FLEXIBLE EXCHANGE RATES IN THE 1970s

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INTRODUCTION

Our recent experience with a system of flexible exchange rates
had led to a renewed interest in the operations of foreign exchange
markets and in studying the principal determinants of exchange rates.
The 1970s witnessed the dramatic evolution of the international mone-
tary system from a regime of pegged exchange rates which prevailed for
about a quarter of a century since the Bretton Woods conference into a
regime of flexible (though managed) rates. The emergence of the new
legal and economic system confronted traders, national governments and
international organizations with new economic problems, choices and
instruments. During the 1970s exchange rates have fluctuated widely
and inflation rates accelerated. The international monetary system had
to accommodate extraordinarily large oil related shocks which affected
trade flows in goods and assets. Huge oil payments had to be recycled.
Uncertainties concerning future developments in international politics
reached new heights and the prospects for the world economy got
gloomier. These developments have placed unprecedented pressures on
the markets for foreign exchange as well as on other asset markets.

They have been associated with a large slide in the value of the U.S. dollar, and have resulted in speeding up the creation of new institutions like the European Monetary System which provides the formal framework for the management of exchange rates among members. The increased interdependence among countries and the recognition that exchange rate policies by one national government exert influence on other economies have also induced a legal response from international organizations. For example, in late April 1977, the Executive Board of the International Monetary Fund approved the details of the second amendment to Article IV of the amended Articles of Agreement dealing with the principles and procedures for surveillance of member countries' exchange rate policies.

These developments provide the background for this paper which is intended to present a brief survey of key issues and lessons from the experience with floating rates during the 1970s. The main orientation of the paper is empirical and the analysis is based on the experience of three exchange rates: the Dollar/Pound, the Dollar/French Franc and the Dollar/DM. In the second section I analyze the efficiency of the foreign exchange markets by examining the relationship between spot and forward exchange rates; in that context I also examine and interpret the extent of exchange rate volatility. The analysis of the foreign exchange markets is important because it sheds light on several questions like: 1) have exchange rates fluctuated "excessively?" 2) is there evidence that speculation in the foreign exchange markets is destabilizing? 3) is there evidence that there is "insufficient" speculation in the foreign exchange markets? 4) is there evidence for a market failure in the sense that there are unexploited profit

opportunities? These issues are relevant for assessing the performance of floating rates as well as for discussing whether there is a case for government intervention in the foreign exchange markets. The analytical framework that is used for interpreting the volatility of exchange rates and the association between spot and forward rates is the modern theory of exchange rate determination. Within this perspective exchange rates are viewed as the prices of assets that are traded in organized markets and, like the prices of other assets, are strongly influenced by expectations about future events.

The relationship between exchange rates and interest rates is analyzed in the third section from the perspective of the monetary approach to the exchange rate. This analysis is of particular relevance in view of the new policies of the Federal Reserve Board, which were announced on October 6, 1979, that are intended to curb inflation and to support the dollar. One of the key issues that is raised in this section is the distinction between anticipated and unanticipated changes in rates of interest. The policy implication of this distinction is obvious. As an analytical matter this distinction is important because the modern approach to exchange rate determination implies that exchange rates are strongly influenced by "news" which by definition is unpredicted. Therefore, unanticipated rather than anticipated changes in interest rates should have a strong effect on changes in exchange rates. This prediction is tested empirically.

The fourth section analyzes the relationship between exchange rates and prices by examining the patterns of deviation from purchasing power parities. This examination is relevant for assessing whether the flexible exchange rate system was successful in insulating national

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economies from foreign shocks, and whether it provided policymakers with an added instrument for the conduct of macroeconomic policy. The evidence on deviations from purchasing power parities is also relevant for the discussion of whether there is a case for managed float. The fifth section concludes the paper with some concluding remarks.

THE EFFICIENCY OF THE FOREIGN EXCHANGE MARKET
AND THE MOVEMENT OF EXCHANGE RATES

In this section I analyze the principal characteristics of the relationship between spot and forward exchange rates which seem to emerge from the experience of the 1970s. Following an analysis of the efficiency of the foreign exchange market I discuss the more general issues underlying the relationships between spot and forward rates and their volatility.

The Efficiency of the Foreign Exchange Market

One of the central insights of the monetary (or the asset market) approach to the exchange rate is the notion that the exchange rate, being a relative price of two assets, is determined in a manner similar to the determination of other asset prices and that expectations concerning future course of events play a central role in affecting current exchange rates.[1]

If the foreign exchange market is efficient and if the exchange rate is determined in a fashion similar to the determination of other asset prices, we should expect current prices to reflect all currently

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[1]For collections of articles summarizing this approach see the Scandinavian Journal of Economics, no. 2, 1976, and Frenkel and Johnson (1978).

available information. Expectations concerning future exchange rates should be incorporated and reflected in forward exchange rates. Thus, to examine the efficiency of the market, I first regress the logarithm of the current spot exchange rate, $\ln S_t$, on the logarithm of the one-month forward exchange rate prevailing at the previous month, $\ln F_{t-1}$, as in equation (1).[2]

(1) $\ln S_t = a + b \ln F_{t-1} + u_t$

If the market for foreign exchange is efficient and if the forward exchange rate is an unbiased forecast of the future spot exchange rate, then we expect that: 1) the constant term in equation (1) should not differ significantly from zero,[3] 2) the slope coefficient should not differ significantly from unity and, 3) the residuals should be serially uncorrelated. I examine three exchange rates: the Dollar/Pound, the Dollar/Franc and the Dollar/DM. Equation (1) was estimated using monthly data for the period June 1973 - July 1979. The beginning of the period was determined by the attempt to concentrate on the experience of the current exchange rate regime (following the initial post Bretton-Woods transition period). The resulting ordinary least-

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[2] For an application of the same methodology in analyzing the efficiency properties of the foreign exchange market during the German hyperinflation of 1921-1923 see Frenkel (1976, 1977, 1979). For an application to other exchange rates during the 1920s, see Frenkel and Clements (1980), for an application to the 1920s and the 1970s, see Krugman (1977); for an interesting analysis using time-series and cross-section data, see Bilson (1979), for an analysis of market efficiency using novel econometric techniques, see Hakkio (1979a), and Hansen and Hodrick (1980), and for surveys, see Levich (1978, 1979).

[3] More precisely, if (assuming risk neutrality) the forward rate measures the expected value of the future spot rate, then the constant term in the logarithmic equation (1) should be $-0.5\sigma_u^2$; see Frenkel (1979).

squares estimates are reported in Table 1. Also reported in Table 1

are additional regressions which will be analyzed shortly. As may be

seen for the Dollar/DM exchange rate, the hypotheses that (at the 95

percent confidence level) the constant term does not differ signifi-

cantly from zero and that the slope coefficient does not differ signifi-

cantly from unity cannot be rejected. These hypotheses are rejected

for the Dollar/Franc exchange rate and are rejected (marginally) for the

Dollar/Pound exchange rate. The joint hypotheses, however, that the

constant is zero and that the slope coefficient is unity cannot be re-

jected at the 95 percent for the Dollar/Pound and the Dollar/DM ex-

change rates and at the 99 percent for the Dollar/Franc exchange rate.

The test statistics for testing the joint hypotheses are reported in

the column headed by F in Table 1.

It was argued above that in an efficient market, expectations

concerning future exchange rates are reflected in forward rates, and

that spot exchange rates reflect all currently available information.

If forward exchange rates prevailing at period t-1 summarize all rele-

vant information available at that period, they should also contain

the information that is summarized in data corresponding to period t-2.

It thus follows that including additional lagged values of the forward

rates in equation (1) should not greatly affect the coefficients of

determination and should not yield coefficients that differ signifi-

cantly from zero. The results reported in Table 1 are consistent with

this hypothesis; in all cases the coefficients of $\ln F_{t-2}$ do not differ

significantly from zero and the inclusion of the additional lagged

variables does not improve the fit. Furthermore, in all cases the

Durbin-Watson statistics are consistent with the hypothesis of the

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Table 4

Efficiency of Foreign Exchange Markets
Monthly Data: June 1973 – July 1979
(standard errors in parentheses)

Dependent Variable: $\ln S_t$	Estimation Method	Constant	$\ln F_{t-1}$	$\ln F_{t-2}$	R^2	s.e.	D.W.	F	m
Dollar/Pound	OLS	.033 (.017)	.956 (.024)		.96	.027	1.72	1.86	
	OLS	.031 (.018)	1.047 (.116)	-.088 (.113)	.96	.027	1.94		
	IV	.035 (.018)	.953 (.024)		.96	.027	1.72		.90
Dollar/Franc	OLS	-.237 (.078)	.843 (.051)		.79	.029	2.23	4.83	
	OLS	-.225 (.082)	.706 (.117)	.146 (.117)	.79	.029	1.90		
	IV	-.219 (.079)	.855 (.052)		.79	.029	2.25		2.73
Dollar/DM	OLS	-.023 (.027)	.971 (.032)		.93	.032	2.12	.51	
	OLS	-.019 (.028)	.913 (.119)	.063 (.122)	.93	.032	1.96		
	IV	-.022 (.028)	.972 (.033)		.93	.032	2.12		.02

Note: s.e. is the standard error of the equation and R^2 is the coefficient of determination; in the case of instrumental variables estimation the R^2 was computed as $1 - \text{Var}(\hat{u}_t)/\text{Var}(\ln S_t)$. The F statistic tests the joint restriction that the constant equals zero and the slope equals unity. The test statistic is distributed as $F_{(2,71)}$. Critical values for $F_{(2,71)}$ are 3.13 (95 percent) and 4.92 (99 percent). The instrumental variable (IV) estimation method is used in order to allow for the possibility of errors in variables arising from using $\ln F_{t-1}$ as a proxy for the expected future spot rate; the instruments are a constant and $\ln F_{t-2}$. Durbin's rank variable. The m-statistic which tests for the absence of errors in variables is distributed χ^2 with 2 degrees of freedom. The critical value for $\chi^2_{(2)}$ is 5.99 (95 percent).

absence of first-order autocorrelated residuals and an examination of higher order correlations (up to 12 lags) shows that no correlation of any order is significant.

To further examine the relationship between the various exchange rates we note that one of the assumptions underlying equation (1) was the notion that the forward exchange rate measures the unobservable value of the _expected_ future spot exchange rate. This assumption provided the justification for using equation (1) instead of the more fundamental relationship that is embodied in equation (2):

(2) $\ln S_t = a + b \ln(S_t^e \mid t - 1) + \varepsilon_t$

where $(S_t^e \mid t-1)$ denotes the expected spot exchange rate for period t based on the information available at period $t - 1$. If, however, the forward exchange rate at $t - 1$ is a "noisy" proxy for the expected future value of the spot rate, (i.e., it measures it with a random error) then we would obtain that

(3) $\ln F_{t-1} = \ln(S_t^e \mid t - 1) + v_{t-1}; \quad E(v_t) = 0$

and substituting equation (3) into equation (2) yields:

(4) $\ln S_t = a + b \ln F_{t-1} + (\varepsilon_t - bv_{t-1}).$

In this case the error term in equation (1) would be $u_t = \varepsilon_t - bv_{t-1}$, and the assumption that the covariance between $\ln F_{t-1}$ and u_t is zero would entail a specification error, and the application of the ordinary least-squares (OLS) procedure would yield inconsistent estimates due to the classical errors in variables bias.

In order to examine the possibility that the OLS estimates might be subject to the errors in variables bias, one needs to test the hypothesis that $cov(u_t, \ln F_{t-1}) = 0$. This test follows the specification test outlined by Hausman (1978).[4] To perform the test equation (1) was estimated by applying the OLS procedure as well as by using an instrumental variables (IV) estimation method. Under the null-hypothesis of no misspecification the OLS coefficients vector $\hat{b}_0$ is an efficient and an unbiased estimate of the true coefficient vector. Under the alternative hypothesis of misspecification the vector $\hat{b}_0$ is biased and an unbiased coefficient vector $\hat{b}_1$ can be obtained by applying an instrumental variables estimation procedure. The test-statistic relevant for testing the null-hypothesis can be written as

$$(5) \quad m = (\hat{b}_1 - \hat{b}_0)'(var \; \hat{b}_1 - var \; \hat{b}_0)^{-1}(\hat{b}_1 - \hat{b}_0)$$

where $var(\hat{b}_1)$ and $var(\hat{b}_0)$ denote the variance-covariance matrices of $\hat{b}_1$ and $\hat{b}_0$, respectively. Under the null-hypothesis m is distributed (in large samples) as χ^2 with two degrees of freedom. Table 1 reports the results of estimating equation (1) by applying the instrumental variables estimation method. As may be seen for all exchange rates the two vectors of coefficients b_1 and b_0 are very close to each other. For example, for the Dollar/Pound exchange rate the constants are .033 and .035 and the slopes are .956 and .953, consequently, the resulting m statistic is .90 which is well below 5.99 -- the critical value of

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[4]This test was recently applied by Obstfeld (1978) to the analysis of the foreign exchange market during the 1970s and by Frenkel (1980a, 1980b) to the analysis of the foreign exchange markets during the 1920s.

$\chi^2(2)$ at the 95 percent confidence level. The m statistics correspond-
ing to the other exchange rates are also below this critical value. It
is concluded, therefore, that the use of the forward exchange rate as a
proxy for expectations does not introduce a significant errors in
variables bias and thus the use of the OLS estimation procedure seems
appropriate.

The efficiency of the foreign exchange market and the rationality
of using data from the forward market to measure expectations can also
be analyzed from a different angle. Consider equation (6):

$$(6) \quad x_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{n} \beta_i x_{t-i} + \gamma \pi_{t-1} + w_t$$

where x_t denotes the percentage change in the spot exchange rate
($\ell n \, S_t - \ell n \, S_{t-1}$), π_{t-1} denotes the forward premium on foreign exchange
($\ell n \, F_{t-1} - \ell n \, S_{t-1}$), t denotes time, n denotes the number of lags, and
w denotes an error term. If π_{t-1} summarizes all available information
concerning the future evolution of the exchange rate, then <u>given</u> the
value of the forward premium π_{t-1}, the past history of the percentage
change of the exchange rate should not "help" the prediction (i.e., the
past history should not be viewed as Granger-causing future changes),
and the joint hypotheses that α_1 and β_i are zero should not be rejected.
The results of applying these tests to the three exchange rates for
various number of lags are reported in Table 2. Also reported in
Table 2 are the results of testing the joint hypotheses that α_1 and β_i
are zero and that γ, the coefficient of the forward premium, is unity.
The relevant statistic for testing the null-hypothesis is an F-
statistic which is reported in Table 2. As is evident in all cases the
null-hypothesis cannot be rejected at the 95 percent confidence level

since the values of the various F-statistics fall well below the corresponding critical values. It is concluded, therefore, that the forward premium on foreign exchange may be viewed as a rational expectations measure of the percentage depreciation of the currency in that it incorporates the available information that is contained in the series of past depreciations.

The principal conclusions that may be drawn from the previous discussion are that the behavior of the foreign exchange market during the 1970s has been broadly consistent with the general implications of the efficient market hypothesis and that the forward exchange rate summarizes the relevant available information concerning the future evolution of the rate.

Exchange Rate Movement: Volatility and Predictability

In this section I analyze the volatility of exchange rates and the extent to which this volatility is predictable. To set the stage for the analysis, I present in Figure 1 the daily and quarterly percentage changes in the three exchange rates. This figure indicates that the various exchange rates have been very volatile and that the degree of volatility of day-to-day changes in the exchange rates have been extraordinarily high and has been much smaller when averaged over longer periods. Further, the standard errors of the regressions in Table 1 indicate that the forecasts of future spot exchange rates based on the forward rates are imprecise: the standard errors of the equations are about 3 percent per month.

These characteristics of price changes are typical to auction and to organized asset markets. In such markets current prices reflect

Table 2

Test of Rationality of Forward Premium Prediction of Currency Depreciation
Monthly Data, June 1973 - July 1979

Dependent Variable $\ln S_t - \ln S_{t-1}$	Null Hypothesis	Number of Lags	F-statistic
Dollar/Pound			
		3	$F(4,64) = 1.680$
	$\alpha_1 = 0,\ \beta_i = 0$	4	$F(5,62) = 1.610$
		5	$F(6,60) = 1.231$
		6	$F(7,58) = 1.141$
		3	$F(5,64) = 1.555$
	$\alpha_1 = 0,\ \beta_i = 0,\ \gamma = 1$	4	$F(6,62) = 1.518$
		5	$F(7,60) = 1.207$
		6	$F(8,58) = 1.131$
Dollar/Franc			
		3	$F(4,64) = 1.175$
	$\alpha_1 = 0,\ \beta_i = 0$	4	$F(5,62) = 1.327$
		5	$F(6,60) = 1.087$
		6	$F(7,58) = 1.014$
		3	$F(5,64) = 1.436$
	$\alpha_1 = 0,\ \beta_i = 0,\ \gamma = 1$	4	$F(6,62) = 1.519$
		5	$F(7,60) = 1.146$
		6	$F(8,58) = 1.063$
Dollar/DM			
		3	$F(4,64) = 1.123$
	$\alpha_1 = 0,\ \beta_i = 0$	4	$F(5,62) = 1.262$
		5	$F(6,60) = 1.321$
		6	$F(7,58) = 1.342$
		3	$F(5,64) = 1.183$
	$\alpha_1 = 0,\ \beta_i = 0,\ \gamma = 1$	4	$F(6,62) = 1.287$
		5	$F(7,60) = 1.403$
		6	$F(8,58) = 1.525$

Figure 1

HORT-RUN VARIABILITY IN EXCHANGE RATES IN TERMS OF U.S. DOLLARS, APRIL 2, 1973 - DECEMBER 31, 1978

(Daily percentage changes)　　　　　　　　　　　　(Quarterly percentage changes)
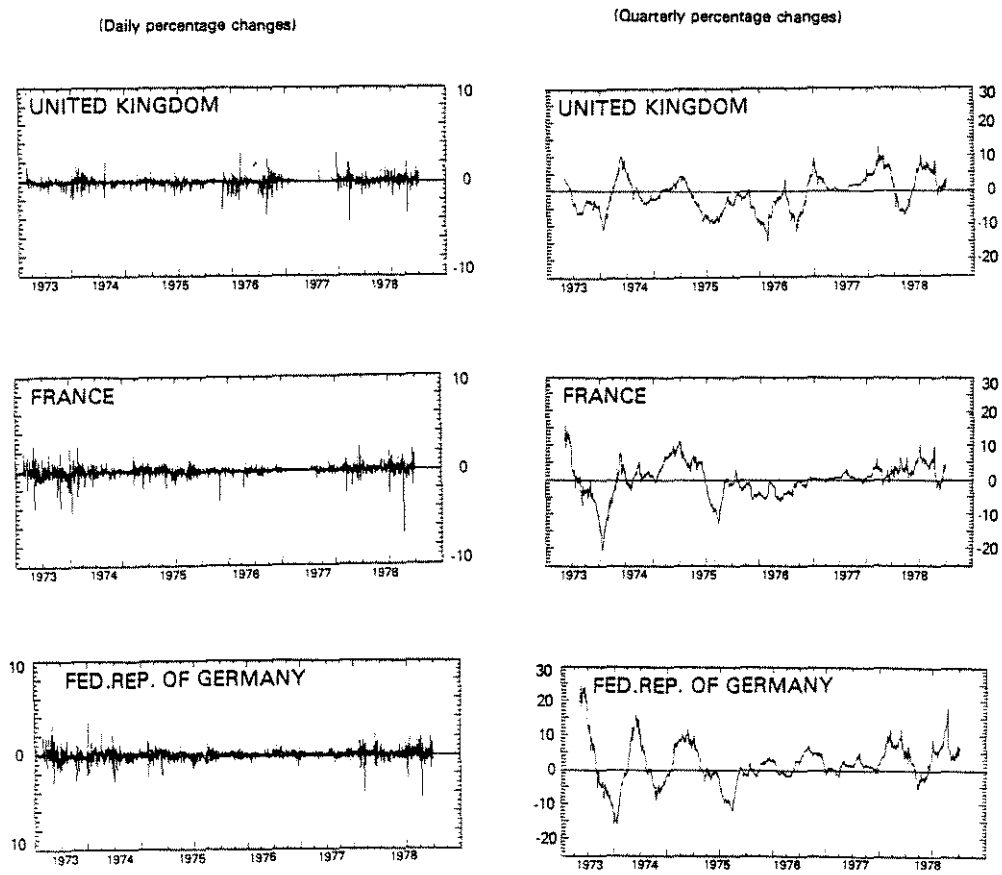
Source: Artus and Young (1979).

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expectations concerning future course of events, and changes in expect-
ations are immediately reflected in corresponding changes in prices.
Periods which are dominated by uncertainties, new information, rumors
and announcements are likely to be periods in which changes in expec-
tations are the prime cause of fluctuations in asset prices. Further,
since the information which alters expectations must be new, the
resulting fluctuations in price cannot be predicted by lagged forward
exchange rates which are based on past information.[5] Therefore, during
such periods, one should expect exchange rates to exhibit large fluctu-
ations and to be unbiased but imprecise forecasts of future spot rates.

To gain further insights into the implications of this perspec-
tive on the relationship between predicted and realized changes in ex-
change rates, I present in Figures 2-4 plots of predicted and realized
changes in exchange rates for the three pairs of currencies where the
predicted change is measured by the lagged forward premium. Also pre-
sented in these figures are the differentials in national inflation
rates which are discussed in the fourth section. The key fact which
emerges from these figures is that predicted changes in exchange rates
account for a very small fraction of actual changes.[6]

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[5]The analysis of the role of "news" in determining current ex-
change rates and in explaining forecast errors from the forward rate
has been made forcefully by Mussa (1976a, 1976b, 1977, 1979a). See
also Dornbusch (1978). The large degree of volatility is also analyzed
by McKinnon (1976) who attributes it to insufficient speculation.

[6]These and the following empirical regularities are analyzed in
detail in Mussa (1979a). See also Frenkel and Mussa (1980). An inter-
esting extension would examine the relationship between the variances
of predicted and actual changes in exchange rates in a manner analogous
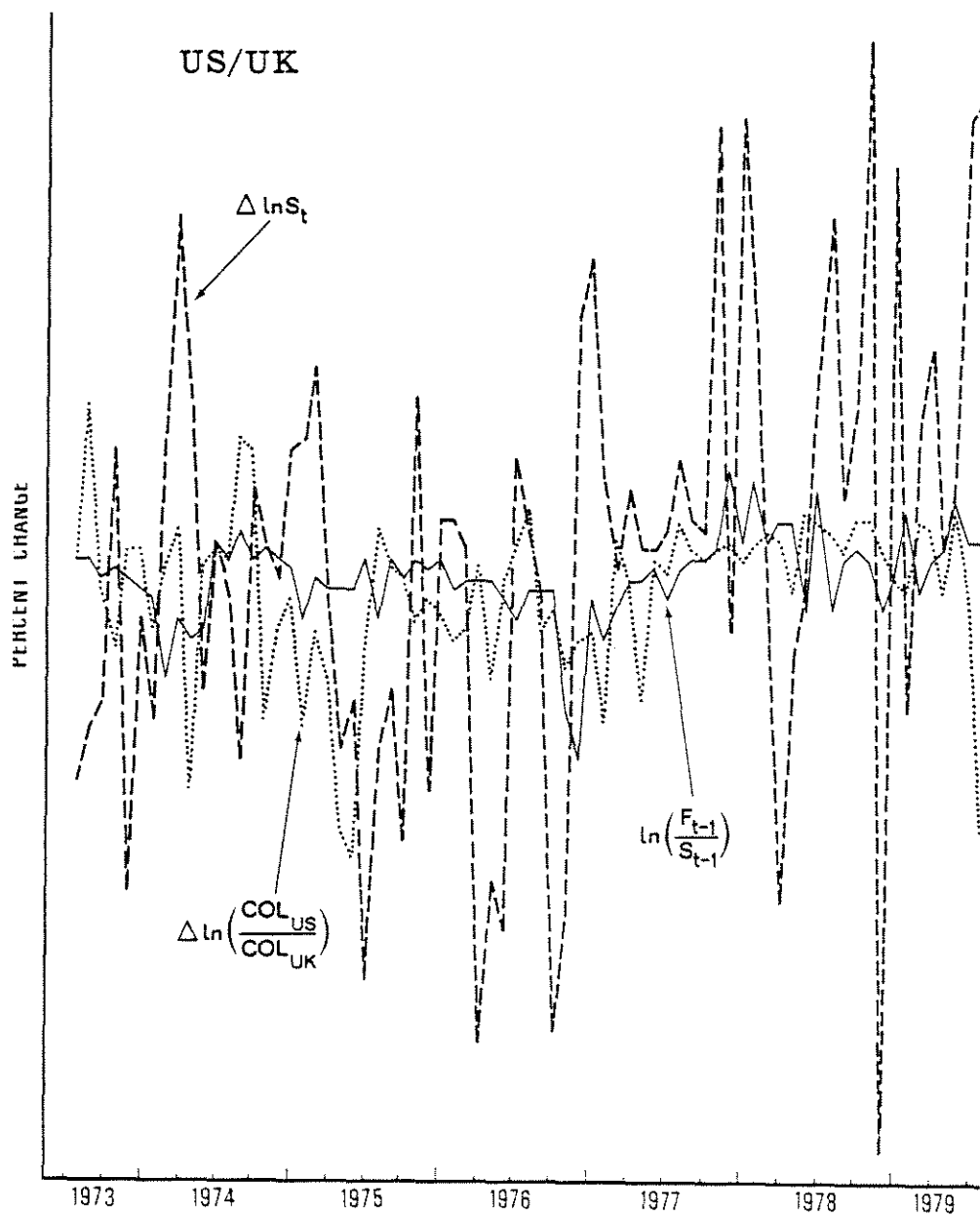to that of Shiller (1979).

US/UK

Figure 2: Monthly percentage changes of the U.S./U.K. consumer price indices $[\Delta(\ell n\ COL_{US}/COL_{UK})]$, of the \$/£ exchange rate, $(\Delta\ \ell n\ S_t)$, and the monthly forward premium; $[\ell n(F_{t-1}/S_{t-1})]$ July 1973 – July 1979.
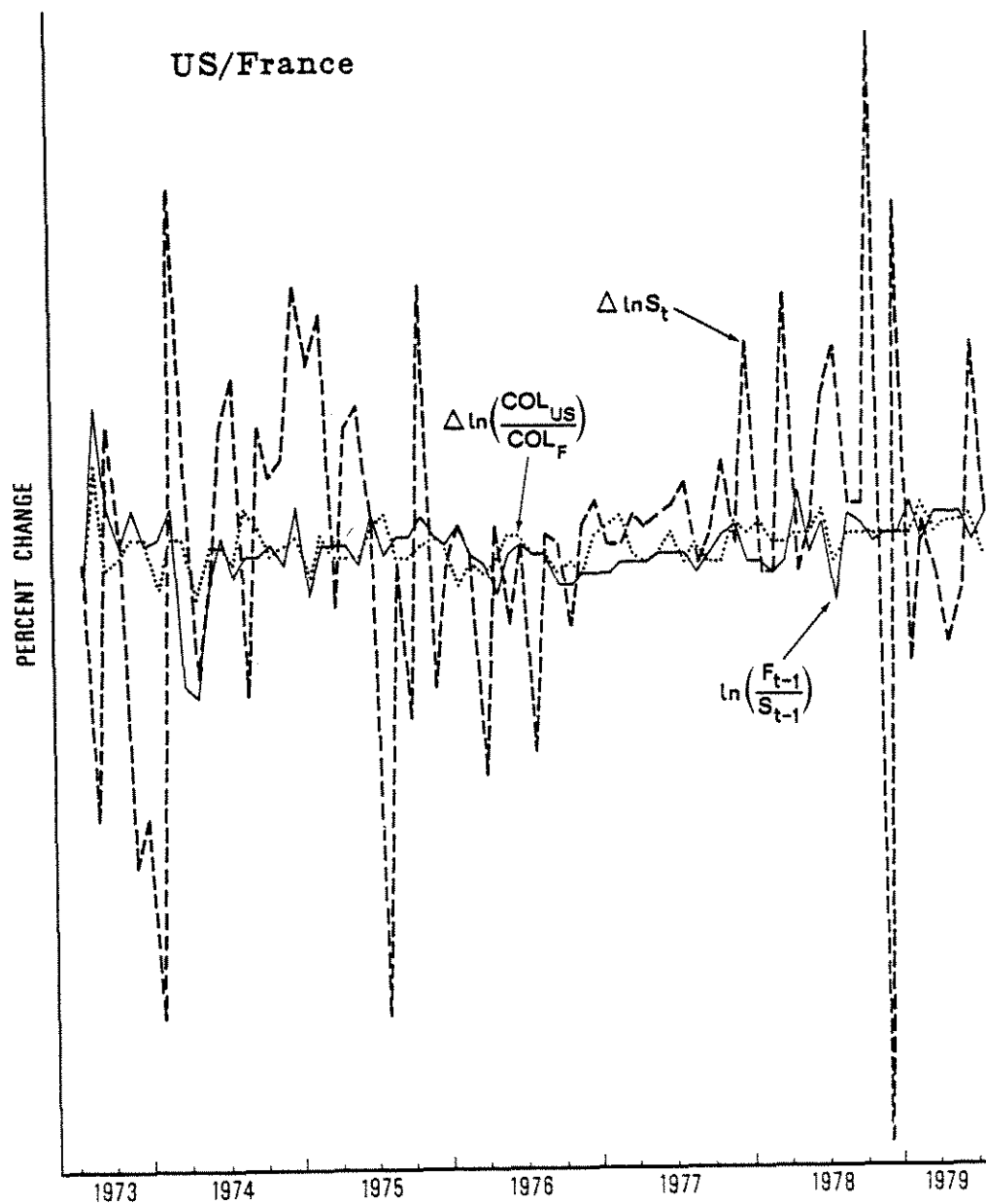
Figure 3: Monthly percentage changes of the U.S./France consumer price indices, $[\Delta(\ln COL_{US}/COL_F]$, of the \$/F.Fr. exchange rate, $(\Delta \ln S_t)$, and the monthly forward premium; $[\ln(F_{t-1}/S_{t-1})]$ July 1973 – July 1979.
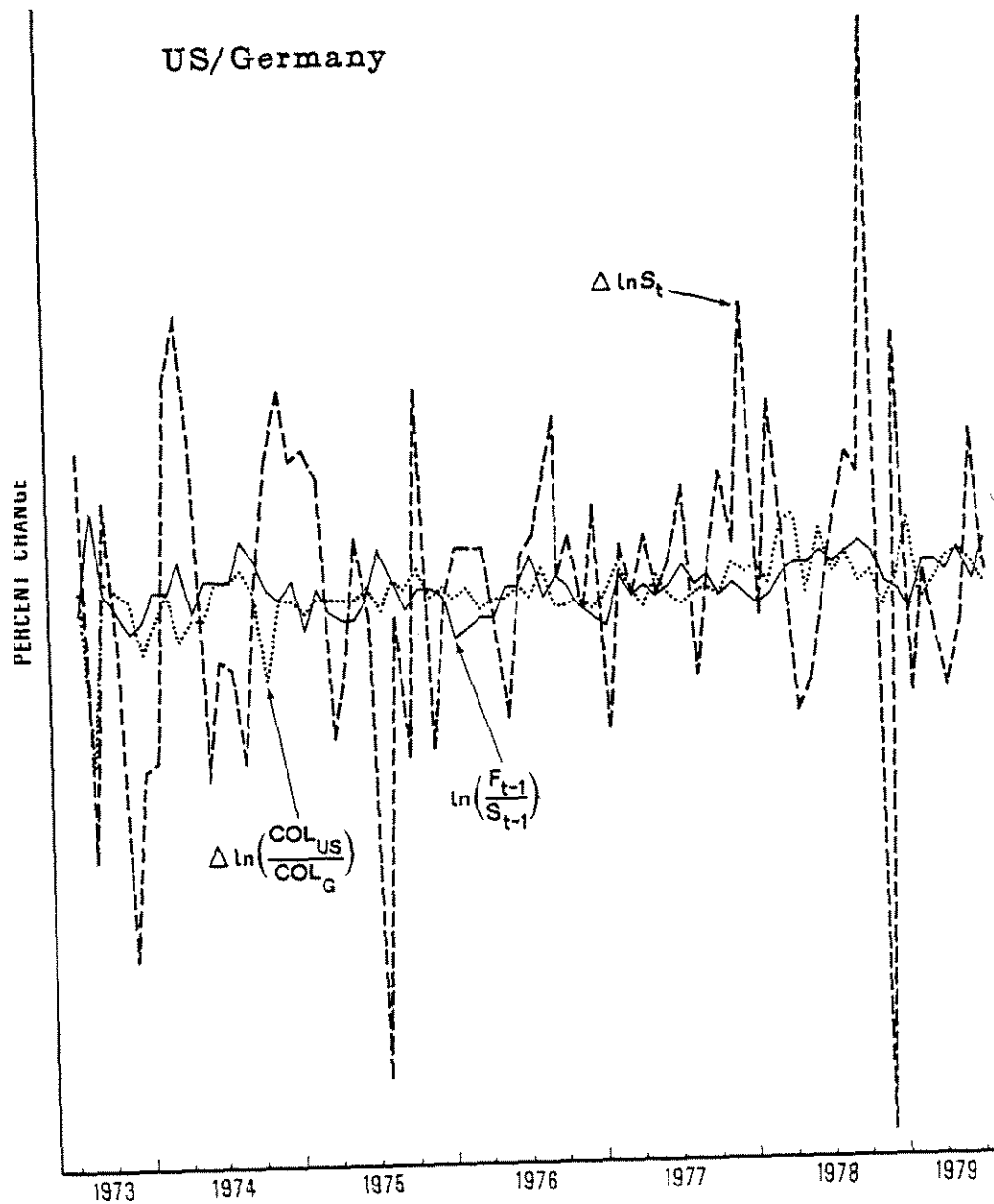
Figure 4: Monthly percentage changes of the U.S./German consumer price indices, $[\Delta(\ln COL_{US}/COL_G)]$, of the \$/DM exchange rate, $(\Delta \ln S_t)$, and the monthly forward premium; $[\ln(F_{t-1}/S_{t-1})]$ July 1973 - July 1979.

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This fact suggests that the bulk of exchange rate changes seem to be due to "new information" which, by definition, could not have been anticipated and reflected in the forward premium or discount which prevailed in the previous period.

In order to examine this hypothesis, I present in Figures 5-7 plots of the spot and the contemporaneous forward exchange rates for the three pairs of currencies. Also presented are the ratios of national price levels which are discussed in the fourth section. If the dominant factor underlying changes in rates is new information, which alters views about current and expected future exchange rates by approximately the same amount, then one should expect a high correlation between movements of spot and forward rates. This fact is clearly demonstrated by Figures 5-7 where it is seen that spot and forward exchange rates tend to move together and by approximately the same amplitude (the vertical difference between the two rates correspond to the forward premium of discount on foreign exchange). The high correlation between movements in spot and forward rates is expected since the two rates respond at the same time to the same flow of new information. This characteristic is typical to the foreign exchange market as well as to other markets for stocks and durable assets. The recent pattern of gold prices provides a useful example of this general principle. Table 3 reports the spot and the future price of gold as recorded recently in the New York Commodity Exchange on four recent consecutive days. The two key facts which are illustrated by this table are the extent of day-to-day volatility in gold prices and the uniformity by which these changes are reflected in the price of gold for immediate delivery as well as in the prices for the twelve future delivery dates.

Figure 5: Monthly observations of the Dollar/£ spot ($\ell n\ S_t$) and Forward ($\ell n\ F_t$) Exchange Rates and the Ratio of the U.S./U.K. Cost of Living Indices [$\ell n\ (COL_{US}/COL_{UK})$(scaled to equal the spot exchange rate at the initial month)]:June 1973 - July 1979.
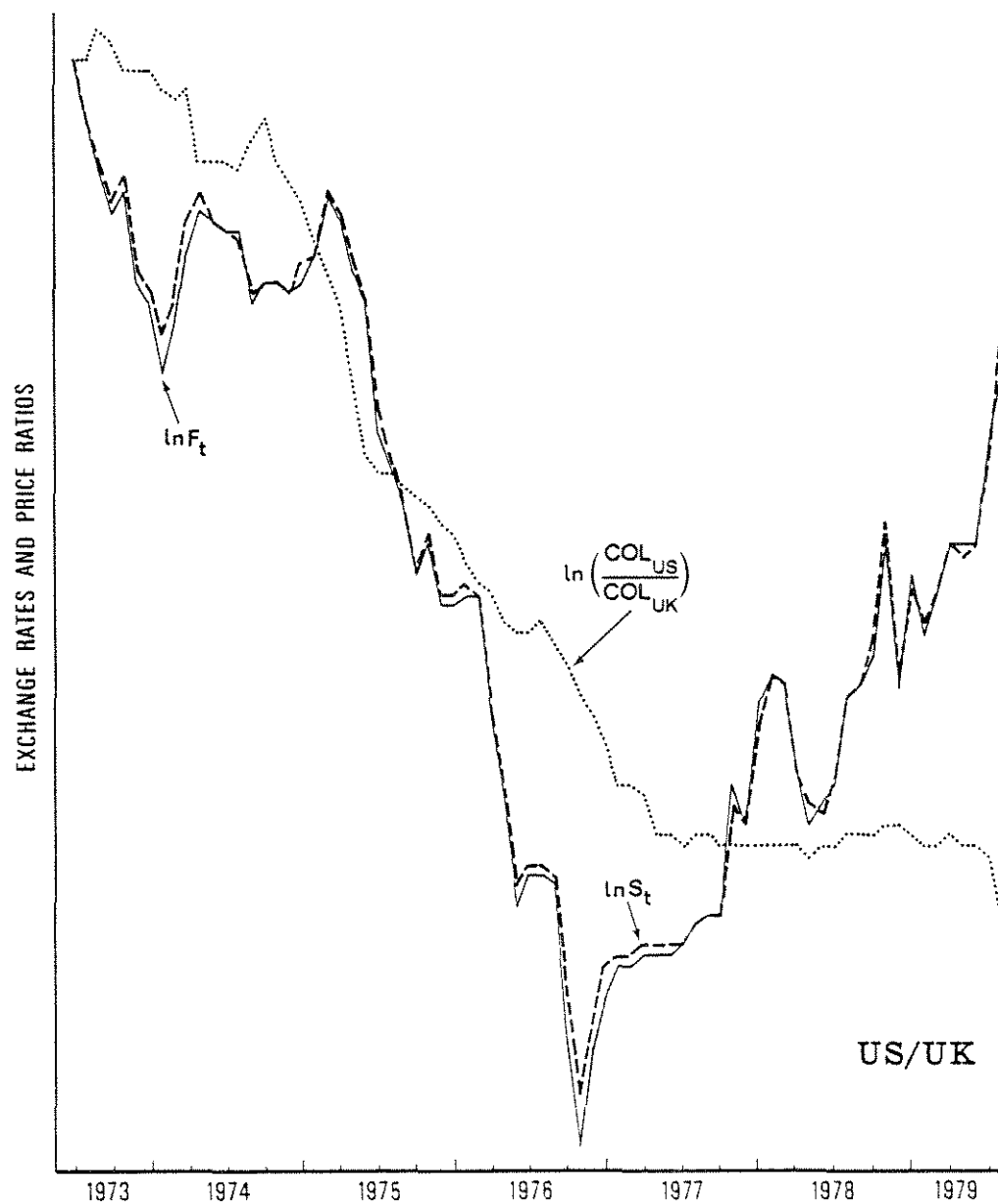
Figure 6: Monthly observations of the Dollar/F.Fr. spot ($\ln S_t$) and Forward ($\ln F_t$) Exchange Rates and the Ratio of the U.S./French Cost of Living Indices [$\ln(COL_{US}/COL_F)$(scaled to equal the spot exchange rate at the initial month)]:June 1973 – July 1979.

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Figure 7: Monthly observations of the Dollar/DM spot ($\ell n\ S_t$) and Forward ($\ell n\ F_t$) Exchange Rates and the Ratio of the U.S./German Cost of Living Indices [$\ell n(COL_{US}/COL_G)$ (scaled to equal the spot exchange rate at the initial month)]:June 1973 – July 1979.
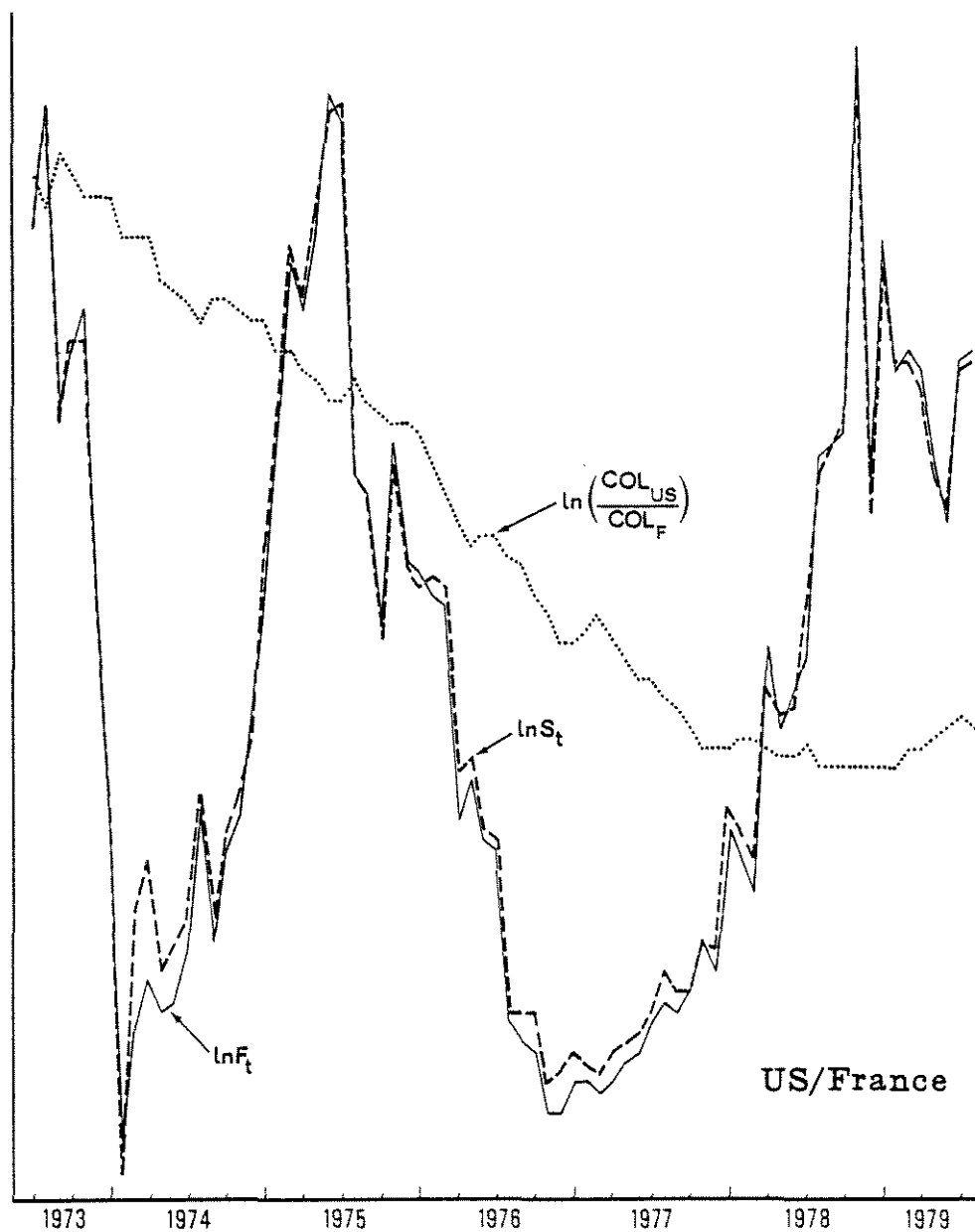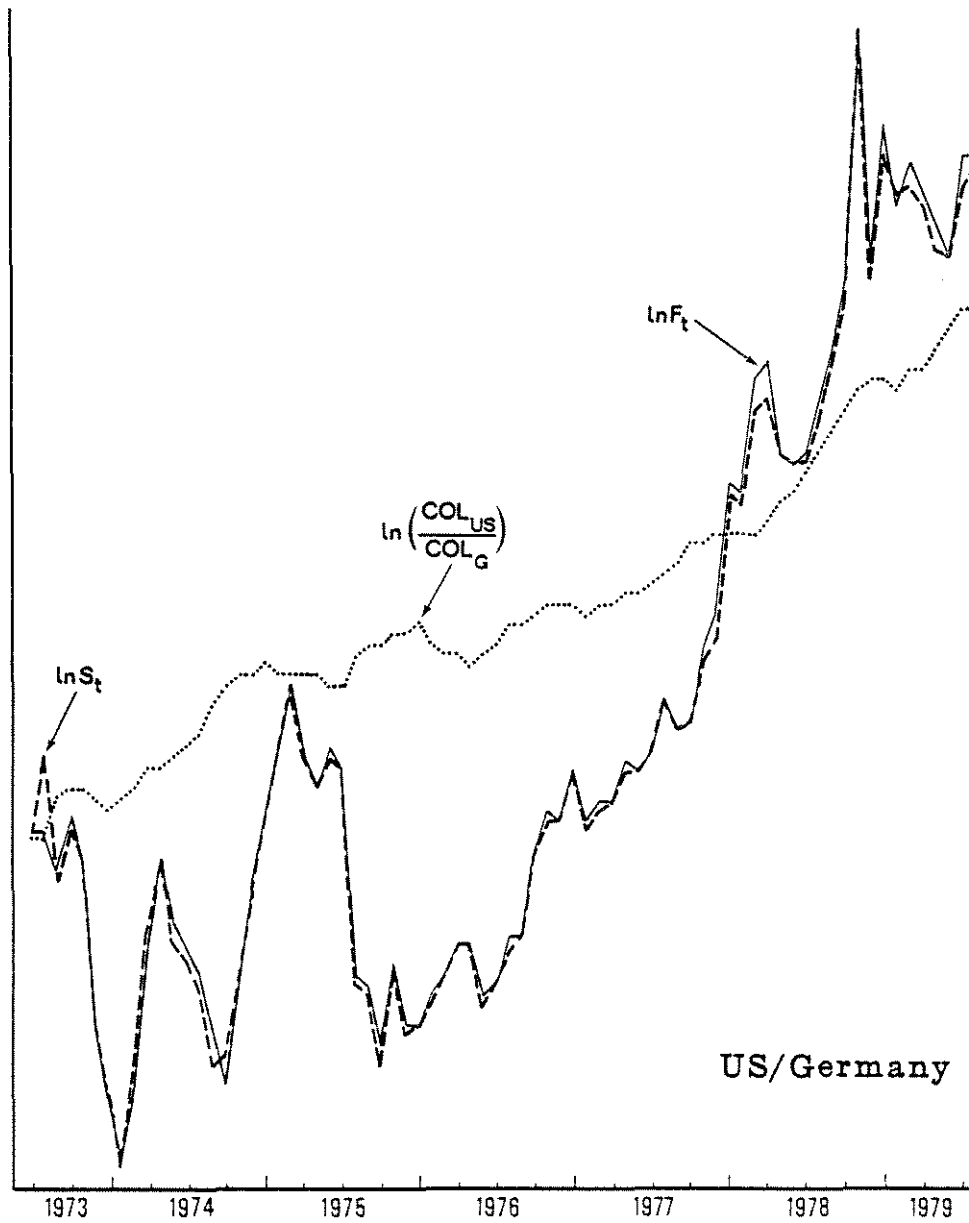
Table 3

Futures Price of Gold on Consecutive Days

Daily Data: October 1, 1979 – October 4, 1979

Price (per ounce) and change from previous day

Delivery Date	Oct. 1, 79	Change	Oct. 2, 79	Change	Oct. 3, 79	Change	Oct. 4, 79	Change
1979 October	416.0	21	411.0	-5.0	393.5	-17.5	369.7	-23.8
November	419.5	20	416.0	-3.5	397.7	-18.3	377.7	-20.0
December	424.5	20	421.0	-3.5	402.5	-18.5	382.5	-20.0
1980 February	432.8	20	429.6	-3.2	410.7	-18.9	390.7	-20.0
April	440.9	20	438.0	-2.9	418.8	-19.2	398.8	-20.0
June	448.6	20	446.0	-2.6	426.6	-19.4	406.6	-20.0
August	456.3	20	454.0	-2.3	434.4	-19.6	414.4	-20.0
October	464.0	20	462.0	-2.0	442.2	-19.8	422.2	-20.0
December	471.5	20	469.8	-1.7	449.8	-20.0	429.8	-20.0
1981 February	478.9	20	477.5	-1.4	457.5	-20.0	437.5	-20.0
April	486.1	20	485.0	-1.1	465.0	-20.0	445.0	-20.0
June	493.3	20	492.5	-0.8	472.5	-20.0	452.5	-20.0
August	500.5	20	500.0	-0.5	480.0	-20.0	460.0	-20.0

Note: These prices are settlement prices at the Commodity Exchange, New York as reported in the Wall Street Journal October 2-5, 1979

Another feature which is revealed by Figures 5-7 is that the ontemporaneous spot and forward exchange rates are approximately equal hus indicating that the market's best forecast of the future spot rate s (approximately) the current spot rate. This phenomenon reflects the act that, as an empirical matter, exchange rates have followed approximately) a random walk process. For such a process, current rices are indeed the best forecasts of future prices. To the extent hat the exchange rate had some drift, the above statement should be nterpreted in reference to that drift. This empirical phenomenon eems to correspond to the actual paths of exchange rates even though t does not reflect a theoretical necessity.

The final characteristic of the foreign exchange market is de-cribed by Figures 8-10, which plot for the three pairs of currencies he spot exchange rate and the forward premium on forward exchange. ince the units of the spot rate and the forward premium are funda-lentally different, the two series were normalized by subtracting from ·ach series its mean and by dividing by the corresponding standard ·rror. The fact which emerges from these figures is that generally though not always) there is a positive correlation between the ex-·ected depreciation of the currency (as measured by the forward premium ·n foreign exchange) and the spot exchange rate. This positive cor-·elation may be rationalized by noting that currencies which are ex-·ected to depreciate are traded at a discount in the forward market .nd, on average, these currencies also command a lower foreign exchange ·alue in the spot market. This correlation is interpreted further in :he next section.

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Figure 8: Monthly observations of the normalized Dollar/£ spot exchange rate ($\ln S_t^N$) and the normalized forward premium $[\ln(F_t/S_t)^N]$. Both series are normalized by subtracting from each series its mean and by dividing by the corresponding standard error: June 1973 – July 1979.

Figure 9: Monthly observations of the normalized Dollar/F.Fr. spot
exchange rate ($\ell n\ S_t^N$) and the normalized Forward Premium
$[\ell n(F_t/S_t)^N]$. Both series are normalized by subtracting
from each series its mean and by dividing by the
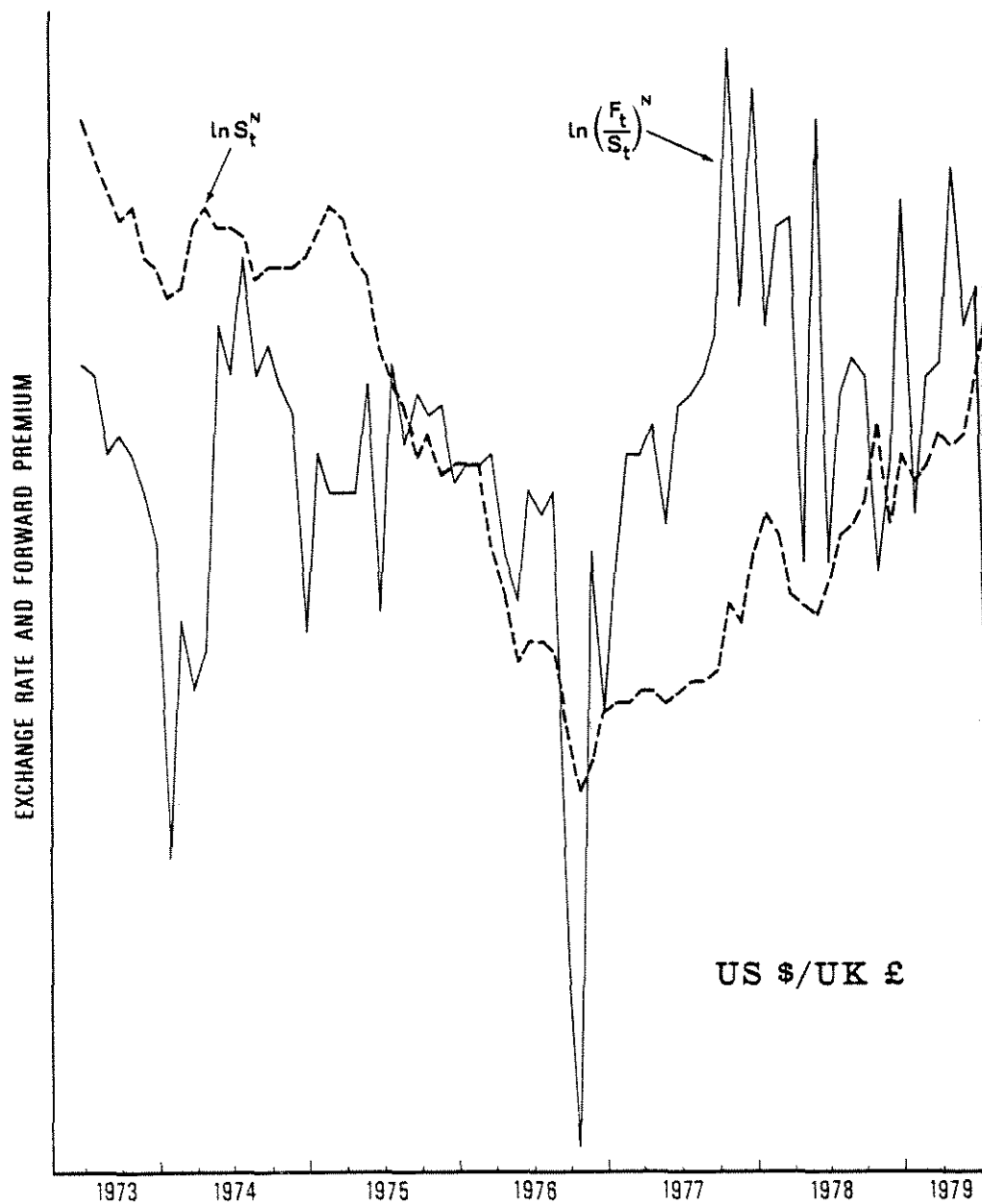corresponding standard error: June 1973 - July 1979.

Figure 10: Monthly observations of the normalized Dollar/DM spot ($\ln S_t^N$) and the normalized Forward Premium [$\ln(F_t/S_t)^N$]. Both series are normalized by subtracting from each series its mean and by dividing by the corresponding standard error: June 1973 – July 1979.
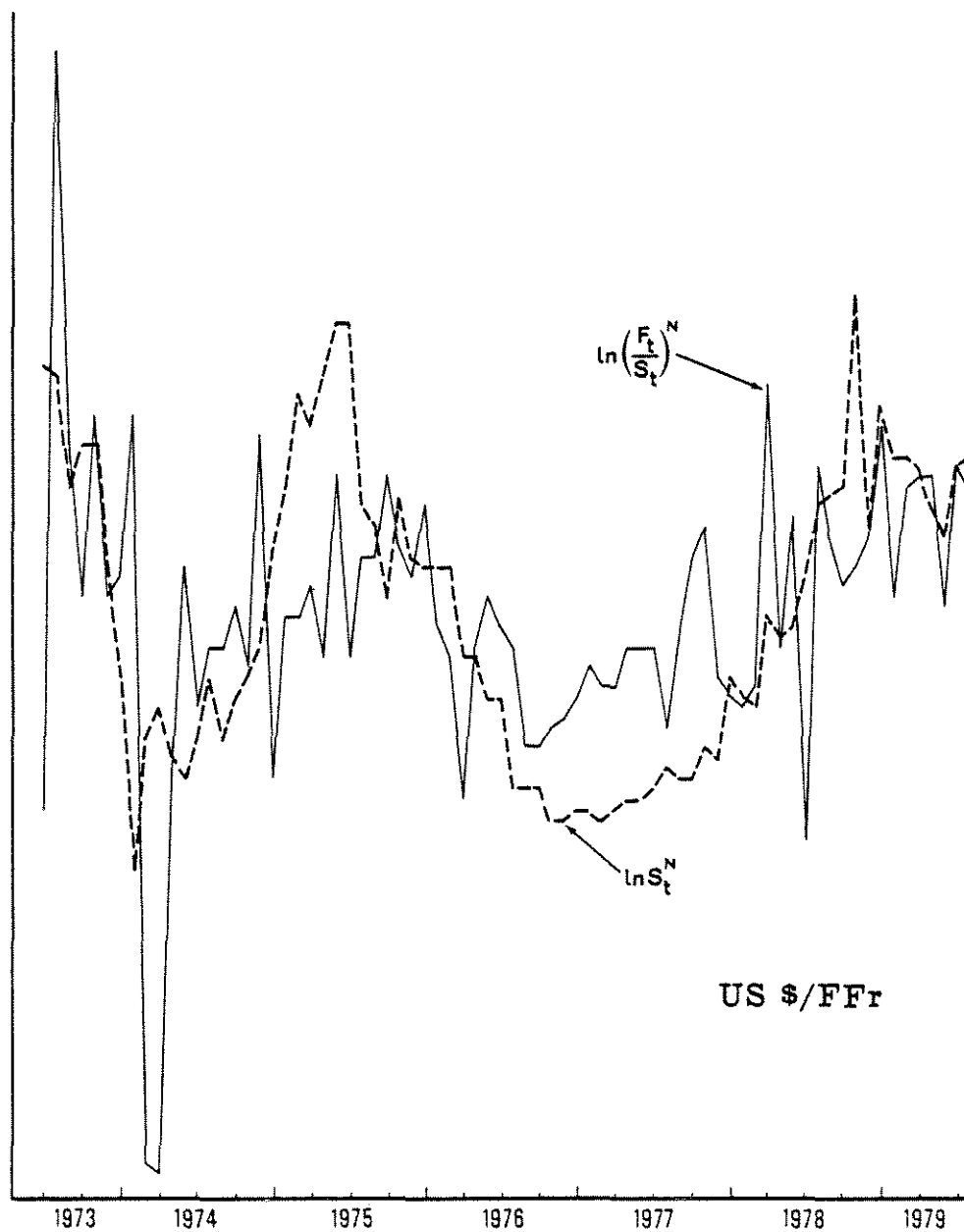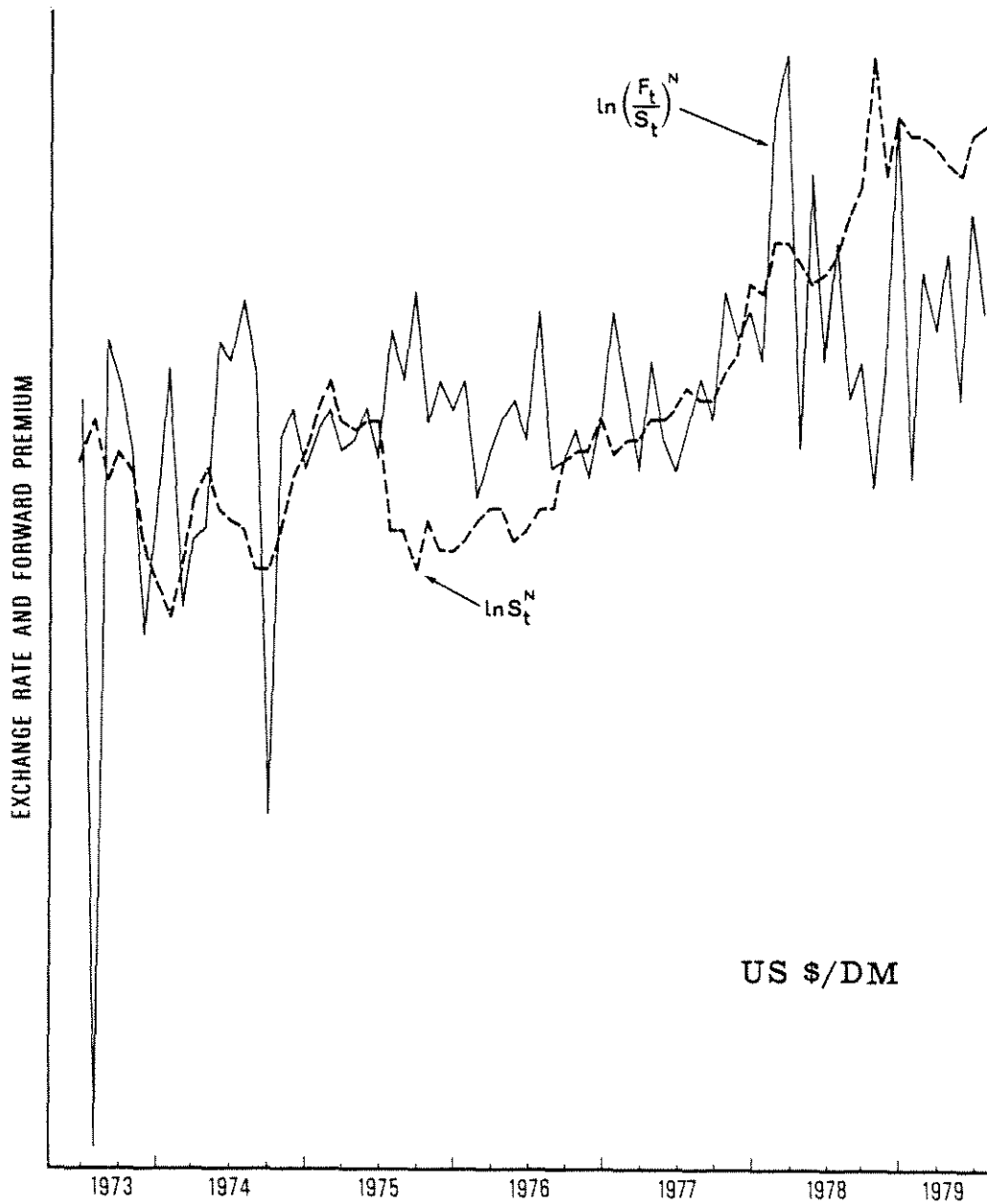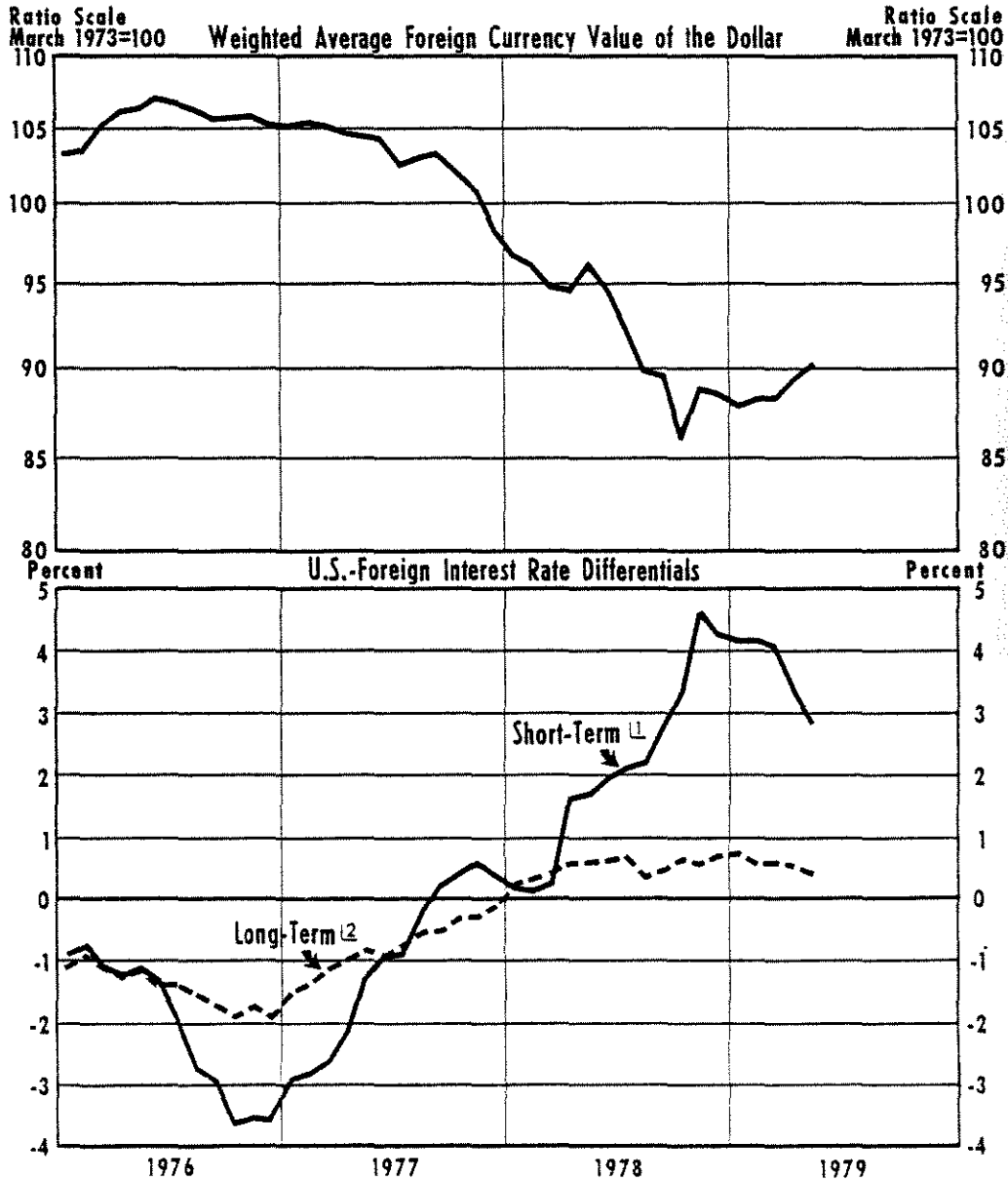
EXCHANGE RATES, INTEREST RATES AND INNOVATIONS

In this section I analyze the relationship between exchange rates and interest rates from the analytical perspective of the monetary approach to the exchange rate. To set the stage for the analytical development it is useful to recall the typical analysis which generally predicts a negative association between the rate of interest and the exchange rate. According to that analysis, a higher rate of interest attracts foreign capital which induces a surplus in the capital account of the balance of payments and thereby induces an appreciation of the domestic currency (i.e., a lower spot exchange rate). Another variant of the popular approach states that the higher rate of interest lowers spending and thus induces a surplus in the current account of the balance of payments which results in a lower spot exchange rate. A third variant of this approach claims that the higher rate of interest implies (via the interest parity theory) a higher forward premium on foreign exchange and to the extent that at a given point in time the forward exchange rate is predetermined by past history, (an assumption that is clearly rejected by the evidence on the comovements of spot and forward rates), the required rise in the forward premium will be brought about by a lower spot rate (i.e., by an appreciation of the domestic currency). Whatever the route, this approach predicts a negative relationship between the rate of interest and the spot exchange rate (or alternatively, a positive relationship between the rate of interest and the foreign exchange value of the domestic currency).

These predictions, however, do not seem to be in accord with the broad facts. Over the recent period the rise in the rate of interest in the U.S. (relative to the foreign rate of interest) has been

Figure 11

Foreign Exchange Value of the
U.S. Dollar and Interest Rate Differentials

Ratio Scale
March 1973=100   Weighted Average Foreign Currency Value of the Dollar   Ratio Scale
March 1973=100

Percent   U.S.-Foreign Interest Rate Differentials   Percent

Short-Term ⌊1

Long-Term ⌊2

1976   1977   1978   1979

Sources: Federal Reserve Statistical Release H.13; Federal Reserve Bulletin; International Monetary
Fund, International Financial Statistics.

⌊1 Secondary market rates for 90-day large certificates of deposit in the United States less the
weighted average of foreign three-month money market rates.

⌊2 U.S. long-term government bond yields less the weighted average of foreign long-term
government bond yields.

Latest data plotted: May

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Source: D. R. Mudd (1979).

associated with a rise in the spot exchange rate (i.e., with a depreci-
ation of the dollar). Figure 11 illustrates the point by plotting the
foreign exchange value of the U.S. dollar against the interest rate
differential. As is evident, in contrast with the popular prediction,
the higher (relative) rate of interest in the U.S. has been associated
with a higher exchange rate (i.e., with a lower foreign exchange value
of the dollar). This contradiction, however, does not arise when the ex-
change rate is analyzed from a monetary (or an asset market) perspec-
tive to which we now turn.

The major building blocks of the monetary approach are hypotheses
concerning the properties of the demand for money and money market
equilibrium and hypotheses concerning the link between domestic and
foreign prices.[7] Consider first the equilibrium in the money markets.
The supplies of domestic and foreign real balances are M/P and M*/P*
where M and P denote the nominal money supply and the price level,
respectively, and where variables pertaining to the foreign country are
indicated by an asterisk. Denoting the demands for real balances by
L and L* (both of which are functions which are specified below),
equilibrium in the money markets is attained when

(7) $L = M/P$ and

(8) $L* = M*/P*$.

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[7]For theoretical developments and applications of the approach
see, for example, Dornbusch (1976a, 1976b), Kouri (1976), Mussa (1976a),
Frenkel (1976), Frenkel and Johnson (1978), Frenkel and Clements (1980),
Bilson (1978), Hodrick (1978), and Frankel (1979).

From equations (7)-(8), equilibrium in the money markets implies that the ratio of the two price levels is:

$$(9) \quad \frac{P}{P*} = \frac{M}{M*} \frac{L*}{L} .$$

The second building block links domestic and foreign prices. Assuming the simple version of purchasing power parity implies that:[8]

$$(10) \quad P = SP*$$

Using equation (10) in (9) yields

$$(11) \quad S = \frac{M}{M*} \frac{L*}{L}$$

which expresses the exchange rate in terms of domestic and foreign supplies and demands for money. To gain further insight into the determinants of the exchange rate and to set the stage for the empirical estimation, assume that the demand for money depends on real income (y) and the rate of interest (i) according to:

$$(12) \quad L = ay^{\eta}e^{-\alpha i}$$

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[8] For a discussion of the choice of the relevant price index to be used in equation (10), see Frenkel (1978). This simple version of the purchasing power parity theory is used here to simplify the exposition. To the extent that there are systematic deviations from purchasing power parity they can be incorporated into the final exchange rate equation. Similarly, to the extent that purchasing power parities holds in the long run but not in the short run, the final exchange rate equation will reflect these dynamic characteristics. To the extent that purchasing power parity pertains to traded goods only, the exchange rate equation would also contain terms which relate to the relative prices of traded to non-traded goods; for a formulation along these lines, see Dornbusch (1976b) and for an empirical application, see Clements and Frenkel (1980). A more refined specification would allow for the effects of tariffs on the relationship between domestic and foreign prices as well as for short-run effects of unanticipated money on output rather than only on prices and the exchange rate.

(13) $L^* = b^* y^{*\eta^*} e^{-\alpha^* i^*}$

Using equations (12)-(13) in (11) and assuming for simplicity of exposition that foreign and domestic parameters of the demand for money are the same, i.e., that $\alpha = \alpha^*$, and that $\eta = \eta^*$, we obtain:

(14) $\ell n\ S = C + \ell n\ \frac{M}{M^*} + \eta\ \ell n\ \frac{y^*}{y} + \alpha(\ i - i^*)$

where $C \equiv \ell n(b^*/a)$.

Equation (14) relates the exchange rate to the ratios of domestic to foreign money supplies and incomes and to the interest rate differential.[9] Most pertinent to the present purpose and in agreement with the facts summarized by Figure 11, equation (14) yields a positive relationship between the rate of interest and the exchange rate. The economic interpretation of this association in the context of the U.S. dollar and the inflationary environment is as follows: a rise in the domestic (relative) rate of interest is primarily dominated by a rise in the expected (relative) rate of inflation which induces a decline in the demand for real cash balances; for a given path of the nominal money supply, asset market equilibrium requires a price level which is higher than the price which would have prevailed otherwise. Since the domestic price level is linked to the foreign price through some form of purchasing power parity, and since the path of the foreign price is

[9] It should be noted that a similar set of variables would also appear in the reduced form of a variety of alternative models. The dependence of the demand for domestic money on the domestic rate of interest and the dependence of the demand for foreign money on foreign rate of interest is assumed only for simplicity of exposition. A more general formulation would recognize that the demands for domestic and foreign monies depend on all margins of substitution. See Frenkel and Clements (1980).

assumed to be given, the higher domestic price can only be achieved through a rise in the spot exchange rate (i.e., through a depreciation of the currency).

This explanation of the positive association between interest rates and exchange rates has an intuitive appeal in that it implies that, in an inflationary environment, a relatively rapid rise in prices is associated with high nominal rates of interest as well as with a depreciation of the currency in terms of foreign exchange. The traditional prediction of a negative relationship between interest rates and the exchange rate may, however, be reconciled with the monetary approach under the assumption that it concentrates on the short-run liquidity effects of monetary changes. Accordingly, in the short-run, a higher rate of interest may arise from tight money which induces an appreciation rather than a depreciation of the currency.[10] It should be emphasized, however, that during an inflationary environment (like the one prevailing in the U.S. in recent years) the variations in the rate of interest are most likely to be dominated by variations in inflationary expectations rather than by liquidity effects associated with changes in the ratio of money to bonds. In such an environment the rate of interest is expected to be positively correlated with the exchange rate.

The discussion provides an illustration of the difficulties associated with using the rate of interest as the relevant monetary indicator. Traditionally, the height of the rate of interest was the

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[10]The short-run liquidity effects is emphasized in Dornbusch (1976b). The role of inflationary expectations in dominating exchange rate developments is emphasized in Frenkel (1976). Frenkel (1979) and Edwards (1979) attempt to integrate these two factors.

criterion for assessing whether monetary policy has been easy or tight:
a high interest rate was interpreted as indicating a tight monetary
policy while a low interest rate was interpreted as indicating an easy
monetary policy. By now it is well recognized that during inflationary
periods it is vital to draw a distinction between nominal and real
rates of interest and, as a result, during inflationary periods the
rate of interest may provide a very misleading interpretation of the
stance of monetary policy. The same logic applies with respect to the
analysis of the relationship between exchange rates and interest rates.

The foregoing analysis also provides the explanation for the ob-
servation (which was noted previously) that generally there is a
positive correlation between the forward premium on foreign exchange
and the level of the spot rate. Since the spot rate is expected to be
positively correlated with interest rate differential and since,
according to the interest parity theory, that differential must equal
the forward premium on foreign exchange, it follows that the forward
premium is also expected to be positively correlated with the level of
the spot rate.[11] That positive correlation may also be rationalized by
noting that currencies which are expected to depreciate are traded at a

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[11] For evidence on the robustness of the interest parity relation-
ship, see Frenkel and Levich (1977). The positive association between
the spot exchange rate and the forward premium has been interpreted in
terms of an explicit monetary model. It is noteworthy that this posi-
tive association would be predicted by any model in which current ex-
change rate reflects immediately the expectations of future deprecia-
tion. See, for example, Mussa (1976a) and Frenkel and Mussa (1980).
Since the rate of interest and the exchange rate are dimensionally
incommensurate, their association raise questions that are familiar
from the discussions of the Gibson Paradox. In a separate paper, I in-
tend to examine the relationship between exchange rates and the forward
premium (or the interest differential) in light of the various explana-
tions of the Gibson Paradox.

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discount in the forward market and, on average, these currencies also command a lower foreign exchange value in the spot market.

Prior to proceeding with the empirical evidence on the relationship between exchange rates and interest rates it might be useful to highlight some of the main features of the monetary approach which are reflected in equations (11) and (14). First, these equations demonstrate the symmetric roles that are being played by the supplies of domestic and foreign monies and the demands for these monies. Since the demands for monies depend on real variables like real incomes as well as on other real variables which underlie expectations and rates of interest, it is clear that the monetary approach does not imply that the exchange rate depends only on the relative supplies of money; nor does it imply that real variables do not affect the equilibrium exchange rate. Second, from the policy perspective the monetary approach brings to the forefront the implications of the homogeneity postulate: ceteris paribus a rise in the quantity of money results in an equiproportionate rise in the exchange rate. This illustrates the intimate connection between monetary policy and exchange rate policy. Third, the positive relationship between interest rates and exchange rates and the central role played by inflationary expectations imply that policies which attempt to induce an appreciation of the currency should aim at reducing inflationary expectations. The reduction in inflationary expectations would halt the depreciation of the currency in terms of goods and in terms of foreign exchange, and would result in lower nominal rates of interest while maintaining (or even raising) real rates of interest.

The discussion in the second section and, in particular, the con-
-ibutions by Mussa (1977, 1979a) and Dornbusch (1978) emphasized that
ⅰe predominant cause of exchange rate movements is news which could
ⅰt have been anticipated. It was also argued in the second section
ⅰat the forward rate seems to summarize the information that is avail-
ⅰle to the market when the forward rate is being set. We may there-
ⅰre express the spot rate at period t as a function of factors which
ⅰve been known in advance and are summarized by the lagged forward
ⅰte, as well as a function of the "news."

15) $\ln S_t = a + b \ln F_{t-1} + \text{"news"}$

The empirical difficulty is in identifying the variable which
ⅰeasures the "news." Assuming that asset markets clear relatively fast
ⅰd that the "news" is immediately reflected in (unexpected) changes in
ⅰhe rates of interest we may write equation (15) as

16) $\ln S_t = a + b \ln F_{t-1} + \alpha [(i - i^*)_t - E_{t-1}(i - i^*)_t]$

ⅰhere the bracketed term denotes the innovation in the interest differ-
ⅰntial and where $E_{t-1}(i - i^*)_t$ denotes the interest differential which
ⅰas expected to prevail in period t based on the information available
ⅰt t - 1. The expected interest rate differential was computed from a
ⅰegression of the interest differential on a constant and on two lagged
ⅰalues of the differential.[12] The previous analysis of the relationship

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[12]An alternative way to compute the expected differential would
ⅰse data on the term structure of interest rates. Since data on the
ⅰifferential of 2-month rates are not readily available, this computa-
ⅰion would require interpolations.

between interest rate differential and the exchange rate implies that the coefficient α is expected to be positive.

Table 4 reports the OLS estimates of equation (16) for the three exchange rates over the period June 1973-July 1979. As may be seen, in all cases the coefficients of the unexpected interest differential are positive and in most cases the coefficients are statistically significant. In order to verify the importance of using the series of innovations in the interest differential, Table 4 also reports estimates of regressions which replace the innovations by the actual series of the interest differential as well as regressions which include both the innovation and the actual differential. In all cases the coefficients of the actual interest differential do not differ significantly from zero.[13] To allow for a simultaneous determination of interest rates and exchange rates, equation (16) was also estimated using a two-stage-least-squares estimation procedure. These results are reported in Table 5, and again in all cases the coefficients of the unexpected interest differential are positive. These coefficients are highly significant in the Dollar/Pound exchange rate but insignificant in the other two rates. On the whole, the record shows that during the 1970s exchange rates and interest rate differential have been associated positively and thus indicating that during that inflationary period the same factors which induced a rise in the interest differential also induced a rise in the spot exchange rates. Furthermore, consistent with

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[13]In order to check whether the dollar rescue policies of November 1978 have had a systematic effect on the estimates, these regressions were also estimated for the period up to September 1978. The results did not change materially.

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Table 4
Interest Rate Differentials and Exchange Rates
Monthly Data: June 1973 - July 1979
(standard errors in parentheses)

Dependent Variable $\ln S_t$	Constant	$\ln F_{t-1}$	$(i-i^*)_t$	$[(i-i^*)_t - E_{t-1}(i-i^*)_t]$	s.e.	R^2	D.W.
Dollar/Pound							
	.032 (.019)	.959 (.025)	.017 (.096)		.027	.95	1.73
	.030 (.017)	.961 (.024)		.388 (.165)	.026	.96	1.77
	.019 (.019)	.968 (.024)	-.155 (.111)	.546 (.199)	.026	.96	1.80
Dollar/Franc							
	-.335 (.100)	.776 (.067)	.184 (.125)		.029	.79	2.11
	-.301 (.079)	.801 (.051)		.377 (.132)	.028	.81	2.22
	-.231 (.104)	.851 (.070)	.195 (.188)	.540 (.206)	.028	.81	2.32
Dollar/DM							
	-.070 (.43)	.926 (.045)	.237 (.229)		.032	.93	2.02
	-.037 (.027)	.955 (.032)		.601 (.271)	.031	.94	2.08
	-.040 (.046)	.952 (.047)	.024 (.290)	.583 (.349)	.031	.94	2.08

NOTE: Interest rates are the one-month (annualized) Euromarket rates. The expected interest rate differential $E_{t-1}(i-i^*)_t$ was computed from a regression of the interest differential on a constant and on lagged values of the differential. $(i - i^*)_t$ denotes actual interest rate differential where i denotes the rate of interest on securities denominated in U.S. dollars and i^* denotes the rate of interest on securities denominated in foreign currency. $[(i-i^*)_t - E_{t-1}(i-i^*)_t]$ denotes the unexpected interest rate differential.

Table 5

Interest Rate Differential and Exchange Rates

Monthly Data: June 1973 - July 1979; Instrumental Variables

(standard errors in parentheses)

Dependent Variable ℓn S_t	Constant	ℓn F_{t-1}	$(i-i^*)_t$	$[(i-i^*)_t - E_{t-1}(i-i^*)_t]$	s.e.	R^2	D.W.
Dollar/Pound							
	.020 (.020)	.966 (.026)	-.153 (.117)		.027	.95	1.69
	.027 (.016)	.965 (.022)		.435 (.164)	.024	.97	1.79
	.017 (.017)	.971 (.022)	-.142 (.098)	.425 (.160)	.023	.97	1.78
Dollar/Franc							
	-.145 (.125)	.909 (.085)	-.301 (.234)		.036	.69	2.18
	-.279 (.081)	.816 (.053)		.216 (.165)	.029	.80	2.22
	-.184 (.126)	.883 (.086)	-.260 (.225)	.165 (.199)	.034	.73	2.21
Dollar/DM							
	-.006 (.047)	.987 (.049)	-.135 (.307)		.034	.92	2.11
	-.040 (.031)	.951 (.036)		.555 (.380)	.034	.92	2.07
	-.040 (.053)	.951 (.055)	-.001 (.003)	.555 (.402)	.034	.92	2.07

NOTE: Interest rates are the one-month (annualized) Euromarket rates. The expected interest rate differential $E_{t-1}(i-i^*)_t$ was computed from a regression of the interest differential on a constant and on two lagged values of the differential. Two-stage least squares estimation method was used. The instruments for the interest differential were a constant and two lagged values of the differential and the instruments for the unexpected differential were a constant and Durbin's rank variable $(i - i^*)$ denotes actual interest rate differential where i denotes the rate of interest on securities denominated in U.S. dollars and i^* denotes the rate of interest on securities denominated in foreign currency. $[(i-i^*)_t - E_{t-1}(i-i^*)_t]$ denotes the unexpected interest rate differential.

the hypothesis that current changes in exchange rates are primarily a response to new information, the evidence shows the importance of the innovations in the interest differential.

The principle that current exchange rates already reflect expectations concerning the future course of events implies that changes in exchange rates are primarily due to innovations. In the present section this principle was applied to the analysis of the relationship between exchange rates and interest rate differential. The principle, however, is general. For example, it implies that the relationship between a deficit in the balance of trade and the exchange rate depends crucially on whether the deficit was expected or not. A deficit that was expected may have no effect on the exchange rate since the latter already reflected these expectations. In contrast, an unexpected deficit in the balance of trade may contain significant new information that is likely to induce a strong effect on the exchange rate.[14]

EXCHANGE RATES AND PRICES

One of the striking facts concerning the relationship between prices and exchange rates during the 1970s is the extent to which the evolution of prices and exchange rates have not coincided. The originators and proponents of the purchasing power parity doctrine (Wheatley and Ricardo during the first part of the 19th century and Cassel during the 1920s) have viewed the doctrine as an extension of the quantity

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[14]For a further elaboration on the relationship between exchange rates, and the current account, see Dornbusch and Fischer (1978) and Rodriguez (1978). For a special emphasis on the role of innovations in the trade balance, see Mussa (1979c) and for empirical evidence, see Hakkio (1979b).

theory of money to the open economy. By now the consensus seems to be that purchasing power parities can be expected to hold in the long-run, if most of the shocks to the system are of a monetary origin which do not require changes in relative prices. To the extent that most of the shocks reflect "real" changes (like differential growth rates among sectors), the required changes in sectoral relative prices may result in a relatively loose connection between exchange rates and aggregate price levels. The experience during the 1970s illustrates the extent to which real shocks (oil embargo, supply shocks, commodity booms and shortages, differential productivity growth) result in systematic deviations from purchasing power parities. As illustrated in Figures 2-4, short-run changes in exchange rates have not been closely linked to short-run differentials in the corresponding national inflation rates, particularly as measured by consumer price indices. Furthermore, this loose link seems to be cumulative. As illustrated in Figures 5-7, divergences from purchasing power parities, measured in terms of the relationship between exchange rates and the ratio of consumer price indices, seem to persist.

The loose link between prices and exchange rates is illustrated in Table 6 which reports the results of regressions of changes in the exchange rates on changes in (wholesale) prices. As may be seen, for the Dollar/Pound and the Dollar/Franc exchange rate, the slope coefficients are very close to unity; for the Dollar/DM exchange rate the slope coefficient is less close to unity. Furthermore, in all cases the parameter estimates are extremely imprecise. The results are even poorer when the wholesale price indices are replaced by the cost of living indices. It should be noted, however, that to some extent this

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Table 6

Relative Purchasing Power Parity; Instrumental Variables
Monthly Data: June 1973 – July 1979
(standard errors in parentheses)

Dependent Variable $\Delta \ln S_t$	Constant	$\Delta \ln(P_w/P_w^*)$	s.e.	D.W.
Dollar/Pound	.003 (.005)	.999 (.653)	.039	1.71
Dollar/Franc	-.001 (.004)	.891 (.682)	.030	2.38
Dollar/DM	-.001 (.008)	1.313 (2.057)	.036	1.92

Note: $\Delta \ln S_t$ and $\Delta \ln(P_w/P_w^*)$ denote, respectively, the percentage change in the spot exchange rate and in the ratios of the wholesale price indices. s.e. is the standard error of the regression. Two stage least-squares estimation method, is used; the instruments are a constant, time, time squared, and lagged values of the dependent and independent variables.

phenomenon is specific to the 1970s. During the floating rates period of the 1920s, the doctrine of purchasing power parities seems to have been much more reliable.[15]

The discussion in the second section emphasized that in periods which are dominated by "news," which alters expectations, exchange rates (and other asset prices) are expected to be highly volatile. Aggregate price indices, on the other hand, are not expected to reveal such a degree of volatility since they reflect the prices of goods and services which are less durable and, therefore, are likely to be less sensitive to the news which alters expectations concerning future course of events. It follows, therefore, that in periods during which there is ample "news" which cause large fluctuations in exchange rates, there will also be large deviations from purchasing power parities.[16] The different degrees of volatility of prices and exchange rates are illustrated in Table 7, which reports the average absolute monthly percentage changes in the various exchange rates and prices. As is evident, the mean absolute change in the various spot exchange rates has been about 2 percent per month (and even slightly higher for the changes in the forward rate). The magnitudes of these changes have been more than double the magnitudes of the changes in most of the various price indices, as well as in the ratios of national price levels. For example,

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[15]For evidence see Frenkel (1976, 1978, 1980b) and Krugman (1978).

[16]On this, see Mussa (1979a). It is noteworthy that the emphasis in the text has been on the words large fluctuations; this should be contrasted with periods during which there are large secular changes in the exchange rate (like the changes which occurred during the German hyperinflation). During such periods the secular changes do not stem necessarily from "news" and need not be associated with deviations from purchasing power parities.

Table 7

Mean Absolute Percentage Changes in Prices and Exchange Rates

Monthly Data: June 1973 - July 1979

ntry	WPI	COL	Stock Market	Exchange Rates Against the Dollar		COL/COL$_{US}$
				spot	forward	
.	.009	.007	.037	—	—	—
.	.014	.012	.066	.021	.021	.007
nce	.011	.009	.054	.020	.021	.003
many	.004	.004	.030	.024	.024	.004

e: All variables represent the absolute values of monthly percentage

changes in the data. WPI denotes the wholesale price index and

COL denotes the cost of living index. Data on prices and exchange

rates are from the IMF tape (May 1979 version). The stock market

indices are from Capital International Perspective, monthly issues.

the mean monthly change in the cost of living price index was .4 percent in Germany, .7 percent in the U.S., .9 percent in France and 1.2 percent in the U.K. These differences are even more striking for the detrended series.

The notion that exchange rates have been volatile is clearly illustrated by Figures 2-4 and by Table 7. The comparison of the magnitudes of the changes in the exchange rates with the magnitudes of the changes in the price indices and in the ratios of national price levels may suggest, according to a narrow interpretation of the purchasing power parity doctrine, that exchange rate fluctuations have been "excessive." The previous discussion, however, has emphasized that exchange rates, being the relative prices of assets, are fundamentally different from the price indices of goods and services and, therefore, are expected to exhibit a different degree of volatility in particular during periods that are dominated by "news." An alternative yardstick for measuring the degree of exchange rate fluctuations would be a comparison with prices of other assets. Indeed, while exchange rate changes have been large relative to changes in national price levels, they have been considerably smaller than changes in the prices of other assets like gold, silver, many other commodities that are traded in organized markets, and common stocks. For example, Table 7 also reports the mean absolute monthly percentage change in stock market indices. As may be seen, the mean monthly change in these indices ranged from over 3 percent in Germany to over 6 percent in the U.K. By these standards it is difficult to argue that exchange rates have been excessively volatile.

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The fundamental difference between the characteristics of exchange rates and national price levels is also reflected in their time series properties. The monthly changes in exchange rates exhibit little or no serial correlation while national price levels do exhibit a degree of serial correlation. The serial correlation of national price levels has been rationalized in recent macroeconomic theorizing in terms of costs of price adjustment, the existence of nominal contracts, confusion between relative and absolute prices and confusion between permanent and transitory changes. This difference between the time series properties of exchange rates and prices is reflected in the low correlation between the practically random month-to-month exchange rate changes and the serially correlated differences between national rates of inflation.

Given the short-run deviations from purchasing power parities, it is relevant to explore whether these deviations tend to diminish with time or tend to persist or even grow in size. In order to examine the patterns of the deviations, I have computed the autocorrelation functions and the partial autocorrelation functions of these deviations for the wholesale and the cost of living price indices. The deviation from purchasing power parities during month t is denoted by Δ and is defined as:

$$(17) \quad \Delta_t = \ell n \, S_t - \ell n(P/P^*)_t.$$

Figures 12-14 illustrate the patterns of the deviations for the three exchange rates. As may be seen, the general pattern is very similar for the three exchange rates and for the two price indices. In all cases the autocorrelation function tails off at what seems to be an

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Figure 12
The Dollar/Pound: Deviations from PPP with Wholesale Price Indices
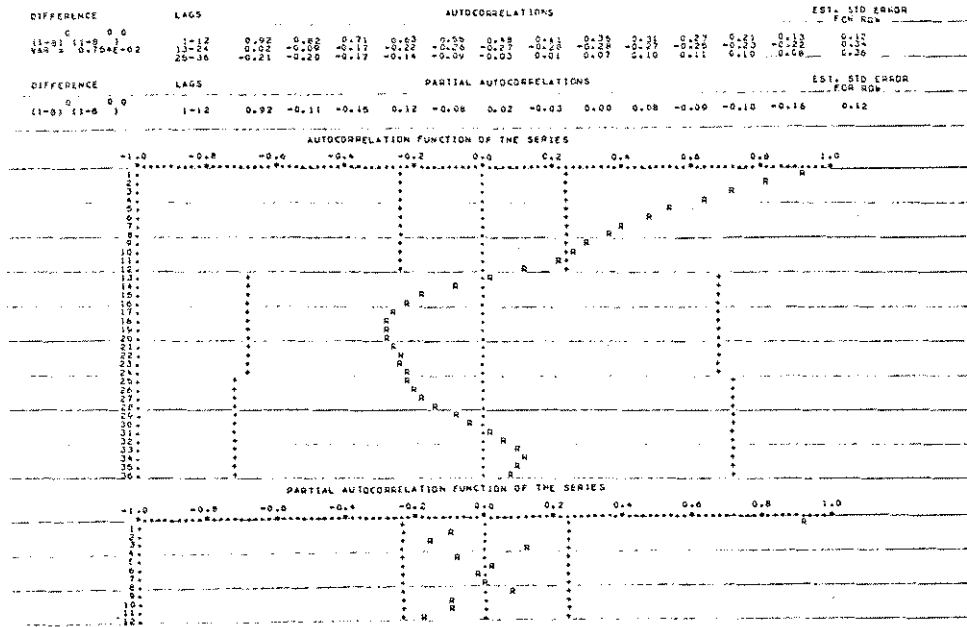
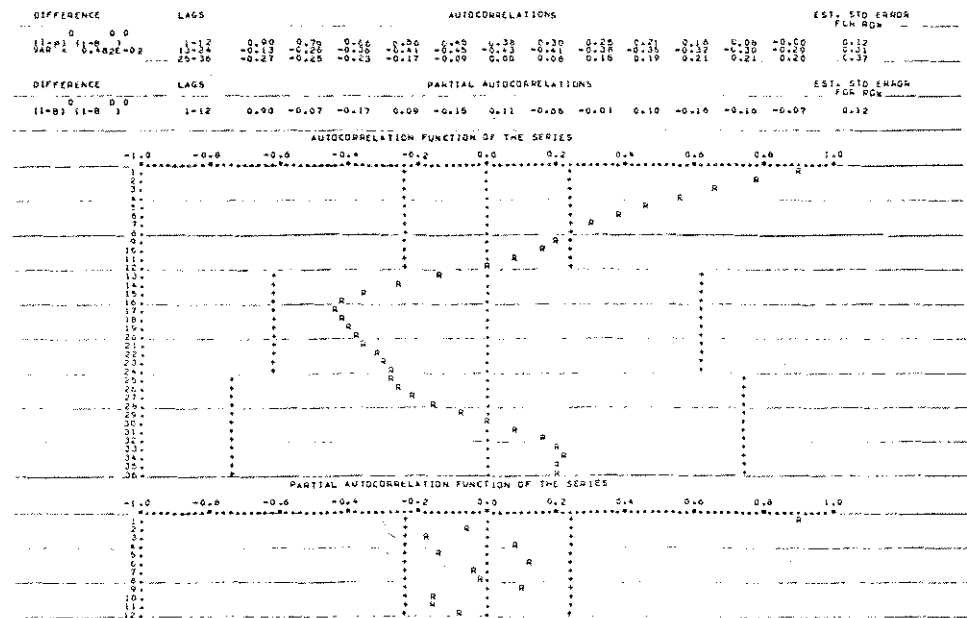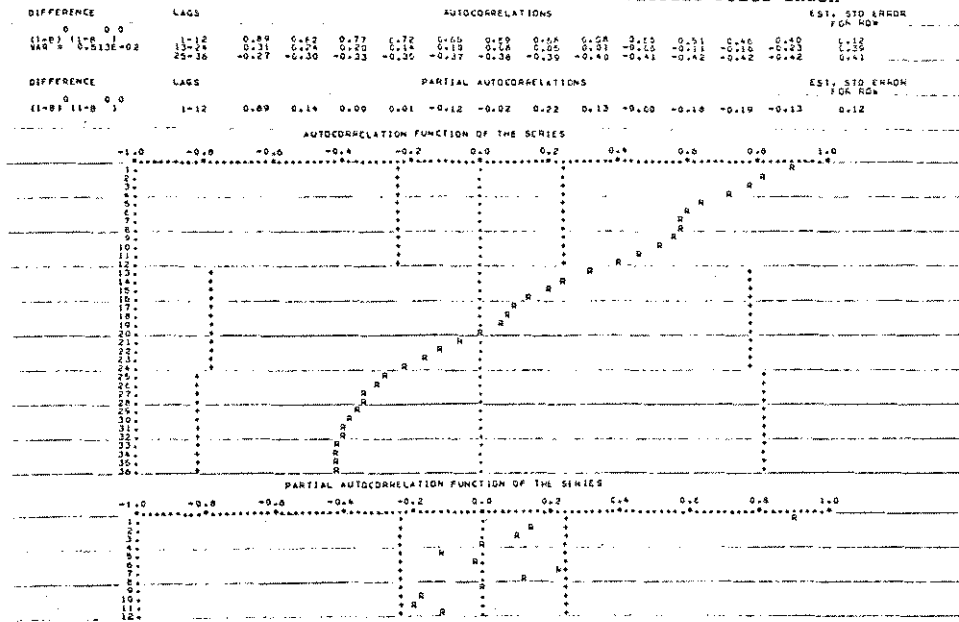The Dollar/Pound: Deviations from PPP with Cost of Living Indices

Figure 13
The Dollar/Franc: Deviations from PPP with Wholesale Price Index

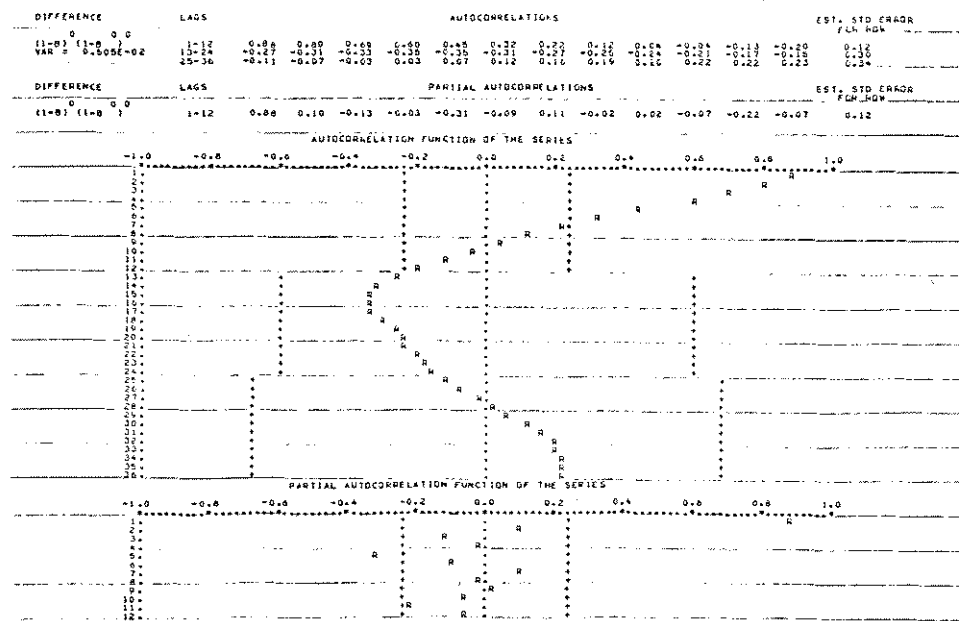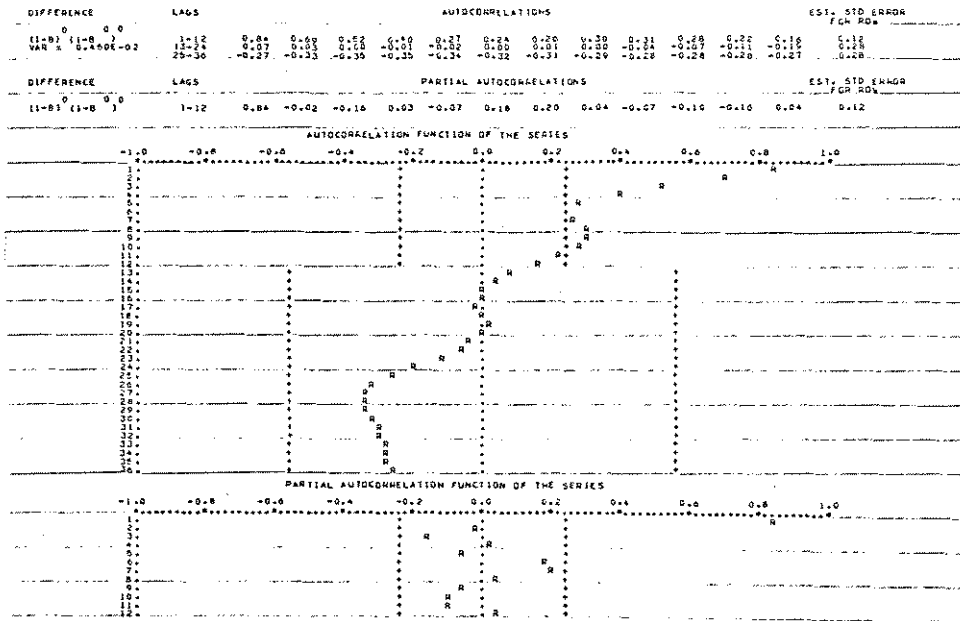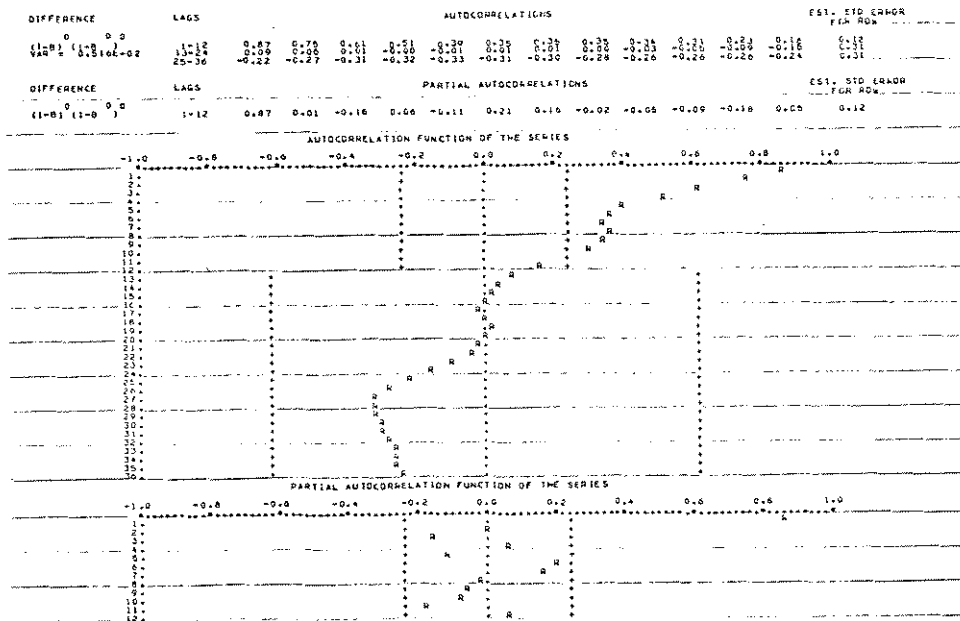The Dollar/Franc: Deviations from PPP with Cost of Living Indices

Figure 14
The Dollar/DM: Deviations from PPP with Wholesale Price Indices

DIFFERENCE	LAGS	AUTOCORRELATIONS											EST. STD ERROR FOR ROW
$(1-B)^0 (1-B^0)^0$ VAR = 0.2460E-02	1-12	0.84	0.69	0.58	0.40	0.37	0.36	0.36	0.39	0.31	0.28	0.22 0.16	0.16
	13-24	0.07	0.05	0.08	-0.01	-0.02	0.00	0.01	0.30	-0.31	-0.07	-0.11 -0.16	0.28
	25-36	-0.27	-0.33	-0.36	-0.35	-0.34	-0.32	-0.31	-0.29	-0.28	-0.24	-0.20 -0.27	0.28

DIFFERENCE	LAGS	PARTIAL AUTOCORRELATIONS											EST. STD ERROR FOR ROW
$(1-B)^0 (1-B^0)^0$	1-12	0.84	-0.02	-0.16	0.03	-0.07	0.16	0.20	0.04	-0.07	-0.10	-0.16 0.04	0.12

AUTOCORRELATION FUNCTION OF THE SERIES

PARTIAL AUTOCORRELATION FUNCTION OF THE SERIES

The Dollar/DM: Deviations from PPP with Cost of Living Indices

DIFFERENCE	LAGS	AUTOCORRELATIONS											EST. STD ERROR FOR ROW
$(1-B)^0 (1-B^0)^0$ VAR = 0.3510E-02	1-12	0.87	0.70	0.61	0.51	0.39	0.35	0.31	0.33	0.33	0.31	0.21 0.18	0.11
	13-24	0.06	0.06	0.01	-0.00	-0.01	-0.00	-0.31	-0.30	-0.24	-0.26	-0.26 -0.24	0.31
	25-36	-0.22	-0.27	-0.31	-0.32	-0.33	-0.31	-0.30	-0.26	-0.26	-0.26	-0.26 -0.24	

DIFFERENCE	LAGS	PARTIAL AUTOCORRELATIONS											EST. STD ERROR FOR ROW
$(1-B)^0 (1-B^0)^0$	1-12	0.87	0.01	-0.16	0.06	-0.11	0.21	0.16	-0.02	-0.06	-0.09	-0.18 0.05	0.12

AUTOCORRELATION FUNCTION OF THE SERIES

PARTIAL AUTOCORRELATION FUNCTION OF THE SERIES

exponential rate and, in all cases, the partial autocorrelation function shows a spike at the first lag. This pattern seems to indicate (as might have been expected on the basis of the time series properties of exchange rates and price indices) that the deviations from purchasing power parities follow a first order autoregressive process. It is noteworthy, however, that in all cases the value of the autoregression term is about 0.9, indicating the possibility that the series may not satisfy the stationarity requirement. To allow for this possibility, I have also examined the autocorrelation functions and the partial autocorrelation functions of $\Delta_t - \Delta_{t-1}$, i.e., of the first difference of the deviations from purchasing power parities. The results indicate that these differences are serially uncorrelated, thus implying that the deviations Δ_t follow a random walk process.[17] In view of this possibility, I conclude that the deviations from purchasing power parities seem to follow a first order autoregressive process but that the data do not provide sufficient evidence to reject the alternative hypothesis of a random walk. Finally, it may be noted that the main difference between accepting the AR(1) rather than the random walk hypothesis relates to the economic interpretation of the two alternative processes. The random walk process implies that deviations from purchasing power parities do not tend to diminish with the passage of time while the stable AR(1) process implies that there are mechanisms which operate to ensure that in the long-run purchasing power parities

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[17]If the deviations follow a random walk process, then they do not entail (ex ante) unexploited profit opportunities. For an analysis of equilibrium deviations from purchasing power parities, see Saidi (1977).

are satisfied. For the purpose of forecasting the near future, how-
ever, there is a very little difference between using the AR(1) process
with an autoregressive coefficient of 0.9 and using the random walk
process.

CONCLUDING REMARKS

In this paper I examined some aspects of the operation of flexi-
ble exchange rates. The analysis was based on the experience of the
1970s. The principle conclusions which may be drawn from the empirical
work are:

(1) In spite of the extraordinary turbulence in the markets for
foreign exchange, it seems that to a large extent the markets
have operated efficiently. It should be noted, however, that in
this context the concept of "efficiency" is somewhat narrow in
that it only refers to the notion that the markets do not seem
to entail unexploited profit opportunities. A broader per-
spective should deal with the social cost of volatility in
terms of the interference with the efficiency of the price
system in guiding resource allocation, as well as with the cost
of alternative outlets for the disturbances that are currently
reflected in the volatility of exchange rates.

(2) The high volatility of exchange rates (spot and forward) re-
flect an intrinsic characteristic of the relative price of
monies and other assets. The price of gold and the price of
stocks as well as exchange rates between national monies depend
critically on expectations concerning future course of events,
and adjust rapidly in response to new information. In this

perspective the exchange rate (in contrast with the relative price of national outputs) is being viewed as a financial variable.

(3) During inflationary periods variations in nominal rates of interest are dominated by changes in inflationary expectations; as a result, high nominal rates of interest are expected to be associated with high exchange rates (a depreciated currency). This relationship was demonstrated within the analytical framework of the monetary approach to the exchange rate, and was supported by the empirical work. In this context the key finding was the dependence of exchange rate changes on the changes in the rates of interest. This finding is in accord with the analytical prediction that current exchange rates already reflect current expectations about the future while changes in the current exchange rates primarily reflect changes in these expectations which, by definition, arise from new information.

(4) The experience of the 1970s does not support the predictions of the simple version of the purchasing power parity doctrine which relates the values of current prices to current exchange rates. The empirical work showed that deviations from purchasing power parities can be characterized by a first order autoregressive process.

One of the key analytical insights that is provided by the monetary (or the asset market) approach to the exchange rate is that exchange rates reflect not only current circumstances but also those circumstances which are expected to

prevail in the future. This anticipatory feature of the exchange rate (which is emphasized by Mussa, 1979b) does not characterize (at least to such a degree) the prices of national outputs. As a result, during periods which are dominated by frequent changes in expectations about the future, one may expect to find frequent deviations from purchasing power parities when the latter are computed using current prices.[18]

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[18]This phenomenon was recognized by Gustav Cassel -- the most recognized proponent of the purchasing power parity doctrine. Since this paper was prepared for presentation on October 20, 1979 -- the date of Cassel's birthday (Cassel was born on October 20, 1866) it seems appropriate to conclude with the quote that reflects this key idea.

> The international valuation of the currency will, then generally show a tendency to anticipate events, so to speak, and become more an expression of the internal value that the currency is expected to possess in a few months, or perhaps in a year's time (Cassel, 1930, pp. 149-50).

DATA APPENDIX

1. Exchange Rates

   The spot exchange rates are end-of-month rates obtained from the
   IMF tape (May 1979 version, updated to July 1979 using the
   November 1979 issue of the International Financial Statistics)
   obtained from the International Monetary Fund. The forward ex-
   change rates are end-of-month rates for one month maturity. The
   forward rates for the U.K. Pound and the DM for the period June
   1973 - June 1978 are bid prices obtained from the International
   Money Market (IMM). For the period July 1978 - July 1979 they
   are sell prices obtained from the Wall Street Journal. The
   forward rates for the French Franc for the period June 1973-
   July 1974 are bid prices calculated from the Weekly Review
   publication of the Harris Bank which reports the spot rate and
   the forward premium; in each case the closest Friday to the end
   of the month was chosen. For the period August 1974 - June 1978
   the rates are bid rates obtained from the IMM and for the period
   July 1978 - July 1979 they are sell prices obtained from the Wall
   Street Journal.

2. Prices

   The wholesale and cost of living price indices are period
   averages obtained from the IMF tape, lines 63 and 64,
   respectively.

3. Rates of Interest

   All interest rates are 1-month Eurocurrency rates obtained from
   the Weekly Review of the Harris Bank. In all cases the figures
   used correspond to the last Friday of each month.

4. Stock Markets

   The stock market indices correspond to the last trading day of
   the month. The sources are Capital International Perspective,
   Geneva, Switzerland, monthly issues.

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