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*The Economic Journal*, Volume 100, Issue 400, Conference Papers (1990), 49-59.

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## CHARTS, NOISE AND FUNDAMENTALS IN THE LONDON FOREIGN EXCHANGE MARKET\*

*Helen Allen and Mark P. Taylor*

This paper presents some empirical evidence on the prevalence, perceived importance and nature of ‘chartist’ or ‘technical’ analysis in the London foreign exchange market. If ‘noise traders’ (see e.g. de Long *et al.*, 1987) are defined as those speculators who do not base their trading strategies on a consideration of market fundamentals, then it clearly encompasses those traders who employ chart analysis – i.e. those who base their strategies on the analysis and extrapolation of past price movements alone.

### I. CHART ANALYSIS: PRACTICE AND PERCEPTION

An essential difference between chart analysis and fundamental economic analysis is that chartists study *only* the price action of a market, whereas fundamentalists attempt to look to the reasons *behind* that action. Chartists see the market price as embodying all aspects of the market – economic or non-economic, rational or irrational, balancing all the forces of supply and demand. Hence the market price is seen as immediately discounting all pertinent information and therefore encompassing all the fundamentalists’ views.<sup>1</sup> Basic chart analysis involves visually identifying recurring patterns in time series price data. For example, certain configurations, known as ‘reversal patterns’, are taken to indicate the imminent reversal of a trend. Perhaps the most famous of these is the ‘head and shoulders’ formation (Edwards and Magee, 1966). Other configurations may be judged to be ‘continuation patterns’ – i.e. patterns that occur *within* established trends (Murphy, 1986). Often, chartists will identify broad ranges within which exchange rates or asset prices are

\* The authors would like to thank C. J. Bailey, R. D. Clews, P. G. de Hoest, J. C. Dorrington, J. S. Flemming, S. G. F. Hall, S. G. B. Henry, A. R. Latter, D. K. Miles, J. Ryding, I. D. Saville and C. T. Taylor for comments on earlier drafts. They are also grateful to seminar participants at the Universities of Leicester, London (Queen Mary College) and Southampton and delegates to the Royal Economic Society annual conference 1989, Bristol. The kind cooperation of survey participants and interviewees is appreciated. The constructive comments of two referees and an editor are also gratefully acknowledged. The usual disclaimer applies in all cases. The authors would also like to thank L. Millham for able research assistance.

A previous version of this paper appeared as Bank of England Discussion Paper Number 40. Any views expressed are strictly those of the authors and are not necessarily those of the Bank of England.

<sup>1</sup> The ‘pure’ chartist assertion that all market information is automatically reflected in the price, however, suggests a paradox, highlighted in a slightly different context by Grossman and Stiglitz (1980): if market prices fully and instantly reflect all available information, then market participants have no incentive to gather costly information, in which case it is hard to see how information gets discounted into market prices. The resolution of the paradox lies in relaxing the assumption that prices *instantly* reflect all available information. It is the possibility of making abnormal profits by very short-term arbitrage which gives agents the incentive to gather and process new information. Another paradox inherent in the assumption of all pertinent information being instantly discounted in the price concerns whether the chartist forecasts *themselves* would be discounted.

expected to trade, and the upper and lower limits of such ranges are termed 'resistance' and 'support' levels respectively.<sup>2</sup>

Chart analysts will generally also employ 'mechanical indicators' when forming a general view. These might be trend-following (e.g. 'buy when a shorter moving average cuts a longer moving average from below') or non-trend following (e.g. 'oscillators' which calculate the rate of change of prices, with the assumption that there is a tendency for markets to 'correct' when an asset has been 'overbought' or 'oversold') – see e.g. Murphy (1986). Other, non-price based indicators may also be considered by chart analysts. For example, attitudinal indicators may be studied for signs of the market being overbought or oversold – market sentiment measures such as surveys of market opinion are widely used in this context. Other indicators which also do not fall strictly into the category of analysing the individual market price itself might be the study of, say, interest rate charts alongside exchange rates, or using indices of the whole market as an additional input to the study of only one price within that market.

Clearly, chart analysis has a large subjective element, and there are probably as many methods of combining and interpreting the various techniques as there are chartists themselves. To the present authors' knowledge, virtually no work exists on the extent and manner by which chartism is used in the foreign exchange markets. In an attempt to ascertain the influence of chartism and the methods used in practice, a questionnaire survey of chief foreign exchange dealers in the London market was conducted. The survey had a wide coverage of dealing institutions and over 200 responses were received.<sup>3</sup>

A key result of the survey was that chartism appears to be most used for forecasting over short time horizons. At the shortest horizons, intraday to one week, approximately 90% of respondents use some chartist input in forming their exchange rate expectations, with 60% judging charts to be at least as important as fundamentals. At longer forecast horizons, of one to three months or six months to one year, the weight given to fundamentals increases and at the longest forecast horizons, one year or longer, the skew towards fundamentals is most pronounced, with nearly 30% of respondents relying on pure fundamentals and 85% judging fundamentals to be more important than charts. Only 8% of respondents thought the two approaches to be competing to the point of being mutually exclusive; the rest held the approaches to be complementary to a greater or lesser degree. However, there appeared to be a persistent 2%, of presumably 'pure' chartists, who never use fundamentals at any horizon. This provides *prima facie* evidence against the Frankel and Froot (1986*b*) model of exchange rate dynamics, where the chartist–fundamentalist relationship is set up as essentially competitive.

<sup>2</sup> A referee has pointed out that resistance and support levels may correspond to focal equilibria of the kind analysed by game theorists; their existence is both confirmed and implied by beliefs.

<sup>3</sup> A more detailed analysis of the survey can be found in Allen and Taylor (1989).

## II. CHARTISTS' EXPECTATIONS: AN EMPIRICAL ANALYSIS

Chartist advice is clearly largely subjective and dependent in construction upon the individual chartist's approach. Moreover, many technical analysts would argue that they are not in the business of making precise predictions at a particular time horizon, but rather are aiming to 'set the parameters' within which market traders operate, while other analysts claim that they can hardly justify their positions as chartists *unless* they can give some specific predictions.

All these factors compound the problem of analysing chartist advice. Clearly, it is not possible to 'simulate' chartist forecasts for the purpose of analysis, neither would it be representative of the many varieties of chartist advice to pick one practitioner and proceed on the basis of the forecasts of that individual alone. It was therefore decided to construct a survey database of chartists' exchange rate expectations, which would enable each contributor to employ whichever methods were felt to be the most appropriate to the particular market situation.

Over the period June 1988 – March 1989 (38 weeks), a panel of chart analysts was telephoned every week and their expectations with respect to the \$/£, DM/\$ and ¥/\$ exchange rates for one and four weeks ahead were recorded. The panel was selected to include chartists who were highly regarded in the City, this having been ascertained through preliminary interviews with a number of chartists and dealers as well as from the questionnaire survey sent out to chief dealers.<sup>4</sup>

Fig. 1 shows graphs of the sample median, high and low chartist forecast for each currency and time horizon, together with the actual rate that materialised. There are at least three points which can be made from inspection of these figures. First, as one should expect, prediction errors are noticeably greater at the four-week horizon. Second, there appears to be a tendency for the forecasts to miss turning points and for forecast errors to narrow when the exchange rate is trending. Third, there is a broad tendency to underpredict in a rising market, and to overpredict in a falling market, strongly suggesting that the average 'elasticity of expectations' is less than unity – i.e. a 1% rise (fall) in the rate appears to induce a less than 1% expected rise (fall) next period.

Statistical tests of unconditional bias were performed by regressing the forecast errors onto a constant. The hypothesis of zero unconditional bias was rejected at the 5% significance level for all four-week ahead forecasts, although significant evidence of bias was shown in certain chartists' one-week ahead predictions, particularly for the DM/\$ (Allen and Taylor, 1989).

Fig. 2 summarises the aggregate qualitative accuracy of the forecasts at both time horizons, for each currency and averaged across all chartists for each month of the survey. These figures again suggest a tendency of chartist expectations to be extrapolative. For example, the rise in average qualitative accuracy of DM/\$ predictions at the one-week horizon between September and October exactly matches the establishment of a downtrend in the rate (Fig. 1c). As the dollar shifts into an uptrend against the mark at the end of

<sup>4</sup> The exact details of the panel are confidential. Approximately twenty chartists participated.

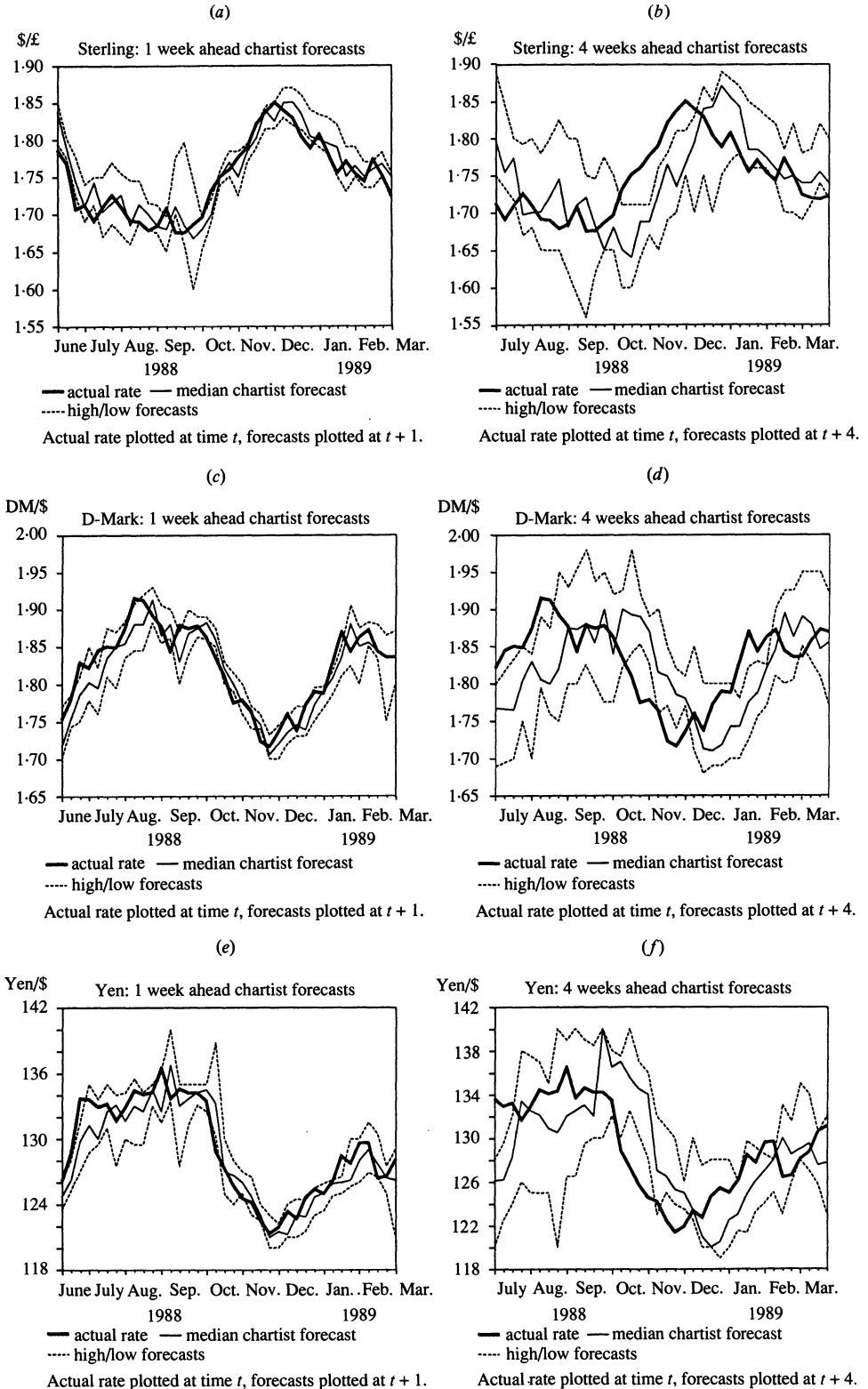
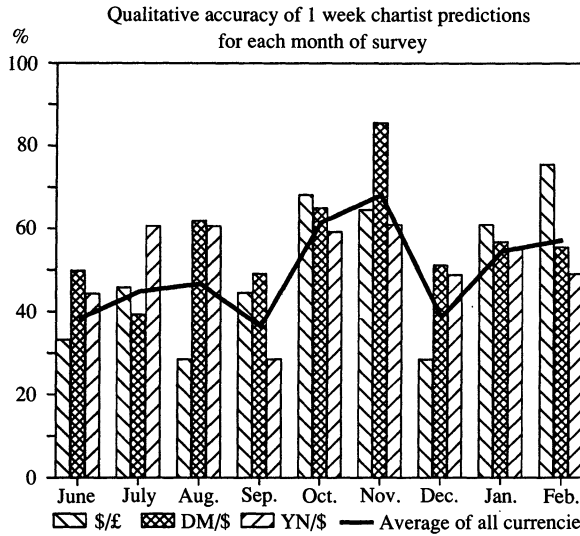


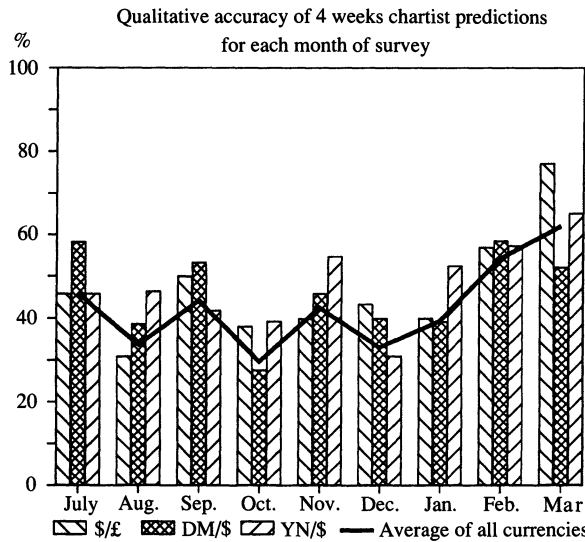
Fig. 1.

(a)



<sup>1</sup> Percentage of chartists who correctly forecasted the direction of currency movements (appreciation/depreciation) over each month of the survey period.

(b)



<sup>1</sup> Percentage of chartists who correctly forecasted the direction of currency movements (appreciation/depreciation) over each month of the survey period.

Fig. 2.

November, the average qualitative accuracy quickly shrinks for December (Fig. 2a).

We next proceeded to test formally whether there were systematic differences in the accuracy of forecasts among the panel. This was done using a non-parametric test procedure which allows for matched samples (Batchelor, 1988;

Allen and Taylor, 1989). This involved mapping the (absolute) forecast errors into ranks at each data point, for each exchange rate and for each time horizon. For  $n$  forecasters, the chartist with the largest error is assigned rank  $n$  and the chartist with the smallest error is assigned rank 1. The null hypothesis is then that the distribution of ranks across the forecasters is purely random. Using the full data set, this statistic was computed and yielded a value which was just insignificant at the 5% level, but significant at the 10% level.<sup>5</sup> Since a well-known feature of non-parametric tests is their low power, this was taken as reasonable evidence of systematic differences in forecasting performances across the panel.

The accuracy of chartist predictions was compared with various economic and statistical approaches, using the root mean square error (RMSE) of the forecasts of each as a performance measure. The results for the RMSEs of one and four-week ahead predictions for a sample of chartists and other forecasting methods are reported in Table 1.

Table 1

*Comparison of % RMSE of chartist forecasts with other forecasting approaches*

Representative selection of individual chartist forecasts and *whole sample* median, compared with ARIMA, random walk, four VAR approaches and the forward rate (Logarithms).

	1 week ahead			4 weeks ahead		
	\$/£	DM/\$	¥/\$	\$/£	DM/\$	¥/\$
Chartist						
<i>A</i>	1.98	1.85	2.03	5.20	5.56	5.41
<i>B</i>	1.47	1.63	1.64	3.05	3.65	3.37
<i>F</i>	1.95	1.46	2.01	4.48	4.13	4.05
<i>H</i>	1.60	1.70	1.82	3.62	3.89	3.66
<i>M</i>	1.21	1.30	1.33	2.37	2.84	2.71
<i>P</i>	1.38	1.41	1.91	3.44	3.60	3.55
Median (whole sample)	1.28	1.33	1.38	3.00	3.38	3.33
Random walk*†	1.25	1.38	1.35	2.81	3.18	3.12
ARIMA	1.77	2.05	2.17	4.14	4.94	4.64
Economic VAR						
Unrestricted	1.64	1.92	1.68	4.63	4.66	4.74
Restricted	1.12	1.39	1.23	2.99	3.76	3.04
Currency VAR						
Unrestricted	1.98	1.75	1.91	5.18	4.12	4.22
Restricted	1.05	1.37	1.29	2.55	3.76	3.28
Forward rate	N/A	N/A	N/A	2.71	3.07	3.10

\* The RMSE of the random walk model being less than that of the ARIMA model, despite the fact that the latter nests the former, is indicative of a time-varying process. While the ARIMA model would have performed better in-sample, its performance out of sample worsened as the data process shifted, leading to the comparative results reported.

† The Table shows that the restricted VARs usually have a lower RMSE than the random walk but that the unrestricted VARs never outperform a random walk. This result is explained by the inefficiency caused by the additional variables in the unrestricted VARs – inefficiency which is reflected in the RMSEs.

<sup>5</sup> The exact value of the statistic and its degrees of freedom cannot be reported, since this would reveal the exact number of participants in the survey.

An obvious feature of the results is that there are substantial differences between individual chartists. Chartist *M* appeared to be particularly accurate across all currencies and time horizons and was the only chartist consistently to outperform the median. The median itself had a lower RMSE than the majority of individual chartists, perhaps suggesting that the consensus chartist view is likely to outperform most individuals' views on aggregate. However, even the median view was generally unable to outperform a random walk, although Chartist *M* was consistently more accurate than the random walk. This is a significant finding, as Meese and Rogoff (1983*a, b*) found that no economic model was able to outperform a random walk in out of sample forecasting tests, as measured by the RMSE.

The ARIMA forecasts were generated by using six months of weekly data immediately prior to the forecast sample to identify and estimate initial ARIMA models (Box and Jenkins, 1976) which were re-estimated recursively until the mid-point of the sample, when new ARIMA models were identified.<sup>6</sup> It is notable that ARIMA models produced a higher RMSE than most chartists – suggesting that chartism is more than simply an 'eye-ball Box-Jenkins' approach.

Finally, the chartist results were compared with forecasts generated by vector autoregressions (VARs). Two types of fourth-order VAR were estimated – an 'economic' VAR based upon the exchange rate, the interest rate differential (against the dollar) and relative stock market performance (against the United States),<sup>7</sup> and a VAR involving only \$/£, DM/\$ and ¥/\$ exchange rates. An initial VAR was estimated using six months of data prior to the survey sample, and a Kalman filter algorithm was used to update the coefficient estimates and forecast dynamically at each data point. We estimated both completely unrestricted VARs and VARs employing Bayesian priors on the coefficients (Litterman, 1981).<sup>8</sup> On an unrestricted basis, the resulting forecast displayed a large error, but this was significantly reduced using the Bayesian technique. At the one-week horizon, the Bayesian currency VAR outperformed the random walk but was beaten by the median chartist forecast and chartist *M* for predictions of DM/\$. At the four-week horizon, chartist *M* outperformed all alternative forecasts for all currencies.

The potentially destabilising nature of chartist advice was examined as follows. Consider the following alternative expectations hypotheses, where  $S_t$  denotes the (logarithm of the) spot rate at time  $t$ ,  ${}_t S_{t+n}^e$  the expected value of  $S_{t+n}$  at time  $t$ ,  $\bar{S}_t$  is the 'equilibrium' exchange rate at time  $t$  and  $\Delta$  is the first-difference operator.

<sup>6</sup> Using the six months of data prior to the survey, the following ARIMA models were fitted: \$/£ ARIMA (1, 1, 0); DM/\$ ARIMA (1, 1, 1); ¥/\$ ARIMA (1, 1, 0). Using data up to the mid-point of the survey period, an ARIMA (1, 1, 2) was fitted to all three exchange rate series.

<sup>7</sup> See Solnik (1987) for a discussion and application of such models.

<sup>8</sup> The Bayesian VARs were computed using the procedures available in the RATS econometric package (Doan and Litterman, 1987). The priors employed were basically that each variable followed a random walk. Thus, the mean vector of the prior distribution has unity for each first own-lag and zeros elsewhere. A spherical prior precision matrix was employed with, in the Doan-Litterman terminology, a tightness parameter of 0.3 and a symmetric parameter of 0.1 (Doan and Litterman, 1987).



Static expectations:

$${}_tS_{t+n}^e - S_t = 0 \quad (1)$$

Bandwagon expectations:

$${}_tS_{t+n}^e - S_t = \alpha \Delta S_t, \alpha > 0 \quad (2)$$

Extrapolative expectations:

$${}_tS_{t+n}^e = (1 - \beta)S_t + \beta S_{t-1}, 1 > \beta > 0 \quad (3)$$

Adaptive expectations:

$${}_tS_{t+n}^e = {}_{t-n}S_t^e + \gamma(S_t - {}_{t-n}S_t^e), \gamma > 0 \quad (4)$$

Regressive expectations:

$${}_tS_{t+n}^e - S_t = -\theta(S_t - \bar{S}_t), \theta > 0. \quad (5)$$

It is clear that the elasticity of expectations in the static expectations case is unity<sup>9</sup> but if agents conform to the bandwagon expectations hypothesis, (2), then the elasticity of expectations will be  $(1 + \alpha) > 1$ . Thus, in the latter case, if chartists heavily influence foreign exchange dealers' behaviour, they will tend to have a destabilising effect on the market as, for example, dealers are advised to sell a currency, which depreciates further, which they are then advised to sell again, and so on (Nurske, 1944). The remaining cases considered – extrapolative, adaptive and regressive expectations – each have an expectations elasticity less than unity and so imply that chartist influences would not be destabilising in this sense. The extrapolative and adaptive expectations formation mechanisms are well known. The regressive expectations formulation is perhaps best known for its application in the exchange rate overshooting model of Dornbusch (1976), who also showed that it would be rational to determine expectations in this way under certain conditions.

Equations (1)–(5) were reparameterised so that the various hypotheses could be tested by regression analysis. In each case the null hypothesis was static expectations, whilst the alternative hypotheses corresponded to one of (1)–(5) (see Allen and Taylor, 1989 for further details). In testing for regressive expectations, we assumed that the equilibrium exchange rate,  $\bar{S}_t$ , remained constant over the sample period. The regressions were carried out using survey data collected for six individual chartists selected at random from our data base (labelled alphabetically to preserve anonymity) as well as for the median forecasts. The results are summarised in Tables 2 and 3.

For the one-week predictions, the general tendency was an inability to reject the hypothesis of static expectations against any of the considered alternatives. The two major exceptions were chartists *A* and *M*, for whom the null hypothesis was often rejected in favour of one of the inelastic alternatives. Chartist *A* also had strongly non-static expectations at the four-week horizon,

<sup>9</sup> Note that Frankel and Froot (1986*a, b*) assume static expectations on the part of chartists.

Table 2  
*Summary of tests for adaptive and regressive expectations\**

Forecaster	1 week predictions						4 week predictions					
	Accept AE?			Accept RE?			Accept AE?			Accept RE?		
	£	DM	¥	£	DM	¥	£	DM	¥	£	DM	¥
<i>A</i>	N	N	N	N	N	N	Y	Y	N	Y	N	N
<i>B</i>	N	N	N	N	N	N	N	N	N	N	N	N
<i>H</i>	N	Y	N	N	N	N	N	N	N	N	N	N
<i>M</i>	Y	Y	Y	N	Y	N	N	N	Y	N	Y	N
<i>P</i>	N	N	N	N	N	N	N	N	N	N	N	N
<i>L</i>	Y	Y	Y	N	N	N	N	N	N	N	N	N
Median	N	N	N	N	N	N	N	N	N	N	N	N

\* AE = adaptive expectations; RE = regressive expectations.

Table 3  
*Summary of tests for static against extrapolative or bandwagon expectations\**

Forecaster	1 week predictions						4 week predictions					
	Accept EE?			Accept BWE?			Accept EE?			Accept BWE?		
	£	DM	¥	£	DM	¥	£	DM	¥	£	DM	¥
<i>A</i>	N	N	N	N	N	N	Y	Y	N	N	N	N
<i>B</i>	N	N	N	N	N	N	N	N	N	N	N	N
<i>H</i>	N	N	N	N	N	N	N	N	N	N	N	N
<i>M</i>	Y	N	Y	N	N	N	N	N	Y	N	N	N
<i>P</i>	N	N	N	N	N	N	N	N	N	N	N	N
<i>L</i>	N	N	N	N	N	N	N	N	N	N	N	N
Median	N	N	N	N	N	N	N	N	N	N	N	N

\* EE = extrapolative expectations; BWE = bandwagon expectations.

with the null hypothesis being rejected in favour of either adaptive, regressive or extrapolative expectations, but *not* bandwagon expectations. Similar results were obtained for chartist *M* at the four-week horizon.

The general result to emerge from this analysis is that chartist advice does not appear to be destabilising in the sense that chartists' expectations do not appear to overreact systematically to changes in the current exchange rate. These results thus confirm our informal impressions gained from a visual inspection of Figs. 1*a-f*. Logically separate from this issue, however, is the question of whether chartist advice may be destabilising in the sense of leading the market away from the underlying fundamentals. The most that can be said, given the present evidence, is that chart advice may at most cause mean-reverting, or stationary, deviations from the fundamentals i.e. 'fads' – see e.g. Poterba and Summers (1987).

## III. CONCLUSION

Recent research in financial economics has concentrated on the role of non-fundamentalist traders in asset markets (e.g. Shiller, 1984; Campbell and Kyle, 1987; de Long *et al.*, 1987). In this paper, we have provided some empirical evidence concerning the nature and perceived importance of one particular kind of non-fundamentalist analysis – chartism – in the London foreign exchange market<sup>10</sup>. At the very least this research should provide ample warning to researchers in financial markets who do not allow for non-fundamental influences. Further empirical and theoretical work on foreign exchange markets, particularly at shorter horizons, should not preclude the consideration of non-fundamentals.

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<sup>10</sup> Several caveats might be made to the analysis and results of this paper. First, any results must be regarded as tentative, given the limited sample size and relatively short period over which the survey data were collected. Second, many chartists prefer to 'set the parameters' for exchange rate movements rather than provide point estimates. However, *all* forecasters, whether fundamental or non-fundamental based, would probably prefer to provide contingent advice with confidence intervals, and in this sense the results have not been biased against chartists. Third, our analysis has been conducted entirely in terms of the accuracy of chartist forecasts and not in terms of their profitability although one would expect a close correlation between the two. Finally, our analysis of chartist forecasts was confined to two horizons although they would seem to cover the range over which most charts are most widely used in the London foreign exchange market, as revealed by our questionnaire survey.

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