0.06	0.00	0.02	0.003	0.015
Norway	0.00	0.00	-0.01	-0.02	-0.00	-0.01	0.00	0.03	-0.01	-0.05	-0.00	-0.01	0.00	0.01	0.00	0.00	--	--	-0.00	-0.00	0.00	0.03	0.00	0.02	0.006	0.017
Sweden	0.00	0.01	-0.00	-0.30	-0.00	-0.00	0.00	0.08	-0.00	0.03	-0.00	-0.00	-0.00	0.01	-0.00	0.00	-0.00	0.00	-0.00	0.00	0.00	0.02	0.00	0.03	0.003	0.004
Switzerland	0.00	0.02	0.00	0.00	-0.00	0.00	0.00	0.12	-0.00	0.06	-0.00	-0.00	0.00	0.03	0.00	0.01	0.01	0.05	-0.00	0.00	0.00	0.03	0.01	0.04	0.001	0.000
U.K.	0.00	0.01	-0.00	0.00	0.00	0.00	0.00	0.08	-0.00	0.04	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	-0.00	0.02	0.01	0.03	0.912	-0.190
Finland	-0.00	0.01	-0.00	0.00	-0.00	-0.00	0.00	0.07	-0.00	0.01	-0.00	0.00	0.00	0.01	-0.00	0.00	-0.00	0.00	--	--	-0.00	0.06	0.00	0.02	0.419	4.926

[a] Change is absolute change, not percentage change, in units of local currency.

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

In this case, unlike in the German and U.K. cases, 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 (equation 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 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 and an increase in U.S. GNP, although the effects on GNP were very small.

TABLE 9. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained Ten 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		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-0.00	0.02	-0.07	-0.18	-0.02	-0.03	--	--	-0.55	-0.67	-0.00	-0.01	0.10	0.19	0.02	0.07	-0.00	0.02	-0.01	-0.02	-0.07	-0.18	-0.20	-0.45	99.103	25.463
Canada	-0.01	-0.03	-0.01	-0.09	-0.01	-0.04	0.01	0.04	-0.18	-0.28	0.01	0.05	0.01	0.02	0.00	0.01	-0.01	-0.03	-0.00	-0.02	-0.01	-0.08	-0.07	-0.15	16.784	12.638
Japan	0.16	0.69	0.11	0.19	0.23	0.04	10.00	10.00	9.97	9.91	0.07	0.57	-1.95	-4.13	-0.04	0.18	0.04	0.69	--	--	6.42	6.49	0.03	0.00	-91.011	35.929
Austria	-0.00	-0.02	-0.01	-0.03	-0.00	-0.01	0.11	0.54	-0.05	0.10	-0.00	-0.02	0.00	0.02	-0.00	-0.01	-0.01	-0.03	-0.00	-0.02	0.06	0.34	-0.01	-0.03	0.059	0.226
Belgium	-0.01	0.00	-0.01	-0.03	-0.02	-0.08	0.10	0.40	-0.05	0.04	-0.00	-0.03	0.01	0.06	-0.00	0.07	-0.01	0.00	-0.01	-0.03	0.05	0.21	-0.04	-0.08	0.374	1.148
Denmark	-0.03	-0.12	-0.01	-0.05	-0.03	-0.12	0.10	0.34	-0.08	-0.06	-0.00	-0.03	0.02	0.06	-0.02	-0.09	-0.03	-0.15	-0.00	0.01	0.03	0.12	-0.01	-0.03	0.017	0.039
France	-0.00	0.02	-0.00	0.02	-0.00	0.04	0.16	0.68	0.05	0.37	-0.00	-0.01	0.00	-0.06	-0.00	0.00	-0.00	0.02	-0.00	0.01	0.05	0.27	-0.01	-0.05	0.035	0.068
Germany	-0.00	-0.01	-0.00	0.00	-0.01	-0.01	0.17	0.61	0.02	0.29	0.00	0.00	-0.00	-0.01	0.00	-0.00	-0.00	-0.02	-0.00	0.03	0.02	0.11	-0.01	-0.04	0.033	-0.104
Italy	0.00	-0.02	-0.00	0.06	0.00	0.12	0.13	0.61	0.02	0.32	0.00	-0.03	0.00	-0.03	0.00	-0.03	-0.00	-0.05	-0.00	-0.00	0.07	0.36	-0.01	-0.02	5.050	17.280
Netherlands	-0.00	0.03	-0.00	-0.01	-0.02	0.00	0.09	0.47	-0.06	0.11	0.01	0.01	0.01	0.04	0.00	0.06	-0.00	0.03	-0.00	0.03	0.07	0.38	-0.02	-0.02	0.044	0.125
Norway	-0.01	-0.03	-0.10	-0.18	-0.07	-0.12	0.04	0.23	-0.41	-0.42	-0.07	-0.16	0.01	0.08	0.00	0.01	--	--	-0.01	-0.03	0.03	0.17	-0.01	-0.04	0.087	0.125
Sweden	-0.00	-0.02	-0.01	-0.04	-0.03	-0.05	0.13	0.51	-0.03	0.14	0.00	-0.02	0.00	0.01	-0.00	-0.01	-0.00	-0.02	-0.00	-0.01	0.02	0.08	-0.05	-0.12	0.018	-0.003
Switzerland	-0.02	-0.06	-0.00	-0.02	-0.01	-0.02	0.18	0.68	-0.01	0.26	0.00	0.02	-0.02	-0.08	-0.00	-0.02	-0.04	-0.18	-0.00	0.02	0.03	0.13	-0.02	-0.06	0.007	0.007
U.K.	-0.00	-0.01	-0.01	-0.00	-0.00	-0.00	0.09	0.58	-0.05	0.26	-0.00	-0.01	-0.00	-0.01	0.00	0.00	-0.00	-0.01	-0.00	-0.00	0.02	0.16	-0.01	-0.03	7.557	-7.938
Finland	-0.01	-0.02	-0.01	-0.03	-0.00	-0.01	0.05	0.43	-0.12	0.02	-0.01	-0.05	0.01	0.01	-0.00	-0.01	-0.01	-0.03	--	--	0.04	0.35	-0.01	-0.03	10.754	28.606

[a]Change is absolute change, not percentage change, in units of local currency.

<u>Increase in the Price of Exports of the Oil Exporting Countries</u>

<u>(Table 10)</u>

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.

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, although 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 world-wide increase in inflation.

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

TABLE 10. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained Fifty Percent Increase in the Price of Exports of the Oil Exporting Countries. Initial Change in 1976I.

Country	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments[a]	
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-0.30	-1.16	1.22	2.96	0.25	0.02	--	--	9.98	10.80	0.03	0.21	-1.89	-4.53	-0.45	-1.44	-0.42	-2.91	0.11	0.22	1.10	2.85	-0.83	-0.79	-3043.052	-2213.703
Canada	-0.19	-1.12	0.33	1.10	0.44	0.80	-0.16	-0.71	4.42	3.59	-0.37	-1.76	-0.75	-3.48	-0.12	-0.95	-0.15	-0.90	0.15	0.40	0.28	0.91	-1.89	-4.99	-680.620	-612.397
Japan	0.03	0.41	0.81	2.91	1.91	2.39	1.47	5.05	22.84	28.58	0.06	1.53	-4.31	-12.88	-0.61	-1.69	0.01	0.21	--	--	1.56	5.44	-0.73	-0.00	-1019.925	-615.189
Austria	0.02	-0.07	0.50	0.44	0.04	0.07	-1.37	-6.29	1.65	-0.83	0.12	0.29	-0.42	-0.53	0.00	-0.12	-0.05	-0.18	--	--	-0.74	-3.96	-0.51	-0.54	-1.476	-1.931
Belgium	-0.04	-0.59	0.26	0.58	0.41	0.65	-1.12	-4.80	2.08	1.25	0.04	-0.53	-0.99	-2.17	-0.15	-1.61	-0.03	-0.58	0.03	0.17	-0.53	-2.44	-0.90	-1.01	-10.627	-14.010
Denmark	0.13	0.70	0.19	0.47	0.72	1.54	-1.32	-4.47	0.91	1.01	-0.27	-0.40	-0.82	-1.83	0.06	0.48	0.12	0.89	0.13	0.37	-0.64	-2.16	-0.70	-1.26	-0.281	-0.567
France	0.47	0.94	0.46	1.89	0.91	0.79	-1.69	-5.26	6.91	4.18	0.10	0.72	-1.47	-1.08	0.17	0.55	0.64	1.84	0.19	0.39	-0.73	-2.18	-0.64	-0.80	-6.471	-6.887
Germany	-0.40	-0.51	0.10	0.08	-0.02	-0.21	-1.47	-6.30	3.68	-0.61	-0.15	-0.33	-0.44	-1.19	-0.18	-0.68	-0.93	-1.00	-0.01	-0.06	-0.25	-1.24	-0.77	-0.21	-3.079	-0.154
Italy	-0.24	0.51	1.33	5.06	2.44	2.31	-0.40	-1.60	9.79	11.32	-0.31	-1.05	-1.40	-4.25	-0.50	-0.85	-0.51	0.82	0.53	1.22	0.12	0.39	-0.64	0.67	-960.986	-869.974
Netherlands	0.13	-1.24	0.43	1.26	0.32	-0.88	-1.21	-5.28	6.96	3.63	0.10	0.77	-1.02	-2.65	-0.08	-2.58	0.13	-1.35	0.08	0.04	-0.90	-4.09	-0.73	-0.92	-2.546	-2.301
Norway	-0.13	-0.17	0.78	1.40	0.58	0.90	-0.50	-2.43	3.11	2.42	0.42	0.94	-0.29	-1.57	-0.12	-0.44	--	--	0.08	0.28	-0.44	-2.12	-0.63	-1.77	-0.751	-0.950
Sweden	-0.17	-0.20	0.14	0.51	0.58	0.39	-2.25	-6.70	1.31	-1.74	-0.11	-0.10	-0.33	-0.95	-0.06	-0.13	-0.14	-0.15	0.09	0.14	-0.48	-1.41	-0.70	-1.16	-0.527	0.027
Switzerland	-0.27	-0.71	-0.03	-0.44	0.04	-0.25	-2.91	-10.18	-1.11	-6.24	-0.02	0.11	-0.48	-0.18	-0.11	-0.41	-0.62	-2.29	0.01	-0.10	-0.84	-3.15	-0.75	-0.17	-0.023	0.295
U.K.	-0.30	-0.71	0.32	1.30	-0.01	-0.12	-0.94	-5.51	7.15	2.34	-0.01	0.38	-0.51	-2.05	-0.37	-1.89	-0.16	-0.62	0.01	0.07	-0.12	-1.04	-0.62	0.39	-725.263	-204.003
Finland	0.10	0.22	0.45	1.08	0.06	0.17	-0.84	-5.10	3.96	2.03	0.20	1.12	-0.68	-1.14	0.05	-0.01	0.09	0.27	--	--	-0.56	-3.91	-0.48	-0.46	-326.593	-471.727

[a]Change is absolute change, not percentage change, in units of local currency.

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 ex-

ample, 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).

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 0.95 per-

cent after six quarters. For the U.K. results in Table 5 the increase

was 2.02 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 7 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 pre-

diction 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

TABLE 11. Estimated Effects of Monetary and Fiscal Policies on Inflation Through Their Effects on Exchange Rates

a = exchange rates endogenous
b = exchange rates exogenous
c = a-b

		1976 I	II	III	IV	1977 I	II	III	IV	1976 I	II	III	IV	1977 I	II	III	IV
		U.S. Spending Increase (Table 1)								U.S. Interest Rate Increase (Table 2)							
GNP Deflator	a	.07	.17	.27	.37	.45	.54	.62	.69	.04	.06	.05	.05	.04	.02	-.01	-.06
	b	.07	.16	.26	.34	.41	.47	.52	.56	.05	.07	.09	.11	.13	.15	.16	.18
	c	.00	.01	.01	.03	.04	.07	.10	.13	-.01	-.01	-.04	-.06	-.09	-.13	-.17	-.24
Price of Imports	a	-.01	.06	.16	.26	.40	.55	.70	.85	-.09	-.16	-.25	-.38	-.50	-.69	-.87	-1.18
	b	.00	.01	.03	.06	.09	.13	.15	.19	.01	.02	.03	.04	.05	.05	.05	.05
	c	-.01	.05	.13	.20	.31	.42	.55	.66	-.10	-.18	-.28	-.42	-.55	-.74	-.92	-1.23
Real GNP	a	1.02	1.43	1.61	1.67	1.59	1.39	1.16	.96	-.13	-.41	-.68	-.99	-1.30	-1.57	-1.80	-2.02
	b	1.02	1.43	1.61	1.67	1.59	1.39	1.17	.98	-.13	-.42	-.69	-1.00	-1.31	-1.58	-1.82	-2.05
	c	.00	.00	.00	.00	.00	.00	-.01	-.02	.00	.01	.01	.01	.01	.01	.02	.03
		German Spending Increase (Table 3)								German Interest Rate Increase (Table 4)							
GNP Deflator	a	.00	.29	.68	1.10	1.52	1.96	2.35	2.70	.00	-.03	-.08	-.16	-.26	-.38	-.52	-.68
	b	.00	.31	.72	1.16	1.59	2.04	2.41	2.75	.00	-.01	-.01	-.00	-.00	-.00	-.00	-.00
	c	.00	-.02	-.04	-.06	-.07	-.08	-.06	-.05	.00	-.02	-.07	-.16	-.26	-.38	-.52	-.68
Price of Imports	a	-.54	-.84	-.81	-.70	-.50	-.21	.19	.72	-.81	-1.57	-2.46	-3.40	-4.27	-5.30	-6.27	-7.37
	b	.00	.00	.01	.01	.02	.03	.03	.04	-.00	.00	-.00	-.00	-.00	-.00	-.00	-.00
	c	-.54	-.84	-.82	-.71	-.52	-.24	.16	.68	-.81	-1.57	-2.46	-3.40	-4.27	-5.30	-6.27	-7.37
Real GNP	a	1.81	2.36	2.50	2.49	2.48	2.36	2.22	2.01	-.17	-.17	-.17	-.15	-.14	-.10	-.06	.04
	b	1.82	2.34	2.46	2.44	2.41	2.31	2.16	1.93	-.17	-.19	-.20	-.21	-.26	-.29	-.34	-.32
	c	-.01	.02	.04	.05	.07	.05	.04	.08	.00	.02	.03	.06	.12	.19	.28	.36
Exchange Rate	a	-.65	-1.05	-1.06	-.95	-.74	-.39	.11	.79	-.99	-1.95	-3.05	-4.26	-5.46	-6.82	-8.18	-9.68
		U.K. Spending Increase (Table 6)								Japanese Spending Increase (Table 8)							
GNP Deflator	a	.03	.06	.13	.25	.39	.56	.74	.93	.00	.01	.02	.05	.08	.12	.16	.20
	b	.03	.06	.10	.16	.21	.26	.32	.38	.00	.01	.02	.04	.07	.10	.14	.18
	c	.00	.00	.03	.09	.18	.30	.42	.55	.00	.00	.00	.01	.01	.02	.02	.02
Price of Imports	a	.01	.70	1.27	1.99	2.74	3.16	3.33	3.48	.10	.25	.42	.66	.92	1.20	1.46	1.70
	b	.00	.00	.00	.01	.01	.01	.02	.02	.00	.00	.00	.00	.00	.00	.01	.01
	c	.01	.70	1.27	1.98	2.73	3.15	3.31	3.46	.10	.25	.42	.66	.92	1.20	1.45	1.69
Real GNP	a	1.28	1.61	1.61	1.50	1.28	1.04	.95	.85	.78	1.17	1.50	1.84	2.10	2.32	2.53	2.69
	b	1.28	1.61	1.62	1.53	1.33	1.14	1.10	1.08	.78	1.17	1.49	1.82	2.07	2.28	2.47	2.60
	c	.00	.00	-.01	-.03	-.05	-.10	-.15	-.23	.00	.00	.01	.02	.03	.04	.06	.09
Exchange Rate	a	.01	.07	1.26	1.98	2.71	3.12	3.27	3.40	.10	.25	.42	.66	.93	1.21	1.47	1.71

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 8 quarters and consider the ratio of the c-row value to the a-row value. This ratio is .19 for the U.S. (.13/.69), -.02 for Germany (-.05/2.70), .59 for the U.K. (.55/.93), and .10 for Japan (.02/.20). The effect for the U.K. 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 -.68 percentage points. For the U.S. the effect after eight quarters is .18 in the exogenous case and -.06 in the endogenous case, for a difference of -.24.

VI. Conclusion

The results in this paper 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 Japan, but decreases it for Germany and the U.K. (Tables 5, 7, and 9). Also, a spending increase leads to a depreciation in Japan, but to an appreciation in Germany and the U.K. (Tables 3, 6, and 8). A spending increase in the U.S. has noticeably different effects on different countries (Table 1).

The results also 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

TABLE A-1. Countries in the Model

Country	Local Currency	Country	Local Currency
1. United States	U.S. Dollars (mil.)	36. Argentina	Arg. Pesos (bil.)
2. Canada	Can. Dollars (mil.)	37. Brazil	Cruzerios (bil.)
3. Japan	Yen (bil.)	38. Chile	Chile Pesos (mil.)
4. Austria	Schillings (bil.)	39. Colombia	Col. Pesos (mil.)
5. Belgium	Bel. Francs (bil.)	40. Mexico	Mex. Pesos (bil.)
6. Denmark	Den. Kroner (bil.)	41. Peru	Soles (bil.)
7. France	Fr. Francs (bil.)	42. Egypt	Egy. Pounds (mil.)
8. Germany	D. Mark (bil.)	43. Israel	Isr. Pounds (mil.)
9. Italy	Lire (bil.)	44. Jordan	Jor. Dinars (mil.)
10. Netherlands	Guilders (bil.)	†45. Lebanon	Leb. Pounds (mil.)
11. Norway	Nor. Kroner (bil.)	46. Syria	Syr. Pounds (mil.)
12. Sweden	Swe. Kroner (bil.)	†47. Bangladesh	Taka (mil.)
13. Switzerland	Swiss Francs (bil.)	†††48. Republic of	
14. United Kingdom	U.K. Pounds(mil.)	China (Taiwan)	N.T. Dollars (bil.)
15. Finland	Markkas (mil.)	†49. Hong Kong	H.K. Dollars (bil.)
16. Greece	Drachmas (bil.)	†50. India	Ind. Rupees(bil.)
17. Ireland	Irish Pounds (mil.)	51. Korea	Won (bil.)
18. Portugal	Escudos (bil.)	52. Malaysia	Ringgit (mil.)
†19. Romania	Lei	53. Pakistan	Pak. Rupees (mil.)
20. Spain	Pesetas (bil.)	54. Philippines	Phil Pesos (mil.)
†21. Turkey	Liras (bil.)	†55. Singapore	Sing. Dollars (mil.)
22. Yugoslavia	Dinars (bil.)	56. Thailand	Baht (bil.)
23. Australia	Aust. Dollars (mil.)	††57. Bulgaria	
24. New Zealand	N.Z. Dollars (mil.)	††58. China (Mainland)	
25. South Africa	Rand (mil.)	††59. Cuba	
†26. Algeria	Alg. Dinars (mil.)	††60. Czechoslovakia	
†27. Indonesia	Rupiahs (bil.)	††61. E. Germany	
28. Iran	Rials (bil.)	††62. Hungary	
†29. Iraq	Iraq Dinars (mil.)	††63. Poland	
†30. Kuwait	Ku. Dinars (mil.)	††64. USSR	
31. Libya	Lib. Donars (mil.)		
32. Nigeria	Naira (mil.)		
33. Saudi Arabia	Riyals (bil.)		
†34. United Arab Emirates	Dirham (mil.)		
35. Venezuela	Bolivares (mil.)		

†No estimated equations for this country.

††No estimated equations for this country and only direction of trade data available.

†††Recently eliminated from the IMF data tapes.

REFERENCES

Ball, R. J., ed. The International Linkage of National Economic Models.
    Amsterdam: North-Holland, 1973.

Dornbusch, Rudiger. "Capital Mobility, Flexible Exchange Rates and Macro-
    economic Equilibrium." In Recent Developments in International
    Monetary Economics, edited by E. Claassen and P. Salin. Amsterdam:
    North-Holland, 1976.

Fair, Ray C. A Model of Macroeconomic Activity. Vol. 1. The Theoretical
    Model. Cambridge, Mass.: Ballinger, 1974.

_____. A Model of Macroeconomic Activity. Vol. 2. The Empirical
    Model. Cambridge, Mass.: Ballinger, 1976.

_____. "A Model of the Balance of Payments." Journal of International
    Economics. 9 (February 1979): 25-46.

_____. "The Fair Model as of August 1, 1980." Mimeographed. New
    Haven, Conn.: Yale University, 1980.

_____. "A Multicountry Econometric Model." Cowles Foundation Dis-
    cussion Paper No. 541R, revised April 30, 1981.

_____ and William R. Parke. "The Fair-Parke Program for the Estima-
    tion and Analysis of Nonlinear Econometric Models." Mimeographed.
    New Haven, Conn.: Yale University, March, 1981.

Frenkel, Jacob A. and Harry G. Johnson, eds. The Monetary Approach to
    the Balance of Payments. Toronto: University of Toronto Press, 1976.

Frenkel, Jacob A. and Carlos A. Rodrigues. "Portfolio Equilibrium and
    the Balance of Payments: A Monetary Approach." The American Economic
    Review. 65 (September 1975): 674-88.

Hickman, Bert G. "International Transmission of Economic Fluctuations
    and Inflation." In International Aspects of Stabilization Policies,
    edited by Albert Ando, Richard Herring, and Richard Martson. Boston:
    Federal Reserve Bank of Boston, 1974.

Kouri, Penti J. K. "The Exchange Rate and the Balance of Payments in the
    Short Run and in the Long Run." Scandinavian Journal of Economics.
    2 (May 1976): 280-304.