International Finance Discussion Papers

Number 168

October 1980

Fluctuations in the Dollar: A Model of Nominal and Real Exchange Rate Determination

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Fluctuations in the Dollar: A Model of Nominal and Real Exchange Rate Determination

I. Introduction and Summary

This paper develops and tests empirically a model to explain movements in the dollar's foreign exchange value during the flexible exchange rate period since early 1973. The model is designed to explain movements in both the nominal and real exchange rates,where the real exchange rate is defined as the nominal rate divided by relative prices. The empirical application is to the foreign exchange value of the dollar against a basket of currencies of ten major industrial countries.

Our theory draws from both the monetary and portfolio balance approaches to exchange rate determination. A monetary model similar to those developed by Dornbusch (1976) and Frankel (1979b) is employed to explain fluctuations in the equilibrium relative price component. The monetary model is modified substantially to allow for imperfect substitutability of bonds denominated in different currencies, the existence of exchange risk premia, and sustained deviations from purchasing power parity.

Shifts in the equilibrium real exchange rate are related to movements in the current account in an expectations framework that is consistent with long-run portfolio balance. This approach is distinguished from the short-run static-expectations portfolio balance model in which exchange rate changes are determined

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* The Board of Governors of the Federal Reserve System. We have benefitted from discussions with Peter Isard, Michael P. Dooley, Ralph W. Smith and Jeffrey A. Frankel in developing the model presented here. Peter Clark and Steven W. Kohlhagen provided helpful comments on an earlier draft. We thank Robert G. Murphy and Kathleen H. Brown for their excellent reserach assistance. The views expressed in this paper are our own and do not necessarily represent the views of the Federal Reserve Board or its staff.

directly by shifts in current relative asset suplies and in which expectations have played only a peripheral empirical role in explaining the exchange rate. In the static expectations approach, for example, a U.S. current account deficit causes the dollar to depreciate as asset holders rebalance their portfolios to accommodate the shift in dollar-denominated assets from U.S. residents to foreign residents. While this model performed reasonably well through 1976 (Branson, Halttunen and Masson (1977)), it has failed to explain significant developments since then. In 1977-78, the dollar depreciated sharply in real terms as the United States was running a series of record current account deficits. That depreciation cannot be explained by the rebalancing of private portfolios, however, because the current account deficits were more than financed by official intervention during that period.[1/]

In the model developed in this paper, movements in the exchange rate are determined primarily by changes in the expectations of asset holders. As both Isard (1980) and Dooley and Isard (1979) have suggested, asset holders continually revise their expectations about the level of the real exchange rate that is required to achieve portfolio balance (i.e. and equilibrium or "sustainable" level of the current account) in the long-run as new information becomes available about underlying determinants of the current account. A shift in the current account can affect the real exchange rate, even if it is financed by official intervention, if asset holders expect the shift to be permanent and the intervention to be

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1/ The cumulative U.S. current amount deficit during 1977-78 was $28 billion; dollar purchases by foreign central banks were more than double that amount during the same period.

transitory. Similarly, asset holders continually revise their expectations about the equilibrium relative price component of the nominal exchange rate. It is through such revisions in expectations that we can begin to explain the very large movements in the exchange rate observed in recent years.

In empirical tests the model explains about 80 per cent of the quarterly variance in the dollar's weighted average value during the floating rate period from early 1973 through 1978. According to this model, roughly 80 per cent of the decline in the dollar between mid-1976 and late 1978 can be attributed to real factors and the remainder to monetary factors (primarily an increase in the expected U.S. inflation rate). The estimation results also tend to support the hypothesis that fluctuations in the real exchange rate are explained predominantly by changes in expectations about the long run equilibrium real rate resulting from shifts in the current account. They tend to reject the view that the short run portfolio rebalancing associated with current account imbalances is a significant factor in explaining real exchange rate changes.

II. Theoretical Structure.

Our exchange rate equation is derived from the open interest arbitrage condition:

(1) $(\Delta \log e)^* = r_f - r + \phi,$

where the expected percentage change in the exchange rate e (in terms of foreign currency per unit of domestic currency) is equal to the foreign minus domestic interest differential plus a risk premium ϕ. Dooley and Isard have shown, conveniently, that the portfolio balance model can be reduced to equation (1), where the risk premium is a function of all variables other than expected rates of return that affect relative asset demands and supplies. In the absence of a risk premium (e.g. assuming perfect substitutability of bonds denominated in different currencies) (1) becomes open interest parity, and is consistent with the monetary approach.

To identify the expected exchange rate change we follow Frankel's example and assume that the expected annual rate of change is a function of the gap between the current spot rate e and market expectations about the current equilibrium rate $\bar{e}$ (defined below), plus the expected rate of change in $\bar{e}$.

(2) $(\Delta \log e)^* = \theta (\log \bar{e}^* - \log e) + (\Delta \log \bar{e})^*,$

where "*" denotes expectations and "$^-$" denotes equilibrium values. The spot rate can deviate from equilibrium following a monetary shock because prices are sticky (this point is considered further below). The parameter θ represents a proportional speed of adjustment: it is equal to 1 divided by the number of years it is expected to take e to return to e* following a shock. The expected change in the equilibrium rate is assumed to equal the differential between foreign and domestic expected equilibrium annual rates of inflation:

(3) $(\Delta \log \bar{e})^* = \bar{\pi}_f^* - \bar{\pi}^*$

Substituting (2) and (3) into (1) and rearranging, we derive the spot exchange rate equation:

(4) $\log e = \log \bar{e}^* - \frac{1}{\theta} [(r_f - \bar{\pi}_f^*) - (r - \bar{\pi}^*)] - \frac{\phi}{\theta}$

This equation states that the deviation between the spot exchange rate and its underlying equilibrium level is proportional to the real interest differential and the risk premium.

The expected equilibrium exchange rate $\bar{e}^*$ is defined as the rate that asset holders believe to be consistent today with current and expected future equilibrium values of its underlying determinants. To derive these determinants we divide the equilibrium nominal rate into relative price and real $(\bar{q})$ components:

(5) $\bar{e}^* = (\bar{P}_f^*/\bar{P}^*) \cdot \bar{q}^*$,

In the absence of changes in the equilibrium real exchange rate, (5) collapses to a long-run purchasing power parity condition, consistent with Frankel's monetary model. Following the monetary model, equilibrium relative prices are assumed to be determined by the relationships between money market equilibrium conditions in the home and foreign (denoted by "f") countries. These conditions are written:

(6) $M/P = y^{\alpha} \exp^{-\beta r}$

(7) $M_f/P_f = y_f^{\alpha} \exp^{-\beta r_f}$

where, M = nominal money supply
P = price level
y = real income
r = interest rate
"exp" denotes an exponential function

With money demand parameters α and β assumed identical across countries, and with the interest differential assumed to equal the expected inflation differential in equilibrium, expected equilibrium relative prices can be derived by dividing the equilibrium values of (6) by those of (7) and rearranging:

$$(8) \quad \frac{\bar{P}_f^*}{\bar{P}^*} = \frac{\bar{M}_f^*}{\bar{M}^*}\left(\frac{\bar{y}_f^*}{\bar{y}^*}\right)^{-\alpha} \exp^{\beta(\bar{\Pi}_f^* - \bar{\Pi}^*)}$$

Before turning to a definition of the equilibrium real exchange rate it would be useful at this point to work through the dynamics of a monetary shock, illustrating how the spot rate can deviate from equilibrium. Figure 1 illustrates the adjustment to a shift in expectations about the equilibrium money supply at time t_0 (for example, due to an unexpected change in the actual money stock at t_0). With the increase in equilibrium money supply the equilibrium level of domestic prices increases. Actual prices are sticky and adjust more slowly, however, causing a temporary increase in the real money supply. This in turn causes domestic short-term interest rates to fall temporarily below their long-term equilibrium level. The decline in domestic interest rates relative to foreign interest rates induces a decline in the home currency due to interest arbitrage (the exchange rate must fall below its equilibrium level by enough to achieve an expected appreciation that offsets the change in the interest differential). As the domestic price level increases to its equilibrium level over time, the domestic short-term interest rate will increase to its long-run equilibrium level and the exchange rate will rise to its equilibrium level. If the short-term real interest differential is closed quickly by t_1 (i.e. if Θ is relatively large) the return of the exchange rate will be rapid, and the initial drop of the exchange rate below its equilibrium level (the degree of overshooting) will be small (distance b c). If, however, the system returns to equilibrium slowly (i.e. if Θ is small) and the real interest differential does not disappear until t_2, the initial fall of the exchange rate below its equilibrium level will be relatively great (distance bd).

B. Equilibrium Real Exchange Rate

The equilibrium real exchange rate is defined as the rate that is expected to equilibrate the current account in the long run. The long-run equilibrium current account, in turn, is determined by the rate at which foreign and domestic residents wish to accumulate or decumulate domestic currency denominated assets net of foreign currency denominated assets in the long run.

The real exchange rate-current account relationship can be expressed:

(9) $\overline{CB}^* = f(\bar{q}^*, \bar{X}^*)$,

where $\overline{CB}^*$ is the expected equilibrium or "sustainable" current account balance, as determined by the desired rate of net asset accumulation in the long run, and $\bar{X}^*$ is a vector of expected equilibrium values of all variables other than the real exchange rate that influence the current account. Assuming $\overline{CB}^*$ is constant over time, a shift in $\bar{X}^*$ necessitates a change in $\bar{q}^*$ to maintain $\overline{CB}^*$. Expectations about future values of $\bar{X}$ are assumed to be static -- for simplicity we do not allow for expected future changes in $\bar{q}$.[1/] Unexpected changes in X that are believed to be transitory do not affect $\bar{q}^*$ because they are not expected permanently to affect the current account. However, temporary shifts in the current account can affect the spot exchange rate through their impact on the risk premium (as discussed below).

[1/] It can be shown that expected future changes in $\bar{q}$ require a real interest differential in equilibrium.

To simplify our empirical analysis we assume that asset holders infer unexpected changes in $\bar{X}$ indirectly from unexpected changes in the current account.[1/] That is, market expectations about the value of the real exchange rate needed to achieve long-run current account equilibrium are revised in response to unexpected non-transitory changes in the current account. This relationship is written explicitly:

$$(10) \quad \bar{q}_1^* = \bar{q}_0^* \exp^{\gamma(CB_1 - CB_0^{*1} - CBT_1)}, \ \gamma > 0$$

where

CB_1 = The observed current account balance in period t_1

CB_0^{*1} = The current account balance expected in period t_0 to prevail in period t_1

CBT_1 = The transitory (e.g. cyclical) component of the unexpected change in the current account balance $(CB_1 - CB_0^{*1})$.

The two-period relationship in (10) can be generalized to a multi-period relationship:

$$(11) \quad \bar{q}_t^* = \bar{q}_t^* \exp^{\gamma \sum_{i=1}^{t} (CB_i - CB_{i-1}^{*i} - CBT_i)}$$

where the equilibrium real exchange rate at period t is determined by a base period equilibrium and the cumulative sum of current and past non-transitory deviations of the current account from its expected value one period ahead.

C. Risk Premium

While our treatment of the current account differs from the standard portfolio balance approach, we retain an essential feature of that approach with the inclusion of the risk premium. The portfolio balance model can be

[1/] Market commentary in recent years concerning the relationship between the trade or current account balance and the exchange rate suggest that this assumption also makes the analysis more realistic.

solved for a risk premium as a function of all variables other than rates of return that affect asset demands and supplies (see Dooley and Isard). In our empirical application we specify the change in the risk premium ($\emptyset$) as a function of the sum of official intervention plus the current account balance -- the primary determinants of changes in the currency-composition of privately held assets.[1/] Specifically, we have:

(12) $\Delta\emptyset_i = - \delta(CB_i + I_i), \; \delta > 0$

where I_i is net official (intervention) purchases of domestic currency assets in period i. A home country current account deficit, or net official sales of home currency assets for foreign currency assets, increases the quantity of home currency assets relative to foreign currency assets in private portfolios. To accommodate this shift, private asset holders demand a higher expected appreciation (risk premium) on home currency assets.

Integrating equation (12) over time, we can solve for the level of the risk premium as a function of the cumulative sum of past current account and intervention flows plus an initial condition:

(13) $\emptyset_t = \emptyset_o - \delta \sum_{i=1}^{t} (CB_i + I_i)$

From equation (4) it should be clear that an increase in the risk premium drives the spot rate down relative to its expected equilibrium level.

Thus, in our model an unexpected shift in the current account below its equilibrium level causes a home currency depreciation through two channels. First, the expected equilibrium real exchange rate drops by enough to return the current account to its long-run equilibrium or "sustainable" level. Second, assuming that the current account deficit is not

[1/] Government budget deficits, private wealth and other determinants of asset supplies and demands are excluded because of difficulties involved in obtaining quarterly data for these series across countries.

financed by official intervention during the length of time it takes to return to equilibrium, the necessary private financing is attracted with a positive risk premium. The risk premium causes the real exchange rate to overshoot its expected equilibrium level. This may cause the current account to oscillate as it returns to equilibrium. The real exchange rate remains below equilibrium until the current account has been reversed by enough to return private portfolios to desired compositions at existing rates of return and a zero risk premium. At that point the real rate has returned to its expected equilibrium level.

D. Complete Model

Our model of exchange rate determination can now be derived by first substituting equations (8) and (11) into (5) to obtain the expected equilibrium exchange rate:

$$\bar{e}^* = \frac{\bar{M}_f^*}{\bar{M}^*} \left(\frac{\bar{Y}_f^*}{\bar{Y}^*}\right)^{-\alpha} \exp^{\beta(\bar{\pi}_f^* - \bar{\pi}^*)} \; \bar{q}_o \exp^{\gamma \sum_i (CB_i - CB_{i-1}^{*i} - CBT_i)} \tag{14}$$

The spot exchange rate equation is then derived by substituting (13) and the log of (14) into (4):

$$\log e = \log \left(\frac{\bar{M}_f^*}{\bar{M}^*}\right) - \alpha \log \left(\frac{\bar{Y}_f^*}{\bar{Y}^*}\right) + \beta(\bar{\pi}_f^* - \bar{\pi}^*) + \log \bar{q}_0$$
$$+ \gamma \sum_i (CB_i - CB_{i-1}^{*i} - CBT_i) - \frac{1}{\theta}\left[(r_f - \bar{\pi}^*) - (r - \bar{\pi}^*)\right] - \frac{\phi_o}{\theta} + \frac{\delta}{\theta} \sum_i (CB_i + I_i) \tag{15}$$

Equation (15) specifies the spot exchange rate as a function of: 1) expected equilibrium relative prices, as determined by expected equilibrium relative money stocks, real incomes, and inflation rates, 2) the expected equilibrium real exchange rate as determined by a (constant) base-period equilibrium real rate and the cumulative sum of unexpected nontransitory changes in the current account balance since the base period, 3) the deviation of the spot rate from its expected equilibrium as a function of the real interest differential (reflecting the slow adjustment of prices to recent monetary shocks), and 4) the deviation of the spot rate from equilibrium due to the effect of shifts in the current account plus official intervention on the risk premium.

III. Empirical Results

In this section we apply the theory of exchange rate determination outlined above and summarized by equation (15) to explain movements in the dollar's foreign exchange value during the floating rate period. The foreign exchange value of the dollar is measured by an index of the dollar's weighted-average exchange value against 10 major foreign currencies.[1/] This is a departure from previous studies which have focused on individual bilateral exchange rates, particularly the mark-dollar rate. Use of the broader weighted-average measure of the dollar's exchange value has the advantage that it reduces the problem of omitted third country effects. This consideration is especially important in estimating the exchange rate impact of current account imbalances. Changes in the U.S. current account balance with the rest of the world should influence the dollar's exchange rate against a broad spectrum of currencies. Explaining the relationship between the current account and a bilateral exchange rate would be more difficult. It is unclear whether the

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1/ The index used is described in the Federal Reserve Bulletin, August 1978, p. 700. See also Hooper and Morton, "Summary Measures of the Dollar's Average Exchange Value," Federal Reserve Bulletin, October 1978.

dollar-mark rate, for example, should be a function of changes in the U.S. current account, the German current account, the bilateral U.S.-German current account, or some combination of all three.

A. Modeling Current Account Expectations

Before estimating equation (15) it is necessary to specify empirical approximations for several variables which cannot be measured directly. The empirical measures of the expected and transitory current account terms in (15) are based on the theory of real exchange rate determination outlined above, with one modification. The modification concerns expressing the equilibrium current account as a ratio to a scale variable.

If $\overline{CB}$, the desired rate of private net foreign asset accumulation or decumulation in the long run differs from zero, it may be reasonable to expect that rate to grow with the scale of total portfolios (wealth), particularly during a period of significant positive inflation rates. Our theoretical construct of identifying changes in $\bar{X}$ with observed changes in CB is simplified if $\overline{CB}$ is assumed constant over time. To stabilize $\overline{CB}$ we express it as a ratio to trend nominal GNP (TGNP), as a proxy for wealth accumulation :

(16) $\overline{cb} = \overline{cb}_i = \overline{CB}_i/TGNP_i$, for all i.

Expected changes in the current account are identified by assuming that following a real shock to the current account, the real exchange rate adjusts a level that is expected to move the current account towards equilibrium. This identification is made operational by assuming that a positive fraction λ of the gap between the actual and equilibrium current account is expected to be eliminated in the next period:

$$(17)\quad cb^{*i}_{i-1} = cb_{i-1} + \lambda(\overline{cb} - cb_{i-1}).$$

The identification of transitory changes in the current account is simplified by assuming that a constant fraction of any deviation of the current account from its expected level is assumed to be transitory:

$$(18)\quad cbt_i = \eta\,(cb_i - cb^{*i}_{i-1}),\ o < \eta < 1.$$

In theory (16) - (18) could be combined with (15) and all parameters in the resulting equation estimated together, although multicollinearity in estimation would be potentially severe. In order to reduce potential estimation problems, estimates of the expectations parameter λ and the equilibrium current account $\overline{cb}$ were first obtained using a reduced form of the complete model. Specifically, combining the logarithmic forms of (11) and (16) - (18) gives,

$$(19)\quad \ln \bar{q}^*_t = \ln \bar{q}^*_o + (1-\eta)\gamma \sum_{i=1}^{t} [cb_i - (1-\lambda)\ cb_{i-1}] - (1-\eta)\gamma\lambda\ \overline{cb} \cdot t$$

This equation was estimated over the period 1973-II to 1978-IV, using a CPI-adjusted exchange rate index for the expected equilibrium real rate. Equations (1) - (5) of Table 1 test different values of λ between 0 and 1. The results suggest a value of $\lambda = 1$, implying that a deviation of the current account from equilibrium is expected to be eliminated in one quarter. As can be seen from (19), with $\lambda = 1$ an estimate of the equilibrium current account may be obtained from the coefficients of equation (5) in Table 1, giving $\overline{cb} = -(-.0074)/1.412 = .0052$, or about 1/2 percent of trend nominal GNP. (In 1978-IV this implies an equilibrium current account surplus of about \$11 billion at an annual rate.) Using these estimates of λ and $\overline{cb}$, (11) becomes:

$$(20)\quad \bar{q}_t = \bar{q}_o \, e^{(1-\eta)\gamma \sum_{i=1}^{t} (cb_i - .005)}$$

The dollar's real exchange rate will rise or fall as the U.S. current account exceeds or falls short of a surplus of 1/2 percent of nominal GNP.1/

B. Regression Results

Replacing (11) with (2), using long-term interest differential $(LR_f - LR)$ a proxy for expected inflation differential2/, and for the moment dropping the risk premium, (15) becomes:

$$(21)\quad \ln e_t = a_o + a_1 \ln\left(\frac{\overline{M}_f}{\overline{M}}\right)_t + a_2\left(\frac{\overline{Y}_f}{\overline{Y}}\right)_t + a_3 (LR_f - LR)_t + a_4 \sum_{i=1}^{t} (cb_i - .005)$$

$$+ a_5 [(r_f - LR_f) - (r - LR)]_t \text{ , where}$$

$$a_o = \ln \overline{q}_o,\ a_1 = 1,\ a_2 = -\alpha < 0,\ a_3 = \beta > 0,\ a_4 = (1-\eta)\gamma > 0,\ a_5 = -1/\theta < 0.$$

1/ Equation (5) in Table 1 suggests that this formulation can explain over three-fourths of the variation in the dollar's real exchange value during the floating rate period.

2/ Long-term interest rates are used as a proxy for expected inflation rates on the assumption that real long-term interest rates are constant so that variations in nominal long-term interest rates reflect changes in inflation expectations. Attempts to use various combinations of current and past actual inflation rates as proxies for expected future inflation proved statistically unsucessful. The superior performance of long-term interest rates probably reflects the fact that they can change immediately in response to new information such as shifts in monetary growth targets.

Regressions based on this equation are shown in table 2. All foreign variables are weighted-averages, consistent with the weighted-average dollar exchange rate index employed. Equations were fitted using both M-1 and M-2 definitions of money supplies. The M-1 equations had superior statistical properties and are reported in Table 2.[1] In order to test for the possibility that asset holders look mainly at changes in the trade balance rather than the current account in forming their expectations about the equilibrium real exchange rate, equations were estimated using a cumulative trade imbalance variable.[2] Equilibrium money supplies and real incomes are measured by weighted-averages of current and past actual values. Both monthly and quarterly equations are fitted covering the period 1973-II through 1978-IV.

The equations reported in Table 2 conform well with theoretical expectations. Nearly 80 percent of the monthly and quarterly variation in the dollar's average exchange value is explained.[3] All of the coefficients

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1/ If monetary policy is influenced by exchange rate changes then estimates based on (21) alone will be biased. To test for this possbility, two-stage least squares was used to estimate (21) simultaneously with

$$\ln (x_f/x)_t = a_o + a_1 \ln (x_f/x)_{t-1} + a_2 (\ln e_t - \ln e_{t-1}), \text{ where } x = \bar{M}_f/\bar{M} \text{ or } r_f - r.$$

The results showed no significant relationship between exchange rate changes and changes in monetary policy (measured by money supply or interest rate levels).

2/ An equilibrium trade balance was estimated using the same procedure outlined in the previous section for estimating the equilibrium current account. Equation (6) of Table 1 gives a point estimate of the equilibrium trade balance, $\bar{tb}$ = -.0013/ 1.12 = -.0012, or a deficit of about 0.1 percent of trend nominal GNP. Since the coefficient on the t variable in equation (6) is not significantly different from zero, trade balance equilibrium is defined as zero.

3/ The $\bar{R}^2$'s of equations (3), (4), (7) and (8) where the relative money supply coefficient is constrained to 1.0 overstate the degree to which variations in the dollar's average exchange value is explained since the dependent variable is $\ln e - \ln (\bar{M}_f/\bar{M})$, not $\ln e$, in these equations.

have the expected sign and all except the coefficients on the short-term interest rate variable are significant at the 1 percent level. When the coefficient on the relative money supply variable is constrained to equal its theoretically expected value of 1.0, the size and significance of the short-term interest rate coefficients are raised sharply. Equations with the cumulative current account imbalance variable ((1) - (4)) are nearly indentical to the corresponding equations with a cummulative trade imbalance variable ((5) - (8)). This suggests that changes in either the current account or the trade balance can be used as indications of real shocks requiring adjustments in the real exchange rate. The corresponding quarterly and monthly equations are also very similar in terms of the size and significance of coefficients and overall explainatory power. They differ sharply, however, in the degree of autocorrelation of their error terms. The low Durbin-Watson statistics for the monthly equations indicate a strong (positive) correlation of errors which is absent in the quarterly equation. This result suggests that transitory shifts in speculative expectations or central bank intervention, etc. may have significant impacts on monthly exchange rate movements but average out over longer periods and have no systematic influence on quarterly exchange rate movements.

Table 3 shows estimates of the exchange rate impacts of unit changes in various independent variables based on the equations in Table 2. The coefficient on the real short-term interest rate term may be interpreted as the expected period of adjustment of the actual exchange rate to its equilibrium level. The unconstrained equations imply a rapid adjustment to equilibrium (about one month). The equation with the relative money supply coefficient constrained to 1.0 suggest an adjustment period of 1 to 1-1/2 years. Table 3 suggests that a $1 billion increase in the U.S. current account/trade balance causes market participants to raise their estimate of the dollar's equilibrium real exchange value by about 1/3 percent. Empirical studies of the determinants of the U.S. trade balance indicate that a 1/3 percent appreciation of the real exchange rate of the dollar will eventually lead to about a $1/2 billion reduction in the U.S. trade balance.[1/] This suggests the only about 1/2 of actual trade balance/current account changes are viewed by market participants as arising from permanent real shocks with the remaining 1/2 due to transitory factors not requiring adjustments in the real exchange rate.[2/]

Chart 2 illustrates the relative importance of factors causing changes in the dollar's average foreign exchange value during the floating rate period. Line A shows the actual path of the dollar over this period. Line B traces out the path of equilibrium relative prices. This represents the course that the dollar would have followed if it had been influenced only by monetary factors (as measured by the money supply, real income and expected inflation variables). Line C plots the movement of the equilibrium real exchange rate. This represents the path the dollar would have followed if it had been influenced only by real shocks (as measured by the cummulative current account imbalance variable) and equilibrium relative prices had

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1/ This estimate is based on Hooper (1978).

2/ Equations (13), (20) and (21) show that the coefficient on the cummulative current account variable is $(1-\eta)\gamma$. If the coefficient equals 1/2 and $\gamma = 1$, then $\eta = 1/2$.

remained constant. Line D shows the path the dollar would have taken if it had been affected only by changes in real short-term interest rates, assuming a constant equilibrium real and nominal exchange rate. The chart suggests that the dollar's fluctuations during this period were caused in about equal part by monetary shocks, real shocks and changes in the deviation of the actual rate from equilibrium. The average absolute quarterly percentage exchange rate changes due to these three factors were 1.8 percent 1.6 percent and 1.3 percent respectively. About 4/5 of the dollar's sharp decline between 1976-IV and 1978-IV was due to real factors (the large U.S. current account deficit) and the remaining 1/5 was due to monetary factors (mainly an increase in the expected U.S. inflation rate.)

The results presented in Table 2 suggest that changes in the U.S. current account balance have a significant impact on the dollar's exchange value. These results are at least consistent with the expectations mechanism we have developed theoretically. To test the robustness of these results we next estimated the same equations with our risk premium proxy (cumulative intervention plus current account flows, also scaled to trend nominal GNP) included.

The results are given in Table 4. The first equation, taken from Table 2, excludes the risk premium. Equation (2) includes the risk premium, but excludes the current account expectations variable, and equation (3) includes both the expectations variable and the risk premium. A comparison of these equations suggests that the current account influences the exchange rate primarily through its impact on long-run portfolio balance (expectations) considerations rather than operating through short-run portfolio rebalancing (risk premium). The coefficient on the expectations variable in equation (1) has the expected sign (a larger than anticipated current account raises the dollar's exchange value) and is highly significant. Equation (2), based on the short-run portfolio balance model, has lower explanatory power and a coefficient on the risk variable (current account + intervention) that is insignificant and of the opposite sign to that predicted by the model. These conclusions are confirmed by equation (3) which includes both types of current account impacts.[1/] The results presented in table 4 are consistent with other empirical studies showing that the risk premium is relatively unimportant in explaining exchange rate changes.[2/]

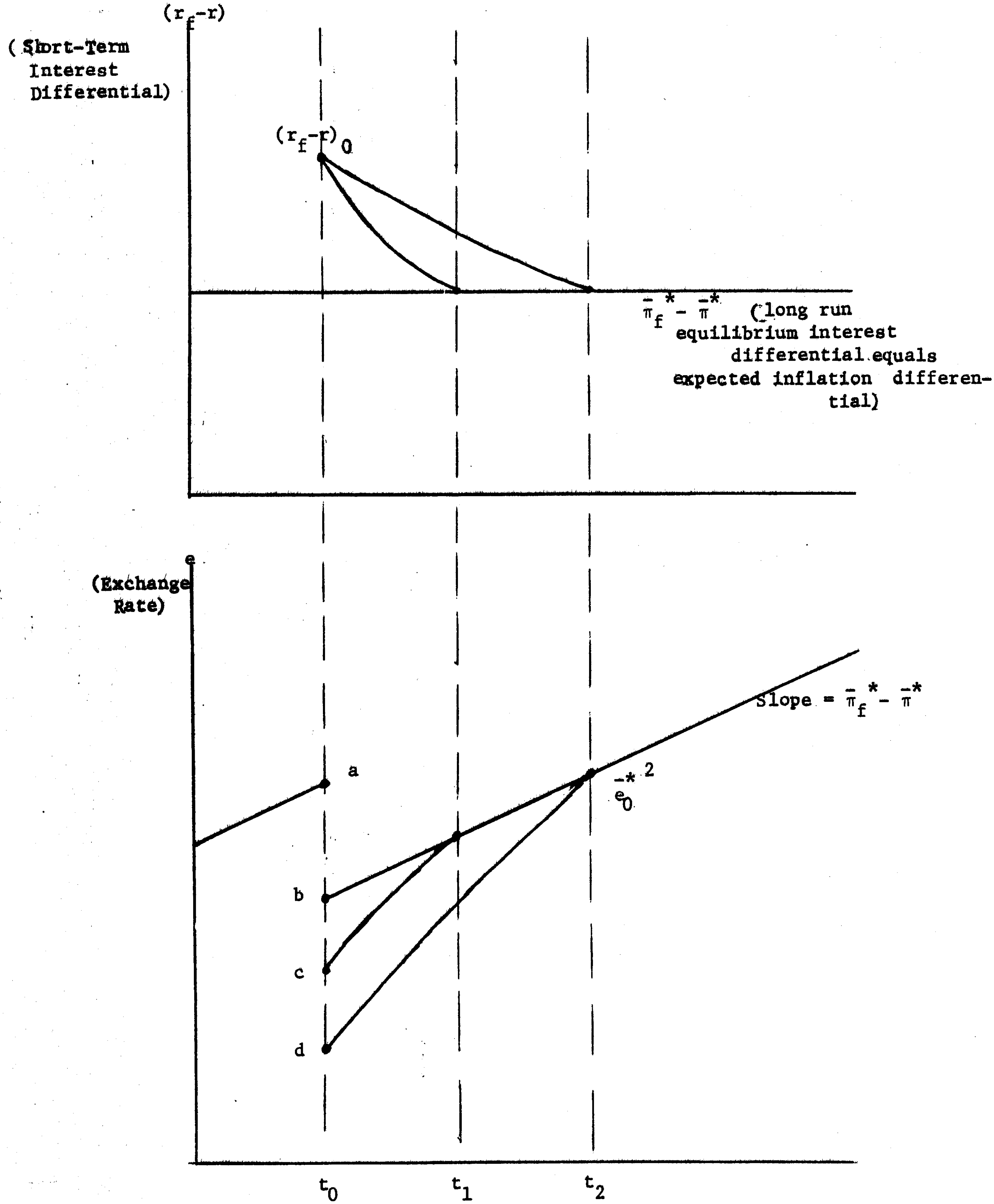
1/ The short-run portfolio balance effect may be underestimated if intervention is aimed at offsetting exchange rate movements. In order to correct for this potential source of bias, the exchange rate equation was estimated simultaneously with an intervention reaction function of the form

$\ln R_t = a_o + a_1 \ln R_{t-1} + a_2 (\ln e_t - \ln e_{t-1})$, where R = central bank reserves.

As shown in equations (4) and (5) of table 4, this procedure did not change the basic conclusions reported above.

2/ See Dooley and Isard (1979), and Frankel (1979a).

Figure 1



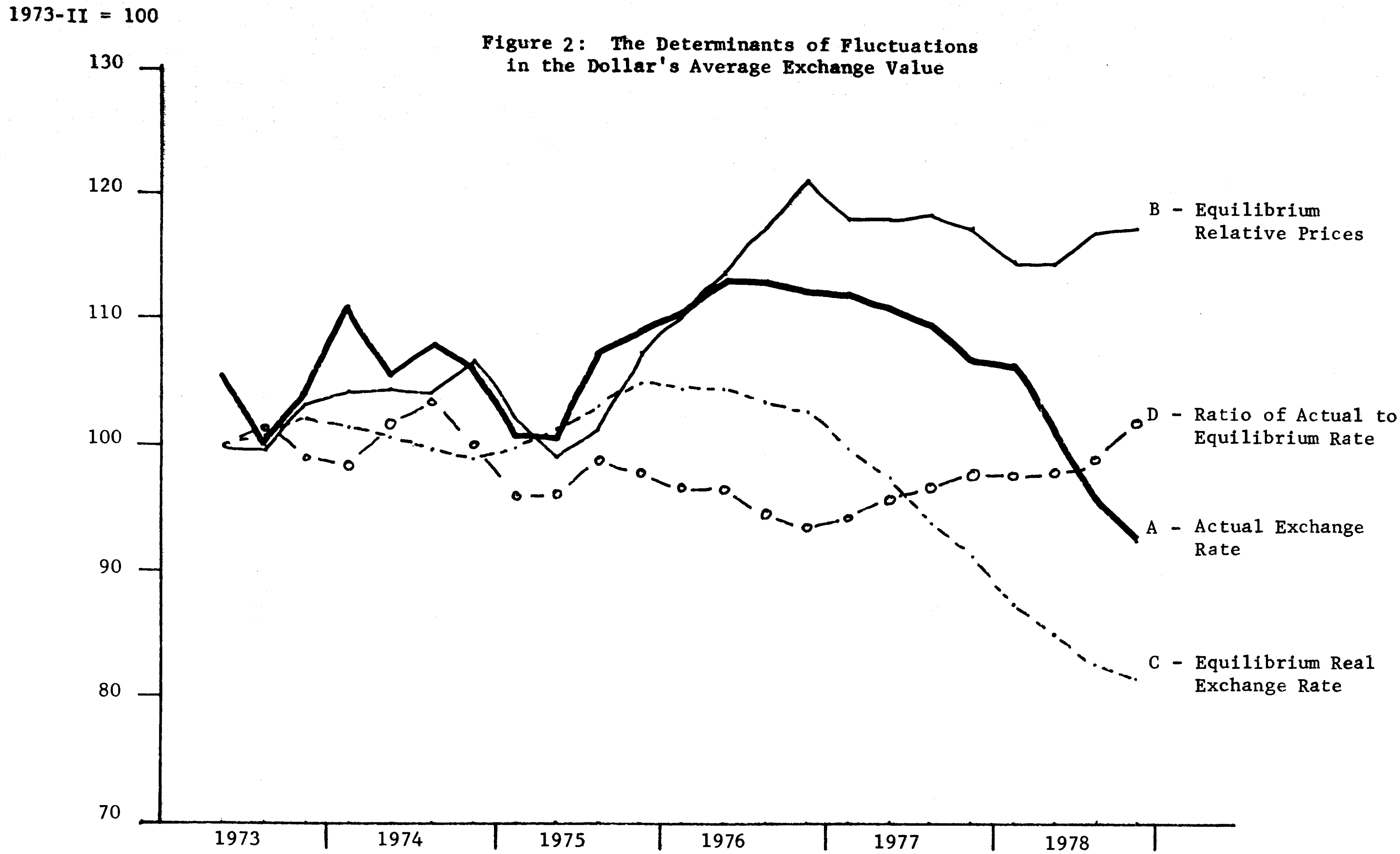
$(r_f - r)$
(Short-Term Interest Differential)
$(r_f - r)_0$
$\bar{\pi}_f^* - \bar{\pi}^*$ (long run equilibrium interest differential equals expected inflation differential)
e
(Exchange Rate)
Slope = $\bar{\pi}_f^* - \bar{\pi}^*$
a
b
c
d
$\bar{e}_0^*$
2
t_0
t_1
t_2

Table 1: Real Exchange Rate Equations

Dependent Variable	Constant	$\sum_{i=1}^{t}[cb_i + (1-\lambda)\ cb_{i-1}]$	time	$\bar{R}^2$	DW
(1) ln re ($\lambda = 0$)	4.63 (175.3)	-1.07 (0.66)	-.0058 (3.21)	.358	0.55
(2) ln re ($\lambda = .25$)	4.58 (202.5)	2.39 (2.44)	-.0046 (3.88)	.494	0.91
(3) ln re ($\lambda = .5$)	4.57 (262.4)	2.20 (4.19)	-.0060 (5.89)	.651	1.15
(4) ln re ($\lambda = .75$)	4.58 (306.4)	1.75 (5.20)	-.0069 (7.19)	.721	1.29
(5) ln re ($\lambda = 1$)	4.58 (336.2)	1.41 (5.81)	-.0074 (7.99)	.756	1.39
		$\sum_{i=1}^{t}[tb_i + (1-\lambda)\ tb_{i-1}]$			
(6) ln re ($\lambda = 1$)	4.56 (317.9)	1.12 (5.51)	.0013 (0.94)	.739	1.29

Estimated by ordinary least squares for 1973-II through 1978-IV. All variables defined in the data appendix. t values in parentheses.

Figure 2: The Determinants of Fluctuations in the Dollar's Average Exchange Value



NOTE: Equilibrium values calculated usings equations (4), (8) and (20) and coefficient estimates from equation (3) of table 2.

Table 2: Determinants of the Dollar's Average Exchange Value

Dependent Variable	Constant	$\ln\left(\frac{\bar{M}_f}{\bar{M}}\right)$	$\ln\left(\frac{\bar{Y}_f}{\bar{Y}}\right)$	$(LR_f - LR)$	$\sum_{i=1}^{t}(cb_i - .005)$	$[(SR_f - LR_f) - (SR - LR)]$	$\bar{R}^2$	D.W.	n
(1) ln e (quarterly)	4.53 (150.2)	0.54 (4.40)	-1.46 (3.00)	4.13 (3.37)	1.47 (4.41)	-0.13 (0.24	.784	1.76	23
(2) ln e (monthly)	4.55 (300.2)	0.43 (7.41)	-1.00 (4.51)	2.70 (4.07)	1.92 (9.40)	-0.28 (0.98)	.809	0.65	70
(3) ln e (quarterly)	4.45 (177.4)	1.0	-2.00 (3.29)	6.32 (4.52)	2.03 (5.28)	-1.51 (2.82)	.917	1.44	23
(4) ln e (monthly)	4.43 (306.5)	1.0	-1.29 (3.69)	5.29 (5.44)	2.64 (8.73)	-2.05 (5.75)	.890	0.38	70
					$\sum_{i=1}^{t} tb_i$				
(5) ln e (quarterly)	4.52 (151.7)	0.69 (4.91)	-1.71 (3.45)	4.43 (3.72)	1.23 (4.48)	-0.11 (0.21)	.788	1.76	23
(6) ln e (monthly)	4.54 (282.6)	0.45 (7.13)	-1.36 (5.44)	3.31 (4.84)	1.45 (8.05)	-0.11 (0.39)	.781	.63	70
(7) ln e (quarterly)	4.47 (194.7)	1.0	-2.11 (4.14)	5.46 (4.50)	1.62 (6.85)	-0.98 (2.32)	.942	1.61	23
(8) ln e (monthly)	4.43 (321.3)	1.0	-1.93 (5.45)	6.05 (6.74)	2.02 (8.15)	-1.71 (4.90)	.891	0.41	70

Estimated by ordinarly least squares. Quarterly, 1973-II thorugh 1978-IV. Monthly, March 1973 through December 1978. All variables defined in data appendix. t values in parentheses.

Table 3: Change in the Average Exchange Value of the Dollar Resulting from Unit Changes in U.S. Economic Variables

	Percent Change in the Dollar's Average Exchange Value		
	(1)	(2)	(3)
1 percent increase in U.S. money supply	-.5	-1.0	-1.0
1 percent increase in U.S. real GNP	1.5	2.0	2.1
1 percentage point increase in expected U.S. inflation rate	-4.1	-6.3	-5.5
1 percentage point increase in real short-term U.S. interest rate	0.1	1.5	1.0
$1 billion increase in U.S. current account	0.3	0.4	--
$ 1 billion increase in U.S. trade balance	--	--	0.3

Estimates based on equations in Table 2, column (1) from equation (1), column (2) from equation (3), and column (3) from equation (7). Current account and trade balance coefficients computed for 1978-IV.

Table 4: Exchange Rate Impacts of the Current Account

Dependent Variable	Constant	$\ln\left(\frac{\bar{M}_f}{\bar{M}}\right)$	$\ln\left(\frac{\bar{Y}_f}{\bar{Y}}\right)$	(LR_f-LR)	$[(SR-LR)_f - (SR-LR)]$	$\sum(cb_i-.005)$	$\frac{\sum(CB+I)_i}{TGNP}$	$\bar{R}^2$	D.W.	Rho
(1) ln e	4.53 (150.2)	0.54 (4.40)	-1.46 (3.00)	4.13 (3.37)	-0.13 (0.24)	1.47 (4.41)		.784	1.76	
(2) ln e	4.51 (51.3)	0.52 (1.26)	-1.04 (0.78)	4.21 (1.80)	0.60 (0.78)		-0.93 (1.00)	.627	1.60	0.59 (3.41)
(3) ln e	4.55 (154.5)	0.86 (4.37)	-2.00 (3.79)	1.70 (1.02)	-0.15 (0.30)	1.78 (5.14)	-1.37 (1.96)	.815	1.75	
(4) ln e	4.55 (131.9)	0.77 (2.56)	-1.84 (2.72)	2.41 (0.98)	-0.15 (0.27)	1.69 (3.90)	-0.97 (0.82)	.780	1.87	
	Constant	$\ln R_{t-1}$	$(\ln e_t - \ln e_{t-1})$							
(5) $\ln R_t$	-0.13 (0.21)	1.04 (7.70)	-0.34 (1.17)					.945	1.38	0.73 (4.96)

Quarterly, 1973-II through 1978-IV. t values in parentheses. All variables defined in data appendix. (1) and (3) estimated by ordinary least squares. (2) estimated using Cochrane-Orcutt correction for several correlation. (4) and (5) estimated jointly using two-stage least squares.

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