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ON THE CONSISTENCY OF SHORT-RUN AND LONG-RUN EXCHANGE RATE EXPECTATIONS

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ABSTRACT

This paper examines whether short-term exchange rate expectations move "too much" by comparing them with long-term expectations. We develop a set of nonlinear restrictions linking expectations at different forecast horizons. The restrictions impose *consistency*, a property weaker than rationality. We use exchange rate survey data to measure expectations and then test whether consistency holds. The data show that a current, positive exchange rate shock leads agents to expect a higher long-run future spot rate when iterating forward their short-term expectations than when thinking directly about the long run. In this sense short-horizon expectations may overreact to current exchange rate changes.

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1. Introduction

Much as the value of the dollar has fluctuated during the 1980s, so too has the view that exchange rate determination should be left entirely to an unrestricted foreign exchange market. Only a decade ago, economists were nearly unanimous in endorsing perfectly flexible exchange rates. In addition to Milton Friedman's (1953) persuasive argument that floating rates provided the least costly means of international adjustment, an avalanche of empirical work seemed to reaffirm economists' belief in free markets; empirical tests of spot and forward market efficiency were unable to reject, and a variety of models using sensible fundamentals appeared to explain important aspects of exchange rate behavior. But by the mid-1980s much had changed: simple efficiency tests had become powerful enough to reject regularly,[1] and researchers turned pessimistic in their search for models that could explain a positive fraction of exchange rate changes on the basis of fundamentals. The bleak situation was underscored by Meese and Rogoff's (1983) demonstration that a random walk, which cannot explain *any* positive portion of exchange rate changes, outperformed every model against which it was pitted.[2]

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[1] Naturally, forward market efficiency would be rejected as a consequence of either a time-varying exchange risk premium, or a failure of rational expectations.

[2] Frankel and Dornbusch (1987) contains a list of ways in which floating exchange rates have failed to function as originally promised.

More recently, some economists have begun to revive older Keynesian views that expectations (and to some extent the currency values themselves) may sometimes be driven by animal spirits, and that the behavior of expectations may be responsible for many of the disappointments with floating rates.[3] Short-term exchange rate expectations are often thought to fall prey to such forces. Nurkse (1944), for instance, is cited frequently for his fear that short-term expectations were subject to bandwagon effects: a contemporaneous depreciation in the spot exchange rate tends by itself to make speculators expect additional depreciation, potentially driving the spot rate further away from equilibrium.

Because expectations are unobservable, there is not much direct evidence on the way expectations behave. What little evidence we have, however, would appear at first glance to support Nurkse's suspicion. Frankel and Froot (1987b, 1988) use survey data on exchange rate expectations to estimate models of expectations formation and find that shorter-term expectations appear to exhibit the bandwagon effects described by Nurkse, while longer-term expectations do not. However, if agents form their expectations rationally, it is not clear why the mere presence of bandwagon expectations should be a source of concern. If, for example, the stochastic process generating the exchange rate displays positive serial correlation over short horizons, bandwagon expectations may rationally and passively reflect the behavior of the spot rate.

As one might expect, there is even less evidence that bandwagon expectations fail to be rational over short horizons. Frankel and Froot test, but are not able to reject, the hypothesis that bandwagon predictions are optimal if agents are limited to current and past exchange rate changes when forecasting future changes. Indeed, there is other evidence that seems to support independently the rationality (or near rationality) of short-term bandwagon expectations. Huizinga (1986) and Kaminski (1987) both find that the

[3] On the behavior of exchange rates and exchange rate expectations see Krugman (1985), Fischer (1986), Dornbusch (1986), and Williamson (1986). In a more general context, a number of authors have suggested that "noise" traders may appear to trade on the basis of expectations that are irrational and even unpredictable. See Black (1986), De Long, Shleifer, Summers and Waldman (1987), and Kyle (1985).

stochastic process governing realized exchange rate changes displays positive serial correlation over short horizons.[4] This finding, coupled with the sheer volatility of the spot rate, suggests that tests of rationality are likely to have the problem of low power in distinguishing among nearby alternatives.[5]

A second problem in tests of rationality in the foreign exchange market, besides low power, is that the usual confidence intervals may not be reliable. Infrequent but important events can create "peso problems" which make the distribution of the regression residuals far from normal, and therefore produce misleading inferences in small samples. Indeed, the notion of peso problems has become so accepted that many recent empirical studies now conclude with partial disclaimers about the reliability of their findings in the presence of such problems.[6] In much the same way, inference may be distorted through the presence of rational stochastic bubbles,[7] unless the bubbles form and pop very frequently in the sample.[8] In sum, the problems both of low power and nonnormal residuals in small samples tend to limit severely the force of any empirical evidence on the rationality of short-term expectations.

In this paper we use a different and potentially more reliable metric to judge whether short-term expectations move too much: long-term expectations. That is, we test whether agents' expectations at different forecast horizons lead to equivalent predictions of the level of the exchange rate far into the future, a property that we call *consistency*. Short-term expectations may be said to be inconsistent relative to long-term expectations if a positive shock to the exchange rate leads agents to expect a higher long-run future spot rate when iterating forward their short-term expectations than when thinking directly about the long run.

[4] Kaminski finds that the real dollar exchange rate is positively correlated over intervals ranging from 1 to about 60 months, and negatively serially correlated over longer intervals. See also Poterba and Summers (1987) and Lo and MacKinlay (1987) who find that U.S. stock returns are positively correlated over short horizons and negatively correlated over longer horizons.

[5] Summers (1986) discusses the power to reject interesting alternatives to the hypothesis that markets are efficient and expected price changes are constant.

[6] Examples include Fama (1984), Hodrick (1987).

[7] See Blanchard (1979).

[8] Meese (1986), for example, uses non-parametric methods to test for the presence of bubbles. See also Obstfeld (1987), who shows how standard inferences may be incorrect in the presence of both peso problems and stochastic bubbles.

Clearly, consistency is a necessary condition if expectations are to be rational. But consistency is weaker than rationality, since it does not require that the expectations process match the stochastic process generating the actual exchange rate. In addition, tests of consistency will be free of many of the statistical problems (such as those created by stochastic bubbles and peso problems) that plague tests of rationality. A failure of short-term expectations to be consistent would imply that even the agents themselves are not willing to live with the long-run implications of their own short-run forecasts.

Naturally, if we are to examine the behavior of expectations independently of the behavior of the actual spot process, we must rely on a measure of the expected future spot rate other than the future realization. Toward this end, we use data from three different surveys of exchange rate expectations. Each of the surveys simultaneously elicits expectations at several forecast horizons, allowing us to test whether the responses in each survey are consistent. In addition, the three surveys include a wide variety of forecast horizons, ranging from one week to one year. We can therefore gain a sense for whether any inconsistency in the data pervades the term structure of agents' expectations, or whether it is confined to very short forecast horizons.

To preview our results, the statistical evidence presented below indicates that expectations do exhibit inconsistencies, although these inconsistencies appear less severe when comparing very short forecast horizons, such as one week and one month. By contrast, both three- and six-month expectations appear to be very significantly inconsistent with expectations at the one-year horizon. However, in terms of economic (rather than statistical) significance the data display a striking similarity across all forecast horizons and currencies: relative to longer-term expectations, shorter-term expectations invariably overreact to an exchange rate shock.

The rest of this paper is structured as follows. Section 2 defines the property of consistency and develops the cross-equation restrictions needed to test it. The results of our tests are presented in section 3. Section 4 concludes.

2. Consistency

Let $\mathbf{e}_{k,t+k}$ denote the k-period change between $t+k$ and t in the log of the spot rate expressed in terms of dollars per unit of foreign currency. We denote the market's expectation at time t of the log percentage change over the same period by $\mathbf{m}_{k,t+k}$. As in a vector-autoregressive model, we assume that one-period ahead expectations are formed as a linear combination of current and lagged spot rate changes, $\mathbf{a}_1(\mathrm{L})\mathbf{e}_{1,t}$, plus other residual factors that are conditionally independent of current and past exchange rate changes:[9]

$$\mathbf{m}_{1,t+1} = \gamma_1 + \mathbf{a}_1(\mathrm{L})\mathbf{e}_{1,t} + \mu_{1,t}, \tag{1}$$

where

$$E(\mu_{1,t}|\mathbf{e}_{1,t}\ldots\mathbf{e}_{1,t-P}) = 0, \tag{2}$$

L is the lag operator, and P is the order of the autoregression.[10] The assumption that $\mu_{1,t}$ is strictly orthogonal to current and past exchange rate changes is a strong one, although it is the usual assumption made when estimating vector autoregressions. Ironically, we are on relatively strong ground in this particular case: the failure of both past exchange rate changes and fundamentals[11] to predict a positive portion of the current change indicates that exchange rate changes are serially uncorrelated as well as uncorrelated with current and lagged fundamentals. The lack of serial correlation suggests that our estimates will be robust to misspecification of P, while the inability of economic fundamentals to explain exchange rate changes suggests that our estimates are robust to the specification and inclusion of these other factors.

Similar to equation (1), the market's expectation of depreciation over the subsequent k periods is given by:

$$\mathbf{m}_{k,t+k} = \gamma_k + \mathbf{a}_k(\mathrm{L})\mathbf{e}_{1,t} + \mu_{k,t}, \tag{3}$$

[9] The autoregressive representation in equation (1) is expressed in changes because of the overwhelming evidence that the nominal spot rate contains a unit root.

[10] To avoid confusion with the notation used below, define the operator E_t to yield the time-t expectation over the appropriate objective density function.

[11] By fundamentals, we mean not only the standard examples such as relative money supplies, output, and interest rates, but also those which come out of newer exchange rate models, such as the conditional variances of monetary and fiscal policies (see Hodrick, 1987).

and we assume

$$E(\mu_{k,t}|\mathbf{e}_{1,t}\dots\mathbf{e}_{1,t-P}) = 0. \tag{4}$$

Notice that the residual terms $\mu_{1,t}$ and $\mu_{k,t}$ in equations (2) and (4), respectively, do not include *ex-post* prediction errors, and are observable at time t.

We can express the upcoming spot rate change in terms of the same linear combination of current and past changes as equation (1), plus a new residual:

$$\mathbf{e}_{1,t+1} = \gamma_1 + \mathbf{a}_1(\mathrm{L})\mathbf{e}_{1,t} + \epsilon_{1,t+1}, \tag{5}$$

where $\epsilon_{1,t+1} = \mu_{1,t} + \eta_{1,t+1}$, and $\eta_{1,t+1}$ is the one-period prediction error made by the market. To move backwards from equation (5) to (1) we define the operator, $E_t^{\mathbf{m}}$, which yields the expectation over the *market's* subjective time-t conditional density function. The market's prediction of the upcoming spot rate change can then be expressed:

$$E_t^{\mathbf{m}}(\mathbf{e}_{1,t+1}) = \gamma_1 + \mathbf{a}_1(\mathrm{L})\mathbf{e}_{1,t} + E_t^{\mathbf{m}}(\epsilon_{1,t+1}), \tag{6}$$

where by construction, $E_t^{\mathbf{m}}(\mathbf{e}_{1,t+1}) = \mathbf{m}_{1,t+1}$ and $E_t^{\mathbf{m}}(\epsilon_{1,t+1}) = \mu_{1,t}$.

Note that if expectations are rational in the sense of Muth, then the market's conditional density function is equal to the objective conditional density function (conditioning on all information available at time t), $E_t^{\mathbf{m}}(.) = E_t(.)$. In that case, equation (6) represents a standard vector-autoregressive model of exchange rate changes. Having made this assumption, we could estimate consistently the expectational parameter vector, $\mathbf{a}_1(\mathbf{L})$, from equation (5) with ordinary least squares (OLS). However, if the subjective and objective densities are not precisely equal, then estimation of equation (5) will *not* generally produce consistent estimates of $\mathbf{a}_1(\mathbf{L})$. In such a case it would not be appropriate to assume that the objective conditional expectation of the prediction error is equal to zero, $E_t(\eta_{1,t+1}|\mathbf{e}_{1,t}\dots\mathbf{e}_{t-P}) = 0$. Because we are interested in the particular linear combination used in forming expectations, we attempt to estimate equation (6) directly. This procedure is more general than one which relies on equation (5), since it allows for, but does not impose, the restriction that agents know the conditional density function of the actual spot process.

In order to develop our test of consistency, we need to express the long-horizon forecasts in equation (3) in terms of the parameters from equation (1). To do this we first rewrite equation (5) as a first-order autoregressive system:

$$\mathbf{x}_{1,t+1} = \Gamma + \mathbf{A}\mathbf{x}_{1,t} + \epsilon_{t+1}, \tag{7}$$

which is given by

$$\begin{pmatrix} \mathbf{e}_{1,t+1} \\ \mathbf{e}_{1,t} \\ \vdots \\ \mathbf{e}_{1,t+1-P} \end{pmatrix} = \begin{pmatrix} \gamma_1 \\ 0 \\ \vdots \\ 0 \end{pmatrix} + \begin{pmatrix} a_{1,1} & \dots & a_{1,P-1} & a_{1,P} \\ 1 & \dots & 0 & 0 \\ & \ddots & & \\ 0 & \dots & 1 & 0 \end{pmatrix} \begin{pmatrix} \mathbf{e}_{1,t} \\ \vdots \\ \mathbf{e}_{1,t-P+1} \\ \mathbf{e}_{1,t-P} \end{pmatrix} + \begin{pmatrix} \epsilon_{1,t+1} \\ 0 \\ \vdots \\ 0 \end{pmatrix}.$$

Consistency will involve restrictions on the companion matrix, $\mathbf{A}$.

By applying iteratively the subjective expectations operator to equation (7), it is straightforward to write the market's expectation of the change in the spot-rate vector, $\mathbf{x}$, between periods $t+j$ and $t+j-1$:

$$\begin{aligned} E_t^{\mathrm{m}}(\mathbf{x}_{1,t+j}) &= \sum_{i=0}^{j-1} \mathbf{A}^i\Gamma + \mathbf{A}^j\mathbf{x}_{1,t} + E_t^{\mathrm{m}}\Big(\sum_{i=0}^{j-1} \mathbf{A}^i \epsilon_{t+j-i}\Big) \\ &= (\mathbf{I}_P - \mathbf{A}^j)(\mathbf{I}_P - \mathbf{A})^{-1} + \mathbf{A}^j\mathbf{x}_{1,t} + E_t^{\mathrm{m}}(\epsilon'_{t+j}) \end{aligned} \tag{8}$$

Equation (8) shows how any expected future one-period change in the spot rate can be expressed as a linear function of current and past exchange rate changes.

Next we use equation (8) to form the expected k-period change given in equation (3). Note that the k-period expected change in the spot-rate vector from $t+k$ to t is given by $\mathbf{x}_{k,t+k} = \sum_{j=1}^{k} \mathbf{x}_{1,t+j}$. Using this fact and equation (8) we have:

$$\begin{aligned} E_t^{\mathrm{m}}(\mathbf{x}_{k,t+k}) &= \Big(k\mathbf{I}_P - (\mathbf{A}^{k+1} - \mathbf{A})(\mathbf{I}_P - \mathbf{A})^{-1}\Big)(\mathbf{I}_P - \mathbf{A})^{-1}\Gamma \\ &+ (\mathbf{A} - \mathbf{A}^{k+1})(\mathbf{I}_P - \mathbf{A})^{-1}\mathbf{x}_{1,t} + E_t^{\mathrm{m}}\Big(\sum_{j=1}^{k} \epsilon'_{t+j}\Big), \end{aligned} \tag{9}$$

where by construction, $E_t^m(\mathbf{x}_{k,t+k}) = \mathbf{m}_{k,t+k}$. Finally, define the Px1 selection vector, $\mathbf{g}' \equiv (1 \quad 0 \quad \ldots \quad 0)$. We now state the main proposition of the paper:[12]

Proposition: Given that short-term expectations are formed according to equation (1), long-term expectations are *consistent* if and only if the restrictions:

$$\gamma_k = \mathbf{g}'\Big(k\mathbf{I}_P - (\mathbf{A}^{k+1} - \mathbf{A})(\mathbf{I}_P - \mathbf{A})^{-1}\Big)(\mathbf{I}_P - \mathbf{A})^{-1}\Gamma, \tag{10}$$

$$\mathbf{a}_k' = \mathbf{g}'(\mathbf{A} - \mathbf{A}^{k+1})(\mathbf{I}_P - \mathbf{A})^{-1}, \tag{11}$$

$$\mu_{k,t} = E_t^m\Big(\sum_{j=1}^{k} \mathbf{g}'\epsilon_{t+j}'\Big) = E_t^m\Big(\sum_{j=1}^{k}\sum_{i=0}^{j-1} \mathbf{g}'\mathbf{A}^i\epsilon_{t+j-i}\Big), \tag{12}$$

are satisfied.

Provided that the assumptions given in equations (2) and (4) hold, the parameters in equations (1) and (3) can be estimated consistently using OLS.

To see how these restrictions operate, consider the simplest case in which agents use only the most recent change in the spot rate to predict the subsequent change, so that $P = 1$. Then equation (11) yields only a single restriction, which reduces to $a_k = \sum_{j=1}^{k} a_1^j$. The long-term expected change is the sum of the individual expected changes, each of which is just the short-term expected change raised to a power equal to the number of periods it lies into the future. Note that as long as $|a_1| < 1$, equation (11) implies that a_1 always has the same sign as a_k. If agents have short-term bandwagon expectations – by which we mean that they extrapolate positively past exchange rate changes into the future, $a_1 > 0$ – then they must have long-term bandwagon expectations if their expectations are to be consistent. Provided that the model in equation (1) is correctly specified and that $P = 1$, evidence that short-term expectations are of the bandwagon type ($a_1 > 0$) while long-term expectations are of the distributed lag type ($a_k < 0$) indicates inconsistency.

[12] Similar cross-equation restrictions were imposed originally by Sargent (1979) in a test of the expectations hypothesis of the term structure of interest rates. See also Ito (1984), and Ito and Quah (1985).

3. Tests of Consistency

3.1. Data

Our independent measure of the market's expected future spot rate is the median survey response from three ongoing exchange rate surveys. Each six weeks since mid-1981, the *Economist Financial Report* has polled currency-room traders and economists at 14 major banks for their views. They are asked to report their expected value of the dollar against five currencies (the pound, French franc, Deutsche mark, Swiss franc, and yen) in three, six and twelve months time. The second and third surveys have been conducted on a weekly basis since early 1984 by Money Market Services (MMS). About 30 traders each week report their expectations of the value of the dollar against four currencies (the pound, Deutsche mark, Swiss franc, and yen) at horizons of one week and one month. The surveys conducted separately by the London and New York branches of MMS are of local traders' views, so that there is no overlap in respondents. We use these data sets to check for the possibility of different characteristics of investors on either side of the Atlantic.[13] Table 1 summarizes the coverage of the survey data sets.

It is worth emphasizing that we do not have to treat the median survey response as though it were a perfect measure of the (unobservable) market expectation. The surveys may be subject to the same kinds of problems inherent in any proxy for this elusive variable. It seems reasonable to suppose that the median investor's expectation is an imprecise estimate of the market's expectation. When agents have different beliefs but their demands can be aggregated into a single representative investor (which is the only way the concept of a unique "market" expectation makes any sense), individuals' expectations would be weighted according to risk tolerance or wealth (see, for example, Rubinstein, 1974). This implies that the median response will be an imprecise, but nevertheless unbiased, estimate of the aggregated expectation as long as risk tolerance and wealth are independent of individuals' beliefs about the rate of future depreciation. A second source of measurement

[13] For more detail on these data sets, see Frankel and Froot (1987a) and Dominguez (1986).

error arises because only a subsample of the investing population is surveyed. As with any sampling method, the resulting measurement error will be purely random provided that the sample group's expectations do not differ systematically over time from those of the population.

Our estimation strategy allows for these sources of measurement error. Because the survey responses will be used only on the left-hand side of equations (1) and (3), any measurement error the surveys contain will end up in the contemporaneous residuals, $\mu_{1,t}$ and $\mu_{k,t}$, and will not affect our tests of consistency.

3.2. Estimation

We estimate systems of the form:

$$\begin{pmatrix} s_{1,t+1} \\ s_{k,t+k} \end{pmatrix} = \begin{pmatrix} \gamma_1 \\ \gamma_k \end{pmatrix} + \begin{pmatrix} a_{1,1} & \cdots & a_{1,P} \\ a_{k,1} & \cdots & a_{k,P} \end{pmatrix} \begin{pmatrix} e_{1,t} \\ \vdots \\ e_{1,t-P} \end{pmatrix} + \begin{pmatrix} \mu_{1,t} \\ \mu_{k,t} \end{pmatrix}, \tag{13}$$

where $s_{1,t+1}$ and $s_{k,t+k}$ represent the survey expected depreciation of the dollar against the foreign currency over the subsequent single period and k periods, respectively, and $\mu_{1,t}$ and $\mu_{k,t}$ include any measurement errors in the survey medians. Before turning to the estimates, we discuss several econometric issues.

Point estimates of the parameters in equation (12) can be obtained using OLS. However, OLS will yield incorrect estimates of the standard errors because under the null hypothesis, the system residuals will display both contemporaneous and serial correlation. Contemporaneous correlation of $\mu_{1,t}$ and $\mu_{k,t}$ will occur because any "other" factors used in short-term forecasts are also likely to be used for long-term forecasts. Even if agents form their expectations by looking only at the past history of the spot rate, so that $\mu_{i,t}$ is purely random measurement error, these errors are likely to be contemporaneously correlated across forecast horizons.

Second, except in the extreme case in which the residuals are purely due to measurement error, serial correlation is also likely to be a problem. To see this, focus first on the long-horizon residual, $\mu_{k,t}$. From equation (12), consistency implies that $\mu_{k,t} = E_t^m(\sum_{j=1}^{k} \sum_{i=0}^{j-1} \mathbf{g}'\mathbf{A}^i \epsilon_{t+j-i})$. This term will in general be correlated with $E_{t+1}^m(\sum_{j=1}^{k} \sum_{i=0}^{j-1} \mathbf{g}'\mathbf{A}^i \epsilon_{t+1+j-i})$ since by the law of iterated projections, the conditional expectation of a future variable follows a martingale. Note that this is true even if the realized short-term residuals are serially uncorrelated, $E_t(\mu_{1,t}\mu_{1,t+1}) = 0$. In spite of the large measurement error component they no doubt contain, the short-horizon residuals will generally also exhibit correlation over time.

To correct for these problems, we use an extension of the GMM estimate of the parameter covariance matrix suggested originally by Hansen (1982) and modified by Newey and West (1985). This estimator allows for contemporaneous and noncontemporaneous correlations of unknown form (both across and within forecast horizons). In addition, within this framework it is straightforward to allow for conditional heteroskedasticity in the residuals as well. There is evidence, however, that heteroskedasticity-consistent covariance estimators may tend to bias the standard errors downward. Consequently, and in an effort to be conservative, we estimated both homoskedasticity- and heteroskedasticity-consistent standard errors and have reported only the larger of the two.[14] To guarantee that our estimate of the covariance matrix is positive definite, we follow Newey and West (1985) by discounting lth order autocovariances by $1 - l/(T^{.25} + 1)$, where T is the number of time-series observations.

In order to specify the lag length P, we began with $P = 1$ and increased it incrementally. In almost all cases the higher order lags above $P = 2$ were both economically and statistically insignificant. We present estimates for both P equal to 1 and 2, although the qualitatively nature of the results does not depend on the precise value of P.

3.3. Regression Results

Our first set of tables contains estimates of the system described by equation (13) for

[14] In the results below the standard errors calculated using these two methods differed by a margin of less than ten percent. See Froot (1987) for evidence on the downward finite sample bias of heteroskedasticity-consistent standard errors.

the case in which P is set to 1. The second set allow P to be 2. In order to gain a sense for the economic importance of our formal consistency tests, we turn in the second part of this section to a set of figures which display the impact of a contemporaneous exchange rate shock on expected future spot rates.

Table 2 reports the regression results for the five currencies included in the Economist survey for the case in which $P = 1$. The forecast horizons for this survey are three, six and twelve months, so that the system in equation (13) must be extended to allow for three equations instead of two. Table 2 shows that the coefficients on the current exchange rate change, $a_{i,1}$, $i = 3, 6, 12$, are statistically less than zero. In the case of the British pound, for example, the point estimates imply that a 10 percent dollar appreciation over the past three months leads to an expected depreciation of 1.5, 2.0, and 2.8 percent over the following three, six and twelve months, respectively. The coefficients for the other currencies are similar. The last column in Table 2 reports a Wald test of the consistency restrictions given in equations (11) and (12). The data reject consistency for all five currencies.

Tables 3 and 4, respectively, report the results for $P = 1$ from the New York and London surveys conducted by MMS. Note that the forecast horizons are now shorter, at one week and one month. In both of these tables, most of the coefficients are positive, indicating the presence of a bandwagon effect. At the one week horizon, 6 out of 8 of these are statistically positive at the five percent level. By comparison, only one of the one-month coefficients is statistically positive and, while some are negative, none is statistically less than zero. In the case of the British pound, the coefficients reported in Table 3 imply that a 10 percent dollar appreciation over the past week leads on average to expectations of an additional 1.0 percent appreciation over the following week and a 0.1 percent appreciation over the following month. In these tables, there is little evidence against consistency: only one of the Wald tests rejects at the five percent level. We nevertheless investigate the implications of the point estimates below.

We cannot test formally the consistency restrictions across data sets, since the models are not nested. Nevertheless, it is important to note that, for all of the currencies, only the shorter-term expectations at the one-week and one-month horizons are related positively to the past exchange rate change. Bandwagon expectations do not appear, however, at any of the longer horizons: the coefficients are negative. Thus, even though we cannot test formally the hypothesis that across surveys the coefficients are the same, the point estimates decline systematically and substantially as the forecast horizon is increased. As we will see in the graphs below, the fact that the short-term estimates are negative and long-term estimates are positive indicates that the short-term expectations will overreact in comparison with long-term expectations.

Tables 5, 6, and 7 present estimates for each of the three surveys when P is set to 2. While in some cases the added coefficients are statistically significant, they have no effect on the $a_{j,1}$ coefficients reported in Tables 2, 3, and 4. The Wald tests for the Economist data in Table 5 continue to reject the null hypothesis that expectations are consistent. The New York MMS data set in Tables 6, however, now rejects consistency restrictions in 2 out of 4 currencies (the Swiss franc and yen), both at significance levels of five percent. The London MMS data in Table 7, however, do not reject the hypothesis of consistency for any of the currencies.

3.4. Graphical Results

Because of the complexity of the cross equation restrictions given by equations (11) and (12), it is difficult to interpret the economic importance of either the Wald test statistics or the parameter estimates in Tables 2 through 7. In this section we therefore look at the graphical implications of our results for the future spot rate path. The pictures can give us a sense (which a Wald statistic cannot) both of the qualitative importance of any inconsistencies, and, more importantly, for whether consistency fails because short-term expectations move too much or too little with respect to long-term expectations.

Consider the following experiment. Assume the exchange rate is a steady state in which current and past exchange rate changes are equal to zero.[15] We then shock the spot rate and trace out its expected future path as implied by both the short- and long-horizon forecasts. The graphs of these experiments are presented below.[16]

Figures 1 through 5 depict the expected future path for each of the five currencies in the Economist survey in the case where $P = 1$. The initial exchange rate appreciation is one percent. All of the figures show that the ultimate expected effect of an exchange rate shock depends substantially on whether three, six, or twelve month expectations are iterated forward. For example, the paths in Figure 1 for the British pound imply that when the current spot rate is perturbed by 1.0 percent, the long-run spot rate predicted by the three-month expectations is $(.88\text{-}.80)/.80 = 0.10$ percent higher than the long-run level predicted by the six-month expectations, and $(.88\text{-}.72)/.72 = 0.22$ percent higher than the long-run level predicted by the twelve-month expectations. Across all five graphs, a clear pattern emerges: a positive exchange rate shock generates a higher expected long run value of the spot rate when shorter-run expectations are used than when longer-run expectations are used. Notice, however, that for all three forecasting equations, part of the original one percent dollar appreciation is undone, so that the long-run value increases less than proportionately in response to current shocks.

Figures 6 through 9, and 10 through 13 show the expected future path when $P = 1$ for the New York and London MMS data sets, respectively. As a group these graphs exhibit two distinctive properties. The first is that within each data set, the one-week expectations overreact to an exchange rate shock in comparison with the one-month expectations. This is the same pattern we saw above. The second distinctive feature of these figures involves a comparison with the Economist graphs. In the MMS data sets, the long run equilibrium

[15] In order to focus on the dynamics of the system, we set the constant terms in equation (13) equal to zero in this experiment.

[16] The paths are constructed by iterating each forecast equation forward, and applying the conditional expectation operator. From equation (1) it is easy to see that using the short forecast horizon ($k = 1$) we can generate consecutive future expected changes. Note that at longer forecast horizons of, say, k periods, forecasts of the spot rate k, $2k$, $3k$, ..., periods in advance are produced by equation (3). However, even when $P = 1$, these forecasts, themselves require forecasts of the spot rate change in $2k - 1$, $3k - 1$, ..., periods into the future. We used the predictions from the short-horizon equation for the expected change between periods nk and $nk - 1$. This procedure is unbiased under the null hypothesis, which states that expectations are consistent. If expectations are not consistent, then this method tends to minimize the observed deviations from consistency.

spot rate increases more than proportionately in response to an exchange rate shock. This is a pattern precisely opposite to that demonstrated in the Economist data. Nevertheless, it is still consistent with the finding that shorter-term expectations appear to be more sensitive to exchange rate shocks that are longer-term expectations.

Graphs 14 through 26 parallel exactly the earlier set, with P set to 2. The qualitative results are the same here as when P was fixed at 1. If anything the increase in the order of the distributed lag increases the visual appearance of the overreaction of short-term forecasts relative to long-term forecasts (especially in the MMS data, Figures 6-13 and 19-26).

4. Conclusions

We have derived a property, called consistency, which all rational forecasts have, but which itself does not require rationality. Our tests using survey data on exchange rate expectations indicate that expectations generally fail to be consistent. Most striking is the particular way in which investors fail to coordinate their predictions: in their shorter-term forecasts, investors tend to exaggerate the implications of current exchange rate changes for the value of the spot rate further into the future. If longer-term forecasts are used as the norm, shorter-term expectations overreact to current exchange rate changes.

One possible way to explain the failure of expectations to be consistent is to think of agents using different models to forecast the spot rate at short versus long horizons, and a blend in between. Frankel and Froot (1986), for example, model the expectations of "chartists" and "fundamentalists" and suggest that agents form expectations by weighting these views according to their own expected trading horizon (with chartist views more important for short horizons, and fundamentalists views more important for long horizons). But obviously, no single explanation of our findings can be completely satisfying, since a failure of consistency implies that expectations cannot be rational.

A second way to explain the rejections of consistency would be that the survey data systematically mismeasure the market's true expectation.[17] If, for example, agents report repeatedly the mode rather than the mean of their subjective distribution, then there is no reason that consistency should hold in these data. Nevertheless, when we tried to test the restrictions developed above using the forward discount in place of the survey measure of expected depreciation, we found results similar to those reported in Tables 2 through 7. We do not present these results, however, because of the difficulty in interpreting them in view of the likely contamination of the forward market data by an exchange risk premium.[18] Nevertheless, one could interpret these results as suggesting that the

[17] We are grateful to Larry Summers for the following point.

[18] In the forward market tests, the coefficients were smaller in absolute value than those presented in Tables 2 - 7, but very similar in sign and statistical significance. In addition, the results of consistency tests were similar to those reported above.

explanation for inconsistency found in the survey data is not solely a result of a tendency to mismeasure expectations.

One important caveat to keep in mind when interpreting our tests is that the expectations process may not be described completely by the observable history of spot rate changes. If other variables matter for expectations, then our results may be biased, although it is not obvious why the bias would produce the persistent appearance of overreaction in short-term expectations.

5. References

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TABLE 1
Description of Data

survey source & frequency	sample period	forecast horizons	Currencies
Economist six-weekly	6/1981 - 8/1987	3, 6, 12 months	BP DM JY SF FF
MMS New York weekly	4/1984 - 4/1987	1 week, 1 month	BP DM JY SF
MMS London weekly	4/1984 - 4/1987	1 week, 1 month	BP DM JY SF

Notes: BP = British pound
DM = German mark
JY = Japanese yen
SF = Swiss franc
FF = French franc

ECONOMIST DATA

Figure 1

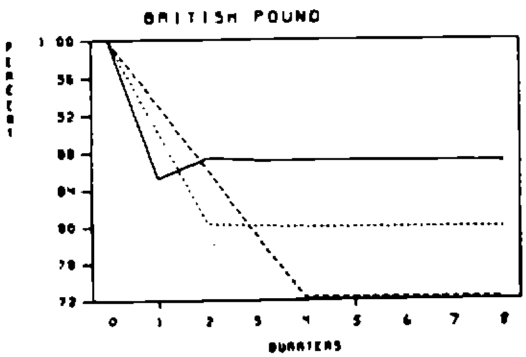
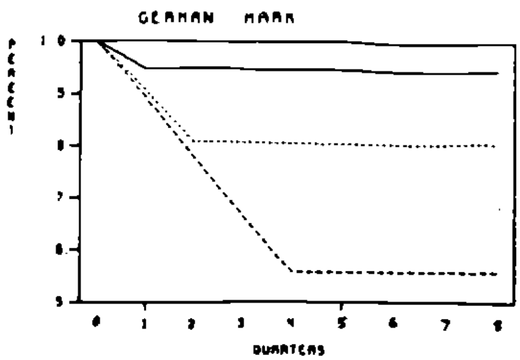


Figure 2



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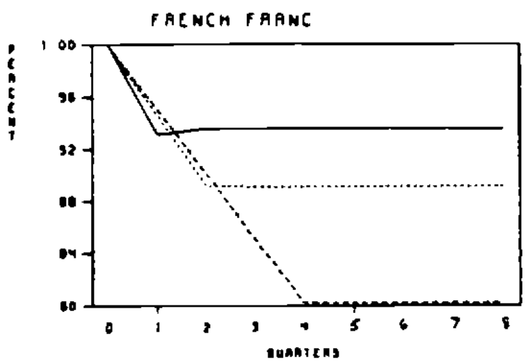

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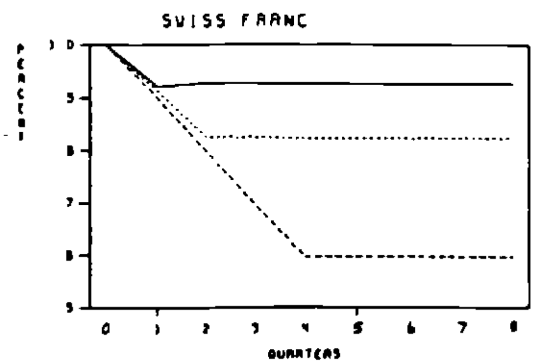

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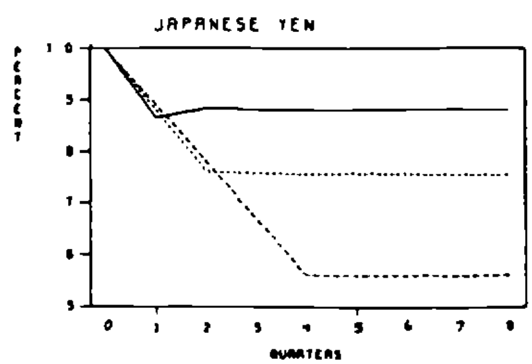
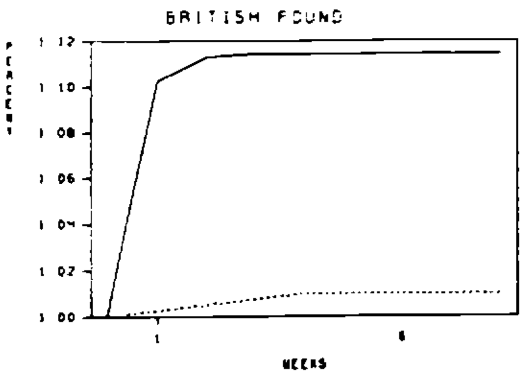


3MO	——
6MO	----
1YR	— —

MMS NEW YORK DATA

Figure 6



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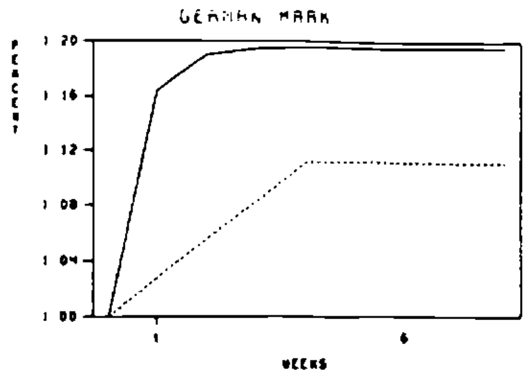

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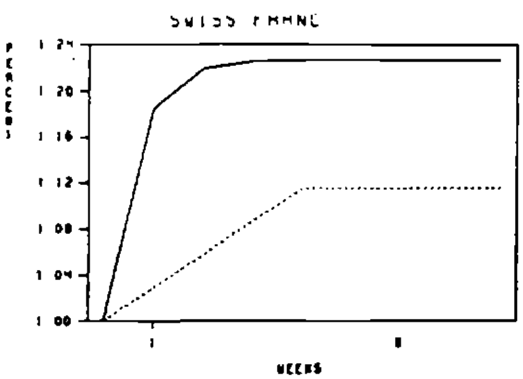

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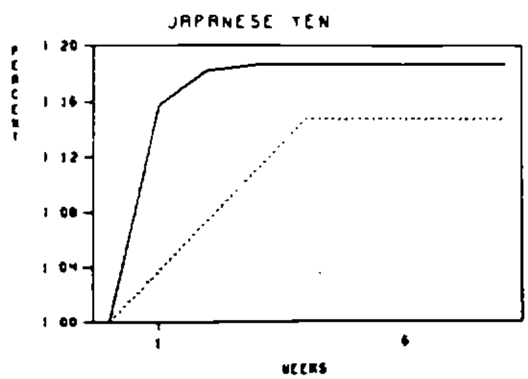

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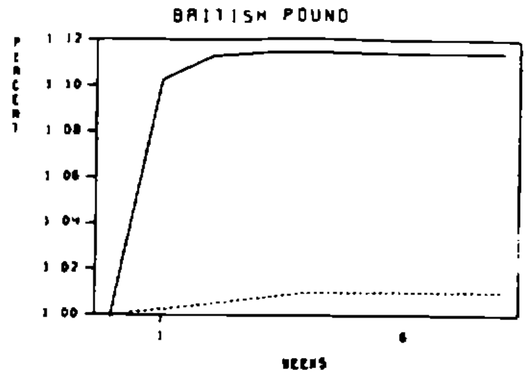
1MO	- - -

MMS LONDON DATA

Figure 10



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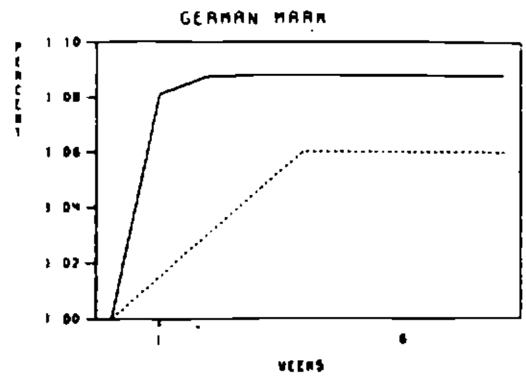

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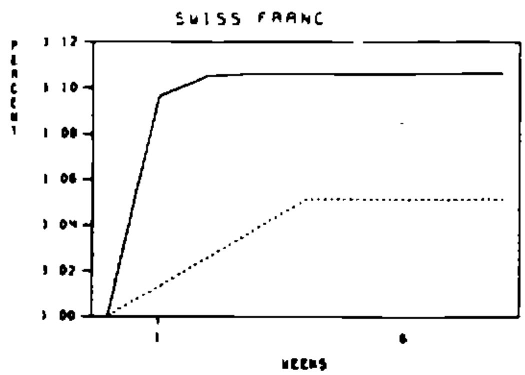

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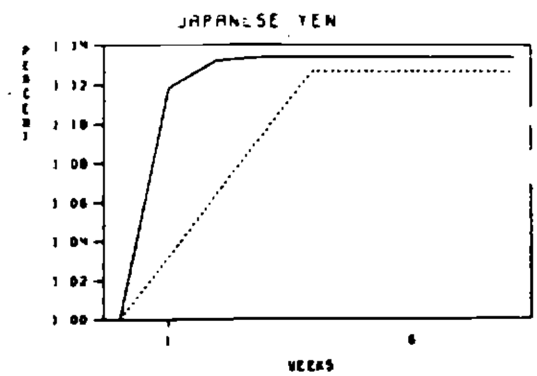

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1MO	---

ECONOMIST DATA

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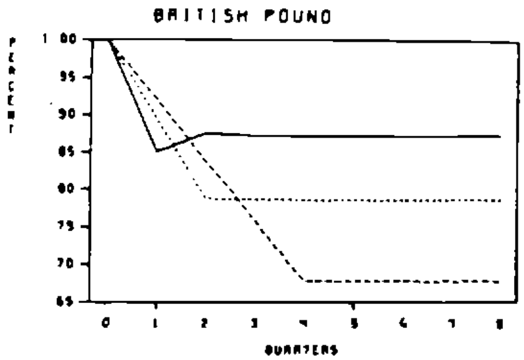

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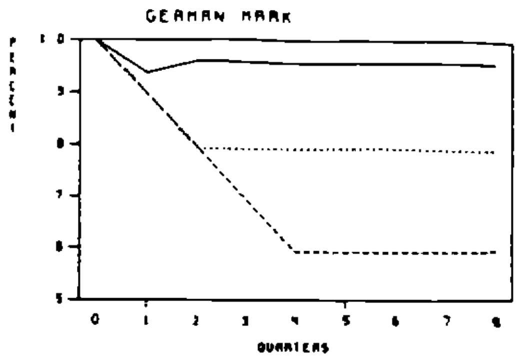

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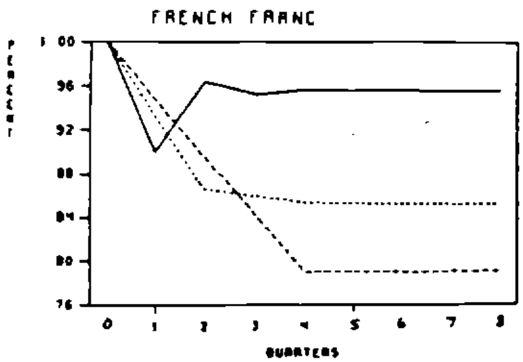

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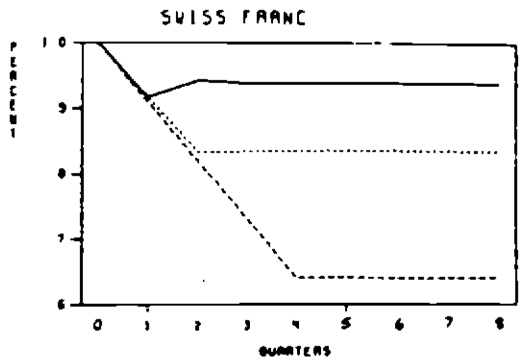

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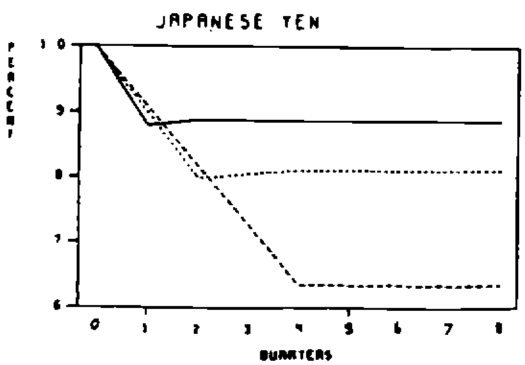
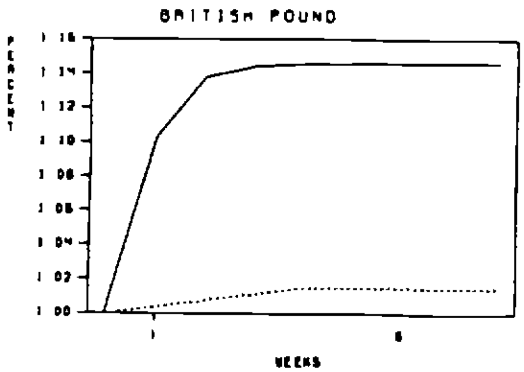


MMS NEW YORK DATA

Figure 19



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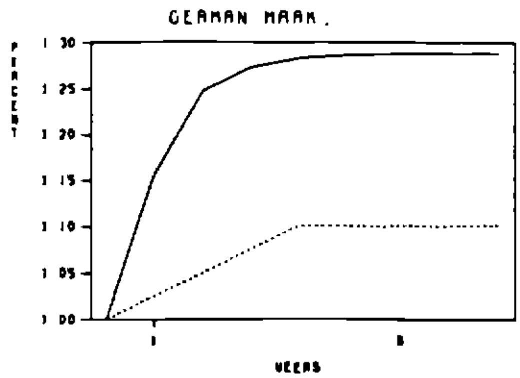

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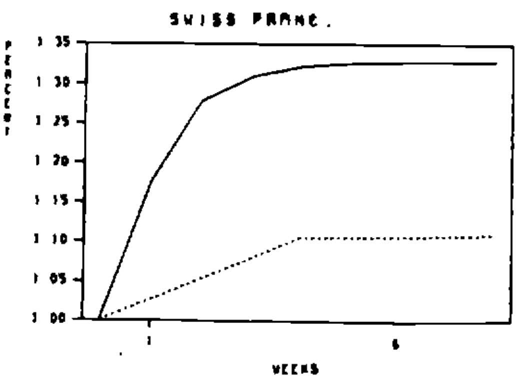

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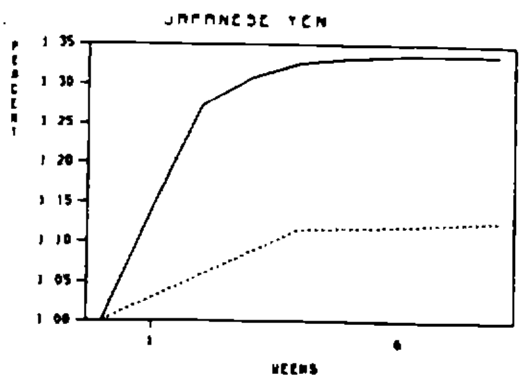
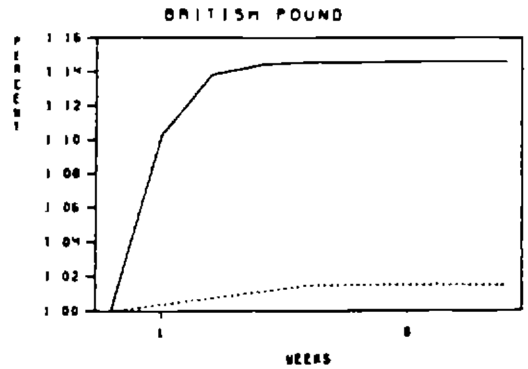


1WK —
1MO ---

MMS LONDON DATA

Figure 23



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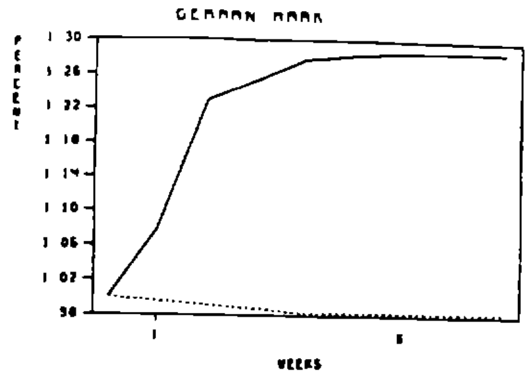

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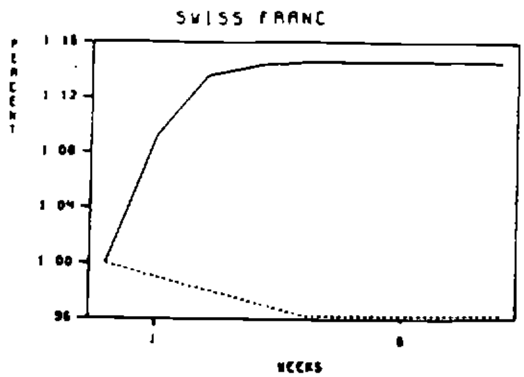

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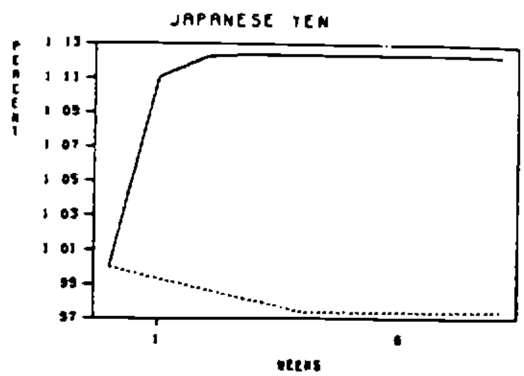

1WK	—
1MO	---

Table 2
Economist Survey

6/81 - 6/87, each 6 weeks

Regressions of: $s_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + u_{k,t}$

Currency	Forecast Horizon (k)	γ_k	$a_{k,1}$	DF	DW	F-Test $\gamma_k = a_{k,1} = 0$	Wald Test for Consistency
British pound	3 months	.0055 (.0031)	-.1480 (.0432)	144	1.07	6.06***	12.68***
	6 months	.0629 (.0024)	-.1966 (.0438)				
	12 months	.0152 (.0051)	-.2776 (.0855)				
German mark	3 months	.0290 (.0028)	-.0557 (.0373)	144	1.05	83.64***	32.28***
	6 months	.0269 (.0026)	-.1934 (.0571)				
	12 months	.0637 (.0049)	-.4426 (.0808)				
French franc	3 months	.0128 (.0022)	-.0686 (.0315)	144	1.33	12.24***	7.80*
	6 months	.0076 (.0027)	-.1085 (.0545)				
	12 months	.0179 (.0047)	-.1980 (.0830)				
Swiss franc	3 months	.0303 (.0024)	-.0794 (.0370)	144	1.51	126.18***	37.02***
	6 months	.0268 (.0025)	-.1750 (.0542)				
	12 months	.0636 (.0043)	-.4036 (.0677)				
Japanese yen	3 months	.0317 (.0032)	-.1349 (.0418)	144	1.26	64.38***	73.59***
	6 months	.0286 (.0023)	-.2394 (.0463)				
	12 months	.0670 (.0039)	-.4389 (.0060)				

Notes: *, **, *** represent statistical significance at the 10, 5, and 1 percent levels, respectively. GMM standard errors, which allow for conditional heteroskedasticity and serial correlation, are in parenthesis.

Table 3
New York MMS Survey

4/84 - 4/87, weekly

Regressions of $S_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + u_{k,t}$

Currency	Forecast Horizon (k)	γ_k	$a_{k,1}$	DF	DW	F-Test $\gamma_k = a_{k,1} = 0$	Wald Test for Consistency
British pound	1 week	-.0015 (.0008)	.1026 (.0424)	220	1.69	2.63***	0.82
	1 month	-.0025 (.0013)	.0099 (.0925)				
German mark	1 week	.0022 (.0011)	.1604 (.0502)	220	1.64	6.17***	1.75
	1 month	.0031 (.0015)	.1118 (.1025)				
Swiss franc	1 week	.0029 (.0009)	.1866 (.0430)	219	1.77	10.04***	5.35*
	1 month	.0036 (.0014)	.1152 (.0892)				
Japanese yen	1 week	.0021 (.0007)	.1573 (.0540)	220	1.68	9.59***	1.85
	1 month	.0042 (.0010)	.1474 (.0651)				

Notes: *, **, *** represent statistical significance at the 10, 5, and 1 percent levels, respectively. GMM standard errors, which allow for conditional heteroskedasticity and seri correlation, are in parenthesis.

Table 4

London MMS Survey

4/84 - 4/87, weekly

Regressions of $S_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + u_{k,t}$

Currency	Forecast Horizon (k)	γ_k	$a_{k,1}$	DF	DW	F-Test $\gamma_k = a_{k,1} = 0$	Wald Test for Consistency
British pound	1 week	-.0014 (.0009)	.0293 (.0435)	201	1.93	1.27	1.62
	1 month	-.0006 (.0013)	-.0591 (.1099)				
German mark	1 week	.0015 (.0008)	.0810 (.0435)	205	1.92	3.09***	0.11
	1 month	.0040 (.0016)	.0602 (.1058)				
Swiss franc	1 week	.0016 (.0011)	.0961 (.0484)	203	1.89	2.75***	0.34
	1 month	.0034 (.0016)	.0515 (.0882)				
Japanese yen	1 week	.0009 (.0006)	.1182 (.0472)	204	1.83	3.91***	0.07
	1 month	.0035 (.0013)	.1266 (.0775)				

Notes: *, **, *** represent statistical significance at the 10, 5, and 1 percent levels, respectively. GMM standard errors, which allow for conditional heteroskedasticity and serial correlation, are in parenthesis.

Table 5
Economist Survey

6/81 - 6/87, each 6 weeks

Regressions of: $s_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + a_{k,2}e_{1,t-1} + u_{k,t}$

Currency	Forecast Horizon (k)	γk	$a_{k\cdot 1}$	$a_{k\cdot 2}$	DF	DW	F-Test $k=a_{k\cdot 1}=a_{k\cdot 2}=0$	Wald Test for Consistency
British pound	3 months	.0057	-.1496	.0037	141	1.05	5.39***	19.48***
		(.0028)	(.0490)	(.0490)				
	6 months	.0063	-.2117	.0270				
		(.0026)	(.0499)	(.0569)				
	12 months	.0150	-.3225	-.1282				
		(.0042)	(.0804)	(.0794)				
German mark	3 months	.0290	-.0632	.0185	141	1.10	81.53***	60.10***
		(.0030)	(.0459)	(.0468)				
	6 months	.0282	-.2079	-.0519				
		(.0023)	(.0607)	(.0527)				
	12 months	.0662	-.4080	-.2860				
		(.0036)	(.0659)	(.0560)				
French franc	3 months	.0135	-.1000	.0541	141	1.37	9.91***	25.12***
		(.0020)	(.0390)	(.0373)				
	6 months	.0075	-.1349	.0321				
		(.0025)	(.0698)	(.0540)				
	12 months	.0175	-.2095	-.0643				
		(.0043)	(.1003)	(.0776)				
Swiss franc	3 months	.03008	-.0823	.0187	141	1.40	79.53***	71.14***
		(.0028)	(.0401)	(.0334)				
	6 months	.0297	-.1654	.0671				
		(.0023)	(.0548)	(.0491)				
	12 months	.0657	-.3599	-.2187				
		(.0034)	(.0547)	(.0486)				
Japanese yen	3 months	.0311	-.1197	-.0064	141	1.22	80.50***	142.88***
		(.0036)	(.0441)	(.0424)				
	6 months	.0296	-.2020	-.1256				
		(.0022)	(.0437)	(.0455)				
	12 months	.0687	-.3664	-.2678				
		(.0032)	(.0521)	(.0488)				

Notes: *, **, *** represent statistical significance at the 10, 5, and 1 per cent levels, respectively. GMM standard errors, which allow for conditional heteroskedasticity and serial correlation, are in parenthesis.

Table 6
New York MMS Survey

4/84 - 4/87, weekly

Regressions of $S_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + a_{k,2}e_{1,t-1} + u_{k,t}$

Currency	Forecast Horizon (k)	γ_k	$a_{k,1}$	$a_{k,2}$	DF	DW	F-Test $\gamma_k = a_{k,1} = a_{k,2} = 0$	Wald Test for Consistency
British pound	1 week	-.0015 (.0008)	.1024 (.0415)	.0223 (.0835)	216	1.69	2.10*	1.37
	1 month	-.0024 (.0013)	.0164 (.0933)	.0009 (.1191)				
German mark	1 week	.0019 (.0009)	.1527 (.0509)	.0694 .0635	216	1.65	4.36***	3.03
	1 month	.0031 (.0015)	.0991 (.1050)	.0933 (.1075)				
Swiss franc	1 week	.0027 (.0008)	.1787 (.0424)	.0692 .0453	215	1.78	8.01***	10.99**
	1 month	.0034 (.0014)	.1060 (.0871)	.1030 (.0814)				
Japanese yen	1 week	.0017 (.0007)	.1419 (.0567)	.1107 (.0563)	216	1.65	9.73***	11.15**
	1 month	.0037 (.0010)	.1150 (.0694)	.2254 (.0697)				

Notes: *, **, *** represent statistical significance at the 10, 5, and 1 percent levels, respectively. GMM standard errors, which allow for conditional heteroskedasticity and seri correlation, are in parenthesis.

Table 7

London MMS Survey

4/84 - 4/87, weekly

Regressions of $S_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + a_{k,2}e_{1,t-1} + u_{k,t}$

Currency	Forecast Horizon (k)	γ_k	$a_{k,1}$	$a_{k,2}$	DF	DW	F-Test $\gamma_k = a_{k,1} = a_{k,2} = 0$	Wald Test for Consistency
British pound	1 week	-.0014 (.0007)	.0296 (.0443)	.0258 (.0428)	198	1.95	0.78	1.43
	1 month	-.0007 (.0013)	-.0519 (.1172)	.0361 (.0846)				
German mark	1 week	.0014 (.0007)	.0775 (.0421)	.0604 (.0405)	202	1.97	3.59***	2.09
	1 month	.0037 (.0017)	.0689 (.1096)	.1238 (.0906)				
Swiss franc	1 week	.0015 (.0012)	.0928 (.0487)	.0552 (.0488)	200	1.89	2.29***	2.67
	1 month	.0033 (.0016)	.0582 (.0928)	.1076 (.1007)				
Japanese yen	1 week	.0007 (.0006)	.1104 (.0414)	.0839 (.0437)	201	1.87	4.20***	2.26
	1 month	.0037 (.0013)	.1106 (.0806)	.0830 (.1042)				

Notes: *, **, *** represent statistical significance at the 10, 5, and 1 percent levels, respectively. GMM standard errors, which allow for conditional heteroskedasticity and serial correlation, are in parenthesis.