Bank of England

Discussion Papers

No 40

Charts and Fundamentals in the Foreign Exchange Market

by

Mrs H L Allen

and

M P Taylor

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The object of this series is to give a wider circulation to research being undertaken in the Bank and to invite comment upon it; and any comments should be sent to the authors at the address given below.

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The views expressed are those of the authors and not necessarily those of the Bank of England. 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.

Issued by the Economics Division, Bank of England, London, EC2R 8AH to which requests for individual copies and applications for mailing facilities should be addressed; envelopes should be marked for the attention of the Bulletin Group.

ISBN 0 903313 95 2
ISSN 0142-6753

Contents

Abstract

Recent research in financial economics has concentrated on the role of non-economic, or non-fundamentalist, speculators in asset markets. This paper presents some empirical evidence concerning the nature and perceived importance of a major form of non-fundamentalist analysis - chartism - in the London foreign exchange market. It analyses the results of a questionnaire survey on chartism conducted among chief foreign exchange dealers in the London market and data on a panel of chartists' one-week and four-week ahead exchange rate predictions. The analysis suggests that a majority of chief dealers use at least some chartist input into their trading decisions, especially at the shorter time horizons. Moreover, charts and fundamentals appear to be used largely as complementary, rather than competing, methods of analysis. This provides prima facie evidence against a certain class of theoretical models of the foreign exchange market which have recently been advanced and which view the relationship as competing. Further analysis of chartist predictions suggests that chartists are far from being a homogeneous group. Indeed, over the sample the most accurate chartists were able to outperform (in terms of average percentage errors) a whole range of competing exchange rate forecasting methods, including the random walk model. Finally, the paper suggests that chartist advice is not intrinsically destabilising with respect to the foreign exchange market but that the effect of non-fundamentalists should not be ignored when analysing the market.

List of Figures and Tables

1 Introduction

Notwithstanding Keynes' famous analogy of the stock market with a beauty contest (Keynes, 1936)[1], economists have typically, at least in the post-war period, assumed that asset prices should reflect fundamental values alone. This is one strand of the efficient markets literature, a corollary of which seemed to be that non-fundamentalist traders would be quickly driven out of business by fundamentalist speculators (Friedman, 1953, Fama, 1965).

Such a view, however, has long been at odds with the practitioners' view of financial markets (see eg Financial Times, 5 April 1988, p.16).[2] Business school graduates, raised on the idea that asset markets are efficient, or even that asset prices follow a random walk (Fama, 1976, Malkiel, 1984), continue to provide counter examples to this theory by earning abnormal profits as traders on Wall Street or in the City.

Besides this phenomenon, empirical research on asset markets has continued to bring to light numerous empirical anomalies which are at variance with the efficient markets hypothesis. These include, inter alia, the excess volatility of stock markets (Shiller, 1981, Campbell and Shiller, 1987) and the failure of forward exchange rates optimally to predict future spot rates (see eg MacDonald and Taylor, 1989a, for a survey).[3] The extreme volatility of exchange rates during the recent float (Dornbusch and Frankel, 1987) and the miserable empirical performance of asset market models of the exchange rate (Meese and Rogoff, 1983a,b, Hacche and Townend, 1981) are related phenomena.

Recently, a number of authors have begun to analyse asset market models with non-fundamentalist speculators ("noise traders"), rather than taking their non-existence as axiomatic (see eg Shiller, 1984, Kyle, 1985, Campbell and Kyle, 1987, Black, 1986 and de Long et al, 1987). De Long et al, 1987, for example, develop a model of the stock market in which fundamentalist traders and non-fundamentalist traders can co-exist. Not only do they demonstrate that the return to noise trading may be positive, but also that it may be optimal for fundamentalist investors to take some account of noise traders' predictions and to some extent mimic their behaviour.

The purpose of this paper is to provide some empirical evidence on the prevalence, perceived importance and nature of 'chartist' or 'technical' analysis in the London foreign exchange market. If we define 'noise traders' as referring to 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 - ie those who base their strategies on the analysis and extrapolation of past price movements alone.

2 Market Perceptions of Chart Analysis

There exists a number of comprehensive surveys of chart analysis (eg Edwards and Magee, 1966, Kaufman, 1978, Pring, 1985, Murphy, 1986, Plummer, 1989). In this section, therefore, we will highlight only the most salient features of technical analysis, before going on to discuss the perceived importance and use of these methods in the London foreign exchange market. A slightly fuller guide to chart techniques is given in the Appendix.

An essential difference between chartists and fundamentalists is that (at least in principle) 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.[4] Basic chart analysis involves visually identifying recurring patterns in time series price data. 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' - ie patterns that occur within established trends (Murphy, 1986). Often, chartists will identify broad ranges within which exchange rates or asset prices are expected to trade, and the upper and lower limits of such ranges are termed 'resistance' and 'support' levels respectively, terms which now seem to have entered common financial parlance.[5]

Chart analysts will generally also employ one or more 'mechanical indicators' when forming a general view. These might be trend-following (eg 'buy when a shorter moving average cuts a longer moving average from below') or non-trend following (eg '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 eg 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. The use of indices is widespread, although technical analysts would generally argue that the indices themselves chart poorly, as they are not a direct reflection of underlying trading.

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 and whether the techniques in any way contribute to price movements. In an attempt to ascertain the influence of chartism on foreign exchange market practitioners, a questionnaire survey of chief foreign exchange dealers in the London market was conducted by the present authors. The survey had a wide coverage of dealing institutions and over 200 responses were received and analysed. The aim of the survey was to assess the manner in which chartism is used in the foreign exchange market - the methods used in practice, the input of chartists into trading decisions and the importance which the actual market participants attach to chartism. Respondents were also invited to add general comments concerning the relevance and use of chartism in the foreign exchange market.

A clear result of the survey was that chartism appears to be most used for forecasting over short time horizons, given the lack of immediate economic data at such frequencies. At the shortest horizons, intraday to one week (figure 1a), 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 (figures 1b, 1c). At the longest forecast horizons, one year or longer (figure 1d), 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. However, it can be seen from figure 1 that there is a persistent 2%, of presumably 'pure' chartists, who never use fundamentals at any horizon.

Several comments made by survey participants indicated a belief that charts essentially measure swings in market psychology, which may be of most importance in the shorter term but may be harder to forecast over the longer horizons, over which fundamental economic factors tend to become more dominant. A slightly different view expressed was that chartism may actually obscure the underlying fundamentals over the shorter horizons; for example:

> '...charts merely prevent fundamentals coming through over the short term. The skill therefore is to spot when the charts will break down, and catch up with the fundamentals. As a trading tool they are useful because they are widely used and therefore can be self-fulfilling'.

Such a view seems to be tantamount to asserting that chartists generate short excursions from fundamentals - ie 'fads'. Another recurring theme among respondents' general comments was the idea that chart analysis may be largely self-fulfilling, with some 40% stating so explicitly. One respondent wrote:

> 'Knowledge of chart signals is essential to all operators as they have a bearing on the action of many market participants ... This holds true both for operators who place high priority on technical analysis and for others - like ourselves - who prefer a more fundamental approach'.

This quotation, and many others like it in our sample, tends to bear out the suggestion of de Long et al that sophisticated speculators will not trade purely on consideration of economic fundamentals, but will also aim to exploit market movements generated by non-fundamentalists (see eg de Long et al, 1987, p2).

The survey also inquired whether participants regarded the chartist and fundamental approaches to exchange rate analysis to be complementary or competing. Only 8% of respondents replied that they thought the 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.

The view that chartist and fundamental analysis may be largely complementary also figured strongly in respondents' general comments as well as the view that charts should be used to confirm but not contradict the message from the fundamentals. One respondent went into some detail on this issue:

> 'A classic attitude on the interbank side is "if I agree with the technical view I'll double my position - if I disagree I'll throw it in the bin". On the customer dealing side [dealers] typically use it to complement their own fundamental view. Good fundamental arguments, for instance, would be put forward for why sterling should fall. The customer will then invariably ask "by how much?" Often technical analysis is used to provide this sort of quantitative level of a fundamental view'.

Given dealers' use of chartist advice, it is logical to enquire as to its source. Almost exactly a quarter of respondents reported that their organisation employs in-house technical analysts, as opposed to 38% who reported having in-house economists. Some 21% of respondents relied on advice from outside commercial chartist companies for their chartist input, whilst 43% subscribed to particular chartist publications. By far the most widespread source of chartist analysis among the survey respondents appeared to be in the form of on-line commercial services. Some 74% of respondents reported using some form of on-line data and graphics computer services, ranging from basic data retrieval and graphics packages to sophisticated, dedicated chartists services providing foreign exchange data updated almost continuously and capable of

producing highly complex, full colour charts. These graphics packages were widely used to produce various calculated indicators - the most widely used of which were the trend following indicators. Approximately 65% of respondents reported using trend-following systems such as moving averages in their chart analysis and 40% reported using them in combination with some form of overbought/oversold indicators.

In the light of the earlier discussion in this section, it is clear that technical analysis is something of an art form which involves subjectively evaluating the gestalt of chartist evidence and forming a view. It is therefore unlikely that a tractable mathematical or statistical model would adequately reproduce chartist behaviour. Yet given the perceived importance and widespread use of chartist advice in the London foreign exchange market, it would seem of importance to analyse the characteristics of the advice. This is the purpose of the next section.

3 Chartists' Expectations

Chartist advice is largely subjective and dependent in construction upon the individual chartist's approach. Moreover, many (but by no means all) 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. To quote a typical piece of chartist advice: "...important support is likely to be found around the year's low at just over ¥120. A break below ¥120 will give an immediate objective of ¥110, and such a decline cannot be ruled out..." (Robert Fleming & Co, Foreign Exchange, 1988, p15). However, other analysts claim that they can hardly justify their positions as chartist unless they can give some specific prediction.

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.[6] In the light of these

considerations, it was decided that the most representative way of collecting chartist advice would be 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, a panel of chart analysts was telephoned every Thursday and their expectations with respect to the sterling-dollar, dollar-mark and dollar-yen exchange rates for one and four weeks ahead were recorded. The panel was selected to include chartists who were highly regarded in the City both by fellow chartists and by foreign exchange dealers, 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.[7]

Figures 2a - 2f show graphs of the sample median, high and low chartist forecast for each currency and time horizon, together with the actual rate that materialised. The forecasts are shifted forward so that points vertically in line on the graphs compare predictions with actual outcomes.

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 - ie a 1% rise (fall) in the rate appears to induce a less than 1% expected rise (fall) next period. This last point will be discussed more formally below.

4 Unconditional Bias and Qualitative Accuracy of Chartists' Expectation

The next task we undertook was to test whether the chartist expectations were characterised by unconditional bias, and to evaluate informally the qualitative accuracy of the forecasts. Statistical tests of unconditional bias were performed by regressing the forecast errors onto a constant (results reported in Tables 1a and 1b)). 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/$.

Table 2 lists the percentage of times a selection of chartists' forecasts were qualitatively correct (ie correctly forecasted appreciation or depreciation). Intuitively, one would expect appreciation or depreciation of a currency to be forecast correctly on 50% of occasions purely by chance, and this seems to be close to what the figures in the table actually suggest.

Figures 3a and 3b summarise the aggregate qualitative accuracy of the forecasts at the one-week and four-week horizons, both 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 (figure 2c). As the dollar shifts into an uptrend against the mark at the end of November (figure 2c), the average qualitative accuracy quickly shrinks for December (figure 3a).

The next section reports the results of some formal tests for differences in forecast accuracy among chartists.

5 Non-Parametric Tests of Homogeneity of Forecast Accuracy

We next proceeded to test formally whether there were systematic differences in the accuracy of forecasts among the panel. (Readers requiring only a summary of the results of this section should refer to the final paragraph.) One method of testing for systematic differences which immediately suggests itself involves conducting an analysis of variance. Since, however, not all currencies and time horizons would have been equally easy to forecast at each data point (figures 3a, 3b), the resulting averaging of errors would not be legitimate (ie there are matched samples). In an analysis of the forecasting records of professional US economic forecasters, Stekler (1987) suggested using a non-parametric test. Batchelor (1988) subsequently pointed out an error in Stekler's analysis, however, and showed that the correct formula is in fact just the Friedman (1937) test for two-way analysis of variance by ranks (Siegel, 1956).

In the present context, the procedure is as follows. First, we map 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. We then summed these ranks for each forecaster over each forecast week, exchange rate and both time horizons, to produce a rank sum

$$r_l = \sum_{i=1,4} \sum_{j=1}^{3} \sum_{k=1}^{T} r_{ijkl} \qquad (5.1)$$

where r_{ijkl} is the rank of the l-th forecaster, at the i-week horizon, for the j-th exchange rate (1=$/£, 2=DM/$, 3=¥/$), for the kth data point (out of a total of T).

Under the null hypothesis of no significant differences in ranks, the expected value of the rank r_{ijkl} is simply the average rank (n+1)/2 and the expected value of the rank sum is 6T(n+1)/2=3T(n+1). Now, under the null hypothesis of random assignment of rank, the sampling variance of an individual rank statistic is n(n+1)/12 (Kendall, 1948), and so for the sum of 6T independent ranks it is 6Tn(n+1)/12 = Tn(n+1)/2.

The test for systematic assignments of rank simply compares the variance of the actual ranks across chartists to the theoretical variance under the null hypothesis:

$$\phi = \sum_{l=1}^{n} \frac{\{r_l - 3T(n+1)\}^2}{Tn(n+1)/2} \qquad (5.2)$$

Under the null hypothesis of no systematic assignment of ranks, ϕ will be distributed as central chi-square with n-1 degrees of freedom[8].

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.[9] Since a well-known feature of non-parametric tests is their low power, this was taken as reasonable evidence of systematic differences in forecasting performance across the panel.

A slightly different version of this test was also constructed in order to ascertain whether one of the forecasters, who from our perusal of the weekly rankings, appeared to have a high number of low ranks, was indeed systematically better than the group average. If this forecaster is labelled the n-th, then there are n-1 others. Using (5.1) above, write

$$r_{(n-1)} = \sum_{l=1}^{n-1} r_l$$

The expected value of $r_{(n-1)}$ is (n-1) times the expected value of r_l, ie $6T(n-1)(n+1)/2 = 3T(n-1)(n+1)$, while the variance is $T(n-1)n(n+1)/2$. Similarly, for the n-th forecaster, the expected value of r_n is $3T(n+1)$ and the variance is $Tn(n+1)/2$. Thus, the statistic

$$\phi_n = \frac{\left\{r_{(n-1)} - 3T(n-1)(n+1)\right\}^2}{T(n-1)n(n+1)/2} + \frac{\left\{r_n - 3T(n+1)\right\}^2}{Tn(n+1)/2}$$

will be distributed as x^2_1 under the null hypothesis of no significant differences in accuracy between the n-th chartist and the rest of the panel. This statistic was computed and yielded a value which is significant at the 1% level.[10]

The results reported so far thus suggest that there are systematic differences in forecast accuracy among chartists, and that at least one chartist appears to be systematically more accurate than the group average.

6 Comparison with Other Forecasting Methods

The accuracy of chartist predictions was then compared with various economic and statistical approaches, using the root mean square error of the forecasts of each. The results for the RMSEs of one and four-week ahead predictions are reported in Tables 3a and 3b respectively (this analysis was conducted with data transformed to logarithms, so that the RMSEs are in percentage terms).

The first obvious feature of these tables 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, suggesting that the consensus chartist view is likely to outperform most individuals' views on aggregate. It is clear, however, that even the median view is 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. Using the forward rate to forecast exchange rates would have produced errors of a similar magnitude to that of a random walk (four week ahead forecasts only).

The ARIMA forecasts were generated as follows. We used six months of weekly data immediately prior to the forecast sample to identify and estimate initial ARIMA models (Box and Jenkins, 1976). These were then re-estimated at each data point, with the new observation included, and one and four-week ahead predictions were recorded. At the mid-point of the survey sample, we identified new ARIMA models, and the process of successive re-estimation and forecasting was continued up to the end of the sample.[11] It is notable that ARIMA models produced a higher RMSE than most chartists - demonstrating that chartism is more than simply an 'eye-ball Box-Jenkins' approach.

Finally, the chartist results were compared with the one- and four-step ahead forecasts generated by vector autoregressions (VARs). Two types of 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 US), and a VAR involving only $/£, DM/$ and ¥/$ exchange rates. A fourth-order lag was used in all cases. 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).[12] 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 outperforms the random walk but is beaten by the median chartist forecast and chartist M for predictions of DM/$. At the four-week horizon, chartist M outperforms all alternative forecasts for all currencies.

7 Chartist Advice: Stabilising or Destabilising?[13]

Consider the following alternative expectations hypotheses, where S_t denotes the (logarithm of the) spot rate at time t, ${}_tS^e_{t+n}$ the expected value of S_{t+n} at time t, S_t is the "equilibrium" exchange rate at time t and Δ is the first-difference operator (eg $\Delta x_t = x_t - x_{t-1}$):

$$\text{Static expectations:} \quad {}_tS^e_{t+n} - S_t = 0 \tag{7.1}$$

$$\text{Bandwagon expectations:} \quad {}_tS^e_{t+n} - S_t = \alpha\Delta S_t, \ \alpha > 0 \tag{7.2}$$

$$\text{Extrapolative expectations:}^{14} \quad {}_tS^e_{t+n} = (1-\beta)S_t + \beta S_{t-1}, \ 1 > \beta > 0 \tag{7.3}$$

$$\text{Adaptive expectations:} \quad {}_tS^e_{t+n} = {}_{t-n}S^e_t + \gamma\left(S_t - {}_{t-n}S^e_t\right), \ \gamma > 0 \tag{7.4}$$

$$\text{Regressive expectations:} \quad {}_tS^e_{t+n} - S_t = -\theta\left(S_t - \bar{S}_t\right), \ \theta > 0 \tag{7.5}$$

If chartists' expectations were static, then they would essentially be assuming that the exchange rate follows a random walk. Although this may not be immediately appealing, it appears that economists themselves have often made such an assumption.[15] For example, in the classic Mundell-Fleming model under perfect capital mobility, domestic and foreign interest rates are set equal to each another. Assuming uncovered interest rate parity, this can only be true if agents have static expectations. Moreover, Frankel and Froot 1986(a,b) assumed static expectations on the part of chartists (albeit for simplicity) in their analyses.

It is clear that the 'elasticity of expectations' in the static expectations case is unity - a 1% change in the current rate will cause expectations of the future rate to be revised upwards by 1%. If, however, agents conform to the bandwagon expectations hypothesis, (7.2), then the elasticity of expectations will be $(1+\alpha) > 1$. Thus, in this 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.

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 straightforward and well known, and so require little further comment. 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.

Equation (7.3) can be rewritten:

$$ {}_tS^e_{t+n} - S_t = -\beta \Delta S_t \qquad (7.6) $$

Hence, if we estimate the slope coefficient in the following regression:

$$ {}_tS^e_{t+n} - S_t = \alpha_0 + \alpha_1 \Delta S_t + u_t \qquad (7.7) $$

(where u_t is an error term assumed to satisfy the usual requirements), then a test of the null hypothesis

$$ H_0: \alpha_1 = 0 $$

would constitute a test of static expectations, whilst the alternative hypotheses

$$ H_1: \alpha_1 > 0 $$

$$ H_2: \alpha_1 < 0 $$

would correspond to bandwagon and extrapolative expectations respectively.[14]

Similarly, equation (7.4) can be reparameterised as:

$$ {}_tS^e_{t+n} - S_t = (1-\gamma)({}_{t-n}S_t^e - S_t) $$

so that in the regression:

$$ {}_tS^e_{t+n} - S_t = \beta_0 + \beta_1({}_{t-n}S_t^e - S_t) + u_t \qquad (7.8) $$

the null hypothesis

$$ H_0: \beta_1 = 0 $$

would again correspond to static expectations whilst the alternative hypothesis

$$ H_1: \beta_1, \neq 0 $$

would correspond to adaptive expectations.

In analysing the regressive expectations hypothesis, we assumed that the perceived equilibrium exchange rate would remain fairly constant over the sample period, ($\bar{S}_t=\bar{S}$), so that (7.5) may be rewritten as

$$ {}_tS^e_{t+n} - S_t = \theta\bar{S} - \theta S_t $$

Hence, in the regression

$$ {}_tS^e_{t+n} - S_t = \gamma_0 + \gamma_1 S_t + u_t \qquad (7.9) $$

we expect $\gamma_1 < 0$; the null hypothesis is again static expectations.[16]

These 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 reported in Tables 4-6 and summarised in Tables 7a and 7b.

For the one-week predictions, the general tendency is an inability to reject the hypothesis of static expectations against any of the considered alternatives. The two major exceptions are chartists A and M, for whom the null hypothesis is often rejected in favour of one of the inelastic alternatives. Chartist A also has strongly non-static expectations at the four-week horizon, with the null hypothesis being rejected in favour of either adaptive, regressive or extrapolative expectations, but <u>not</u> bandwagon expectations. Similar results are obtained for chartist M at the four-week horizon.

Overall, therefore, these results suggest an inelasticity of expectations. Static expectations are never rejected in favour of bandwagon expectations for any chartist at any horizon. The general result to emerge from the analysis of this section is thus that chartist advice does not appear to be intrinsically destabilising in the sense that chartists' expectations do not appear to overreact systematically to changes in the current exchange rate. These results thus bear out our informal impressions gained from a visual inspection of figures 2a-2f.

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 (ie 'fads' - see eg Poterba and Summers, 1987).

8 Conclusion

Recent research in financial economics has concentrated on the role of non-fundamentalist traders in asset markets. 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. It emerges that, especially at the shorter end of the market, some chartist input into exchange rate forecasts appears to be widespread. Indeed, many market participants believe it is sufficiently widespread to lead them to attempt to account for its effects in forming a view, despite not explicitly subscribing to the approach themselves.

Moreover, the majority of chief foreign exchange dealers appear to view fundamentals and charts as complements rather than substitutes. This in itself provides evidence against the Frankel and Froot (1986b) model of exchange rate dynamics, where the chartist-fundamentalist relationship is set up as essentially competitive.

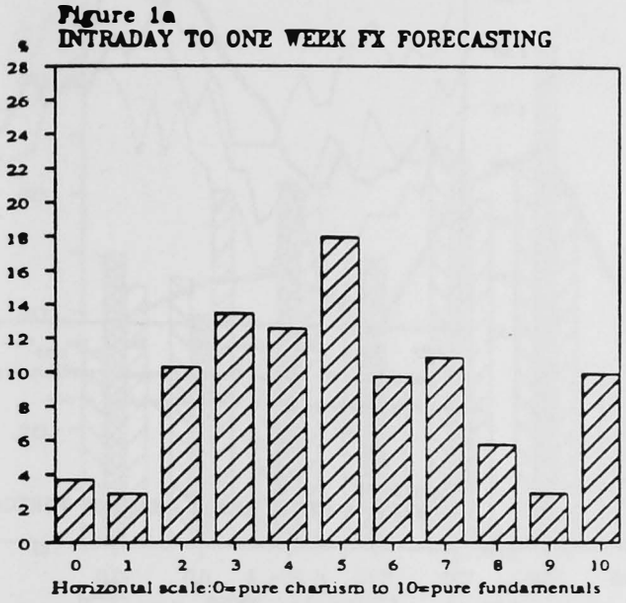
Analysing the exchange rate predictions of a panel of chartists revealed several notable features of their forecasts. First, chartists are far from being a homogenous group. They adopt numerous different approaches, emphasising the importance of particular techniques and producing distinctly heterogeneous forecasts of differing accuracy. Comparison of chartism with other forecasting approaches, however, show that it is more than a naive 'eyeball Box-Jenkins' method, and that the better chartists can in fact outperform a random walk.

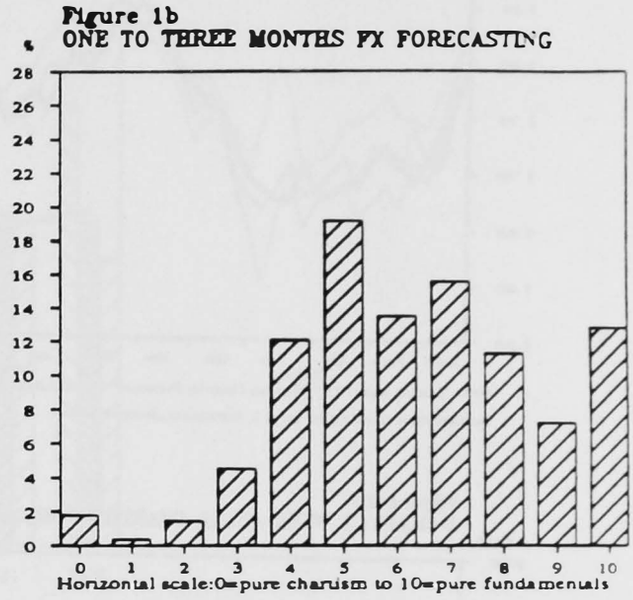
At a wider level, our results suggest that chartist expectations are generally inelastic and as such are not an intrinsically destabilising influence in the foreign exchange market. The most that can be said on the evidence available is that chartist advice is unlikely to cause explosive deviations of exchange rates from the path suggested by fundamentals (ie "bubbles"), but may generate temporary, mean-reverting deviations from this level (ie "fads").

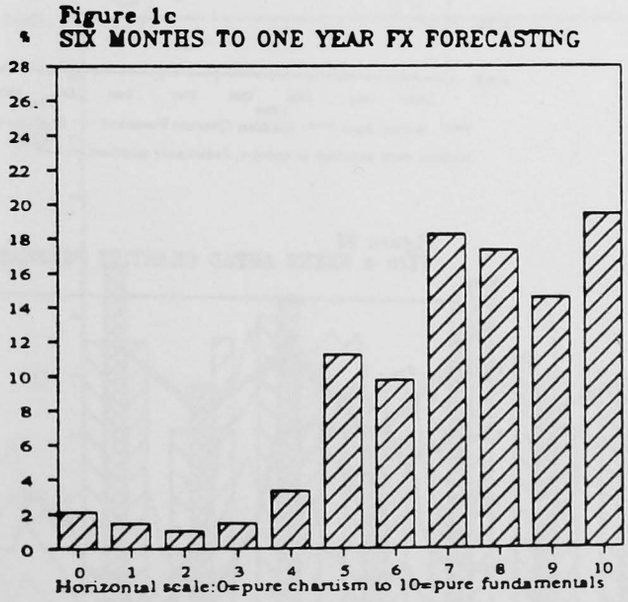
Several caveats must be made to the analysis and results of this paper. First, any results must be regarded as tentative, given the limited sample size and relatively short period over which the survey data was collected. Second, many chartists prefer to 'set the parameters' for exchange rate movements 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 accuracy and profitability. Finally, our analysis of chartist forecasts was confined to two horizons - one and four-weeks and thus excludes intraday and day-to-day use of charts and examination of any possible short-term volatility thereby induced. The horizons examined would seem, however, to cover the range over which most charts are most widely used in the London foreign exchange market, as revealed by our questionnaire survey (figure 1).

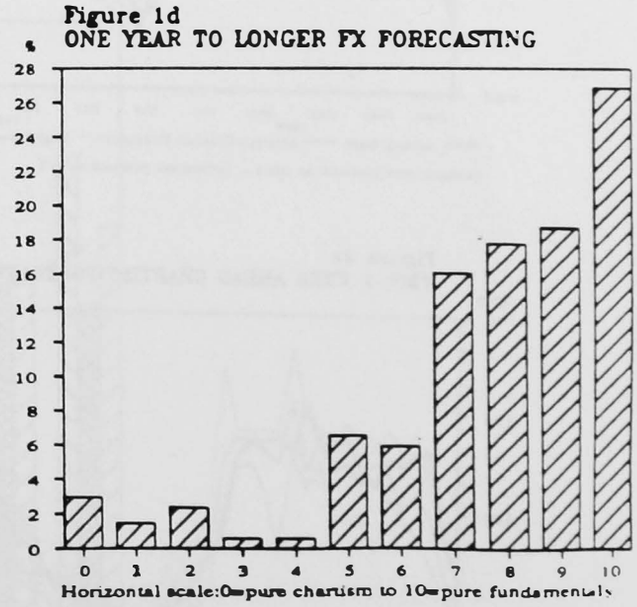
At the very least, however, the research reported should provide ample warning to researchers in financial markets who do not allow for non-fundamental influences. Further empirical and theoretical work on foreign exchange markets, particularly at shorter horizons, should not preclude the consideration of non-fundamentals.

Figure 1: Perceived importance of chartism and fundamentals in exchange rate forecasting[a]





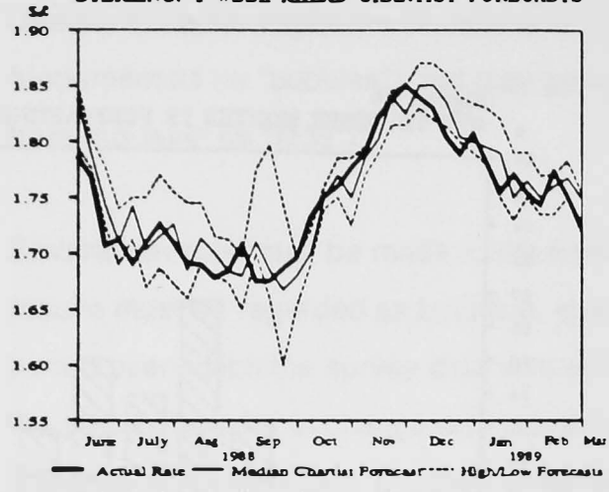




(a) Percentage of chartists advocating particular chart/fundamental weighting in forecasting path of exchange rates at each time horizon.

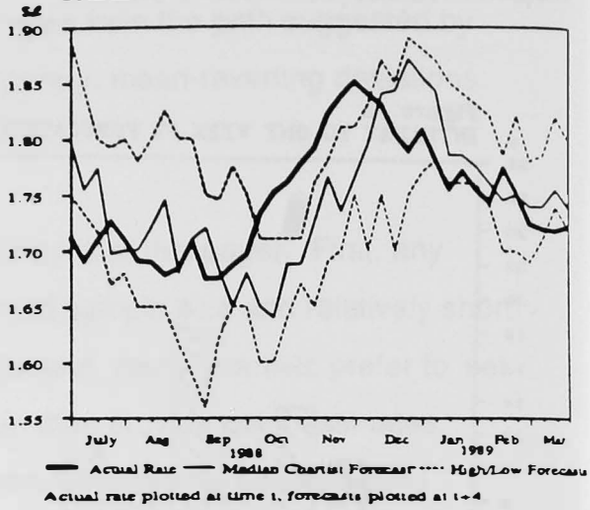
Figure 2: Chartist forecasts, one week and four weeks ahead

Figure 2a
STERLING: 1 WEEK AHEAD CHARTIST FORECASTS



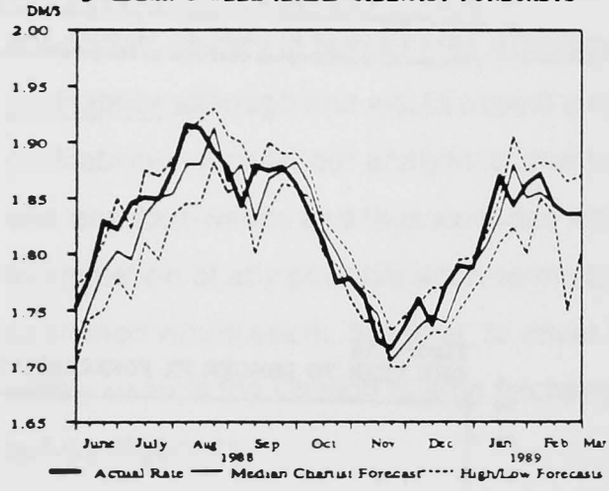
Actual rate plotted at time t, forecasts plotted at t+1

Figure 2b
STERLING: 4 WEEKS AHEAD CHARTIST FORECASTS



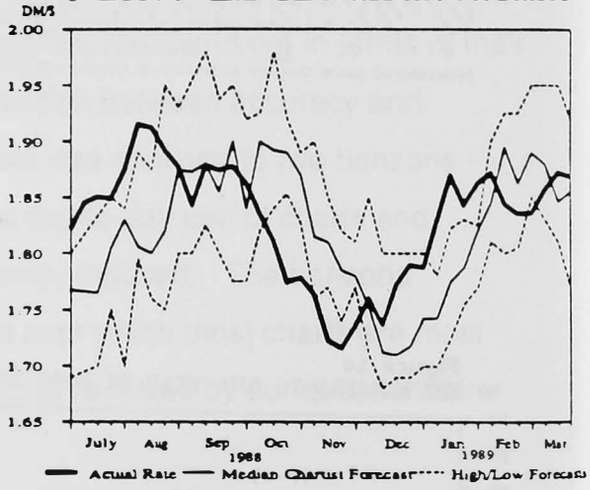
Actual rate plotted at time t, forecasts plotted at t+4

Figure 2c
D-MARK: 1 WEEK AHEAD CHARTIST FORECASTS



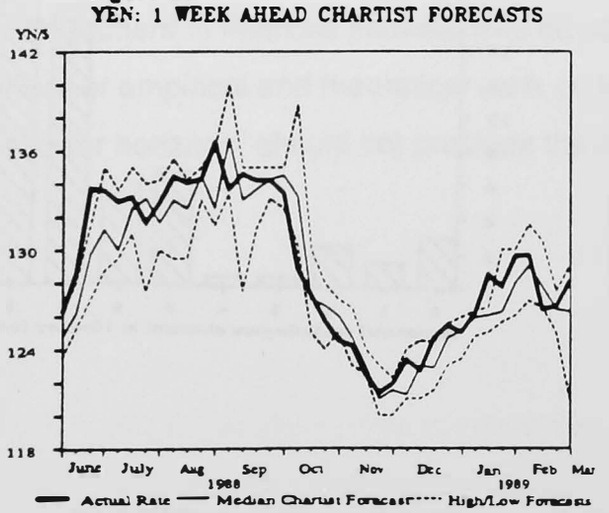
Actual rate plotted at time t, forecasts plotted at t+1

Figure 2d
D-MARK: 4 WEEKS AHEAD CHARTIST FORECASTS



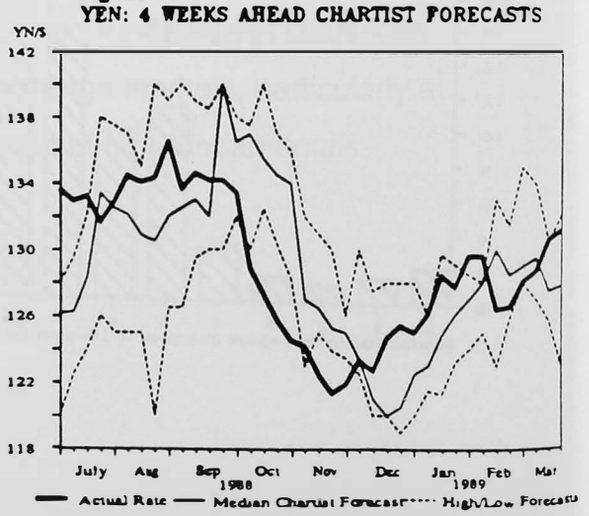
Actual rate plotted at time t, forecasts plotted at t+4

Figure 2e
YEN: 1 WEEK AHEAD CHARTIST FORECASTS



Actual rate plotted at time t, forecasts plotted at t+1

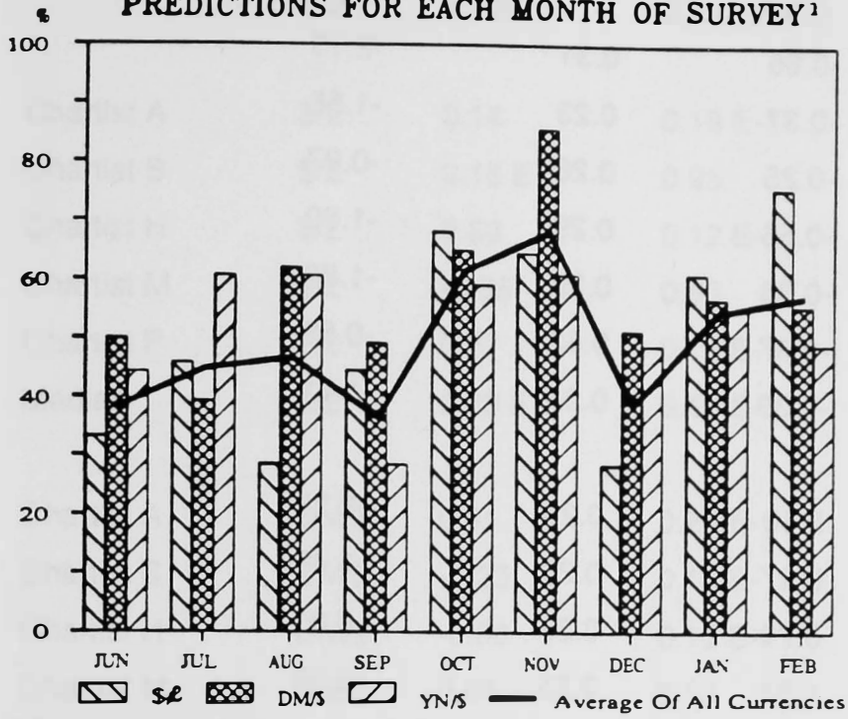
Figure 2f
YEN: 4 WEEKS AHEAD CHARTIST FORECASTS



Actual rate plotted at time t, forecasts plotted at t+4

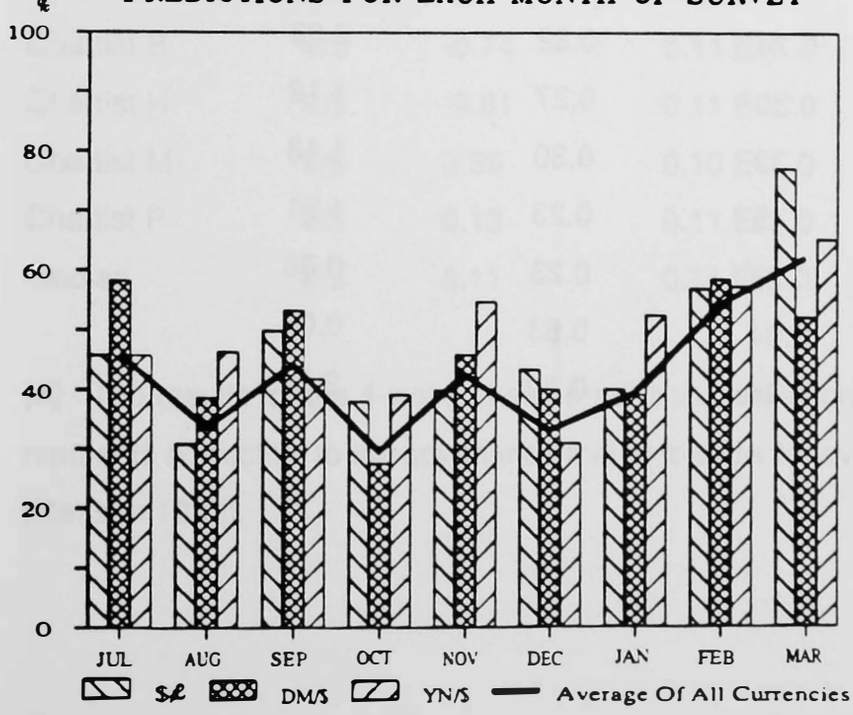
Figure 3: Aggregate qualitative accuracy of chartist forecasts

Figure 3a
QUALITATIVE ACCURACY OF 1 WEEK CHARTIST PREDICTIONS FOR EACH MONTH OF SURVEY[1]



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

Figure 3b
QUALITATIVE ACCURACY OF 4 WEEKS CHARTIST PREDICTIONS FOR EACH MONTH OF SURVEY[1]



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

Table 1a: Testing for unconditional bias:
1 week ahead predictions (dependent variable (S_{t+1}-$_tS^e_{t+1}$))

	Rate	Mean	SD of mean	t-ratio
Chartist A	$/£	-0.65	0.31	-2.13
Chartist B	$/£	-0.37	0.23	-1.56
Chartist H	$/£	-0.25	0.26	-0.97
Chartist L	$/£	-0.56	0.29	-1.90
Chartist M	$/£	-0.38	0.20	-1.86
Chartist P	$/£	-0.37	0.62	-0.59
Median	$/£	-0.33	0.20	-1.61
Chartist A	DM/$	0.66	0.28	2.35
Chartist B	DM/$	0.37	0.26	1.43
Chartist H	DM/$	0.23	0.28	0.81
Chartist L	DM/$	0.51	0.25	2.08
Chartist M	DM/$	0.54	0.23	2.36
Chartist P	DM/$	0.24	0.62	0.39
Median	DM/$	0.49	0.20	2.40
Chartist A	¥/$	0.74	0.32	2.33
Chartist B	¥/$	0.30	0.27	1.12
Chartist H	¥/$	0.33	0.30	1.13
Chartist L	¥/$	0.45	0.23	1.91
Chartist M	¥/$	0.23	0.23	0.98
Chartist P	¥/$	0.04	0.63	0.06
Median	¥/$	0.44	0.22	2.04

Table 1b: Testing for unconditional bias:(a)

4 week ahead predictions (dependent variable ($S_{t+1}-{}_tS^e_{t+1}$))

	Rate	Mean	SD of mean	t-ratio
Chartist A	$/£	0.14	0.19 E-1	0.72 E-1
Chartist B	$/£	0.13 E-3	0.95	0.14 E-1
Chartist H	$/£	0.83	0.12 E-1	0.67
Chartist M	$/£	-0.65	0.83	-0.78
Chartist P	$/£	0.37	0.12 E-1	0.30
Median	$/£	0.89 E-3	0.10 E-1	0.89 E-1
Chartist A	DM/$	0.51	0.20 E-1	0.25 E-1
Chartist B	DM/$	-0.23	0.13 E-1	-0.18
Chartist H	DM/$	-0.60	0.13 E-1	-0.45
Chartist M	DM/$	0.55	0.93	0.60
Chartist P	DM/$	0.24	0.11 E-1	0.21
Median	DM/$	0.57	0.12 E-1	0.49
Chartist A	¥/$	0.34	0.20 E-1	0.17
Chartist B	¥/$	-0.74	0.11 E-1	-0.65
Chartist H	¥/$	-0.81	0.11 E-1	-0.71
Chartist M	¥/$	0.36	0.10 E-1	0.36
Chartist P	¥/$	0.13	0.11 E-1	0.11
Median	¥/$	0.11	0.11 E-1	0.96 E-1

(a) The results for the 4-week ahead predictions were computed using a method of moments correction to the covariance matrix to allow for overlapping forecast errors (Hansen 1982).

Table 2: Qualitative accuracy of chartism[(a)] - whole sample period

	1 week			4 weeks		
	$/£	DM/$	¥/$	$/£	DM/$	¥/$
Chartist A	50	60	42	42	31	36
Chartist B	55	47	52	47	44	42
Chartist F	47	39	47	50	44	44
Chartist H	40	52	42	21	43	57
Chartist J	48	56	48	45	48	41
Chartist L	57	66	51	57	66	69
Chartist M	50	68	59	46	40	50
Median Forecast	55	63	55	50	42	47
Average accuracy	51	57	51	46	47	49
Standard deviation of accuracy	5.44	9.65	6.49	11.10	10.11	9.77

(a) Percentage of occasions on which the direction of currency movements (appreciation/depreciation) was correctly predicted.

Table 3a: Comparison of % RMSE of 1 week Chartist Forecasts with Other Forecasting Approaches

Representative selection of individual chartist forecasts and whole sample median, compared with ARIMA, random walk and four VAR approaches.

	1 week ahead		
	$/£	DM/$	¥/$
A	1.98	1.85	2.03
B	1.47	1.63	1.64
F	1.95	1.46	2.01
H	1.60	1.70	1.82
M	1.21	1.30	1.33
P	1.38	1.41	1.91
Median (whole sample)	1.28	1.33	1.38
Random walk[(a)(b)]	1.25	1.38	1.35
ARIMA	1.77	2.05	2.17
Economic VAR (unrestricted)	1.64	1.92	1.68
Economic VAR (restricted)	1.12	1.39	1.23
Currency VAR (unrestricted)	1.98	1.75	1.91
Currency VAR (restricted)	1.05	1.37	1.29

(a) 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.

(b) From Tables 3a and 3b it can be seen 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.

Table 3b: Comparison of % RMSE of 4 week 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.

	4 weeks ahead		
	$/£	DM/$	¥/$
A	5.20	5.56	5.41
B	3.05	3.65	3.37
F	4.48	4.13	4.05
H	3.62	3.89	3.66
M	2.37	2.84	2.71
P	3.44	3.60	3.55
Median (whole sample)	3.00	3.38	3.33
Random walk(a)(b)	2.81	3.18	3.12
ARIMA	4.14	4.94	4.64
Economic VAR (unrestricted)	4.63	4.66	4.74
Economic VAR (restricted)	2.99	3.76	3.04
Currency VAR (unrestricted)	5.18	4.12	4.22
Currency VAR (restricted)	2.55	3.76	3.28
Forward rate	2.71	3.07	3.10

(a)(b) See footnote to Table 3a.

Table 4a: Testing for static expectations against bandwagon or extrapolative expectations, 1 week ahead forecasts[a] (Dependent variable ($_tS_{t+1}$-S_t))

	Rate	Constant	ΔSt	R^2	DW
Chartist A	$/£	0.54 (2.19)	-0.12 (-0.62)	0.01	1.61
Chartist B	$/£	0.28 (1.60)	-0.10 (-0.72)	0.15 E-5	1.94
Chartist H	$/£	0.14 (0.74)	0.11 (0.68)	0.14 E-1	1.64
Chartist L	$/£	0.39 (1.34)	-0.26 (-1.12)	0.36 E-1	0.98
Chartist M	$/£	0.45 (3.72)	-0.24 (-2.15)	0.14	1.64
Chartist P	$/£	0.17 (0.91)	-0.19 E-1 (-0.12)	0.47 E-3	1.94
Median	$/£	0.17 (1.46)	0.20 E-1 (0.21)	0.13	2.17
	Rate	Constant	ΔSt	R^2	DW
Chartist A	DM/$	0.53 (-2.25)	-0.47 (-0.28)	0.24	1.68
Chartist B	DM/$	-0.29 (1.66)	0.14 (1.58)	0.40 E-1	1.57
Chartist H	DM/$	-0.45 E-3 (-0.25)	-0.14 (-1.12)	0.35 E-1	1.15
Chartist L	DM/$	-0.37 (-1.73)	0.47 E-1 (0.31)	0.28	1.16
Chartist M	DM/$	-0.54 (-4.10)	-0.14 (-1.40)	0.61 E-1	1.59
Chartist P	DM/$	-0.34 (-1.91)	0.86 E-1 (0.65)	0.14 E-1	2.14
Median	DM/$	-0.33 (-2.81)	0.16 E-1 (0.19)	0.11	1.74

(a) Figures in parentheses are t-statistics.

Table 4a (contd.)

	Rate	Constant	ΔSt	R^2	DW
Chartist A	¥/$	-0.72 (-2.72)	0.29 (1.49)	0.62 E-1	1.51
Chartist B	¥/$	-0.30 (-1.55)	0.14 (0.10 E-1)	0.30 E-5	1.54
Chartist H	¥/$	-0.32 (-1.44)	-0.49 E-1 (-0.31)	0.28	1.12
Chartist L	¥/$	-0.39 (-2.43)	-0.18 (-1.53)	0.64 E-1	1.23
Chartist M	¥/$	-0.41 (-4.00)	-0.26 (-3.07)	0.24	1.91
Chartist P	¥/$	-0.28 (-1.16)	0.22 (1.15)	0.44 E-1	2.36
Median	¥/$	-0.41 (-3.12)	-0.55 E-1 (-0.57)	0.94	2.08

Table 4b: Testing static expectations against bandwagon or extrapolative expectations, 4 week ahead forecasts[a] (Dependent variable ($_tS_{t+4}$-S_t))

	Rate	Constant	ΔSt	R^2	DW
Chartist A	$/£	-0.78 (-1.45)	-0.76 (-4.11)	0.35	0.64
Chartist B	$/£	-0.23 (-0.72)	0.21 (1.88)	0.99 E-1	1.61
Chartist H	$/£	-0.12 E-1 (-3.95)	0.16 (1.88)	0.68 E-1	0.87
Chartist M	$/£	0.74 (3.00)	0.72 E-1 (0.77)	0.22 E-1	1.32
Chartist P	$/£	-0.28 (-0.86)	0.44 E-1 (0.36)	0.50	1.37
Median $/£	$/£	-0.32 (-1.79)	0.73 E-1 (1.16)	0.40 E-1	1.43
	Rate	Constant	ΔSt	R^2	DW
Chartist A	DM/$	0.74 (1.26)	-0.58 (-3.28)	0.25	0.64
Chartist B	DM/$	0.72 (2.33)	0.13 (1.34)	0.53 E-1	1.33
Chartist H	DM/$	0.11 E-1 (3.60)	0.11 (1.17)	0.41 E-1	1.26
Chartist M	DM/$	-0.53 (-2.16)	-0.57 E-1 (-0.73)	0.19 E-1	0.86
Chartist P	DM/$	-0.31 (-0.96)	0.37 E-1 (0.36)	0.50	1.03
Median	DM/$	-0.92 E-3 (-0.44)	-0.17 E-1 (-0.27)	0.22	0.97

(a) Figures in parentheses are t-statistics.

Table 4b (contd.)

	Rate	Constant	ΔSt	R^2	DW
Chartist A	¥/$	-0.83 E-2 (-3.12)	-0.13 (-1.51)	0.67 E-1	1.85
Chartist B	¥/$	-0.25 E-2 (-1.38)	-0.70 E-2 (-0.12)	0.48 E-3	1.51
Chartist H	¥/$	-0.24 E-2 (-1.20)	0.91 E-1 (1.43)	0.60 E-1	1.39
Chartist M	¥/$	-0.44 E-2 (-3.81)	-0.10 (-2.61)	0.20	1.95
Chartist P	¥/$	-0.34 E-2 (-1.34)	0.46 E-1 (0.55)	0.12 E-1	2.24
Median	¥/$	-0.42 E-2 (-3.35)	-0.53 E-1 (-1.35)	0.54 E-1	2.06

Table 5a: Testing for adaptive expectations, 1 week ahead forecasts[a] (Dependent variable $({}_tS_{t+1}-S_t)$)

	Rate	Constant	$({}_{t-1}S^e_t-S_t)$	$\bar{R}^2$	DW
Chartist A	\$/£	0.46 E-2 (1.76)	0.15 (1.16)	0.39 E-1	1.85
Chartist B	\$/£	0.26 E-2 (1.44)	0.24 E-1 (0.19)	0.11 E-2	1.99
Chartist H	\$/£	0.19 E-2 (0.93)	-0.22 E-1 (-0.18)	0.99 E-3	1.65
Chartist L	\$/£	0.13 E-2 (0.46)	0.52 (3.65)	0.29	1.60
Chartist M	\$/£	0.34 E-2 (2.76)	0.25 (2.39)	0.16	2.11
Chartist P	\$/£	0.16 E-2 (0.88)	0.15 E-1 (0.11)	0.43 E-3	1.95
Median	\$/£	0.20 E-2 (1.64)	-0.56 E-1 (-0.59)	0.10 E-1	2.07

	Exchange Rate	Constant	$({}_{t-1}S^e_t-S_t)$	$\bar{R}^2$	DW
Chartist A	DM/\$	-0.43 E-2 (-1.68)	0.12 (0.85)	0.21 E-1	1.86
Chartist B	DM/\$	-0.26 E-2 (-1.40)	-0.17 E-1 (-0.15)	0.72 E-3	1.53
Chartist H	DM/\$	-0.32 E-3 (-0.18)	0.23 (2.26)	0.13	1.58
Chartist L	DM/\$	-0.11 E-2 (-0.68)	0.24 (2.02)	0.11	1.39
Chartist M	DM/\$	-0.43 (-3.13)	0.20 (2.10)	0.13	2.06
Chartist P	DM/\$	-0.34 E-2 (-1.91)	0.86 E-1 (0.65)	0.14 E-1	2.14
Median	DM/\$	-0.31 E-2 (-2.41)	0.24 E-1 (0.25)	0.19 E-2	1.66

Table 5a (contd.)

	Rate	Constant	$(_{t-1}S^{e}_{t}-S_{t})$	R^2	DW
Chartist A	¥/$	-0.72 E-2 (-2.42)	-0.35 E-1 (-0.24)	0.18 E-2	1.54
Chartist B	¥/$	-0.26 E-2 (-1.28)	0.12 (0.98)	0.28 E-1	1.78
Chartist H	¥/$	-0.24 E-2 (-1.10)	0.24 (1.92)	0.10	1.46
Chartist L	¥/$	-0.22 E-2 (-1.41)	0.33 (3.15)	0.23	1.78
Chartist M	¥/$	-0.32 (-3.05)	0.24 (3.07)	0.24	2.33
Chartist P	¥/$	-0.37 E-2 (-1.55)	-0.19 (-1.52)	0.74 E-1	2.10
Median	¥/$	-0.41 E-2 (-2.82)	0.32 E-1 (0.31)	0.29 E-2	2.05

(a) Figures in parentheses are t-statistics.

Table 5b: Testing for adaptive expectations, 4 weeks ahead forecasts[a] (Dependent variable $({}_tS^e_{t+4} - S_t)$)

	Rate	Constant	$({}_{t-4}S^e_t - S_t)$	R^2	DW
Chartist A	$/£	-0.60 E-2 (-1.28)	0.48 (5.66)	0.50	1.06
Chartist B	$/£	-0.30 E-2 (-0.92)	-0.17 (-1.60)	0.74 E-1	1.51
Chartist H	$/£	-0.13 E-1 (-3.97)	-0.67 E-1 (-0.80)	0.20 E-1	0.74
Chartist M	$/£	0.79 E-2 (3.14)	-0.46 E-1 (0.44)	0.70 E-2	1.31
Chartist P	$/£	-0.28 E-2 (-0.85)	-0.25 E-1 (-0.28)	0.29 E-2	1.37
Median	$/£	-0.35 E-2 (1.91)	-0.64 E-1 (-1.11)	0.37 E-1	1.44

	Rate	Constant	$({}_{t-4}S^e_t - S_t)$	R^2	DW
Chartist A	DM/$	0.87 E-2 (1.68)	0.44 (4.77)	0.42	0.88
Chartist B	DM/$	0.81 E-2 (2.62)	-0.98 E-1 (-1.21)	0.43 E-1	1.28
Chartist H	DM/$	0.12 E-1 (3.95)	-0.90 E-1 (-1.17)	0.41 E-1	1.16
Chartist M	DM/$	-0.48 E-2 (-1.89)	0.77 E-1 (0.91)	0.30 E-1	0.86
Chartist P	DM/$	-0.34 E-2 (-1.06)	-0.57 E-1 (-0.69)	0.18 E-1	1.06
Median	DM/$	-0.63 E-3 (-0.30)	0.55 E-1 (0.94)	0.27 E-1	0.95

Table 5b (contd.)

	Rate	Constant	$\frac{(_{t-4}S^e_t - S_t)}{\quad}$	R^2	DW
Chartist A	¥/$	-0.74 E-2 (-2.79)	0.14 (1.88)	0.99 E-1	1.87
Chartist B	¥/$	-0.25 E-2 (-1.37)	0.40 E-2 (0.71 E-1)	0.16 E-3	1.51
Chartist H	¥/$	-0.27 E-2 (-1.32)	-0.68 E-1 (-1.11)	0.37 E-1	1.36
Chartist M	¥/$	-0.41 E-2 (-3.54)	0.10 (2.61)	0.20	1.93
Chartist P	¥/$	-0.35 E-2 (-1.42)	0.60 E-1 (-0.86)	0.28 E-1	2.24
Median	¥/$	-0.40 E-2 (-3.16)	0.53 E-1 (1.30)	0.50	2.07

(a) Figures in parentheses are t-statistics.

Table 6a: Testing for regressive expectations, 1 week ahead forecasts[a] (Dependent variable $({}_tS^e_{t+1} - S_t)$)

	Rate	Constant	S_t	R^2	DW
Chartist A	\$/£	0.10 (2.34)	-0.17 (-2.22)	0.13	1.86
Chartist B	\$/£	-0.13 E-2 (0.38 E-1)	0.67 E-2 (0.11)	0.40 E-3	1.94
Chartist H	\$/£	-0.31 E-1 (- 0.84)	0.58 E-1 (0.90)	0.25 E-1	1.73
Chartist L	\$/£	0.76 E-1 (1.35)	-0.13 (-1.28)	0.49 E-1	1.11
Chartist M	\$/£	0.55 E-1 (2.47)	-0.90 (-2.28)	0.15	1.97
Chartist P	\$/£	-0.19 E-1 (-0.57)	0.37 E-1 (0.62)	0.13 E-1	1.98
Median	\$/£	0.13 E-1 (0.57)	-0.20 E-1 (-0.50)	0.78 E-2	2.08
	Rate	Constant	S_t	R^2	DW
Chartist A	DM/\$	0.11 (2.42)	-0.18 (-2.54)	0.17	2.01
Chartist B	DM/\$	-0.38 E-1 (-1.06)	0.59 E-1 (0.99)	0.30E-1	1.60
Chartist H	DM/\$	-0.58 E-1 (-1.64)	0.95 (1.61)	0.75 E-1	1.40
Chartist L	DM/\$	-0.33 E-2 (-0.99 E-1)	0.21 E-2 (0.38 E-1)	0.45 E-4	1.41
Chartist M	DM/\$	0.65E-1 (2.76)	-0.12 (-2.99)	0.23	1.82
Chartist P	DM/\$	0.30 E-2 (0.87 E-1)	-0.11 E-1 (-0.19)	0.12 E-2	2.02
Median	DM/\$	0.98 E-2 (0.42)	-0.21 E-1 (-0.55)	0.93 E-2	1.71

Table 6a (contd.)

	Rate	Constant	S_t	R^2	DW
Chartist A	¥/$	0.68 (1.86)	-0.14 (-1.88)	0.99 E-1	1.88
Chartist B	¥/$	0.38 E-1 (0.13)	-0.83 E-2 (-0.14)	0.64 E-3	1.51
Chartist H	¥/$	-0.18 (-0.58)	0.36 E-1 (0.57)	0.10 E-1	1.19
Chartist L	¥/$	0.42 (1.89)	-0.88 E-1 (-1.90)	0.10	1.39
Chartist M	¥/$	0.32 (2.11)	-0.67 E-1 (-2.14)	0.13	2.01
Chartist P	¥/$	-0.25 (-0.74)	0.50 E-1 (0.73)	0.18 E-1	2.37
Median	¥/$	0.20 (1.08)	-0.42 E-1 (-1.10)	0.37 E-1	2.09

(a) Figures in parentheses are 't-ratios' - those for the constant term will have a t-distribution, those for the exchange rate term will have a Dickey-Fuller distribution. Significance values for the latter are 1% -3.58; 5% -2.93; 10% -2.60 (Fuller, 1976).

Table 6b: Testing for regressive expectations: 4 week ahead forecasts[a] (Dependent variable ${}_tS^e_{t+1} - S_t$))

	Rate	Constant	S_t	R^2	DW
Chartist A	\$/£	0.42 (4.34)	-0.77 (-4.43)	0.38	0.57
Chartist B	\$/£	-0.14 (-2.41)	0.24 (2.37)	0.15	1.67
Chartist H	\$/£	-0.24 (-5.65)	0.41 (5.37)	0.47	1.49
Chartist M	\$/£	0.11 (2.76)	-0.18 (-2.58)	0.20	1.45
Chartist P	\$/£	-0.12 (-2.14)	0.21 (2.10)	0.15	1.59
Median	\$/£	-0.40 E-1 (-1.19)	0.66 E-1 (1.09)	0.36 E-1	1.43
	Rate	Constant	S_t	R^2	DW
Chartist A	DM/\$	0.31 (2.54)	-0.51 (-2.51)	0.16	0.54
Chartist B	DM/\$	-0.15 (-2.64)	0.26 (2.78)	0.19	1.64
Chartist H	DM/\$	-0.19 (-3.60)	0.33 (3.83)	0.31	1.80
Chartist M	DM/\$	0.14 (3.55)	-0.24 (-3.70)	0.34	1.03
Chartist P	DM/\$	-0.48 E-1 (-0.77)	0.74 E-1 (0.72)	0.20 E-1	1.04
Median	DM/\$	-0.78 E-2 (-0.19)	-0.15 (-0.21)	0.14 E-2	0.96

Table 6b (contd.)

	Rate	Constant	S_t	R^2	DW
Chartist A	¥/$	0.77 (0.35)	-0.16 (-2.20)	0.13	1.99
Chartist B	¥/$	-0.11 (-0.45)	0.22 E-1 (0.44)	0.59 E-2	1.51
Chartist H	¥/$	-0.33 (-1.17)	0.68 E-1 (1.16)	0.40 E-1	1.29
Chartist M	¥/$	0.37 (2.32)	-0.77 E-1 (-2.34)	0.17	2.00
Chartist P	¥/$	-0.22 (-0.64)	0.45 E-1 (0.63)	0.15 E-1	2.25
Median	¥/$	0.15 (0.85)	-0.32 (-0.87)	0.23 E-1	2.07

(a) See footnote to Table 6a.

Table 7a: Summary of tests for adaptive and regressive expectations[(a)]

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

Table 7b: Summary of tests for static against extrapolative or bandwagon expectations[(b)]

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

(a) AE = adaptive expectations; RE = regressive expectations.
(b) EE = Extrapolative expectations; BWE = bandwagon expectations.

Appendix: Chartist Methodology

This appendix aims to provide a brief guide to chartist methodology with particular reference to the market for spot foreign exchange, towards which the analysis in this paper is directed. The contents of this appendix draw on various chartist texts (eg Edwards and Magee 1966; Murphy 1986; Pring 1985), and on interviews with practising chartists.

A standard tool of the technical analyst is the daily bar chart, on which each day's price range is plotted as a vertical bar, with a tick to the right indicating the closing price.[17] Several other indicators may be derived from the price series itself and are generally drawn upon to provide supplementary information. Moving averages of price series are widely used in the belief that they can help to identify the direction of trend in a market, while other indicators are designed to attempt to clarify the rate of change of the prevailing price movements. Unlike straightforward price charts, these latter categories of indicators can be used to generate precise trading signals.

The principal application of bar charts is in the area most closely allied with the popular conception of chart analysis - the recognition of known, identifiable patterns in market price movements. With experience, chartists tend to acquire an individual approach to pattern identification and preferences for the use of various other indicators, which in practice may well differ somewhat from 'textbook' approaches. However, in order to convey the broad methodology of chartism, we describe some standard analytical tools.

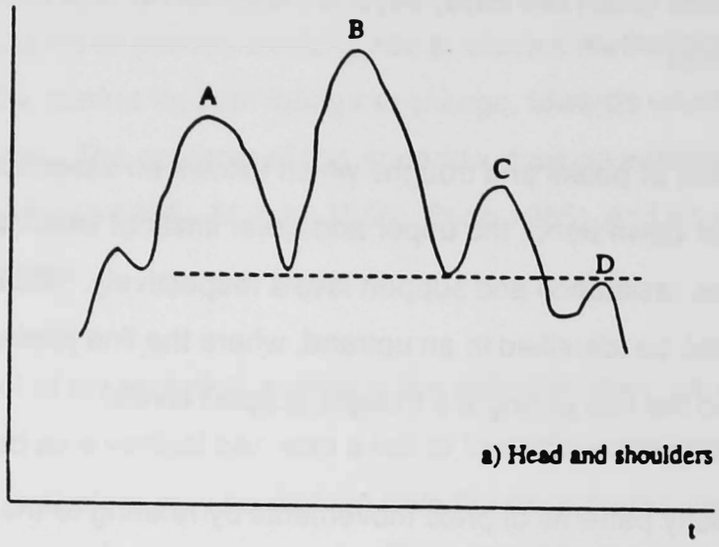
Trendlines are one of the most widely used chartist tools, which are used to try to clarify the direction of market movement. An up trendline connects a series of successively higher lows while a down trendline is drawn between successively lower highs. The breaking of the trendline is held by chartists to be a possible early warning of a change in the direction of the market - a rule sometimes applied is that penetration of the up trendline is a sell signal, while violation of the downward trendline would be a buy

signal. Some confirmation criterion may also be applied - such as a requirement of a minimum number of closes (often two days) beyond the trendline, or a minimum percentage change in price.

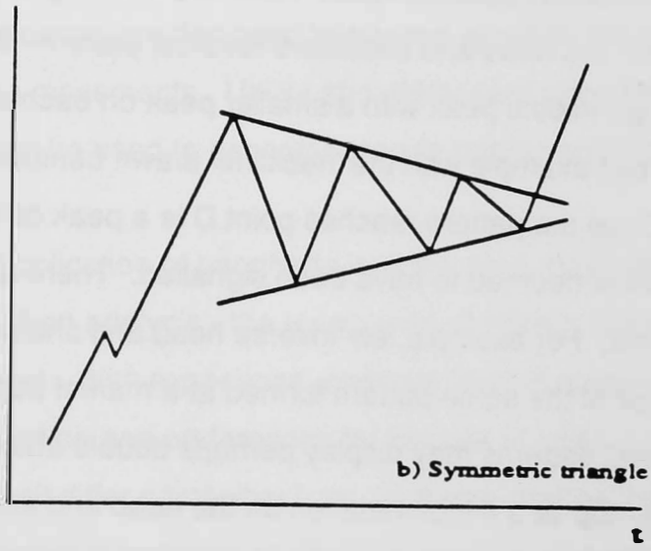
A trading range is a series of peaks and troughs which follows an essentially sideways path rather than an up or down trend, the upper and lower limits of which are sometimes referred to as resistance and support levels respectively. Support and resistence levels can also be identified in an uptrend, where the line joining the peaks would be resistance and the line joining the troughs support levels.

Chartists generally classify patterns of price movements by refering to their relationship with the market trend - 'reversal patterns' are characterised by a reversal of the incumbent trend, while 'continuation patterns' occur within a prevailing trend. For illustrative purposes, consider the head and shoulders reversal pattern - a three-part formation consisting of a large middle peak with a smaller peak on each side. Figure A1a shows an idealised example with the 'neckline' drawn beneath the left and right shoulders, A and C. Once the pattern reaches point D ie a peak below the neckline, a full trend reversal is deemed to have been signalled. There are many variations on this basic theme. For example, an 'inverse head and shoulders' is essentially an inverted image of the same pattern formed at a market bottom, while 'complex head and shoulders' patterns may display perhaps double shoulders, or two heads. The so-called 'triple top' is a minor variation on the head and shoulders formation, with all its peaks at the same level, whereas a 'double top' would be said to occur when a trend reversal takes the form of two peaks of roughly equal magnitude. One of the standard continuation patterns, used here to illustrate the principle, is the triangle. Chartists define three basic types of triangle: symmetric, ascending and descending, the former two of which are illustrated in figure A1b, c. Symmetric triangles (figure A1b) can be outlined by two converging trend lines, while ascending triangles consist of a rising trendline and a horizontal upper line (figure A1c). Descending triangles would similarly consist of price movement enclosed by a down trendline and a horizontal lower line. Identifying various such patterns may lead chartists to infer that trends are set to continue or reverse, and they would base their trading advice accordingly.

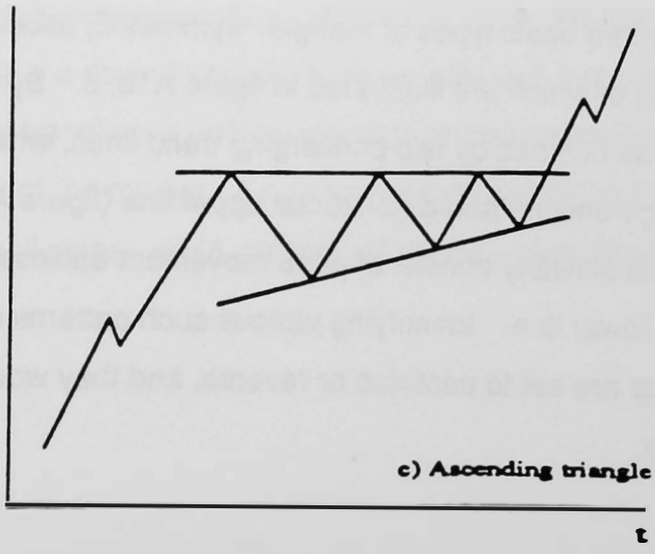
CHART A1 Reversal and Continuation Patterns



a) Head and shoulders



b) Symmetric triangle



c) Ascending triangle

At least one problem with pattern recognition is that it is in practice very subjective. Patterns will usually not conform exactly to the textbook example, and considerable experience will generally have to be brought to bear in their recognition. In addition, one might also argue that they are easy to see ex post, but not ex ante, and it is the latter which is of prime importance to market traders. For these reasons, most technical analysts will generally want to supplement pattern recognition with other, less ambiguous, indicators. It is here that mechanical indicators play a role. Most such mechanical systems are trend-following in nature, for example relying on some form of moving average which could generate trading signals when the average line crosses the price line, or alternatively, when moving averages of different lengths cross each other. Other types of system, which might be termed non-trend following, are basically those which calculate the rate of change of price series, extreme values of which would be regarded as unsustainable, and therefore indicative of an imminent trend reversal.

This might suggest that the use of mechanical trading indicators would to some extent counterbalance much of the subjective element of pattern-based trading and thereby produce a more consistent approach - while chartists may disagree over pattern formations, mechanical systems should be unequivocal. This would, however, be to oversimplify the case partly because of the varieties of systems and hybrid indicators which could be used, but especially because the signals generated are normally considered in conjunction with other, more subjective, chartist approaches.

There are also other, non-price based indicators that may 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 participants are widely used by chartists.[18] Other indicators which 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.

While it has been claimed (eg Murphy, 1986) that all possible information is reflected in the price line and hence that one can chart without even knowing the name of the stock, exchange rate, commodity etc, our interview evidence suggests that such a 'purist' view is rarely found in the market. Experienced chartists suggest that different markets tend to display different combinations of patterns and indeed, that some markets are not amenable to charting at all, implying that using an anonymous chart would not be fully efficient.

There are, of course, very many other chartist devices in use, but the above should illustrate the nature of technical analysis. Moreover, as suggested in the main text, there are probably as many methods of combining and interpreting the various techniques as there are chartists themselves. While some practitioners can very much be described as 'classical' chartists, looking for standard patterns in price series, supplemented by moving averages and overbought/oversold indicators, others will claim that such a 'textbook' approach is too naive and will prefer to draw upon their own variety of patterns and indicators derived from their first-hand experience of particular markets. Perhaps more common is a pragmatic approach, looking at all manner of indicators and basing opinion on whichever direction the majority indicate.

Notes

1 Keynes had gone further in his Treatise on Money (Keynes, 1930):

> '...the vast majority of those who are concerned with the buying and selling of securities know almost nothing whatever about what they are doing. They do not possess even the rudiments of what is required for a valid judgement, and are the prey of hopes and fears easily aroused by transient events and as easily dispelled. This is one of the odd characteristics of the capitalist system under which we live, which, when we are dealing with the real world is not to be overlooked'.

2 'In the hurly-burly of City dealing rooms, where anomalous price movements are exploited daily, the [efficient markets] theory has always been dismissed as the product of remote academic theorising', (Financial Times, April 5, 1988, p.16).

A similar sentiment was expressed by Withers nearly a century earlier (Withers, 1897):

> '...we need only ask whether any reader of this journal would dream of consulting an economist if he wanted to know what will be the price of Consols, or the figure of the Bank rate, ... this day week, or this day four weeks, or this day twelve months; and whether any bucket-shop tipster would increase his clientele by advertising that he kept a professor of political economy on the premises for the express purpose of furnishing forecasts to customers who called to consult him'.

3 The idea that a wedge is driven between forward rates and expected spot rates by risk premia, rather than inefficiency, has met with little empirical success - see eg Domowitz and Hakkio, 1985, Fraser and Taylor, 1989, MacDonald and Taylor, 1989b.

4 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.

5 To quote from the Financial Times:

> "Earlier in the day the dollar had already stalled, having failed to break resistance at 1.8300" (28.6.88).
>
> "Elsewhere the D-mark held above a support level of ¥71.43 against the yen..." (28.6.88).

6 Goodman (1979, 1980), Levich (1980) and Bilson (1981) have carried out ex-post evaluations of forecasting services, some of which were provided by technical analysts. A major finding of these studies is that certain foreign exchange advisory services consistently outperform the forward rate as a spot rate predictor. Goodman, in fact, finds that technical services are consistently superior to the forward rate in this respect, whereas econometric and other 'fundamentalist' services are not.

7 The exact details of the panel are confidential. Some participants could occasionally not be contacted: the number of chartists responding in any one week was between ten and twenty. The precise details are withheld to preserve anonymity.

8 As forecasters sometimes could not be contacted at certain data points formula 5.2 was modified slightly to allow for this.

9 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.

10 This result should, of course, be treated with caution because of the problem of pre-test bias; there will always be one or two forecasters who are apparently better than the rest purely by chance.

11 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.

12 The Bayesian VAR 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).

13 Readers requiring a non-technical summary of this sub-section should refer to the penultimate paragraph.

14 This classification follows Frankel and Froot, 1987. Note, however, that both (7.2) and (7.3) can be written

$$ {}_{t}S^{e}_{t+n} = (1-\beta)S_{t} + \beta S_{t-1} $$

where $\beta>0$ for extrapolative expectations and $\beta<0$ for bandwagon expectations. It might be of interest, therefore, to consider further the case where $\beta>1$, since this implies a negative elasticity of expectations. A taxonomy incorporating this case might therefore be:

$0<\beta<1$: extrapolative expectations;
$\beta<0$: strongly extrapolative or "bandwagon" expectations;
$\beta<1$: "regressive" or "reverting" expectations.

In section 3.4, however, we follow the taxonomy given in the main text. First, because we are primarily concerned with testing for elastic as opposed to inelastic expectations; and second, to follow the precedent set by Frankel and Froot (1986b).

15 In our empirical analyses, we do not distinguish between simple random walks and random walks with drift. This is because we are primarily concerned with slope coefficients (and hence elasticities) rather than intercepts. Intercepts are included in all estimated equations.

16 As exchange rates generally follow an I(1) process, equation (7.9) is essentially the same formulation as the Dickey-Fuller test for stationarity. This will therefore mean that the coefficient γ_1 is baised towards zero, and follows the Dickey-Fuller distribution. Hence the significance levels of the coefficient should be taken as those implied by the Dickey-Fuller, and not the t-distribution (see eg Fuller, 1976).

17 The illustrative charts in the appendix are drawn in the form of 'close-only' charts, where the price is the only piece of information plotted, although standard charts often contain information on up to three aspects of trading - the price, volume of trade (the total number of contracts traded - not available for spot foreign exchange) and, in the case of futures, the amount of open interest (the number of outstanding contracts at close of business).

18 Such indicators may be used to form a 'contrary opinion', an approach often cited by chartists which essentially involves moving in the opposite direction to the market as a whole. For example, if market sentiment appears overwhelming bullish, then a chartist may feel that there is not sufficient upward potential remaining in the market (because, perhaps, most traders could be holding long positions, or be at high exposure), and therefore would be inclined to advise selling.

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Bank of England Discussion Papers

	Title	Author
1-5, 8, 11-14, 16-17, 19-22	*These papers are now out of print, but photocopies can be obtained from University Microfilms International (see below).*	
6	'Real' national saving and its sectoral composition	C T Taylor A R Threadgold
7	The direction of causality between the exchange rate, prices and money	C A Enoch
9	The sterling/dollar rate in the floating rate period: the role of money, prices and intervention	I D Saville
10	Bank lending and the money supply	B J Moore A R Threadgold
15	Influences on the profitability of twenty-two industrial sectors	N P Williams
18	Two studies of commodity price behaviour: Interrelationships between commodity prices Short-run pricing behaviour in commodity markets	Mrs J L Hedges C A Enoch
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