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1 June 1987

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Dear Michael

MERM

Harry Walsh passed on your letter of 7 April enclosing the draft article on the effect of updating the trade data in MERM. The following reflects the views both of the Treasury and the Bank.

We are in principle in favour of a full updating of the MERM weights; there is obviously merit in their reflecting the current state of the world. But the present updating seems to be very partial indeed; the trade matrices have been updated but not the input/output coefficients, the trade elasticities or the feedback parameters. Some of the changes in the MERM weights implied by the partial updating seem highly implausible prima facie. In particular, it is difficult to understand the apparent rise in the United States dollar weight in sterling - from about a quarter to nearly a third.

So while we would want to continue to press for a full updating, we cannot see that it would be sensible to change the published weights on the basis of the interim study. To do so may indeed be confusing and positively unhelpful. We also have no wish to be under pressure to make an early change in the composition and base date for our own trade weighted exchange rate index, having devoted much effort to persuading the market and commentators to focus on the index rather than individual bilateral exchange rates.

I note from Richard Fox's letter to Mark Courtney of 24 September 1986 that Malcolm Knight was not in fact likely to propose a change on the basis of this study. We ought therefore to be able to reach agreement fairly easily. But if the Masson study itself is to be published, it ought to be quite explicit about just how partial it is.

I am copying this letter to Stephen Matthews here and to Dick Ware at the Bank.

Best wishes

Joe

J W Grice

4555/003

Filing

FROM: J W GRICE
DATE: 2 JUNE 1987

MR PERETZ o/r

D3

cc: Mr C W Kelly
Mr Bottrill
Ms Goodman
Mr Carr
Mr Pike

CHARLES GOODHART'S INAUGURAL LECTURE : THE FOREIGN EXCHANGE MARKET

You may like to have a copy of Charles Goodhart's Inaugural Lecture at the LSE, which I attended a few days ago. It is written in Charles' usual clear style and provides a good survey of the state of our knowledge of the foreign exchange rate. Not surprisingly, the main conclusion is that none of the theoretical models of exchange rates explains their behaviour in practice at all well.

JWG

J W GRICE

The Foreign Exchange Market: A Random Walk with a Dragging Anchor

Abstract

There are a number of puzzling anomalies that can be observed in the current working of the foreign exchange market. For example, the currently dominant 'overshooting' model, eg as developed by Dornbusch, suggests that spot rates should 'jump' beyond their longer term equilibrium levels on the receipt of 'news'. Yet various empirical tests, ranging from casual empiricism to more formal econometric, suggest that, rather than exhibiting such immediate jumps with subsequent reversion towards equilibrium, the forex market shows some slight signs of persistence, positive auto-correlations of changes, in spot rates in high frequency daily and weekly data.

Per contra, current theory implies that, over the medium and longer term, real exchange rates should be anchored by fundamental equilibrium conditions, notably purchasing power parity, PPP. Yet over the period 1973-1985 at least, any such equilibrating tendencies were extraordinarily hard to detect in the data; indeed during this period the real exchange itself did not appear to revert towards an equilibrium; instead its path closely approximated to a random walk.

Despite some faint signs of persistence in high frequency, daily and weekly data, the nominal exchange rate has generally been also found to approximate closely to a random walk. Accordingly the best estimate of the future spot rate should be that it would be about the same as the present spot rate. In practice, however, forward rates deviate from present spot rates by the extent of the nominal interest differential, with covered interest parity holding at all times. Indeed it is demonstrated that forward exchange rates provide absolutely no information on the likely future path of spot exchange rates.

It is of particular interest that similar kinds of behavioural results are being found in other asset markets. Thus economists such as Shiller and Summers and Mankiw have found that, recently at any rate, movements in longer term rates have tended to under-react to contemporaneous changes in short rates, that there is virtually no information about future movements of short-term interest rates contained in the shape of the term structure, and that medium and longer term fluctuations in asset prices, eg in the Stock Market, may well be subject to long-lasting fads and fashions.

It is not easy to provide an explanation for these results either in the forex market, or in asset markets more generally. In some large part the hypotheses contained in current models of the foreign exchange market require the participation of speculators prepared to wager large sums of money on their expectations of longer term equilibrium. It is dubious whether this is realistic. Speculation in the forward exchange market in particular is of negligible importance; there is much more speculation in the form of the adoption of open spot positions, (which will have the same effect in practice as speculation, however, in the forward market), but even that is limited by risk aversion and uncertainty.

Moreover, the basic information that speculators use can reasonably vary. As already noted, it is perfectly rational for some to assume (the continuation of) random walks; others may use fundamental analysis and predict some reversion to a longer term equilibrium; others again may use even technical analysis (Chartism). With speculators having both limited funds, and differing view points, it is possible to explain how the forward rate can diverge from the current spot rate and how misalignments can occur and persist.

While such explanations are tentative, the main theme of the paper is that economists cannot just rely on assumptions and hypotheses about how speculators and other market agents may operate in theory, but should examine how they work in practice, by first hand-study of such markets.

B. Does the Overshooting Model Fit the Facts?

But I am running ahead of myself. I should really begin by outlining for you again the main elements of the current dominant 'overshooting' model. Then I shall try to present evidence to support my contention that this model exaggerates both the extent of short-term overshooting and of longer-term reversion to a (real) equilibrium. Next I shall present evidence that the forward rate is not an unbiassed efficient predictor of the future spot rate. I shall attempt to draw analogies between the working of the foreign exchange market and of other financial markets. Finally if time permits, I shall try tentatively to suggest a relatively new line of attack that might help to explain some part of these anomalies.

Anyhow, let me start by trying to recapitulate for you the current state of thinking, and model building, about the determination of exchange rates, broadly based on the 'overshooting' model, e.g. as developed by Rudi Dornbusch, in which relatively sticky goods prices are complemented by rapid adjustments in financial markets. We start with the assumption that, when in due course prices do fully adjust to clear markets, the spot exchange rate must become such as to bring the prices of tradeable goods in the two countries invloved towards equality, i.e. that Purchasing Power Parity will in the end hold, in its relative if not in its absolute form. This terminal, or transversality, condition then fixes the forward rate one period prior to the terminal condition, since the forward rate must then equal the next period's, that is the terminal period's, assumed known spot rate. Meanwhile, the current spot rate is determined in this same period, one before the horizon, by the relative interest rates then expected to rule, in order to satisfy covered interest parity. By similar repeated steps, one works back to the determination of the present spot and forward rates. So, present movements in spot and forward exchange rates are seen as dependent on a long-term forward-looking convolution of expectations about relative goods prices at a quite far distant horizon, and on relative interest rates in the intervening period. Meanwhile, the existence of

relatively sticky goods prices ensures that real interest rates will shift in response to nominal monetary shocks, and this in turn leads to the famous 'overshooting hypothesis', that is that spot rates will have to jump by more than consistent with long-term equilibrium in response to 'news', for example of such monetary shocks, because, while the n-period forward rate is supposed to adjust into line with the expected n-period ahead future spot rate, the current spot rate must adjust by more in order to maintain covered interest parity, as the interest differential becomes more favourable in the country tightening monetary policy.

There is much that is intuitively attractive about this general line of argument. It is firmly based on a realistic appreciation of relative speeds of adjustment in the goods markets on the one hand and in financial markets on the other. It does provide, at a pinch, a plausible account of the quantitative extent of misalignment, for example of sterling in 1980/81 and of the $ in more recent years, in some large part as a consequence of the conduct of monetary policies in the countries concerned. Given the stark and remarkable facts about the behaviour of exchange rates in the flexible exchange rate era, it is not suprising that most of us have embraced a theory that explains how 'overshooting' can occur.

And yet I do not believe that it will do, at least not in its present standard form. Although the theory <u>may</u>, with the help of some good will, provide an explanation of the broad magnitude of misalignment, it is hard to reconcile the actual time path of exchange rates with the predictions of the theory. The overshooting theory would seem to imply sudden, major jump responses to unanticipated news, for example of elections, announced policy changes, changes in administered interest rates, etc., with subsequent auto-correlated reversions towards an equilibrium, as shown by line A in figure 1, whereas the actual path of the exchange rate appears both less subject to major jump changes and more akin to a random walk with, perhaps at times, some persistent drift.

Let me now present my evidence that exchange markets tend to under-react rather than over-react in the short-term. Let me start with some good old-fashioned ad hoc casual empiricism. What are the really

important, newsworthy events for our economy? I would include general elections and budgets among them. Now, in so far as the results or changes in these are anticipated, they do not really represent news; but budgets are certainly meant to be secret, and, even with the advent of opinion polls, actual election results must dispel some doubts. On table 1 I report the percentage change in the foreign exchange markets from the close of the day before the last two general elections to the close on the day after the elections when the results are known. Similarly I report the change in the exchange rate from the close before Budget day, to the close both on the day itself, and the day after the Budget, since Budget speeches may overlap the formal closing hour. In order to provide some comparison, I had the absolute daily percentage from June 2, 1986 to October 30th, 1986 calculated. The average daily change, without regard to sign, over this fairly quiet period was 0.46%. The distribution of the absolute daily percentage changes is as shown in Figure 2.

In the case of the elections there was clearly no jump. Admittedly 1983 was a foregone conclusion, but were there no doubts dispelled by the 1979 result? Again many of the changes on, and after, Budget day hardly represent jumps, scarcely a skip, hardly a hop; even on occasions such as the 1980 unveiling of the MTFS or the 1981 complete abandonment of Keynesian demand stabilisation. The clear exception, of course, is the change in the exchange rate around the time of the 1985 Budget. But it is not at all clear that this particular jump was due to the Budget, which was not particularly memorable for measures that could be expected to reduce future UK nominal demand and price levels. Instead, as shown at the bottom of Table 1, March 1985 was an extraordinarily volatile month in the foreign exchange market, as the market finally broke decisively away from its flirtation with a possible £1 = 1$. The Budget simply occurred in the middle of this.

This latter illustrates one feature of foreign exchange markets, that there are short periods of extreme volatility interspersed among quieter spells, or in the jargon heteroscedasticity occurs. This latter is inconsistent with a true random walk, which besides the property that it is equally likely to fall as to rise, so that the best expected future value

.s simply its present value, should also exhibit a constant variance. I should formally instead use the term martingale, but I will not do so, primarily because the term random walk is so splendidly evocative.

Fun though it is to point out that the foreign exchange market hardly reacted to the most extreme announcement of a long term targetted reduction in monetary growth -- ie the MTFS- in British history, it hardly represents a formal test. I did then try to formulate myself a test of the overshooting hypothesis. Briefly, what I did was to observe those occasions, events, when the authorities acted in the UK to bring about a shift change in bank base rates, and then seek to estimate how much of such a change was unanticipated, by a comparison of (various alternative) market interest rates at the close of business in the day before the change with the rate ruling at the close on the day of the change. Having then obtained an estimate of the extent of unanticipated change in interest rate (differentials), I would then examine the contemporaneous, (and subsequent), effect of such an unanticipated change on spot and forward exchange rates ruling in the market.

I shall not report the format and results of this econometric test to this audience in full detail. They are presented instead in an accompanying appendix. The results do not support the overshooting hypothesis. Instead, they indicate that what needs explanation is rather why exchange rates, both spot and forward, in the event react <u>so little</u> to unanticipated interest rate changes. While the spot-forward premium <u>did</u> react, as one would have expected given covered interest parity, [to changes in interest rates and interest rate differentials, (except when the 3-month Treasury Bill rate was the rate used in the test)], the results showed no significant positive response of either spot, or forward exchange rate levels to an unanticipated change in interest rates.

I had not expected such an extremely negative result, [nor that the volatility of the exchange rate, as measured by its absolute % change, was not significantly different on the day of the change in base rates, at 0.61%, than the average for the days immediately preceding and the two subsequent days, at 0.64%]. One possible explanation for the lack of any

significance is that markets often believe that the authorities have private information about future economic events. If so, an administered rise in base rates could be treated as a signal that the authorities knew that conditions were even worse than expected, rather than just as a policy measure that should strengthen the exchange rate. Maybe. Anyhow my friends reckon that this possibility makes the result of this test moot.

So, let me try yet another approach. If markets over-react, jump, in response to monetary shocks, as represented in figure 1, then the basic relationships, auto-regressions, between price changes at time t and time t+1, t+2, etc., should be negative. If the market follows a random walk, the auto-regressions should be insignificantly different from zero. If the market under-reacts, exhibits persistence, the auto-regressions should be positive.

When Richard Smith and I did our study on 'The Relationship between Exchange Rate Movements and Monetary Surprises: Results for the United Kingdom and the United States Compared and Contrasted', Manchester School Journal, 1985, we found some puzzling signs of persistence*, a finding that I rechecked recently. This finding was that much of the impact of the unanticipated change in the UK money stock appeared to affect the £/$ exchange rate on the day after the announcement. I should add, however, that all the US findings indicated a virtually immediate response.

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* In a comment in the Manchester School Journal (1987), entitled 'On Testing the Relationship between Exchange Rate Movements and Monetary Surprises: A Comment on Smith and Goodhart', Peel and Pope criticized Richard Smith and myself for implicitly assuming, in our earlier study, 'The Relationship between Exchange Rate Movements and Monetary Surprises: Results for the United Kingdom and the United States Compared and Contrasted', that the spot $/£ exchange rate followed a random walk, and also for ignoring the time lag between the formation of the expectations incorporated in the expectational survey series and the announcement, eg of the actual change in the money stock.

Thus in an equation,

$$\Delta \$/\pounds = a + b_1 \ (\Delta \pounds M3 - \Delta \widehat{\pounds M3}),$$

where $\Delta \widehat{\pounds M3}$ is the previously formed expectation of the change in £M3, the true value of b_1 will be biassed if there is any information available which will allow the prior expectation to be systematically improved, (or,

Again, tests whether the series for changes, first differences, of spot exchange rates generally exhibit signs of auto-correlation, either positive or negative, have quite commonly been carried out in the context of tests whether such series were random walks. I know of several tests, usually using high frequency data, daily or weekly changes in foreign rates, that have rejected random walk behaviour because of positive auto-regression. Patrick McMahon and Richard Baillie find such significant positive auto-correlation in a study of four weekly nominal spot exchange rates.+

+Table 4 in their paper on 'Empirical Regularities in Exchange Rate Behaviour', unpublished paper prepared for the International Economics Study Group conference, Sussex University, September 1985, also included in Chapter 4 of McMahon's forthcoming book.

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less plausibly, worsened), over the time interval between sampling the expectations and the announcement itself.

While this criticism is fair and valid, Peel and Pope are even more concerned about the possibility that the exchange rate may not be a random walk. If so, they claim that persistence, (eg a positive correlation between an appreciation of £ and an unanticipated rise in £M3 on the day after the announcement), may be due to non-random-walk behaviour in the spot rate, not necessarily to market inefficiency, though non-martingale behaviour in high frequency, eg daily, data is itself generally inconsistent with market efficiency. Second, positive autocorrelation in spot rates could lead to an association between the formation of monetary expectations some days back and the current change in spot rates. Third, this could lead to serially correlated error terms in equations such as that above with accompanying loss of efficiency. While Peel and Pope referred to other studies that rejected the random walk model for daily data, they did not actually examine this hypothesis on the Smith/Goodhart data set; so I did.

The results showed that there were signs both of significant positive first order auto-correlation, and of day-of-the-week effects in the daily data. The latter appeared to arise, prior to October 1981, from a particular feature in the settlement for foreign exchange deals in the USA, which could then be made either in Federal Funds, good value and investible on the day received (t + 2 in the case of a foreign exchange deal) or, as most payments were, in clearing house funds which were not investible until the day following the value date, i.e. t + 3. Even thereafter the standard two day settlement period in the forex market might be expected to make it slightly more profitable to sell the currency with the higher interest rate on Thursday or Friday (to enjoy the higher interest yield over the weekend), and to buy in the earlier part of the week, but any such residual effects are much weaker.

While the majority of such tests have usually reaffirmed random walk behaviour, a significant minority have found signs of consistently positive auto-correlation.[o] Both these kinds of econometric study, and the more recent variance ratio tests, tend to suggest signs of initial slight persistence, under-reaction at first, in financial markets, including the forex market.

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[o] The only examples of negative auto-correlation that I am familiar with in financial markets have occurred in studies of ultra high-frequency hourly data in the forex market, both by Diana Whistler here and by Ito and Roley in their study of the Yen/$ exchange rate ('News from the U.S. and Japan: Which Moves the Yen/Dollar Exchange Rate?', NBER Working Paper, No. 1853, March 1986). This needs more examination, but it may result from the market trying to 'hunt' towards a new equilibrium after being disturbed by some (major) news story.

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An ordinary least squares equation in daily first differences of the spot \$/£ exchange rate (cents per £), from 1977-1983, 1823 observations, gave the result,

$$\$/£ = \underset{(0.00059)}{0.00196} - \underset{(0.00084)}{0.00171}\text{ Monday} - \underset{(0.00084)}{0.00259}\text{ Tuesday}$$

$$- \underset{(0.00084)}{0.00310}\text{ Thursday} - \underset{(0.00084)}{0.00307}\text{ Friday} + \underset{(0.02343)}{0.04867}\ \$/£_{t-1}$$

$$R^2 = 0.0096 \quad D.W. = 1.998 \quad F(5,1817) = 4.54.$$

On the other hand, as noted later, there is rather more support for random walk behaviour in the series for <u>weekly</u> first differences in spot exchange rates, (though there are still some cases of significant positive auto-correlations reported in the literature); and there is virtual unanimity that <u>monthly</u> first differences of spot exchange rates do approximate very closely to a random walk.

If, however, one tries to take some account both of possible revisions to expectations and of the positive daily autocorrelation in the daily exchange rate series by regressing the change in the exchange rate between the close on the day after the announcement, to take account of the already mentioned indication of slight persistence, and the close a <u>week</u> previously, on the unanticipated component of the money stock announcement, the results still show a positive impact, but one that is much weaker and not strictly significant, as follows:-

$$\%\Delta\ S_{t+1} - S_{t-4} = \underset{(.14)}{-.06} + \underset{(.19)}{.30}\ (\Delta M3 - \Delta \hat{M3})$$

$$\bar{R}^2 = .02 \quad D.W. = 2.01 \quad F(1,68) = 2.36$$

Once again, this is not conclusive evidence against the overshooting model, since it is only in response to monetary shocks that such models should unambiguously exhibit overshooting. If the majority of shocks were, in practice, to be non-monetary, it might be possible to reconcile findings of slight persistence with the existing model. Even so, I hope to have established at least a prima facie case against.

The real problem that we may have to explain in the forex market over short periods, i.e. in high frequency data, is not why it jumps so much, but why it more regularly appears to under-react to 'news'. While I accept that the Dornbusch 'overshooting' model provides a good story of why the market might over-react in theory, I have to challenge those who believe this to show equivalent empirical evidence that the market does over-react to 'news' in fact.

Per contra, the same theoretical model has the lower frequency, longer term evolution of the real exchange rate firmly anchored by PPP, purchasing power parity. Here the evidence is rather the reverse. While the theory exaggerates short-term volatility, it seems to understate longer term misalignments. The stabilising pull of equilibrium conditions is apparently less than most economists would have expected. I can be brief in outlining the evidence for this, since I have done none of the empirical work myself. First let me appeal once again to ad hoc casual empiricism. If you look at figure 3, you will note that the path of the $/£ exchange rate has been dominated by the extraordinary misalignment of the $ up till the early months of 1985, and its subsequent reversal. Certainly anyone looking at events up till the end of 1985 could only conclude that the pull of PPP was weak, or even non-existent.

A recent study, in the March 1987 Economic Journal, by Koromzay, Llewellyn and Potter, on "The Rise and Fall of the Dollar: Some Explanations, Consequences and Lessons", notes that it would be difficult, if not impossible to believe that these developments were consistent with a rational reaction to 'news' in the context of the standard Dornbusch overshooting model. Thus, they state, "Historically, the problem with this

is that it requires 'news' over the 1980-6 period to have exhibited a pattern of serial correlation that belies its definition", [P. 27]. Moreover, having asked whether there is "any explanation for the implied massive upward revision of the real expected equilibrium rate for the dollar over the period up to 1985 that is robust in the face of the subsequent dollar fall?" [,P.30], they finally come to the view "that markets just got it wrong.... still seems more plausible"[P. 32].

Let me revert to more formal studies. Adler and Lehmann in their 1983 Journal of Finance article present results for their data set that indicate that changes in real exchange rates even for annual data are not significantly different from a martingale. Admittedly it is difficult to distinguish a martingale from a series with a first-order autoregression with a coefficient of 0.9, but in that case "it would typically take 20 years for the real exchange rate to achieve 90% of the return to PPP after an initial shock".

More recently my colleague, Mark Taylor, has run tests on real exchange rate series over the period 1973-1985. In one of these he looked for the presence of a unit root in the time series representations of such real exchange rates, and could not reject the hypothesis of its presence. He noted that these "findings imply the absence of any tendency of the nominal exchange rate to converge on purchasing power parity, even in the long run." In a further test over the same data period he examined whether the series for monthly nominal exchange rates and relative prices for five countries, each relative to the USA, were cointegrated, as they must be if PPP is to hold at all. His conclusion was that the exchange rate and relative prices did not appear to be cointegrated for any of the countries examined.

I find it extremely hard to believe either that relative prices have absolutely no effect on nominal exchange rates, even in the long run, or alternatively that real interest rate differentials can widen without bound. Now that the US $ has collapsed from the remarkable high levels of 1984/85, and appears to have passed back through its PPP level on the way down, the results of the formal exercises may, I guess, change somewhat,

nd the use of variance ratio tests may also show some signs of mean reversion. Be that as it may, and casual or formal, the evidence is surely clear that the long run equilibrating forces in the forex market appear weak and uncertain both in strength and timing, notably much weaker than many current forward-looking rational expectations models imply. If economists wish to base their models on transversality conditions, they may be less firm than we might like.

C. Is the Forward Rate a Good Predictor?

I want to turn now to my next puzzle, which concerns the inability of the forward exchange rate to serve as an efficient predictor of future spot rates. Let me start by rehearsing some stylised facts about the forex market, which I can support with empirical results. First the nominal spot exchange rate approximates closely to a random walk in most cases that have been studied. It can hardly be the case that this remains so for highly inflationary, or hyperinflationary, countries, or, if it does hold, it must do so with significant drift. In addition, as already noted, there are a number of high frequency data sets in which the first differenced series exhibits significant positive auto-correlation. Apart from these exceptions, the now standard Dickey-Fuller tests for a random walk are usually satisfied, at least for weekly and monthly data series, and again generally exhibit no significant drift. The daily data series need more careful handling. Because of peculiarities in the procedure for settling foreign exchange deals in the USA up till October 1981, there were day-of-the-week effects up till that date. Even thereafter, the two day lag in settlement might imply some advantage in selling the currency with a higher interest rate on Thursday or Friday, rather than earlier in the week, to enjoy the higher interest rate over the week-end also, and this can inject a significant day-of-the-week effect. Anyhow, the results of applying such Dickey-Fuller tests to the data set assembled for my exercise is presented in another Appendix, which was authored by Mark Taylor, and shows once again that the Dickey-Fuller tests were satisfied for our weekly and monthly series, without significant drift, except in one borderline case.

The next stylised fact is that covered interest parity holds in the forex market.[+] So long as the interest bearing financial instruments

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[+] My colleague, Mark Taylor, in a forthcoming Economica paper, entitled 'Covered Interest Parity: A High Frequency, High-Quality Data Study', has sampled actual market data at ten minute intervals for a period of three days to see if he could detect any evidence of deviations from covered interest parity. In the course of 3,456 possible arbitrage opportunities, only one tiny deviation was found, which could be fully accounted for by brokerage costs.

involved have exactly the same credit-risk, and are not subject to potential, or actual, exchange control or to differential risks of blocking, or repudiation, then any deviation from such covered parity, in a market where transactions costs for market dealers are negligible, would allow for absolutely riskless arbitrage profits. These conditions hold exactly in the euro-markets, where the euro-rate on any currency's instrument can be exactly estimated from the equivalent maturity euro-$ rate and forward exchange rate, and similarly where the forward exchange rate can be exactly calculated from the relationship between the two euro-currency rates involved.* Again we ran statistical tests to see how closely our data series for spot, forward and euro-interest rates matched up to the theoretical expectations implied by CIP. The results are also shown in an Appendix, which indicate that the fit is close to that expected, but exhibits in a few cases a small, but still significant difference, which we cannot explain.

Be that as it may, let us provisionally accept both random walk and covered interest parity as being approximately true. If a series has historically been a random walk, then its expected future value should be the same as its present value. But if CIP holds, the forward rate will diverge from the present spot rate by the extent of the interest differenital, and will thus <u>not</u> be an efficient predictor of future spot rates.

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* Indeed, in the data from Barings this was how the forward exchange rates were calculated.

Before I demonstrate this, let me just indicate the data set° that we have used for these tests in Table 2. As I have stated, what we find is that the forward rate is generally in these tests a less good predictor of the future spot rate, than is the current spot rate; and that its coefficient in an equation relating it, and a constant, to the future spot rate is generally further away from unity than is the coefficient in the equation relating the spot rate to its own past value; and in a number, but not all, of our data sets, the coefficient on the forward rate is significantly different from unity. All this is set out in Table 3.

[Table 3]

You will note that in every case, except with data set H, the coefficient on the spot rate, in equation 1, is closer to unity and better defined, than the coefficient on the forward rate, in equation 2. Moreover, in every case, the fit of the equation is better, albeit often marginally so, when the current spot rate, rather than the forward rate, is the predictor of the future spot rate. You will also, however, observe the generally low level of the Durbin-Watson ratio, which suggests that there must be other explanatory influences which have been omitted from this consciously simple exercise. In fact, considerably more powerful econometric tests can be run

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° I began with a data set provided by the Bank of England, giving end-of-week figures for the £/$ exchange rate, the 1 and 3 month forward premium, and the related 1 and 3 month values for the euro-dollar and £ inter-bank interest rates, covering the period 1977 Week 1 to 1984 Week 46. Subsequently, however, and as a cross-check on my origginal results, my colleague, Mark Taylor and I have expanded our data set to include three other similar data sources, providing similar sets of spot exchange rates, one and three month forward exchange rates and one and three month interest rates. These data sets were obtained respectively from the Harris Bank, covering the DM/$ and Swiss Fr/$ exchange rates and associated interest rates, weekly from the begining of 1974 to end-1980; from the OECD again covering the DM/$ and Swiss Fr/$ exchange rates and interest rates, using monthly data from January 1974 to June 1986; and from Baring Brothers, using daily data for the DM/$, Yen/$ and Swiss Fr/$ exchange rates and interest rates from January 1981 to September 1986. These nine data sets thus cover differing bilateral exchange rate relationships, over differing time periods, and sampled with differing frequencies.

to prove that the forward rate is not an unbiassed efficient estimator of the future spot rate. A good example can be found in the work of Patrick McMahon of Birmingham who has used vector auto-regressions for this purpose.

Just to go one step further here, the equation relating the *level* of the future spot rate to the current *level* of the forward rate can be transformed into first difference form, by relating the actual change in spot rates from t to t+1 to the forward premium between the current forward and spot rate at time t. This equation was examined by Fama in his 1984 paper on 'Forward and Spot Exchange Rates', *Journal of Monetary Economics*, who found that the coefficient on the forward premium in this equation was generally markedly different from the expected value of unity, often significantly so, and was more often negative than positive. We reproduce the same form of equation in Table 4 and generally replicate his findings on our own data sets.

[Table 4]

Now these results leave us with a conundrum, because it appears that not only do forward rates provide, by themselves, *no useful information at all* on the likely future path of spot rates, (note the uniformly abysmal value of R^{-2}) but also that there appears to be *better* information to hand in the guise of the current level of spot rates than that contained in the forward rate.

Is there really no information whatsoever about future exchange rates to be found in forward rates? Clearly taken by themselves they have virtually no informational value, but some further tests that I ran suggested that if you regressed the future spot rate against both the current forward rate *and* the interest differential, with both those variables unconstrained, then the coefficient on the forward rate reverted

close to unity, and the explanatory power (R^{-2}) was higher than for a random walk.

[Table 5]

Moreover, in some associated work, Patrick McMahon has been reporting that tri-variate auto-regressions, using data for forward rates and interest differentials, as well as prior spot rates, appear to predict quite a lot better than the pure random walk model.

I should like to end this Section by noting that, if the forward rate was always held equal, or very close to, the spot rate, say by speculation based on the historical random walk properties of the spot rates, then nominal interest differentials could not differ greatly from zero, given CIP. This implies that an administered increase in nominal interest rates would have to lead to such a large appreciation in exchange rates that the economic consequences would be to force domestic interest rates immediately back into line with those abroad. It is the passivity, the slackness, in forward rates -- that they are not unbiassed predictors -- that largely allows for national monetary autonomy, without causing excessive volatility in exchange rates.