An Econometric Evaluation of International Monetary Policy Rules: Fixed versus Flexible Exchange Rates

by

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Most international monetary policy questions still boil down to the classic choice between a flexible exchange rate system and a fixed exchange rate system. Of course, neither system is a complete specification of monetary policy. With flexible exchange rates, there are still questions about which monetary policy rule is best for each country, and whether there are gains from coordinating policy among countries. Even with fixed exchange rates and highly mobile capital, questions remain about which countries should sacrifice their monetary policy to maintain the fixed rates, whether the responsibility should be shared by all countries, and finally whether an active monetary policy rule for the world money supply--as constrained by the fixed exchange rate system--is desirable.

The fixed versus flexible exchange rate question is now a focal point in discussions of international policy reform. At the most recent economic summit in Tokyo, for example, an agreement was reached to reduce the size of exchange rate fluctuations. This agreement is viewed by many commentators as a move towards a fixed exchange rate system. Despite the importance of this question of fixed versus flexible exchange rates there have been few empirical studies that have attempted to evaluate such international monetary systems quantitatively. To my knowledge there have been no econometric policy evaluations that have dealt with expectational issues and capital mobility, both of which are widely viewed as crucial to exchange rate behavior. Policy advisors have had to rely on purely theoretical studies or intuitive judgements. Theoretical studies can and have been successful in pointing to the parameters on which the answer to the question will depend: the fixed exchange rate system will work better if the shocks to certain sectors are in a specified range and are correlated with shocks to other sectors in particular ways, and if the demand and supply elasticities are in a certain range. The flexible exchange rate system will work better under other circumstances. To get any further than this requires empirical work.

The purpose of this paper is to evaluate and compare flexible versus fixed exchange rate systems using a rational expectations policy evaluation technique that has been developed in recent years. The econometric approach is a multicountry generalization of one that I have used previously (for example, Taylor (1979)) to evaluate empirically monetary policy rules for a closed economy: a rational expectations model is estimated using macro time series data, and the model is then stochastically simulated under alternative assumptions about policy rules using the estimated covariance matrix. The different rules are ranked according to the fluctuations in real GNP and inflation about given targets. In some cases no policy dominates in terms of both criteria. In these cases a social utility function that balances the two criteria must be specified. The stochastic simulation of a rational expectations structural model explicitly deals with the Lucas (1976) critique of traditional econometric policy evaluation methods which do not use rational expectations.

Partly for computational reasons and partly for the purpose of narrowing the range of alternative policies to an easily digestable list, the analysis reported in this paper is limited in two ways. First, I only consider flexible exchange rate systems in which the growth rate of the money supply in all countries is fixed, and I only consider fixed exchange rate systems in which the money supply in one country--the United States--is fixed. In addition, fiscal policy is assumed to be exogenous and held fixed when comparing the two regimes. As suggested in the opening paragraph there are many alternatives to these monetary assumptions, including feedback rules for money supply, interest rate rules and nominal GNP rules. Second, in the stochastic simulations I only consider "price" or "supply" shocks, and the stochastic simulations are conducted for only a small number of quarters. In future research I plan to stochastically shock all equations in the system using the estimated covariance matrix of the residuals: in fact, the ability to use this covariance matrix rather than consider one type of shock at a time is perhaps the greatest advantage of an econometric approach as opposed to a simulation approach. Interpretation of such a complex stochastic simulation, however, will undoubtably require some partial experimentation with a limited number of shocks as provided in this study. Some of the alternative monetary assumptions have been explored previously using simulation models that are not empirically estimated (see Carlozzi and Taylor (1985), for example) and I plan to investigate such alternatives empirically in a later phase of this research project.

Though subject to these limitations, this policy evaluation gives rather sharp results. In particular, it suggests that there are significant advantages of a flexible exchange rate system (as defined here) compared to a fixed exchange rate system (as defined here): when all economies are subject to independent "price" shocks, the variance of output is significantly less for most countries under a flexible exchange rate system, and insignificanty greater for the other countries.

The paper is organized as follows. Section 1 summarizes the econometric model. Section 2 describes the workings of the model using deterministic simulations. Section 3 describes the stochastic policy evaluation procedure and the policy results.

1. Brief Description of the Model

The econometric model is built to explain short-run economic fluctuations in seven industrialized countries: the United States, Canada, France, Germany, Italy, Japan, and the United Kingdom. It is a quarterly model fit to data largely from quarterly national income accounts. The parameters of the model are based on quarterly observations from 1971 through 1985 with the exact starting and ending quarters depending on the type of equation (number of leads and lags) and data availability.

The definition of the variables used in the model and the notation is described in Table 1. A listing of the model equations is found in Table 2. The equations are presented with numerical parameter values. The functional forms and the number of lags and leads are chosen to correspond with the empirical findings. The details of how the particular functional forms were chosen, as well as the estimation procedures and the statistical properties of the estimates are described in Taylor (1986, Ch. 4). I only summarize the equations here.

The rational expectations assumption is a highlight of the model. To be sure this assumption may not be appropriate in periods immediately following a policy reform (when market participants are learning about the policy), but it does seem appropriate for estimating the longer-term effects of a new policy. Expectations are assumed to be rational in all markets--labor markets as well as financial markets. Hence, wages are both "sticky" and "forward-looking." Monetary policy has an effect on real output, though of a qualitatively different type than in Keynesian models without rational expectations.

The financial side of the model is a disaggregated version of the Mundell-Fleming approach to international financial markets with perfect capital mobility and with perfect substitution between assets. The nominal interest rate spread between each pair of countries is equal to the expected rate of change in the exchange rate between the same two countries. In the classic Mundell-Fleming model the interest rates are equalized because expectations of exchange rates are not considered. In this model expectations of exchange rate changes are forward looking and are computed using the entire model.

Although capital flows between countries may be quite large, the perfect capital mobility approximation does not require that these flows be calculated explicitly. Even in the case of fixed exchange rates it is not necessary to compute how much foreign exchange the central banks must absorb.

According to the model, aggregate demand determines output in the short run as the aggregate wage and price level are essentially predetermined in each quarter--only a fraction of the workers adjust their wages each quarter. Aggregate demand is built up from disaggregated spending decisions--consumption, investment, government, and net exports. The important price variables in these demand equations are the real interest rate (rational expectations of future inflation are a factor here) and the relative price of domestic goods to foreign goods (the exchange rate is a factor here).

Consumption is disaggregated into durables, nondurables, and services in most of the countries. Negative real interest rate effects are found for durables in the U.S., Canada, and Japan, and for total consumption in Germany. The real interest rate effect is small in the other equations.

Investment depends with a lag on changes in demand and on the real interest rate. For most countries investment is disaggregated into equipment, nonresidential structures, residential structures, and inventory investment. Only total fixed investment equations were estimated for Germany and Italy. No inventory equation was estimated for Italy because of data limitations. There are a total of 22 investment equations. With the exception of equipment investment in France, the real interest rate has a strong negative impact on investment for every country and every type of investment, including inventory investment. The "accelerator" terms relating investment to changes in demand are also strong.

Government spending is exogenous so the remaining component of aggregate demand in the model is net exports. Imports and exports depend on the ratio of the price of imports to the price of exports. In addition imports depend on domestic output, and exports depend on a weighted average of output in the other countries. Imports and exports are not disaggregated by type of good in the model. The equations are in logarithmic form for each country. For each equation, an increase in the relative price of exports to imports increases import demand and lowers export demand. These equations are dynamic (lagged dependent variables are included in the estimated equations). In the short run, the elasticity is less than in the long run.

Wages in the model are determined according to the staggered contract approach used in Taylor (1980). That is, wages are assumed to be bid up relative to expected future wages and prices if aggregate demand (as measured by actual output) is above potential output. Potential output is assumed to grow at a constant rate. There is no impact of increases in the capital stock on potential output, however.

Output prices are set according to a markup over wages and import prices with an allowance for trend increases in productivity and demand effects in some countries. A lagged dependent variable allows for slow adjustment so that margins fall in the short run after an increase in wages or import prices. Eventually the full wage and import price increase is passed through. The coefficient on wages is about 5 times as large as the coefficient on import prices for the United States. With the exception of Canada and Italy the coefficient on wages is larger than the coefficient on import prices.

For each of the seven countries import prices are assumed to depend directly on an average of prices in the rest of the world converted into domestic currency units using the exchange rate between each country. The effect of exchange rates on domestic prices occurs through this channel in that domestic prices are affected by import prices as described above. Export prices, on the other hand, are assumed to move immediately in response to domestic prices.

The determination of interest rates and exchange rates in the different countries can be explained recursively even though the determination is in fact simultaneous. Suppose that the money supply is exogenous in each country as would be possible in the case of flexible exchange rates. Standard partial adjustment money demand equations for each country are inverted to give an equation for the short term interest rate. The short term interest rates are then used to determine long term rates through a forward looking term structure equation: the long rate is assumed to be a geometric distributed lead of the short rate. Finally, the exchange rate is related to the differential between interest rates in each country according to uncovered interest rate parity.

Taking the money supply and government spending in each country as exogenous, the model consisting of the above equations can be solved in each period for the endogenous variables. Rational expectations of future variables appear throughout the model: expectations of future prices appear in the durable consumption and investment equations (in computing the real interest rate), expectations of future exchange rates appear in the exchange rate equations, expectations of future interest rates appear in the term structure equations, and expectations of future wages, prices, and output appear in the wage equations. The solution is performed numerically using the extended path algorithm discussed in Fair and Taylor (1983). With the software I am now using each solution of the model for one quarter takes about 5 to 30 minutes of CPU time on an IBM 4381. For a deterministic solution the intermediate calculations of future periods--necessary in a rational expectations model--can be used to get the predicted values for these periods without additional calculations.

2. Deterministic Simulations

In this section I report on the effects of unanticipated changes in monetary and fiscal policy on the the endogenous variables both for the case of fixed exchange rates and for the case of flexible exchange rates. In particular I look at the effects of two unanticipated policy shocks: a permanent increase in the U.S. money supply and a permanent increase in real U.S. government spending. The effects of the shocks on the behavior of output, investment, consumption, the trade balance, inflation, exchange rates and other key variables in the seven countries are examined by deterministically simulating the multicountry model. In addition to providing answers to practical questions about one-time changes in policy, these deterministic simulations provide important information about the dynamic properties of the model under both fixed and floating exchange rates. The usefulness of these deterministic simulations for this purpose remains even if these rather special one-time anticipated or unanticipated changes in the paths of the policy instruments do not usually occur. (The effect of anticipated changes in policy can also be evaluated with this model as reported in Taylor (1986, Ch.5)).

Because the model is nonlinear, the period over which one conducts policy experiments can in principle make a difference for the results. In practice, however, I have found that the time period of the simulation and the level of the variables makes only small differences for this model. For these experiments I look at the period from 1975.1 through 1984.4. The first period that the policy instruments differ from the baseline values is 1975.1, and I report the results through 1984.4.

During the simulation period the historical "residuals" of all the equations are put back into the equations so that in the baseline simulation the endogenous variables track the actual historical values perfectly--a perfect tracking solution. The "residuals" used here are computed as if the future expectations of the endogenous variables that appear in the model are equal to the actual values. These residuals therefore include not only the shocks to the equations, but also the forecasting errors. Taken literally, this means that a person forming expectations of the future in 1975.1 is assumed to know with perfect certainty the shocks to all the equations in future periods. While this is not meant to be realistic, the historical path is a natural baseline for such comparisons. Moreover, as already mentioned the results of the experiments on this model--stated as percentage deviations of the variables from the baseline path--do not seem to be much affected by the choice of baseline path or historical period.

All the experiments involve changes in the U.S. money supply or government spending. With flexible exchange rates the levels of money supplies in the other countries are held to the baseline path. With fixed exchange rates only the U.S. money supply is exogenous: all other countries manipulate their money supplies to keep their currencies pegged to the dollar. While this characterization of fixed exchange rates is probably an historically accurate description of the dollar standard that existed under Bretton Woods, it is not the only fixed exchange rate system. McKinnon (1984) for example has proposed that this asymmetry be replaced by a fixed exchange rate system in which world money growth--a weighted average of money in the different countries--be held constant.

The results of all the deterministic experiments are reported in graphical form in the Figures 1 through 4 at the end of the paper. The charts show the percentage deviation of a particular variable--GNP, the price level, etc.--from the baseline path. (Note that in the case of interest rates, the charts do not show basis points. Note also when the change is small relative to the baseline--as in the case of interest rates--that the fluctuations in the percentage change can be influenced by fluctuations in the baseline path).

2.1 Flexible Exchange Rates.

I first look at the effects of the increase in the money supply and then at the effects of an increase in government spending.

Monetary Expansion

Consider the case of a one time unanticipated 3 percent increase in the level of the U.S. money supply relative to its baseline, which is phased in gradually to prevent erratic interest rate behavior at about 3/4 percentage points for the first four quarters. Although unanticipated at the time of the initial increase, the rest of the path of the money supply is assumed to be incorporated into people's forecasts. In other words, they know that the increase is permanent.

Money is neutral in the long run. Hence, in the long run the level of the U.S. price level should increase by 3 percent along with U.S. nominal wages and other U.S. prices, and the dollar exchange rate should depreciate by 3 percent. U.S. real

GNP, the components of GNP, interest rates and the real exchange rate should return to the baseline. In the other countries, all variables--real and nominal--should return to the baseline.

The difficult questions concern what happens between the time of the money increase and the long run. The Mundell-Fleming fixed price models which ignore exchange rate expectations, predict an expansion of output in the U.S. and a contraction of output in the rest of the world. The Dornbusch (1976) model, which incorporates rational exchange rate expectations, predicts that the dollar will depreciate at the time of monetary expansion by more than it does in the long run.

The predictions of the empirical model are shown in Figures 1a through 1f. There is a sharp expansion in U.S. output in the first year reaching a peak of 1-1/4 percent above the baseline after four quarters, and then dissipating monotonically over the next two years. The U.S. price level rises gradually as does the nominal wage level, the slow movement due to the staggered wage setting assumptions. Short term interest rates drop by a maximum of about 220 basis points in the fourth quarter into the simulation, and then overshoot the baseline before returning to normal. (Recall the units are percentage change in the graph.) The long term interest rate fluctuates with a similar time pattern, but is naturally attenuated relative to the short term rate. There is probably no simple explanation for the overshooting of the interest rates, except that the real interest rate can remain below normal even though the nominal rate is above normal when the expected rate of inflation is above the baseline path. In any case this fluctuation in nominal interest rates will require fluctuation in the expected exchange rate, as I describe below.

There are no surprises in the behavior of consumption and investment. The pattern of durable consumption is more peaked than nondurables because of the effects of the lower real interest rate on durables. (Services consumption also has a negative real interest rate elasticity in the U.S. and thereby has a more peaked response to the monetary shock). Of the components of investment, producers equipment rises by most in percentage terms, and structures (with a relatively low interest rate elasticity) has the smoothest response.

The response of exchange rates is shown in Figure 1d. Note that the real and nominal dollar exchange rate moves by about the same amount with respect to all the other currencies. The pattern of the nominal exchange rate is consistent with the pattern of interest rate differentials. The dollar quickly depreciates (jumps) by more than 3 percent, and then appreciates during the period that the U.S. interest rate is below interest rates in the rest of the world. The appreciation takes the dollar above the long run equilibrium, however, and the dollar then begins to gradually depreciate to 3 percent below normal. During this depreciation the U.S. short term interest rate is above world levels. The real exchange rate response is simpler than the nominal exchange rate. There is a jump depreciation followed by a smooth appreciation back to normal.

The trade balance is dominated by the large fluctuation in imports. Exports fluctuate by a relatively small amount. Both the price and income elasticities are smaller in the export equation, than in the import equation for the U.S. Moreover, demand in the other economies does not fluctuate by much. Hence, the trade balance goes toward deficit, in response to a monetary expansion. The favorable effects on the trade balance of the dollar depreciation are apparently overwhelmed by the negative effects of the expansion in the U.S economy.

The effects of the U.S. monetary expansion on the other countries output and prices are clearly small. The short term effects on output are positive, unlike the simple Mundell-Fleming model, but they are probably insignificantly different from zero in a statistical sense. It appears that most of the positive effect on output in the other countries is due to the increased demand for their products from the U.S.

For all countries except France, the price level declines relative to the baseline path. The appreciation of the currencies has a negative effect on inflation. In the case of France this is offset by the larger expansion in demand for domesticaly produced goods which drives up wages and prices.

Fiscal Expansion

Now consider an unanticipated increase in government spending in the U.S. in 1975.1 of $27 billion, or one percent of GNP in that first year, and remaining at one percent of historical GNP in all remaining years. This represents a permanent fiscal shock with a magnitude fixed both in real terms and in terms of the growing trend in real GNP.

What happens in the long run? If such a fiscal shock is neutral on real GNP in the long run, then the non-government components of GNP (consumption, investment, and net exports) should decline in the long run by the increase in government spending. Prices, wages, interest rates, and the real exchange rate in the U.S. should permamently rise. Prices and interest rates in other countries should also permanently rise in the long run in order to offset the stimulative effects of the depreciated currencies in those countries. However, the magnitudes of all these long run effects depend on the long run elasticities.

Figures 2a through 2f describe what happens according to the multicountry model during the ten years following such a fiscal shock. Real GNP in the U.S. increases quite sharply during the first year, and then gradually returns to the baseline path. The increase in GNP implies that the government spending multiplier for the U.S. is 1.21 in the first quarter, 1.87 in the second quarter, and then begins to fall, reaching 1.67 in the third quarter and steadliy moving towards zero in later quarters. The large multiplier during the first year is due to the increase in real interest rates that occurs after the fiscal shock becomes known. The fiscal expansion implies that inflation must rise in the future. People realize this and adjust their inflationary expectations up accordingly. By definition this reduces the real interest rate and stimulates consumption and investment demand. In fact, prices do increase in the simulations and there is some "crowding in" of durable consumption and investment. Eventually, however, the expected rate of inflation returns to the baseline value and the real interest rate increases crowding out these components of demand. In the long run prices must rise by 5 percent to reduce real money balances by a sufficient amount to increase nominal interest rates and perform the crowding out function. Interest rates rise by about 5 percent in the long run, as does the real exchange rate in dollar terms.

The effect of the fiscal expansion is to cause a trade deficit, as imports rise and exports fall. The appreciation of the dollar generates this effect, especially in the long run when output is back to normal. The decline in net exports is a type of crowding out and occurs both in the short run and in the long run. In terms of savings and financial flows the trade deficit is the counterpart of the fiscal budget deficit. Foreigners are buying Treasury bills to help finance the American budget deficit. In this model with perfect capital mobility this situation will continue until the government budget deficit is reduced.

The effect of the fiscal expansion in the rest of the world is shown in Figures 2c through 2f. There is a positive effect on output in all the other countries, with Japan and Germany having the smallest impact and Canada the largest. The effects are smaller than in the U.S. but not insignificant as in the case of a monetary expansion. Prices rise in all other countries, but by less than in the U.S.

The trade balance improves in all the other countries because of the depreciation of their currencies. Because this increase in net exports stimulates demand it must eventually be offset by a decline in investment and durable consumption. Hence, interest rates in the rest of the world rise. As exchange rates settle down to the baseline, this increase in world interest rates matches that in the U.S.

2.2 Fixed Exchange Rates.

Now suppose that exchange rates are fixed. The U.S. money supply and the six bilateral exchange rates are exogenous. The money supplys in the other six countries are endogenous as these countries manipulate their money supplies to keep their exchange rate pegged to the dollar. Technically the model is changed in two ways. First, the short term interest rate equations in all countries except the U.S. (the inverted money demand equations) are rearranged with money on the left hand side. Hence, money is the endogenous variable. Second, the interest rates in all countries are made endogenous by placing them on the left hand side of the interest rate parity equations. In other words, interest rates in the other countries are explained by the movements in the U.S. interest rate plus any residual in the interest rate parity equations. Of course the expected change in the exchange rate is assumed to be zero in the interest rate parity equations.

Monetary Expansion

Again consider an unanticipated increase in the U.S. money supply of 3 percent. Since money is neutral in the long-run, prices and wages in the U.S. will eventually increase by 3 percent and output and the components of demand will return to their baseline values. With exchange rate fixed, prices and wages in all the other countries must also eventually increase by 3 percent. The money supplies in all the other countries will increase by 3 percent to bring about the required inflation. In the long-run, output and the components of demand in the other countries also return to the baseline path.

In the short-run there will be effects on output, the components of demand, and the trade balance. The impact on real GNP is shown in Figure 3. The results are much different from the flexible exchange rate case where U.S. output expanded by about 1-1/4 percent and there was almost no effect on output in the other countries. With fixed exchange rates the impact on U.S. GNP is still about 1-1/4 percent, and the effects on the domestic spending components of GNP in the U.S. are very similar to the flexible exchange rate case. Short term interest rates in the U.S. fall slightly more in the fixed exchange rate case, but there is less overshooting. The big difference is in the effect on the other countries as is evident from comparing Figures 1c and 3c. With exchange rates fixed Japan's GNP expands by almost the same amount as the U.S. and Germany's GNP expands by almost three times as much in percentage terms. Recall that in the case of flexible exchange rates there was almost no change in the GNP in the other countries in response to this U.S. monetary shock. There is also a big difference in the behavior of prices and inflation in the other countries in comparison with the flexible exchange rate case. In the long run prices rise by 3 percent, but the adjustment is neither smooth nor uniform across all countries.

The reason for these output and price differences is clear from Figure 3e where the endogenous movements in the money supply in the other countries is shown. In order to keep the exchange rates on target, the foreign central banks must expand their money supplies when the Fed's monetary expansion puts downward pressure on short term interest rates. The resulting monetary expansion is largest in Germany and the U.K. In all countries the monetary expansion overshoots in the sense that the increase in the first year or two is greater than the long run increase of 3 percent. These monetary expansions in turn stimulate demand in these countries because wages and prices adjust slowly. Real money balances rise, and nominal interest rates fall along with the U.S. interest rates. Real interest rates in the other countries drop, possibly by more than in the U.S., because wages and prices rise (and are expected to rise) at different rates than in the U.S. The drop in real interest rates affects investment and durable consumption by amounts that depend on the size of real interest rate elasticities. As the simulations show, the effect in the other countries of the U.S. monetary expansion can even be larger than in the U.S.

It is interesting that the U.S. monetary expansion has a bigger effect on U.S. exports in the case of fixed exchange rates. This is primarily due to the larger expansion in the other countries. The ratio of U.S. export prices to U.S. import prices rises in the case of a U.S. monetary expansion with fixed exchange rates, but falls in the case of flexible exchange rates. For this reason U.S. imports rise by a greater amount when there is a monetary expansion under fixed exchange rates. The price effect works in the same direction as the income effect.

Fiscal Expansion

The final deterministic experiment is a shock to U.S. government spending in the case of fixed exchange rates. The size and timing are exactly the same as the fiscal shock in the flexible exchange rate case. The results are therefore directly comparable: fixed rates in Figure 2, flexible rates in Figure 4. The effects of the fiscal shock are much the same in the U.S. in the case of flexible exchange rates and fixed exchange rates. Real GNP rises by about the same amount in the short run as do interest rates. The components of demand fluctuate by about the same amount. The behavior of U.S. import prices is surprisingly similar in the fixed and flexible exchange rate cases. With flexible exchange rates U.S. import prices first fall because the dollar immediately appreciates, but then rise as inflation picks up abroad. With fixed exchange rates import prices first fall because prices abroad fall, and then rise again with foreign prices.

The biggest difference between the effects of a fiscal shock with fixed and flexible exchange rates is found in output behavior in the other countries. With flexible exchange rates output expands slightly abroad when the U.S. fiscal shock hits. The appreciation of the U.S. dollar and the demand effects emanating from the U.S. are the sources of this expansion. In the case of fixed exchange rates, the U.S. fiscal shock causes a severe contraction in output in the other countries. The decline in output in Germany is especially severe--about 5 percent relative to the baseline. Canadian GNP falls by over 2 percent, and the other countries by about one percent.

The reason for this contraction abroad is the reduction in money growth necessary to keep the exchange rate fixed in the face of upward pressure on interest rates in the United States. With fixed exchange rates, the other countries monetary authorities must increase their interest rates to match the increase in U.S. interest rates that occurs during the fiscal expanion. Clearly flexible exchange rates provide a cushion in other countries against fiscal shocks in the U.S. which is lost when exchange rates are pegged.

The last set of results would be somewhat different if the U.S. had sacrificed some of its monetary independence along with the other countries. In other words if the growth rate of a weighted average of world money growth were fixed rather than U.S. money growth, then the contraction in the other countries would have been smaller. The U.S. would have expanded its money supply somewhat thereby reducing the increase in interest rates and allowing the other countries to get away with smaller monetary contractions. However, this "accommodative" monetary policy in the U.S. would have exacerbated the effects on output of the fiscal shock in the U.S.

Linear combinations of the above experiments would generate approximately linear combinations of the results. For example, a decline in U.S. government spending of one percent of GNP would be contractionary in the U.S. and expansionary abroad by about the same absolute magnitude as the above experiment. If the decline in government spending had been partly accommodated by the Fed so as to share the sacrifice of fixed exchange rates, then the decline in GNP in the U.S. would be larger, and the increase in GNP in the rest of the world would be smaller. Similarly, a decline in the U.S. money supply with fixed exchange rates would cause a contraction in the U.S. and the rest of the world of roughly the same magnitude as the increase documented above.

3. Stochastic Policy Evaluation

As discussed in the introduction an advantage of an econometric approach to the evaluation of alternative monetary systems is that the stochastic shocks--including their covariance--can be chosen to correspond exactly to the shocks observed during the historical sample period. This requires that the residuals be computed during the sample period and then used to estimate a covariance matrix. The model can then be stochastically simulated by drawing new shocks from this estimated covariance matrix. The estimation of the covariance matrix is thus as integral to the policy evaluation as the estimation of the parameters of the equations of the model.

In the stochastic simulations reported here we stop short of computing the full covariance matrix. Instead we draw shocks for only a select group of equations. In particular we suppose that only the "contract" wage equations (the X equations in Table 2) are hit by disturbances. The wage equations in all the countries are hit by shocks with the same distribution--normal with mean zero and standard deviation of 1/2. The shocks are assumed to be independent across countries and across time. In this model nominal wage shocks have effects similar to nominal price shocks, or what are sometimes called supply shocks.

This is the same type of stochastic simulation that was used by Carlozzi and Taylor (1985) in a small simulation model to investigate the potential for coordinating policies in different countries. Hence it is useful for comparion purposes. Moreover, there is a sense in which the shocks to the wage equations are more fundamental for policy considerations. In a textbook world of flexible exchange rates at least, shocks to the aggregate demand equations or to the liquidity preference relations could in principle be offset by appropriate monetary or fiscal policy changes. Shocks to wage equations cannot be completely offset, however. For this reason abstracting from spending and money demand shocks and focussing on wage shocks is a natural first experiment.

The stochastic simulations were performed both for the fixed exchange rate regime and for the flexible exchange rate regime. The period for the experiment is 1987:1 through 1989:4. That is, the same set of random shocks were drawn twice. In the first case the world entered the remainder of the 1980s with a flexible exchange rate system. In the second case the world entered the remainder of the 1980s with a fixed exchange rate system. The question is which world would look better in terms of macroeconomic performance.

The baseline for these experiments (that is the forecast for the world economy over the late 1980s with no wage shocks) was chosen to correspond with real GNP growth for all countries at about the same rate as potential GNP. By early 1987 most economies are assumed to be close to potential, so the baseline approximately assumes full employment. As noted earlier, however, the actual baseline position of the economy for these experiments does not appear to matter much.

The results are reported in Figures 5, 6, and 7, and in Table 3. Figure 5 shows the behavior of U.S. output during the period with both fixed rates and flexible rates. Figure 6 shows the behavior of German output and Figure 7 shows the behavior of Japanese output. Table 3 gives summary statistics for all countries in terms of standard deviations of output, prices, imports, and exports. The variables plotted in all cases are the percentage differences of the variable from the baseline. The standard deviations are simply the root mean square percentage deviation form the baseline.

The main result can be stated rather simply. The fluctuations in real GNP in the U.S. are about the same under both flexible exchange rates and fixed exchange rates. The standard deviation for U.S. output is slightly larger with flexible exchange rates, but the difference is very small. On the other hand the fluctuations in real GNP in the other countries are much larger with fixed exchange rates than with flexible exchange rates. In particular for this realization, Germany undergoes a large recession in 1988 with fixed exchange rates and avoids the recession entirely with flexible exchange rates. Table 3 indicates that the same general difference holds with the other countries. Table 3 also indicates that the fluctuations in the price level are higher with fixed exchange rates for Canada, France, Italy, Japan, and the U.K., but lower for the U.S. as well as Germany. The fixed versus flexible differences are all smaller than the differences in output fluctuations.

Finally, the fluctuations in imports and exports are <u>less</u> under the flexible exchange rate system with only one exception: export fluctuations in Germany are smaller with fixed exchange rates, but the difference is rather small. In all the other countries export fluctuations are considerably less with flexible exchange rates than with fixed exchange rates. One of the rationales for a fixed exchange rate system which has been emphasized in recent years is that flexible exchange rates cause costly and inefficient shifts in resources between tradeable and non-tradeable goods sectors. If the results reported in Table 3 are robust to a more complete set of stochastic shocks then this rationale is not supported by this model. On the contrary fixed exchange rates cause export industries to experience fluctuations in demand.

Recall that the shocks to the wage equations are drawn from the same distribution for all countries. One of the reasons that economic performance deteriorates with fixed exchange rates in non-U.S. countries is probably related to the asymmetric aspects of the fixed exchange rates system. Simulations with a more symmetric exchange rate system will be able to test this conjecture. If the results are due to the asymmetry then it is likely that with a more symmetric system, output performance in the other countries under the fixed exchange rate system will improve, but performance in the U.S. will deteriorate (in comparison with the fixed exchange rate results reported here).

4. Conclusion.

The main objective of this paper has been to report on the preliminary results of a new empirical approach to evaluating international monetary systems. The focus is narrowed to the question of fixed versus flexible exchange rate systems. For both systems, when money growth is exogenous it is assumed to be set on a constant growth rate path. Stochastic simulations with only one type of shock (wage shocks) in each country were considered, and the stochastic experiments were conducted over a short time span--the remainder of the 1980s. The results indicate that a flexible exchange rate system works better than a fixed exchange rate system. In future research I plan to see whether this result continues to hold with more empirically based and longer stochastic simulations, with alternative fixed exchange rate systems, and with more active monetary and fiscal policies.

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Table 1. Notation and Definition of Model Variables

Variable Name Conventions

(1). An "L" at the beginning of a variable name indicates the logarithm.

(2). A "D" at the beginning of a variable name indicates the first difference.

(3) A number at the end of a variable name indicates the country:

1 = Canada
2 = France
3 = Germany
4 = Italy
5 = Japan
6 = U.K.

No number at the end of the variable name indicates the U.S.

(4) Lags are indicated by a negative number in parentheses.

(5) Leads are indicated by a positive number in parentheses.

Financial Variables

RS	short term interest rate (US: Fed Funds; Canada: call money, France: call money, Germany: call money, Italy: 6-mo. T-bills, Japan: call money, UK:call money)
RL	long term interest rate (US: Aa Corp, Canada: Lt-Gov't, France: Lt-Gov't guar., Germany: Lt-Gov't, Italy: Lt-Gov't, Japan: Lt-Gov't, UK: Lt-Gov't)
RRL	real interest rate (RL less expected growth of GNP deflator over next four quarters, scaled by the trend in income growth)
Ei	exchange rates ($.01 per unit of each currency: i=1,...,6) E1: Canada/dollar, E2: France/franc, E3: Germany/deutche mark, E4: Italy/lira, E5: Japan/yen, E6: UK/pound.
M	money supply (billions of local currency, M1 definition)

Real GNP (or GDP) and spending components

Billions of local currency units; base years are as follows: US: 1982, Canada: 1971, France: 1970, Germany: 1976, Italy: 1970, Japan: 1975, UK: 1980. The output measure is GNP for the U.S., Canada, Germany, and Japan; GDP for France, Italy and the U.K.

Y	real GNP (or GDP)
C	consumption (total)
CD	durable consumption
CS	services consumption
CN	nondurables consumption
INS	non-residential structures investment
INE	non-residential equipment investment
IR	residential investment
II	inventory investment
IF	fixed investment (total)
IN	nonresidential investment (total)
IR	residential investment (total)
EX	exports in income-expenditure identity
IM	imports in income-expenditure identity
G	government purchases of goods and services

Variables relating to GNP and its expenditure components

YW	weighted foreign output (of other six countries)
YT	trend or potential output
T	time trend (T = 1 in 1971.1)
YG	gap between real GNP and trend GNP
KNCD	stock of consumer durables in the U.S.
CD	depreciation of consumer durables in the U.S.

Wages and Prices

W	average wage rate (US: ave. hrly earnings, nonfarm, 1982=1; Canada: hrly earnings, manuf, 1971=1; France: ave. labor costs, 1980=1; Germany: ave. hrly earnings, 1976=1; Italy: min. contractual wage, 1980=1; Japan: ave. monthly earnings, 1975=1; UK: ave. monthly earnings, 1980=1)
X	"contract" wage rate (constructed by procedure described in section on estimation of wage equations in the text)
P	GNP (or GDP) deflator (see above GNP for base year)
PIM	import price deflator (see above GNP base year)
PEX	export price deflator (see above GNP base year)
PW	trade weighted foreign price (foreign currency units)
EW	trade weighted exchange rate (foreign currency/domestic currency)
FP	trade weighted foreign price (domestic currency units)

Table 2. Listing of the Model Equations.

```
Money Demand  (inverted)
RS  = -1.29 - 2.79*(LM-LP)    + 2.67*(LM(-1)-LP(-1))    + .27*LY
RS1 = -0.21 - 1.32*(LM1-LP1) + 1.19*(LM1(-1)-LP1(-1)) + .13*LY1
RS2 =  2.36 - 2.39*(LM2-LP2) + 1.39*(LM2(-1)-LP2(-1)) + .47*LY2
RS3 = -2.53 - 1.17*(LM3-LP3) + 0.62*(LM3(-1)-LP3(-1)) + .78*LY3
RS4 = -0.83 - 1.47*(LM4-LP4) + 1.19*(LM4(-1)-LP4(-1)) + .35*LY4
RS5 =  1.79 - 1.93*(LM5-LP5) + 1.54*(LM5(-1)-LP5(-1)) + .21*LY5
RS6 = -1.30 - 0.81*(LM6-LP6) + 0.68*(LM6(-1)-LP6(-1)) + .34*LY6

Interest Rate Parity
LE1 = LE1(+1) + .25*(RS1-RS)
LE2 = LE2(+1) + .25*(RS2-RS)
LE3 = LE3(+1) + .25*(RS3-RS)
LE4 = LE4(+1) + .25*(RS4-RS)
LE5 = LE5(+1) + .25*(RS5-RS)
LE6 = LE6(+1) + .25*(RS6-RS)

Term Structure Relations
RL  =  .30*RS  + .70*RL(+1)
RL1 =  .29*RS1 + .71*RL1(+1)
RL2 =  .16*RS2 + .84*RL2(+1)
RL3 =  .39*RS3 + .61*RL3(+1)
RL4 = 1.00*RS4 + .00*RL4(+1)
RL5 =  .28*RS5 + .72*RL5(+1)
RL6 =  .15*RS6 + .85*RL6(+1)

Consumption Demand
CD = -313.51 +  .32*Y    -  .40*KNCD     -  68.59*RRL
CN =   22.34 + .017*Y    +  .90*CN(-1)
CS = -141.27 + .15*YT  +  .66*CS(-1)  - 126.73*RRL

CD1 =   -2.59 + .070*Y1   +  .55*CD1(-1) -   3.36*RRL
CN1 =    1.27 + .0067*Y1  +  .94*CN1(-1) -   1.07*RRL
CS1 =     .55 + .0073*Y1  +  .95*CS1(-1)

CD2 = -19.00 + .037*YT2+  .71*CD2(-1) -  15.40*RRL
CN2 =  37.16 + .14*Y2  +.057*YT2 + .30*CN2(-1)
CS2 = -27.68 + .041*Y2 +.031*YT2 + .82*CS2(-1)

C3= -29.52 + .15*Y3 +.10*YT3 +.61*C3(-1) - 225.78*RRL3

C4  = -806.1 + .20*Y4  +.11*YT4 +  .54*C4(-1)

CD5 = -1048.4 +.024*Y5 + .52*CD5(-1)   - 2004.77*RRL5
CN5 =  4668.8 +.019*Y5 + .83*CN5(-1)
CS5 = -1722.3 +.098*YT5 + .65*CS5(-1) - 3335.70*RRL5

CD6 = -4.01 +  .039*Y6 + .64*CD6(-1)
CN6 =  7.92 +  .086*Y6 + .62*CN6(-1)
CS6 =  -.61 +  .012*Y6 + .96*CS6(-1)
```

Investment Demand

```
INE = -90.39 + .62*INE(-1) +.115*Y(-1) - .055*Y(-2) - 107.8*RRL
INS = -16.82 + .95*INS(-1) +.042*Y(-1) - .034*Y(-2) - 19.43*RRL
IR  = 23.64  + 1.37*IR(-1) -.52*IR(-2)  -  27.05*RRL
II  = -59.61 +  .36*Y(-1) - .33*Y(-2)   - 180.89*RRL

INE1  = -1.15 +.81*INE1(-1) +.055*Y1(-1) -.029*Y1(-2) -3.27*RRL1
INS1  = -1.08 +.96*INS1(-1) +.013*Y1(-1) -4.12*RRL1
IR1 =   1.43 +.98*IR1(-1) -.42*IR1(-2) +.079*Y1(-1) -.070*Y1(-2)-
        - 3.20*RRL1
II1   = -1.58 +.49*II1(-1) +.45*Y1(-1) -.44*Y1(-2) -8.34*RRL1

INE2 = -6.7 + .76*INE2 + .13*Y2(-1) -.096*Y2(-2)
INS2 = 17.46 +.74*INS2(-1) -4.62*RRL2
IR2  = 10.22 + .84*IR2(-1) -.012*DY2(-1) -20.65*RRL2
II2  = -7.56 + .58*II2(-1) + .40*Y2(-1) -.39*Y2(-2) -27.47*RRL2

IF3  = 3.51 + .77*IF3(-1) +.052*Y3(-1) -168.96*RRL3
II3  = -61.08 + .072*Y3(-1) -603.82*RRL3

IF4  = 438.49 +.85*IF4(-1) +.072*Y4(-1) -.051*Y4(-2) -2382.5*RRL

IN5  = -3354.72 + .83*IN5(-1) +.052*Y5(-1) -9186.0*RRL5
IR5  = 2221.61 +.77*IR5(-1)+.166*DY5(-1) -34.21*RRL5
II5  = -1805.5 -.29*II5(-1) +.021*Y5(-1) -13351.7*RRL5

INE6 = -2.39 +.40*INE6(-1) + .060*Y6(-1)  -4.65*RRL6
INS6 =  5.19 +.65*INS6(-1) + .029*DY6(-1) -1.83*RRL6
IR6  =  1.77 + .80*IR6(-1) + .015*DY6(-1) -0.94*RRL6
II6 = .083   + .56*II6(-1) + .20*DY6(-1)  -6.30*RRL6
```

Exports

```
LEX  = -1.02  + .77*LEX(-1)   - .15*(LPEX - LPIM)   + .29*LYW
LEX1 = -4.59  + .54*LEX1(-1) -.39*(LPEX1 - LPIM1) + .74*LYW1
LEX2 = -6.0   + .49*LEX2(-1) -.33*(LPEX2 - LPIM2) +1.06*LYW2
LEX3 = -2.90  + .48*LEX3(-1) -.55*(LPEX3 - LPIM3) + .71*LYW3
LEX4 = -2.44  + .62*LEX4(-1) -.061*(LPEX4 - LPIM4) +.80*LYW4
LEX5 = -0.71  + .85*LEX5(-1) -.15*(LPEX5 - LPIM5) + .31*LYW5
LEX6 = -4.22  + .28*LEX6(-1) -.25*(LPEX6 - LPIM6) + .85*LYW6
```

Imports

```
LIM  = -8.47 + .39*LIM(-1) +  .40*(LPEX - LPIM)    + 1.49*LY
LIM1 = -1.35 + .52*LIM1(-1) + .13*(LPEX1 - LPIM1) + .63*LY1
LIM2 = -3.77 + .65*LIM2(-1) + .22*(LPEX2 - LPIM2) + .81*LY2
LIM3 = -4.90 + .31*LIM3(-1) + .35*(LPEX3 - LPIM3) +1.25*LY3
LIM4 = -13.4 + .16*LIM4(-1) + .56*(LPEX4 - LPIM4) +1.91*LY3
LIM5 = -2.59 + .89*LIM5(-1) + .16*(LPEX5 - LPIM5) + .31*LY5
LIM6 = -1.81 + .63*LIM6(-1) + .017*(LPEX6 -LPIM6) + .61*LY6
```

Income-Expenditure Identities

```
Y = CD+CN+CS+INE+INS+IR+II+G+EX-IM
Y1 = CD1+CN1+CS1+INE1+INS1+IR1+II1+G1+EX1-IM1
Y2 = CD2+CN2+CS2+INE2+INS2+IR2+II2+G2+EX2-IM2
Y3 = C3+IF3+II3+G3+EX3-IM3
Y4 = C4+IF4+II4+G4+EX4-IM4
Y5 = CD5+CN5+CS5+IN5+IR5+II5+G5+EX5-IM5
Y6 = CD6+CN6+CS6+INE6+INS6+IR6+II6+G6+EX6-IM6
```

Wage Determination Equations

```
LX   = .25*(LW + LW(+1) + LW(+2) + LW(+3))
     + .100*(.25)*(LYG + LYG(+1) + LYG(+2) + LYG(+3))
LX1 = .25*(LW1 + LW1(+1) + LW1(+2) + LW1(+3))
     + .100*(.25)*(LYG1 + LYG1(+1) + LYG1(+2) + LYG1(+3))
LX2  = .25*(LW2 + LW2(+1) + LW2(+2) + LW2(+3))
     + .100*(.25)*(LYG2 + LYG2(+1) + LYG2(+2) + LYG2(+3))
LX3  = .25*(LW3 + LW3(+1) + LW3(+2) + LW4(+3))
     + .100*(.25)*(LYG3 + LYG3(+1) + LYG3(+2) + LYG3(+3))
LX4  = .25*(LW4 + LW4(+1) + LW4(+2) + LW4(+3))
     + .100*(.25)*(LYG4 + LYG4(+1) + LYG4(+2) + LYG4(+3))
LX5  = .25*(LW5 + LW5(+1) + LW5(+2) + LW5(+3))
     + .100*(.25)*(LYG5 + LYG5(+1) + LYG5(+2) + LYG5(+3))
LX6  = .25*(LW6 + LW6(+1) + LW6(+2) + LW6(+3))
     + .100*(.25)*(LYG6 + LYG6(+1) + LYG6(+2) + LYG6(+3))
```

Aggregate Wage Identities

```
LW = .25*(LX + LX(-1) + LX(-2) + LX(-3))
LW1 = .25*(LX1 + LX1(-1) + LX1(-2) + LX1(-3))
LW2 = .25*(LX2 + LX2(-1) + LX2(-2) + LX2(-3))
LW3 = .25*(LX3 + LX3(-1) + LX3(-2) + LX3(-3))
LW4 = .25*(LX4 + LX4(-1) + LX4(-2) + LX4(-3))
LW5 = .25*(LX5 + LX5(-1) + LX5(-2) + LX5(-3))
LW6 = .25*(LX6 + LX6(-1) + LX6(-2) + LX6(-3))
```

Aggregate Price Determination Equations

```
LP  = .025 +.80*LP(-1) + .17*LW  +.03*LPIM + .03*LPGAP  -.00027*T
LP1 = .022 +.87*LP1(-1) +.04*LW1 +.09*LPIM1             -.00042*T
LP2 = .017 +.91*LP2(-1) +.05*LW2 +.04*LPIM2 +.08*LYGAP2 -.00057*T
LP3 = .026 +.89*LP3(-1) +.09*LW3 +.03*LPIM3             -.00062*T
LP4 = .021 +.93*LP4(-1) +.03*LW4 +.04*LPIM4 +.16*LYGAP4 -.00028*T
LP5 = .043 +.92*LP5(-1) +.05*LW5 +.03*LPIM5 +.25*LYGAP5 -.00116*T
LP6 = .039 +.79*LP6(-1) +.17*LW6 +.04*LPIM6             -.00069*T
```

Import Price Equations

```
LPIM  =  .18 + .90*LPIM(-1)  + .10*LFP
LPIM1 =  .29 + .88*LPIM1(-1) + .12*LFP1
LPIM2 =  .06 + .94*LPIM2(-1) + .06*LFP2
LPIM3 =  .04 + .97*LPIM3(-1) + .03*LFP3
LPIM4 = -.38 + .90*LPIM4(-1) + .10*LFP4
LPIM5 = -.41 + .91*LPIM5(-1) + .09*LFP5
LPIM6 =  .45 + .81*LPIM6(-1) + .19*LFP6
```

Export Price Equations

```
LPEX =  -.009 + LP
LPEX1 =  .053 + LP1 + .00148*T
LPEX2 = -.033 + LP2 + .00112*T
LPEX3 = -.032 + LP3 + .00045*T
LPEX4 =  .031 + LP4 - .00086*T
LPEX5 =  .073 + LP5 - .00647*T
LPEX6 =  .030 + LP6
```

Weighted Price of Other Six Countries (Foreign Currency Units)

```
LPW  =        .09*LP1 +.18*LP2 +.26*LP3 +.12*LP4 +.19*LP5 +.16*LP6
LPW1 =.27*LP          +.14*LP2 +.21*LP3 +.10*LP4 +.15*LP5 +.13*LP6
LPW2 =.29*LP +.08*LP1          +.23*LP3 +.11*LP4 +.16*LP5 +.13*LP6
LPW3 =.31*LP +.08*LP1 +.16*LP2          +.12*LP4 +.18*LP5 +.15*LP6
LPW4 =.27*LP +.07*LP1 +.15*LP2 +.22*LP3          +.16*LP5 +.13*LP6
LPW5 =.29*LP +.08*LP1 +.15*LP2 +.23*LP3 +.11*LP4          +.14*LP6
LPW6 =.28*LP +.08*LP1 +.15*LP2 +.22*LP3 +.11*LP4 +.16*LP5
```

Weighted Exchange Rate (Foreign Currency/Domestic Currency)

```
LEW  =     - .09*LE1 -.18*LE2 -.26*LE3 -.12*LE4 -.19*LE5 -.16*LE6
LEW1 =        LE1    -.14*LE2 -.21*LE3 -.10*LE4 -.15*LE5 -.13*LE6
LEW2 =      -.08*LE1 + LE2    -.23*LE3 -.11*LE4 -.16*LE5 -.13*LE6
LEW3 =      -.08*LE1 -.16*LE2 +  LE3   -.12*LE4 -.18*LE5 -.15*LE6
LEW4 =      -.07*LP1 -.15*LP2 -.22*LP3 +  LE4   -.16*LP5 -.13*LP6
LEW5 =      -.08*LP1 -.15*LP2 -.23*LP3 -.11*LP4 +  LE5   -.14*LP6
LEW6 =      -.08*LP1 -.15*LP2 -.22*LP3 -.11*LP4 -.16*LP5 +  LE6
```

Weighted Price of Other Six Countries (Domestic Currency Units)

```
LFP  = LPW  - LEW
LFP1 = LPW1 - LEW1
LFP2 = LPW2 - LEW2
LFP3 = LPW3 - LEW3
LFP4 = LPW4 - LEW4
LFP5 = LPW5 - LEW5
LFP6 = LPW6 - LEW6
```

Weighted Output of Other Six Countries

```
LYW  =        .09*LY1 +.18*LY2 +.26*LY3 +.12*LY4 +.19*LY5 +.16*LY6
LYW1 =.27*LY          +.14*LY2 +.21*LY3 +.10*LY4 +.15*LY5 +.13*LY6
LYW2 =.29*LY +.08*LY1          +.23*LY3 +.11*LY4 +.16*LY5 +.13*LY6
LYW3 =.31*LY +.08*LY1 +.16*LY2          +.12*LY4 +.18*LY5 +.15*LY6
LYW4 =.27*LY +.07*LY1 +.15*LY2 +.22*LY3          +.16*LY5 +.13*LY6
LYW5 =.29*LY +.08*LY1 +.15*LY2 +.23*LY3 +.11*LY4          +.14*LY6
LYW6 =.28*LY +.08*LY1 +.15*LY2 +.22*LY3 +.11*LY4 +.16*LY5
```

Trend Output Paths (Logs)

```
LYT  = 7.83 + .00593*T
LYT1 = 4.60 + .00689*T
LYT2 = 6.75 + .00651*T
LYT3 = 6.91 + .00523*T
LYT4 = 11.1 + .00594*T
LYT5 = 11.7 + .01081*T
LYT6 = 5.30 + .00356*T
```

Output Gaps

```
LYG  = LY  - LYT
LYG1 = LY1 - LYT1
LYG2 = LY2 - LYT2
LYG3 = LY3 - LYT3
LYG4 = LY4 - LYT4
LYG5 = LY5 - LYT5
LYG6 = LY6 - LYT6
```

Real Interest Rates (Scaled)

```
RRL  = (RL  - LP(+4)  + LP)*(YT/2505.8)
RRL1 = (RL1 - LP1(+4) + LP1)*(YT1/99.0)
RRL2 = (RL2 - LP2(+4) + LP2)*(YT2/851.7)
RRL3 = (RL3 - LP3(+4) + LP3)*(YT3/998.4)
RRL4 = (RL4 - LP4(+4) + LP4)*(YT4/65138.0)
RRL5 = (RL5 - LP5(+4) + LP5)*(YT5/123589.9)
RRL6 = (RL6 - LP6)+4) + LP6)*(YT6/200.5)
```

Stock of Consumer Durables in the U.S.

```
KNCD = KNCD(-1) + (CD/4) - DCD(-1)
DCD = KNCD*.0515 in 4th quarter
    = DCD(-1) 1st, 2nd, and 3rd quarters
```

Table 3. Fluctuations in Output, Prices, Imports and Exports, 1987:1-1989:4, Independent Stochastic Wage Shocks in Each Country (Standard Deviation of Percent Difference from Baseline)

	Country	Fixed Exchange Rates	Flexible Exchange Rates
Output			
	U.S.	.8582	.9387
	Canada	2.0472	.3051
	France	.9830	.1897
	Germany	7.8983	1.8923
	Italy	.5726	.1254
	Japan	2.1441	.3478
	U.K.	1.0933	.3425
Prices			
	U.S.	2.5122	2.5173
	Canada	.3582	.3433
	France	.3692	.3253
	Germany	.9796	.9829
	Italy	.4678	.4381
	Japan	.8503	.6751
	U.K.	2.1328	2.1020
Imports			
	U.S.	2.2789	2.5617
	Canada	1.3111	.2467
	France	.8630	.1400
	Germany	10.1833	2.7379
	Italy	1.2775	.3506
	Japan	.7894	.2449
	U.K.	.6928	.2503
Exports			
	U.S.	1.2375	.4637
	Canada	1.4785	.4082
	France	2.3277	.6894
	Germany	.5065	.5881
	Italy	1.7680	.4666
	Japan	.5692	.1617
	U.K.	1.8442	1.0461

Note: The baseline path is the forecast of the model for this period when there are no shocks to the wage equations.

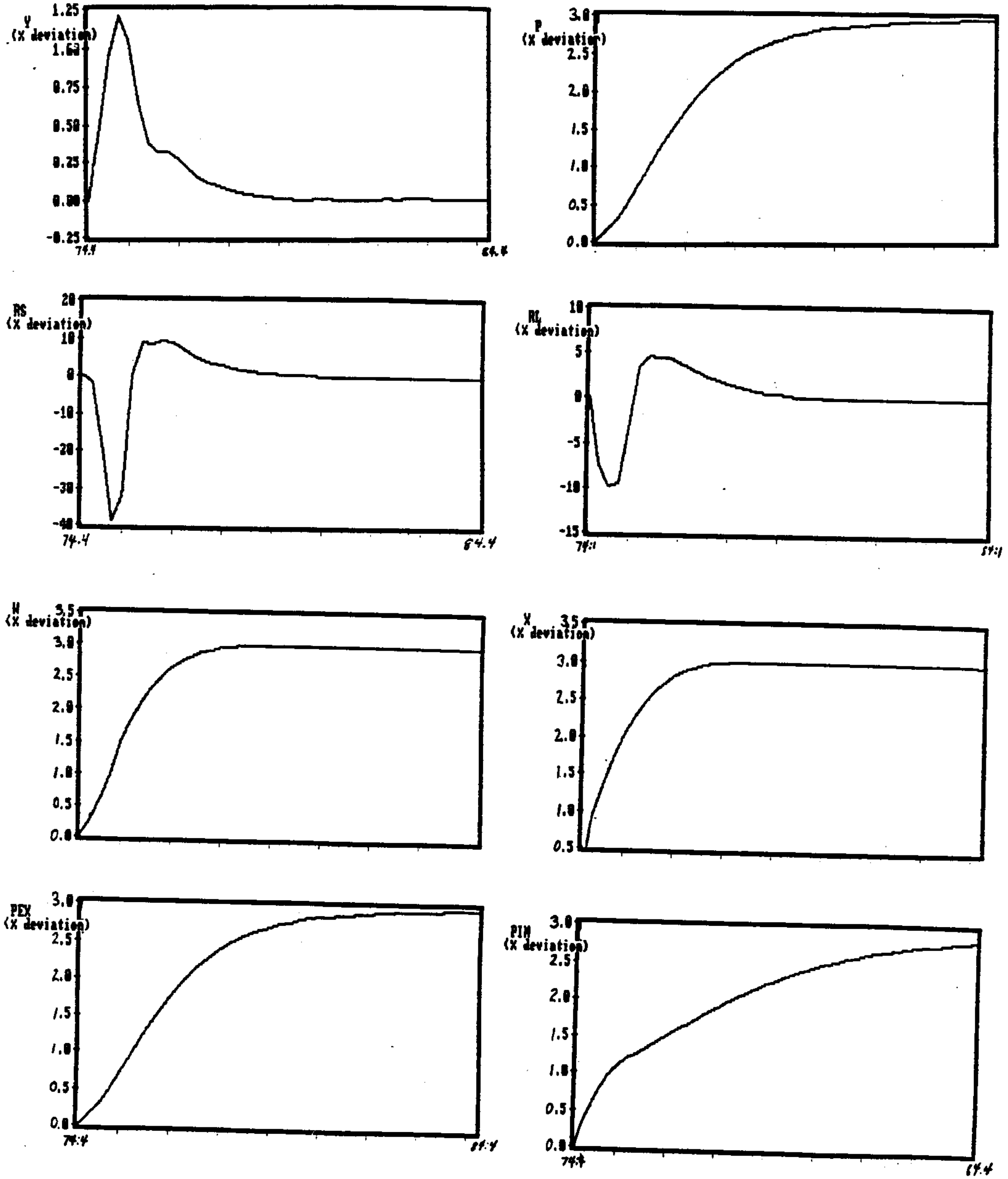


Figure 1a: Increase in U. S. Money: Impact on U. S. Output, Interest Rates and Prices

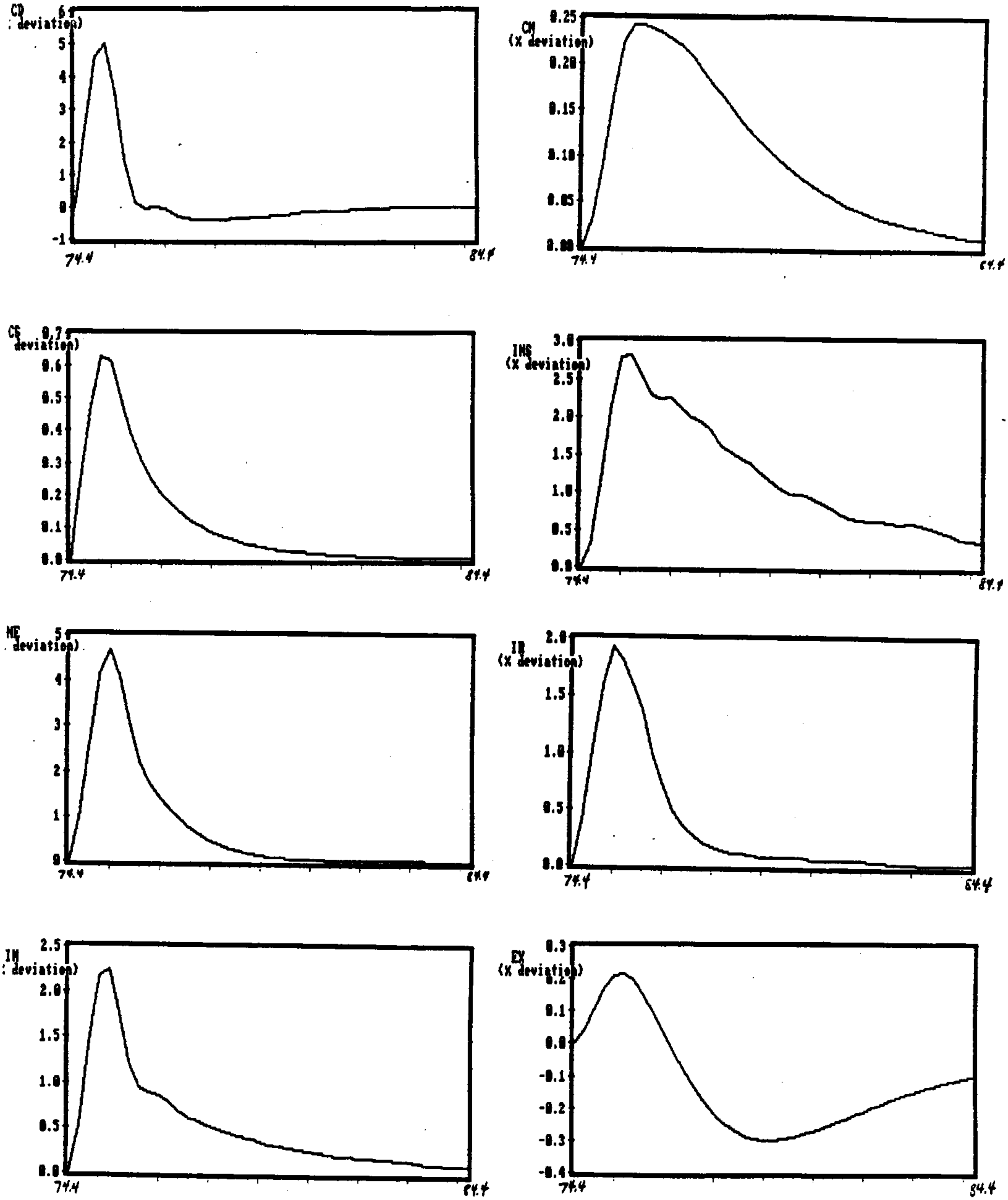


Figure 1b: Increase in U. S. Money: Impact on Components of U. S. Demand

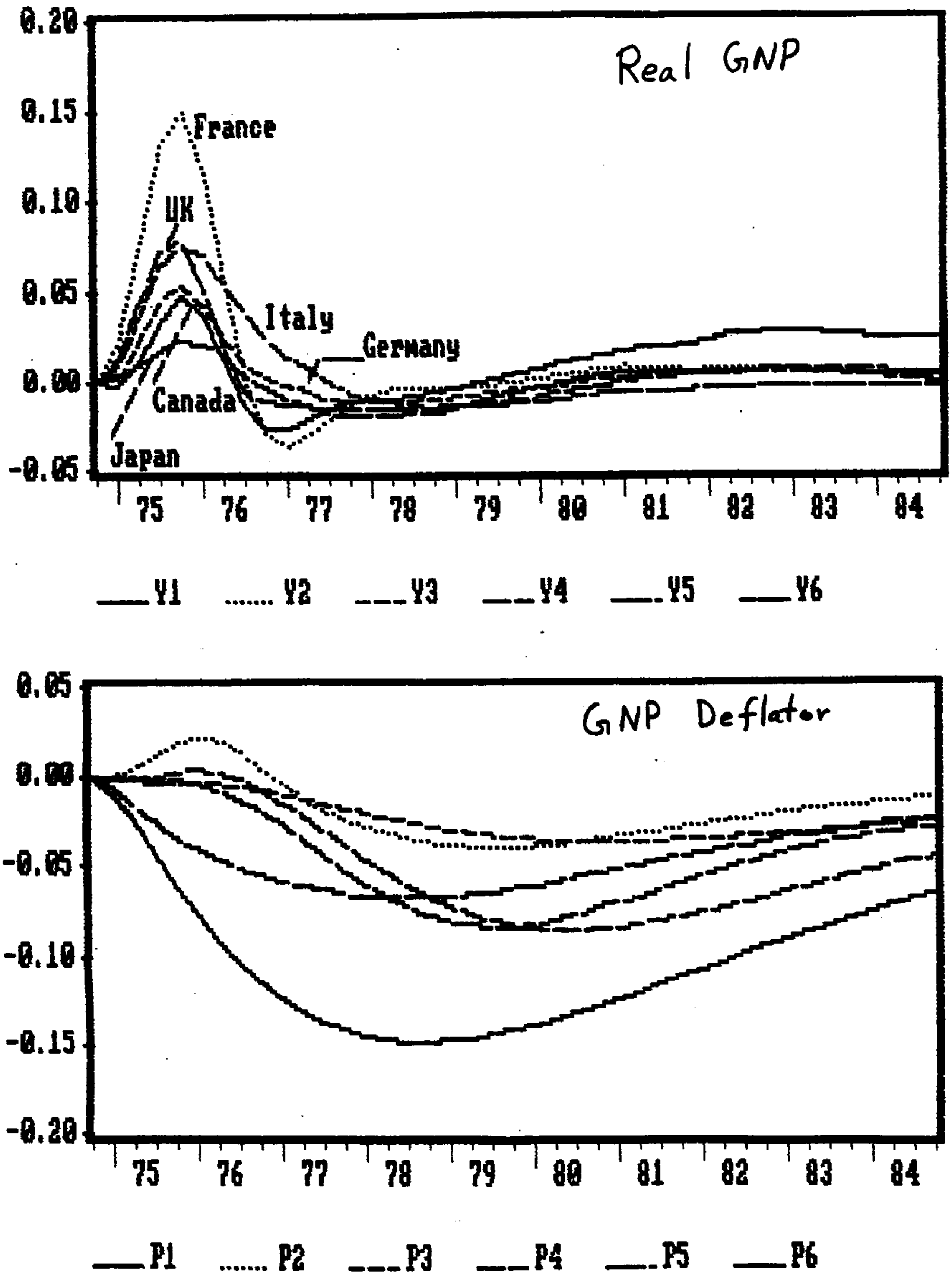
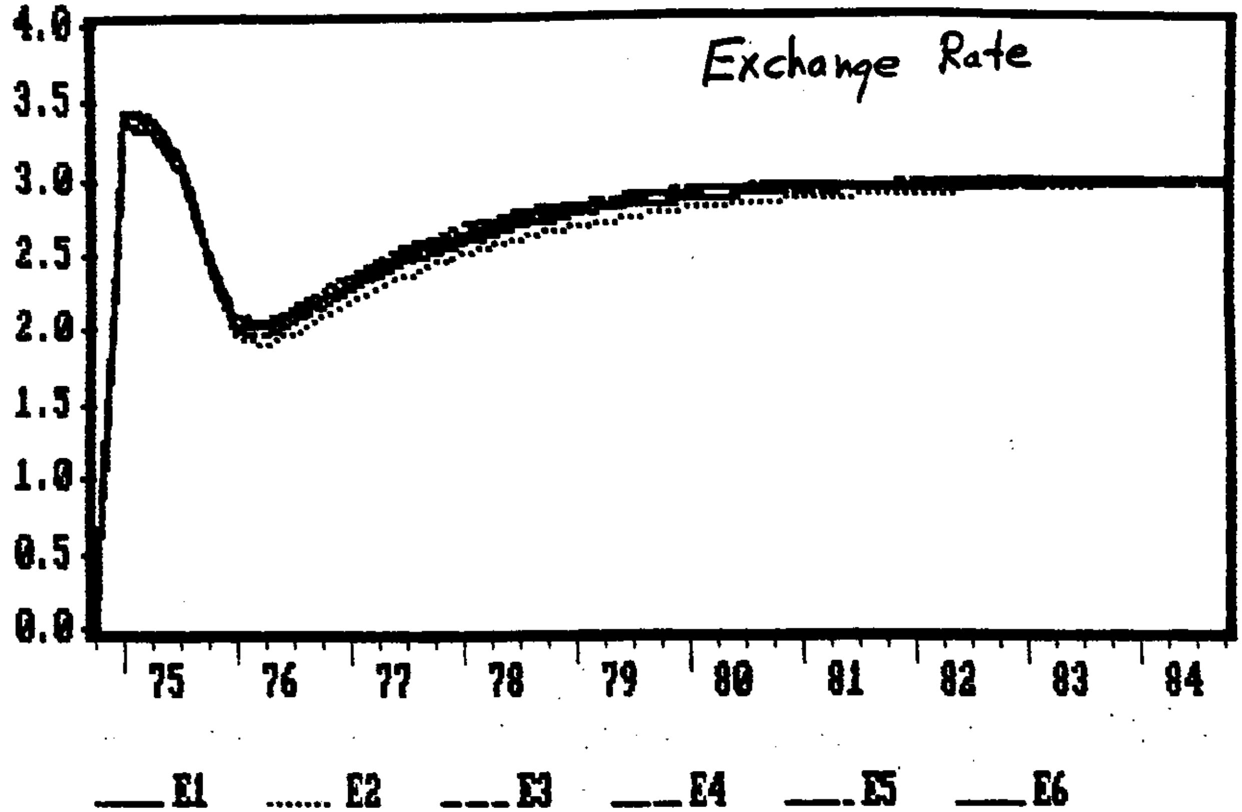


Figure 1c. Increase in U. S. Money: Impact on Output and Prices Abroad



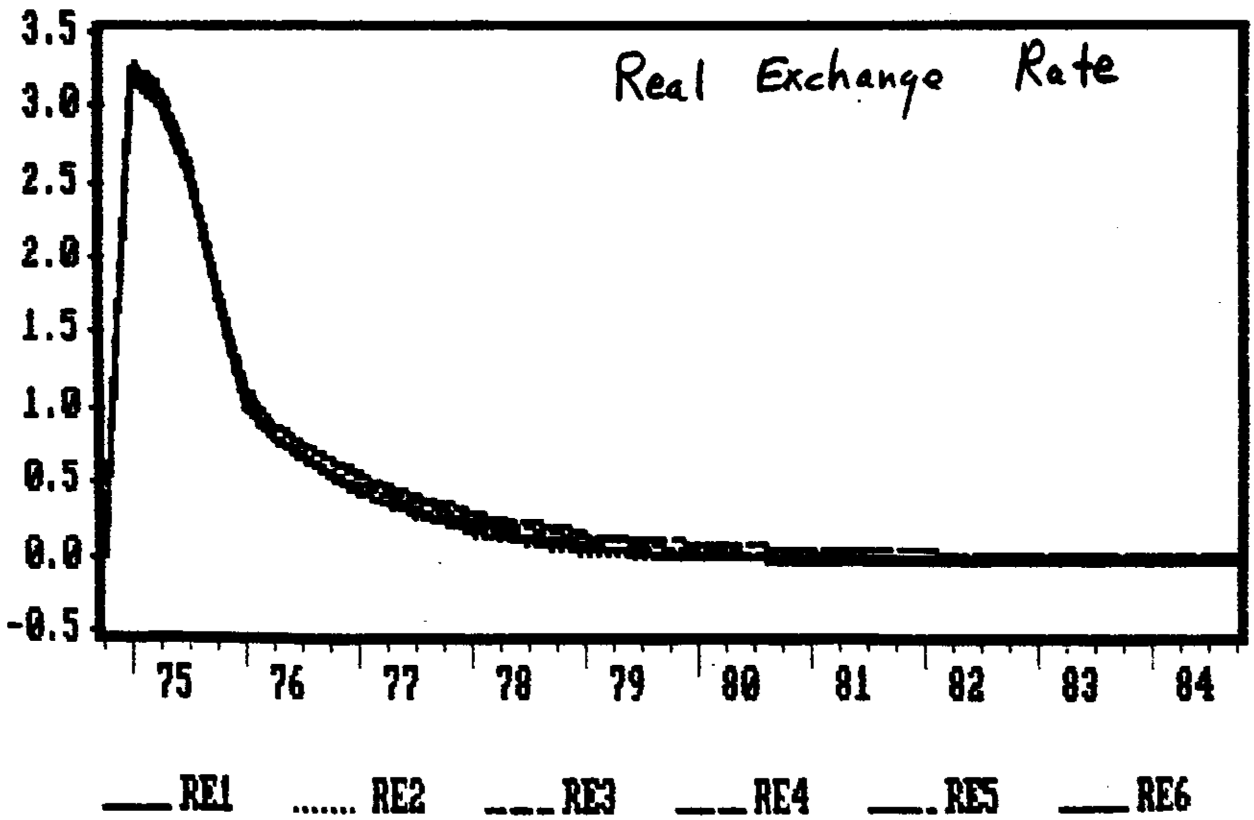


Figure 1d. Increase in U. S. Money: Impact on Foreign Exchange Rates

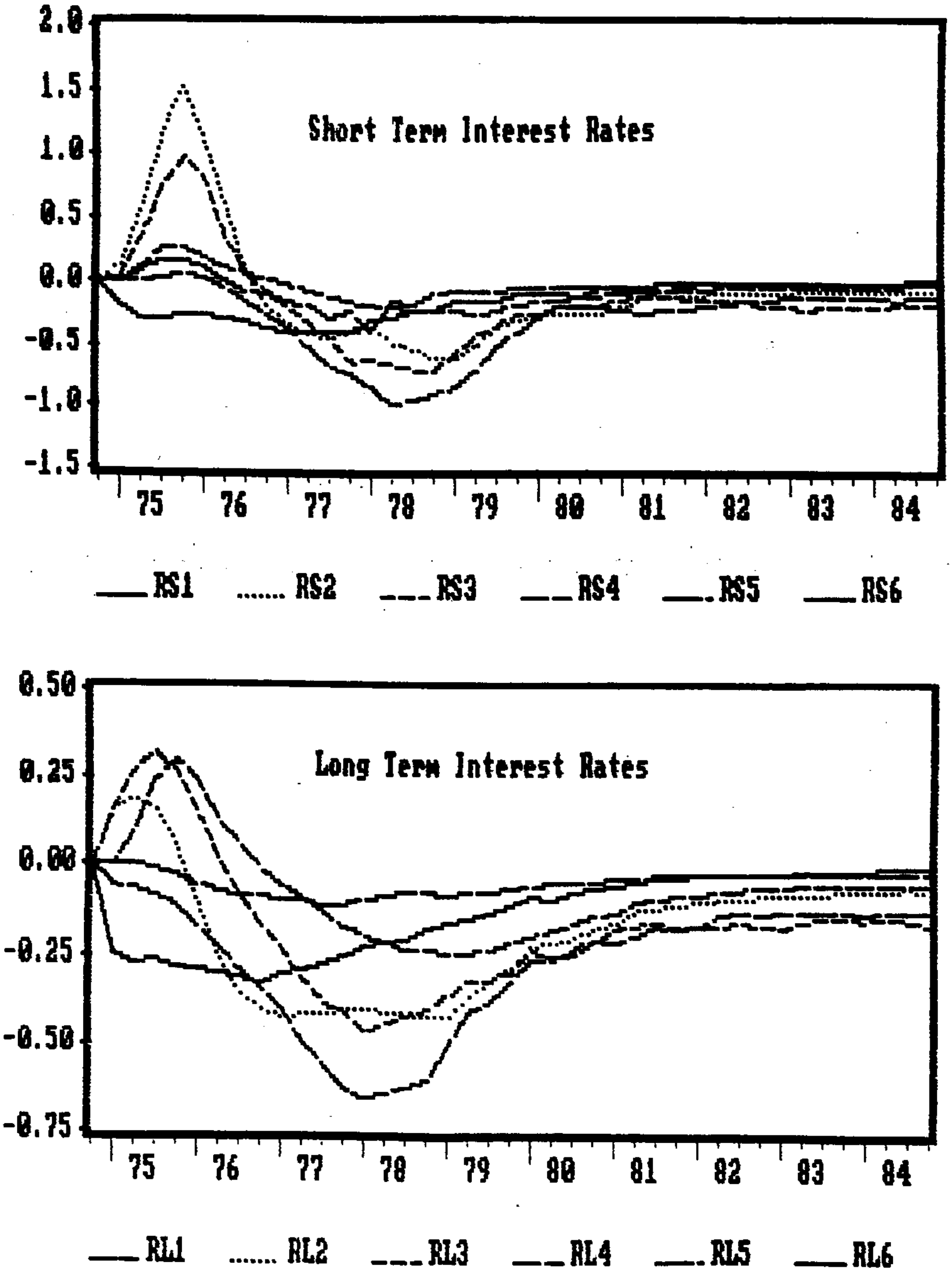


Figure 1e. Increase in U. S. Money: Impact on Interest Rates Abroad

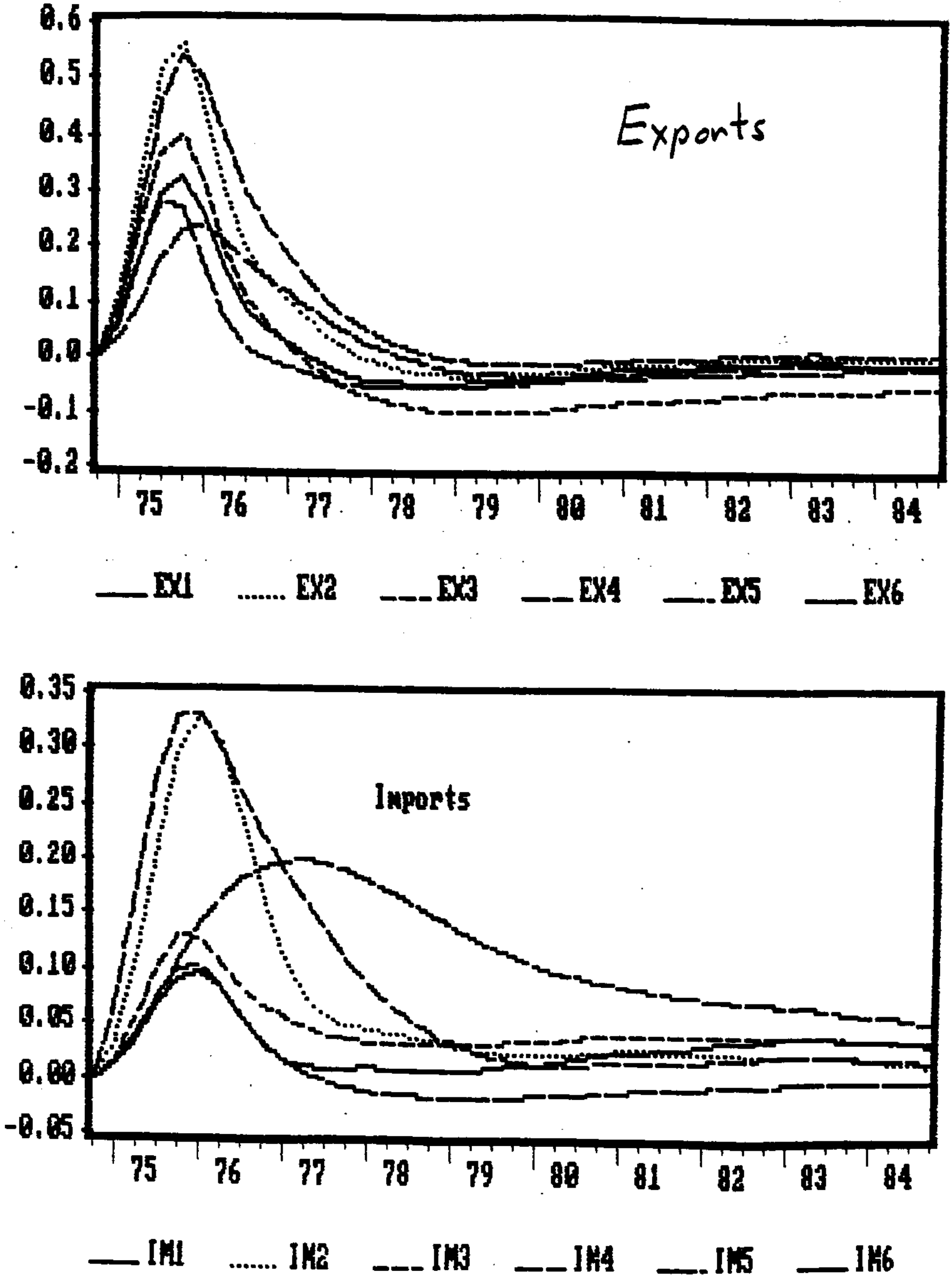


Figure 1f. Increase in U. S. Money: Impact on Exports/Imports Abroad

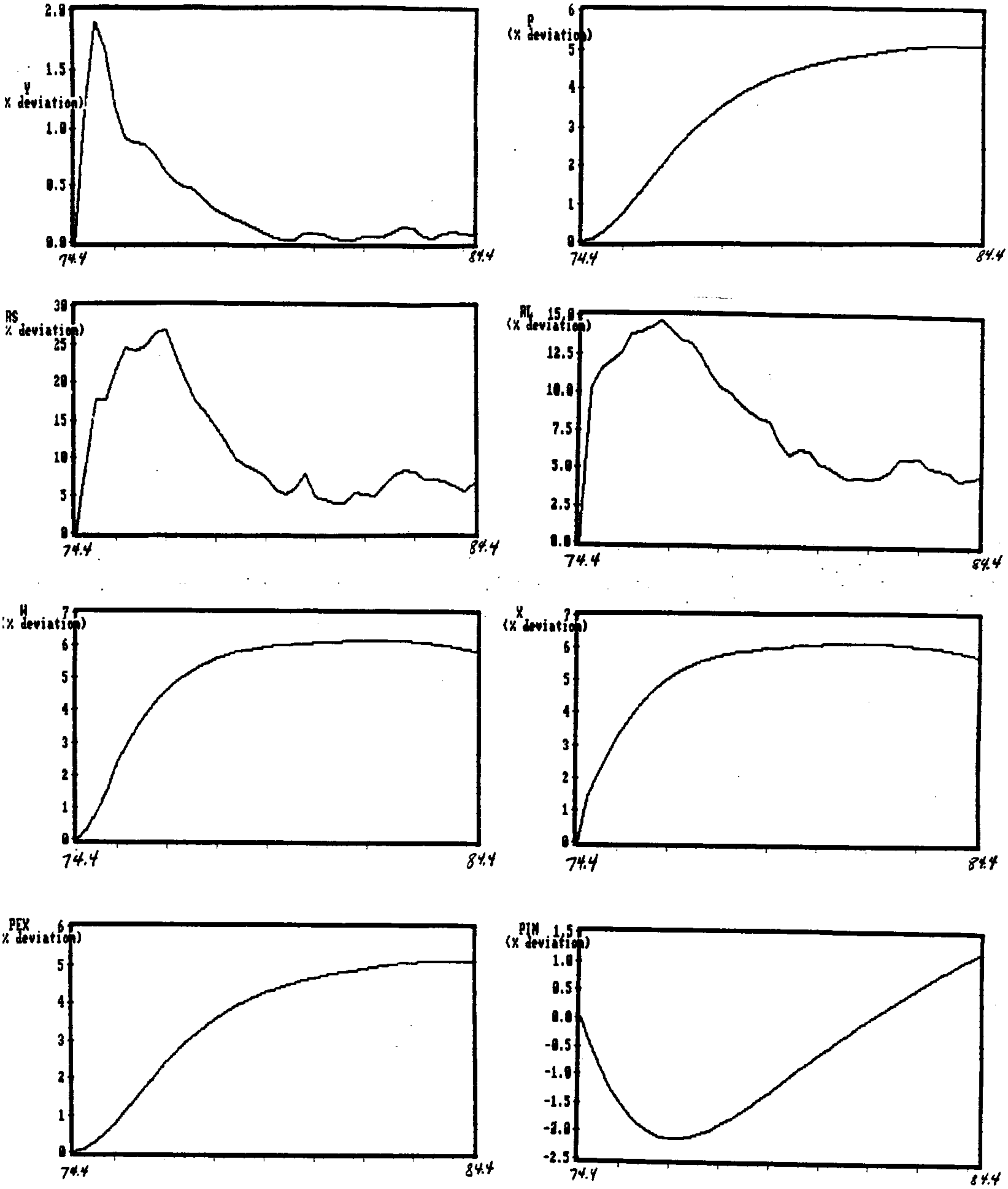


Figure 2a. Increase in U. S. Government Purchases: Impact on U. S. Output, Interest Rates, and Prices

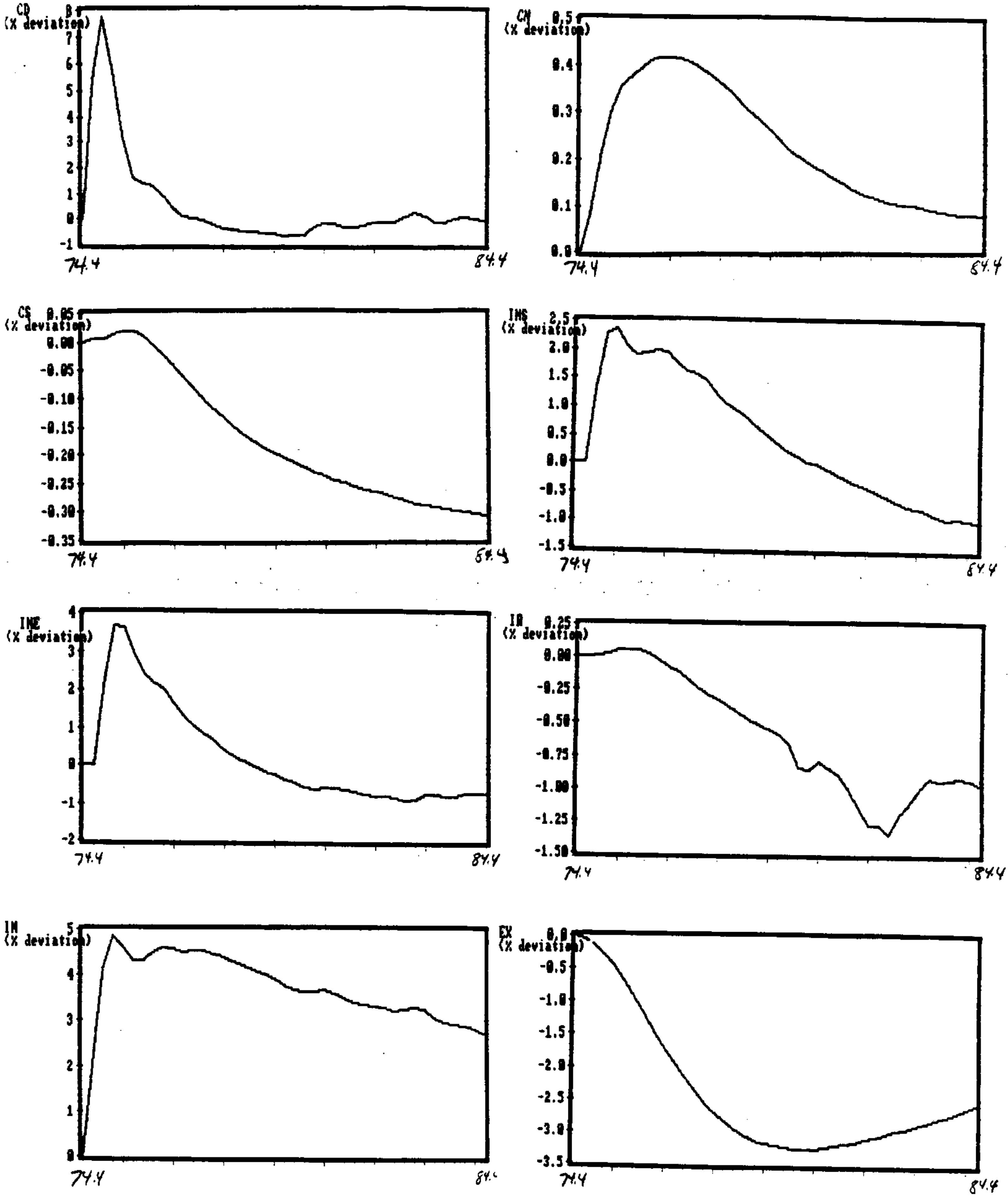
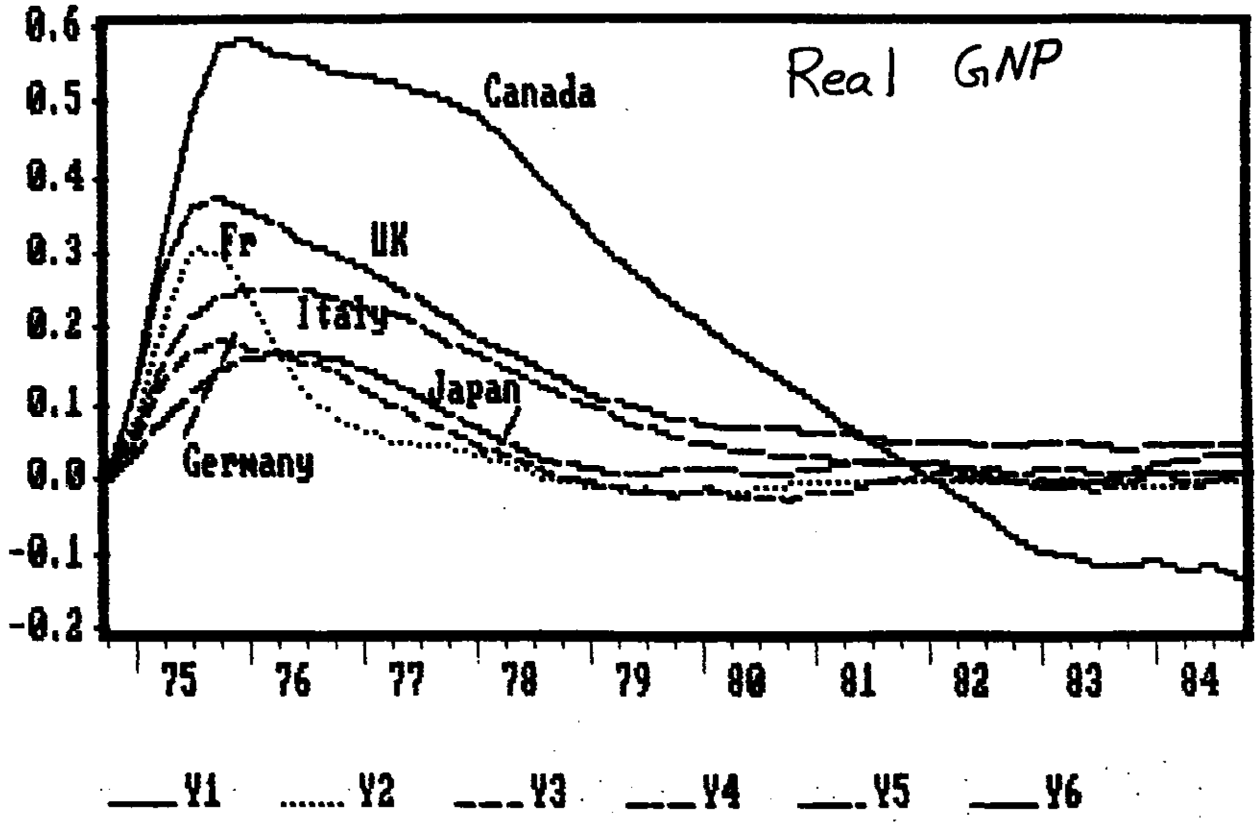


Figure 2b. Increase in U. S. Government Purchases: Impact on Componenets of U. S. Demand



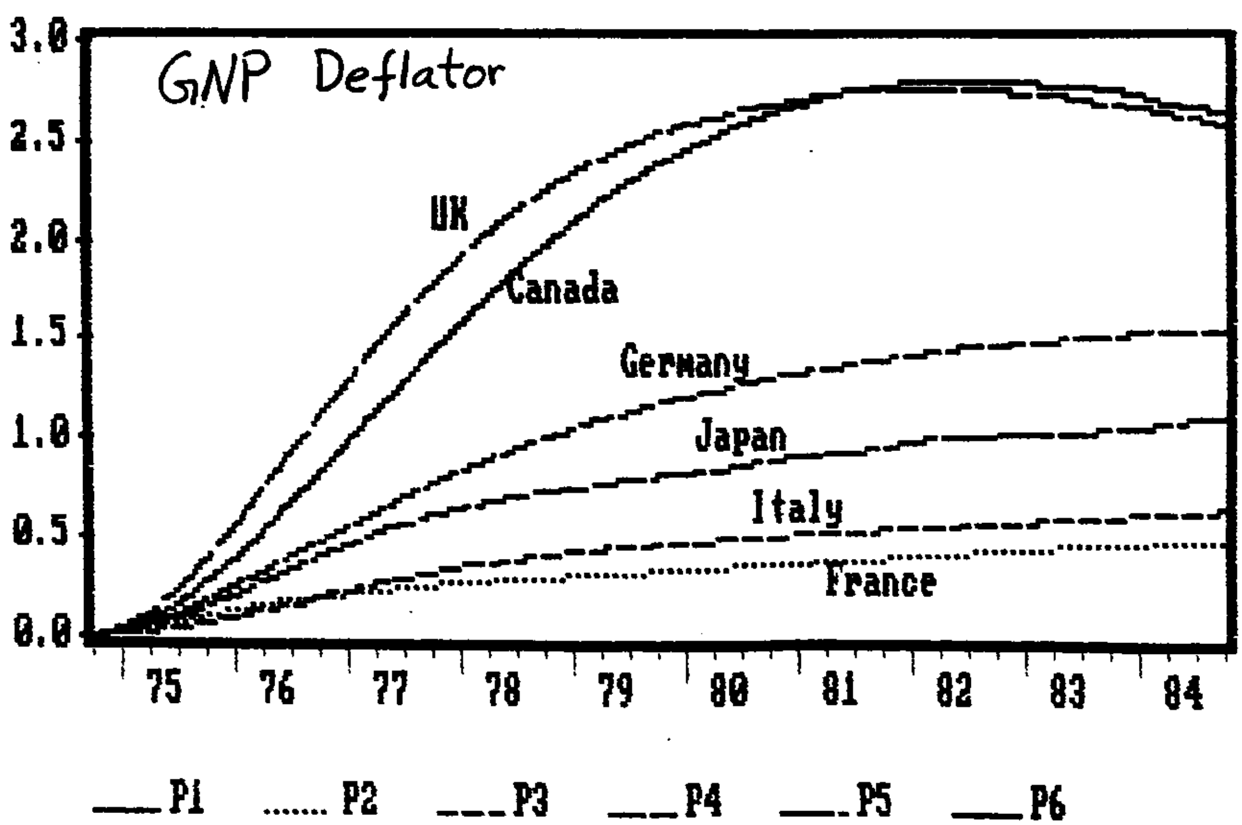
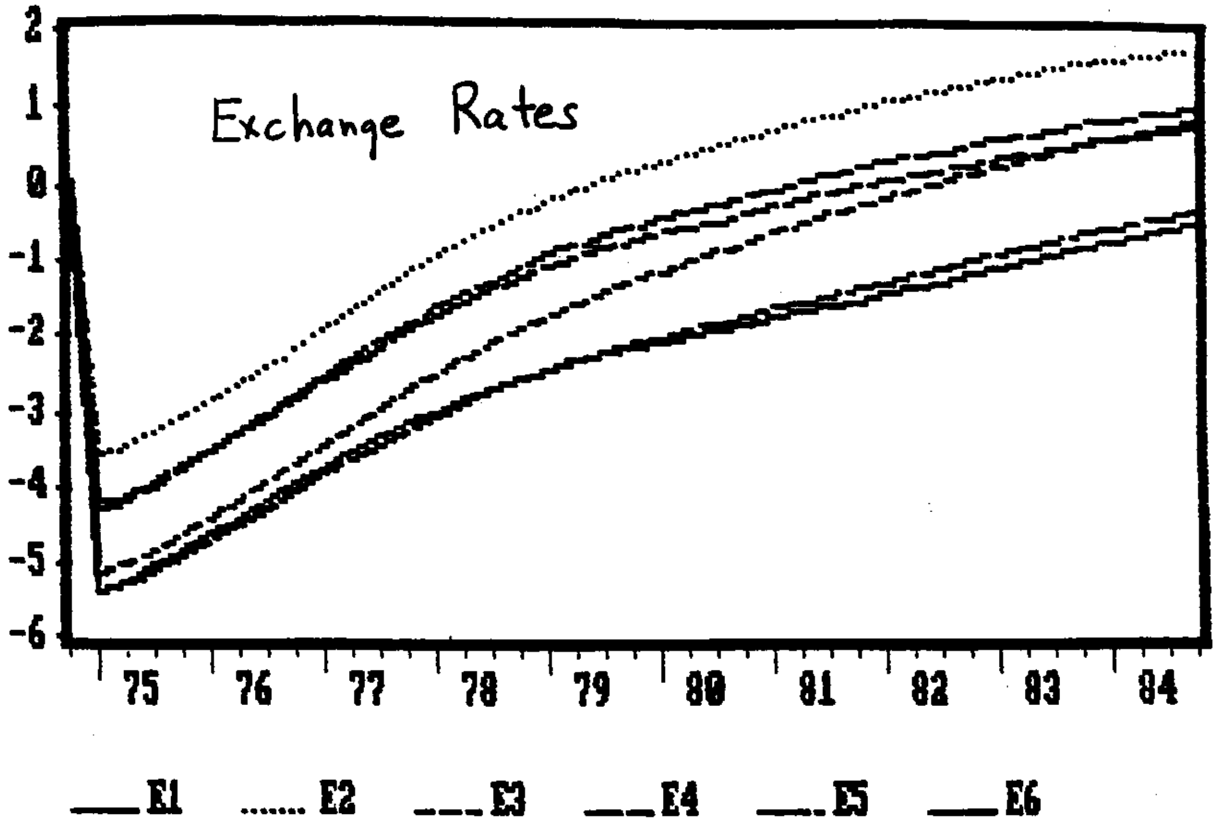


Figure 2c. Increase in U. S. Government Purchases: Impact on Output and Prices Abroad



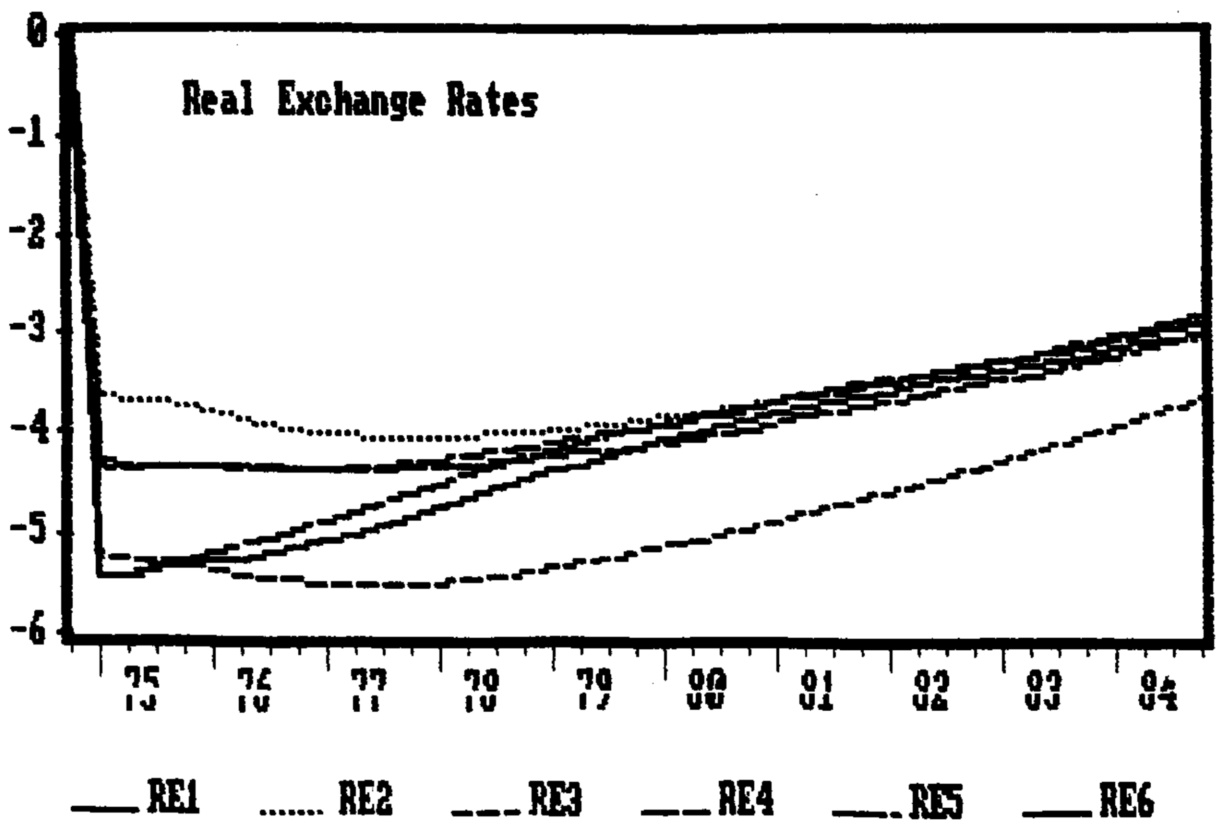
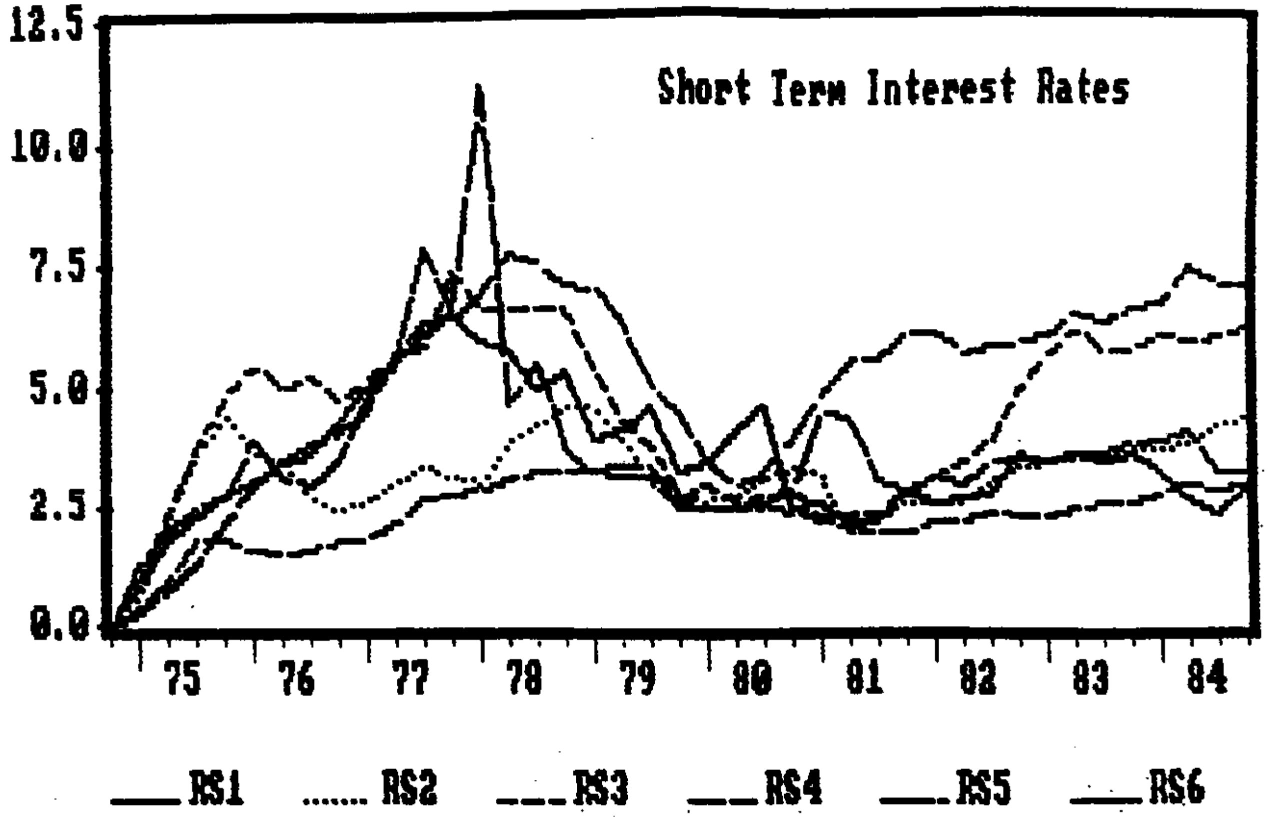


Figure 2d. Increase in U. S. Government Purchases: Impact on Foreign Exchange Rates



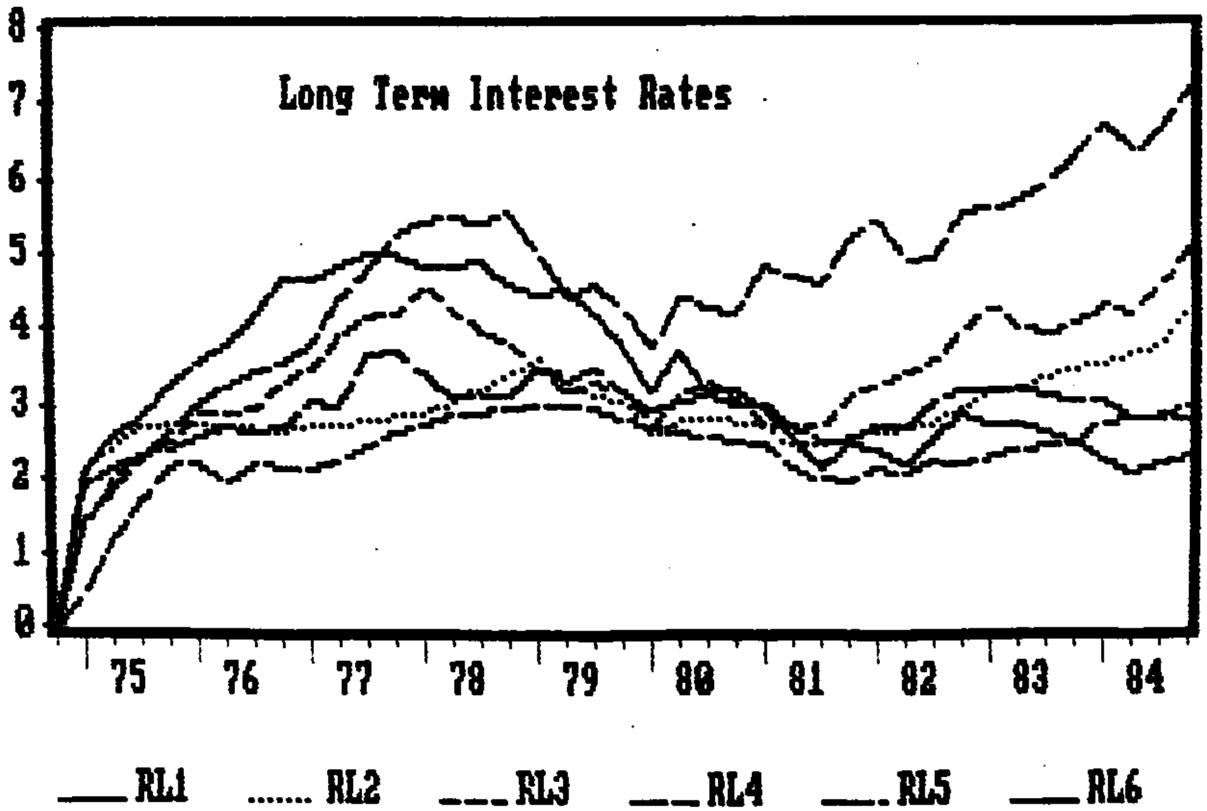


Figure 2e. Increase in U. S. Government Purchases: Impact on Interest Rates Abroad

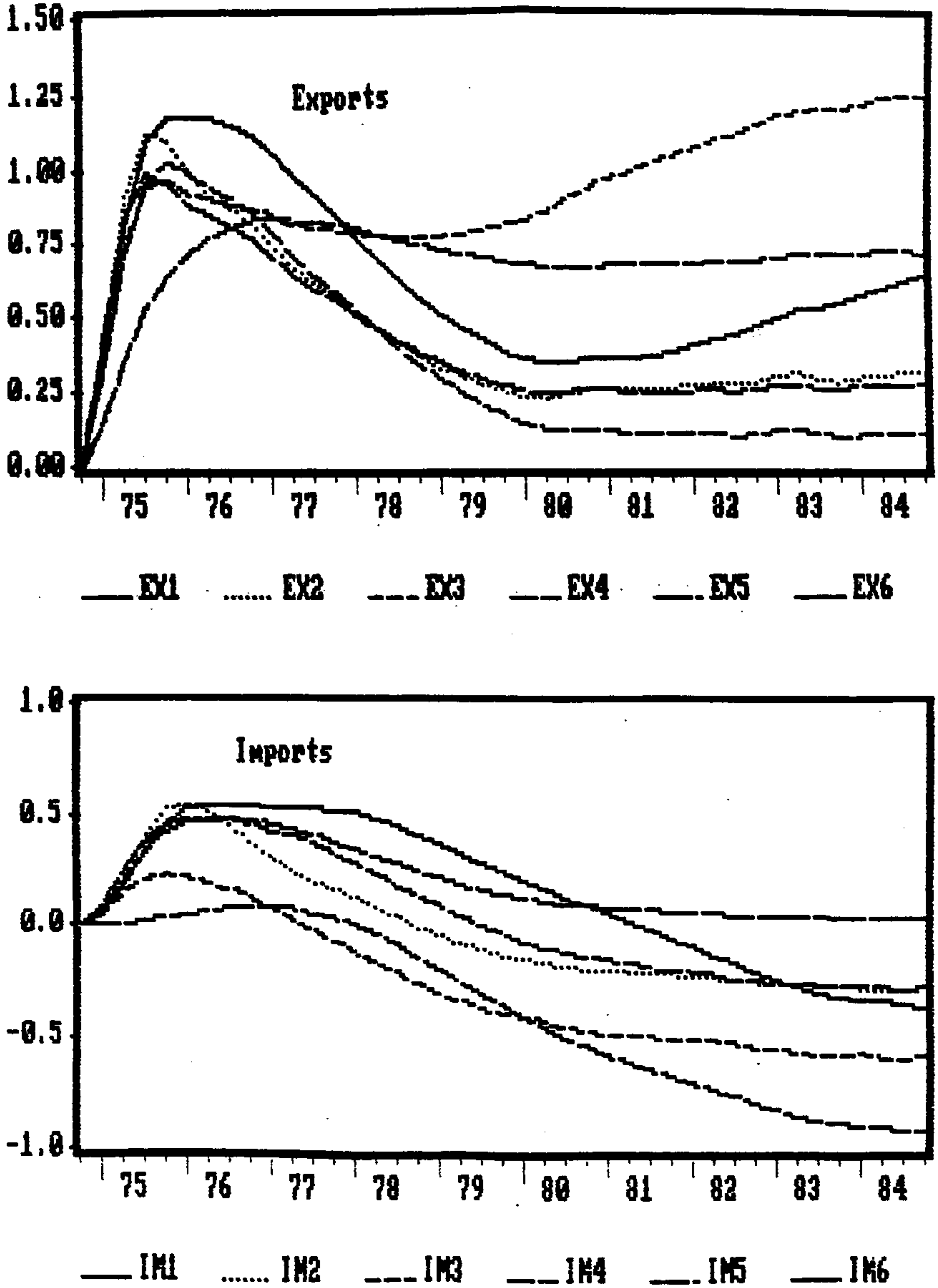


Figure 2f. Increase in U. S. Government Purchase: Impact on Exports/Imports Abroad

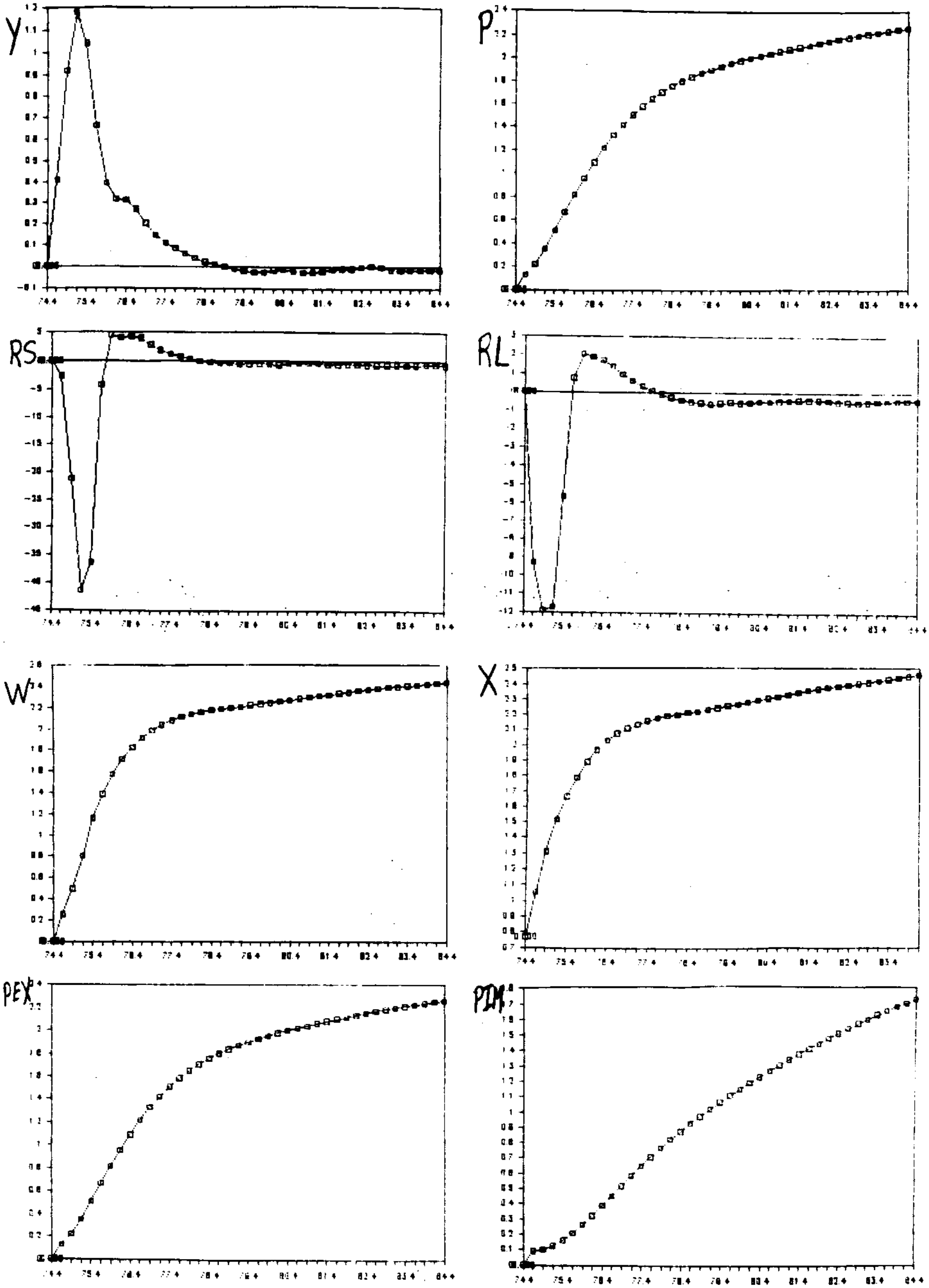


Figure 3a. Increase in U.S. Money with Fixed Exchange Rate: Inpact on U.S. Output, Interest Rates and Prices

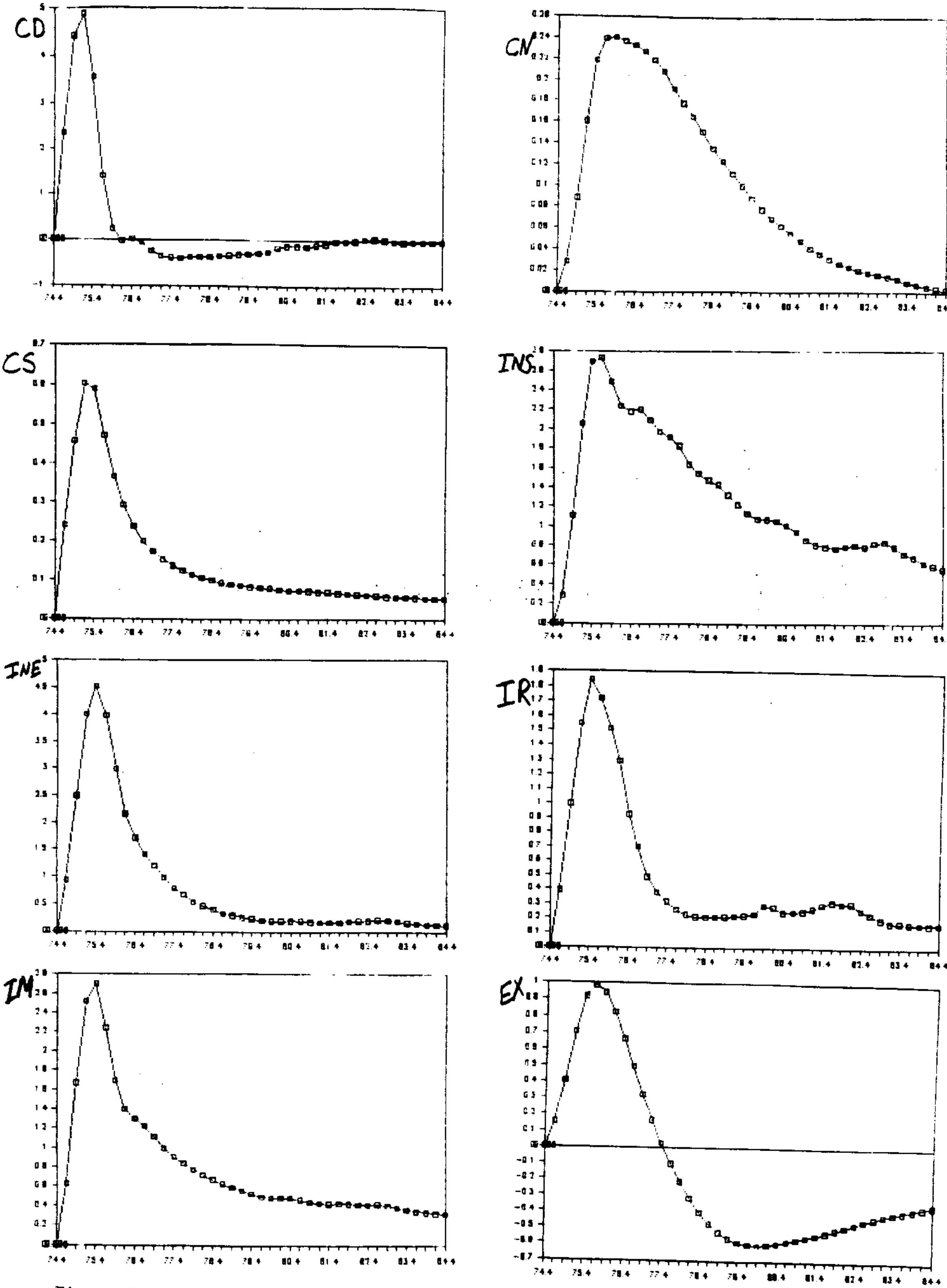


Figure 3b. Increase in U.S. Money with Fixed Exchange Rates: Impact on Components of U.S. Demand

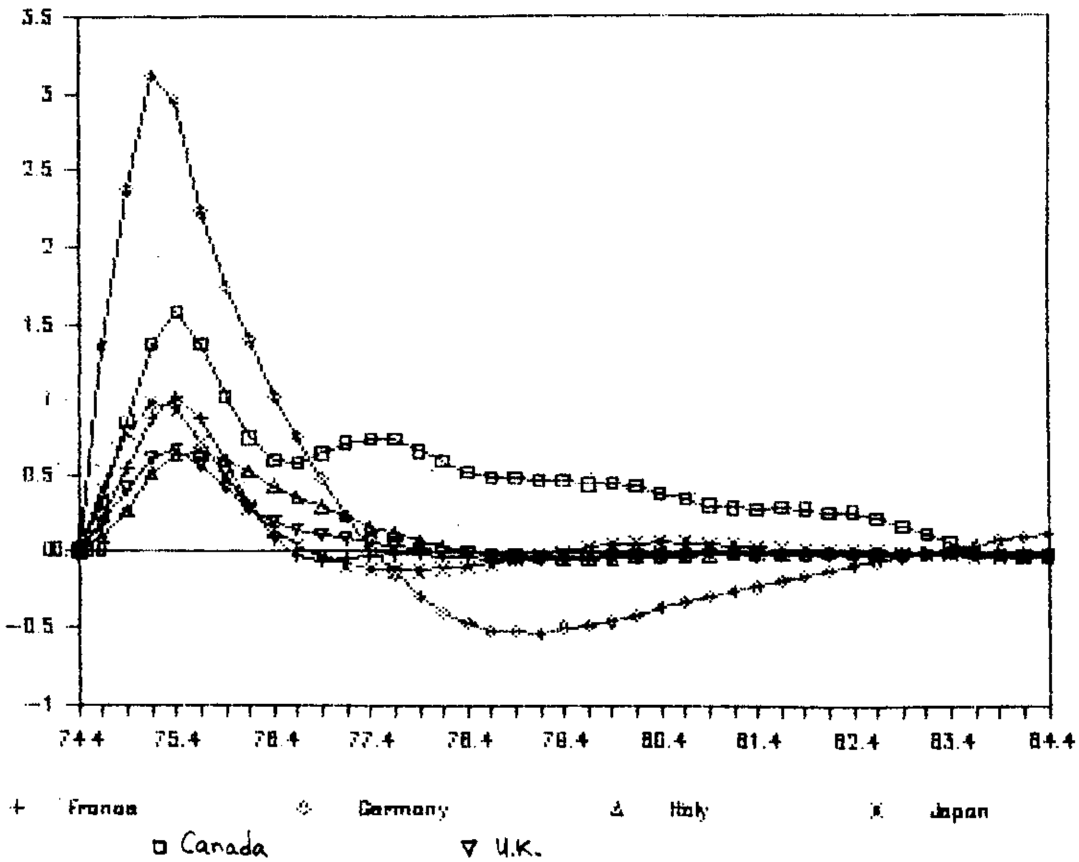


Figure 3c. Increase in U.S. Money with Fixed Exchange Rates: Impact on Real GNP in Six Other Countries

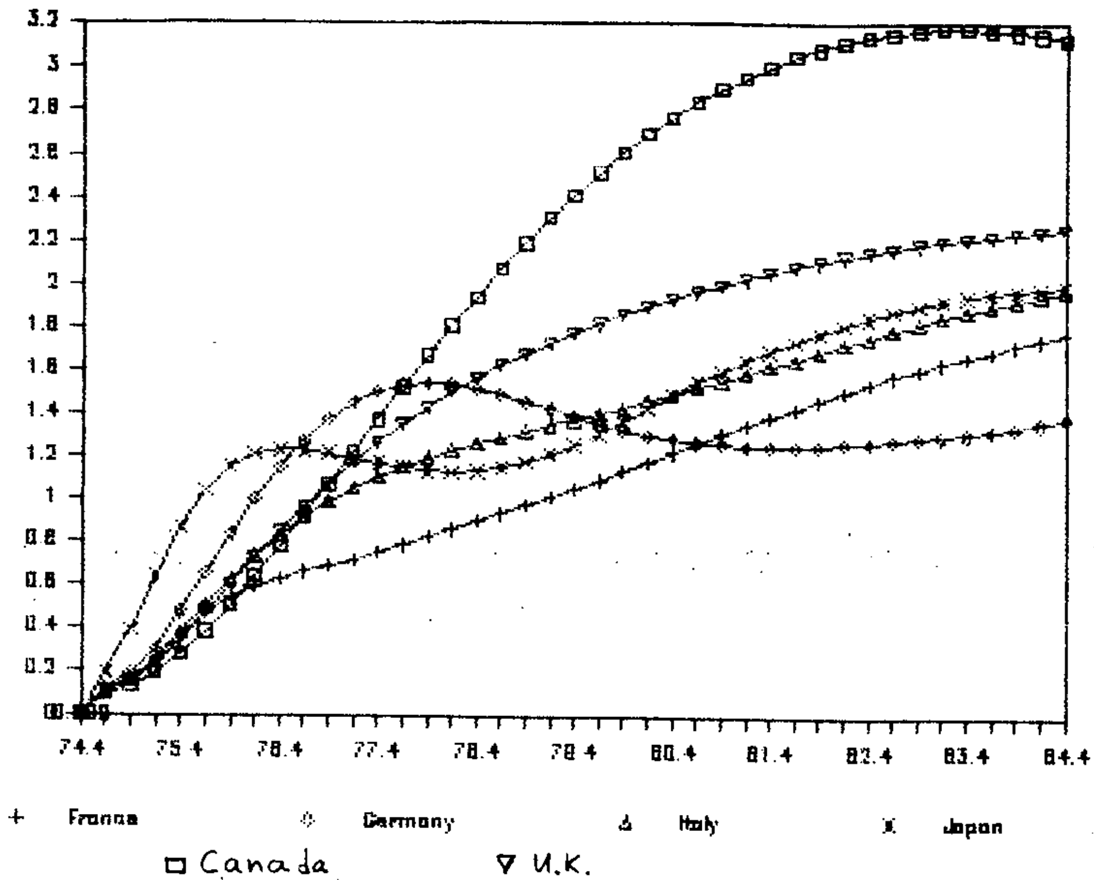


Figure 3d. Increase in U.S. Money with Fixed Exchange Rates: Impact on GNP Deflator in Six Other Countries

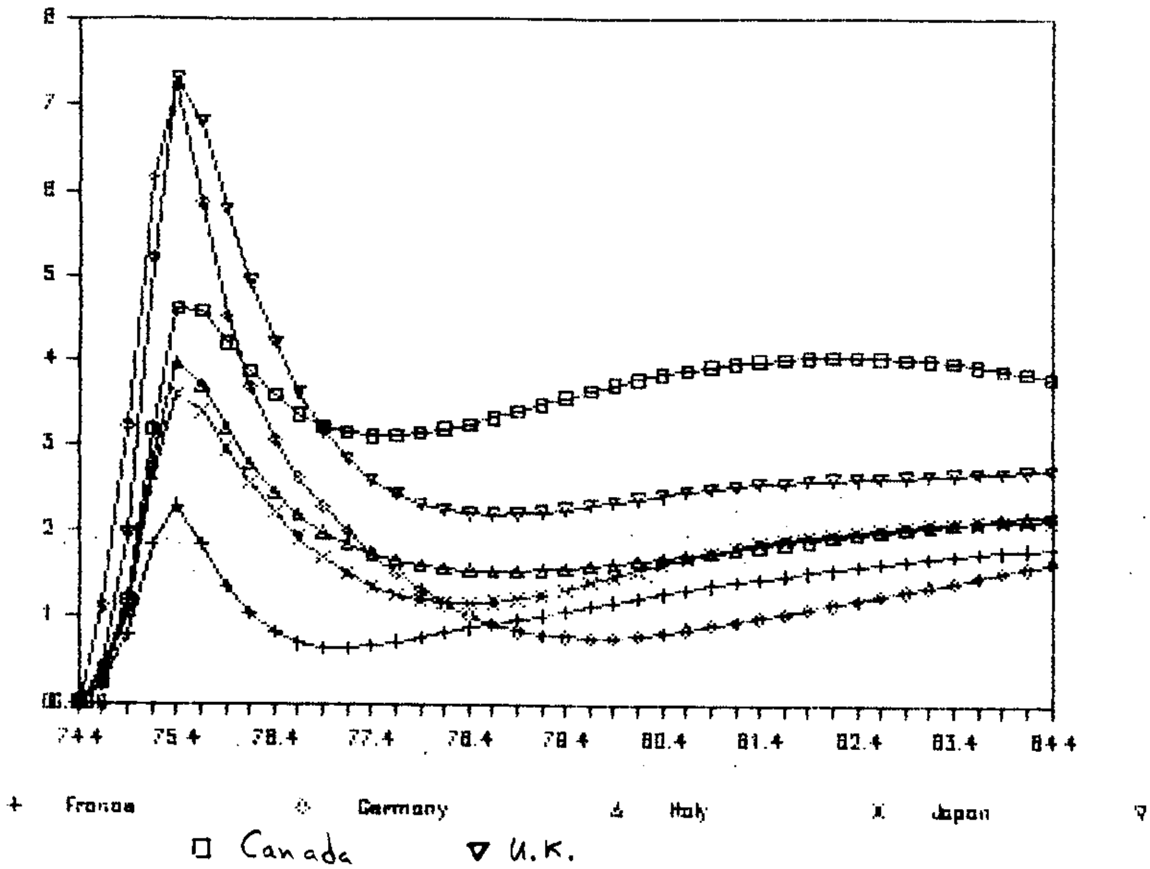


Figure 3e. Increase in U.S. Money Supply with Fixed Exchange Rates: Impact on Money Supplies in Six Other Countries.

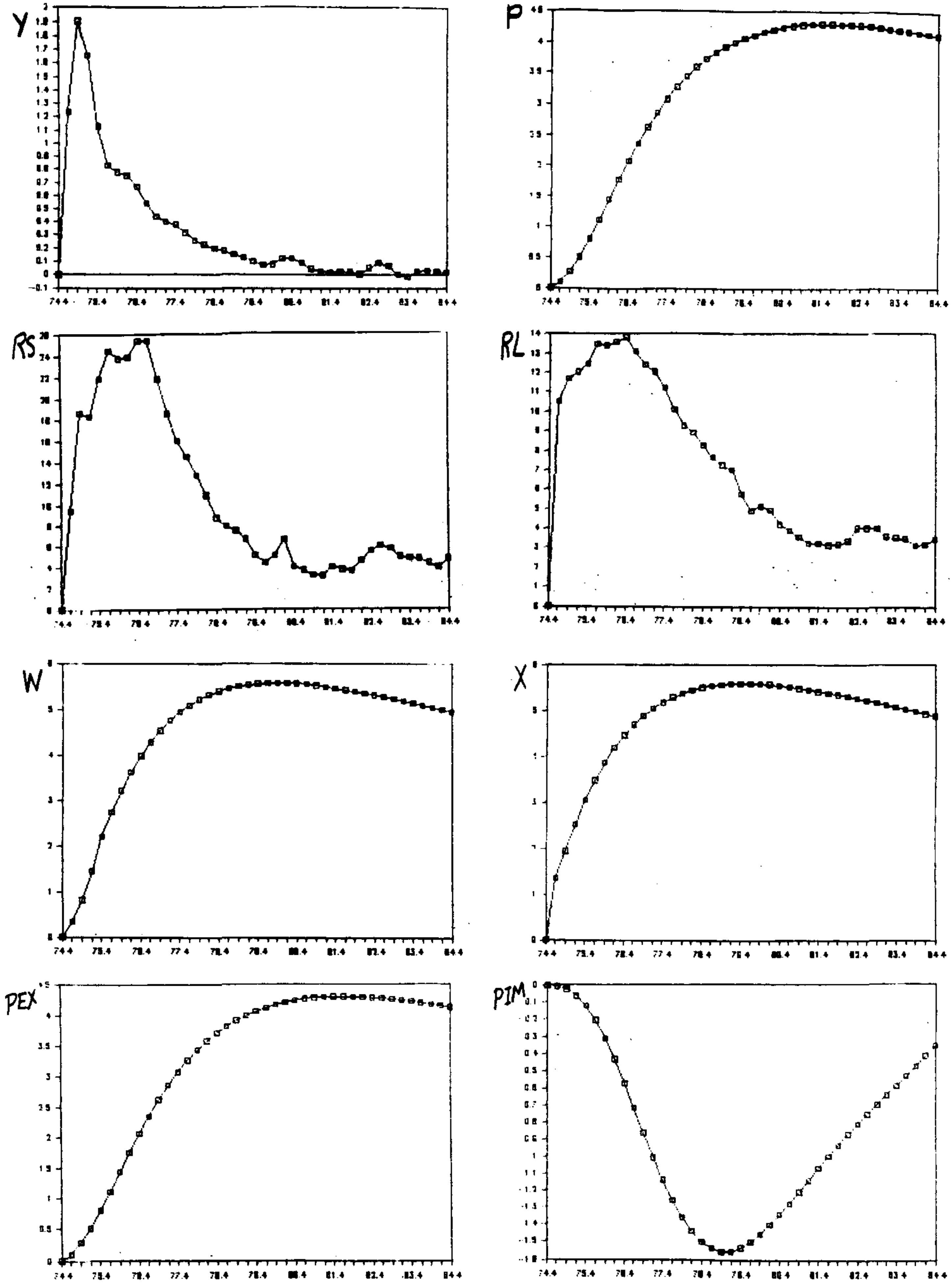


Figure 4a. Increase in U.S. Government Purchases with Fixed Exchange Rates: Impact on U.S. Output, Interest Rates and Prices

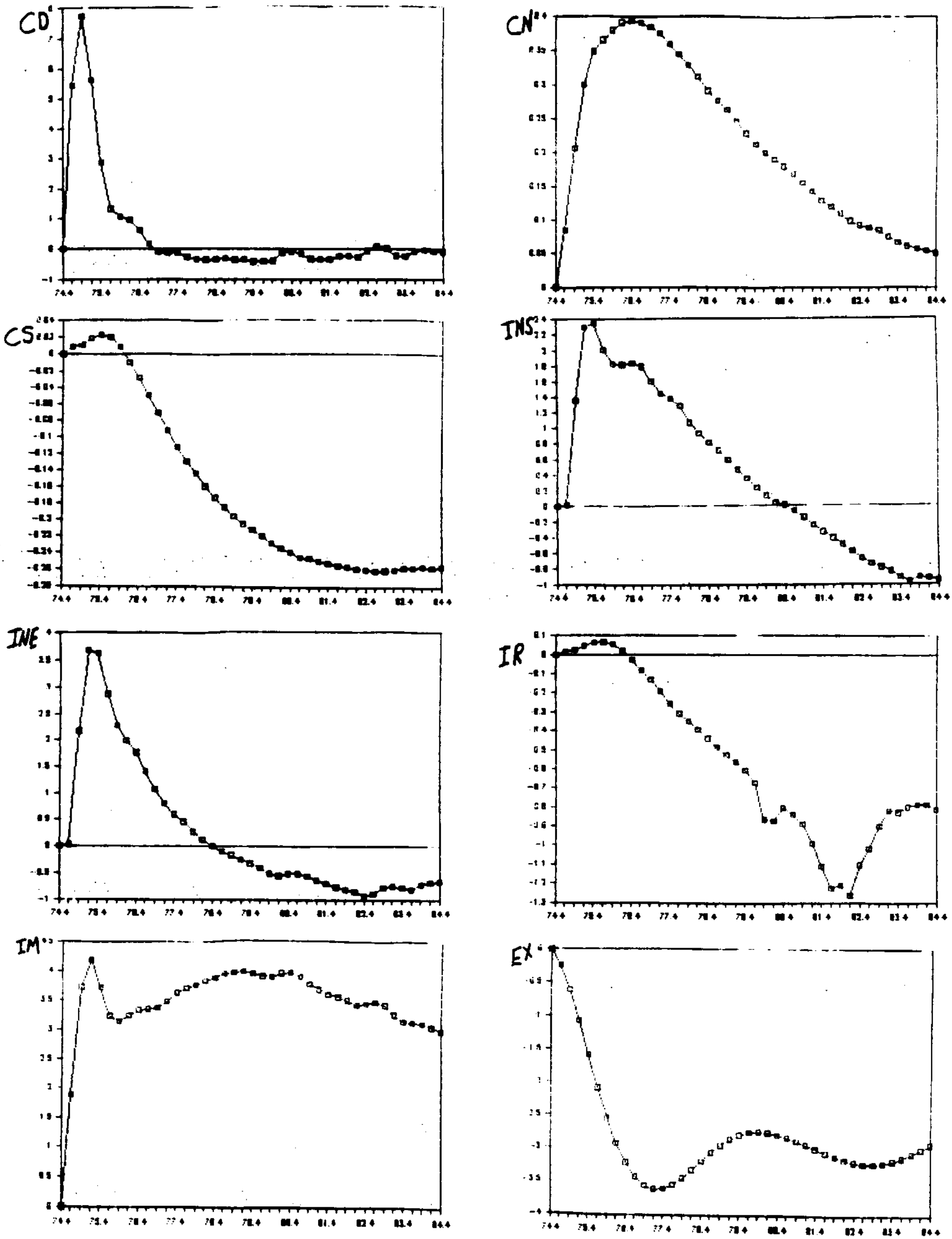


Figure 4b. Increase in U.S. Government Purchases with Fixed Exchange Rates: Impact on Components of U.S.

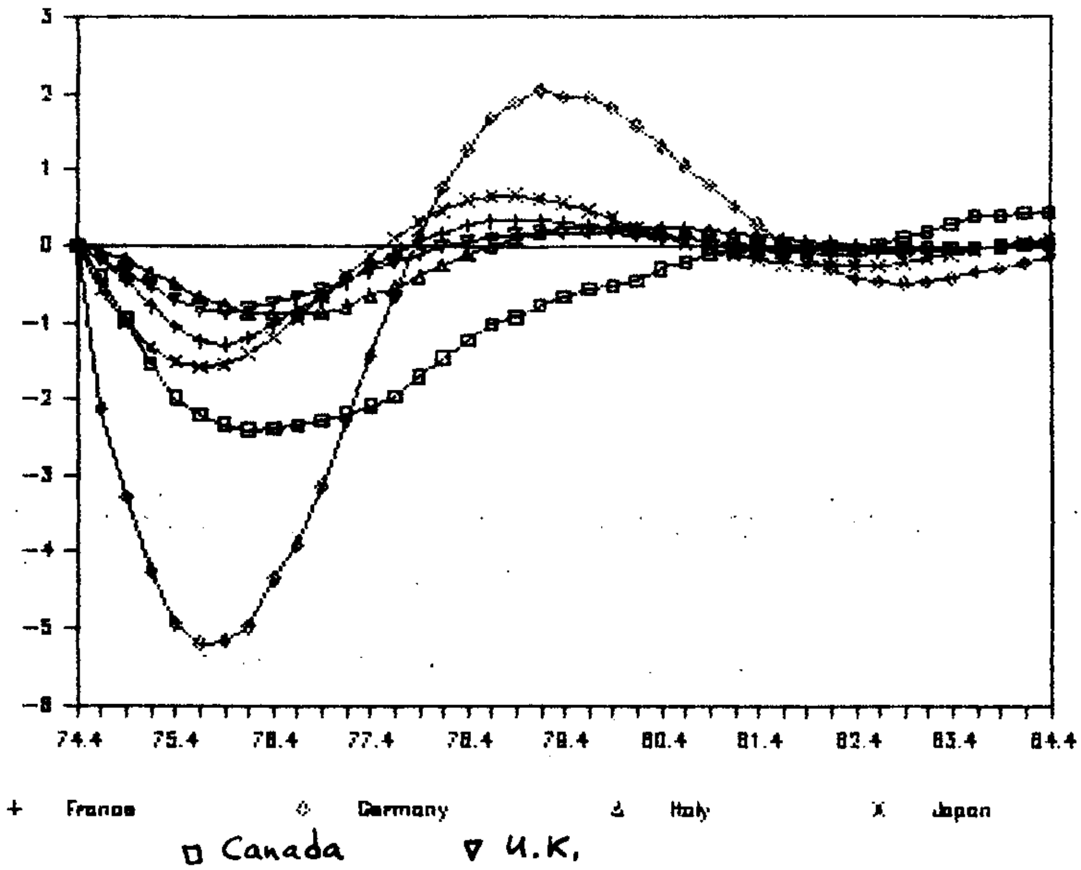


Figure 4c. Increase in U.S. Government Purchases with Fixed Exchange Rates: Impact on Real GNP in Six Other Countries

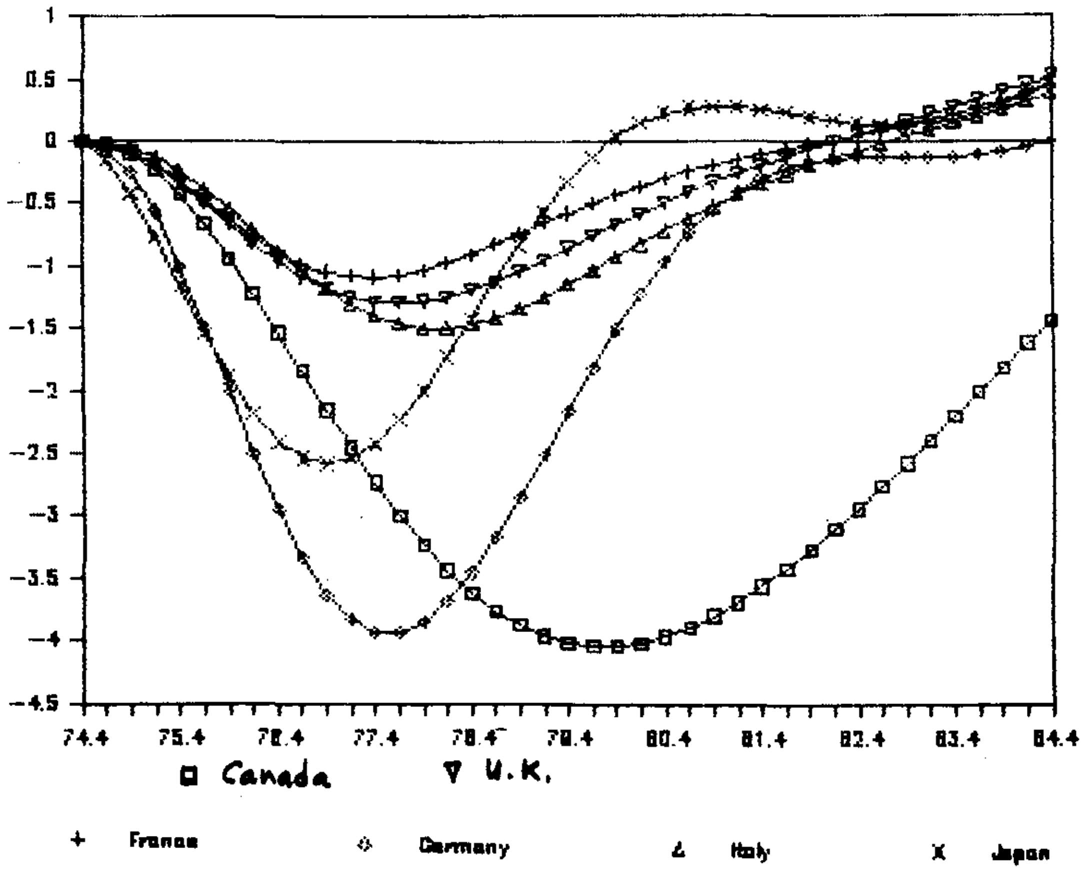


Figure 4d. Increase in U.S.Government Purchases with Fixed Exchange Rates: Inpact on GNP Deflators in Six Other Countries

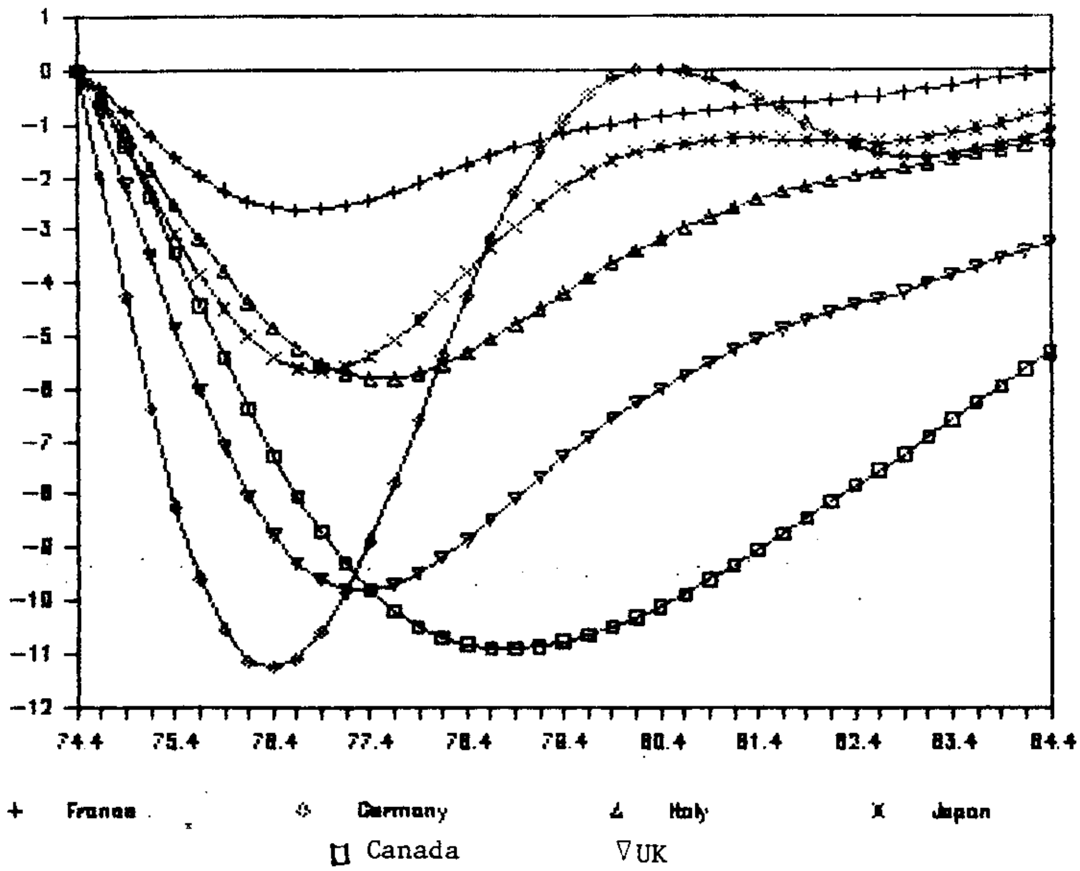


Figure 4e. Increase in U.S. Government Purchases with Fixed Exchange Rates: Impact on Money Supplies in Six Other Countries

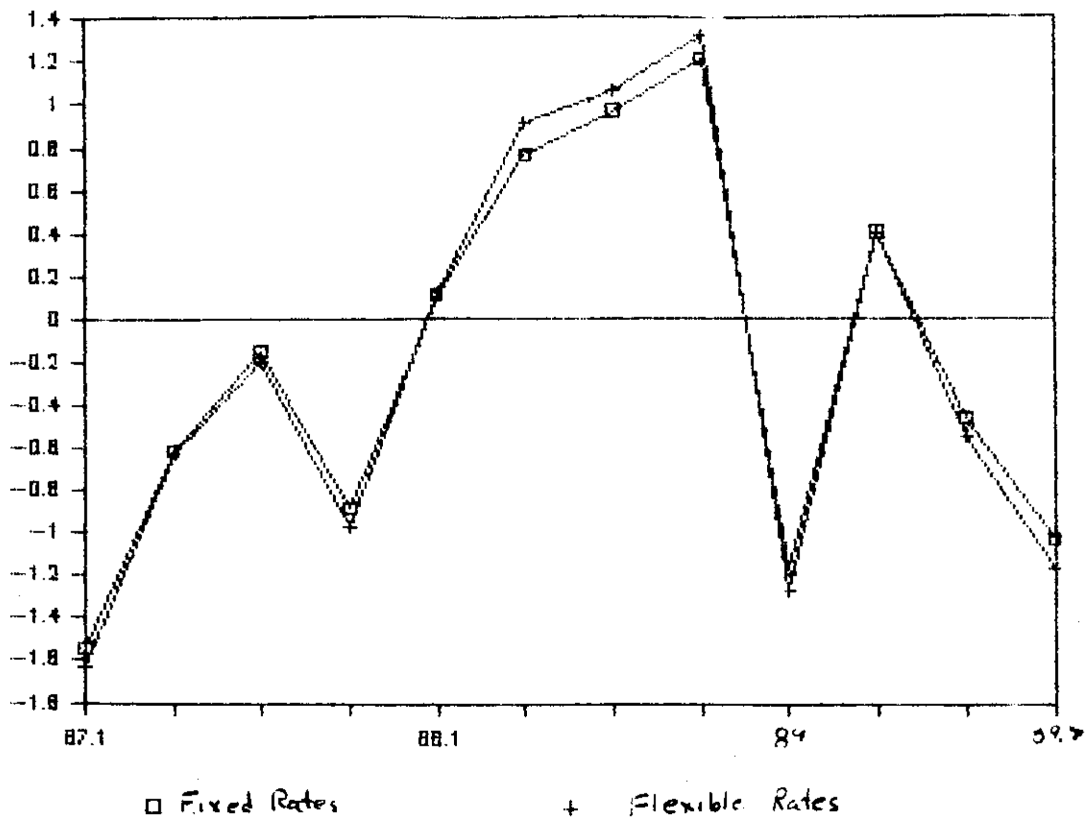


Figure 5. U. S. Output with Wage Shocks

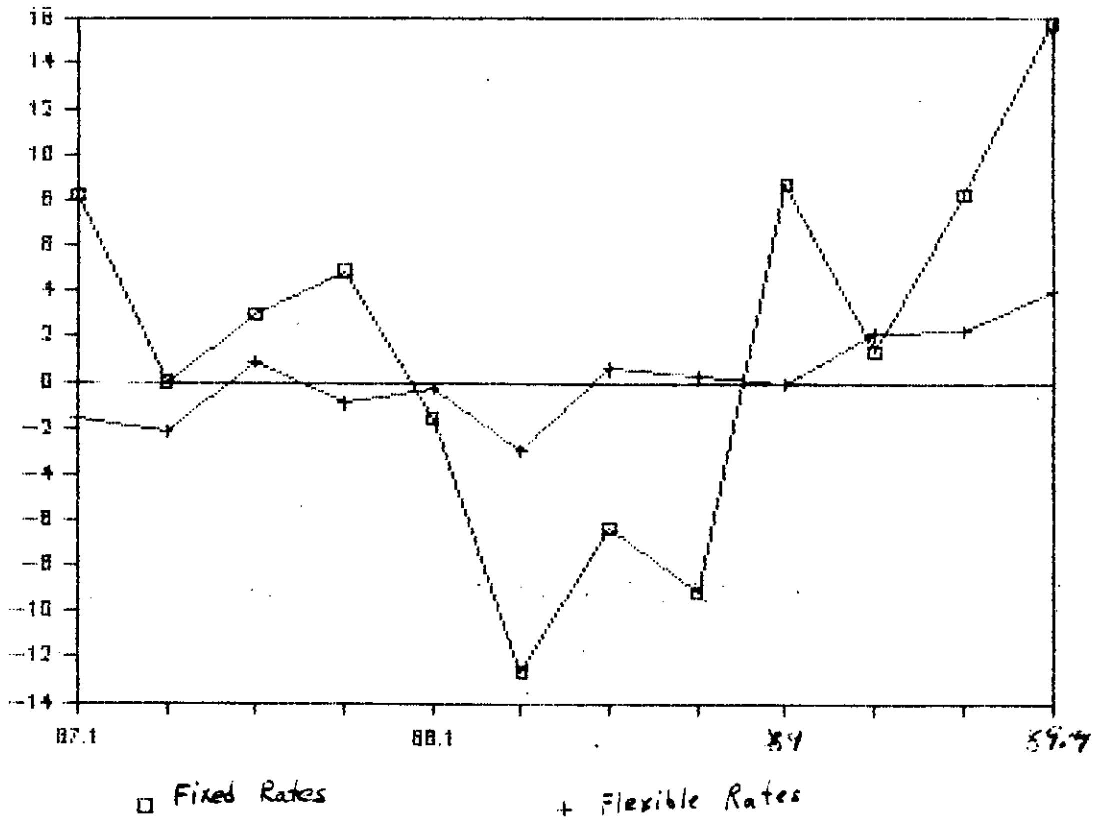


Figure 6. German Output with Wage Shocks

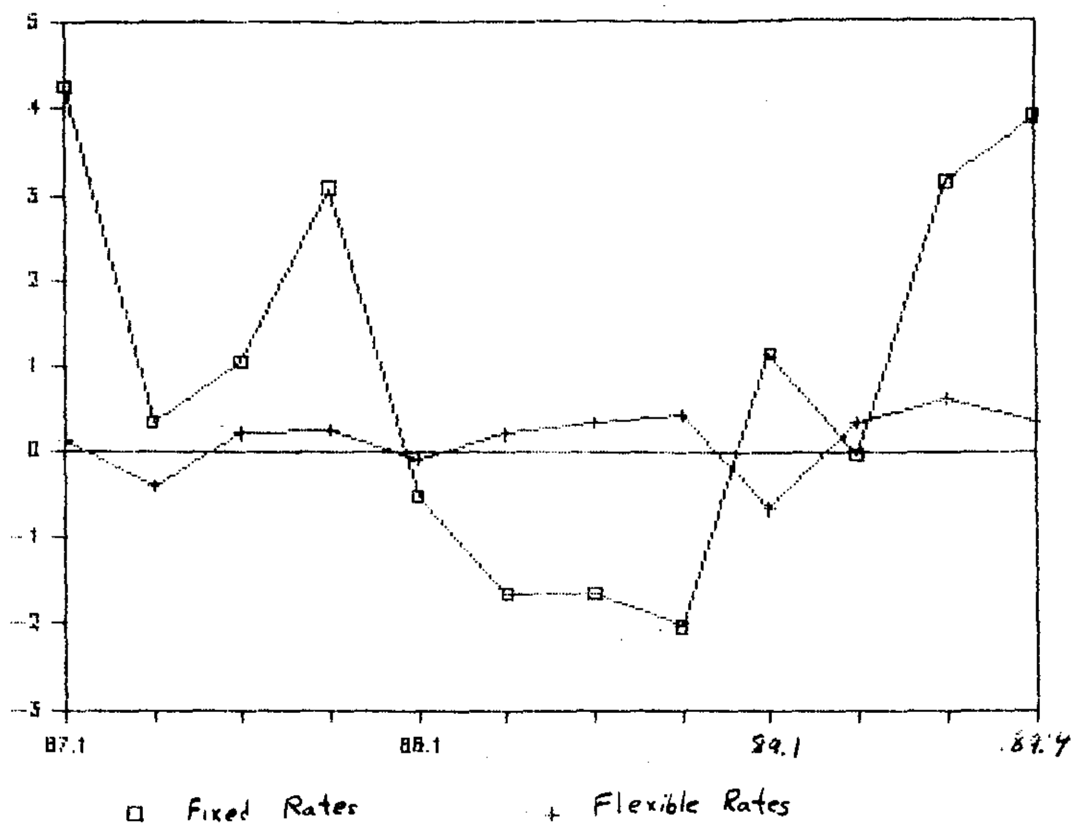


Figure 7. Japan Output with Wage Shocks