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The Long Swings in Real Exchange Rates

—Do They Fit into Our Theories ?

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In this paper it is argued that, although the rational expectations models of the exchange rates are able to explain some features of the exchange rate behavior, they fail to explain the long run cycles in the real exchange rates. An alternative modelling approach is proposed, using concepts of bounded rationality. It is shown that in such models it may be rational for agents to combine forward looking with backward looking rules (such as technical analysis). It is also argued that a "near-rational" expectations model can better explain the long-run drift in real exchange rates.

I. Introduction: The Nature of the Exchange Rate Variability

It is clear for even the most casual observer that exchange rates have become much more variable since the major currencies started to float, and that something fundamental has happened in the way exchange rates behave since the early 1970s.

Three stylized facts about the movements of exchange rates stand out. First, the observed exchange rate movements have been much larger than the forward premia (discounts). This well-known phenomenon is illustrated in Figures 1 and 2. This has generally been interpreted to mean that most of the observed exchange rate movements have been unanticipated.[1] There is a problem, however, which remains unresolved. The systematically lower forward premia (or discounts) relative to the future exchange rate changes imply that agents have systematically underestimated the size of the future

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1. This phenomenon was noted by Mussa(1979) in a well-known article. There is a very large literature on the issue whether the forward premium is an unbiased estimate of the future exchange rate changes (see Levich(1985) for a survey). A consensus seems to emerge that the forward premium is a biased predictor of future exchange rate changes, mainly because of risk premia. See, for example, Fama(1984).

Figure 1. DM/Dollar Exchange Rate
(yearly change in percent)

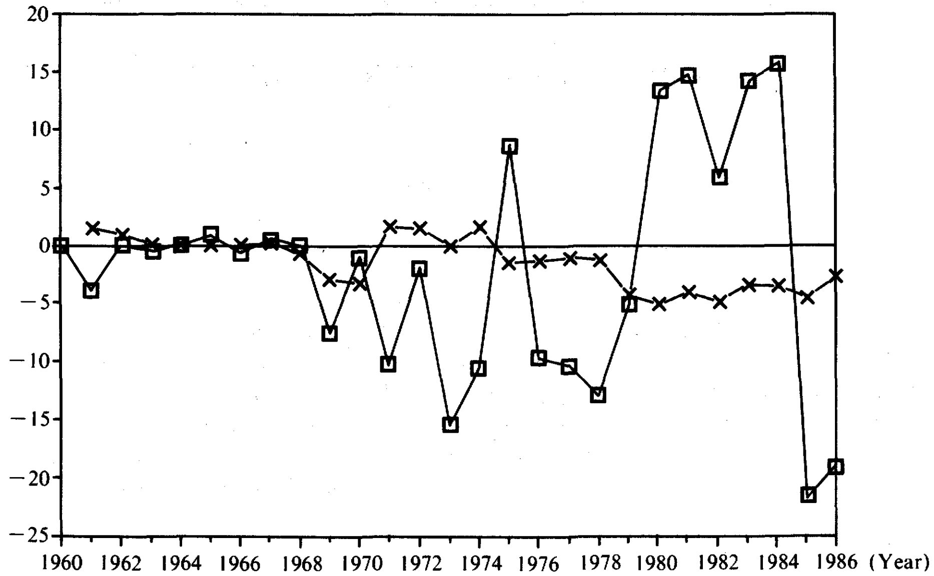
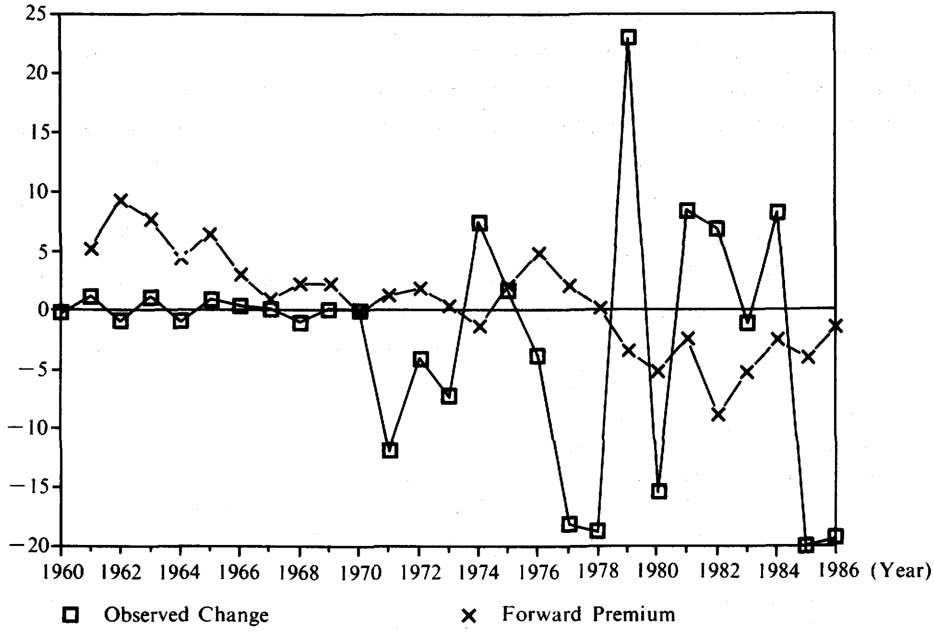


Figure 2. Yen/Dollar Exchange Rate
(yearly change in percent)



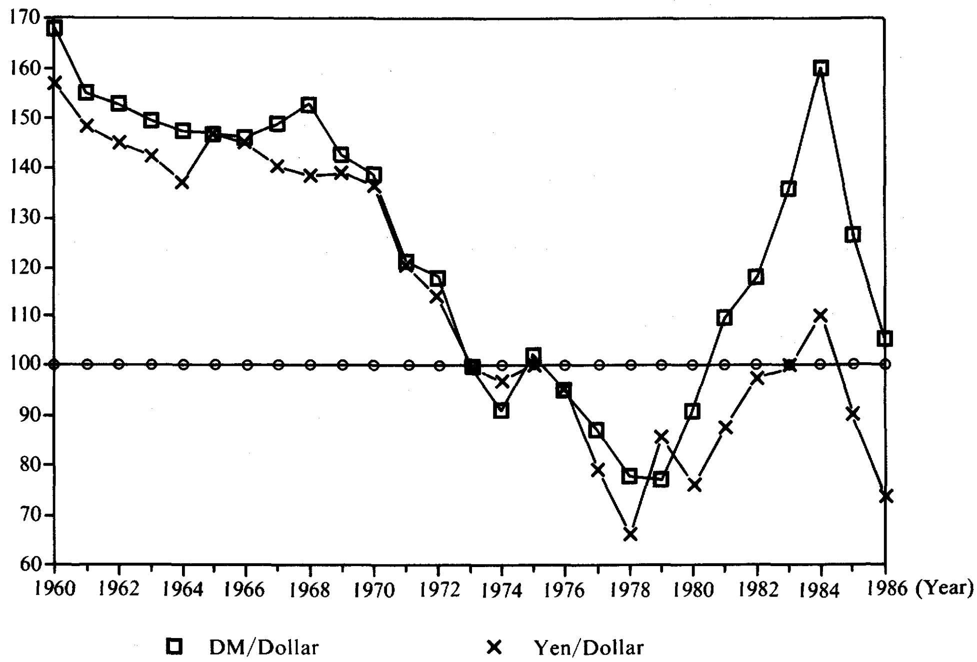
Source : IMF, International Financial Statistics.

exchange rate changes. In this paper we will present a model which helps to explain this phenomenon.

Second, the exchange rates have been substantially more variable than the national price levels. As a result, one observes a strong correlation between the nominal and the real exchange rate changes.

A third important feature of the exchange rate variability since the early 70s is that there have been persistent movements of the exchange rates away from their PPP-values. But differently, the real exchange rates have not shown a clear tendency to return to a constant value. In Figure 3 we illustrate this with the real exchange rates of the DM/dollar, and the Yen/dollar. (The real exchange rate is defined here as the nominal exchange rate times the ratio of the domestic (German or Japanese) and the foreign (US) consumption price index.)[2] Note also that an increase (decline) of the real exchange rate means that the dollar experiences a real appreciation (depreciation) against the DM and the Yen. In these figures we have chosen 1973 as the base year. This means that we

Figure 3. Real Exchange Rates (1973=100)



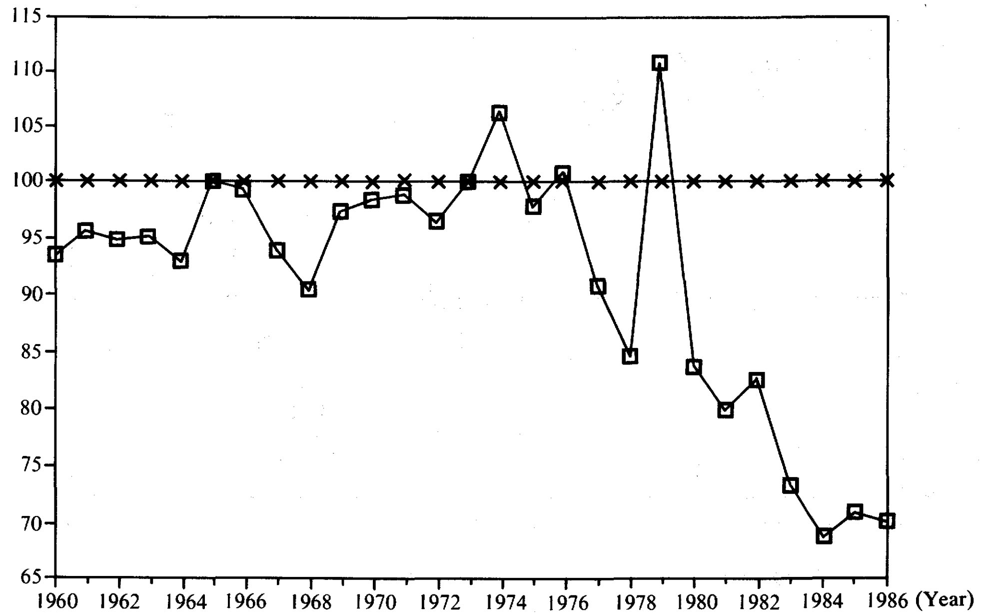
2. It should be mentioned here that this feature of the exchange rate movements does not generalize to other hystorical periods of floating, or to other exchange rates than those of the industrialized countries. Elsewhere it was shown that in periods of high inflation, the positive correlation between nominal and real exchange rates is reduced considerably. See De Grauwe et al (1985).

implicitly believe that in 1973 the exchange rate was close to its equilibrium PPP-value. This choice of the base year is of great importance. It colors our view of whether the exchange rate was in equilibrium or in disequilibrium during the rest of the period. For example, we could have chosen 1959 as the base year. This would lead to a quite different view about the periods of under- or overvaluation of the yen (or the DM) in relation to the dollar during the postwar period.[3]

The choice of the base period, however, is of no relevance for establishing the empirical phenomenon stressed here. This is the fact that the real exchange rates exhibit very long cycles. For example, if we take the early 70s as the starting point we find that the dollar goes through a first cycle declining from 1970 to 1979 to go back to its initial level in the first half of the 80s.

Another feature present in the data is a long-term drift of the real exchange rates. This is especially evident in the case of the Yen/dollar. From 1960 to 1986 the real Yen/dollar rate declines by close 100% (i.e., the Yen appreciates in real terms by 100%). The same phenomenon of long-term drift is present in other exchange rates. In Figure 4 we show the real Yen/DM rate. We can see that from the middle of the 70s the real

Figure 4. Real Exchange Rate of the Yen/DM
(1973=100)



Source : IMF, International Financial Statistics.

3. See McKinnon and Ohno(1987) on this issue.

Yen/DM rate exhibits substantial downward drift. It could be, of course, that this is only the first leg in a cyclical movement. If this is the case, the cycle is an extremely long one and surpasses by far the typical length of a business cycle.

How can we explain these stylized facts concerning the nature of the variability of the exchange rates? Do we have theories which allow for a consistent explanation?

II. Theories of Exchange Rate Determination : The Sticky Price Model

Undoubtedly, the sticky price rational expectations model has become the most popular model used by economists in explaining exchange rate behavior. It has now graduated to the status of the conventional model, presented in detail in all textbooks of international economics.

The sticky price model of exchange rates comes in two versions. One is the Dornbusch model, which is the most widely used, and which has led to a large literature seeking to refine the original model. The other can be called the portfolio balance model, pioneered by Branson and Kouri.[4]

Both models do a reasonable job in explaining the short-run variability of the exchange rate. The latter is explained by the instantaneous reaction of asset prices (the exchange rates) to unanticipated disturbances. In these models economic agents are forward looking, i.e., they forecast the future exchange rate based on a model of the economy and their forecast of the future exogenous variables. This future expected exchange rate then determines the path the exchange rate will have to follow. In general, this implies that the exchange rate will have to jump to the right initial value so as to follow the unique path to the expected equilibrium exchange rate.

The positive correlation between nominal and real exchange rates can be explained in these models by the fact that some variables are "sticky." In the Dornbusch model this is price stickiness, in the Kouri-Branson model it is the stickiness in the accumulation of assets (the current account).[5] As is well-known, these models typically produce "overshooting" behavior of the exchange rate as part of the adjustment path of the exchange rate to its equilibrium value.

Although these models are able to explain some features of the exchange rate movements, there are important other features which cannot easily be explained by these models. First, there is the sluggishness of the forward premia, mentioned earlier. In the Dornbusch and Kouri-Branson model one would expect the forward premia to react

4. The references are Dornbusch(1976), Kouri(1975), Branson(1977). The major difference between these two models is that the former assumes perfect substitutability of assets denominated in different currencies, while the latter assumes imperfect substitutability. For a survey see Frenkel and Mussa(1985). For an implementation in a multicurrency environment see Fukao(1983).

5. This stickiness can be reduced to price stickiness.

quickly to new information. The evidence of Figures 1 and 2 indicates that this is not the case.

Second, it has now become clear that the sticky price rational expectations models fail to explain the protracted long run movements of the real exchange rates. As we observed in the previous section these movements have exhibited cycles of very long duration, which have been longer than a typical business cycle. It is difficult to see how such a long cycle can be made to fit into the overshooting cycle predicted, for example, by the Dornbusch model. It would be quite unreasonable to explain the ten year cycle of the real dollar/Yen or dollar/DM exchange rate during the 70s or the eight year cycle from 1979 to 1986 by price stickiness. Thus, the dynamics inherent in the sticky price models is unsatisfactory in explaining the long run behavior of the real exchange rates.

Although these models can quite often be used to explain ex post some particular movement of the exchange rates, it can be said that they have a poor predictability. With poor predictability is meant here not only that we lack models that enable us to forecast the future, but also (and more importantly) that our models cannot easily be used to predict how a particular disturbance will affect the exchange rates. This lack of predictive power of most structural exchange rate models has been dramatized by the work by Meese and Rogoff, which indicates that the existing empirical exchange rate models fail as a predictive instrument.[6]

The inability of the popular exchange rate models to explain some important features of the variability of the exchange rates raises the question of the usefulness of these models, and their basic paradigm. In the following sections we propose a different modelling approach, which hopefully will be more successful in explaining some basic empirical phenomena. The model will be based on the concept of "near-rationality."

III. The Micro-foundations of Near-rational Behavior[7]

In this section we present a model based on individual utility maximization. This model provides the foundation for the behavior of individuals which will be assumed in the next section.

Assume a risk avert speculator who takes a forward position in a foreign currency. His expected profit is

$$E\ (\hat{e}-e_0)\ W,$$

where $\hat{e}$ is the uncertain future exchange rate; e_0 is the current (forward) exchange rate; W is the forward purchase (sale) of the foreign currency. W can be positive or negative depending on whether the speculator buys or sells forward. It will be assumed that $\hat{e}$ is

6. See Meese and Rogoff(1983).
7. I have benefitted a lot from comments and suggestions made by Hideo Hayakawa in drafting this section.

normally distributed with a mean e^*, and a variance s^2.

Assuming a utility function with a constant absolute risk aversion, we obtain the following expression for the expected utility of the speculator :

$$U=E(\hat{e}-e_0)W-(R/2)\mathrm{var}((\hat{e}-e_o)W), \tag{1}$$

where R is the degree of absolute risk aversion, which is assumed to be constant. The first order conditions for an optimum are given by

$$(e^*-e_0)-Rs^2W=0. \tag{2}$$

This yields the following expression for the optimal forward position of the speculator

$$W=(e^*-e_0)/Rs^2. \tag{3}$$

This is the standard, and well-known expression of the optimal portfolio in a mean variance framework. The optimal speculative position depends positively on the difference between the expected future exchange rate and the current forward rate, and negatively on the variance of the expected return.

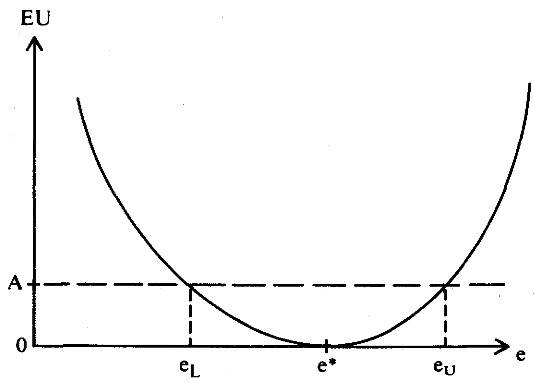
We can now substitute W from (3) into the utility function to obtain the expected utility of the optimal portfolio :

$$EU=(1/2Rs^2)(e^*-e_0)^2. \tag{4}$$

Equation (4) is represented graphically in Figure 5. On the vertical axis we set out the expected utility ; on the horizontal axis the difference between the current and the expected rate (e^*-e_0). When $e^*=e_0$ the expected utility gain from taking a forward position is zero. As the current rate deviates from the expected rate the expected gain from taking a short or long position increases.

A first characteristics of the function EU is its nonlinearity. As a result, around the

Figure 5. Expected Utility



point where the current rate equals the expected rate ($e^*=e_0$) the function is almost flat.One can say that the gains are then of second order.

A second characteristics of the function EU has to do with the variance of the estimated exchange rate. When this variance increases, EU declines and the function becomes flatter around the point $e^*=e_0$. Thus, when the precision of the estimation of the future exchange rate declines (for example, because of increasing uncertainty), the gains from taking a speculative position decline.

Suppose now that the current exchange rate and the expected exchange rate initially coincide. An exogenous disturbance changes the expected future rate. If this change is small and if there is some small cost (a "menu" cost) in changing the optimal portfolio, it will not be worthwhile for economic agents to change their forward position. We represent this case in Figure 5. The cost (a "menu" cost) of changing one's portfolio is represented by OA. If the expected rate remains within the boundaries set by e_Le_U, it will not be worthwhile for economic agents to change their portfolio. Put differently, when the expected exchange rate moves within this range, economic agents do not act on their views about the future developments of the exchange rates. We will call the range e_Le_U, a range of "agnosticism". Not in the sense that economic agents have no view of what the future exchange rate will be, but in the sense that they distrust their view because of the risk involved. In what follows we will say that when economic agents do not act on their beliefs about the future, they are "agnostic" about the future.

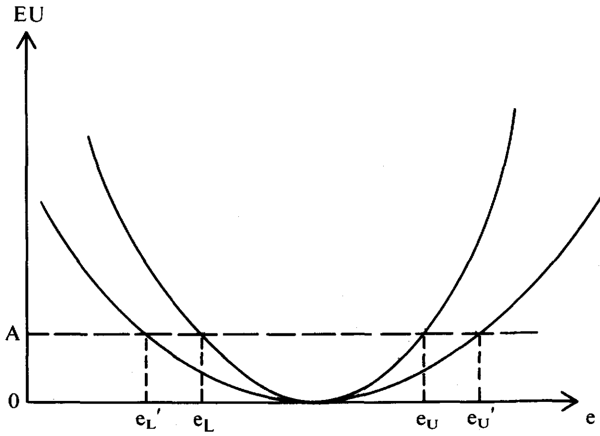
In a sense one can say that when the expected exchange rate moves within this band of agnosticism, the economic agent rationally decides not to use all available information. Such behavior has also been called "near-rational."[8]

An important implication of the previous analysis is the following. When the precision of the estimation of the future exchange rate declines (s^2 increases), the range of "agnosticism" increases. We show this in Figure 6. The increase in s^2 makes the EU curve flatter. With a given "menu" cost, the range between which it will not be worthwhile to change a forward position increases from e_Le_U to $e_L'e_U'$.

Some additional remarks concerning the "menu" costs are appropriate here, because these play an important role in the model. It is generally taken for granted that the transactions costs in the exchange markets (and more generally in financial markets) are small, and therefore trivial. The costs involved here, however, are not only the transaction costs, i.e., the costs of buying and selling assets, but also the costs involved in the decision process that leads to a change in portfolio. Most large investors are institutions,

8. The concept of near-rationality has been used by (among others) Akerlof and Yellen(1987) to argue that economic agents quite often deviate from full rational optimizing behavior, because such behavior does not lead to significant losses. See also Mankiw(1985) for an application in the context of imperfect competition. The existence of small "menu" costs will prevent firms to change their price when shocks in demand occur.

Figure 6. Increasing Uncertainty



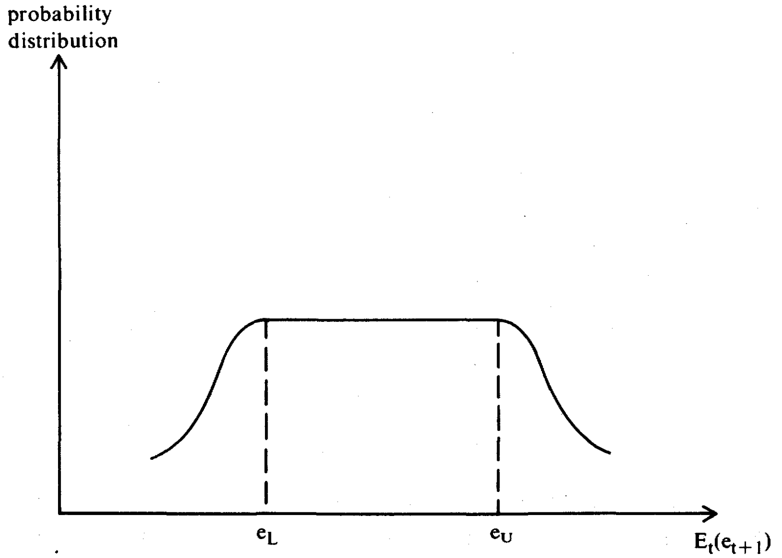
in which a decision to alter the optimal portfolio requires a procedure with checks and balances. Activating this decision process by the financial managers is not costless.

IV. Exchange Rates and Limited Rationality

The analysis of the previous section allows us to assume that there is a range within which economic agents are "agnostic" about the precise value of the future exchange rate. We can represent this assumption by a distribution function as in Figure 7. On the horizontal axis we set out the agents' forecasts of the future exchange rate. On the vertical axis we have the probability economic agents attach to these future rates. The assumption here is that economic agents forecast this rate to be within the range e_L and e_U. They have, however, no reliable method to know which of the many exchange rates between this upper and lower limit are more likely to occur. Therefore, they attach "almost" equal probabilities to the values between e_L and e_U. As a result the probability distribution function is "almost" flat. We use the adjective "almost" to indicate that the differences in the probabilities of occurrence of the exchange rates between e_L and e_U is of a second order of magnitude, so that it can be approximated by an uniform distribution between e_L and e_U. Exchange rates beyond these two extremes are given a probability which declines quickly when the exchange rate moves away from these limits.[9]

9. An example will clarify the assumption introduced here. Suppose economic agents would be asked (anno 1987) whether the fundamental Yen/dollar rate is 120, 150 or 180. They would find it impossible to decide which one is more likely. They cannot expect help from economists (who should know) on this problem, for the latter typically disagree. Economic agents, however, are not completely agnostic. They are much more certain that a value of say 100 Yen for 1 dollar or 300 Yen for 1 dollar are much less likely. These values are so far outside the band of reasonable estimates of the equilibrium exchange rate, that a consensus will emerge that they are less likely to arise than the exchange rates which lie inside this band.

Figure 7.



The foregoing assumptions have important implications for the theory of exchange rate determination. We illustrate this in Figures 8 and 9 where we plotted today's exchange rate and the expected exchange rate for the next period, together with the path linking these two values.

In Figure 8 we represent the perfect foresight model. Economic agents forecast a future exchange rate $E_t(e_{t+1})$ based on a model and their forecast of the future exogenous variable. The interest parity condition then allows to telescope this future rate to the present (e_t). We have

$$e_t=\frac{1+r}{1+r_f}E_t(e_{t+1}),$$

where r is the domestic interest rate and r_f is the foreign interest rate. The spot rate will have to jump to the value e_t to be consistent with the forecast and the implied model.

In Figure 9 we represent the model of "near-rationality." The range of future expected exchange rates is represented by the line segment $E(e_L)E(e_U)$. These are the exchange rates which economic agents expect to be realized with "almost" equal probabilities. The line segment $E(e_L)E(e_U)$ corresponds to the range of expected exchange rates between e_Le_U in Figure 7.

Since e_L and e_U are the extreme values of the expected range of future exchange rates, we can telescope these back to the present, using the same interest parity condition.

In a full rational expectations model, economic agents would have computed the mathematical expectation of the future exchange rate, which lies somewhere between $E(e_U)$ and $E(e_L)$, say in $E(e_1)$. This then would have pinned down the present exchange rate in e_1. This fully rational behavior ensures that expected profits will be maximized.

In the uncertain environment considered here, choosing another exchange rate than e_1 will do almost equally well in terms of the expected utility of speculative gains, as long as the exchange rate which is selected is in the neighborhood of the mathematically expected exchange rate (represented by the range between e_U and e_L). Selecting another such exchange rate can be called *near-rational.*

The literature on near-rationality suggests that when the environment is extremely uncertain, economic agents allow themselves to be guided by the initial values of the

Figure 8. The Perfect Foresight Model

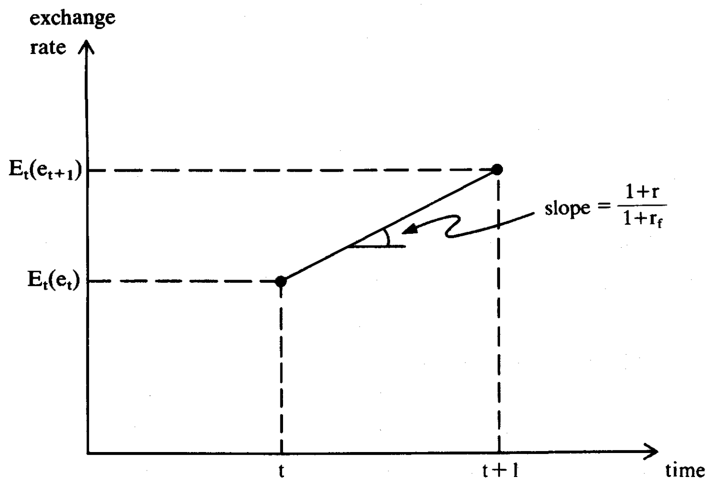


Figure 9. The Near-rational Model

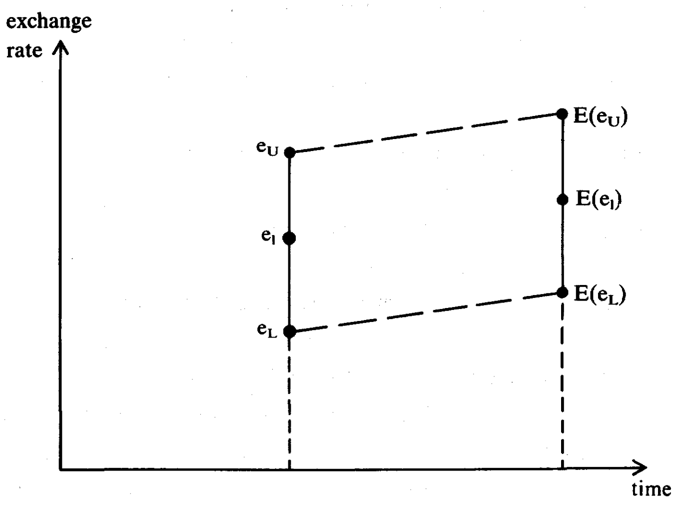
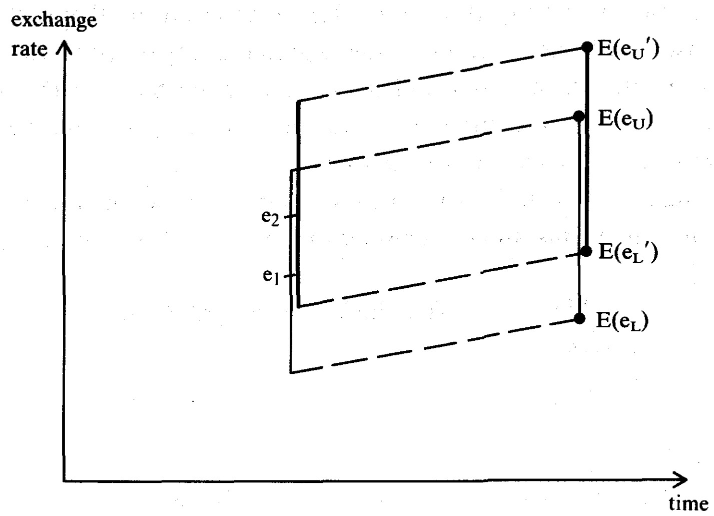


Figure 10.



price when deciding on the best price (exchange rate). The latter function as "anchors" in individuals' judgment of the optimal price (exchange rate) (see Ackerlof and Yellen 1987).

We can apply these insights by returning to Figure 9. Let us assume that the observed exchange rate today is e_1 (which may have been set previously following a full optimization rule). There now occurs a shock which changes the objective distribution of the future exchange rate. We represent this shock by an upward movement of the line segment $E(e_L)E(e_U)$ to $E(e_L')E(e_U')$ (see Figure 10). Full optimization requires agents to change their portfolio, and thereby to change the exchange rate today from e_1 to e_2. However, not changing the exchange rate at all will not lead to a significant expected loss, because the agents still consider the old optimal exchange rate to be as good an approximation of the equilibrium rate as the new optimal exchange rate. Anchoring then implies that agents when confronted to a shock as the one presented in Figure 10 will not adjust today's exchange rate.

More generally, anchoring implies that economic agents use the last available exchange rates as approximations of the optimal rates. They do this as long as the disturbances which change the optimal portfolios are not too large.

V. Technical Analysis as a Near-rational Rule of Behavior

Technical analysis has become a widely used practice in forecasting exchange rates. It implies the use of techniques which aim at extrapolating some systematic tendency observed in the past and present exchange rates. These rules can be relatively simple such as moving averages, or can be based on more complex models (ARIMA or other time series models). Despite the fact that it is much frowned upon by economists, technical analysis can be considered as a set of near-rational rules of behavior. These rules of behavior are "near rational" responses of economic agents to the fact that economic models do not provide reliable information to forecast the future. In the absence of an instrument which will anchor individuals' beliefs about the future, technical analysis takes over, and provides such a function. Put differently, technical analysis will tend to dominate fundamental analysis, when it becomes clear that the latter has lost its value in anchoring individuals' expectations about the future.

VI. How is the Spot Exchange Rate Determined in a Near-rational World ?

The assumptions embodied in the previous sections about how economic agents set their expectations in an uncertain environment allows us to sketch a model of how the spot exchange rate is determined.

We consider the spot exchange rate as the outcome of current events in the foreign exchange market and of the expectations about the future exchange rate. More formally, we have an equation

$$e_t = aZ_t + bE_t\Delta e_{t+1}, \qquad (5)$$

where e_t is the current exchange rate; Z_t is a vector of exogenous variables which affect the demand and the supply of foreign currency today; $E_t\Delta e_{t+1}$ is the expected rate of depreciation. Note that this equation can also be used as the starting point of a perfect foresight rational expectations model. The expected rate of depreciation would then have to be determined in a forward looking manner based on a forecast of the future exogenous variables Z_t.[10]

Here we assume, on the contrary that in order to set their expectations about the future, economic agents use a combination of a backward looking and a forward looking rule. That is, when the exchange rate is within the margin of agnosticism (the range between e_L and e_U in Figure 9) the technical analysis (backward looking rule) will drive the expectations in the market. When, however, the exchange rate is driven outside this range, i.e., when it becomes clear that the exchange rate is deviating sufficiently strongly from the "fundamentals," the forward looking rational expectations behavior will tend to dominate the market's expectation. In the latter case, as economic agents become more certain that the current exchange rate deviates from the rationally expected rate, they will start to use a forward looking rule. We can specify such a rule in very general terms as follows[11]:

10. See Mussa(1976), and Frenkel(1976).

11. For previous formulations of such rules see De Grauwe(1983), and more recently Frankel and Froot(1986a).

$$E_t e_{t+1}=k(\sum_{i=0}^{n} c_i \Delta e_{t-i})+(1-k)(e_t-e^*). \quad (6)$$

The first term on the right hand side of equation (6) is the backward looking rule. It says that the expected depreciation of the exchange rate ($E_t\Delta e_{t+1}$) is some average of past and present rates of depreciation. The exact nature of that rule is determined by the coefficients c_i. These can be positive, negative or zero. If they are positive we have extrapolation of past and present rates of depreciation. If negative economic agents expect a regression, i.e., a depreciation is followed by appreciation and vice versa. Finally, if these coefficients are zero, the exchange rate is expected to follow a random walk. This backward looking term in equation (6) is given a weight k. (We come back to the problem of how this weight is determined.)

The second term in equation (6) is the forward looking component (multiplied by the weight 1–k). It says that economic agents will adjust the expected rate of depreciation when the current exchange rate is perceived to deviate from the equilibrium exchange rate e^*, as determined by an underlying model. More precisely, when the current exchange rate is perceived to be above (below) this equilibrium rate economic agents expect the future exchange rate to go down (to increase).

The weights given to these two expectation rules is determined by the parameter k. This parameter is itself a function of the degree to which the exchange rate deviates from the equilibrium. If the exchange rate is within the "band of agnosticism," k will be close to 1. That is, economic agents give no (or almost no) weight to fundamentals and underlying economic models. The backward looking rule dominates expectations formation. We have called this "near rational" behavior.

When, however, the exchange rate deviates sufficiently from the equilibrium level, the parameter k declines, thereby increasing the weight given to the second and forward looking term in equation (6).

One of the main features of the model is that it can easily produce the kind of real exchange rate movements which we have observed in previous chapters, whereby the exchange rate seems to be wandering away from its fundamentals for long periods of time, before being pushed back towards the equilibrium. All we need for such a result is that the coefficients of the backward looking term (the c_i's in equation (6)) are positive or zero.

This result can be explained as follows. Let us start from an initial exchange rate in period 1 equal to e_1. This falls within the range of agnosticism (within the limits set by e_L and e_U). Thus, expectations will be dominated by a backward looking (technical analysis) rule. Suppose now a shock occurs in the exchange market during period 1, which leads to excess demand for foreign exchange. (This is a shock in the variable Z_t). As a result, the exchange rate moves up during period 1 and reaches the level e_2 at the start of period 2. Let us make the simplest possible assumption about the nature of the backward looking rule, and assume that all c_i's in equation (6) are zero. In other words we assume that the market's expectations are that the exchange rate follows a random walk. Equation (6) then becomes

$$E_t\Delta e_{t+1}=0, \tag{7}$$

or

$$E_te_{t+1}=e_t. \tag{8}$$

Remember that because the economic agents are in the dark about what the true equilibrium value is, they set the weight k equal to one. In other words as their uncertainty about the true equilibrium value is complete, they only rely on the things they can observe, i.e., the past and present exchange rate (in the assumption of a random walk only the present exchange rate).

It follows immediately from the preceding analysis that the initial shock leads to persistence, i.e., there is nothing to bring the exchange rate back to its initial level. There is also nothing that will prevent the exchange rate to wander away "aimlessly" as long as it remains within the band of agnosticism. The exchange rate will be driven by current shocks which then leads to an inertial movement of the exchange rate.

Some richer dynamics is obtained if the backward looking rule has an extrapolative component (the coefficients c_i are positive). In that case an initial shock which leads to a depreciation of the currency, will lead to further depreciations in the future. The exchange rate will then be moving away from the equilibrium rate, and will then surely tend to leave the range of agnosticism. At that point, the forward looking component in the expectations formation will become important again, driving down the exchange rate into that range. From then on the technical analysis leads to new "wanderings" of the exchange rate.

The question will arise here whether it is reasonable to assume such extrapolative behavior. There are some good reasons to do so. In an uncertain world, economic agents face the difficulty of interpreting whether a current change in the exchange rate is a move away from equilibrium, or a move towards equilibrium. Put differently, economic agents have great difficulty to extract the right signal from the observed movements. Observed movements of the exchange rates in one direction may become a signal of a fundamental change, and lead to extrapolative expectations. There is also empirical evidence indicating that extrapolation is an important phenomenon.[12]

We are now in a position to analyze some important implications of the "near rational" expectations view proposed here. This will also allow us to interpret some of the empirical puzzles concerning the movements of the real exchange rates which we have noted in previous sections.

12. See Frankel and Froot(1987).

VII. Empirical Tests

The model of near-rationality of expectations in the exchange market can be tested in several ways. A direct test consists in estimating equation (6) in order to find out whether expectations do follow a backward-looking rule. The problem with this approach is that the dependent variable is unobservable. One can, of course, use survey based data of expectations. The series which are available today, however, have relatively few observations so that the use of econometric techniques is severely limited.[13]

The theory can also be tested indirectly by confronting the predictions of the model concerning the nature of variability of the exchange rates with the data. We can summarize these predictions as follows. First, the model predicts that the exchange rate movements will typically be characterized by *inertia*. Second, according to the model, the real exchange rates tend to exhibit *persistence*, i.e., they do not easily return to their equilibrium value (as dictated by purchasing power parities) when shocked in one or the other direction.

1. Inertia in Exchange Rate Movements

One rather striking implication of the model of near rationality presented in the previous section is that the exchange rate exhibits inertia. This was shown in Figure 10. Shocks in exogenous variables which drive the economic models do not lead to instantaneous jumps of the exchange rate. The intuition behind this result is that the uncertainty about the correctness of the underlying model is such that economic agents do not attach information content to such an exogenous disturbances. In the uncertain environment they face, it will be near-rational for economic agents to attach information content to the past and present movements of the exchange rate.

This view is in stark contrast with the full rational expectations model, which predicts that if a disturbance like an increase in the money stock leads economic agents to recalculate the future expected exchange rate, the spot exchange rate will immediately reflect this by jumping to a new value. This will be achieved irrespective of the past history of the exchange rate. This history is irrelevant for today's exchange rate.

How can we device tests to discriminate between the two hypotheses? In the past, the rational expectations view has often been given empirical support by contrasting the large variability of the exchange rates during the floating exchange rate period with the much lower variability during the fixed exchange rate regime. In fact this is also what we did in section II when we concluded that the rational expectations model could explain the large increase in exchange rate variability observed since the early 1970s.

This comparison of fixed and flexible exchange rates, however, is not the appropri-

13. The Amex Bank Review publishes surveys once or twice a year since 1976. The Economist Financial Report has published surveys since June 1981 six times a year.

ate procedure. After all, the model of near-rationality presented here also predicts that in a flexible exchange rate environment the exchange rate will be more variable than in a fixed exchange rate system.

A valid test consists in comparing the exchange market to other asset markets (or markets of non-perishable goods, such as commodity markets) where the forward looking rational expectations model is generally accepted as a correct representation of their functioning. Let us, therefore, first compare the exchange markets with the stock markets, and then with some leading commodity markets.

In Table 1 measures of the monthly variability of some major exchange rates and of stock prices (as measured by a market index) are presented. It can be seen that since the early 70s the monthly variability of the stock prices in three major countries has typically been twice as large as the variability of the exchange rates.

The evidence of Table 1 in fact underestimates the difference in variability of the exchange rates and the stock prices. The reason is that the stock prices in Table 1 are averages of many individual prices of shares, and therefore tend to eliminate some of the variability of the individual stock prices. The exchange rates, however, are the individual prices of, say, the dollar in terms of the FF. A more appropriate procedure would involve a comparison of individual share prices with individual exchange rates, or market indices of the stock prices with some average of the exchange rates of a particular currency, for example its *effective* exchange rate.

Table 1. Monthly Variability of Exchange Rates and of Stock Prices (1973–82)

	Mean absolute change (in percent)	Standard deviation of monthly changes (in percent)
Exchange rates		
FF/dollar	2.1	1.9
DM/dollar	2.2	1.9
pound/dollar	1.9	1.4
Stock prices		
France	4.9	4.8
Germany	2.6	2.4
United Kingdom	4.6	4.8

Source : exchange rates : IMF, *International Financial Statistics*
stock prices : OECD, *Main Economic Indicators*

Thus it appears from the evidence of Table 1 that the stock markets have exhibited considerably more price volatility than the exchange markets since the early 70s.[14] What could be the reason for this striking difference?

An interpretation which is consistent with the model presented in the previous section is as follows. It is easier to find some consensus about the underlying fundamental model which drives the stock prices than about the model which determines the exchange rates. Although a lot of uncertainty exists about the fundamentals which drive the stock prices, many economists will agree that the stock prices are determined by expected future profits of the firm. It will be difficult, if not impossible to find such agreement concerning the relevant model for the exchange rate. As a result, the working of the stock market can be approximated more closely (although imperfectly) by the forward looking behavior of the rational expectations model. Thus, new information about important variables influencing the profitability of the firm lead to quick adjustment in the stock prices. It also follows that the stock prices will be more volatile than the exchange rates. In the latter case the greater uncertainty about the relevance of new information dampens the effect of this information on the exchange rate.

Thus, the forward looking rational expectations model comes closer to the true description of the stock market than of the exchange market. An implication of this is that the occurrence of speculative bubbles, and crashes is more likely to occur in the stock market than in the exchange market. For we know that such bubble behavior is a distinct possibility in forward looking rational expectations models.

A comparison of the exchange markets with some leading commodity markets leads to similar conclusions. In Table 2 we present some evidence on the short-term variability in these commodity prices and compare it with the short-term variability of the exchange rates. The evidence is borrowed from a recent paper by Bui and Pippenger (1987).

The evidence of Table 2 reinforces our previous conclusion. The short-term (weekly) variability of the leading exchange rates is considerably lower than the variability of the commodity prices. In fact we find that the standard deviation of the weekly price changes is two to four times higher in the commodity markets than in the exchange markets. It should also be noted that this difference holds not only for the commodity markets selected in Table 2. It holds generally for a large spectrum of commodity markets.

This difference in the short-term variability of commodity prices and of exchange rates is consistent with the hypothesis of near rationality formulated in this chapter. The underlying fundamentals driving the exchange rates are highly uncertain, and much more uncertain than the fundamentals driving the commodity markets. As a result, the latter behave more like the forward looking rational expectations model than the exchange markets.

14. This empirical phenomenon has also been noted by other authors. For example Levich(1981), and Bui and Pippinger(1987).

Table 2. Short-term Variability of Exchange Rates and Commodity Prices (standard deviations of weekly changes in percent)

Exchange Rates (1977–86)	
DM/dollar	1.4
Yen/dollar	1.3
Commodity prices	
Rubber, London (1974–79)	3.7
Silver, New York (1972–80)	6.0
Tin, New York (1972–80)	2.7
Wheat, U.S. (1977–82)	3.9

Source : commodity prices : Bui and Pippenger (1987)
exchange rates : Own calculations from Chase Econometrics.

Table 3. Long-run Variability of Exchange Rates and Commodity Prices (standard deviations of yearly changes in percent)

Exchange Rates (1977–86)	
DM/dollar	14.8
Yen/dollar	14.4
Commodity prices (1977–86)	
Rubber, London	14.1
Silver, New York	21.7
Tin, New York	16.0
Wheat, U.S.	12.0

Source : International Monetary Fund, *International Financial Statistics*, various issues

It is also of interest to compare the variability of exchange rates and commodity prices over longer periods than weeks. In Table 3 we compare the variability of *yearly* changes of exchange rates and commodity prices. We observe that there is practically no difference in the long-run (yearly) variability of exchange rates and commodity prices. Thus, although the weekly changes of exchange rates are relatively small compared to commodity prices, these changes cumulate to relatively large yearly movements. This phenomenon can be interpreted as providing additional evidence for the model of "near-rationality." The backward looking behavior, which is stimulated by the distrust in economic models, leads to short-term sluggishness. These backward looking rules, however, still allow for considerable movements of the exchange rates over the longer run.

From the evidence of this section we can conclude that the exchange rates do not seem to behave as the forward looking rational expectations model predicts them to behave. We have come to this conclusion by comparing the volatility of the exchange rates with the volatility of stock prices and commodity prices. The latter exhibit significantly more short-term volatility and appear to conform much better to the forward looking rational expectations predictions than the exchange rates. Thus, contrary to what is often said the main characteristics of the movements of the exchange rates is not the free jumping around, but rather the considerable inertia in these movements. This, however, does not prevent real exchange rates to exhibit substantial long term variability.

2. Forward Premia and Risk Premia

Another important implication of the "near-rational" theory concerns the relation between the expected exchange rate changes and the risk premia. The "near-rational" theory predicts that changes in the expected future exchange rate will be negatively correlated with the risk premia (as these are commonly measured). This follows immediately from the model developed in section IV. When disturbances occur which change the expectations about the future, these expectational changes do not affect the portfolios and the exchange rate if the latter moves within the "band of agnosticism." Since the forward premium is defined as the sum of the expected change of the exchange rate and the risk premium, the latter will have to move in the opposite direction of the expected change.

There is now considerable empirical evidence that this is the case. In a well-known paper Fama(1984) came to the conclusion that risk premia (as commonly measured) and the rationally expected future exchange rate changes were negatively correlated for the major currencies. Frankel and Froot(1986) came to the same conclusion using survey data of exchange rate expectations.

3. Exchange Rates and Persistence

A last major implication of "near-rationality" in modelling the exchange rates is that this model predicts persistence in the movements of the real exchange rates. With persistence is meant here that the real exchange rates move in a particular direction for many years without a clear tendency for it to return to an equilibrium value. Only when the movements of the real exchange rates become large enough will there be fundamental forces driving them back to where they came from. However, the model does not exclude the possibility that in this return movement the real exchange rate "gets stuck" for a long period at a level which appears to be out of line with the economic fundamentals. This feature of the model comes from the fact that when the real exchange rate is pushed back by the "fundamentals" it reaches the "range of agnosticism" where backward looking rules become important again. It cannot be excluded that the real exchange rate from then on stops moving in the direction of the equilibrium (PPP for example). This feature of the exchange rate being stuck for quite some time far away from what the fundamentals would indicate, seem to have been the case of the dollar/yen during 1982–85, as is illustrated in Figure 11.

On the whole it appears that this model which takes into account near-rational rules of behavior, seems better able than the perfect foresight model to explain the persistence and the long swings observed in the real exchange rates, and which we have documented in previous sections.

Figure 11. Yen/Dollar Exchange Rate, 1978–86 (weekly data)

Source : Chase Econometrics

The persistence of the real exchange rate movements is confirmed by more formal tests which have been performed recently indicating that the real exchange rate behaves very much like a random walk.[15] This means that there is no clear tendency for the real exchange rate to return to a constant value.

VIII. Conclusion

One of the major surprises concerning the nature of the exchange rate variability is the occurrence of long swings in the real exchange rates. These swings have been of unequal length, and have been much longer than a typical business cycle.

The theories of exchange rate determination which have been developed during the 1970s have been based on the idea that exchange rates are determined by forward looking behavior of agents who forecast the implications of current and expected future events. This has led to models in which exchange rates react quickly to new information, and in which overshooting is a common feature. In this paper we argued that these models are unable to explain some important features of the volatility of the exchange rates.

An alternative way of modelling exchange rates was, therefore, proposed, based on recent theories of near-rationality. Instead of stressing the forward looking behavior, we emphasized that in an uncertain environment, economic agents may prefer to use backward looking rules for most of the time. Put differently, when the future is extremely uncertain, and when economic models cannot be relied on as instruments to improve predictions, economic agents will revert to backward looking rules. This behavior will make exchange rates sluggish compared to what the perfect foresight model predicts them to be. At the same time, however, it introduces conditions for long and protracted movements of the exchange rates away from their equilibrium values.

The empirical evidence presented in this paper in favor of the "near-rational" view of the exchange rate determination should be called suggestive. Evidence based on formal statistical testing has not been undertaken here. It is hoped that more formal testing of the hypothesis will be forthcoming.

15. See Frankel and Meese(1987). See also Hakkio(1986), and Frenkel(1981).

REFERENCES

Akerlof, George and Yellen, Janet, "Rational Models of Irrational Behavior", *American Economic Review*, May 1987.

Branson, William, "Asset Markets and Relative Prices in Exchange Rate Determination", *Sozialwissenschaftliche Annalen*, 1977.

Bui, Nhuong, and Pippinger, John, "Excessive Exchange Rate Volatility", paper presented at the Meetings of the European Economic Association, Copenhagen, August 1987.

Cassell, Gustave, *Money and Foreign Exchange after 1914*, London: Constable, 1922.

De Grauwe, Paul, "Exchange Rate Oscillations and Catastrophe Theory", in Claassen and Salin, eds., *Recent Issues in the Theory of Flexible Exchange Rates*, North Holland, 1983.

———, Janssens, Marc and Leliaert, Hilde, "Real Exchange Rate Variability from 1920 to 1926 and 1973 to 1982", in *Princeton Studies in International Finance*, No. 56, 1985.

Dornbusch, Rudiger, "Expectations and Exchange Rate Dynamics", *Journal of Political Economy*, 1976.

———, "Exchange Rate Economics: Where Do We Stand ?", *Brookings Papers on Economic Activity*, 1980.

———, "Equilibrium and Disequilibrium Exchange Rates", *Zeitschrift für Wirtschaft- und Sozialwissenschaften*, 1982.

Fama, Eugene, "Forward and Spot Exchange Rates", *Journal of Monetary Economics*, November 1984.

Frankel, Jeffrey and Froot, Kenneth, "The Dollar as a Speculative Bubble : A Tale of Fundamentalists and Chartists", NBER Working Paper, No. 1854, May 1986.

——— and ———, "Interpreting Tests of Forward Discount Bias Using Survey Data on Exchange Rate Expectations", NBER Working Paper, No. 1963, 1986.

——— and ———, "Short-term and Long-term Expectations of the Yen/Dollar Exchange Rate : Evidençe from Survey Data", NBER Working Paper, No. 2216, April 1987.

Frenkel, Jacob, "A Monetary Approach to the Exchange Rate : Doctrinal Aspects and Empirical Evidence", *Scandinavian Journal of Economics*, 1976.

———, "The Collapse of PPP During the Seventies", *European Economic Review*, 1981.

——— and Mussa, Michael, "Asset Markets, Exchange Rates and the Balance of Payments", in R. Jones and P. Kenen, eds., *Handbook of International Economics*, Vol. 2, Chapter 14, North-Holland, 1985.

Fukao, Mitsuhiro, "The Theory of Exchange Rate Determination in a Multi-Currency World", *BOJ Monetary and Economic Studies*, Vol. 1, No. 2, October 1983.

———, "A Risk Premium Model of the Yen-Dollar and DM-Dollar Exchange Rates", *OECD Economic Studies*, No. 9, Autumn 1987.

Hakkio, Craig, "Does the Exchange Rate Follow a Random Walk", *Journal of International Economics*, June 1986.

Kouri, Pennti, "The Exchange Rate and the Balance of Payments in the Short Run and in the Long Run", *Scandinavian Journal of Economics*, 1976.

Levich, Richard, "Overshooting in the Foreign Exchange Market", Occasional Paper No. 5, Group of Thirty, New York, 1981

———, "Empirical Studies of Exchange Rates : Price Behavior, Rate Determination and Market Efficiency", in R. Jones and P. Kenen, eds., *Handbook of International Economics*, Vol. 2, Chapter 19, North-Holland, 1985.

Loopesko, L., paper presented at the NBER Conference on Exchange Rate Misalignments, May 7–8, 1987, Cambridge, Massachusetts.

Mankiw, Gregory, "Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly", *Quarterly Journal of Economics*, May 1985.

McKinnon, Ronald and Ohno, Kenichi, "Purchasing Power Parity as a Monetary Standard", mimeo, Stanford University, September 1987.

Meese, Richard and Rogoff, Kenneth, "Empirical Exchange Rate Models of the Seventies : Do They Fit Out of Sample", *Journal of International Economics*, 1983.

Mussa, Michael, "The Exchange Rate, the Balance of Payments and Monetary and Fiscal Policies under a Regime of Controlled Floating", *Scandinavian Journal of Economics*, 1976.

———, "Empirical Regularities in the Behavior of Exchange Rates and the Theories of the Foreign Exchange Market", in Carnegie-Rochester Conference Series on Public Policy, *Journal of Monetary Economics*, 1979.

Niehans, Jürg, *International Monetary Economics*, Johns Hopkins University Press, 1985.
Takagi, Shinji,"On the Statistical Properties of Floating Exchange Rates : A Reassessment of Recent Experience and Literature", *BOJ Monetary and Economic Studies*, Vol. 6, No. 1, June 1988.