



The Performance of UK Exchange Rate Forecasters

David Blake, Michael Beenstock, Valerie Brasse

The Economic Journal, Volume 96, Issue 384 (Dec., 1986), 986-999.

Your use of the JSTOR database indicates your acceptance of JSTOR's Terms and Conditions of Use. A copy of JSTOR's Terms and Conditions of Use is available at <http://uk.jstor.org/about/terms.html>, by contacting JSTOR at jstor@mimas.ac.uk, or by calling JSTOR at 0161 275 7919 or (FAX) 0161 275 6040. No part of a JSTOR transmission may be copied, downloaded, stored, further transmitted, transferred, distributed, altered, or otherwise used, in any form or by any means, except: (1) one stored electronic and one paper copy of any article solely for your personal, non-commercial use, or (2) with prior written permission of JSTOR and the publisher of the article or other text.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

The Economic Journal is published by Royal Economic Society. Please contact the publisher for further permissions regarding the use of this work. Publisher contact information may be obtained at <http://uk.jstor.org/journals/res.html>.

The Economic Journal
©1986 Royal Economic Society

JSTOR and the JSTOR logo are trademarks of JSTOR, and are Registered in the U.S. Patent and Trademark Office. For more information on JSTOR contact jstor@mimas.ac.uk.

©2001 JSTOR

THE PERFORMANCE OF UK EXCHANGE RATE FORECASTERS*

David Blake, Michael Beenstock and Valerie Brasse

There have been many tests of the hypothesis that the forward exchange rate is an unbiased predictor of the future spot exchange rate, see e.g. Hansen and Hodrick (1980), Cornell (1977), Levich (1979), Bilson (1981), Baillie *et al.* (1983), and Bailey *et al.* (1984). Their methodology has been largely, but not exclusively, confined to weak form tests of the joint hypotheses of unbiasedness and efficiency in the foreign-exchange markets. In addition there have been limited attempts to test the accuracy and unbiasedness of various exchange rate forecasting services, e.g. Levich (1980), Goodman (1979) and Bilik (1982). The two issues are clearly related, for if the foreign exchange market is efficient and responds promptly and correctly to new, price-sensitive information, then no trading rule, including one based on foreign exchange rate forecasts, can be profitable.

That these services have proliferated in recent years would tend to corroborate the findings of Hansen and Hodrick (1980), Geweke and Feige (1979) and Bilson (1981) that the forward rate has been largely discredited for most major currencies as the best unbiased predictor of future spot rates.

Yet Levich (1979), whose sample consisted largely of US-based exchange-rate forecasting services, found that the forward rate tends to outperform the forecast services as far as quantitative accuracy is concerned, although the opposite applies for some services with respect to qualitative (i.e. directional) accuracy. Likewise the main conclusion of Goodman's North American-based study was that forecasts derived from 'technical analysis' outperform the forward rate in qualitative tests while judgmental and econometric forecasts are outperformed by the forward rate. These findings are supported by Bilik.

In this paper, we carry out quantitative tests of the accuracy of a number of UK-based exchange-rate forecasts. These forecasts are in the main judgemental and econometric but in practice they are no doubt influenced by recent exchange rate movements. Our sample does not contain, therefore, any forecasts derived from technical analysis. The choice of UK forecasters is intentional.

In Section I, we discuss our methodology. Results are reported in Section II and our conclusions are drawn in Section III.

* We are grateful for the comments of three referees and colleagues, Peter Warburton, Stephen Pudney and Andrew Harvey which have helped us significantly improve the paper. We also gratefully acknowledge the co-operation of the forecasters for providing us with their data. It was very brave of them. Finally, we would like to thank the ESRC for financial support under the following grants: B00220011 (LSE), B01250013 (CUBS) and B01250012 (LBS).

I. METHODOLOGY

The exchange rate forecast error is defined as

$$v_{j,t+m}^k = E_t(s_{j,t+m}^k) - s_{t+m}^k,$$

where s^k = spot exchange rate for currency k ; m = forecast horizon; j = forecasting service; t = time period in which the forecast was made. Thus $v_{j,t+m}^k$ is the m -step ahead prediction error made at time t by service j about exchange rate k .

Our central methodology follows Frenkel (1981). The unbiasedness and efficiency of non-overlapping exchange rate forecasts may be explored by running the following regression

$$s_{t+m}^k = \alpha + \beta E_t(s_{j,t+m}^k) + e_{t+m}^k, \quad (1)$$

where e denotes a random disturbance. To support the hypothesis that the forecast is unbiased we require that $\hat{\alpha}$ and $\hat{\beta}$ should not be significantly different from zero and unity, respectively. If $\beta = 1$ and $\alpha = 0$, then

$$|e_{t+m}^k| = |v_{j,t+m}^k|.$$

Furthermore, if the foreign exchange market is efficient so that prices contain all relevant information, then the forecast errors $v_{j,t+m}^k$ should contain no price-sensitive information. Market efficiency therefore requires that

$$E_t(v_{j,t+m}^k v_{j,(t+i)+m}^k) = 0, \quad (2)$$

for all $i > 0$ and for all k , i.e. forecast errors should be serially independent (at lags greater than $(m-1)$) and the current forecast error for one currency should be uncorrelated with previous forecast errors on any of the other currencies. If these conditions are not met it would be possible to improve the forecasts; in other words the exchange rate forecasts would not be efficient.

Equation (1) is valid provided that the exchange rate forecasts do not overlap. In Section II, shortage of degrees of freedom forces us to use overlapping exchange rate forecasts. The alternative is to select those observations where the sampling interval and forecast interval are the same. Cornell (1977), Frenkel (1977, 1978, 1979), Levich (1978) and Geweke and Feige (1979) have all used non-overlapping samples but have sacrificed observations in the process.

If, however, exchange rate forecasts overlap, it is well known, see e.g. Hansen and Hodrick (1980), that e_t in equation (1) is no longer white noise but is equal to an $(m-1)$ -order moving average process of the form¹

$$e_t^k = \sum_{i=0}^{m-1} h_i^k \omega_{t-i}, \quad (3)$$

¹ For example, suppose s_t^k depends on a single stationary exogenous variable x_t

$$s_t^k = \gamma^k x_t,$$

where x_t has a Wold moving-average representation in innovations ω_t

$$x_t = \sum_{i=0}^{\infty} \Theta_i \omega_{t-i},$$

with $\Theta_0 = 1$, $\sum_{i=0}^{\infty} \Theta_i^2 < \infty$, $E\omega_t = 0$, $E\omega_t^2 = \sigma_{\omega}^2$, $E\omega_t \omega_s = 0$ for $t \neq s$ (see e.g. Sargent (1979),

where ω_t is an innovation in the exogenous variables that drive the exchange rate and m denotes the forecast horizon. For instance, if t is measured in months and three-month ahead forecasts are made every month, i.e. $m = 3$, equation (3) implies that a second-order moving average error process is induced. And if, as is the case below, twelve-month-ahead forecasts are made at monthly intervals, an eleventh-order moving average error process results. This implies that for market efficiency, equation (2) only applies for $i \geq m$.

It also implies that equation (1) cannot be estimated by standard OLS techniques. Bilson (1981) suggested that equation (1) can be estimated by GLS in terms of the appropriate MA error process implied by equation (3). However, Hansen and Hodrick (1980) have pointed out that the GLS estimator would be inconsistent in the case of overlapping forecasts. This is because GLS requires the strict exogeneity of the independent variables, which, in turn, implies that knowledge of the future innovations $\omega_{t+1}, \dots, \omega_{t+m}$ would not influence current expectations. But knowledge of the future innovations would be extremely useful in forecasting future spot exchange rates, so the strict exogeneity assumption is inappropriate. Instead, they argue that the only effect of the MA error process is to render inefficient the OLS estimator of the parameter covariance matrix. The OLS estimates of the parameters themselves are consistent. They suggest that an appropriate estimator of the parameter covariance matrix is

$$\text{Var} \begin{pmatrix} \hat{\alpha} \\ \hat{\beta} \end{pmatrix} = \hat{\sigma}_e^2 (\mathbf{X}'\mathbf{X})^{-1} \mathbf{X}'\hat{\Omega}\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}, \tag{4}$$

where

$$\hat{\Omega} = \begin{bmatrix} 1 & \hat{\rho}_1 & \dots & \hat{\rho}_{m-1} & 0 & \dots & 0 \\ & 1 & & & & & 0 \\ & & \ddots & & & & \\ & & & 1 & & & \\ & & & & \ddots & & \\ & & & & & 1 & \\ & & & & & & 1 \end{bmatrix}, \tag{5}$$

and $\hat{\rho}_j$ is the estimated residual autocorrelation coefficient at lag j . (More details of Hansen and Hodrick's approach are provided in Blake (1983).)

p. 257). With an m -period forecasting horizon, the unbiased and efficient forecast is given by

$$E_t(s_{t+m}^k) = \gamma^k \sum_{i=m}^{\infty} \Theta_i \omega_{t+m-i}.$$

The forecast error is therefore

$$\begin{aligned} e_{t+m}^k &= s_{t+m}^k - E_t(s_{t+m}^k) \\ &= \gamma^k \sum_{i=0}^{m-1} \Theta_i \omega_{t+m-i}. \end{aligned}$$

which is an $(m-1)$ -order moving average process. It immediately follows from this that h_i^k in equation (1) is given by

$$h_i^k = \gamma^k \Theta_i.$$

It is also possible, given periods of both turbulence and calm in foreign-exchange markets, that the residuals e_t^k might be heteroskedastic in which case the Hansen and Hodrick transformation would have to be extended along the lines proposed, e.g. by White (1980). However, when we tested for heteroskedasticity we could find no evidence of it for any of the forecast services over the sample period.¹

To apply the Hansen and Hodrick methodology (denoted HH), the exchange rates and their forecasts must be stationary. This has the effect of minimising the bias to the estimated variance of the residuals $\hat{\sigma}_e^2$ when using OLS in the presence of the MA error process. Since on the whole the data were non-stationary, stationarity was induced by expressing equation (1) in terms of changes with respect to the current exchange rate

$$s_{t+m}^k - s_t^k = \gamma + \delta [E_t(s_{t+m}^k) - s_t^k] + \epsilon_{t+m}^k. \quad (6)$$

If indeed $\alpha = 0$ and $\beta = 1$ we should find that $\gamma = 0$ and $\delta = 1$, and $e_{t+m}^k = \epsilon_t^k$. Similarly if e_t^k is serially uncorrelated at lags greater than $(m-1)$ then so should ϵ_t^k .

Baillie *et al.* (1983) and Hayashi and Sims (1983) have suggested alternative and perhaps more efficient estimators than HH. Nevertheless, we believe that HH estimates of equation (4) provide a sensible starting point for our analysis of forecasting performance. We also apply these tests to forward exchange rates. In this case, we may legitimately have $E(\gamma) \neq 0$ or $E(\delta) \neq 1$ because the forward exchange rate may reflect either an additive or a multiplicative risk premium in relation to the expected future spot exchange rate, see e.g. Adler and Dumas (1983). Of course, there is nothing in economic theory to suggest that the risk premium would be constant over time and this detracts from the appropriateness of such 'tests' of market efficiency. For the forecasts of course, there can be no risk premium and so unbiasedness does require $\gamma = 0$, $\delta = 1$.

II. EVIDENCE

Data

Over twenty major UK research institutions, banks and stockbrokers were approached to participate in this study and supply their forecast data. Not surprisingly few wished to submit their forecasts to academic scrutiny publicly. Of the nine services that agreed to participate three were judged invalid because of the brevity of their forecasting experience, and one service preferred to remain anonymous.

Since regression analysis forces us to observe some minimum degrees of freedom, we concentrate in this paper on three forecast series for which the sample period is relatively long and for which there are few missing observations (see Table 1). No attempt was made to standardise forecasts for the sake of

¹ The statistic that we used to test for heteroskedasticity is

$$(\text{D.F.}_2) \sum_{T_1}^{T_2} (e_t^k)^2 / (\text{D.F.}_1) \sum_{T_3}^{T_4} (e_t^k)^2 \quad (1 \leq T_1 < T_2 < T_3 < T_4 \leq T),$$

which is distributed as $F(\text{D.F.}_1, \text{D.F.}_2)$ in the absence of heteroskedasticity, where $\text{D.F.}_1 = T_2 - T_1 + 1$ and $\text{D.F.}_2 = T_4 - T_3 + 1$ and where the test is conducted over non-overlapping sub-samples of the data.

comparability (Levich, 1980; Bilson, 1983). In our opinion, this might violate a forecaster's exchange rate prediction and bias the analysis. In addition to the forecast services, we follow Bilson (1981) *et al.* in considering the forward rate as a predictor of the future spot rate, and the (end of) three-month and twelve-month forward rates are included in the analysis.

The choice of currencies, £ sterling (£), French franc (FF), Deutsche mark (DM), Japanese yen (Y) and Italian lire (L), was dictated by data availability in that the currencies were common to all the forecast services. All currency rates are quoted against the dollar, although we adopt the usual convention and use the dollar/sterling exchange rate. For the purpose of forecast evaluation, we used the monthly average spot exchange rate. Where a specific forecast date was given, our analysis was based on the corresponding spot and forward rates. But since more often than not the same forecast was not available on the same day of the

Table 1
Forecast Services

	Sample data	No. of observations	Frequency per year	Type of forecast	Horizon
Henley Centre	Jan. 1978 to July 1982	55	12	Monthly mid-point	3, 12 months ahead
Exchange Rate Outlook	Jan. 1979 to June 1982	32	12	End of month	12 months ahead
Forex	Jan. 1977 to June 1982	30-64*	12	Monthly average	3, 12 months ahead
Forward Rate	Jan. 1978 to July 1982	30-55*	12	End of month	3, 12 months ahead

* 3 months ahead.

month, nor even on the same day for every client of a forecast service, the monthly average spot rate had to suffice. This may bias our results either way but the bias appears not to be significant on the basis of spot checks.

Summary Statistics

Brasse (1983) has already summarised the forecasting performance of the three services listed in Table 1 in addition to those services for which the sample period was too short for our present purposes. These included Hoare Govett, the Economist Financial Report and a service which preferred to remain anonymous. She found that 11 out of 23 three-month-ahead forecasts had mean errors that were significantly different from zero and 18 out of 28 twelve-month-ahead forecasts were significantly biased. However, these biases were under-represented among the services' £/\$ forecasts and the forecasts of the Henley Centre.

Using Theil's (1971) coefficient as a normalised measure of forecasting accuracy she found that the forward exchange rate outperformed all the three-month-ahead forecasts for all currencies except the mark where the Henley Centre was the most accurate. In the case of the twelve-month-ahead forecasts

the Henley Centre excelled with the lire, the forward rate with the yen, and a random walk model achieved the best performance in the case of sterling, the franc and the mark. She also found that for the three-month-ahead forecasts, none of the five series surveyed succeeded in forecasting the correct direction of change more than 50 % of the time. This 100 % record of failure to outperform the toss of a coin fell to 86 % at the twelve-month horizon.

This track record is scarcely impressive. However, our central purpose in this paper is to submit this record to closer statistical scrutiny using the techniques described above. We also investigate whether forecasts can be improved by weighting the different services together in an optimal fashion.

Tests of Unbiasedness and Efficiency

Tests of unbiasedness and efficiency of the exchange rate forecasts are based upon the regression estimates of equation (6) using the modified covariance matrix of estimates (4) suggested by Hansen and Hodrick (1980). For the forward rates, the stationarity requirement involves testing the relationship between the appreciation in the spot rate and the forward premium; for the forecasts, we measure how well the expected change in the exchange rate matches the actual change in the rate.

The tests of efficiency and unbiasedness are components of a joint test and since we want the overall test to have a significance level of no more than 5 %, we adopt the Bonferonni procedure, and conduct each of the two individual tests at the 2.5 % level.¹ In addition, the form of the unbiasedness test depends on whether or not the exchange rate forecasts are efficient. The HH modification to the standard OLS covariance matrix explicitly assumes that the forecast errors contain an $(m-1)$ -order moving average process but it implicitly assumes that no other autocorrelated process is present at lags greater than $(m-1)$. We can test for autocorrelated errors at lags greater than $(m-1)$ using a modified version of the Ljung-Box (1978) test (where T is the number of observations in the sample)

$$LB^* = \frac{(T+2) \sum_{j=m}^n (T-j)^{-1} \hat{\rho}_j^2}{\left(1 + 2 \sum_{j=1}^{m-1} \hat{\rho}_j^2\right) / T}, \quad (7)$$

¹ The Bonferonni procedure is designed to find the significance levels on a set of joint tests necessary to give a required overall significance level. Suppose that we have two tests: T_1 (an unbiasedness test) and T_2 (an efficiency test) with

$$\begin{aligned} \text{Prob (Type I error on } T_1) &= \alpha_1, \\ \text{Prob (Type I error on } T_2) &= \alpha_2. \end{aligned}$$

Therefore

$$\begin{aligned} \text{Prob (Type I error on } T_1 \text{ or } T_2) &= 1 - \text{Prob (no Type I error)}, \\ &= 1 - (1 - \alpha_1)(1 - \alpha_2), \\ &= \alpha_1 + \alpha_2 - \alpha_1\alpha_2. \end{aligned}$$

If the required overall significance level is $\bar{\alpha}$ and $\alpha_1 = \alpha_2 = \alpha$, then

$$\bar{\alpha} = 2\alpha - \alpha^2$$

or (taking the appropriate root of this equation)

$$\alpha = 1 - (1 - \bar{\alpha})^{\frac{1}{2}}.$$

If $\bar{\alpha} = 0.05$ then $\alpha \simeq 0.025$.

which has an asymptotic χ^2 -distribution with $n - (m - 1)$ D.F. in the absence of serial correlation between lags m and n . In (7), the denominator is the variance of the sample autocorrelation coefficients (for $j > (m - 1)$) in the presence of an $(m - 1)$ -order moving average process; see Harvey (1981, pp. 148 and 153). If we cannot find significant autocorrelation between these lags then the HH formulation for estimation is valid, otherwise the OLS covariance matrix has to be further modified by expanding the non-zero band along the principal diagonal of $\hat{\Omega}$ from order $(m - 1)$ to order n . We note that (7) is a test which avoids having to estimate the moving average process (3). So our strategy is to test for efficiency using the modified Ljung-Box test (7) (at the 2.5 % significance level) and then

Table 2
*Tests of Efficiency on the Single Forecast Equations Using the
Modified Ljung-Box Test*

	£	DM	Y	FF	L
3-month horizon					
Henley Centre	3.94	2.05	1.65	1.06	1.22
Forex	5.33	2.02	3.03	1.46	0.38
Forward	2.05	2.89	9.07	2.14	1.74
12-month horizon					
Henley Centre	0.10	2.06	27.62*	9.53	5.79
Exchange Rate Outlook	2.11	16.83*	12.68*	16.25*	17.07*
Forex	11.78*	10.69	0.82	8.52	14.17*
Forward	13.48*	14.86*	8.07	16.05*	25.78*

* Significant at 2.5 % level.

Note. The modified Ljung-Box test is given by (7) in the text. We have chosen $n = 6$ over the 3-month horizon and $n = 15$ over the 12-month horizon, so that LB^* is χ^2 -distributed with 4 D.F. in each case; the critical value with 4 D.F. and a 2.5 % level of significance is 11.1.

to test for unbiasedness (also at the 2.5 % significance level), the precise formulation of the latter test depending on whether or not the exchange rate forecasts are efficient. The results of the efficiency tests are given in Table 2 and those for unbiasedness are given in Table 3.

From Table 2, we find that all the three-month forecasts and the forward rates are efficient across all currencies. For the forward rates, whilst unbiasedness may not be incompatible with an efficient foreign exchange market, the presence of significantly autocorrelated errors (after allowing for the first $(m - 1)$ autocorrelations) certainly is. Over the twelve-month horizon, on the other hand, each forecasting service produces at least one inefficient forecast. The Henley Centre comes off best with only its yen forecast being inefficient. Forex has two inefficient forecasts, while Exchange Rate Outlook has four out of five inefficient forecasts. The forward rate also appears to be inefficient in four out of five cases. As a result, the unbiasedness tests in Table 3 have to be modified along the lines proposed above whenever the modified Ljung-Box test of Table 2 indicates inefficiency.

For the forecasts, the results are quite devastating. We can reject the hypothesis of unbiasedness ($\gamma = 0$, $\delta = 1$) for most forecasters over most currencies. Moreover in cases where we cannot reject unbiasedness, we are unable to discriminate between this hypothesis and the hypothesis of no relationship at all ($\gamma = 0$, $\delta = 0$), such is the size of the HH covariance matrix. So, for example, the Forex three-month forecasts are biased for all currencies apart from sterling, but in this case we cannot reject the hypothesis that the slope coefficient is also zero. The poor determination of the estimates is even more striking over the twelve months horizon.

A similar story applies with the forward rate. Of the three-month forward rates, only that for sterling is unbiased. The twelve-month forward rate for the franc is also unbiased, although here we cannot simultaneously reject the hypothesis of no relationship. This result again follows from the size of the HH covariance matrix, since the point estimate of the slope is in excess of 2. However, as we have already mentioned, for the forward rates, although not for the forecasts, this biasedness may not be inconsistent with the joint hypothesis of rational expectations and market efficiency.

Composite Forecasting

Our evidence thus far suggests that our forecast sample is biased. But it may well be that the question of bias in foreign exchange rate forecasts is largely irrelevant and that we should concentrate instead on the degree of fit or explanatory power of the forecasts. For example, the twelve-month Italian lire Exchange Rate Outlook forecast was biased since $\hat{\gamma}$ was significantly different from zero. But we cannot conclude that the forecast was therefore a 'bad' one. The watch that is always five minutes fast is still a good timekeeper. Likewise the forecast that overestimates or underestimates by 5 % is still a good forecast as long as those who use it are aware of the error and the error remains constant over time. And if this is generally the case, we might expect some combination of forecasts to explain subsequent spot rates better than any one forecast on its own.

The idea of a composite forecast has intuitive appeal. Information is costly to acquire and forecasters may choose to specialise in certain pieces of price-sensitive information to the exclusion of others. Composite forecasting or some combination of forecasts may then exploit more information than any one forecast on its own. But even if information acquisition is costless, composite forecasting could increase forecasting accuracy if the correlation of error terms between services is less than one.

We use regression analysis (with the HH covariance matrix of estimates) to construct the composite forecast, s_{t+m}^k , with the forecast series and the forward rate (f_{t+m}^k) according to the equation

$$s_{t+m}^k - s_t^k = \delta_0 + \sum_{j=1}^J \delta_j [E_t(s_{j,t+m}^k) - s_t^k] + \delta_{J+1} (f_{t+m}^k - s_t^k) + \epsilon_{t+m}^k. \quad (8)$$

We follow Granger and Ramanathan (1984) in not constraining δ_0 to zero. Nor do we constrain the sum of the forecast weights to unity, i.e. $\sum_{j=1}^J \delta_j + \delta_{J+1} \neq 1$. The reason for the former is that some or all of the forecasts might be biased in

Table 3
Tests of Unbiasedness on the Single Forecast Equations Using the HH Covariance Matrix of Estimates

	\mathcal{L}		DM		Y		FF		L	
	$\hat{\gamma}$	$\hat{\delta}$	$\hat{\gamma}$	$\hat{\delta}$	$\hat{\gamma}$	$\hat{\delta}$	$\hat{\gamma}$	$\hat{\delta}$	$\hat{\gamma}$	$\hat{\delta}$
3-month horizon Henley Centre										
F-test	-0.001 (0.030)	0.040 (0.310)	-0.001 (0.030)	-0.302 (0.298)	1.124 (2.750)	0.288 (0.287)	0.066 (0.054)	-0.674 (2.53)	32.650 (11.520)	-0.612 (0.279)
$\gamma = 0, \delta = 1$ $\gamma = 0, \delta = 0$	R F(2, 52, 4.01) = 0.01		R F(2, 53, 4.01) = 0.57		R F(2, 53, 4.01) = 0.51		R R		R R	
Forex	0.005 (0.026)	0.279 (0.292)	-0.012 (0.027)	-0.394 (0.327)	-1.406 (3.100)	0.056 (0.174)	0.055 (0.046)	-0.814 (0.243)	18.130 (10.200)	-0.554 (0.270)
F-test										
$\gamma = 0, \delta = 1$ $\gamma = 0, \delta = 0$	F(2, 62, 3.93) = 3.12 F(2, 62, 3.93) = 0.46		R F(2, 62, 3.93) = 0.72		R F(2, 62, 3.93) = 0.23		R R		R R	
Forward	-0.002 (0.005)	0.923 (0.038)	0.026 (0.003)	0.816 (0.023)	2.697 (0.297)	0.848 (0.031)	0.008 (0.011)	0.746 (0.030)	-7.242 (1.285)	0.754 (0.036)
F-test										
$\gamma = 0, \delta = 1$ $\gamma = 0, \delta = 0$	F(2, 52, 4.01) = 2.19 R		R R		R R		R R		R R	

12-month horizon										
Henley Centre										
F-test										
$\gamma = 0, \delta = 1$	0.017 (0.116)	-0.011 (0.842)	-0.009 (0.095)	-0.676 (0.796)	-5.891 (11.052)*	3.56 (0.803)*	0.386 (0.154)	-1.269 (0.586)	147.230 (47.263)	-1.169 (0.684)
$\gamma = 0, \delta = 0$	F(2, 53, 4.01) = 1.26		F(2, 53, 4.01) = 2.52		F(2, 53, 4.01) = 0.36*		R		R	
Exchange Rate	F(2, 53, 4.01) = 0.02		F(2, 53, 4.01) = 0.39		F(2, 53, 4.01) = 0.35*		R		R	
Outlook										
$\gamma = 0, \delta = 1$	0.054 (0.162)	1.178 (1.277)	0.203 (0.217)*	0.109 (1.159)*	33.816 (20.340)*	1.199 (0.909)*	0.550 (0.305)*	-0.478 (1.176)*	156.230 (50.863)*	-0.115 (1.377)*
F-test										
$\gamma = 0, \delta = 1$	F(2, 30, 4.18) = 0.06		R		F(2, 30, 4.18) = 1.76*		R		R	
$\gamma = 0, \delta = 0$	F(2, 30, 4.18) = 0.50		F(2, 30, 4.18) = 2.44*				F(2, 30, 4.18) = 3.82*		R	
Forex										
$\gamma = 0, \delta = 1$	-0.138 (0.128)*	-0.381 (1.088)*	-0.051 (0.136)	-0.762 (0.976)	1.300 (14.856)	0.559 (0.827)	0.314 (0.177)	-1.459 (0.757)	153.950 (47.225)*	-0.608 (1.067)*
F-test										
$\gamma = 0, \delta = 1$	F(2, 29, 4.20) = 0.95*		F(2, 51, 4.01) = 2.58		F(2, 51, 4.01) = 0.39		R		R	
$\gamma = 0, \delta = 0$	F(2, 29, 4.20) = 0.60*		F(2, 51, 4.01) = 0.35		F(2, 51, 4.01) = 0.41		F(2, 51, 4.01) = 3.06		R	
Forward										
$\gamma = 0, \delta = 1$	-0.106 (0.124)*	0.191 (1.463)*	0.319 (0.101)*	1.774 (1.182)*	5.325 (12.381)	-0.108 (1.384)	0.639 (0.226)*	2.096 (1.328)*	23.580 (45.413)*	2.880 (0.823)*
F-test										
$\gamma = 0, \delta = 1$	F(2, 29, 4.20) = 0.56*		R		F(2, 29, 4.20) = 0.74		R		R	
$\gamma = 0, \delta = 0$	F(2, 29, 4.20) = 0.37*		R				R		R	

* Calculated with diagonal band of $\hat{\Omega}$ (see (5)) expanded from order 11 to order 15, as indicated by modified Ljung-Box test of Table 2.

Notes. (1) HH standard errors in parentheses. (2) F-test is of the form $F(D.F._1, D.F._2, c.v.)$ where $D.F._1$ and $D.F._2$ are the numerator and denominator degrees of freedom and c.v. is the critical value at the 2.5 % level of significance; R implies the F-test is rejected at 2.5 % level.

which case δ_0 will help to ensure that the composite forecast does not systematically over- or under-predict. The reason for the latter is that exchange rate movements may be systematically more or less volatile than the forecasters believe. In this case constraining the weights to sum to unity would lead to the composite forecast being correspondingly less or more volatile than the actual currency movements.

The following joint hypotheses are also tested:

	δ_0	δ_j	$\delta_{i \neq j}$	δ_{J+1}
H1	0	0	0	0
H2	0	1	0	0
H3	0	0	0	1

The results are presented in Table 5 (Table 4 shows that there are three inefficient currency forecasts over the twelve-month horizon). The δ_j are estimates of the weights given to each forecast service within the composite forecast. For example, the Henley Centre three-month forecast has a positive weight of

Table 4
*Tests of Efficiency on the Composite Forecast Equations Using
the Modified Ljung-Box Test*

	£	DM	Y	FF	L
3-month horizon	3.71	2.75	9.18	0.90	2.19
12-month horizon	18.24*	3.98	22.51*	6.68	19.88*

* Significant at 2.5 % level.
Note. The note on Table 2 applies.

0.063 in the composite forecast of sterling but a negative weight of -0.046 in the composite forecast of the yen. The fact that a weight can be positive or negative tells us nothing about the absolute forecasting ability of the service, it simply indicates the manner in which the forecast should be used in combination with other forecasts.

Over the three-month horizon, on the basis of the HH F-tests, almost all the joint hypotheses are rejected (including that of no relationship, H1). There is only one exception: we cannot reject the hypothesis that only the forward rate is relevant in predicting the future sterling spot rate (i.e. H3). For the other currencies, the combination of forecasts and forward rates using least squares weights is more efficient (in terms of error variance) than using any of these variables separately. This is so despite the fact that on an HH t-test, the forward rate carries the largest individually significant weight for all currencies.

Over the twelve-month horizon, all joint hypotheses are rejected, again with one exception. In the case of the Japanese yen, we cannot reject the hypothesis (H1) that there is no relationship between the variables.

Figlewski and Ulrich (1983) have pointed out that composite forecasts of the type that we have described will not be optimal if the covariance matrix of the

Table 5
Tests of Unbiasedness on the Composite Forecast Equations Using the HH Covariance Matrix of Estimates

	£	DM	Y	FF	L
3-month horizon					
Constant (δ_0)	-0.004 (0.005)	0.026 (0.004)	2.730 (0.574)	0.008 (0.008)	-9.148 (3.999)
Henley Centre (δ_1)	0.063 (0.070)	0.016 (0.058)	-0.046 (0.068)	0.071 (0.058)	0.070 (0.080)
Forex (δ_2)	0.064 (0.094)	-0.008 (0.073)	0.037 (0.111)	0.081 (0.081)	0.088 (0.086)
Forward (δ_3)	0.921 (0.036)	0.818 (0.025)	0.856 (0.030)	0.791 (0.036)	0.792 (0.027)
F-test					
H ₃ : ($\delta_0 = 0, \delta_1 = 0, \delta_2 = 0, \delta_3 = 1$)	F (4, 50, 3.42) = 1.48				
12-month horizon					
Constant (δ_0)	0.177 (0.089)*	0.662 (0.152)	44.180 (16.490)*	1.048 (0.152)	41.650 (49.630)*
Henley Centre (δ_1)	-2.140 (0.779)*	-3.702 (1.368)	0.058 (0.483)*	-4.756 (1.121)	-0.732 (0.810)*
Exchange Rate Outlook (δ_2)	6.480 (1.110)*	4.695 (1.864)	1.410 (0.632)	4.678 (1.142)	0.659 (0.912)*
Forex (δ_3)	-2.870 (0.673)*	-0.345 (0.644)	0.954 (0.466)*	-0.837 (0.514)	-0.054 (0.666)*
Forward (δ_4)	-0.936 (0.900)*	0.279 (0.709)	-0.851 (1.000)*	-0.853 (1.136)	2.880 (0.745)*
F-test					
H ₁ : ($\delta_0 = 0, \delta_1 = 0, \delta_2 = 0, \delta_3 = 0, \delta_4 = 0$)	R	R	F (5, 25, 3.13) = 2.83*	R	R

* Calculated with diagonal band of $\hat{\Omega}$ (see (5)) expanded from order 11 to order 15, as indicated by modified Ljung-Box test of Table 4.
Notes. (1) Notes of Table 3 apply. (2) All the other F-tests indicated rejection of their null hypotheses.

forecast errors of the various services varies over time. When this occurs, Figlewski and Urich argue that the composite weights should be updated each period. However, in order to implement this approach, it is essential to have sufficient observations since degrees of freedom have to be sacrificed when forming reliable initial estimates of the covariance matrix. Unfortunately, our observations are too few, especially in the twelve-month case, to explore this issue satisfactorily.

Although data limitations prevent us from applying the superior methodology of Figlewski and Urich, we did test whether the covariance matrix of forecast errors for a particular currency and forecast horizon varied significantly over time.¹ At any reasonable level of significance, we found that the test rejected the hypothesis that the covariance matrix did not vary in all but two cases. So we recognise the desirability of Figlewski and Urich's procedure, even though with the present data set we are unable to take it into account.

III. CONCLUSION

In this paper we have set out to examine the performance of some UK foreign-exchange forecasting services using the forward rate for comparison. *A priori*, we should expect these forecasts to be pure forecasts of future movements in the spot exchange rate, yet our tests have shown them to be not only biased in that they systematically fail to predict the magnitude of change, but more often than not the correct direction of change too. Moreover, this bias is in the same direction as, and usually bigger than, that observed in the forward rate which may reasonably expect to contain some element of market premium. In addition, some of the forecasts appear to be inefficient over the twelve-month horizon, although none was found to be over the three-month horizon.

It would be rather interesting to discover whether different services performed better or worse than others in different sub-samples of the data set, or how well the forecasts compared during periods of great turbulence, or the effect of the up-dating procedure for composite forecasts proposed by Figlewski and Urich. But the small size of the present data set has prevented us from examining these questions on this occasion.

*City University Business School,
London Business School*

Date of receipt of final typescript: June 1986

¹ In order to test whether the covariance matrix of forecast errors changes over time, we divided the sample roughly into halves and constructed the covariance matrix of forecast errors, for each currency and forecast horizon over each half sample. The null hypothesis is

$$H_0: \Sigma_1^{km} = \Sigma_2^{km},$$

where Σ_i^{km} is the covariance matrix of forecast errors for the k th currency and the m -period ahead forecast horizon over the i th half sample (sample size T_i).

The test statistic is taken from Anderson (1958, chap. 10). The likelihood ratio is given by

$$\lambda^{km} = \frac{|\hat{\Sigma}_1^{km}|^{T_1/2} |\hat{\Sigma}_2^{km}|^{T_2/2}}{|\hat{\Sigma}^{km}|^{(T_1+T_2)/2}},$$

$$\hat{\Sigma}^{km} = \frac{T_1 \hat{\Sigma}_1^{km} + T_2 \hat{\Sigma}_2^{km}}{T_1 + T_2}.$$

where

Now, asymptotically,

$$-2 \ln \lambda^{km} \sim \chi^2(J(J+1)/2),$$

under H_0 , where J is the number of forecast services.

REFERENCES

- Adler, M. and Dumas, B. (1983). 'International portfolio choice and corporation finance: a synthesis.' *Journal of Finance*, vol. 38 (June), pp. 925-84.
- Anderson, T. W. (1958). *An Introduction to Multivariate Statistical Analysis*. New York: John Wiley.
- Bailey, R. W., Baillie, R. T. and McMahon, P. C. (1984). 'Interpreting econometric evidence of efficiency in the foreign exchange market.' *Oxford Economic Papers*, vol. 36 (March), pp. 67-85.
- Baillie, R. T., Lippens, R. E. and McMahon, P. C. (1983). 'Testing rational expectations and efficiency in the foreign exchange market.' *Econometrica*, vol. 51 (May), pp. 553-63.
- Blake, D. (1983). 'HANSES: a program to calculate Hansen-Hodrick standard errors in models with overlapping data.' LSE/ESRC DEMEIC Research Programme (1982-1985).
- Bilik, E. (1982). 'Forecasting accuracy of forward exchange rates and the efficiency of the market for foreign exchange: an inquiry into the performance of the foreign exchange forecasting industry.' Unpublished PhD dissertation, Ohio State University.
- Bilson, J. F. O. (1981). 'The "speculative efficiency" hypothesis.' *Journal of Business*, vol. 54 (July), pp. 435-51.
- (1983). 'The evaluation and use of foreign exchange rate forecasting services.' In *Managing Foreign Exchange Risk* (ed. R. J. Herring). Cambridge: Cambridge University Press.
- Brasse, V. (1983). 'The inaccuracy of exchange rate forecasting services in the United Kingdom.' *Economic Review* (CUBS), vol. 1 (May), pp. 35-44.
- Cornell, B. (1977). 'Spot rates, forward rates and exchange market efficiency.' *Journal of Financial Economics*, vol. 5 (August), pp. 55-65.
- Figlewski, S. and Ulrich, T. (1983). 'Optimal aggregation of money supply forecasts: accuracy, profitability and market efficiency.' *Journal of Finance*, vol. 28, pp. 695-710.
- Frenkel, J. A. (1977). 'The forward exchange rate, expectations, and the demand for money: the German hyperinflation.' *American Economic Review*, vol. 67 (September), pp. 653-70.
- (1978). 'Purchasing power parity: doctrinal perspective and evidence from the 1920s.' *Journal of International Economics*, vol. 8 (May), pp. 169-91.
- (1979). 'Further evidence on expectations and the demand for money during the German hyperinflation.' *Journal of Monetary Economics*, vol. 5 (January), pp. 81-97.
- (1981). 'Flexible exchange rates, prices and the role of "news": lessons from the 1970s.' *Journal of Political Economy*, vol. 89, no. 4, pp. 665-705.
- Geweke, J. and Feige, E. (1979). 'Some joint tests of the efficiency of markets for forward foreign exchange.' *Review of Economics and Statistics*, vol. 61 (August), pp. 334-41.
- Goodman, S. H. (1979). 'Foreign exchange forecasting techniques: implications for business and policy.' *Journal of Finance*, vol. 34 (May), pp. 415-27.
- Granger, C. W. and Ramanathan, R. (1984). 'Improved methods of combining forecasts.' *Journal of Forecasting*, vol. 3 (April/June), pp. 197-204.
- Hansen, L. P. and Hodrick, R. J. (1980). 'Forward exchange rates as optimal predictors of future spot rates: an econometric analysis.' *Journal of Political Economy*, vol. 88 (October), pp. 829-53.
- Harvey, A. C. (1981). *Time Series Models*. Oxford: Philip Allan.
- Hayashi, F. and Sims, C. (1983). 'Nearly efficient estimation of time series models with predetermined, but not exogenous, instruments.' *Econometrica*, vol. 51 (May), pp. 783-98.
- Levich, R. M. (1978). 'Tests of forecasting models and market efficiency in the international money market.' In *The Economics of Exchange Rates: Selected Studies* (ed. J. A. Frenkel and H. G. Johnson). Reading, Mass.: Addison-Wesley.
- (1979). 'On the efficiency of markets for foreign exchange.' In *International Economic Policy: An Assessment of Theory and Evidence* (ed. R. Dornbusch and J. A. Frenkel). Baltimore, Maryland: Johns Hopkins University Press.
- (1980). 'Analysing the accuracy of foreign exchange advisory services: theory and evidence.' In *Exchange Risk Exposure* (ed. R. M. Levich and C. Whilbour). Lexington: D. C. Heath.
- Ljung, G. M. and Box, G. E. P. (1978). 'On a measure of lack of fit in time series models.' *Biometrika*, vol. 66, pp. 67-72.
- Sargent, T. J. (1979). *Macroeconomic Theory*. New York: Academic Press.
- Theil, H. (1971). *Applied Economic Forecasting*. Amsterdam: North Holland.
- White, H. (1980). 'A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity.' *Econometrica*, vol. 48 (May), pp. 817-38.