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Real Exchange Rates: Some Evidence from the Postwar Years

THE MOVE TO FLEXIBLE EXCHANGE RATES early in 1973 is the type of experiment that economic researchers experience rarely. A marked change in monetary regime from fixed to flexible rates was followed by years of floating rates. Initially, some governments may have thought of flexible rates as a temporary expedient to last only until new parities were firmly established. Within a few years, however, the governments of principal developed countries, including the United States, accepted flexible rates as a durable arrangement. Although there has been considerable intervention in the currency markets, attempts at policy coordination and talk about target zones (particularly in recent years), the dollar and several other currencies have continued to float. Most major trading countries have reduced or removed exchange controls and other restrictions on capital mobility.

A frequent, and probably the dominant, assessment of experience with flexible rates is that they have not worked as anticipated. Robert Aliber (1992, p. 44) writes that "Few of the advantages noted by proponents of floating exchange rates have been realized in the 1970s and the 1980s." Krugman and Miller (1992, p. 1) share this view and, in addition, criticize theories of exchange rate determination. They write that "interventionist

economists believed that left to themselves exchange markets would introduce unnecessary and harmful volatility into the exchange rate." These writers summarize the current state of research as showing that monetary models "have had almost no empirical success. Indeed, money supplies, if they enter at all, typically enter with the wrong sign." (*ibid.*, p. 9)

Singleton (1987, p. 9) reports the professional judgment that "by most measures, exchange rates have been relatively unstable since 1973." He recognizes, however, that the instability may reflect uncertainty that the public faces in adjusting to information about the future. And he notes that observed variability of exchange rates may have lower welfare costs than alternative regimes.

Mussa (1986) studied fluctuations in bilateral exchange rates for the principal market economies. He showed that the variability of bilateral real exchange rates from 1957 to 1984 was eight to 80 times higher in flexible-rate periods. There were no examples of lower variability under flexible rates among the 17 countries studied. The reason is clear from Mussa's data. Under flexible exchange rates the variability of nominal exchange rates increases much more than the variability of the ratio of relative price levels declines. In fact, the variance of bilateral rela-

tive price levels was not always lower in flexible-rate regimes.

Mussa did not draw any conclusion about the welfare properties of alternative regimes. The increased variance of bilateral real exchange rates may substitute for the variance of other variables, may be absorbed at relatively low cost by hedgers and speculators in financial markets, or in part may represent permanent shocks, such as the oil shocks of the 1970s and 1980s, that require adjustment of relative prices and real values. But the alternative is also plausible. Some of the higher variances under fluctuating rates may be the source of excess burden.

A main problem in reaching a judgment about the operation of fluctuating rates is that there is no benchmark for comparing alternative regimes. Economic models of exchange rates have performed poorly compared with statistical models such as the random walk. Many papers report that there is no significant relation, often no evidence of any reliable relation, between exchange rates and other economic variables. Meese and Rogoff's (1983) well-known paper found that a random walk performed as well out of sample as any estimated structural model. This suggests that many changes in exchange rates are random events, unrelated to policy or macroeconomic performance. Chinn (1991) summarizes recent tests for cointegration of real and nominal exchange rates with standard economic aggregates such as money and output at home and abroad or, for nominal exchange rates, relative rates of inflation. The tests reject cointegration, suggesting that there is no long run relationship between exchange rates and any of these aggregates.

Critics have commented especially on the relatively large change in dollar exchange rates in the 1980s. Even Haberler (1987), a long-time proponent of floating refers to "the widespread disenchantment with floating exchange rates." Critics have not been satisfied with computations showing that the variances of exchange rates, like the prices of other traded assets, exceed the variances of prices of current production. Nor have they accepted as sufficient explanation for observed variability that foreign exchange markets, like other markets for traded

assets, respond to new information, which arrives continuously in a changing world.¹ Without evidence showing that the news is systematically linked to exchange rate changes and that the adjustments are toward a new equilibrium, the proposition is nearly empty.²

A longer summary of the large literature on flexible rates would belabor the obvious. Neither the critics nor the proponents of flexible exchange rates have produced much evidence on which to base comparative judgments about exchange rate regimes. Claims that variability is larger or too large are meaningless unless an alternative is specified and its properties compared. Yet it is common to find statements that flexible rates have not worked as expected. They "do not substantially shield a country from events abroad"; that "current account imbalances have been protracted", and that "wide movement and reversals have contributed to the widespread impression that floating rates tend to overshoot." "Although clean floating has not yet become a dirty word, the simple faith that the market is always right has been shaken."³

This paper reconsiders experience under flexible exchange rates. Section 1 summarizes the claims about flexible rates in Milton Friedman's classic 1953 paper to show that Friedman's claims are more modest than is often supposed. Section 2 presents some key facts about exchange rates and comparative variability of several variables under fixed and flexible rates. Section 3 estimates a model of the so-called real exchange rate under Bretton Woods and flexible rates and tests for the effect of economic aggregates on the exchange rate. The model incorporates some of the principal variables affecting exchange rates suggested by Friedman. Section 4 discusses some limitations of the results. A conclusion completes the paper.

FRIEDMAN'S CASE FOR FLEXIBLE EXCHANGE RATES

In "The Case for Flexible Exchange Rates," written shortly after the Bretton Woods System started, Friedman claims four benefits for flexible rates: (1) increased liberalization of trade, (2) avoidance of direct controls, (3) facilitation of

¹See Frenkel (1983).

²The qualification is needed because some testable propositions result. Changes may be unbiased or larger in periods of large shocks such as wars and oil price changes.

³See Wallich (1984).

rearmament, and (4) harmonization of internal monetary and fiscal policies.⁴ The point that concerned later critics most, variability or instability, is dismissed early with the claim that exchange rate instability reflects instability in the economy and is not a property of a flexible or floating rate system. This claim is not self-evident, and it has not been accepted by the principal critics of flexible rates. Friedman appears to have anticipated this outcome. He devotes more space to refuting or dismissing the charge of instability than to making the positive case for the four benefits claimed for flexible rates.

Friedman's essay does not claim that flexible exchange rates are optimal for all countries or even for a single country. When discussing the former sterling bloc, he considers a mixed system in which groups of countries may elect to maintain fixed exchange rates internally and flexible rates against all other groups or countries. Although there are structural differences between the sterling bloc and the proposed European Monetary Union, Friedman anticipates the principal issues: policy harmonization, avoidance of trade controls and exchange restrictions, absence of a political authority and, in the absence of controls, the need to choose between unemployment and exchange rate changes in the short term.

Recognizing that optimality of flexible rates cannot be established, Friedman limits his claim to the judgment that flexible exchange rates are more desirable socially than the four alternative means of offsetting changes in international position. The four alternatives are: (1) official changes in currency reserves; (2) changes in domestic price levels and incomes; (3) periodic realignment of parities; and (4) direct controls.

The key conditions are posited. First, with flexible exchange rates, there are "broad, active, and nearly perfect markets ... in foreign exchange" whenever they are permitted. Second, a fixed but adjustable exchange rate "insures a maximum of destabilizing speculation. Because the exchange rate is changed infrequently and only to meet substantial difficulties, a change tends to come well after the onset of difficulty, to be postponed as long as possible."⁵ These conditions, it seems fair to say, have not been accepted

by the critics of flexible rates. The critics typically argue that speculation is (or can be) destabilizing.

Friedman considers and rejects some common conjectures about destabilizing speculation. His main argument is that there is no empirical foundation for these claims. Appearances to the contrary are misleading and subject to misinterpretation. A main problem in any study is to separate the actions of speculators based on correct predictions of parity changes and actions that cause parity changes that would have been avoided. These problems arise under an adjustable peg, but Friedman claims they would be prevented under continuous adjustment of flexible rates. Friedman is cautious, however. He avoids a general claim that speculation is stabilizing. Instead, he argues that if destabilizing speculation is common, governments (or exchange stabilization funds) would profit by intervening. And he recognizes that governments may have more information or more timely information that gives them an advantage over private speculators. He is willing to let a government agency intervene to smooth temporary fluctuations if they can do so profitably (p. 188), but he is skeptical that they would be able to profit consistently. They are less likely to profit, he claims, than private speculators who risk their own wealth.

The reason for choosing flexible rates is that other means of adjustment are less satisfactory. Fixed exchange rates were maintained in the 19th century because the public and governments tolerated larger fluctuations in domestic prices and employment than would be acceptable in the late 20th century. Direct controls are least satisfactory because they introduce distortions and do not correct permanent differences in relative prices in foreign and domestic markets.

Timing of adjustments is a source of variability about which little is known with precision. Anticipating future discussion, Friedman considers overshooting and undershooting of exchange rates. Overshooting arises because initial adjustment is borne by prices that adjust most readily. The exchange rate is such a price. Later other prices adjust, and the overshooting reverses, although it may be replaced by undershooting of the final change, followed by a series of adjustments around the new equilibrium.

⁴The essay was written in 1950 but not published until 1953.

⁵See Friedman (1953), pp. 162-64.

Thus Friedman recognizes that there will be variability and fluctuations of exchange rates, not prompt, rapid adjustment from the old to the new equilibrium. The possibility that the fluctuations, though not destabilizing, produce excess burden and welfare loss is not addressed directly. Friedman's main response to this central issue is comparative. His conclusion can be summarized in two paragraphs.

First, comparison of exchange rate regimes must include the costs of adjustment under alternative policies. The comparison cannot be limited to the size of changes in exchange rates or the variability of exchange rates under different regimes. Changes in the relative prices of goods and services are not the same under different policies. With gradual adjustment of real wages and other relative prices, labor market adjustment, hence unemployment rates, will differ under different regimes. And direct controls introduce distortions and welfare losses.

Second, there is no presumption that social costs could not be increased by flexible exchange rates. "About all one can say ... is that there seems no reason to expect the timing or pace of adjustment under the assumed conditions [flexible exchange rates] to be systematically biased in one direction or the other from the optimum or to expect that other techniques of adaptation—through internal price changes, direct controls, and the use of monetary reserves with rigid exchange rates—would lead to a more nearly optimum pace and timing of adjustment."⁶

EXCHANGE RATE CHANGES AND VARIABILITY, 1973–90

Excessive variability is one of the main issues raised by the critics of flexible rates. Evidence of increased variability of real or nominal ex-

change rates after 1973 is easy to produce. To draw any conclusion about the effects on welfare, two issues must be resolved. First, as Friedman noted, increased variability of exchange rates may reduce variability of output, consumption, employment or other variables of interest to consumers. Reduced variability of these variables can produce a welfare gain despite the increased variability of exchange rates. Second, increased variability of exchange rates may result from real shocks, such as an oil shock, or from policy activism, or it may reflect increased knowledge of the operation of exchange markets.

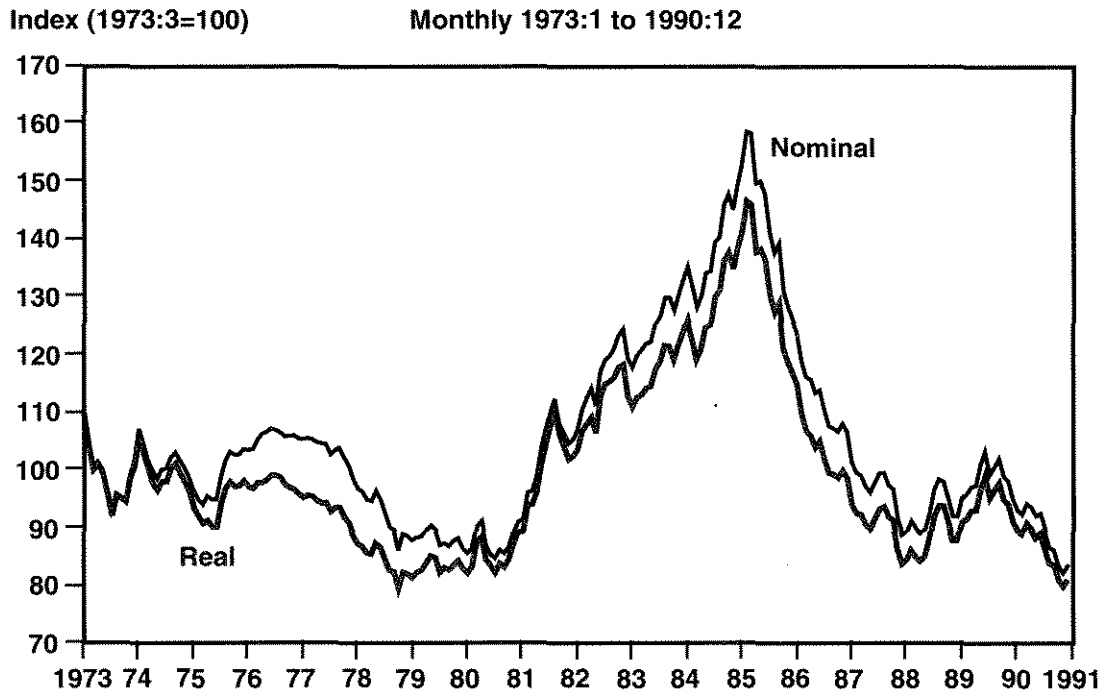
This section considers changes and variability of exchange rates and some other variables under Bretton Woods and flexible rates. Figure 1 shows the monthly trade-weighted nominal and real exchange rate for the United States, using Federal Reserve weights, for the period 1973–90. A rise in the index is an appreciation of the dollar. Two facts are immediately apparent. First, real and nominal exchange rates move together and by similar amounts.⁷ This fact has been demonstrated repeatedly for bilateral rates. See Mussa (1986) and Edwards (1989) for studies of developed and developing countries. Second, trade-weighted exchange rates moved over a relatively wide range during the 18-year period. The movement is dominated by a persistent appreciation from 1980 to 1985 followed by a persistent depreciation lasting to early 1987. Both exchange rates then returned to approximately the same range they had left in 1979.

Other measures of trade-weighted exchange rates developed by the International Monetary Fund (IMF) using wholesale prices or unit labor costs in the various countries to compute real exchange rates show the same general pattern. Experiments with different weighing patterns

⁶See Friedman (1953). The conflicts in the system developed more slowly than Friedman predicted. He predicted that "direct controls over exports and imports would be reimposed on a large scale within two or three years at the most." This prediction was inaccurate. The United States introduced some controls on capital movements in the 1960s, but the trend in the 1950s and 1960s was toward reduction of trade barriers under General Agreement on Tariffs and Trade rules. The conflicts in the system were resolved partly by changes in parities abroad but mainly by inflation in the 1960s and early 1970s.

⁷The so-called real exchange rate measures the ratio of the price level in the United States to a weighted average of foreign price levels expressed in a common currency.

Figure 1
Trade-Weighted Nominal and Real Exchange Rates



do not appear to change the general features, although computed variances and ranges differ for the individual measures.⁸

The exchange rate data shown in figure 1 raise two issues that will concern us. First, why do real and nominal exchange rates move together? Second, is the higher variability of real exchange rates under fluctuating exchange rates caused by policy actions, or is there evidence of excess burden arising from increased variability unrelated to policy action?

The similarity of real and nominal exchange rate changes in figure 1 is not peculiar to U.S. data. Figure 2 shows monthly values of the exchange rate of the Japanese yen for the German mark during the period 1973-90. The real exchange rate is obtained using the relative con-

sumer price indexes for the two countries. In the first years, the real and nominal exchange rates differ; consumer prices rose more rapidly in Japan than in Germany. In real terms Japan paid more yen per mark than in nominal terms. After 1976, the two price levels had about the same rate of change, so the real and nominal exchange rates are often indistinguishable on figure 2.

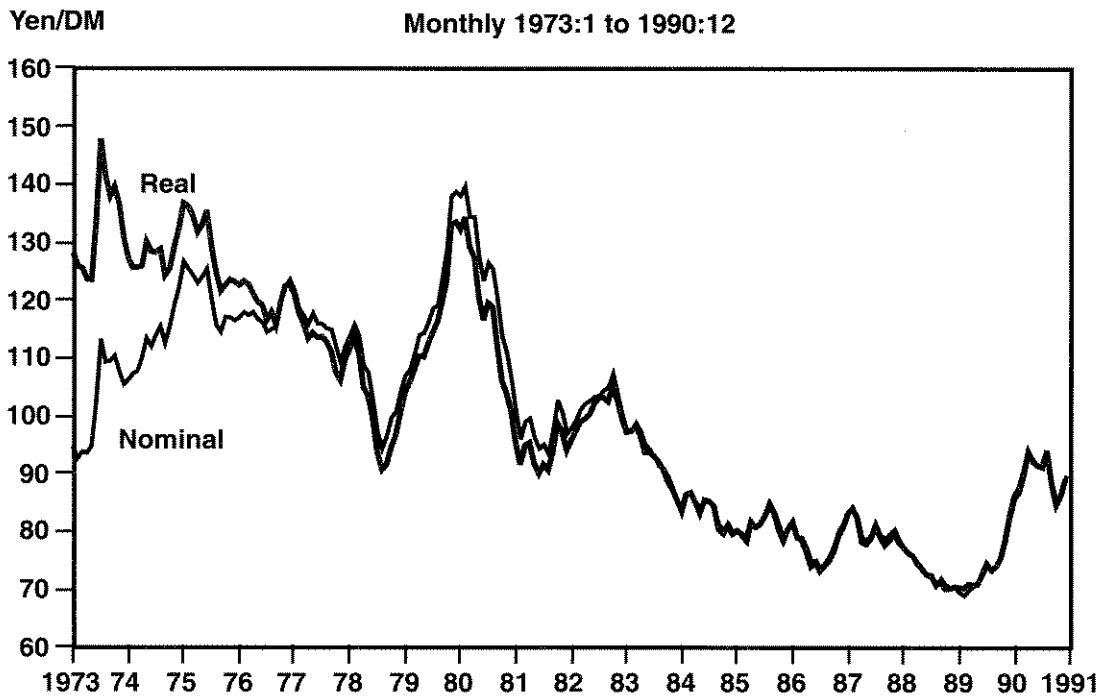
Mussa's (1986) study of changes in bilateral exchange rates for a broad sample of developed countries during the years 1957-1984 found the same result. Under flexible exchange rates, changes in nominal and real exchange rates are highly correlated, but changes in nominal or real exchange rates are not closely correlated with changes in the ratio of price index numbers.

⁸Becketti and Hakkio (1989) computed the correlation between innovations in seven alternative measures of trade-weighted exchange rates. Most of the correlations are above 0.9 using quarterly data for 1976 to 1988. They show that similar results hold for percentage rates of change of exchange rates.

The Federal Reserve index uses weights reflecting country shares of world trade. I computed an alternative index based on U.S. trade weights and reweighted the index at

the start of each decade-1960, 1970 and 1980-to adjust for changes in relative trade shares. The main conclusion sensitive to the change in weights is that the variance of the trade-weighted real exchange rate is lower for the alternative measure. I have used the Federal Reserve index throughout.

Figure 2
Real and Nominal Yen/DM Exchange Rates



Meltzer (1990) considered the variability of multilateral exchange rates using data from the IMF. Real exchange rates are based on both relative wholesale prices and relative unit labor costs, and variances are used to measure variability. Again, countries with flexible exchange rates had greater variability of nominal and real exchange rates than countries in the European Monetary System (EMS) that maintained an adjustable peg with other members of the EMS. Changes in real and nominal exchange rates were highly correlated under flexible rates. However, the variability of relative unit labor costs was typically lower in the countries with flexible exchange rates, whereas the variability of wholesale price ratios was higher.

Table 1 summarizes these data. Both nominal (N) and real (R) exchange rate changes are more variable under flexible exchange rates than under fixed but adjustable rates, whereas relative prices are not. The variability of R or N under flexible rates is significantly different at the 1 percent level from the variability experienced under EMS or the mixed regimes (denoted other) that had crawling pegs or some other type of partially fixed nominal exchange rate during this

period. Changes in multilateral real exchange rates are 4 or 5 times more variable in flexible-rate countries than in the EMS. Generally, the variances for "other" countries lie between the variances for the EMS and flexible-rate countries. The exception is P_{ULC} —the variability of changes in relative prices based on unit labor costs, P_{ULC} has been lower on average under flexible rates, although the difference between regimes is not significant by the usual standards.

The much-discussed increase in the variability of real exchange rates in a flexible exchange rate regime may reflect only that flexible exchange rates change more frequently, whereas the relative price ratios are not much affected by the change in regime. Using the terms of trade as a measure of relative prices, table 2 shows that the variances of relative price ratios do not differ systematically across exchange rate regimes. Variability of the terms of trade rose in all countries but to different degrees unrelated to the exchange rate regime. The comparatively high variability of Japan's terms of trade suggests that there is no simple relation between the variability of this measure and the growth of trade.

Table 1

Variations of Changes in Relative Prices, Real and Nominal Exchange Rates I/1979-III/1989

	Average Quarterly Values x 100		
	EMS ¹	Flexible Rates ²	Other ³
P _{ULC}	.013	.007	.017
P _{WP}	.017	.037	.030
R _{ULC}	.037	.154	.058
R _{WP}	.033	.158	.059
N	.025	.143	.043

¹Austria plus seven EMS countries (Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands)

²Japan, Switzerland, United Kingdom and the United States

³Norway, Spain, Sweden, Finland and Canada

Source: IMF where N = R + P

NOTE:

P is the first difference of the logarithm of the relative price of domestic to foreign goods or services.

R is the first difference in the logarithm of the real exchange rate

N is the first difference in the logarithm of the nominal exchange rate

Table 2

Variations under Fixed and Flexible Rates United States, Germany, Japan and the United Kingdom (quarterly values at annual rates)

Period	Real GNP or GDP				TOT			
	U.S.	Germany	Japan	U.K.	U.S.	Germany	Japan	U.K.
I/1960-III/1971	11.0	27.9	32.3	30.0	15.5	26.0	23.5	25.9
I/1973-III/1991	15.7	8.5	11.3	32.6	92.2	92.5	390.8	62.6
Relative value	1.4	0.3	0.3	1.1	5.9	3.6	16.6	2.4
I/1973-II/1975	24.2	10.6*	37.4	70.5	202.3	285.2	237.7	197.3
III/1975-III/1980	19.7	7.1*	5.1*	59.8	60.2	52.4	431.1	40.8
III/1980-III/1987	13.3	6.6*	5.8*	10.6*	61.7	78.2	388.8	31.6
IV/1987-III/1991	5.2*	3.5*	7.8*	11.0*	71.0	24.8*	170.8	27.6

TOT is terms of trade; variances are squared deviations from $x_t = (X_t - X_{t-1})/X_{t-1}$

NOTE: * denotes that the variance is lower than under Bretton Woods.

Table 2 also compares real output variances under fixed and flexible exchange rates in four countries. There is no relation between the relative variances and the monetary system. Real output variability declined in the same proportion in Germany and Japan with (mainly) fixed and flexible rates respectively and rose moderately in the United States and the United Kingdom.⁹

The last four lines of the table show variances for subperiods. The oil shocks of the 1970s increased the variances in table 2 in the early years of flexible rates. Variability of output fell in the United States in each successive period. In all countries the variance of real GDP was lower in 1987-91 than under the Bretton Woods regime.

⁹Meltzer (1986) reports similar results for the four countries using unanticipated variances. Unanticipated variances were computed using forecasts obtained from a multivariate, univariate Kalman filter.

The countries shown in table 2 have different exchange rate systems. Japan and the United Kingdom had flexible exchange rates during the period, although the United Kingdom fixed to the exchange rate mechanism (ERM) of the EMS at the end of the period. Germany has been in the fixed-but-adjustable-rate ERM system since March 1979, and it experimented with other fixed-but-adjustable-rate systems with its neighbors beginning in the mid-1970s. The mark fluctuated, however, against the dollar, yen and many other currencies.

Though the variability of Germany's output growth is, on average, lowest of the countries in table 2, this cannot be attributed entirely to the reliance on fixed-but-adjustable rates. Variability of output growth in Germany was also lower than in Japan or the United Kingdom during the Bretton Woods period, and the relative decline in variability is the same for Germany and Japan. Further, during 1975-80 and 1980-87, periods of declining inflation, variability of Japan's output growth is comparable to (and even slightly below) Germany's.

The main conclusion drawn from table 2 is that there is no basis for a general proposition that output is more variable under fixed rates than under flexible rates. Relative prices (terms of trade) are more variable in all countries after 1973, but the increase is smallest in the United Kingdom.

POLICIES AND REAL EXCHANGE RATES

Friedman (1953) made two suggestions that have been overlooked. He gave prominence to policy—particularly rearmament—as one of the main factors affecting U.S. real exchange rates. Rearmament changes relative prices and the balance of payments (Friedman, pp. 159-60). Also, Friedman distinguished permanent and transitory changes in exchange rates. He noted the different response of speculators to changes that were expected to reverse and those that were expected to persist.¹⁰

Real government spending for defense rose and fell during the postwar years. Spending rose during the Vietnam War and declined dur-

ing the 1970s both absolutely and relative to real output. Spending rose again in the 1980s, reached a peak in the mid-1980s and declined modestly to the end of the decade. Maintained changes in the level of real defense spending act like any fiscal change. Increases in real defense spending raise aggregate spending and interest rates. Higher interest rates attract a capital inflow, appreciating the exchange rate. In the absence of capital controls and restrictions, the capital inflow reverses the rise in the interest rate. Reductions in real defense spending have the opposite effects.¹¹ The sign of real defense spending per unit of output should be positive.

Real money balances also affect real exchange rates. Injections of money temporarily increase real balances, and if the price level does not adjust instantly, the increase in money depreciates the real exchange rate. Reductions in real balances brought about by reductions in money or by a rise in prices for a given quantity of money appreciate the exchange rate.

Let r_t , the real exchange rate, have a permanent and transitory component, so that

$$(1) r_t = \bar{r}_t + u_t$$

where \bar{r}_t is the permanent component and u_t is the transitory disturbance. In the absence of changes in defense spending, real U.S. money balances and foreign real balances, the expected value of the exchange rate is the permanent value. The current permanent value is a weighted average of last period's exchange rate and any persistent effect of defense spending (relative to GDP) and real money balances at home and abroad as shown in equation (2).

$$(2) \bar{r}_t = \alpha r_{t-1} + (1 - \alpha) f(d_t, m_t, m_t^*) + v_t$$

Combining equations (1) and (2) gives equation (3), a testable equation for the real exchange rate.

$$(3) r_t = \alpha r_{t-1} + (1 - \alpha) f(d_t, m_t, m_t^*) + \varepsilon_t$$

where ε_t has the usual properties.

If the real exchange rate is mainly a random walk, $r_t = r_{t-1}$ plus a transitory white noise term.

¹⁰See Friedman (1953, p. 162). I began work on the relation of permanent and transitory fiscal and monetary changes to real exchange rates before I reread Friedman's essay. I was pleased to find that the results I had obtained provided evidence on some of his principal propositions.

¹¹Defense spending is a large share of government spending on goods and services. It has the advantage of being independent of income and hence a good measure of the thrust of exogenous fiscal policy. It also permits a test of Friedman's proposition.

Table 3
Determinants of the Real Exchange Rate*
(t statistics in parentheses)

Periods	(1) 1962-91 Annual	(2) 1972-91 Annual	(3) II/1971-IV/1991 Quarterly	(4) 1962-91 Annual	(5) 1972-91 Annual
$REER_{t-1}$	0.80 (6.40)	0.72 (3.69)	0.82 (11.76)	0.67 (5.37)	0.55 (3.12)
m_t	-0.15 (4.45)	-0.16 (4.49)	-0.11 (2.60)	-0.13 (3.87)	-0.16 (4.43)
m_t^*	0.28 (2.55)	0.26 (1.72)	0.07 (0.52)	0.21 (1.77)	0.16 (1.06)
d_t	5.32 (2.92)	9.75 (1.92)	3.37 (1.62)	5.88 (2.82)	13.02 (2.45)
constant	53.64 (3.26)	44.59 (2.45)	20.87 (2.42)	62.31 (3.16)	52.53 (2.63)
R^2/DW	0.89/1.89	0.78/2.03	0.92/1.95	0.88/1.92	0.77/2.00
$\rho(AR1)$	0.09(0.36)	-0.11(0.26)	0.26(1.75)	0.14(0.50)	-0.10(0.23)

*See appendix for definition of variables. $\rho(AR1)$ is the coefficient of the AR1 serial correlation correction and its t-statistic.

But if monetary and fiscal actions have persistent effects, these effects will be found significant in estimates of equation (3). Equation (3) therefore permits a test of the influence of the defense spending share and real money balances against the alternative hypothesis that real exchange rates are approximately a random walk and independent of systematic monetary and fiscal effects. If the real exchange rate is mainly a random walk, α is close to one. If there are persistent and systematic effects of money and the defense spending share, current values of these variables will have a significant effect on the real exchange rate.

The first two columns of table 3 show estimates for 1962-91 and 1972-91 based on annual data; the former includes the fixed exchange rate period, whereas the latter does not. The two sets of estimates are similar. The standard errors of estimate for the two equations are 5.9 and 6.8, a difference of approximately 1 percent of the mean value of the real exchange rate. The implied standard error of estimate for the Bretton Woods period is 3.6, about half the value for the flexible rate period. These values suggest that transitory random variation increased under flexible rates, but the increase is much smaller than is commonly alleged. A main reason is that the estimates here remove the effects of permanent changes in m , m^* , and d . These variables, particularly real money balances, have significant effects on the trade-weighted real exchange rate.

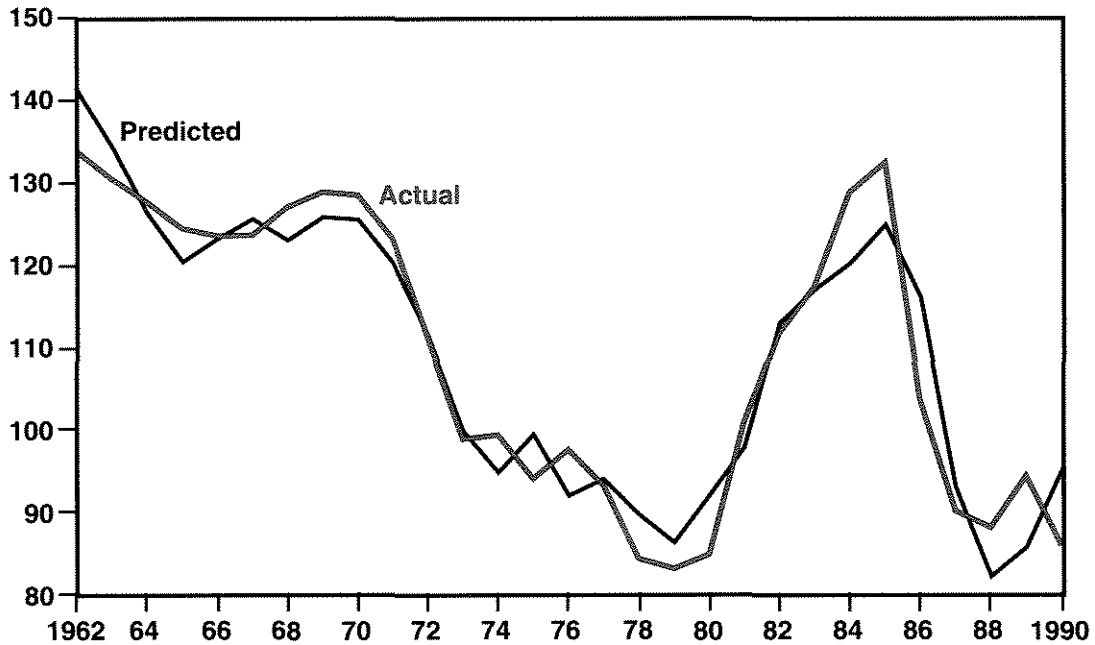
One problem with these estimates is that the coefficient of m_t^* is much larger than the coefficient of m_t using annual data. The difference may not be meaningful, however. The definitions of money differ (as described in the Appendix), and the difference in coefficients is not significant.

Figure 3 shows the actual and predicted values of table 3 using equation (1). Many of the claims about exchange rate instability are based on the relative changes in the 1980s. The chart suggests that much of the swing in the trade-weighted real exchange rate during the 1980s is driven by the variables in the model. The defense spending share rose by more than a percentage point in the early 1980s then fell after the middle of the decade. Real money balances moved in the opposite direction, falling through 1982, then rising, particularly in 1985 and 1986. The forecasts and actual values are extremely close for 1981-83. There is some evidence of overshooting by the actual rate in 1984-85, but the errors are not much larger than the standard error of estimate. The subsequent decline in the forecast value lags the actual decline, however, in 1986 and 1987. The largest error in the 29-year span is in 1986.

The third column in table 3 shifts the time interval from annual to quarterly data. The results are similar to the annual data except that m_t^* is no longer significant. Current real money balances remain significant at the usual level, and the defense spending share nearly so.

Figure 3
Trade Weighted Real Exchange Rate

Index (1973:3=100)



The dependent variable in the regressions reported in the first and third columns of figure 3 is the average trade-weighted real exchange for the period. The fourth and fifth columns repeat the regressions for annual data using the monthly average value for December as the dependent variable. The results are similar.

The estimates in table 3 permit a test of the unit coefficient on RER_{t-1} implied by the random-walk hypothesis. All of the estimates are below unity, but two are not significantly different from unity; these are in the first and second columns of table 3. The estimates in the third and fifth columns differ from unity by more than two standard errors, so they reject this central implication of the random walk.

Recent work on the causes of fluctuations emphasizes the importance of real shocks to aggregate supply as a cause of fluctuations. The effects on the real exchange rate of the rise and fall of the relative price of oil in the 1970s and 1980s is an obvious candidate for investigation. The relative price of oil can be included in equation (2) as an additional variable affecting the permanent component of the real exchange rate. Annual data for 1972-90 and 1962-90 reject the effect;

the coefficient of the relative oil price is small (-0.03) in each period and has a standard error larger than the estimated coefficient.

The use of real money balances combines the separate effects of money and prices. To separate the effect of policy actions from the effects of prices, I first differentiate $m_t = (M_t/p_t)$ then lag the denominator by one period to get

$$(4) \quad dm_t = \frac{dM_t}{P_{t-1}} - \frac{dp_t}{P_{t-1}} \left(\frac{M}{P_{t-1}} \right)$$

The first term is the real value (in past prices) of the current change in nominal balances. The second is the revenue from the inflation tax on last period's real money balances. To estimate responses to these variables, I take first differences of equation (3) using equation (4) to replace dm_t .

Table 4 shows estimates relating the annual change in the real exchange rate to changes in some policy variables and real shocks. I have omitted the change in m^* to conserve a degree of freedom. Δm^* typically has a small negative coefficient and is not significant. Changes in money and changes in defense spending relative

Table 4
Response of ΔRER to Changes in Policy

Periods	(1)	(2)
	1972-90 Annual	1972-89 Annual
ΔRER_{t-1}	0.60 (3.05)	0.72 (6.66)
$\Delta M_t/p_{t-1}$	-0.39 (4.42)	-0.47 (8.41)
Δd_t	23.91 (2.62)	13.86 (3.60)
Inflation tax	-0.01 (0.07)	-0.001 (0.00)
Δ real debt	-0.005 (0.93)	
Δ gov't net worth*		0.004 (0.30)
Δ RGDP	0.07 (2.39)	0.03 (1.81)
constant	13.95 (1.23)	19.32 (2.47)
R^2/DW	0.59/1.79	0.80/2.51
$\rho(AR1)$	-0.19(0.43)	-0.68(2.51)

t-statistics are in parentheses. Coefficients of ΔRER_{t-1} are significantly different from unity at the 2 σ level.

*The data are from Bohn (1992). These data are available only through 1989. For other data, see appendix.

to GDP have considerable effect. For example a 0.1 percentage point change in the share of defense spending changes the real exchange rate between 1.4 percentage points and 2.4 percentage points based on the two equations. The 1982 increase in defense spending alone appreciated the dollar by 8.7 percentage points using the coefficient estimate for 1972-89.¹²

The inflation tax is not significant in the regression or in alternative estimates. This is unsatisfactory. Without a significant response to inflation, the equations imply that a change in nominal money has a permanent effect on the real exchange rate. If the equations are interpreted as short-term responses, they leave an important part of the dynamics unspecified.

Much recent discussion of the appreciation of the real exchange rate in the early 1980s, following the Reagan tax cuts, linked the appreciation either to the budget deficit or to the increased after-tax return to real capital. The change in the real value of government debt measures the

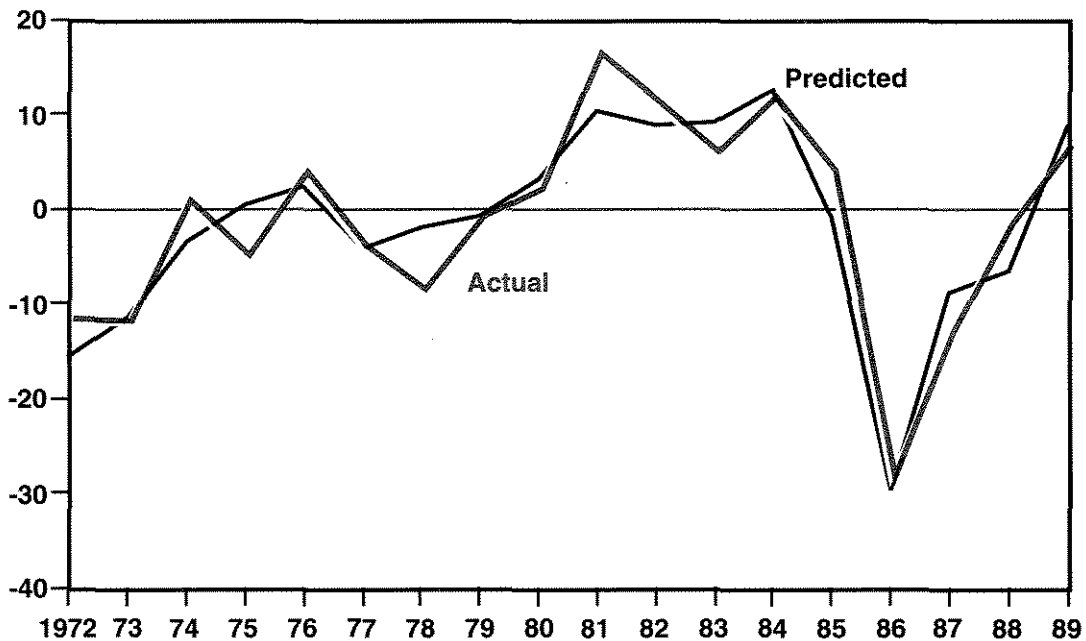
part of the current federal budget deficit financed by borrowing. I used the change in real GDP (RGDP) as a measure of the real return to real capital. This variable also captures the effects of changes in real output emphasized in the business cycle literature. Because real output is close to a random walk, changes in RGDP are a measure of unanticipated changes.

The change in RGDP has a significant effect on the change in the real exchange rate. The size of the coefficient is misleading because the changes are in billions of dollars. A more suggestive comparison is given by the change in the real exchange rate induced by changes in RGDP and the defense spending rates during four years of appreciation—1981-84. The total appreciation of the real exchange rate for this period is 44. The coefficients in the first column of table 4 assign slightly less than half of this change to the change in the defense spending ratio and slightly more than half to the change in RGDP. These calculations neglect other variables, particularly changes in money and lags of the real exchange rate. And the calculation overstates the importance of supply shocks or changes in tax rates because the changes in RGDP include the recovery from the 1981-82 recession that would have occurred in the absence of tax changes or supply shocks.

The response to deficit finance, measured by the change in real government debt, is small and insignificant. A problem with testing for effects of the budget deficit is the incomplete and imprecise way in which the deficit is measured. Eisner and Pieper (1984) called attention to this problem and showed that there are large differences between current accounting measures and measures of a more economically relevant magnitude. Bohn (1992) computed a measure of government net worth that includes principal government assets and liabilities other than Social Security and Medicare liabilities. The second column substitutes the change in real government net worth from Bohn for the change in the real value of the federal debt as a measure of the deficit. Government's net worth is negative, and if properly measured, the level of government net worth is the value of future tax payments. Changes in net worth have no significant effect. The responses to changes in RGDP and changes in the defense spending share both fall. Each explains a smaller fraction of the

¹²I neglect possible changes in the properties of the error term when taking first differences of equation (3).

Figure 4
Annual Changes in Real Exchange Rates



change in the real exchange rate during 1981 to 1984 (and other periods). The implied change in the real exchange rate resulting from changes in RGDP and the defense spending share are now approximately 25 percent and 29 percent respectively.

Figure 4 shows predicted and actual changes in the real exchange rate based on the estimates in the second column of table 4. Inspection suggests that the equation explains the annual changes more accurately for the 1980s than for the 1970s. This is particularly true in 1974 and 1975. There are only three years in which actual and predicted changes go in opposite directions—1975, 1978 and 1983. Actual and predicted changes move together during the appreciation and subsequent depreciation of the dollar in the 1980s. The equation suggests that contemporaneous changes in money and in defense spending are the principal factors keeping the predicted changes in step with actual changes.

LIMITATIONS

The empirical results are subject to some limitations. This section briefly discusses some problems arising from the absence of a structural

model, neglect of simultaneity, and problems of stationarity.

First, the estimates are obtained from a simple model of permanent and transitory changes, not from a structural model. The equations are neither structural equations nor reduced forms of a structural model. An advantage of the model is that it nests the effects of money and defense spending within a popular statistical model, the random walk.

Second, several of the variables such as the price level, output, the real value of money and the defense spending share are simultaneously determined. Simultaneity has been neglected throughout. The changes reported in table 4 and the use of lagged prices removes some of these problems. That the principal results are unaffected suggests that simultaneity may not impart serious bias to the estimates in table 3.

Third, many studies of exchange rates have investigated the stationarity of exchange rates. Tests of non-stationarity at first seemed to support the hypothesis. More recent work using longer time series, however, casts doubt on this conclusion. Engel and Hamilton (1990) did not test for stationarity, but they found persistent

departures from a random walk. Earlier, Krasker (1980) coined the term *peso problem* for persistent deviations of exchange rates in a particular direction. Papers by Huizinga (1987), Hakkio and Joines (1990), Lothian (1991), and Diebold, Husted, and Rush (1991) are part of the growing literature rejecting non-stationarity based on evidence that real exchange rates return to a mean value.

A main reason for the differences in findings between earlier and later studies is the use of a longer span of years. Some early studies used daily or monthly data to obtain a larger number of observations. Recent studies suggest that an increased number of high-frequency observations is a poor substitute for the relative paucity of low-frequency data.¹³

The principal conclusion to draw from many of the studies is that the real exchange rate is subject to persistent and transitory changes. Some changes in the real exchange rate persist for long periods. Some of the changes are reversed quickly. Diebold, Husted, and Rush (1991) conclude that on average the half-life of a shock to the real exchange rate has been about three years. This finding is similar to the decay rates implied by the coefficients on annual values of the lagged real exchange rate in table 3.

Inspection of figure 1 suggests that the multilateral real exchange rate remained within a range of 95 ± 15 from 1973 to 1980 and returned to approximately the same range in 1987. To test for stationarity, I used quarterly data for first quarter 1973 to fourth quarter 1990 but omitted the sharp appreciation and depreciation from third quarter 1980 to first quarter 1987.¹⁴ The coefficient of the lagged multilateral real exchange rate on the change in the real exchange rate is -0.14 with a t-statistic of 2.72. The Dickey-Fuller test statistic is 2.93 at the 5 percent level and 2.60 at the 10 percent level. On this basis, I reject non-stationarity.

CONCLUSION

Milton Friedman's (1953) essay on flexible exchange rates anticipated much of the discussion and many of the controversies of the next 40 years. Friedman did not claim that flexible exchange rates would be stable rates. Stability

depends on the size and frequency of shocks. Friedman claimed that flexible exchange rates would (1) contribute to trade liberalization, (2) avoid reliance on direct controls, (3) facilitate rearmament and (4) allow countries to follow domestic policies to achieve price stability.

Several of these conjectures were correct. Direct controls on capital movements have been reduced since 1973 in all developed countries and in some developing countries. It seems likely that rearmament (defense spending) would have provoked greater conflict about payments imbalances in the 1980s under fixed exchange rates than under the system that prevailed. Flexible rates permitted countries to choose how much of the stimulus emanating from the United States they wished to absorb. Many countries, indeed most developed countries, both purchased dollar securities and appreciated their currency.

The average rate of inflation has been brought down under flexible rates, and some countries have achieved price stability at times. Trade restrictions, however, increased in the 1980s, particularly in the United States, and the movement toward trade liberalization slowed.

Friedman did not argue that exchange rates would be stable. He argued that the path followed by real exchange rates would depend on the real and monetary disturbances to which the economy is subject and on the persistence of shocks. Critics argued that destabilizing speculation and random movements dominate exchange rate changes and create an excess burden. This burden, some suggested, could be reduced by fixing exchange rates or establishing target zones.

The paper does not address the issue of excess burden. However, I compare variability of output and the terms of trade for four countries under the Bretton Woods System and the different regimes adopted after 1973. There is no evidence that real output is generally more variable under flexible exchange rates. Terms of trade are more variable after 1973, but the data do not suggest that the increased variability is mainly the result of the exchange rate regime.

Further, I compare levels and changes in real exchange rates to the values predicted by a model.

¹³Hakkio and Rush (1991) reach the same conclusion based on more formal tests.

¹⁴The hypothesis implies and the data suggest that the appreciation and depreciation in this period is mainly the result of policy action.

The forecast errors do not give evidence of large, persistent errors. On the contrary, the models call the turning points in the level and changes in the exchange rate with considerable accuracy. The data suggest, however, that there is more unexplained variability of real exchange rates after 1973 than before when measured by the standard error of estimate for the regression equation.

The evidence also suggests that much of the movement in both levels and changes in annual values of the U.S. multilateral real exchange rate is explained by permanent or persistent changes in a few variables. The principal variables are real money balances and the share of defense spending in GDP. When the change in real balances is separated into variables measuring the current change in nominal money and the current change in the price level, the data suggest that the change in nominal money (measured at past prices) has a more important short-run effect. Quarterly data on levels of the variables support the principal findings.

Monetary and fiscal variables are nested within a random walk model of the real exchange rate. If the random-walk component dominated the exchange rate, the data would reject the relevance of the monetary and fiscal variables. The tests based on annual and quarterly data and on annual changes support the opposite conclusion: monetary and fiscal effects are persistent and reliable, and their effect is contemporaneous—within the current year or quarter. Of course, none of the findings here deny that the random walk may dominate levels or changes of the exchange rate at higher frequencies.

Two principal observations about fluctuating exchange rates during the past 20 years are: (1) the close relation between real and nominal exchange rates and (2) the sharp appreciation and subsequent depreciation of the real dollar exchange rate in the 1980s. I conjecture that the principal reason for the correspondence between movements in real and nominal exchange rates is that real exchange rates are driven by contemporaneous permanent changes in real variables, particularly real defense spending and real money balances, whereas nominal exchange rates are driven by the nominal values of the same variables. Much of the short-term effect of money on the real exchange rate appears to be the result of changes in nominal money, so it would not be surprising to find that changes in nominal money balances have a significant effect on the nominal exchange rate also.

DATA APPENDIX

Nominal exchange rate (FNER): Index of the trade-weighted foreign exchange value of the United States dollar compiled by the Federal Reserve. The index is a geometric average of 10 industrialized countries' dollar value of their currencies weighted by their shares of world trade between the years 1972 and 1976. The 10 countries are Germany, Japan, France, United Kingdom, Canada, Italy, Netherlands, Belgium, Sweden and Switzerland.

Trade-weighted price level (TWCPI): Geometric average of 10 industrialized countries' consumer price indexes weighted by their shares of total world trade.

Real exchange rate: FNER deflated by the ratio of the United States consumer price index (CPI) to the 10 countries' trade-weighted CPI.

Real money balances (m): United States M1 monetary aggregate deflated by the United States CPI.

Defense spending share (d): Ratio of the United States defense spending in current dollars to GDP in current dollars.

Foreign money balances (TWNM): Arithmetic average of indexes of M2 monetary aggregates of Canada, Germany, Great Britain, and Japan (M2 & CD), weighted by their shares of total world trade between the years 1972 and 1976.

Foreign real money balances: TWNM deflated by TWCPI.

Real government net worth: Real government deficit measured by the US government real net worth from Bohn (1992).

Relative price of oil: Oil price measured by composite refiners' acquisition cost deflated by GNP deflator.

Real federal debt: Gross federal debt net of Federal Reserve holdings deflated by the CPI.

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