On the consistency of short-run and long-run exchange rate expectations

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This paper examines whether short-term exchange rate expectations 'overreact' 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 investors 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.

The failure of standard models to explain the extraordinary dollar cycle of the 1980s has led some economists to reconsider the Keynesian view that expectations may overreact to recent information.[1] Short-term exchange rate expectations, in particular, are often criticized on this score. Nurkse (1944), for instance, is cited frequently for his fear that short-term expectations are 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.

How might one evaluate these claims of overreaction? Perhaps the most direct

method would be to compare the stochastic processes generating expected and
actual spot-rate changes. If expected changes display bandwagon effects, but actual
changes do not, then there might be a case for overreaction. Frankel and Froot
(1987b, 1988) use survey data on exchange rate expectations to estimate the
expected and actual spot processes separately. They find that shorter-term
expectations exhibit Nurske's bandwagon effects while longer-term expectations
do not. But they cannot reject the hypothesis that bandwagon predictions are
rational if agents are limited to current and past exchange rate changes.
Unfortunately, these tests of rational expectations are unlikely to be very
informative. They suffer from low power in distinguishing among nearby
alternatives and from inconsistent small-sample inferences in the presence of peso
problems and bubbles.[2]

In this paper, we use a different and potentially more reliable metric than the
realized spot rate to judge whether short-term expectations overreact: 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.

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 actual exchange rates. 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 short-run
forecasts.

Naturally, if we are to examine the behavior of expectations without requiring it
to match 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 four different surveys of exchange rate expectations. Each of the surveys
simultaneously elicits expectations at several forecast horizons, allowing us to test
whether the responses of each survey are consistent. The variety of survey sources
helps to ensure that our results are not due to the particularities of a single small
sample. The variety forecast horizons—ranging from one week to one
year—allows us to test for consistency across the term structure of agents'
expectations.

To preview our results, the statistical evidence presented below indicates that
expectations do exhibit inconsistencies. Although the inconsistency between
short-term forecasts of one week and one month is not statistically significant, one-,
three-, six-, and 12-month expectations all appear to be statistically inconsistent
with one another. In terms of economic (rather than statistical) significance,
however, the data display a striking similarity across all 20 sets of forecast horizons,
currencies, and surveys: *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 I defines the property of
consistency and develops the cross-equation restrictions needed to test it. The
results of our tests are presented in Section II. Section III concludes.

I. Consistency

Let $e_{k, t+k}$ 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 $m_{k, t+k}$. 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, $a_1(L)e_{1, t}$, plus other residual factors that are conditionally independent of current and past exchange rate changes:[3]

$$\langle 1 \rangle \qquad m_{1, t+1} = \gamma_1 + a_1(L)e_{1, t} + \mu_{1, t},$$

where

$$\langle 2 \rangle \qquad E(\mu_{1, t} | e_{1, t} \ldots e_{1, t-P+1}) = 0,$$

L is the lag operator, and P is the order of the autoregression.[4] 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. The lack of serial correlation in exchange rate changes suggests that our parameter estimates will be robust to misspecification of P.

Similar to equation $\langle 1 \rangle$, the market's expectation of depreciation over the subsequent k periods is given by:

$$\langle 3 \rangle \qquad m_{k, t+k} = \gamma_k + a_k(L)e_{1, t} + \mu_{k, t},$$

and we assume

$$\langle 4 \rangle \qquad E(\mu_{k, t} | e_{1, t}, \ldots, e_{1, t-P+1}) = 0.$$

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

Note that it is always possible to express the upcoming spot rate change in terms of the same linear combination of current and past changes as equation $\langle 1 \rangle$, plus a new residual:

$$\langle 5 \rangle \qquad e_{1, t+1} = \gamma_1 + a_1(L)e_{1, t} + \varepsilon_{1, t+1},$$

where $\varepsilon_{1, t+1} = \mu_{1, t} + \eta_{1, t+1}$, and $\eta_{1, t+1}$ is the prediction error made by the market. Equation $\langle 5 \rangle$ is *not* a substantive statement about the actual spot process: the prediction error $\eta_{1, t+1}$ may be correlated with current and lagged spot rate changes or with other information available at time t.

To move backwards from equation $\langle 5 \rangle$ to $\langle 1 \rangle$ we define the operator, E_t^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:

$$\langle 6 \rangle \qquad E_t^m(e_{1, t+1}) = \gamma_1 + a_1(L)e_{1, t} + E_t^m(\varepsilon_{1, t+1}),$$

where by construction, $E_t^m(e_{1, t+1}) = m_{1, t+1}$ and $E_t^m(\varepsilon_{1, t+1}) = \mu_{1, t}$.

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), $E_t^m(\cdot) = E_t(\cdot)$. In that case, equation $\langle 6 \rangle$ represents a standard vector-autoregressive model of exchange rate changes. Having made this assumption, we could estimate consistently the

expectational parameter vector, $\mathbf{a}_1(L)$, from equation $\langle 5 \rangle$ with ordinary least squares (OLS). However, if the subjective and objective densities are not precisely equal, then estimation of equation $\langle 5 \rangle$ will *not* generally produce consistent estimates of $\mathbf{a}_1(L)$. In such a case, the objective conditional expectation of the prediction error will generally differ from zero, $E_t(\eta_{1,t+1}|\mathbf{e}_{1,t}\cdots\mathbf{e}_{t-P+1})\neq 0$. Because we are interested in the particular linear combination used in forming expectations, we estimate equation $\langle 6 \rangle$ directly. This procedure is more general than one which relies on equation $\langle 5 \rangle$, since it allows for, but does not impose, the restriction that agents know the conditional density function of the sample spot process.

To develop our test of consistency, we express the long-horizon forecasts in equation $\langle 3 \rangle$ in terms of the parameters from equation $\langle 1 \rangle$. To do this we first rewrite equation $\langle 5 \rangle$ as a first-order autoregressive system:

$$\langle 7 \rangle \qquad\qquad \mathbf{x}_{1,t+1} = \boldsymbol{\Gamma} + \mathbf{A}\mathbf{x}_{1,t} + \varepsilon_{t+1},$$

which is given by

$$
\begin{pmatrix} \mathbf{e}_{1,t+1} \\ \mathbf{e}_{1,t} \\ \vdots \\ \mathbf{e}_{1,t-P+2} \end{pmatrix} = \begin{pmatrix} \gamma_1 \\ 0 \\ \vdots \\ 0 \end{pmatrix} + \begin{pmatrix} a_{1,1} & \cdots & a_{1,P-1} & a_{1,P} \\ 1 & \cdots & 0 & 0 \\ & \ddots & & \\ 0 & \cdots & 1 & 0 \end{pmatrix} \begin{pmatrix} \mathbf{e}_{1,t} \\ \vdots \\ \mathbf{e}_{1,t-P+2} \\ \mathbf{e}_{1,t-P+1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t-1} \\ 0 \\ \vdots \\ 0 \end{pmatrix}.
$$

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

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

$$\langle 8 \rangle \qquad E_t^m(\mathbf{x}_{1,t+j}) = \sum_{i=0}^{j-1} \mathbf{A}^i \boldsymbol{\Gamma} + \mathbf{A}^j \mathbf{x}_{1,t} + E_t^m\left(\sum_{i=0}^{j-1} \mathbf{A}^i \varepsilon_{t+t-i}\right)$$

$$= (\mathbf{I}_P - \mathbf{A}^j)(\mathbf{I}_P - \mathbf{A})^{-1} + \mathbf{A}^j\mathbf{x}_{1,t} + E_t^m(\varepsilon'_{t+j}).$$

Equation $\langle 8 \rangle$ 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 $\langle 8 \rangle$ to form the expected k-period change given in equation $\langle 3 \rangle$. 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 $\langle 8 \rangle$ we have:

$$\langle 9 \rangle \qquad E_t^m(\mathbf{x}_{k,t+k}) = (k\mathbf{I}_P - (\mathbf{A}^{k+1} - \mathbf{A})(\mathbf{I}_P - \mathbf{A})^{-1})(\mathbf{I}_P - \mathbf{A})^{-1}\boldsymbol{\Gamma}$$

$$+ (\mathbf{A} - \mathbf{A}^{k+1})(\mathbf{I}_P - \mathbf{A})^{-1}\mathbf{x}_{1,t} + E_t^m\left(\sum_{j=1}^k \varepsilon'_{t+j}\right),$$

where by construction, $E_t^m(\mathbf{x}_{k,t+k}) = \mathbf{m}_{k,t+k}$. Finally, define the $P \times 1$ selection vector, $\mathbf{g}' \equiv (1\ 0\ \ldots\ 0)$. We now state the main proposition of the paper:[5]

Proposition: Given that short-term expectations are formed according to equation $\langle 1 \rangle$, long-term expectations are *consistent* if and only if the restrictions:

$$\langle 10 \rangle \qquad \gamma_k = \mathbf{g}'(k\mathbf{I}_P - (\mathbf{A}^{k+1} - \mathbf{A})(\mathbf{I}_P - \mathbf{A})^{-1})(\mathbf{I}_P - \mathbf{A})^{-1}\boldsymbol{\Gamma},$$

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

$$\langle 12 \rangle \qquad \mu_{k,t} = E_t^m \left(\sum_{j=1}^{k} \mathbf{g}' \varepsilon_{t+j}' \right) = E_t^m \left(\sum_{j=1}^{k} \sum_{i=0}^{j-1} \mathbf{g}' \mathbf{A}^i \varepsilon_{t+j-i} \right),$$

are satisfied.

Provided that the assumptions given in equations $\langle 2 \rangle$ and $\langle 4 \rangle$ hold, the parameters in equations $\langle 1 \rangle$ and $\langle 3 \rangle$ can be estimated consistently—in a statistical sense—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 $P = 1$. Then equation $\langle 11 \rangle$ 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 $\langle 11 \rangle$ implies that a_1 always has the same sign as a_k. If agents have short-term bandwagon expectations—by which we mean they extrapolate past exchange rate changes into the future—then they must have long-term bandwagon expectations if their expectations are to be consistent. Provided that the model in equation $\langle 1 \rangle$ 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.[6]

II. Tests of consistency

II.A. Data

Our independent measure of the market's expected future spot rate is the median survey response from four ongoing exchange rate surveys. The first survey is conducted by the *Economist Financial Report*. Each six weeks since mid-1981, the Report has polled currency-room traders and economists at 14 major banks for their expectations of the value of the dollar against five currencies (the pound, French franc, Deutsche mark, Swiss franc, and yen) in three-, six-, and 12-months' time. The second and third surveys have been conducted by phone 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 London and New York branches of MMS separately conduct their own local surveys, so there is no overlap in respondents.[7] The fourth survey was conducted by the Japan Center for International Finance (JCIF) each two weeks from May 1985 to July 1987. This survey, also conducted by phone, canvases the views of 44 foreign-exchange experts in financial-services and traded-goods industries. It is of the yen/dollar rate at one-, three-, and six-month horizons.[8] Table 1 summarizes the coverage of the four data sets.

It is worth emphasizing that we do not treat the survey responses as though they are a perfect measure of the (unobservable) market expectation. We assume that the median investor's expectation reported by each survey is an imprecise estimate of the market's expectation. Measurement error in the surveys might arise from a number of sources. When investors have different beliefs, but aggregable demands (so the concept of a unique 'market' expectation still makes sense), the market expectation is a weighted average of investors' expectations, with weights

TABLE 1. Description of data.

Survey source and 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
JCIF Tokyo biweekly	5/1985–6/1987	1, 3, 6 months	JY

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

reflecting risk tolerance and/or wealth.[9] If risk tolerance and wealth are independent of beliefs, the median response will be an unbiased estimate of the aggregate expectation. The surveys may also contain measurement error because only a subsample of the investor population is represented. As with any sampling method, the 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 $\langle 1 \rangle$ and $\langle 3 \rangle$, any measurement error in the surveys will end up in the contemporaneous residuals, $\mu_{1,t}$ and $\mu_{k,t}$, and will not affect our tests of consistency.

II.B. Estimation

We estimate systems of the form:

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

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 $\langle 13 \rangle$ 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 $\mu_{1,t}$ and $\mu_{k,t}$ are purely random measurement errors, 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 $\langle 12 \rangle$, consistency implies that $\mu_{k,t} = E_t^m(\sum_{j=1}^k \sum_{i=0}^{j-1} \mathbf{g}'\mathbf{A}^i\varepsilon_{t+j-1})$. This term will in general be correlated with $E_{t+1}^m(\sum_{j=1}^k \sum_{i=0}^{j-1} \mathbf{g}'\mathbf{A}^i\varepsilon_{t+j})$ since by the law of iterated projections, the conditional expectation of a future variable follows a martingale. 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). We also allow for conditional heteroskedasticity in the residuals. 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.[10] To guarantee that our estimate of the covariance matrix is positive definite, we follow Newey and West (1985) by multiplying lth-order autocovariances by $1 - l/(T^{0.25} + 1)$, 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 qualitative nature of the results does not depend on the precise value of P.

II.C. Regression results

Our first set of tables contains estimates of the system described by equation $\langle 13 \rangle$ for the case in which P is set to 1. The second set allows P to be 2. In order to gain a sense for the economic importance of our formal consistency tests, we turn in the next subsection 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 12 months, so the system in equation $\langle 13 \rangle$ must be extended to allow for three equations instead of two. Table 2 shows that the coefficients on the current exchange rate change, $a_{i,1}$, $i = 3, 6, 12$ months, are statistically less than zero. In the case of the British pound, for example, the point estimates imply that a 10 per cent dollar appreciation over the past three months leads to an expected depreciation of 1.5, 2.0, and 2.8 per cent over the following three, six, and 12 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 $\langle 10 \rangle$ and $\langle 11 \rangle$. 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, six out of eight of these are statistically positive at the 5 per cent level. By

TABLE 2. *Economist* survey.

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

6/81–6/87, each 6 weeks

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	0.0055 (0.0031)	−0.1480 (0.0432)	144	1.07	6.06***	12.68***
	6 months	0.0629 (0.0024)	−0.1966 (0.0438)				
	12 months	0.0152 (0.0051)	−0.2776 (0.0855)				
German mark	3 months	0.0290 (0.0028)	−0.0557 (0.0373)	144	1.05	83.64***	32.28***
	6 months	0.0269 (0.0026)	−0.1934 (0.0571)				
	12 months	0.0637 (0.0049)	−0.4426 (0.0808)				
French franc	3 months	0.0128 (0.0022)	−0.0686 (0.0315)	144	1.33	12.24***	7.80*
	6 months	0.0076 (0.0027)	−0.1085 (0.0545)				
	12 months	0.0179 (0.0047)	−0.1980 (0.0830)				
Swiss franc	3 months	0.0303 (0.0024)	−0.0794 (0.0370)	144	1.51	126.18***	37.02***
	6 months	0.0268 (0.0025)	−0.1750 (0.0542)				
	12 months	0.0636 (0.0043)	−0.4036 (0.0677)				
Japanese yen	3 months	0.0317 (0.0032)	−0.1349 (0.0418)	144	1.26	64.38***	73.59***
	6 months	0.0286 (0.0023)	−0.2394 (0.0463)				
	12 months	0.0670 (0.0039)	−0.4389 (0.060)				

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 parentheses.

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 per cent dollar appreciation over the past week leads investors to expect on average an additional 1.0 per cent *appreciation* over the following week and a 0.1 per cent *appreciation* over the following month. In these tables, there is little evidence against consistency: only one of the Wald tests rejects at the 5 per cent level.

TABLE 3. New York MSS survey.

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

4/84–4/87, weekly

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	−0.0015 (0.0008)	0.1026 (0.0424)	220	1.69	2.63***	0.82
	1 month	−0.0025 (0.0013)	0.0099 (0.0925)				
German mark	1 week	0.0022 (0.0011)	0.1604 (0.0502)	220	1.64	6.17***	1.75
	1 month	0.0031 (0.0015)	0.1118 (0.1025)				
Swiss franc	1 week	0.0029 (0.0009)	0.1866 (0.0430)	219	1.77	10.04***	5.35*
	1 month	0.0036 (0.0014)	0.1152 (0.0892)				
Japanese yen	1 week	0.0021 (0.0007)	0.1573 (0.0540)	220	1.68	9.59***	1.85
	1 month	0.0042 (0.0010)	0.1474 (0.0651)				

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 parentheses.

Table 5 reports the results from the JCIF survey for $P = 1$. This survey is useful because the forecast horizons of one, three, and six months bridge those of the *Economist* and MMS surveys. In order to separate the comparison of one- and three-month horizons from three- and six-month horizons, we estimated the one- and three-month forecasts letting k in $\langle 13 \rangle$ indicate months, and the three- and six-month horizons letting k indicate quarters. These two sets of parameter estimates are reported in Table 5. Note that the one-month coefficient is positive, reflecting a slight bandwagon effect, while the three- and six-month coefficients are statistically negative. The top set of estimates implies that a 10 per cent dollar appreciation over the past month generates the expectation of a 0.2 per cent *appreciation* over the next month, but a 1.5 per cent *depreciation* over the next three months. The Wald tests for consistency reject strongly. Overall, the JCIF survey corroborates the finding in the earlier three surveys that expectations at horizons of one month and less exhibit bandwagon effects, while expectations at horizons longer than one month do not.

In sum, for all data sets and currencies, only the shorter-term, one-week and one-month forecasts are related positively to the past exchange rate change. One-week forecasts show particularly strong bandwagon effects. Bandwagon expectations, however, do not appear at any of the longer horizons; the coefficients are all negative. Thus, even though we cannot test formally the hypothesis that

Consistency of exchange rate expectations

TABLE 4. London MMS survey.

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

4/84–4/87, weekly

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	−0.0014 (0.0009)	0.0293 (0.0435)	201	1.93	1.27	1.62
	1 month	−0.0006 (0.0013)	−0.0591 (0.1099)				
German mark	1 week	0.0015 (0.0008)	0.0810 (0.0435)	205	1.92	3.09***	0.11
	1 month	0.0040 (0.0016)	0.0602 (0.1058)				
Swiss franc	1 week	0.0016 (0.0011)	0.0961 (0.0484)	203	1.89	2.75***	0.34
	1 month	0.0034 (0.0016)	0.0515 (0.0882)				
Japanese yen	1 week	0.0009 (0.0006)	0.1182 (0.0472)	204	1.83	3.91***	0.07
	1 month	0.0035 (0.0013)	0.1266 (0.0775)				

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 parentheses.

TABLE 5. JCIF survey.

Regression of: $S_{t,t+k} = \gamma_k + a_{k,1}e_{1,t} + \mu_{k,t}$

5/85–6/87, biweekly

Currency	Forecast horizon	γ_k	$a_{k,1}$	DF	DW	F-test $\gamma_k = a_{k,1} = 0$	Wald test
yen	1 month	−0.0148 (0.0012)	0.0285 (0.0196)	43	1.41	240.12***	
							546.13***
	3 month	−0.0187 (0.0033)	−0.1489 (0.0430)	43	0.50	33.94***	
yen	3 month	−0.0226 (0.0026)	−0.0785 (0.0260)	37	0.56	86.11***	
							1483.3***
	6 month	−0.0172 (0.0050)	−0.2538 (0.0641)	37	0.46	16.22***	

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 parentheses.

across surveys the coefficients are the same, the point estimates match up at each forecast horizon, declining systematically as the forecast horizon is increased, and becoming negative at forecast horizons greater than one month. As we will see in the graphs below, the fact that the short-term estimates are negative, and long-term estimates positive, indicates that the short-term expectations will overreact in comparison with long-term expectations.

Tables 6–9 present estimates for each of the four surveys when P is set to 2. While in some cases the added coefficients are statistically significant, they have no important effect on the $a_{i,1}$ coefficients reported in Tables 2–5. The Wald tests for the *Economist* data in Table 6 and the JCIF data in Table 9 continue to reject the null hypothesis that expectations are consistent. The New York MMS data set in Table 7 rejects the consistency restrictions in 2 out of 4 currencies (the Swiss franc and yen), both at significance levels of 5 per cent. The London MMS data in Table 8, however, do not reject the hypothesis of consistency for any of the currencies.

II.D. Graphical results

Because of the complexity of the cross equation restrictions given by equations $\langle 10 \rangle$ and $\langle 11 \rangle$, it is difficult to interpret the economic importance of either the Wald test statistics or the parameter estimates in Tables 2 through 9. In this section we therefore examine the graphical implications of our results. The pictures can give 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.

We consider the following experiment. We assume the exchange rate is in a steady state in which current and past exchange rate changes are equal to zero.[11] 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.[12]

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 1 per cent. All of the figures show that the ultimate expected effect of an exchange rate shock depends substantially on whether three-, six-, or 12-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 per cent, the long-run spot rate predicted by the three-month expectations is $(0.88 - 0.80)/0.80 = 0.10$ per cent higher than the long-run level predicted by the six-month expectations, and $(0.88 - 0.72)/0.72 = 0.22$ per cent higher than the long-run level predicted by the 12-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-term expectations are used than when longer-term expectations are used.

Notice that for all three forecasting equations, part of the original 1 per cent dollar appreciation is undone, so the long-run expected exchange rate increases less than proportionately in response to current shocks. This indicates that investors believe there is a statistically and economically significant temporary component to exchange rate changes: they do not believe exchange rates follow a random walk even over horizons as short as three months.

TABLE 6. *Economist* survey.

Regressions of: $S_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + a_{k,2}e_{1,t-1} + \mu_{k,t}$
6/81–6/87, each 6 weeks

Currency	Forecast horizon (k)	γ_k	$a_{k,1}$	$a_{k,2}$	DF	DW	F-test $k=a_{k,1}=a_{k,2}=0$	Wald test for consistency
British pound	3 months	0.0057 (0.0028)	−0.1496 (0.0490)	0.0037 (0.0490)	141	1.05	5.39***	19.48***
	6 months	0.0063 (0.0026)	−0.2117 (0.0499)	0.0270 (0.0569)				
	12 months	0.0150 (0.0042)	−0.3225 (0.0804)	−0.1282 (0.0794)				
German mark	3 months	0.0290 (0.0030)	−0.0632 (0.0459)	0.0185 (0.0468)	141	1.10	81.53***	60.10***
	6 months	0.0282 (0.0023)	−0.2079 (0.0607)	−0.0519 (0.0527)				
	12 months	0.0662 (0.0036)	−0.4080 (0.0659)	−0.2860 (0.0560)				
French franc	3 months	0.0135 (0.0020)	−0.1000 (0.0390)	0.0541 (0.0373)	141	1.37	9.91***	25.12***
	6 months	0.0075 (0.0025)	−0.1349 (0.0698)	0.0321 (0.0540)				
	12 months	0.0175 (0.0043)	−0.2095 (0.1003)	−0.0643 (0.0776)				

Swiss franc	3 months	0.03008 (0.0028)	−0.0823 (0.0401)	0.0187 (0.0334)	141	1.40	79.53***	71.14***
	6 months	0.0297 (0.0023)	−0.1654 (0.0548)	0.0671 (0.0491)				
	12 months	0.0657 (0.0034)	−0.3599 (0.0547)	−0.2187 (0.0486)				
Japanese yen	3 months	0.0311 (0.0036)	−0.1197 (0.0441)	−0.0064 (0.0424)	141	1.22	80.50***	142.88***
	6 months	0.0296 (0.0022)	−0.2020 (0.0437)	−0.1256 (0.0455)				
	12 months	0.0687 (0.0032)	−0.3664 (0.0521)	−0.2678 (0.0488)				

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 parentheses.
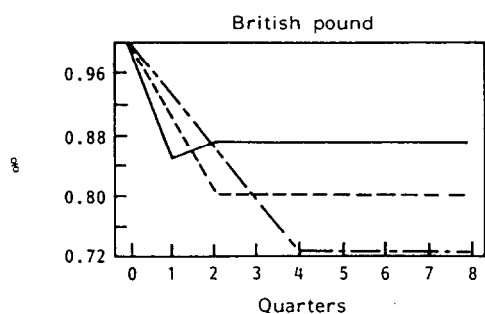
TABLE 7. New York MMS survey.
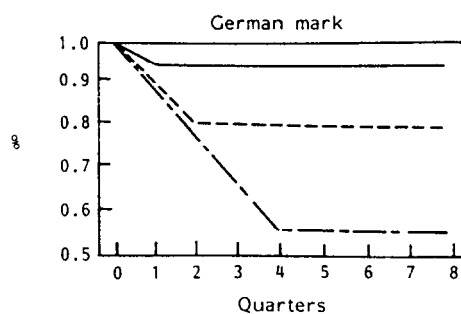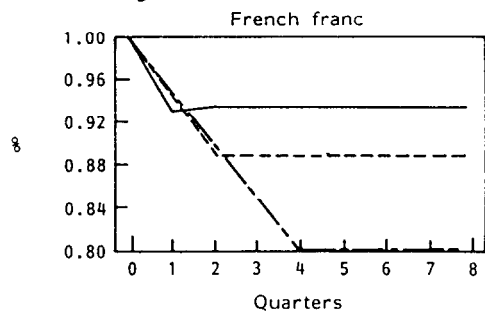
Regressions of: $S_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + a_{k,2}e_{1,t-1} + \mu_{k,t}$

4/84–4/87, weekly

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	−0.0015 (0.0008)	0.1024 (0.0415)	0.0223 (0.0835)	216	1.69	2.10*	1.37
	1 month	−0.0024 (0.0013)	0.0164 (0.0933)	0.0009 (0.1191)				
German mark	1 week	0.0019 (0.0009)	0.1527 (0.0509)	0.0694 (0.0635)	216	1.65	4.36***	3.03
	1 month	0.0031 (0.0015)	0.0991 (0.1050)	0.0933 (0.1075)				
Swiss franc	1 week	0.0027 (0.0008)	0.1787 (0.0424)	0.0692 (0.0453)	215	1.78	8.01***	10.99**
	1 month	0.0034 (0.0014)	0.1060 (0.0871)	0.1030 (0.0814)				
Japanese yen	1 week	0.0017 (0.0007)	0.1419 (0.0567)	0.1107 (0.0563)	216	1.65	9.73***	11.15**
	1 month	0.0037 (0.0010)	0.1150 (0.0694)	0.2254 (0.0697)				

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 parentheses.

Table 8. London MMS survey.

Regressions of: $S_{k,t+k} = \gamma_k + a_{k,1}e_{1,t} + a_{k,2}e_{1,t-1} + \mu_{k,t}$, 4/84–4/87, weekly

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	0.0014 (0.0007)	0.0296 (0.0443)	0.0258 (0.0428)	198	1.95	0.78	1.43
	1 month	−0.0007 (0.0013)	−0.0519 (0.1172)	0.0361 (0.0846)				
German mark	1 week	0.0014 (0.0007)	0.0775 (0.0421)	0.0604 (0.0405)	202	1.97	3.59***	2.09
	1 month	0.0037 (0.0017)	0.0689 (0.1096)	0.1238 (0.0906)				
Swiss franc	1 week	0.0015 (0.0012)	0.0928 (0.0487)	0.0552 (0.0488)	200	1.89	2.29***	2.67
	1 month	0.0033 (0.0016)	0.0582 (0.0928)	0.1076 (0.1007)				
Japanese yen	1 week	0.0007 (0.0006)	0.1104 (0.0414)	0.0839 (0.0437)	201	1.87	4.20***	2.26
	1 month	0.0037 (0.0013)	0.1106 (0.0806)	0.0830 (0.1042)				

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 parentheses.

TABLE 9. JCIF survey.

Regression of: $S_{t,t+k} = \gamma_k + a_{k,1}e_{1,t} + a_{k,2}e_{1,t-1} + \mu_{k,t}$

5/85–6/87, biweekly

Currency	Forecast horizon	γ_k	$a_{k,1}$	$a_{k,2}$	DF	DW	F-test $\gamma_k - a_{k,i} = 0$	Wald test
yen	1 month	−0.0144 (0.0010)	0.0211 (0.0218)	0.0421 (0.0172)	40	1.64	401.61***	
	3 month	−0.0212 (0.0033)	−0.1680 (0.0464)	−0.0646 (0.0321)	40	0.50	56.56***	832.07***
yen	3 month	−0.0228 (0.0020)	−0.0669 (0.0315)	−0.0092 (0.0189)	35	0.52	190.93***	
	6 month	−0.0236 (0.0025)	−0.2396 (0.0726)	−0.1016 (0.0517)	35	0.42	91.30***	1135.9***

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 parentheses.

ECONOMIST DATA

Fig 1

British pound

Fig 2

German mark

Fig 3

French franc

Fig 4

Swiss franc

Fig 5

Japanese yen

3 months	——
6 months	- - -
1 year	—·—·
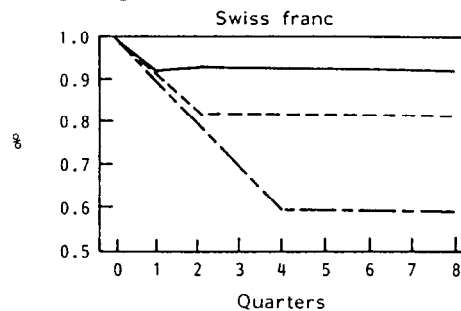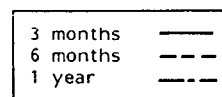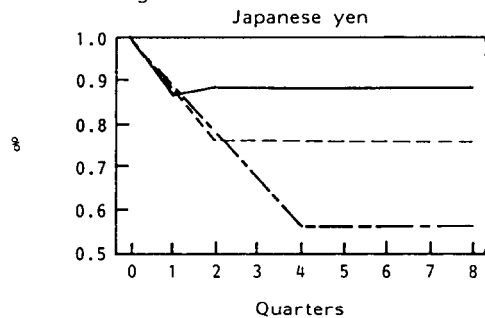
Figures 6–9 and 10–13 show the expected future path when $P = 1$ for the New York and London MMS data sets, respectively. As a group these graphs exhibit two distinctive properties. The first is that within each data set, the one-week expectations overreact to an exchange rate shock in comparison with 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 expected long-run 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 than are longer-term expectations.

MMS NEW YORK DATA

Fig 6

British pound

Fig 7

German mark

Fig 8

Swiss franc

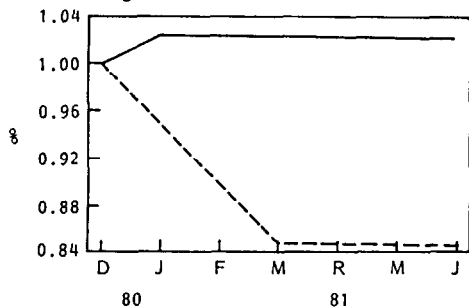Fig 9

Japanese yen

| 1 week | —— |
| 1 month | – – – |
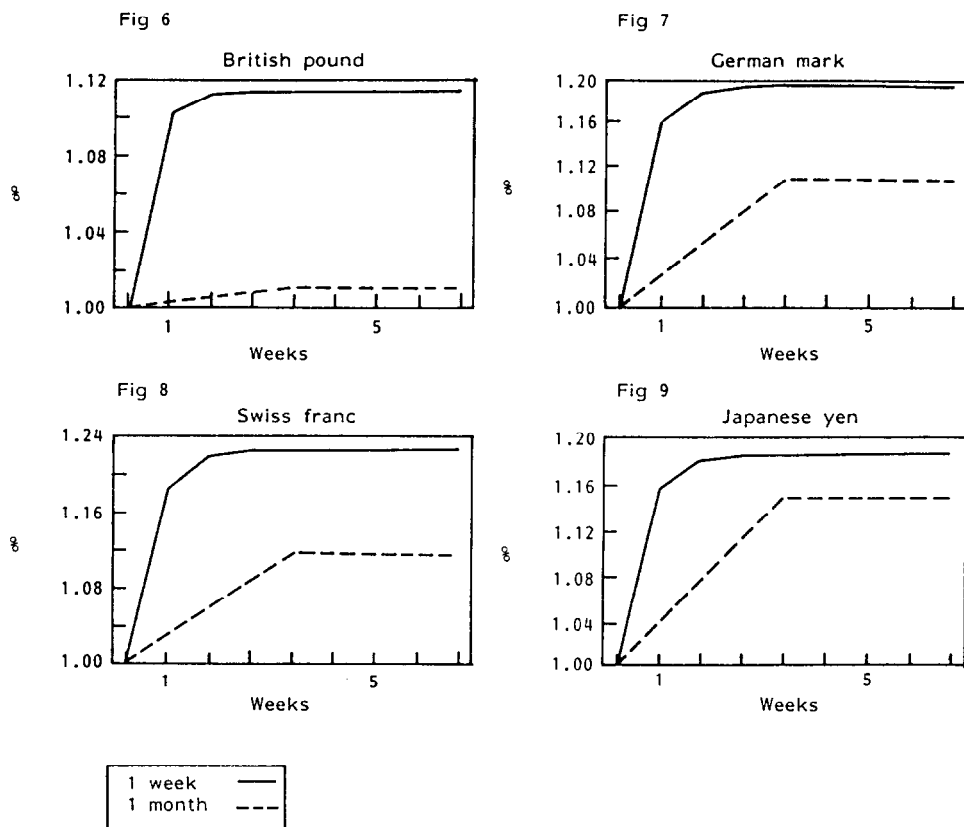
Figures 14–15 show the JCIF predictions of the future path of the dollar. Once again, shorter-term expectations are more explosive than longer-term expectations. Figure 14 shows that, according to the one-month data, a 1 per cent dollar appreciation leads to an additional 0.08 per cent expected appreciation. By contrast the three-month expectations show a 0.16 per cent *depreciation* in the expected future value of the dollar.

Graphs 16–30 parallel exactly the earlier four sets, 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).

III. Conclusions

We study 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

MMS LONDON DATA

Fig 10

British pound

Fig 11

German mark

Fig 12

Swiss franc

Fig 13

Japanese yen

| 1 week | —— |
| 1 month | ---- |
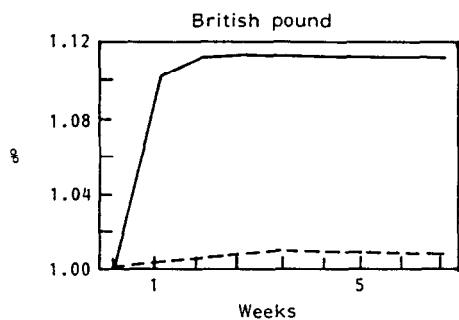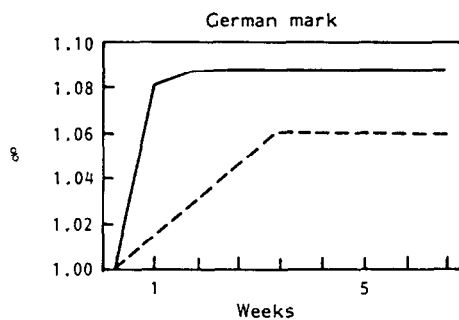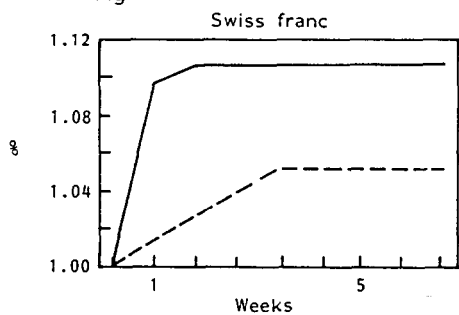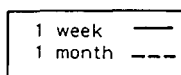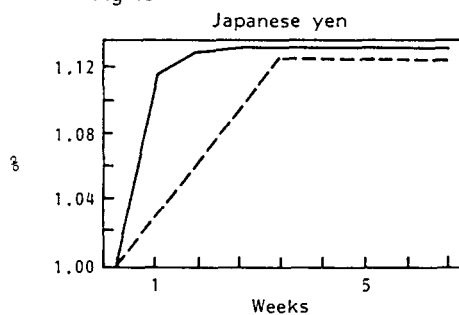
JCIF DATA
Japanese yen

Fig 14

Fig 15

| 1 month | — |
| 3 months | -- |

| 3 months | — |
| 6 months | -- |

ECONOMIST DATA

Fig 16

British pound

Fig 17

German mark

Fig 18

French franc

Fig 19

Swiss franc

Fig 20

Japanese yen

3 months	———
6 months	– – –
1 year	—·—
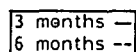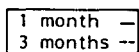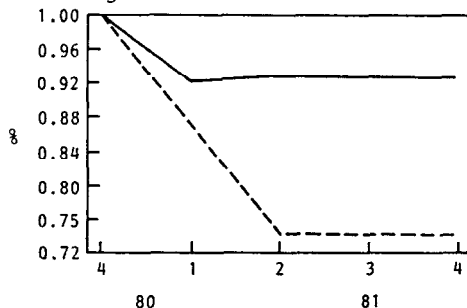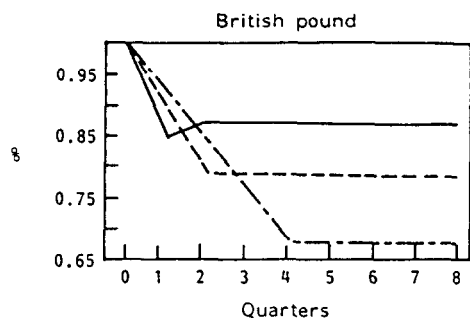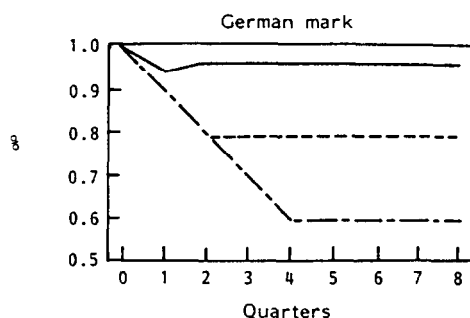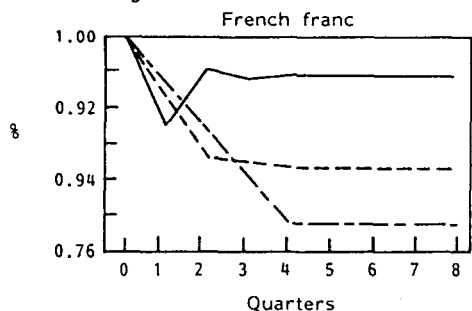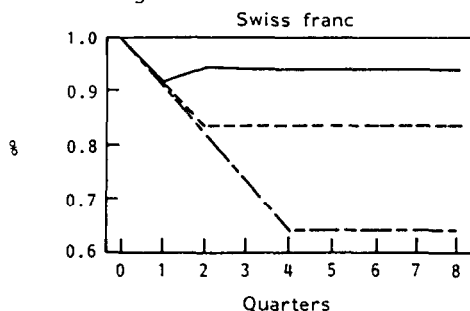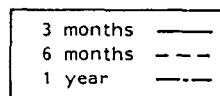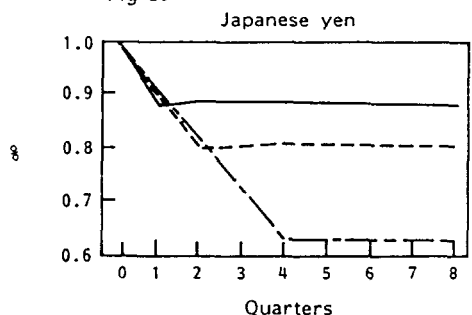
current exchange rate changes for the value of the spot rate further into the future. *In every one of 20 sets of time-series estimates encompassing four surveys, five forecast horizons and five currencies, shorter-term expectations overreact relative to longer-term expectations when the exchange rate 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 (1988), for example, model the expectations of 'chartists' and 'fundamentalists' and suggest that investors 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.

A second way to explain the rejections of consistency would be that all four
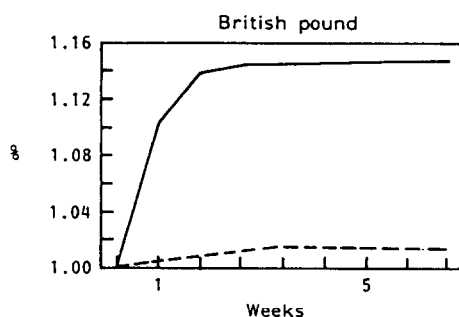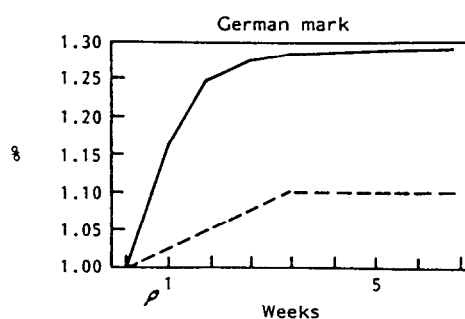
MMS NEW YORK DATA

Fig 21

British pound

Fig 22

German mark

Fig 23

Swiss franc
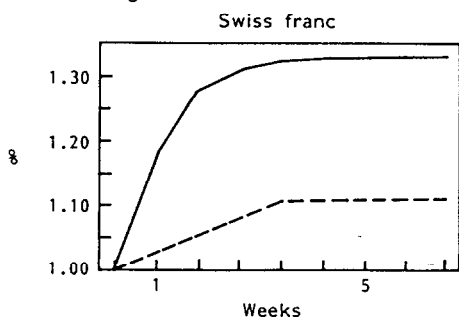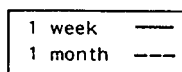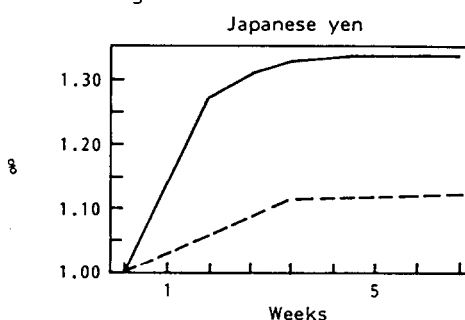
Fig 24

Japanese yen

| 1 week | ——— |
| 1 month | — — — |

survey sources systematically mismeasure the market's true expection. 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.[13] 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 9. We do not present these results, however, because of the difficulty in interpreting them in view of the contamination of forward market data by an exchange risk premium.[14] However, one could interpret the forward-rate results as suggesting that the inconsistencies in the survey data are not solely a consequence of mismeasurement.

A third possible explanation of our findings is that the tests are misspecified. The expectations process may not be described completely by recent spot rate changes. While we found that changes at greater than two lags had small and statistically insignificant impacts on expected depreciation, the cumulative effect of a longer, more extensive lag structure could potentially explain our results. Such an explanation would rely on an asymmetric effect of these additional lags on short- versus long-horizon expectations. There was, however, no evidence in our data of such an asymmetry at longer lags. Finally, recall that our tests would also be
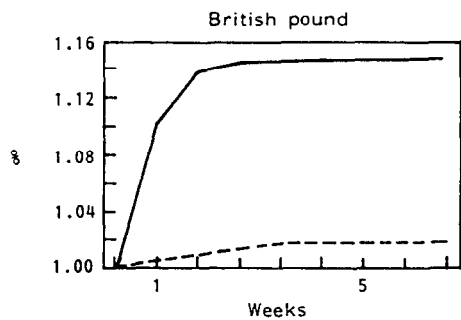
MMS LONDON DATA

Fig 25

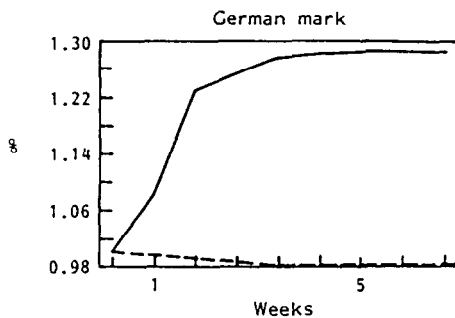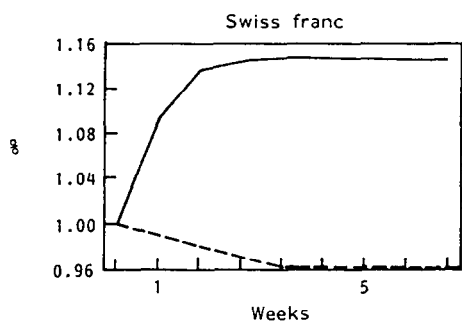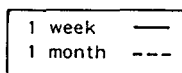**British pound**

Fig 26

German mark

Fig 27

Swiss franc

Fig 28

Japanese yen

1 week ———
1 month - - - -

JCIF DATA
Japanese yen

Fig 29

Fig 30

1 month ———
3 months - -

3 months ———
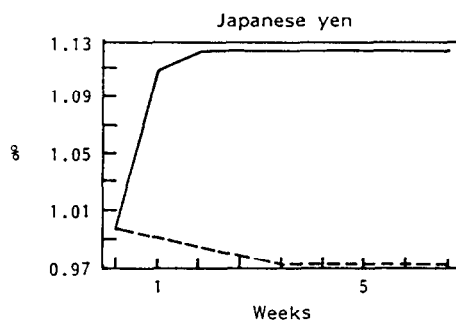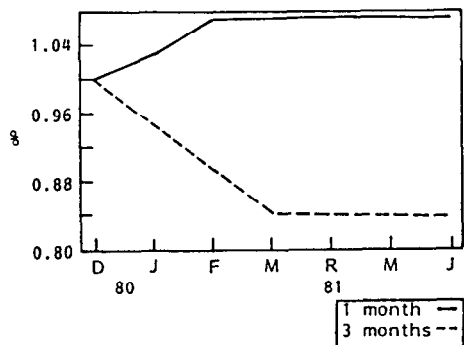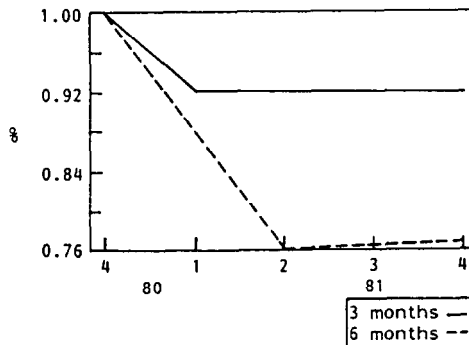6 months - -

misspecified if variables other than past exchange rate changes matter for expectations.

Notes

1. On the behavior of exchange rates and exchange rate expectations see Dornbusch (1986, 1989), Dornbusch and Frankel (1987), Frankel and Froot (1987a, 1988), and Krugman (1985, 1988). 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. See Black (1986), De Long *et al.* (1987), and Kyle (1985).
2. Huizinga (1987) and Kaminski (1986) find that exchange rate changes display positive serial correlation over horizons of less than about 48 months. But their parameter estimates are too imprecise to reject even a random walk. See Fama (1984) and Hodrick (1987) for a discussion of peso problems in exchange rates. Obstfeld (1987) demonstrates how standard inference procedures may be incorrect in the presence of peso problems and stochastic bubbles.
3. The autoregressive representation in equation $\langle 1 \rangle$ is expressed in changes because of the overwhelming evidence that the nominal spot rate contains a unit root.
4. 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.
5. 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 (1988a), Ito and Quah (1989), and Pesaran (1987).
6. In the tests that follow, the common factors included in equations $\langle 10 \rangle$ and $\langle 11 \rangle$ were removed.
7. For more detail on the New York MMS data set, see Frankel and Froot (1987a) and Dominguez (1986).
8. For more detail on these data, see Ito (1988b).
9. See, for example, Rubinstein (1974).
10. In the results below the standard errors calculated using these two methods differed by a margin of less than 10 per cent. See Froot (1989) for evidence on the downward finite sample bias of heteroskedasticity-consistent standard errors.
11. In order to focus on the dynamics of the system, we set the constant terms in equation $\langle 13 \rangle$ equal to zero in this experiment.
12. The paths are constructed by iterating each forecast equation forward, and applying the conditional expectation operator. From equation $\langle 1 \rangle$ 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 $\langle 3 \rangle$. However, even when $P = 1$, these forecasts, themselves require forecasts of the spot rate change $2k - 1$, $3k - 1$, ..., 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 appropriate 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.
13. We are grateful to Larry Summers for the following point.
14. In the forward market tests, the coefficients were smaller in absolute value than those presented in Tables 2–9, but very similar in sign and statistical significance. In addition, the results of consistency tests were similar to those reported above.

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