CHARTISM IN THE FOREIGN EXCHANGE MARKET

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To my husband Terry

DECLARATION

I declare that the University Librarian is granted powers of discretion to allow this thesis to be copied in part or in whole without further reference to the author.

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Date

ABSTRACT

This thesis examines the use and nature of chartism in the foreign exchange market, bringing together an analysis of chartist methods and the views/empirical work of economics. A survey of general chartist methods demonstrates the origins of the modern techniques, the construction of the various indicators, the use of pattern recognition and the variety of calculated indices. Despite these methods being widely used in the market, there seems to be very little bridging between practical chartism and the many fundamental-based academic studies of exchange rate determination/forecasting. Key points of the academic literature which have features pertinent to non-fundamental chart analysis are therefore discussed, and what little explicit analysis of chartism has been done is highlighted. It is clear that analysis of the subject is a growing area of the literature.

It transpires, however, that there is minimal actual evidence available about the use of chartism in practice. To provide information on this, a questionnaire survey was conducted to examine the extent to, and manner by which, chartism is used in the (London) foreign exchange market and how it is perceived by the market participants themselves. This gives clear information on the extent of chartist advice in the market and the wide variety of techniques used, along with insights into the differing views held by market participants on the subject. While something of a broad consensus emerges regarding the possible methods and the weights given to charts at differing time horizons, there is sufficient heterogeneity in general to suggest that differences of views will be transmitted in actual chartists advice.

To test this directly, a database of chartists' forecasts was constructed by a telephone survey of a panel of chartists, to compile their one and four week ahead predictions for the three major bilateral rates. This gives a unique data set, from which it is possible to analyse the forecasts of individuals as well as the median forecast. The data is subjected to a battery of tests and comparisons, a recurring result of which is indeed the apparent difference in accuracy between individual chartists. For example comparisons with a range of other forecasting techniques (economic and statistical), show some chartists under-perform these consistently while the best are even able to outperform a random walk.

Tests of the implied expectations mechanism reveal that the hypothesis of rationality of chartism cannot be entirely rejected over the short horizon, but that there is stronger evidence of irrationality over the four week period, a result which becomes more pronounced as the information set is expanded, which provides evidence against the chartist tenet that 'the price discounts everything'. Testing for different methods of expectation formation reveals that in general the hypothesis of static expectations cannot be rejected against the variety of alternatives considered. Overall, the crucial result in this area was that of an inelasticity of expectations: chartists' advice does not appear to exert a destabilising on the foreign exchange market by overreacting systematically to changes in the current rate.

In sum, this thesis forms a bridge between chartism and economics, by examining the methods and results of the former and analysing them with the tools of the latter.

1 INTRODUCTION AND OVERVIEW

1.1: Introduction

Chartist, or technical, analysis involves using charts of financial asset prices, together with certain descriptive statistics to try to infer the likely course of future prices and so construct forecasts and trading strategies. The approach, first explicitly developed in terms of the stock market, is now applied to all asset markets - such as commodities and foreign exchange, spot and future markets. It is with reference to the market for spot foreign exchange that the analysis in this thesis is specifically aimed, although the principals of chartism are common to many financial markets.

The chartist approach contrasts starkly with the methods of economists. While economists see themselves as trying to infer the behaviour of asset prices from solid fundamental reasoning, chartists analyse the market in terms of its past price movements alone. An essential difference between chart analysis and fundamental economic analysis is hence that chartists study only the price movement of a market, whereas fundamentalists attempt to look to the reasons behind that movement. 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 by chartists as immediately discounting all pertinent information and therefore encompassing all the fundamentalists' views.

It is clear at the outset that the ideas purported by chartists are not dissimilar in some respects to those of rational expectations, (Muth, 1961). And this can lead to a paradox, highlighted by Grossman and Stiglitz (1980) - if market prices fully and instantly reflect all available information, then agents have no incentive to gather costly information, in which case it is not clear how the information gets discounted into market prices.(1) Another paradox inherent in the chartist assumption of all pertinent information being immediately

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(1) This is dicussed further in section 2.2.1.2 in relation to Dow Theory.

discounted in the price is that of why chartist do not therefore believe that their own forecasts are discounted: in which case it would be impossible to construct profitable trading strategies. It is questions such as these which probably lead economists to believe that chartism is built on untenable ground.

There have, however, long been suggestions of the widespread use of chartism - even cursory contact with market practitioners and the large body of chartist literature would reveal a depth of interest. More formal studies, such as the study of the foreign exchange market conducted by the Group of Thirty (1985) have also pointed to widespread interest. The popular perception of chartism among economists, however, contrasts oddly with its existence in the market. The popular perception of chartism among economists is probably of it being somewhat irrational, a view succinctly expressed by The Economist, 'Technical analysis is the alchemy of the modern investment world ... like any other cult [chartism] is not overly worried by logic'. (The Economist, 30.1.88 - 5.2.88, p 65). It is probably fair to say that this also sums up the prevailing attitude of academic economists, at least until recently. As Marris (1989) writes, 'Until quite recently economists treated technical analysis - or chartism - with undisguised scorn; indeed again until quite recently, they had not even bothered to look at what chartists were doing'.

There does, however, recently appear to have been a growing interest among economists in the role of chartists in financial markets. In large part this appears to stem from the numerous empirical features of markets which cannot be explained by standard fundamental 'efficient market' type theories. It is probably true to say that such approaches in any case seem somewhat counter to the beliefs of financial practitioners. To quote the Financial Times, (5.4.88, p16), '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'. This continuing undiluted scepticism and mounting empirical evidence on the inadequacy of purely fundamental exchange rate models (eg Meese and Rogoff, 1983a,b) has in large part been the motivation behind the explicit acknowledgement of non-fundamentals influences on financial markets. The inclusion of chartist players in models (for example, those of Frankel and Froot, 1986b,d, 1987b) has been able to account for movements in the path of the dollar which fundamental models have to leave unexplained. The very continuation of the existence of non-fundamental 'noise-traders' in the market, in contrast to the traditional view which would claim such players would be wiped out by 'smart' speculators has been demonstrated by De Long et al (1987, 1988, 1989), and the potential profitability of trading using simple chartist rules has been demonstrated for the recent period by Schulmeister (1988). These, along with other examples considered later, evidence a move in the literature towards the inclusion of non-fundamentals which seems capable of producing results more in accord with real-world phenomena.

Reasons why interest in chartism is important therefore become clear. First, chartism is an actual facet of the market, and hence it seems unreasonable to dismiss it without consideration, particularly given evidence (both presented in this thesis and available elsewhere) of its widespread consideration by market practitioners. Second, it does seem that the appropriate role for economists is to endeavour to explain the actual features of markets, rather than regarding departure of market behaviour from what theory would predict as some kind of aberration. Third, given that chartism is a widespread market tool, its potential effects upon markets should be considered. Particularly crucial seems to be the question of whether these players may exert a destabilising influence on the market. These issues are explored further in the main body of the thesis, an overview of the contents of which is given next.

1.2: Overview of thesis

The starting point of this thesis (Chapter 2) is to survey the techniques used by chartists in practice: the origins of the methods, to explain the construction of the indicators which chartists consult, and to examine how they can be interpreted and used as forecasting tools. It is shown how these indicators can be either subjective - in the form of identifying visually recurring patterns in price series; or objective - such as the analysis of various calculated indices of price movements. The plethora of methods and potentially different ways of combining them, however, means that the results of either or both may well be highly user-dependent.

The treatment of chartism and related issues in the literature is considered in Chapter 3. Some points regarding this were made in the overview of the previous section: it is apparent that there is a growing interest in, and acknowledgement of, chartism and general 'non-fundamental' aspects of markets, following previous neglect. Promising results do seem to come from models which incorporate such features - certain aspects of price behaviour unexplained by traditional approaches are able to be demonstrated.

Despite this growing interest in chartism, there is virtually no work which specifically examines the extent to, and manner by which, chartism is used in the foreign exchange model. Clearly a pre-requisite for the examination of this question is a thorough knowledge of chartist techniques, as provided in Chapter 2. Given this, Chapter 4 goes on to explain the design and implementation of a questionnaire on chartism targeted at every chief foreign exchange dealer in the London market.

The questionnaire was designed to elicit answers to three basic questions. First, to determine which chartist technique are most used in practice; second, to ascertain the role of the chartist practitioners themselves; and third, to explore how market participants view the role of chartism. This survey gave hard empirical information on which type of chartist techniques are widely

used, and of views of chartism held by market participants. The detailed results are discussed in Chapter 4, but two points worth highlighting here are that chartism appears to be most used at shorter forecasting horizons (intraday to one week) and that most of those questioned regarded chartism and fundamental analysis as complementary, rather than competing, tools of analysis. The result concurs with the impression gained from a survey of chartist techniques in Chapter 2 - implying that chartist advice can be highly subjective - the advice presumably being even more diluted if combined with fundamental opinion as well.

The actual predictions of chartists are subject to empirical analysis in Chapter 5. A telephone survey was conducted over a nine-month period, asking a panel of chartists for their forecasts of the level of the three major bilateral exchange rates one and four weeks ahead. This gave a unique data set, in that it consisted entirely of chartist views. An additional advantage of the data is that it enables the testing of the properties of the individual as well as the median forecasts - whereas most surveys only allow researchers access to composite data. The data was subject to a variety of tests to examine its nature and to compare its predictions with other forecasting approaches.

A recurring result throughout this analysis is the apparent difference in accuracy between individual chartists, evidenced in both their qualitative (direction of movement) accuracy and in the size of absolute errors. Comparison with a range of other forecasting techniques gives a range of results, with some chartists underperforming an array of standard economic and statistical approaches, while the best even outperformed a random walk over the sample period. Given this information, Chapter 6 goes on to test the degree of rationality present in the forecasts.

Three nested degrees of rationality were defined and tested: first that of using the past price movement of the currency in question alone; second, also including information on past price movements of the two other currencies; and third, also using key fundamental information available at the time. The results overall showed that hypothesis of rationality was sooner rejected at the four week horizon than at the one week horizon. This can be adduced as further evidence of chartism having most use as a short-term forecasting tool, since information on past errors seems to be lost.

In Chapter 7, the examination of expectations continues with analysis of the implied expectations mechanisms in the chartists' forecasts. Crucially examined is the question of whether chartism may exert a destabilising influence on the market. The result to emerge is 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.

The key results and conclusions are highlighted in the overall conclusion of the thesis in Chapter 8.

2 A SURVEY OF CHARTIST TECHNIQUES

2.1: Introduction

Chartist analysis involves using charts of financial asset prices, together with certain descriptive statistics, to try to infer the likely course of future prices and so construct forecasts and trading strategies. This chapter surveys chartist methodology with particular reference to the market for spot foreign exchange, which is the particular concern of this thesis. The next section discusses Dow Theory and Elliott Wave Theory, from which much modern technical analysis can be traced. Section 2.3 describes the construction of charts and allied indicators, while Section 2.4 considers pattern recognition - the identification of visually recurring patterns in time series price data. Mechanical trading systems, widely used in conjunction with these, are then explained, while Section 2.6 concludes.

2.2: Dow theory and Elliott wave theory

Much of modern technical analysis can be traced back to Dow Theory, which was developed specifically in relation to the stock market. Its principles laid the foundations for many of the charting techniques still used today and as such, Dow Theory is an appropriate introduction to the general subject of chartism. Closely allied to Dow Theory is Elliott Wave Theory which goes slightly further by attempting to provide an overall market perspective in attempting to anticipate, rather than follow, market moves.

2.2.1: Dow theory

2.2.1.1: The origins of Dow theory

Dow Theory is probably the oldest, most basic and a particularly well known method of chartist analysis. It is in fact the result of the combined work of Charles H Dow and William Peter Hamilton. Dow was one of the founders of

Dow, Jones & Co, the publishers of The Wall Street Journal (WSJ), of which he was the first editor, while Hamilton was a close associate of Dow's, and edited the newspaper for twenty years until 1929. The identifiable principles of what is now known as Dow Theory date from a series of Wall Street Journal editorials. The only expression Dow himself made of the theory was in a number of those editorial articles written between 1900 and 1902. These stock market observations were first dubbed 'Dow Theory' by S A Nelson in The ABC of Stock Speculation (1902). It was Hamilton who further developed the work of Dow in a further series of WSJ editorials entitled 'The Price Movement', and published an outline of the theory's principles in his book The Stock Market Barometer: a Study of its Forecast Value based on Charles H Dow's Theory of the Price Movement' in 1922.

The first formalised account of Dow Theory was due to Rhea (1932a,b), who took as his source the total of 252 WSJ editoral of Dow and Hamilton and related writings.

2.2.1.2: The Dow theory approach

Descriptions of Dow theory generally start by asserting several basic tenets - discussed below. From these the concerns of the approach can be understood and the trading/forecasting strategy appreciated. These are:

(a) 'The averages discount everything' Dow originally worked with two indices, one covering industrials and the other railroads, which was subsequently widened to transport - these indices were 'the averages'. Since daily closing prices were assumed to reflect the judgement and sentiment of

market participants,(2) it was held that, 'this process discounts everything known and predictable that can affect the demand supply relationships of stocks' (Pring 1985). This clearly bears with it an implicit assumption of something akin to rational expectations - Muth (1961). The point of the assumption is that 'fundamentals' can be ignored for the purposes of forecasting so that, for example, information on past and expected future money supply, etc should already be discounted into asset prices, enabling the chartist to ignore them for the purposes of analysis.

This does not necessarily mean that prices are unpredictable. Most modern fundamentalist approaches to asset price determination also assume rational expectations - for example, the discounted present value model asserts that the current share prices reflects the entire expected future path of dividends (see eg Brealey and Myers 1981). In the long run, share prices and dividends will move in line with each other, so share prices will only follow a random walk if dividends do so.

This first tenet of Dow theory also 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 not clear how information gets discounted into market prices. The resolution of the paradox lies in relaxing the assumption that prices instantly reflect all available

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(2) Or as expressed in Rhea, 1932, 'The fluctuations of the daily closing prices of the Dow-Jones rail and industrial averages afford a composite index of all the hopes, disappointments, and knowledge of everyone who knows anything of financial matters, and for that reason the effects of coming events (excluding acts of God) are always properly discounted in their movement. The averages quickly appraise such calamities as fires and earthquakes'. Rhea (1932b) p19.

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. If data are gathered discretely, it is assumed that the arbitrage process has taken place within the period. Another paradox inherent in the assumption of all pertinent information being immediately discounted in the price concerns whether the chartist forecasts themselves would be discounted.

(b) 'The market has three trends' According to Dow Theory, there are simultaneously three movements or trends governing behaviour of the averages: the primary or major trend, the secondary trend and the minor trend.(3) Dow theorists would give the following rationale of market movements. The primary trend, lasting two or three years, is in turn divided into three distinct phases. For example, a primary bull movement would begin as the bear market bottoms out, the averages have discounted the worst news, and informed buying by the most knowledgeable investors begins - the 'accumulation' phase. The second phase would set in as prices begin to advance noticeably and business news improves, the point at which chartist analysts would aim to begin to participate. In the third and final stage, when the market becomes dominated by bullish overspeculation, 'knowledgeable' investors would aim to begin to take their profit as the market peaks out - the so-called distibution' phase.

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(3) To quote an original WSJ editoral by Hamilton, 'Simultaneously in any broad stock market there are - acting, reacting and interacting - three definite movements. That on the surface is the daily fluctuation; the second is a brief movement typified by the reaction in a bull market or the sharp recovery in a bear market which has been oversold; the third and main movement is that which decides the trend over a period of many months, or the main true movement of the market.' The Wall Street Journal, August 8, 1919.

Secondary or intermediate reactions are seen as being superimposed on the primary trend and may be defined as ' ... an important decline in a bull market or advance in a bear market, usually lasting from three weeks to as many months during which interval the movement generally retraces from 33 to 66 per cent of the primary price change since the termination of the last preceeding secondary reaction' (Rhea 1932b).

If the primary trend were viewed as analogous to the tide of the market, and the secondary reactions as the waves of the tide, then minor movements would be the ripples on the waves. Dow theorists regard minor movements, which could last from a few hours to two or three weeks, as having little more than nuisance value.

(c) 'The averages must confirm each other' This tenet refers back to Dow's two original indices - one for industrials and one for transport. The point is that, according to Dow theorists, action should only be taken when the charts for both markets are giving the same signal - perhaps within a short lag of each another. The motivation for this tenet is presumably simply to try to distinguish distinct movements from temporary observations; but some expositors have read more into it than this, calling upon specific fundamental justifications for the price movements. Recalling that the two averages are for industrials and transport, Pring (1985) writes: 'It is not possible to have a healthy economy where goods are being manufactured but not sold (ie shipped to market)'.

(d) 'Volume must confirm the trend' Dow theorists would use the volume of trading as a secondary input into interpreting chart signals. The basic idea is that trading volume should expand in the direction of the major trend - ie should be heaviest in the major up or down trends. For example, in a down trend, the volume should be heaviest as prices drop and should begin to fade on minor rallies in the downtrend. The opposite situation may well be taken as

a signal of an impending reversal in the major trend. In the present context of Dow theory, however, volume is very much regarded as a secondary indicator.

(e) 'A trend must be assumed to continue until definite reversal signals are perceived' This might be paraphrased as 'Dow's first law of motion'. The major part of Dow's Theory is in fact concerned with recognising reversal signals in the major trends, some simple illustrations of which are given in Chart 2.1. Chart 2.1a illustrates a major bull trend on which secondary reactions (of perhaps three months or so) are superimposed. During a major bull trend, Dow Theory characterises the secondary trends as taking 'three steps up and two or three back'.

In Chart 2.1b a break in a major bull trend would be suggested as the secondary peak of C is below the preceeding peak at A. This is 'confirmed' as the secondary downward reaction goes through the level of the preceeding secondary trough at B, which would generate a sell signal at D.

The situation is less clear in Chart 2.1c, when although the secondary correction from B falls below the level of the preceeding secondary trough at A, it is not clear whether C should be recognised as a sell point since its peak B was higher than those before it. Some Dow theorists may interpret the movement through point C as a possible sell signal. Further evidence of a trend reversal, however, would be taken in this case from the relatively low secondary peak at E, confirming a definite sell signal at F.

In practice, further evidence might be adduced in analysing Charts b and c in conjunction with trading volume figures. For example, if volume had thinned during the rise from A to B and expanded from B to C (Chart c), a Dow theorist might well recommend selling at C rather than waiting for F.

This summary of the theory has served to highlight the salient issues of Dow Theory as it has become known. The original expositions of the theory in fact run to great length - Rhea (1932b, p11) prefaced his description with the suggestion that, "Dow theory, like algebra, is not readily understood after a mere casual reading of a text book in the subject".

2.2.2: Elliott wave theory

The Elliott wave principle is complementary to the Dow Theory described in the previous section, but many chartists claim it goes further by providing an overall perspective to market movements and allowing an analyst to anticipate reversals in trends (Frost and Prechter, 1978). The basic principle was presented by R N Elliott, who described it as a 'much needed complement to Dow Theory'. It was first published in 1939, in a series of twelve articles in the Financial World magazine and was originally applied to stock market averages. The basis of Elliott wave theory is that financial markets are claimed to follow a repetitive cycle of a five wave advance followed by a three wave decline. Before describing the important elements of the Elliott wave principle, it is worth looking at its numerical basis - the Fibonacci sequence.

2.2.2.1: Fibonacci numbers

Fibonacci numbers are taken as the numerical basis of Elliott wave theory. The Fibonacci sequence is constructed such that the sum of any two consecutive numbers equals the next number ie:

$$x_j = x_{j-1} + x_{j-2}, \quad j > 2$$

$$x_1 = x_2 = 1$$

Thus the sequence begins

1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144 etc

The sequence displays a number of properties, one of which is an almost constant relationship between the numbers. The ratio of any number to the next highest number approaches 0.618 via a damped oscillatory path and similarly, the ratio of any number to its next lowest number is 1.618. This is the so-called 'golden ratio', which has known applications in many areas of human activity eg architecture (several examples are given in Plummer, 1989). The series itself was first presented by a thirteenth century mathematician, Leonardo Fibonacci.(4)

The basic Elliott wave form can be broken down into Fibonacci numbers. As the analysis of these wave forms is the central tenet of the Elliott approach, the subject considered next.

2.2.2.2: The Elliott wave principle

The basic Elliott pattern is shown in Chart 2.2 - a complete wave consisting of a five wave advance followed by a three wave decline. The first, second and third waves in the advancing phase are called the impulse waves, while the second and fourth are the correction waves. These are followed by a three wave correction (decline). Within each eight wave cycle there can be subcycles, with each wave subdividing into waves of one lesser degree, and so on.

Subdividing the eight waves in Chart 2.2 into lesser waves gives 34 smaller waves, then subdividing the 34 smallest waves further gives 144 waves, all numbers of the basic Fibonacci sequence. Whether a particular wave divides into 5 waves or 3 waves would be in theory determined by the direction of the

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(4) In the book Liber Abaci (Book of Numbers) in 1202.

trend. In Chart 2.2 waves 1, 3 and 5 are following the trend of the advancing wave 1 and so divide into 5, whereas waves 2 and 4 go against the prevailing advancing wave and divide into 3. The converse would apply to the downwave.

While the eight wave cycle is the basic Elliott form, wave theorists claim to identify several variants. For example, while the basic up trend has five waves, one of the impulse waves may be elongated (an 'extension') and consist of five additional waves. There are, in fact, numerous variations which have been described on the theme (Frost and Prechter,1978) - including the integration of some standard chartist patterns (eg ascending and descending triangles) into the waves. Though such occurrences make pattern identification less clear and often ambiguous, Elliott theorists are not deterred, and claim that these do not negate the underlying principle.

Chart analysts who subscribe to Elliott wave theory thus claim that use of the patterns gives a wider perspective than traditional charting techniques by helping to determine where the market is in its overall cycle. In terms of forecasting, by distinguishing the direction of fives and threes, the analyst attempts to determine what to expect next (according to the Elliott wave principle) - whether the general market is advancing or correcting. For example, a three wave decline would imply correction (not reversal) of an overall bull market, whereas a five wave decline appearing in a bull market would be taken as an indication of the beginning of a downtrend. (Frost and Prechter, 1978).

By trying to impose an overall perspective on the market, Elliott wave theorists aim to give advanced warning of market peaks and troughs. In this respect, they try to meet one of the major criticisms of the Dow approach, which only registers signals after a trend has been established.

Elliott wave theory is built implicitly on one of the same tenets that underlies Dow Theory - that 'the average discounts everything'. Only the movement of the market price is considered; all other information is held to be extraneous. Clearly the criticisms regarding the role of information, along with the links with the rational expectations hypothesis, apply as equally to the Elliott principle as they do to Dow theory.

Elliott wave theorists argue that the principle that financial markets, such as equity markets, follow a five wave pattern with a three wave correction can be applied to shed light on historical market movements. Elliott himself identified different degrees of the patterns, the longest being the Grand Supercycle, spanning some two hundred years - see, for example, Pring 1985. (This does of course beg the question as to what extent it is possible to identify two hundred year cycles when the 'industrial society' has only existed since the latter half of the eighteenth century.) The Grand Supercycle was further divided by Elliott into eight supercycle waves, which again were subdivided into eight cycle waves. The process could continue through the primary, intermediate, minute, minuette, and subminuette waves - the latter which would cover only a few hours. According to Elliott's theory, the current Grand Supercycle began around 1800, with the latest (and third) up wave having begun in 1932.

Probably one of the major objections which an economist is likely to raise in connection with Elliott wave theory is that there appears to be no theoretical (or indeed logical) a priori basis for market movements to occur in patterns of three and five. This, in a sense, brings into the open the distinction between chartism and fundamentalism. Pure chartists offer few arguments as to why certain patterns should recur in financial markets other than that observation convinces them that they do. In that sense, chartism is largely extrapolative. Clearly, there will always be a problem in trying to identify market turning points using extrapolative methods (this is a classic criticism of Dow theory), and Elliott theory can be seen as an attempt to provide Dow theory with a

predictive basis. On the other hand, the predictive nature of Elliott theory is weak in the sense that, although it might predict the eventual occurrence of market corrections, the exact timing remains unstated. For example, in the description of the Grand Supercycle, there is no indication of when the assumed three correcting waves might occur. Advocates of the approach do, however, claim that the timespan between stock market peaks and troughs are often Fibonacci numbers, where simple Fibonacci time targets(5) are found by counting forward from significant turning points (Pring 1985). Elliott practitioners will cite examples where the next turning points occurred on the 5th, 8th, 13th day/week etc after a significant change in trend (see, eg. Pring 1985, Table A.1, p 383), although the predictive power ascribed to this method even by ardent advocates is very slight.

Another method practitioners might use to try to quantify the wave foms is that of proportional relationships between waves and Fibonacci ratios. Two such examples (Murphy 1986) are:

- multiplying the length of wave 1 by 1.618 and adding the result to the bottom of wave 2 gives minimum target for the top of wave 3.

- if one of the impulse waves extends (see earlier), the other two should be about equal in time and magnitude.

In assessment, these time and quantitative aspects of Elliott waves must be the weakest link in the theory, a prevalent problem with all types of technical analysis. Practitioners of the Elliott principle claim that by far the most weight should be placed on pattern assessment rather than the time or ratio relationships and in general, Elliott wave theorists use the techniques in

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(5) Plummer (1989, Chapter 10) describes the calculation of more complex Fibonacci time targets.

conjunction with other technical tools. Furthermore, few chartists appear to subscribe to the explicit use of Dow and Elliott theory, instead tending to combine the insights from these with evidence from various other approaches.

Having considered what is regarded as the origins of modern chartism, which was essentially developed in relation to the stock market, the next sections go on to look at the main methods of chart analysis currently in use in virtually all asset markets, beginning by looking at the basic tools of the subject - the charts and technical indicators themselves.

2.3: Technical indicators and chart construction

There are several types of charts and indicators used by chart analysts - this section explains their use and the methods by which they are constructed, looking at the bar chart, close-only charts and point and figure charting and introduces the area of moving averages, momentum and oscillator analysis.

The widespread use of computers has enabled technical analysts to conduct a far more detailed, immediate and wide-ranging study of charts. Until relatively recently, chartism was a paper-based form of analysis, with graphs drawn on long rolls of paper. (Edwards and Magee, 1966, in fact offer chartists specific practical advice on how to continue charts on new piece of paper, and caution that a chartist should have, " ... plenty of pencils, a dozen at least, well sharpened, so that as soon as one becomes a trifle dull ... you can ... continue at once with another ... " p295). As the Financial Times pointed out, "In the old days a chartist would be hard-pressed to keep a dozen charts up to date; now he or she can monitor the state of hundreds of shares, as well as currencies and commodities. "(Financial Times, 9.12.89, p III)

2.3.1: Bar Charts

The daily bar chart is a standard tool of the technical analyst. It contains information on up to three aspects of trading - the price[6] , volume of trade and, in the case of futures contracts, the amount of open interest. A typical example of a daily bar chart, for gold futures, is shown in Chart 2.3a, and a bar chart of spot foreign exchange (DM/$) is shown in Chart 2.3b.[7]

Each day's price range is plotted as a vertical bar, the end points therefore marking the high and low of the day with a tick to the right of the bar indicating the closing price. The closing price which is held by chartists to have most technical significance, as it is interpreted as the market's final evaluation of the day's trading. (See quotation from Edwards and Magee in section 2.5.1.1). Some charts also incorporate the opening price as a tick to the left of the bar.

The volume of trade (where available) in the market is shown as vertical bars plotted on the bottom of the chart. The volume is the total number of contracts traded during the day, and is often referred to in the financial press in terms of it being 'light' (or thin), or 'heavy' during particular periods. These figures will not be available for some markets, such as spot foreign exchange, and in any case volume information is thought by many practising chartists to give unreliable signals.

Open interest, applicable to futures markets, is the total number of outstanding contracts held by traders at the end of the day. It is the total of outstanding long or short contracts - only one side need be known as the two figures are, by definition, identical. Open interest is plotted as a solid line along the bottom of the chart, between the volume and the price bars. A dotted line which

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(6) Other indicators of price movements are sometimes also included on bar charts. In the example shown, moving averages of the price are shown on both charts, while a rate of change indicator (see section 2.5.2.1) is included on Chart 2.3b.

(7) Charts 2.3a,b were kindly supplied by Investment Research of Cambridge.

shows a longer-term average of open interest is also sometimes included, in order to give a guide to seasonal movements.

While daily (or shorter term) bar charts are probably the most widely used tool for immediate trading purposes, analogous charts can be constructed for any time period, to give a longer perspective of price movements. A weekly chart may cover some five years or so, and a monthly chart may go back twenty years, as opposed to the nine months or so of information which is usually contained in the daily chart. Used in combination, monthly, weekly and daily charts may be used by the trader to attempt to put short-term price movements into a longer-term perspective. The longer term charts would be studied first, to convey an impression of the potential longer term trends, and then the daily charts would help determine the exact timing of trading activity.

At this point some necessary mechanics included in the construction of bar charts can be mentioned. A daily bar chart is usually plotted so as to exclude weekends, and a blank space is left for weekdays on which the exchanges are closed. The vertical axis can be constructed on either an arithmetic or logarithmic scale. On an arithmetic scale, the vertical distance is equal for each unit of price change, whereas on a logarithmic scale, equal distance implies an equal percentage change. While it may be clearer to use a logarithmic scale for longer term charts if prices have risen particularly steeply (probably due to inflation), commercial traders and chart services generally use a standard arithmetic scale. The diagrams in this chapter follow this convention.

2.3.2: Close-Only or Line Charts

A second type of chart is the close-only or line chart, where the closing price is the only price of information plotted. Most of the illustrative charts in this thesis are drawn in the form of 'close-only' charts.

The usual reason for a trader plotting a line chart as opposed to a bar chart is that intra-day data is not available for some price series. Bar charts, however, are generally more readily available from commercial services than line charts, and are usually preferred by traders as they embody more information.

2.3.3: Point and Figure Charts

A third type of chart used by traders is the point and figure chart. The distinguishing feature of these charts is that they disregard the time dimension of price changes, with entries being made only when the price has moved by some predetermined amount. Chart 2.4 shows a point and figure chart(8) of the $/£ rate from late 1986 to early 1990, from which it can be seen that the entries are made in the form of columns of X's for rising prices and O's for falling prices. Each entry represents a price movement of a specified amount, called the box size. On Chart 2.4, the box size is 0.5 cents ($ 0.005) hence a rise in the $/£ rate of ten cents would require a column of twenty X's to be plotted. Alternatively, choosing a box size of 0.2 would require a column of five O's to denote a price fall of one cent. If the price moves by an amount less than the box size, no entry is made. By convention, the first O in a column is always plotted one box below the last X in the previous column, and the first X is plotted one box above the lowest O in the preceding column.

The convention for the initiation of a new column depends on the variety of point and figure chart used. The regular point and figure chart would begin a new column whenever the day's price reversed by an amount greater than the box size. Alternatively, a 'reversal chart' formulation may be adopted, whereby a new column of X's or O's can only be initiated when the price has moved by some specified amount in the opposite direction to the previous trend. This amount is called the 'reversal size', and would usually be specified in the form of a multiple of the box size.

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(8) Chart 2.4 was kindly supplied by Chart Analysis.

While the choice of box (and reversal size if used) is arbitrary, the figures chosen significantly affect the number of entries made on the chart. Some experimentation is generally used in order to find the most informative size for a particular market and time period. Obviously, if a reversal size of N boxes were used, the number of 0's or X's in each column must, by definition, be at least equal to N.

2.3.4: Other Technical Indicators

Although charts, particularly the daily bar chart, are a standard tool of technical analysis, other indicators are drawn upon to provide supplementary information. Moving averages are widely used to try to clarify the direction of trend in a market (see Section 2.5.1.1), while 'oscillator' and 'momentum' indicators emphasise the rate of change of the prevailing price action. Unlike charts, these latter categories of indicators can be used to generate precise trading signals. Their use will be discussed in further detail in Section 2.5.

Market profile: One of the latest chartist tools currently in use is the 'market profile'. Chart 2.5 is an example of such a chart, constructed over a day's trading of spot DM/$. On the left hand side, each letter represents an hour's trading (A for the first hour of the day, etc) and a letter is repeated every time the price moves into a different 5-point range. (1 'point' = 0.0001 for DM/$ and $/£, 0.01 for Y/$.) The right hand side is a histogram of tick volume - increments to which are made when any price change registers on the on-line dealing screen. Hence, on the day illustrated, there was most volatility (assumed to correspond to more volume of trade) around the upper end of the day's price range. The analysis of volatility using tick volumes is the main distinguishing feature of this method - clearly such analysis is only feasible with modern on-line systems. The chart is constructed as the day's trading progresses, so the technical analyst can watch the shape of the day's trading taking place and construe associated intraday support and resistance levels from those areas where little (assumed) trading has taken place.

Non-price based indicators: 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. 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.

The above attitudinal indicators may further 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 overwhelmingly 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. (See section 2.5.2.2).

2.4: Pattern recognition

A major application of bar charts is in the area most closely allied with the popular conception of chart analysis - ie the recognition of regular, known, identifiable patterns in market price movements. Chartists generally classify price movements by referring 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. Before discussing these two varieties of pattern further, the concept of trend itself is considered.

2.4.1: Trend and related features

Trends are one of the most widely used chartist descriptions, which are used to try to clarify the direction of market movement. A trend may be described as the overriding direction of the market: an uptrend is a series of successively higher peaks and troughs, a downtrend is characterised by successively lower peaks and troughs, while a sideways trend (also called a 'trading range' or a 'trendless market') consists of a series of approximately level peaks and troughs. Chart 2.6 illustrates the principle.

Trendlines and Channels: Trendlines are one of the simplest but most widely used chartist tools, which are used to try to judge the overriding direction of market movement. An up trendline connects a series of successively higher lows while a down trendline is drawn between successively lower highs. Three consecutive higher lows (lower highs) are formally required to confirm the validity of an up trendline (down trendline), as illustrated in Chart 2.7a,b.

A trend channel is a pair of parallel lines enclosing a trend, and price movements may be spotted which trend between the basic trendline and a channel line drawn parallel to it (Chart 2.7c).

Penetration of trendlines and channels can sometimes be taken as an indication of a significant change in price direction. The chartist tenet that trends tend to remain in motion until definite reversal signals are perceived ('Dow's first law of motion') is held to be a pertinent concept here as, once a trendline has been identified, a chartist might expect a similar angle of slope to be maintained. Breaking of the trendline is held by chartists to be one of the best early warnings of a change in the trend (Murphy 1986), and the penetration is judged to be all the more important the more significant is the trendline (ie the longer lasting and the greater the number of peaks and troughs it has). Also, violation by a closing price is regarded as more

important than an intra-day penetration. One rule usually applied to trendlines and channels is that penetration of the up trendline is a sell signal (eg. in Chart 2.8a), while violation of the downward trendline is a buy signal, indicating an upside trend reversal (Chart 2.8b). Some confirmation criterion may 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. For example, a price filter of the form of a 3% penetration criterion might be applied, which would require that the trendline be broken, on a closing basis, by at least 3%. A penetration is not, however, always believed to lead to a trend reversal, it may instead merely indicate, say, the formation of a new trendline at a different angle. However, a chartist would probably claim that if this price fails to reach the channel line it is usually a sign of a weakening of the trend. Chartists would use such a signal as an early warning of a possible price reversal, and may well anticipate that such a move may be followed by penetration of the trendline.

Trading Ranges: Trading ranges are essentially a series of peaks and troughs which follow a horizontal path rather than an up or down trend. 'Breakouts' from these patterns, such as that shown in Chart 2.8c are held by chartists to be among the most reliable of technical indicators, often taken as a signal of the initiation of a new trend in the direction of the breakout. The longer has been the duration of the trading range, the more technical significance tends to be attached to a breakout (Edwards and Magee, 1966). Breakouts from narrow ranges are held by chartists to provide particularly reliable market signals.

Trading ranges contain an element of self-perpetuation in that trading orders may be activated if the price moves a little outside the range. Some believe (eg Schwager 1984) this to account for the way in which prices will often break out of the trading range by only a small amount, only to then return within the

range. The argument is that, as stop orders may be clustered in the areas just outside the trading range, a minor drift beyond the range might trigger a series of stops. Once these have been executed the breakout would peter out, unless there is sufficient alternative pressure for the price to move further. Partly due to this, the breakout signal is taken to be more reliable if the price holds beyond the trading range for a number of days (perhaps five or so).(9)

Support and Resistance: The concept of support and resistance is related to the foregoing discussion of trends, but can also be considered as an application by chartists of fundamental pressures of supply and demand. The terms support and resistance have entered common financial parlance (see quotations below) - a support price is one which appears to 'halt', or reverse, a downtrend, while a resistance level seems to 'stop' an uptrend. Chart 2.9 shows the support and resistance levels in an uptrend, where the peaks are resistance levels and the troughs (or reaction lows) form support levels. A possible fundamental justification given for these phenomena is that a support range represents an area of concentrated buying, sufficient to overcome the selling pressure and maintain at least a certain price level. Conversely, a resistance area would be analogous to a region at which there is concerted selling.

If it appeared from a chart that resistance to further price increases was being encountered at the point of previous major highs, a penetration of the resistance level would be regarded by chart analysts as a significant buy signal. In a similar fashion, a price movement below previous 'resistance' lows

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(9) A stop order is executed when the price attains a given level. A buy stop must be above the market price, while a sell stop must be below it. For example, if a speculator believed that a price movement to an area above the current trading range would be indicative of a potentially bullish market, he would place a stop order to buy if the price reached a specified level a little above the trading range.

would be a sell signal. Chartists point out that once previous support or resistance levels have been penetrated their roles may reverse - previous resistance levels then acting to support prices. Murphy (1986, p62) draws out what he believes to be an important rule from this: 'Whenever a support or resistance level is penetrated by a significant amount, they reverse their roles and become the opposite'. Chart 2.9 illustrates how the resistance at point A is transformed into support at point B. The testing of a previous resistance level in an uptrend is regarded as a particularly critical phase for the market and failure to break through previous resistance levels may be interpreted as the first indication of an impending reversal of a trend.

Considerable 'psychological' importance may be attached in the market to support and resistance levels. Looking at the daily financial press will confirm this - currencies are often seen to hover around what the market regards as significant bilateral rates. To quote from the Financial Times:

> "Earlier in the day, the dollar had already stalled, having failed to break resistance at DM 1.8300." 28.6.88.
>
> "Elsewhere the D-Mark held above a support level of Y71.43 against the yen ..." 28.6.88.
>
> " .. the US currency today broke through what traders regard as the psychologically important levels of DM 1.80 and Y 130 ..." 25.6.88.

As illustrated by the last quotation, certain numbers may become focal points for market psychology - with round numbers being particularly renowned for offering support and resistance. Traders cautious of this possibility may tend to avoid placing trading orders right on these round numbers, lest their role as support and resistance levels means that the market price will never quite get there.

On a related point to these 'levels-based' points of market focus, there is some evidence regarding the existence of calendar-based anomolies in price movements. For example, the 'January effect' - Rozeff and Kinney (1976) found higher average stock returns in January than in any other month; the

'weekend effect' (see, inter alia, Cross 1973, French 1980, Jaffe and Westerfield 1985) shows that stock and bond returns are on average negative from market close on Fridays to opening on Mondays. Recently Cadsby (1989) observed that the stock market crash on Monday 19 October, 1987 was perhaps in hindsight no surprise since his 1962-85 stock market data showed that the worst day of the week, day of the month and month of the year to hold stock were Monday, the 19th and October respectively. Such findings perhaps offer some statistical evidence to support what otherwise may seem to be 'irrational' beliefs in psychological levels for market movements.

To consider a specific pattern based application of trendlines and levels of support and resistance, the so-called 'fan-principle' can be cited.

The Fan Principle: This chart formation derives its name from the three trendlines which are used in its identification. Chart 2.10 illustrates the path which price might follow after an initial breach of an up or down trend. Considering this chart, following the violation of the original trendline 1, prices subsequently rallied but failed to break back up through the line which now is seen as acting as resistance. A second trendline (line 2), is similarly broken by a price drop and tested by a rally, and if a third trendline (line 3) is broken it is taken as a signal that prices have further to fall.

Whether the fan principle is applied to an up trend (as in Chart 2.9) or a down trend, the trend reversal signal is still deemed to be given by the breaking of the third fanline. Failure of the fan pattern is claimed to be soon recognisable (Edwards and Magee 1966), thus in principle enabling a trader to limit losses should it fail.

Trend Measurement: Observation of price lines shows that financial market prices often tend to trend in a zig-zag manner, retracing some of their previous moves before advancing further. Technical analysts attempt to quantify these minor countertrend moves into percentage retracements. Chart 2.11a

illustrates a 50% retracement, whereby an up trend, having moved from a price of 100 to 200, then retraces 50% of its advance by falling to 150 before continuing it upward path. Widely cited maximum and minimum retracements are 33% and 66% ie - during a pronouced trend, a chartists would be looking for the market to retrace at least a third of each move. A chartist may well construct his trading opportunities around the identification and anticipation of likely retracement zones. Were the price, however, to move beyond a 66% retracement, the likelihood would be that the chartist would then suspect that the trend was actually reversing rather than only pausing before further advance. On Chart 2.11a, 33% and 66% retracements would have involved the price dropping from 200 to 166 2/3 and 133 1/3 respectively.

Speed resistance lines (or speedlines) are another method of quantifying trends. These are designed to measure the rate of ascent or descent of a line, by the method demonstrated in Chart 2.11b. Using the example of an up trend, a vertical line is drawn from the level at which the trend began (A) to its current peak (B) and this line (E to B) is then divided into thirds, enabling 1/3 and 2/3 speedlines to be drawn from the origin of the trend to these points. (Speedlines for a down trend are constructed in an equivalent way.) It is necessary to redraw the speedline each time the price advances further in the direction of the trend.

A chartist may use speedlines as a yardstick to try to judge whether price movements are likely to be simply retracements or full trend reversals. According to the speedline method, if the price during an up trend was simply making a retracement before continuing its path, it should usually stop falling around the higher (2/3) speedline, and were it to fall below the 1/3 speedline, it would be a signal that prices would probably fall back to the levels seen at the beginning of the trend, and that a new down trend was underway.

The previously discussed 'role reversal' concept of support and resistance levels can also be applied to speedlines. During an up trend (as in Chart 2.11b), if prices fall through the upper 2/3 speedline to the 1/3 line and rally thereafter, the upper line now would be interpreted as acting as a resistance level and it would require the price to break through the 1/3 speedline to signal to chartists that the old highs were probably about to be tested.

These measurement techniques may be used by technical analysts in the appraisal of chart patterns. Once a pattern formation is identified (or even just suspected in its formative stages), the likely degree of future price movements would be anticipated, possible support and resistance levels drawn in, likely retracement moves forecast, and so on. By such methods the chartist would aim to anticipate price movements and attempt to position himself on the right side of any trend.

In the following section that area most closely allied with the popular conception of chart analysis is considered - the recognition of known, identifable patterns in market price movements. It was noted above that price patterns may be categorised according to their relationship with the market trend, with reversal patterns being characterised by a reversal of the incumbent trend and continuation patterns occurring within a prevailing trend. 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, some standard, or 'classical' chart pattern formations are analysed, beginning with reversal patterns.

2.4.2: Reversal Patterns

The reversal of a trend may be spread over a considerable time period. There are several major reversal patterns which have been classified by chartists - this section considers the well-known head and shoulders pattern, double/triple tops and bottoms, 'V' (or spike) formations, and saucer patterns, a prerequisite for all of which is the existence of a previous trend. Probably the best known chartist formation is the reversal pattern called the head and shoulders.

Head and Shoulders: The head and shoulders is a three part formation consisting of a large middle peak with two smaller peaks on either side. Chart 2.12a shows an idealised example with the 'neckline' drawn beneath the left and right shoulders, A and C. The head and shoulders formation is not generally considered by classical chartists to be complete until the final penetration of the neckline and last peak (point D) has occurred. Once the pattern reaches point D, a full trend reversal is deemed to have been signalled.

It can be seen from Chart 2.12b the way in which the path of the Deutsche mark against the dollar over the period 1984-86 was interpreted by certain chartists to have traced out head and shoulders formation.

There are many variations on the basic head and shoulders theme. For example, a 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. Failed head and shoulders display the initial three peaks formation, but violate the standard pattern because the price line crosses back above the neckline after the right shoulder, invalidating the standard formation, in which the price line should not recross the neckline after this point.

Chartists assert that identifiable patterns can have some underlying justification in terms of the fundamental supply and demand behaviour of the market. Combining chart information on price activity and trading volume enables stories to be told about the market activity behind the chart formation. Consider this for the standard head and shoulders pattern. From Chart 2.12a, the course of events of a 'typical' realisation was explained by the classic textbook, Edwards and Magee (1966) along the following lines.

- A strong rally to a peak (Point A) accompanied by rising volume is followed by a minor recession on lower volume. This is the left shoulder.

- The price rallies to new highs on slightly lighter volume and peaks (Point B) above the previous high. The price then drops back to a level near the bottom of the previous recession. This completes the head of the formation.

- A third a rally (to C) on significantly lower volume fails to reach the heights of the previous peak. The right shoulder has now been formed.

- The price moves below the 'neckline' - a line drawn across the bottom of the two preceding lows.

- The pattern is completed with a slight return move back to the neckline. This is followed by new lows.

This classic pattern seems to have developed something of a 'folklore' about the course of underlying events - although all such justifications might be regarded simply as ex post rationalisations. The accompanying classic 'tale' of this movement in the stock market is as follows. (Edwards and Magee 1966, pp 48-51)

A group of investors may believe that a certain asset is presently undervalued, and as a consequence buy what comes available, although hoping not to attract the attentions of other investors too early. After a while, other investors begin to show interest in the asset, perhaps having perceived the accumulation or having upgraded their rating of the asset for reasons similar to those which attracted the original investors' interest. As the asset is scarce, the extra demand begins to push up the prices.

The up move gathers momentum as demand is buoyant, and the market realises that perhaps this asset was undervalued in fundamental terms. By now the price is reaching the level at which the original investors had planned to take profits. To sell a large number of units now, however, would weaken the price - clearly a gradual approach is required. Hence they begin to sell their holdings little by little.

However, a lull in demand may occur before they have distributed their entire holdings, possibly caused by the market sensing an increase in supply. Consequently, the group of original investors stops selling, and may even buy, in an attempt to support the price. As the flow of supply has now ceased, the price is free to rise again and move into new highs. This gives the investors the opportunity to unload the rest of their holdings. Provided they judged the market correctly, their sales will have satiated demand for some time to come, and prices will drift back to the previous support level. A minor rally will follow on the strength of new buying from traders who were waiting for just such a minor reaction, then the full down trend is underway.

A similar story is told for formations at market bottoms, except the focus is then on accumulation rather than distribution. Technical analysts will argue that all chart patterns can be justified as mirroring the market's supply and demand reactions. It is, however, enlightening to realise that the entire motivation for the above story lies in differential information - to some extent negating the premise of the price discounting mechanism.

It is clear from these 'folklore' tales justifying the major patterns that chartists see themselves as being able to spot patterns which the behaviour of the rest of the market has caused. In this sense, their beliefs can perhaps be characterised as a view that they themselves are 'smart' traders, while the rest of the market acts naively, trading on 'mistaken' beliefs about fundamental influences. This is an interesting contrast to the academic literature surveyed

in Chapter 3, in which economic models incorporating participants with different views invariably characterise the so-called non-fundamental/noise/chartist-type traders as 'naive', while it is the fundamentalists who are 'smart'.

Furthermore, looking at Chart 2.12b of a head and shoulders top in the foreign exchange market, one can easily point to fundamental economic reasons for the pattern - for example the September 1985 Plaza Accord causing the right shoulder.

Justification for the major price patterns, including the head and shoulders, is offered by Plummer (1989), who views the behaviour of the market in terms of crowd psychology.(10) He suggests that a crowd's response to shocks (in the case of contra-trend shocks, a three wave response he terms the 'price-pulse') combined with the 'natural rhythms' of the crowd are reflected in those patterns identified by traditional technical analysis.

Tops and Bottoms: There are several groups of so-called 'top and bottom' patterns, but the triple top and bottom can be regarded as only a minor variation on the above head and shoulders formation. Triple tops and bottoms essentially the same pattern, but have all their peaks at the same level. A double top or bottom, as its name implies, may be identified if a trend

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(10) The behaviour of market participants analysed from a pshychological viewpoint is also apparent in some recent literature on cognitive psychology. Systematic biases have been documented in the decision making processes of individuals - see, for example, Arrow (1982), Hogarth and Reder (1987). This literature is also discussed in Chapter 3, section 3.4.5.3.

reversal takes the form of two peaks of roughly equal magnitude. The likelihood of a significant trend reversal following such a movement is supposedly greatly increased the more pronounced was the previous trend.

Rounded tops and bottoms (or saucers) are claimed (eg Schwagar 1984) to be one of the most reliable formations, but less common than reversal patterns. A rounded top is a shape which chartists perceive as being indicative of a very gradual change in trend, and the classical form of the pattern would be accompanied by a mirror-image movement trading volume.

Spikes, or 'V' Tops and Bottoms: The V top or bottom differs from most the other standard reversal patterns in that it is recognised at a sudden, rather than a gradual, change in trend. Because of this it is held by chartists to be more difficult to anticipate for trading purposes, but certain features are claimed to suggest its imminent occurrence. For example, if the chartist suspects the trendline is unsustainable - eg especially steep with few retracements and possibly several gaps in the price line - a sudden reversal may well be believed to be imminent. Traders would usually tend to be wary of such price paths, but there is naturally a temptation to remain in the market for as long as possible during a pronounced trend in order to let the profits run.

Triangles: If reversals assume a pattern, whereby (say) an up trend reverses by the price tracing out a succession of diminishing peaks and troughs, it would be termed a triangle. Triangular chart formations will be discussed in more detail in the next section as they are more usually identified by chartists in mid-trend as continuation patterns.

Price Gaps and Reversals: If there are price 'gaps' in the price path, chartists assert that the path is probably unsustainable. A gap on a price chart is a range over which no trading has taken place: the low of the day is above the previous day's high, or the day's high is below the previous day's low. Chartists distinguish four types of gap:

(i) The Common Gap: This is held to be the least significant type of gap, appearing within a trading range, and is interpreted as being indicative of lack of interest in thinly traded markets. Such gaps are generally ignored by chartists.

(ii) The Breakaway Gap: If the price suddenly surges out of a trading range, leaving an area where no trading activity has taken place, it is termed a breakaway gap. If they are accompanied by heavy volume, they are asserted to be among the most reliable chart signals.

(iii) The Runaway (or Measuring) Gap: Usually cited in strong up or down trends, runaway gaps occur when the price movement accelerates and leaps forward. In an uptrend such a gap would be taken as a sign of strength, in a downtrend a sign of weakness.

(iv) The Exhaustion Gap: The so-called exhaustion gap precedes a trend reversal, occurring near the end of a market move. Its use is largely descriptive - even chartists say that the best way of distinguishing a runaway gap from a exhaustion gap is hindsight.

If the charted price movement of a trend reversal is flanked by gaps on either side, the resulting the pattern is the island reversal - a pattern which is believed often to signal major trend transitions, and as such, will tend to carry much weight in chartist analysis.

Having seen the major classifications of chart reversal patterns, the next section considers those formations which instead suggest trend continuation.

2.4.3: Continuation Patterns

Continuation patterns are generally identified by chartists within long-term trends, and the patterns themselves are said to tend to materialise over a much shorter time horizon than the foregoing reversal patterns (Murphy 1986). One of the most common type of continuation patterns is that of the triangle.

Triangles: There are three basic classifications of triangle: symmetric, ascending and descending, their text-book formation is shown in Chart 2.13. Symmetric triangles (Chart 2.13a) can be outlined by two converging trend lines. The point at which these lines would cross if extended is termed the apex, and the full vertical height of the pattern is called the base. Ascending triangles consist of a rising trendline and a horizontal upper line (Chart 2.13b) descending triangles similarly consist of price movement enclosed by a down trendline and a horizontal lower line.

The crucial aspect of triangles is held to be the direction of breakout of the price line from the pattern. As triangles are usually identified as continuation patterns, the breakout would therefore tend to be in the direction of the prevailing trend. (Chartists do, however, point to occasions where reversals assumed a triangular formation.) The general "rule" though is that an ascending triangle is a bullish indicator, a descending triangle a bearish sign, and that a symmetric triangle will probably 'breakout' in the direction of the prevailing trend.

Looking at Chart 2.13a, the 'minimum requirement' for any valid triangle is four reversal points, although six points as illustrated are more usual. Note that six reversal points give the five wave advances of an Elliott wave - see Section 2.2.2.2.

Another chartist pattern, the diamond is a combination of two triangles back-to-back, although this is more commonly cited as a reversal pattern at market tops.

Most triangle and triangle-based formations tend to last for perhaps a few months. The class of much shorter term patterns assuming a similar appearance are referred to as flags and pennants.

Flags and Pennants: These are held to be particularly common patterns, but of only short duration, lasting for periods of up to 2-3 weeks within trend phases. The price movements for both are similar, the distinction drawn being that a flag can be enclosed by parallel lines while a pennant is price movement within converging lines. See Chart 2.14.

A feature of both patterns is that they are supposed to point in opposite directions to the prevailing trend, and develop noticeably quicker during a down trend. Flags and pennants are attached to a so-called 'flag-pole', in the form of a sharp decline or advance before the pattern develops. In a classical 'textbook' formation, the sharp preceding move would take place on very heavy volume, which would subsequently decline as the pattern develops. Then, once the flag or pennant is complete, the trend would be expected to resume in a new flurry of trading activity. It is at the point of the breakout from the formation at which chart-based dealers would often take positions in the direction of the prevailing trend.

Continuation Head and Shoulders: While the head and shoulders is probably regarded by chartists as the most reliable reversal pattern, occurrences of it have been pointed to in mid-trend. However, while the pattern may be recognised under such circumstances, its forecasting value would naturally be markedly inferior to its reversal counterpart.

The Wedge: The so-called 'wedge' continuation is very similar to the triangle in both appearance and duration. However, the distinguishing feature of this formation is that the two covering lines which enclose the price movement lie on a marked slant, as illustrated in Chart 2.15a. Wedges, like pennants, slant against the prevailing trend - hence a falling wedge is considered to be bullish, and a rising wedge bearish. This bull/bear guidance is their main application to trading, and positions would probably be taken accordingly once an analyst believes the onset of a wedge has been identified. Generally, chartists would expect that the price line would move about two-thirds of the way towards the apex before breaking out to continue the trend. Like other continuation patterns, volume is ideally supposed to diminish as the pattern develops and the formation ought to take shape quicker in a down trend.

The Rectangle: As its name suggests, a rectangle is interpreted as a pause in the trend during which the price moves between two parallel horizontal lines. Chart 2.15b shows an example of a bullish rectangle in an up trend. The price movements are akin to a trading range, but of shorter duration. A close markedly outside the rectangle is usually interpreted as indicating the direction of the ensuing trend - so although the rectangle is generally cited as a typical manifestation of a continuation pattern, the chartist would not rule out a reversal.

Trading approaches to rectangles will differ between analysts. Some may try to avoid what they consider to be a trendless market altogether, while others may assume the rectangle will be a continuation pattern and take say, long positions near the lower end of the price band in an up trend.

2.4.4: Concluding comments on pattern recognition

This completes a description and categorisation of the main chart patterns which chartist analysts claim to be able to identify in financial price series. Economists firmly wedded to fundamentalist explanations of market behaviour will no doubt remain sceptical of these. However, a possible rationalisation would be that the 'long and variable lags' inherent in the economic system, together with ignorance of the 'true model', means that perhaps the best that can be done, at least over the short to medium term, is to identify regular patterns which are seen to occur in the data, without concern over their justification. This 'black box' rationalisation is again reminiscent of the justification often given for using 'black box' statistical techniques, such as the Box-Jenkins methodology. An empirical comparison of a set of chartist forecasts and the Box-Jenkins approach is included in Chapter 5, Section 5.6.3.

At least one problem with pattern recognitions however, 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 went to supplement pattern recognition with other, less ambiguous indicators. It is here that mechanical indicators play a role.

2.5: Mechanical trading rules

Whereas chartist pattern identification is largely subjective and open to individual interpretation, the various chartist mechanical trading rules or systems can be used to generate precise signals.

This might suggest that the use of mechanical systems would to some extent counterbalance the subjective element of pattern-based trading and thereby produce a more consistent approach - while chartists may disagree over pattern formations, mechanical signals 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. Hence even if a mechanical system alone is used, the results are prone to be user-dependent.

The following discussion of mechanical trading rules is divided broadly into trend following and non-trend following systems. Moving averages and breakout systems are the two most widely used methods in the former category, to which can be applied various additional confirmation ('filter') rules. The major non-trend following systems are brought together under the heading of 'overbought and oversold indicators', which includes an analysis of the classes of momentum, oscillator and rate of change indicators. To each mechanical system numerous alterations could be made and hybrid indicators constructed: but the aim of this section is to explain the core methods used by technical traders.(11)

2.5.1: Trend Following Systems

2.5.1.1: Moving Averages

Most mechanical trading schemes rely on some form of moving average system. The basic form of moving average is constructed by taking the average of the previous N period's prices. Several variations in this construction are possible, though a standard interpretation of them appears to be adopted.

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(11) Recent academic work in economics (Schulmeister, 1988) has assessed the performance of various combinations of mechanical trading rules. This work is discussed in Chapter 3, section 3.4.4.

The closing price is most commonly used in the calculation of a moving average, as it is generally held by chartist to be the most important price of the day. Edwards and Magee (1966, p8) describe it as, "...the final evaluation...made by the market during the day...the figure upon which the majority of prospective traders base their plans for the following day. Hence its technical significance...". Some technicians, however, may instead use the midpoint of the day's range, while others use the average of the high, low and closing price.

Another issue is the placement of the moving average. The statistically correct way to indicate a trend with a moving average is to centre it, by plotting it in the middle of the time period to which it refers, thus a thirteen day moving average would be plotted seven days back. Moving averages used for day-to-day trading purposes by chartists, however, are almost invariably plotted on the final day of the period, so in effect the latest price is being compared with the value some period earlier.

Because of various perceived shortcomings of a simple moving average, namely the time lag before turning points are indicated, the fact it is unweighted and that only the period covered by the average is taken into account, various weighting systems are sometimes used by chartists.

By using a linear weighting, greater importance can be given to more recent observations. While the linearly weighted moving average can be seen to lead a simple moving average, thus alleviating the time lag problem, it does not overcome the difficulty of accounting for only a limited length of price movements. Alternatively, by using an exponentially weighted moving average, it is possible to include all available price data in the calculation, but still to assign greater weight to more recent observations. Despite these more complex systems, a simple moving average appears to be the most widely used form.

The decision of what length of moving average system to use is held to be particularly important as short or long term averages can give very different signals. Long term moving averages are held by chartists to be most effective in a trending market, as being less sensitive to minor movements, they will follow the direction of the trend and probably give less false signals (whipsaws) than a shorter average. Looking at the moving averages on Chart 2.3a and 2.3b shows how the longer (40 or 50 day) moving averages follow the trend better compared with the shorter (10 or 20) day averages, keeping the trader on the right side of the market with few whipsaws throughout the trending phases.

It has been suggested in the chartist literature (see eg Pring 1985) that Fibonacci numbers can be useful in moving average analysis. Many of the timespans commonly used by chartists are in fact numbers in the Fibonacci series. For example, the 21 day moving average is a standard calculation for daily charts, while the 13 week average is widely used in stocks and commodity charts.

When prices are in a sideways (trendless) trading range, a short term moving average is widely believed to be more effective. By indicating minor price movements, it will give more frequent and earlier signals than its longer term counterpart. As illustrated in Chart 2.3b, because the length of the longer 50 day average exceeds any minor 'cycles' during the sideways price movement (around June-September 1989), it provides virtually no information, following a straight line through the period. Yet while the higher sensitivity of the short term 20 day moving average can capture minor turning points in the trendless market of Chart 2.3, it is prone to give less clear movements and whipsaws in the later trending market.

Clearly, choice of time span affects the type of information conveyed. The 'optimal' length varies between individual chartists and individual markets, but the argument that longer term moving averages are most useful in trending markets while shorter term averages provide early information on trend

reversals and minor cycles appears to be a generally accepted principle among technical analysts. Most technical analysts will in fact use more than one length of average, drawing on the perceived advantages of each.

2.5.1.2: Trading signal generation from moving averages

Single moving average: By plotting a single moving average on a bar chart, buy and sell signals are generated when the average crosses the price line. A buy signal would be generated when the closing price moves above the moving average, while the price moving below the average would give a sell signal. Both situations can be seen from Charts 2.3a and 2.3b. While the signal is usually taken to be given when the closing price crosses the moving average line, some technicians advocate that the moving average line itself should turn in the direction of the price line for extra confirmation.

Multiple moving averages: Two moving averages of different time spans can be used to generate signals, via the double crossover method.(12) A buy signal would occur when the shorter average cuts the longer from below, and a sell signal would be generated when the shorter average moves below the longer, situations occurring in Charts 2.3a and 2.3b. Widely used combinations are 5 and 20 day averages, 10 and 40 day averages and, for major movements, 10 and 30 week averages.

There are several variations and additions to this standard cross-over method, all of which attempt to look for further confirmation of the buy/sell signals. One commonly cited confirmation caveat is that major trends are assumed not to have reversed until both lines are moving in the same direction. The use of additional rules, such as the filter rules discussed below, are intended to improve the performance of moving average systems, largely by reducing the number of whipsaws which inevitably occur.

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(12) The double cross-over method is a generalisation of single moving average signal generation, as the price line in the latter can be regarded as a 'one-period moving average'

It is also possible to use three moving averages to generate signals, in a similar fashion to the double crossover method. As shorter moving averages follow the price line more closely than longer moving averages, it follows that there should be, at least during trending phases, a predictable alignment of the multiple averages. For example, during a bull market the shortest average would be above the medium average, which would be above the longest. The most common choice of timespan for a triple moving average, and that generally used by the commercial chart services, is 4-9-18 days. Hence a buy signal would be anticipated during a down trend when the 4 day line crosses above both the 9 and 18 line. The signal would be confirmed when the 9 day line crosses above the 18, thus giving the 4-9-18 ordering expected in an uptrend. Conversely, a definite buy signal would not be given until first, the 4 day line crosses below the 9 and 18, followed by the 9 crossing below the 18.

However, in terms of the various types of moving averages discussed above, some chartist studies have shown that, despite the theoretical advantages of more complex calculations, a combination of two simple moving averages often proves to be the most effective tool (see eg Hochheimer 1980), and indeed appears the most widely used among practising chartists.

The perceived advantages and disadvantages of moving average systems are largely common to all trend following systems. The other major type of trend following system is the 'breakout', described in the next section - which is followed by an appraisal and possible modifications applicable to such systems.

2.5.1.3: Breakout systems

Breakout systems are also known by various other names - such as price channels and weekly rules. Like moving averages, there are many variations on their central theme but they all operate on the principle that market

movement to a significant new high or low is indicative of there being sufficient potential to continue the trend in the direction of the breakout.

The Four-Week Rule: The four week rule was found by Dunn and Hargitt (1970) to be the most successful of an array of mechanical systems available at that time. It is based on the following rules (applied to the spot market):

1 Buy (go long) whenever the price exceeds the highs of the previous four full calendar weeks.

2 Sell (go short) whenever the price falls below the lows of the previous four full calendar weeks.

A whole array of modifications has been applied to such systems. For example, the general rule above has the disadvantage that it is 'continuous', ie the trader always has a position, so is exposed to whipsawing during trendless phases. Attempts can be made to reduce this hazard by modifying the system so as to make it non-continuous. This can be done by using a shorter breakout rule (perhaps a two-week rule) for liquidation purposes. So while the initiation of a new position would require a four-week breakout, the position would be liquidated if there were to be a two-week signal in the opposite direction. According to the rule, the trader would then only enter the market again at the signal of a new four-week breakout.

The length of such breakout rules is usually adapted for individual markets (so-called 'optimisation'). The length used will generally dictate the sensitivity of the system, in the same way that the choice of length of a moving average will involve a trade-off between rapid recognition of valid turning points and unwanted whipsaw effects.

2.5.1.4: Trend following systems and filter rules

Both moving average and breakout systems are trend following in construction, and as such are perceived to display similar advantages and disadvantages. They tend to let profits run while cutting losses short - thus following one of the oldest maxims of trading. However, they are reactive by construction, inevitably signalling with a lag. The user of trend following systems faces the trade-off between excessive false signals and speed of response to turning points - hence the popularity of the double crossover moving average which utilises the features of both long and short term measurement. Finally, all trend following systems work best in trending markets - during periods of sideways movement they are especially prone to generate false signals. Most modifications to trend following systems impose additional confirmation requirements upon signals, in order to reduce this endemic whipsaw problem.

Filter rules impose screening conditions which aim to eliminate trades which have a low probability of success. Some possible filtering mechanisms which can be imposed on mechanical signalling systems are described below:

(i) Using a fundamental model to confirm technical signals could act as a filter by clarifying the market direction. The buy and sell signals would only be acted upon if the economic model confirmed the direction of the trend.

(ii) As well as requiring the single moving average (say) to cross the price line in order to generate a buy/sell signal, a filter may require that the entire day's price action clear the average.

(iii) A crossover signal may also be required to achieve some kind of breakout on the chart - this is clearly a more stringent requirement than normal, so will generate stronger (albeit less frequent) signals.

(iv) A time delay could be imposed before acting on signals. While this would mean that false signals could be largley avoided as they tend to reverse themselves very quickly, the imposition of a time filter entails the penalty of late market entry in response to genuine signals.

Clearly all such modifications will give more and more scope for variety in chartist analysis. While the imposition of filter rules such as (i) seem to negate the pure chartist principle, the suggestion of such a combined approach does seem to accord with the complementary approach to charts and fundamentals which is apparent in practice (see results of survey in Chapter 4).

2.5.2: Non-trend following rules

2.5.2.1: Overbought and oversold indicators

There exists a large class of indicators which differ from trend following systems in that they are designed to attempt to anticipate rather than simply to lag changes in price movements. By using them chartists hope to warn of strengths or weaknesses in price movements before the ultimate peaks or troughs, and provide more useful information in sideways markets than do simple trend following systems.

A plethora of overlapping terminology surrounds these indicators. They are here drawn together under the general heading of 'overbought and oversold indicators', which encompasses the class of indicators which might broadly be termed 'oscillator', 'rate of change' or 'difference' analysis. As an introduction to the type of indicators, the basic rate of change oscillator is described.

Rate of Change (ROC): One of the basic oscillator formulations is a simple rate of change formula, using the ratio of the most recent closing price to that of k days ago:

$$ROC(K) = \frac{P_t}{P_{t-k}} * 100$$

(For presentational purposes, this series is sometimes plotted as ROC(k)-100 to give a centre-line of zero). The ROC line is interpreted by chartists as a momentum indicator: a rising ROC index would imply growth in momentum - a bullish factor, while a falling index would point to a loss of momentum and a bear market. An ROC indicator is plotted on Chart 2.3b.

The concept of momentum underlies overbought and oversold analysis, as the subject is concerned with the change in prices rather than the price levels themselves. This analysis, however, is regarded by most chart analysts as secondary to trend analysis in that trades should never be made against an overriding market trend (Murphy 1986). There are many different ways in which momentum oscillators are constructed, but their interpretation is broadly similar. The oscillator is usually plotted along the bottom of price charts and would be used to support and highlight the signals in the price line - as in Chart 2.3b.

Overbought and oversold indicators of all kinds move within a fairly flat band, and extreme values, either upper or lower, are usually taken to be a warning that the price is too high or too low to be sustained and that the market is due for a correction. While oscillators are essentially used as a tool to supplement other technical indicators, they can be used to generate specific buy and sell signals.

The general overbought/oversold trading rule would be based on the crossing of the zero line:

1 Buy when the oscillator moves above the zero line.
2 Sell when the oscillator moves below the zero line.

- with the caveat that trades should only be made in the direction of the prevailing market trend.

As well as the ROC indicator described above, several other types of overbought and oversold indicators will illustrate the principle.

Momentum Line: A standard momentum line is constructed by subtracting the closing price of k days ago from the last closing price:

$$M(k) = P_t - P_{t-k}$$

The resulting positive or negative figure is then plotted around a zero line, in much the same way as the ROC indicator. Some divisor is often used as scaling factor, commonly P_{t-k} (which does not affect the signals generated).

$$M(k) = \frac{P_t - P_{t-k}}{P_{t-k}}$$

Moving Average Oscillator: The use of multiple moving averages to generate buy and sell signals was discussed earlier under the category of trend following systems. The same double moving average principle is used by chartists to construct oscillator charts. The usual way this is done is to plot the difference between the two averages as a histogram, the bars of which appear as a positive or negative value around a zero line. Alternatively, the percentage difference between the two averages (shorter as a percentage of longer) can be plotted.

When the lines move far apart, it is taken as an indication of a market extreme which may result in a pause or change in the trend. Thus, as well as their standard use as a trend following system, the relationship between two moving averages can be used to try to identify overbought and oversold conditions.

Relative Strength Indicator (RSI): A perceived problem of most overbought and oversold indicators is that they offer no guide to what constitutes 'extreme' values - identification of highs and lows is somewhat arbitrary. Another disadvantage is that momentum lines are prone to erratic movements, often caused when extreme values are dropped off the calculation of a difference, so that sharp movements k days ago, even when recent price movement has been relatively smooth, can cause marked shifts in the momentum line. Distortions such as these could be minimised by some smoothing process.

The Relative Strength Indicator (RSI) (Welles Wilder, 1978) is a measure designed in an attempt to overcome these problems. It incorporates a moving average to smooth the series and it assumes a constant scale of 0 to 100, thus solving the problem of measurement of upper and lower values.

The RSI is defined as:

$$RSI = 100 - \frac{100}{1 + RS}$$

$$\text{where } RS = \frac{\text{Average of previous k days' price increases}}{\text{Average of previous k days' price falls}}$$

For example, were a 14 day period to be used, the numerator of the relative strength calculation would be the total points gained on the up days, divided by 14. In a period of near unbroken up movements, the RSI would approach 100, while in the opposite situation it would approach zero. The smaller the period (k) over which the indicator is calculated, the more sensitive it is, and the wider its amplitude.

The RSI can be employed by chartists in both a subjective and a mechanical fashion. When graphed, its pattern formations might be interpreted in a similar manner to price charts - head and shoulders, triangles, pennants and so forth may in some cases be identified on the RSI line. Interactions between the price and RSI lines are also considered by chartists. For example, a serious warning of likely market reversal is taken to be the divergence of the RSI and the price line.

Moving onto a more mechanistic interpretatation, 'extreme' values of the RSI are considered to be 30 and 70 - indicating oversold and overbought conditions respectively. (These margins are often widened to 20 and 80 for RSIs calculated over shorter periods). The 30 and 70 lines of an RSI can be used to generate specific buy and sell signals. To illustrate, a value of 70 plus is thought to be a warning of overbought conditions, and the chart-based trader who saw the RSI reach the 70 level would probably anticipate selling as he would believe the market may soon peak and turn down. A crossing back below the 70 line is taken to signal the appropriate sell point. Similar principles apply to the crossing of the 30 line.

2.5.2.2: Overbought/oversold analysis and contrary opinion

Another chartist technique often linked to overbought/oversold analysis, which is used to anticipate market extremes, is the principle of contrary opinion.

Contrary opinion holds that the view of the majority is generally wrong. It follows, therefore, that a subscriber to this principle should ascertain the view of 'the majority' and then take the opposite course of action, moving in the opposite direction to the market as a whole.

Measures of contrary opinion are usually based on the recommendations published by market advisory services, thus implicitly assuming that these give a fair reflection of overall market sentiment. The results are usually presented in the form of the percentage of bullish opinion, with around 75% and 25%

being taken as indication of overbought and oversold conditions respectively. The justification for the apparent perversity of the contrary opinion doctrine lies in terms of fundamental supply and demand relationships.

For example, if market sentiment appears overwhelmingly 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.

Contrary opinion, although generally classified as a device of technical analysis, has its feet in several camps. On the one hand it has been likened to oscillator analysis in that it attempts to anticipate market extremes, but it is also a sentiment indicator, trying to reflect the psychology of the market, in assessing whether attitudes are bullish or bearish. In this respect, contrary opinion tends towards fundamentalism, as it is looking behind the pure market price movements to the reasons underlying it. Contrary opinion measures also can be looked upon as a type of mechanistic filter rule - sell at over 80%, buy at under 20% etc.

Perhaps another interesting point concerning the principle of contrary opinion is that it is almost diametrically opposed to Keynes' (1936) description of financial markets as akin to a newspaper 'beauty contest' competition in which the winner is the one who guesses what everybody else thinks everybody else is thinking (and so on).

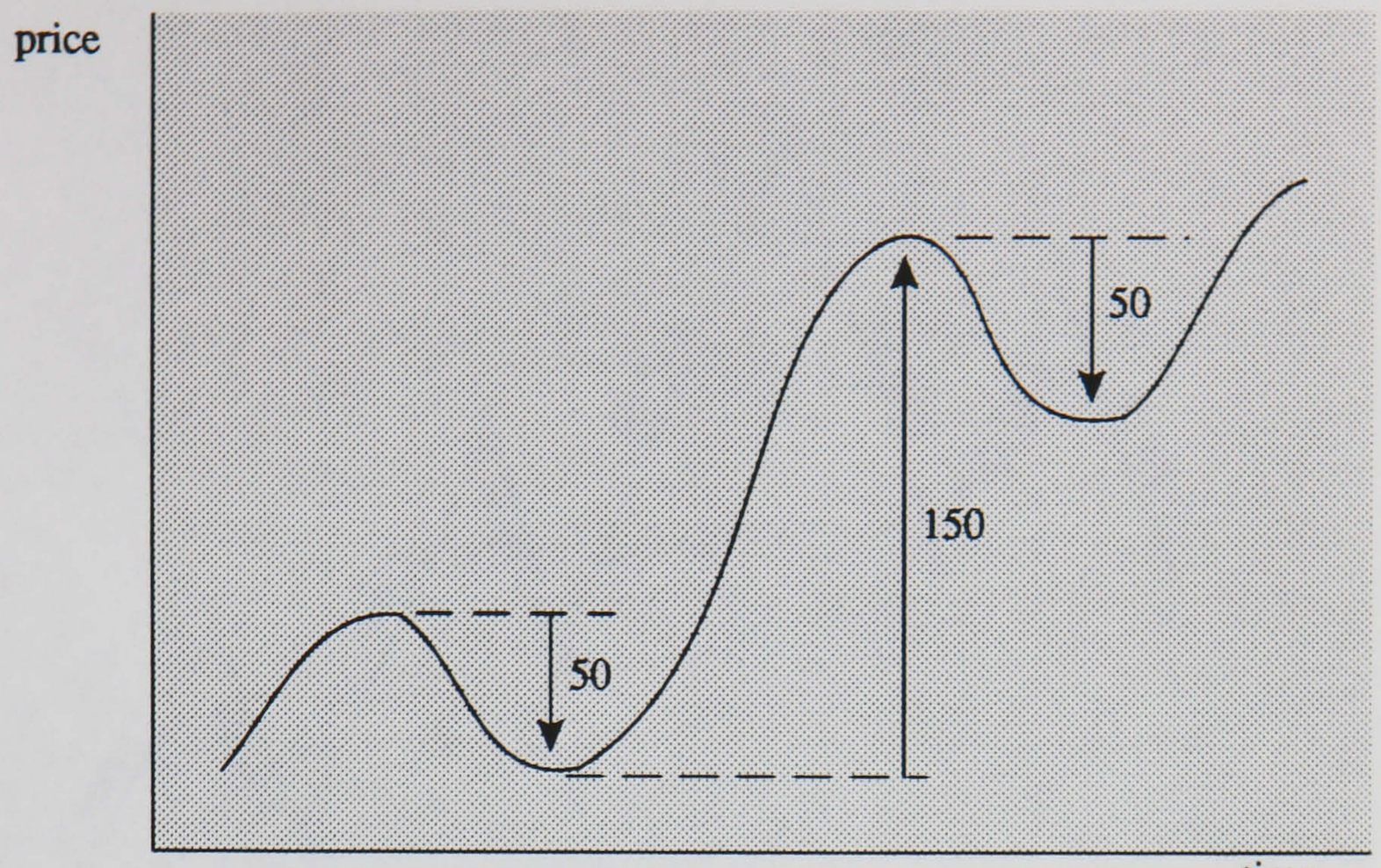
2.6: Conclusion

This completes a summary of the major techniques used by chartist analysts. Rather than attempt to summarise what is essentially a summary of chartist methods, it is perhaps appropriate at this point to consider which of the techniques outlined above are used most intensively in the financial markets. Having spoken, however, to a large number of active technical analysts, it

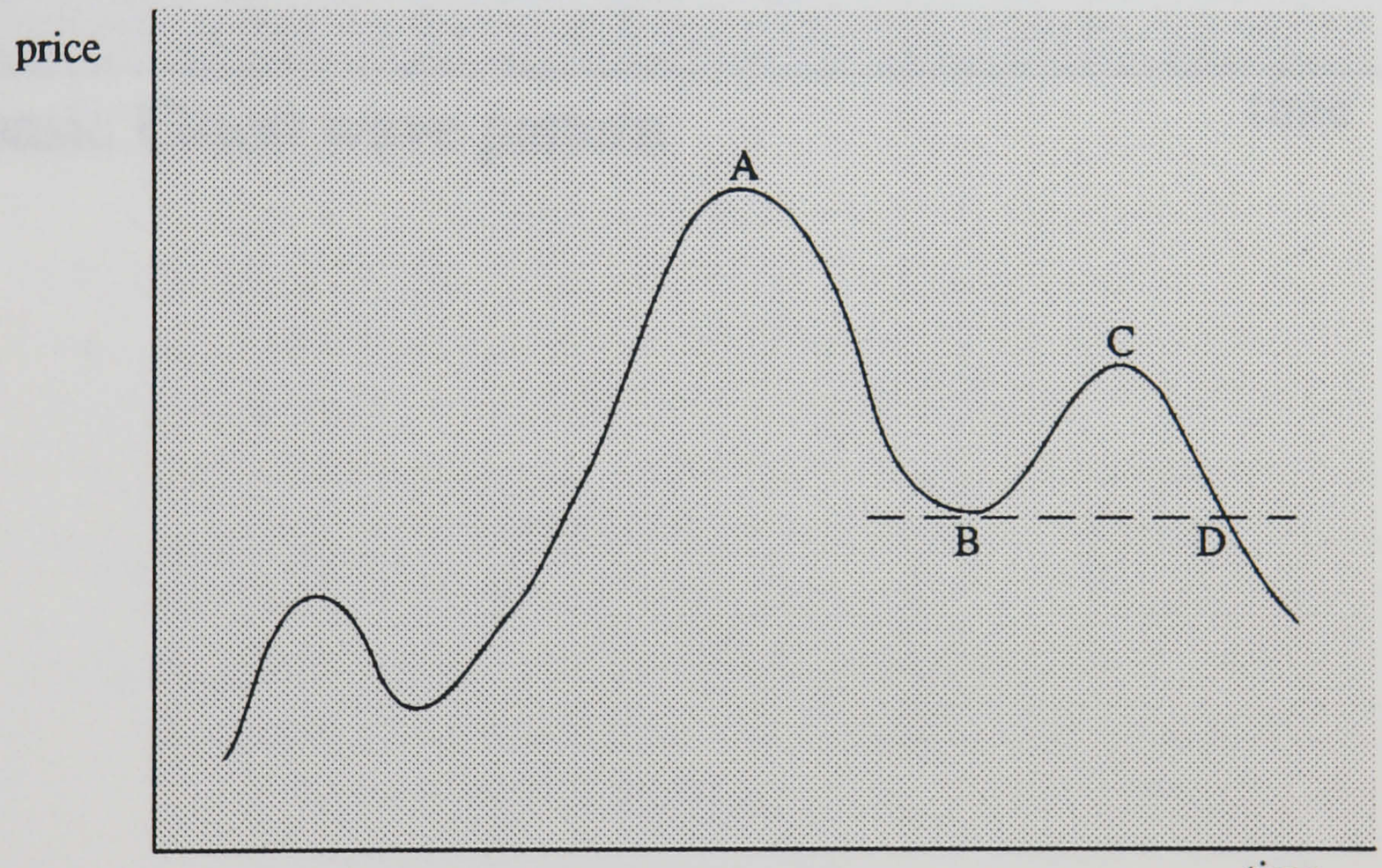
seems clear that a single chartist could not give a representative answer to this question. Apart from the fact that almost every technical analyst will have a unique approach, nearly all of the methods discussed above can be used to some extent in any particular piece of chart analysis, although individual chartists may concentrate on a particular type of analysis. Thus, an analyst might recognise a pattern in the time series, a head and shoulders formation, say, but also supplement this analysis by looking at rate of change indicators and moving averages. He might also add that, for example, the partially complete right shoulder is composed of five secondary upwaves so that, according to the Elliott principle, it should be completed by three downwaves. Hence any particular application of chart analysis will generally involve a mixture of both subjective and objective techniques to produce an overall prognosis.

Empirical evidence on the use and role of chartism in practice will be presented in Chapter 4. In the next chapter, however, the treatment of non-fundamental, chartist analysis in the academic literature is considered. While this once neglected area now seems to be gaining attention, it does also appear that little work has yet been done to examine the actual role of chartism and its genuine predictions, areas which are the concern of the rest of this thesis.

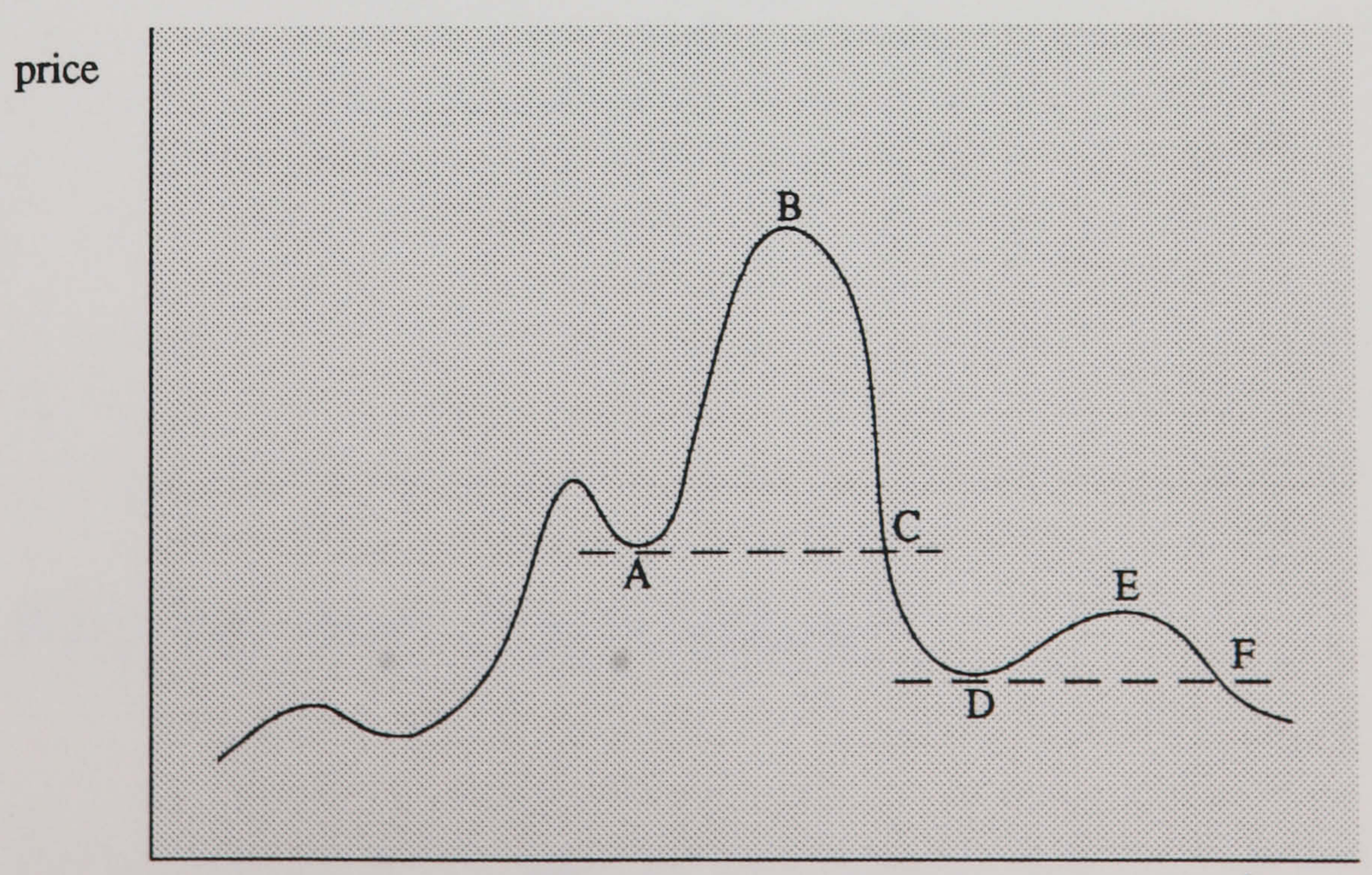
Chart 2.1: Dow theory



a) Dow theory: major bull trend

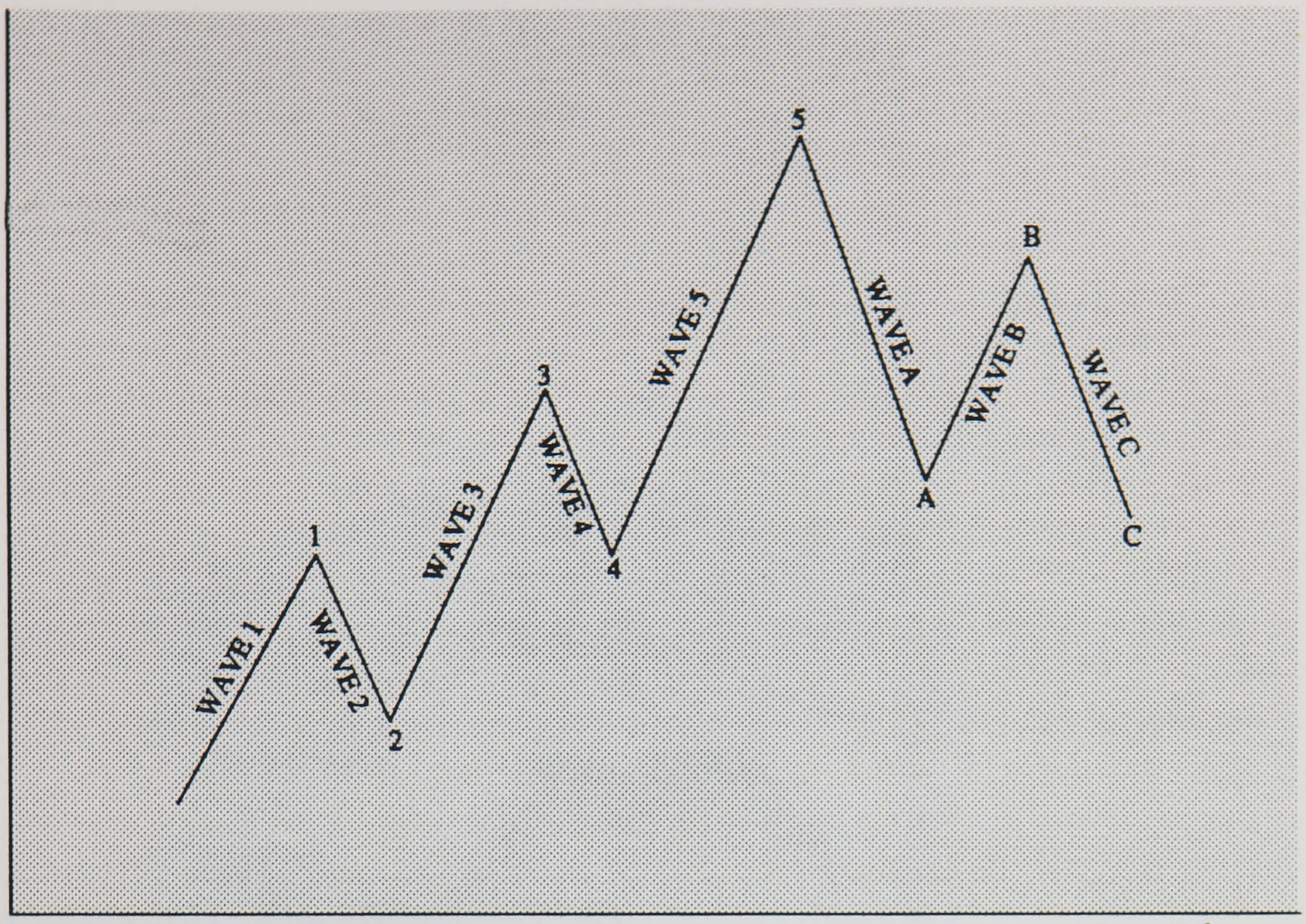


b) Dow theory: clear break in major bull trend



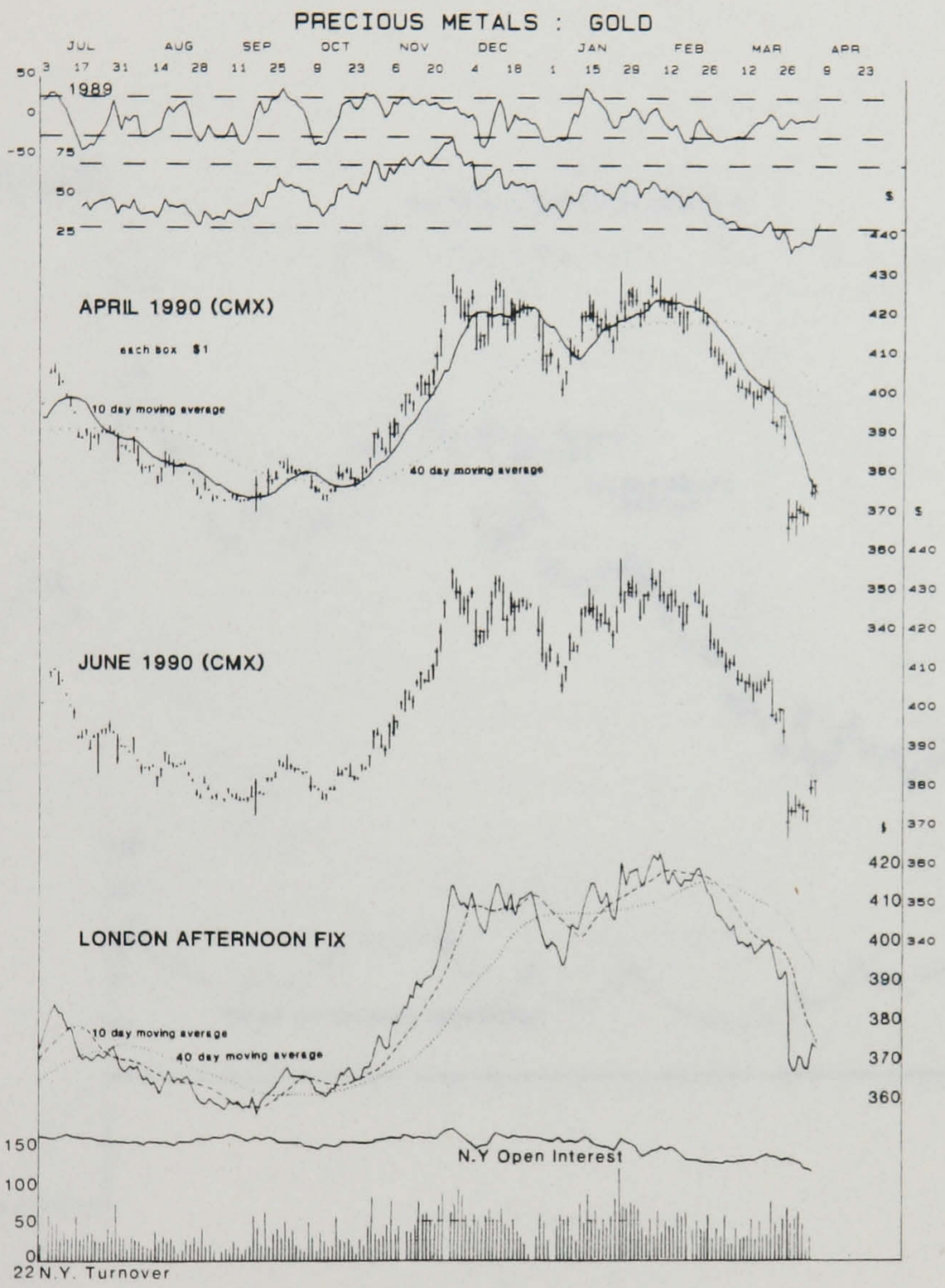
c) Dow theory: less clear break in major bull trend

Chart 2.2: The Basic Elliott Wave pattern

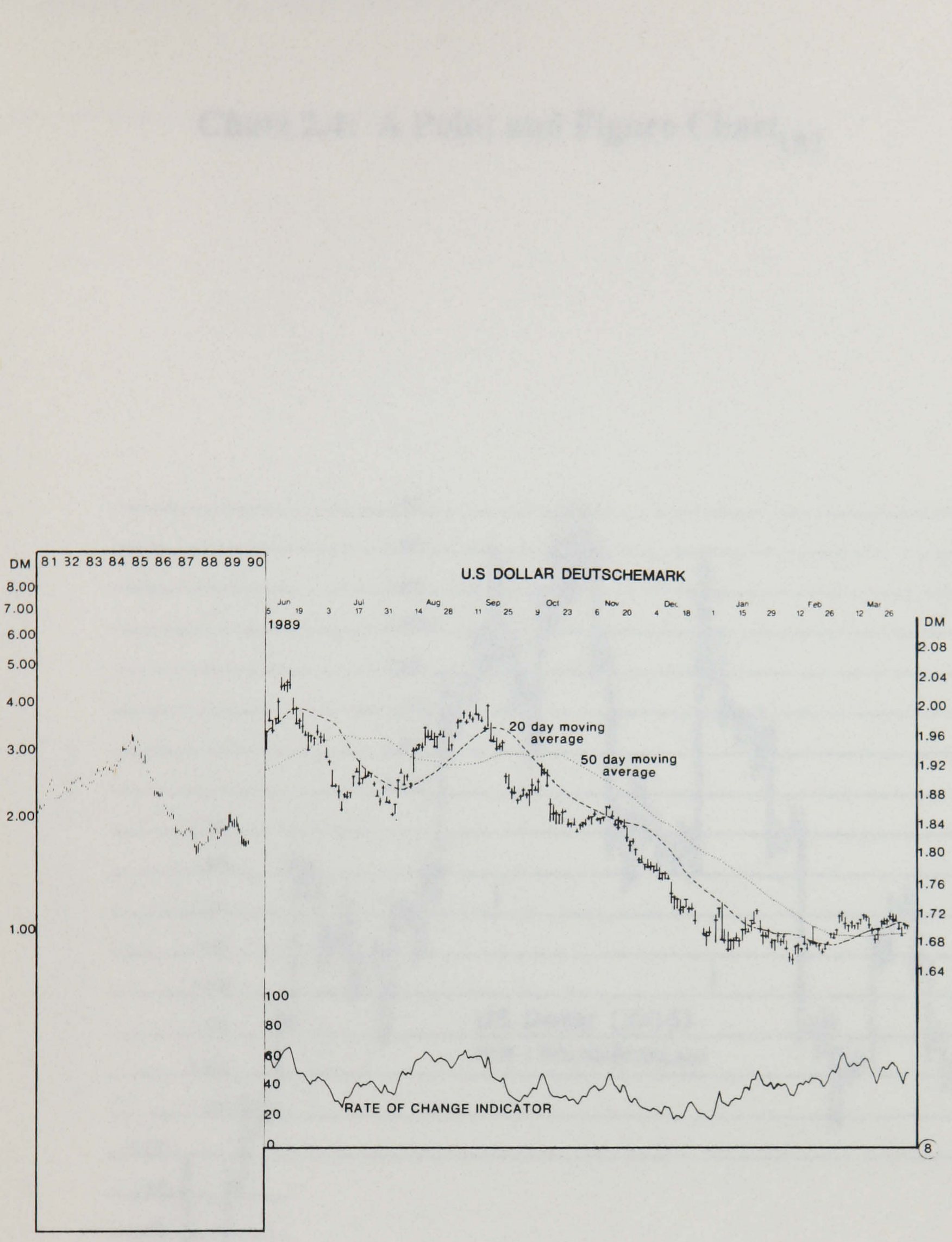


The basic Elliott wave pattern

Chart 2.3: Daily Bar Charts



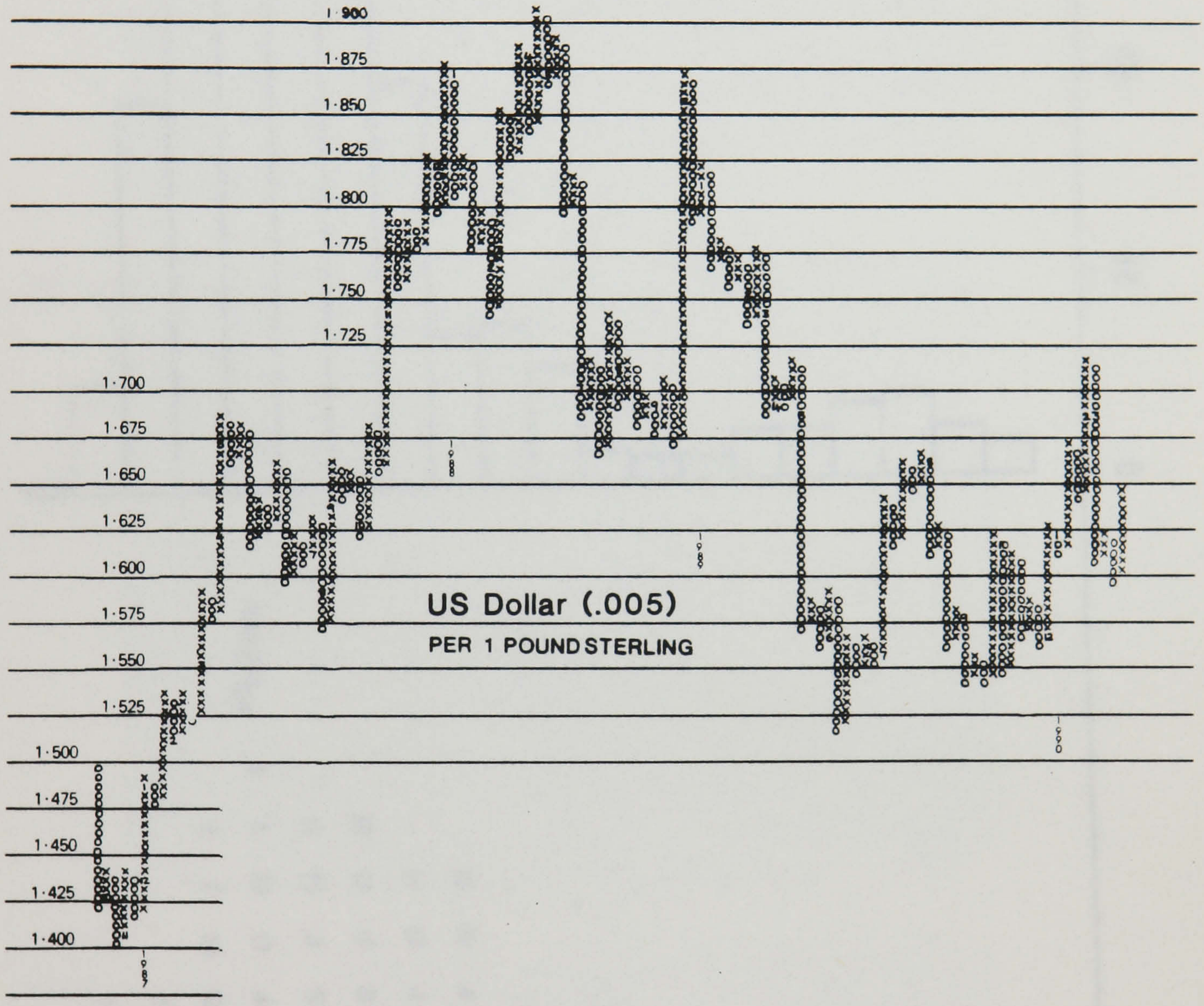
a) A daily bar chart of gold futures[a]



b) A daily bar chart of spot DM/$[a]

(a) Charts 2.3 a and b were kindly supplied by Investment Research of Cambridge.

Chart 2.4: A Point and Figure Chart(a)



(a) Chart 2.4 was kindly supplied by Chart Analysis.

Chart 2.5: A Market Profile

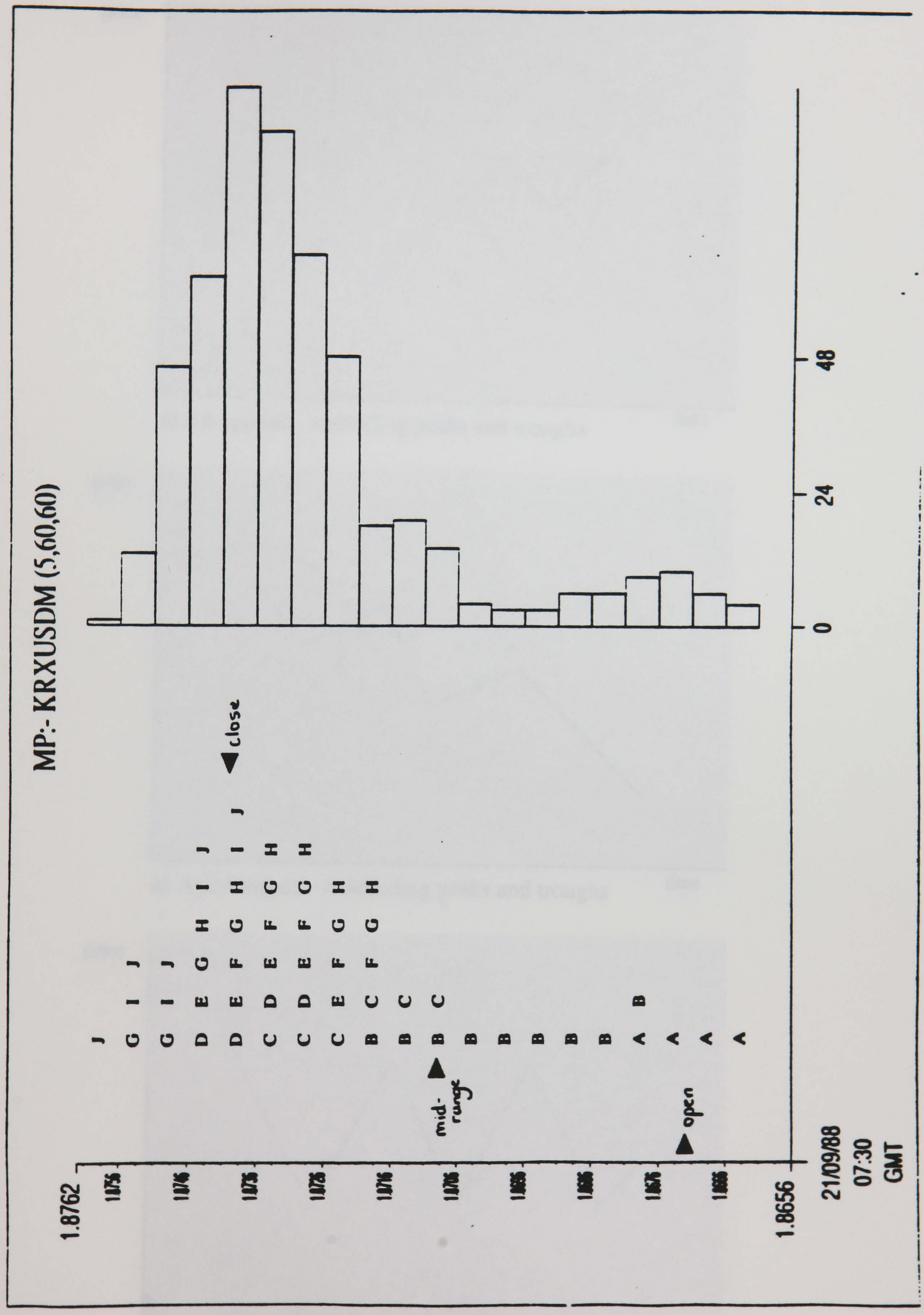
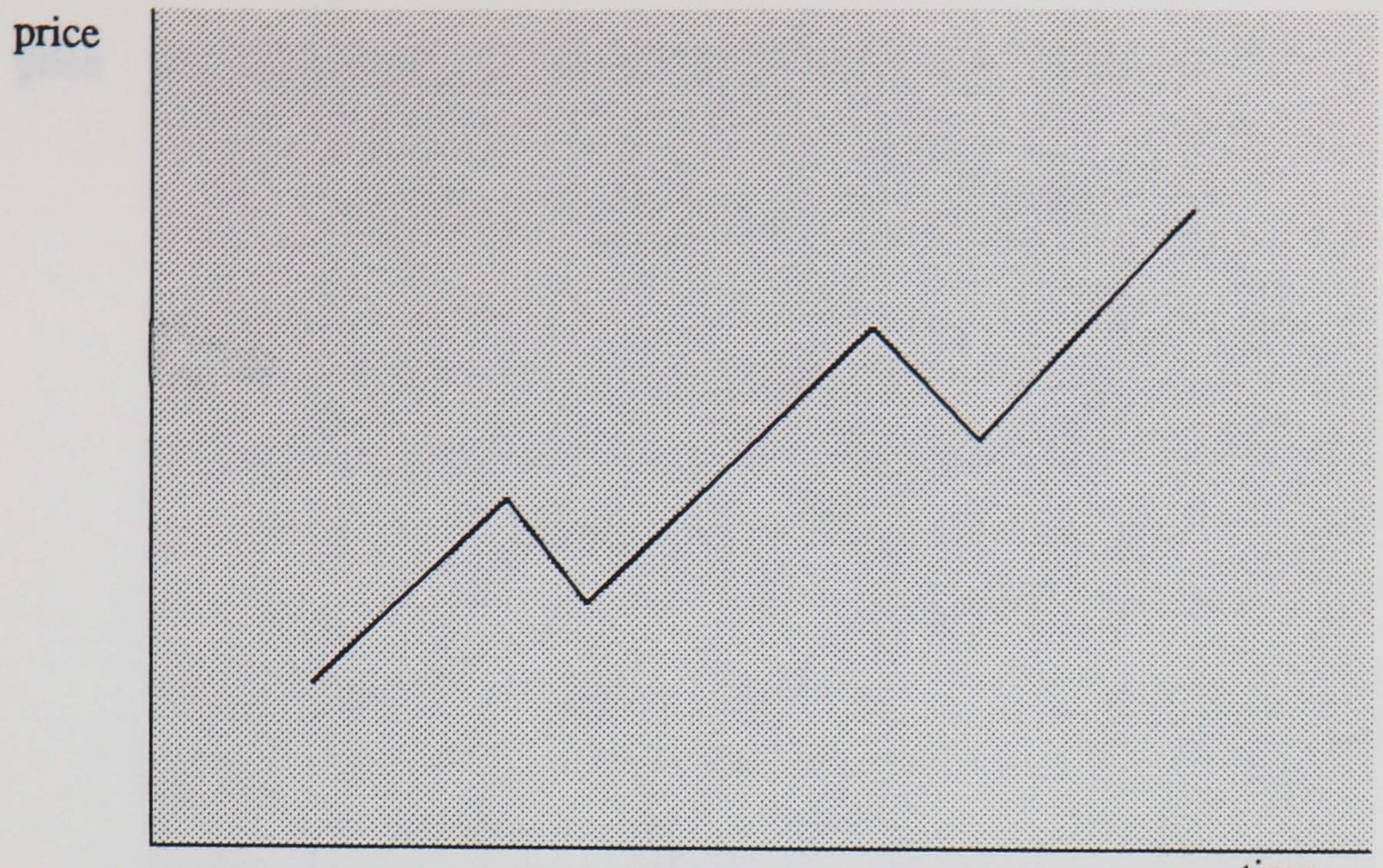
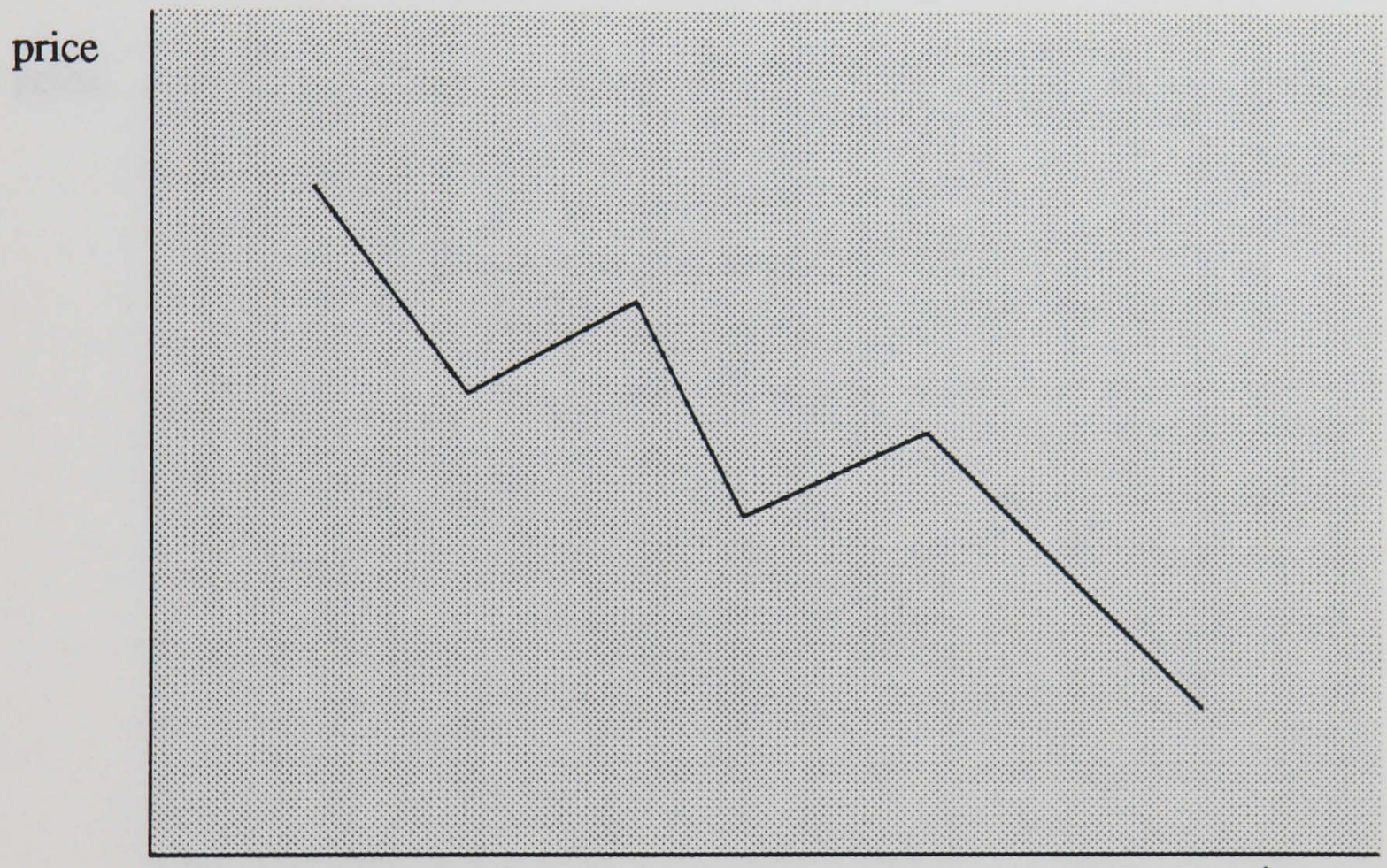


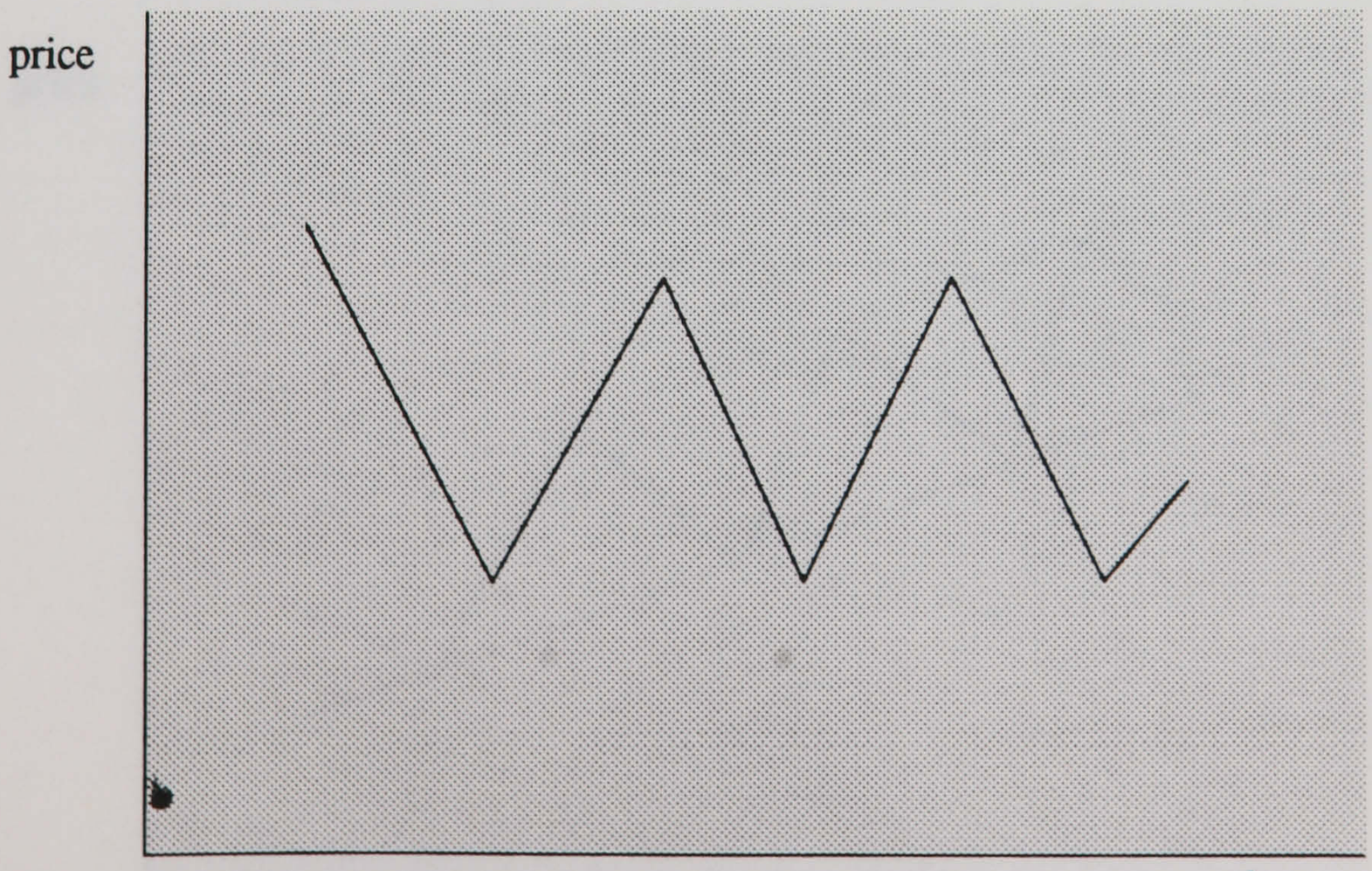
Chart 2.6: Trends



a) An uptrend - ascending peaks and troughs

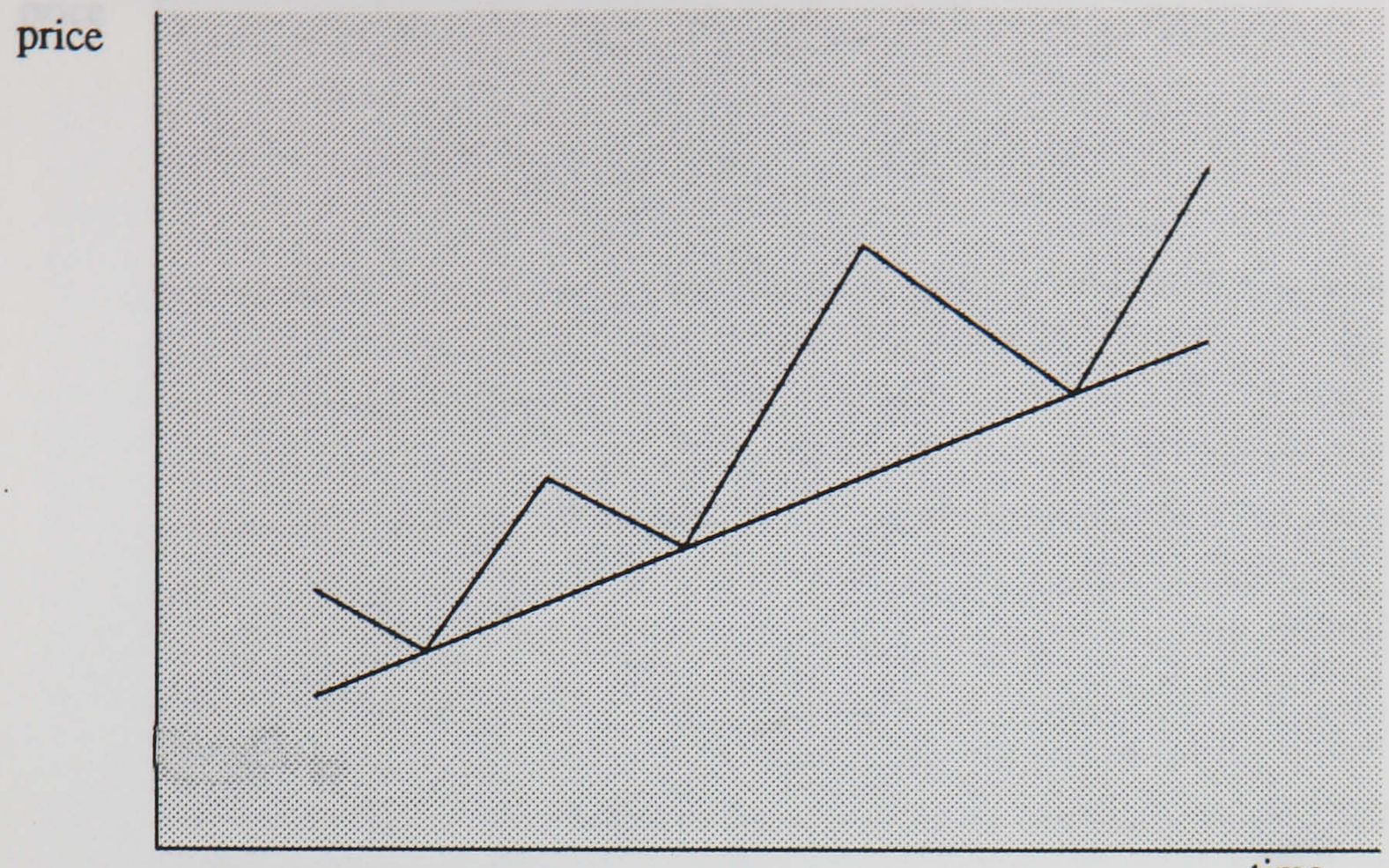


b) A downtrend - descending peaks and troughs

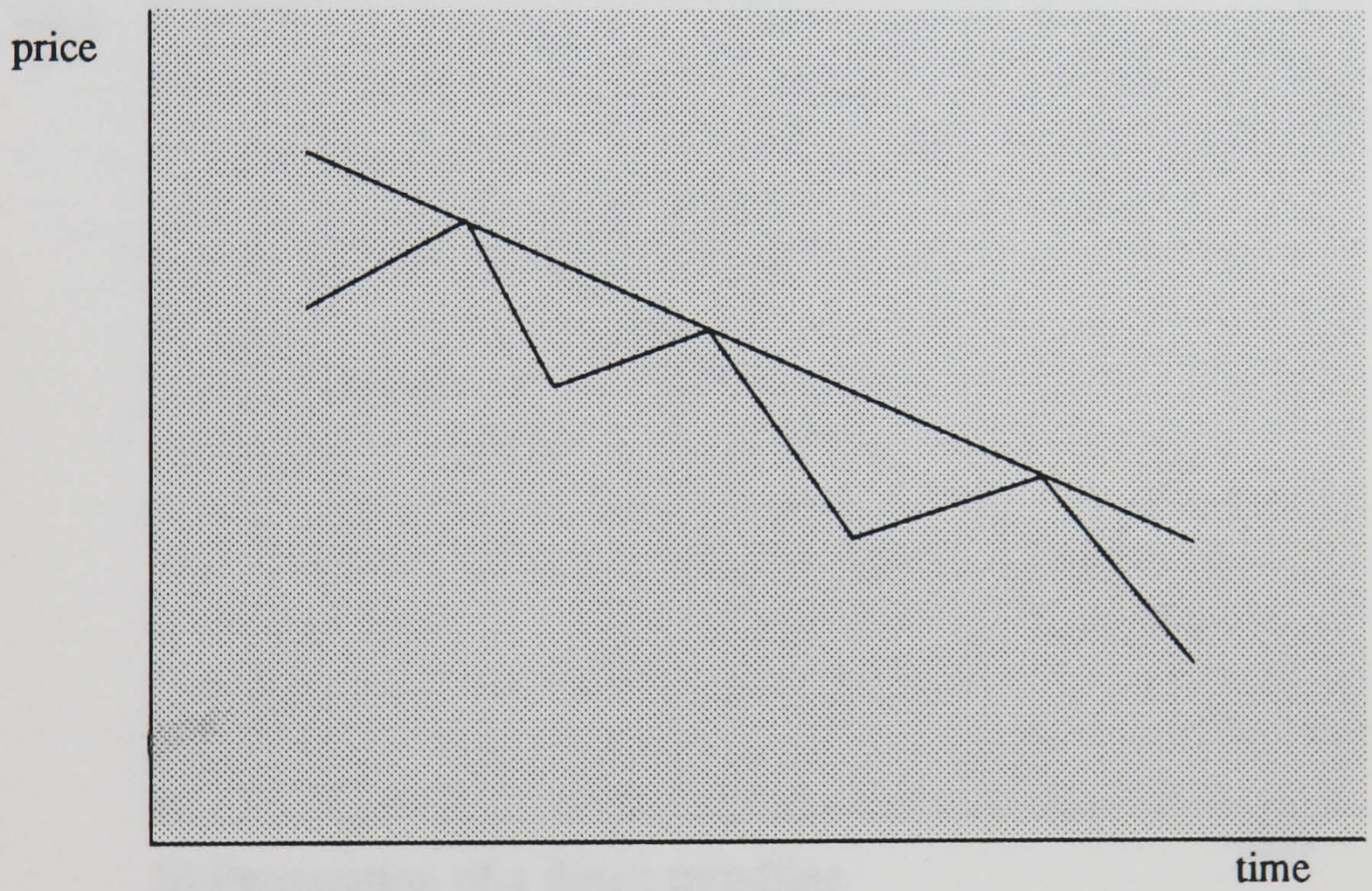


c) A sideways trend - horizontal peaks and troughs

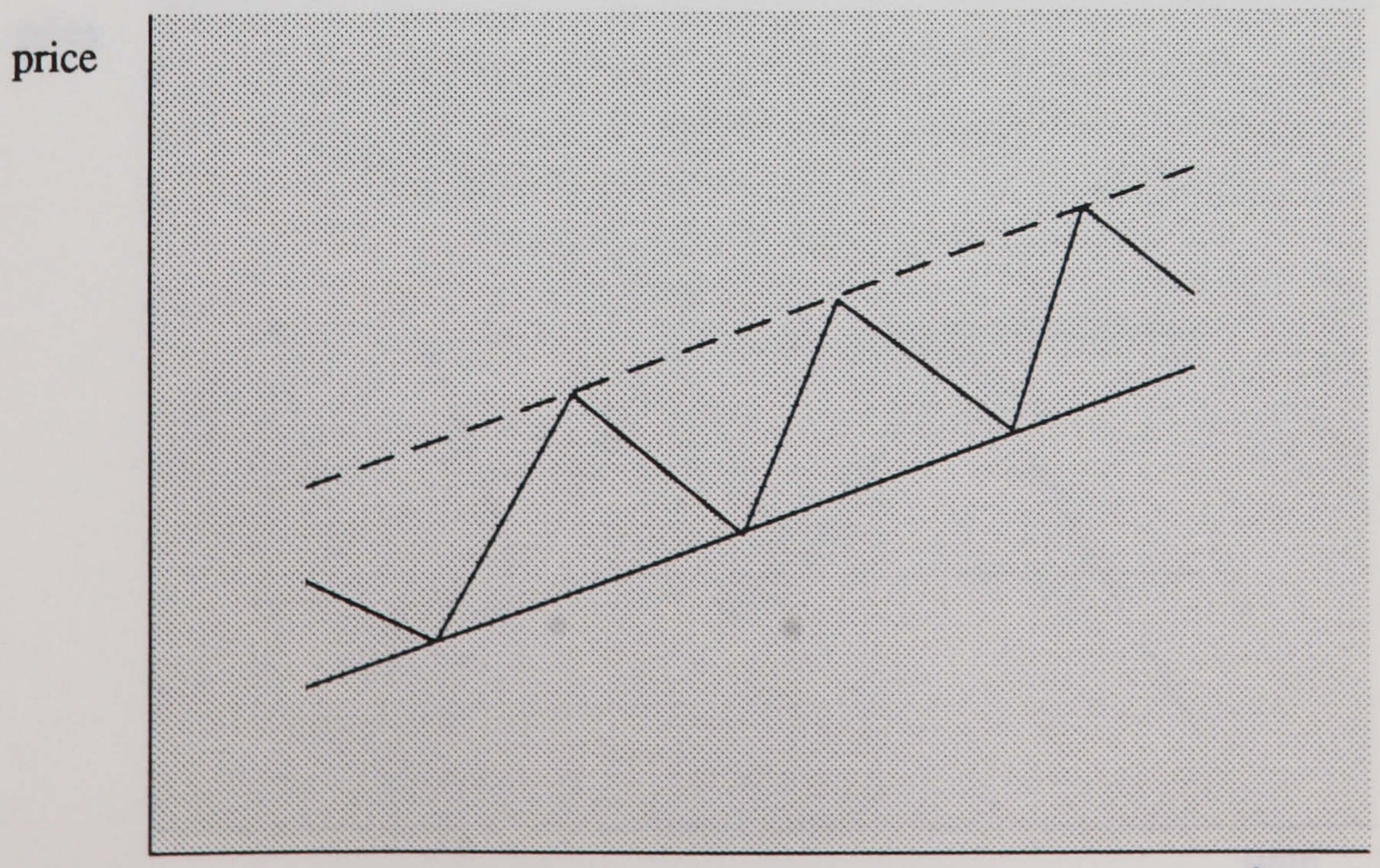
Chart 2.7: Trendlines and trend channels



a) An up trendline

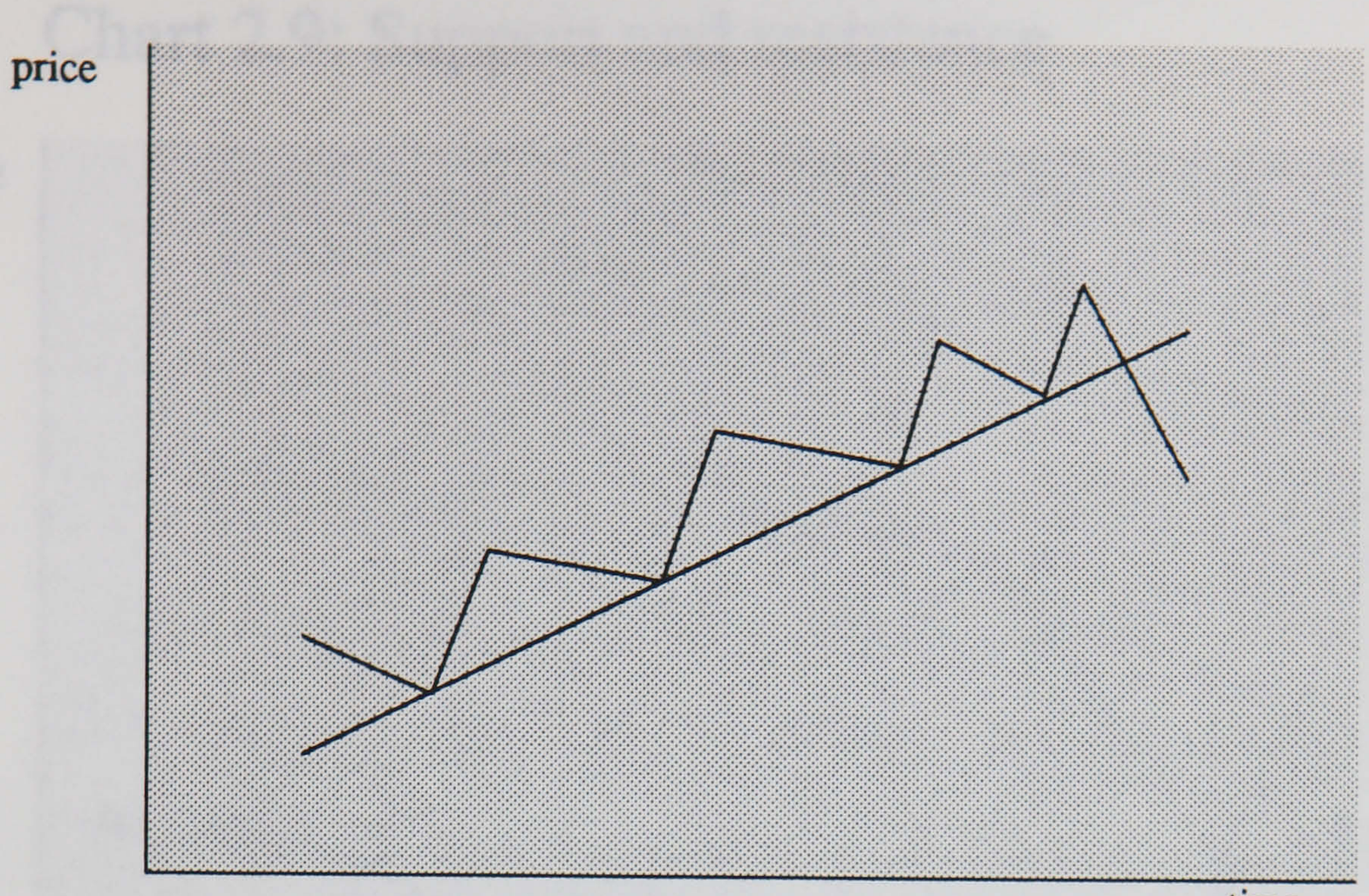


b) A down trendline

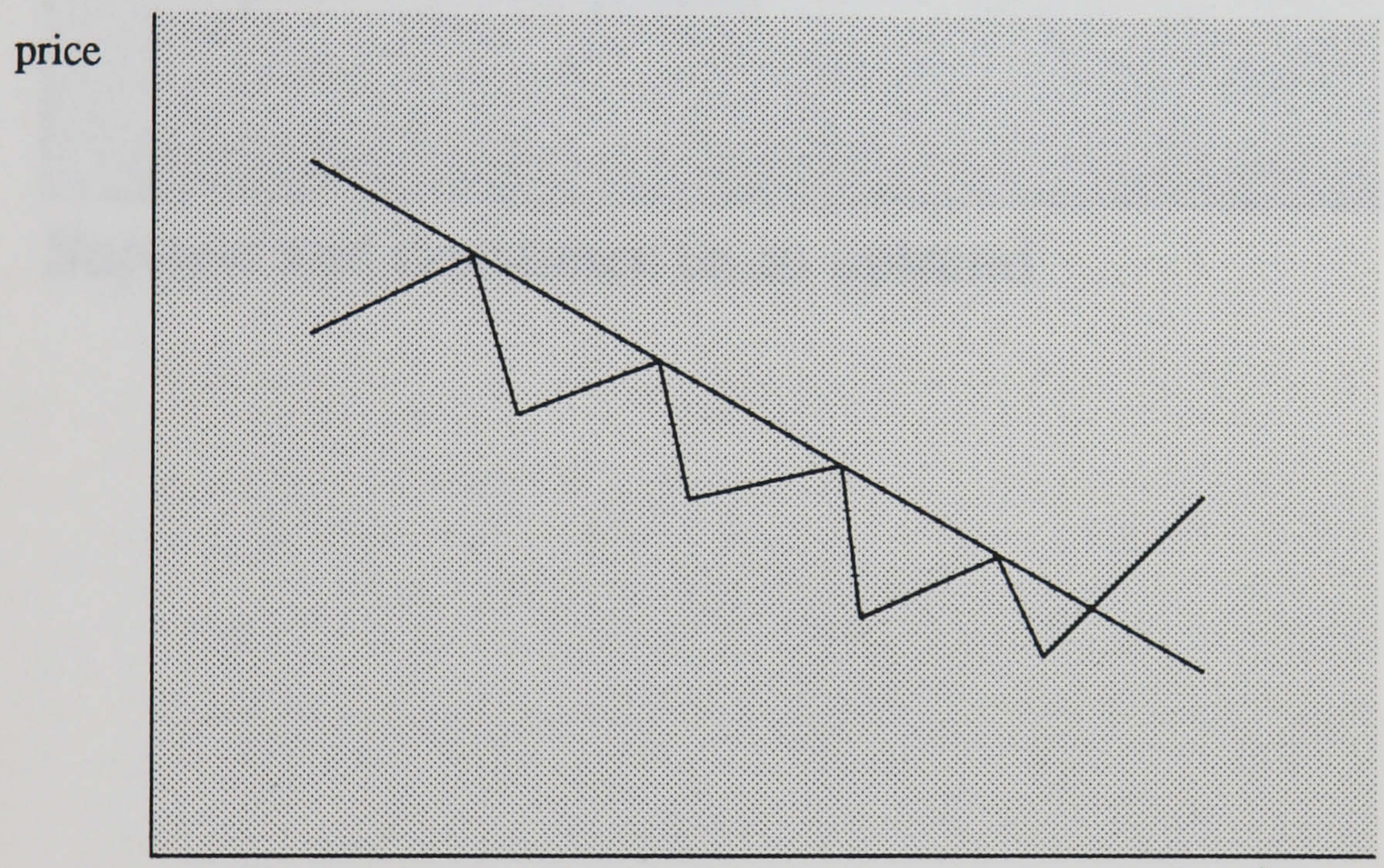


c) A trend channel

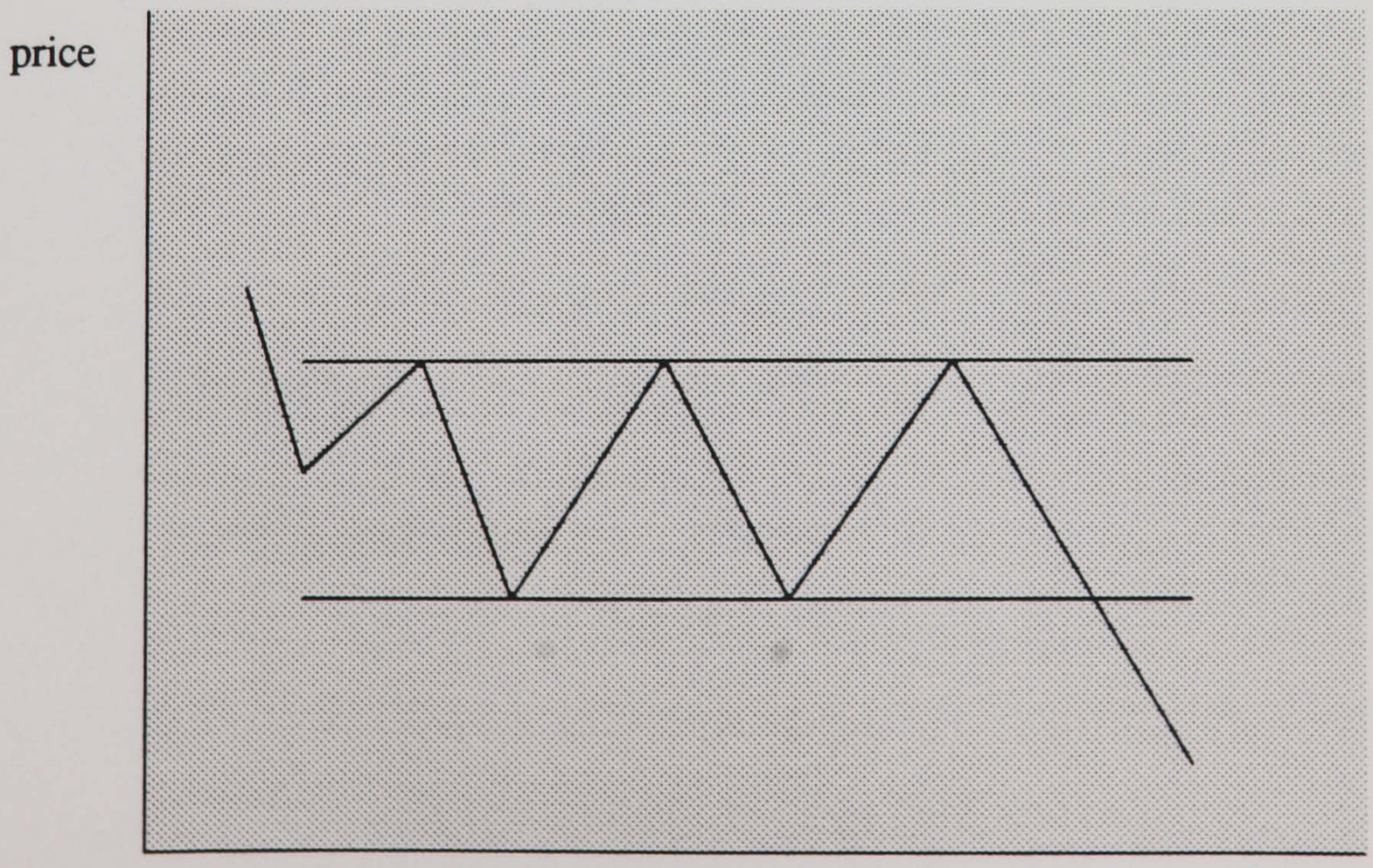
Chart 2.8: Penetration of trendlines and trading ranges



a) Penetration of an up trendline

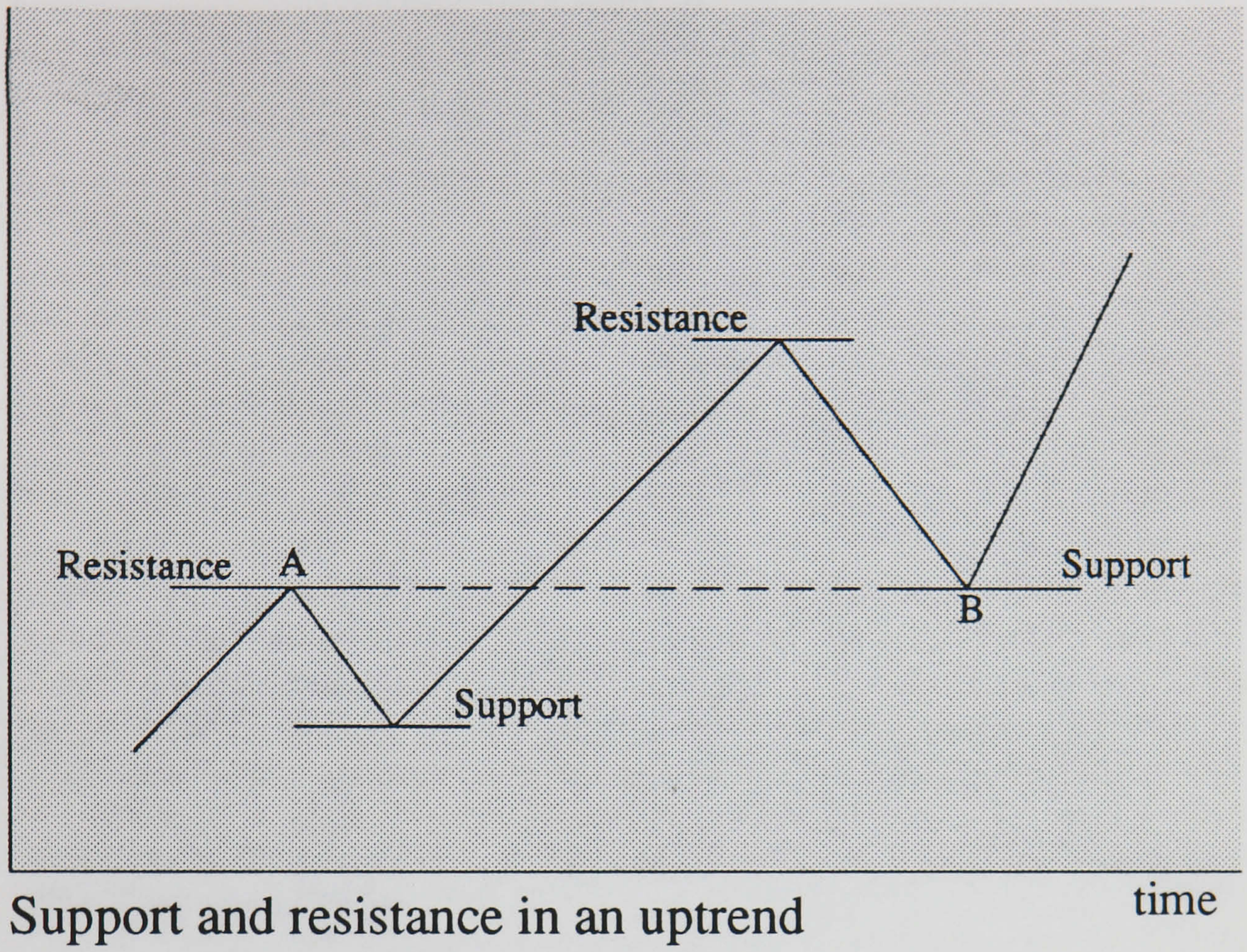


b) Penetration of a down trendline



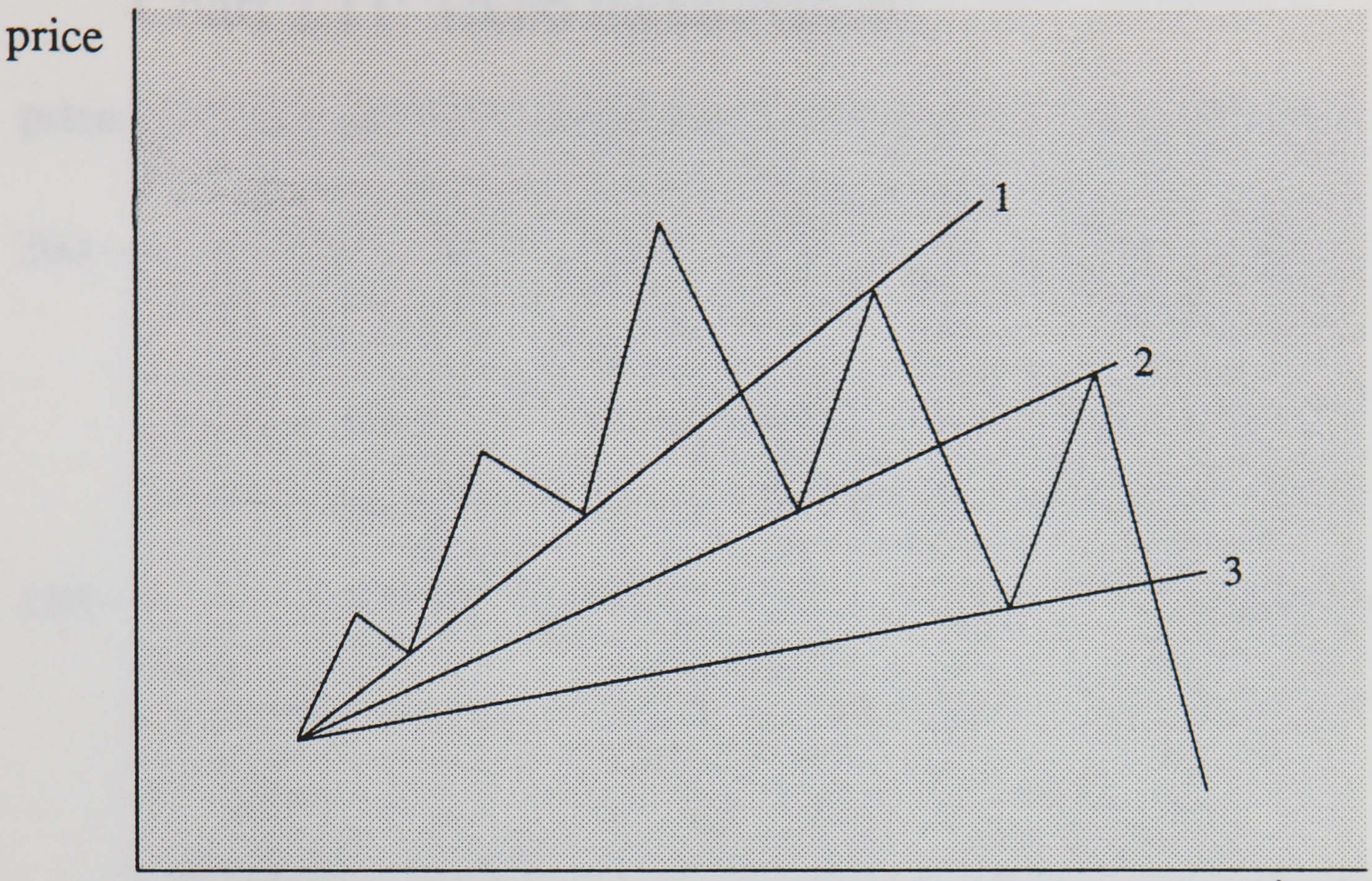
c) A breakout from a trading range

Chart 2.9: Support and resistance



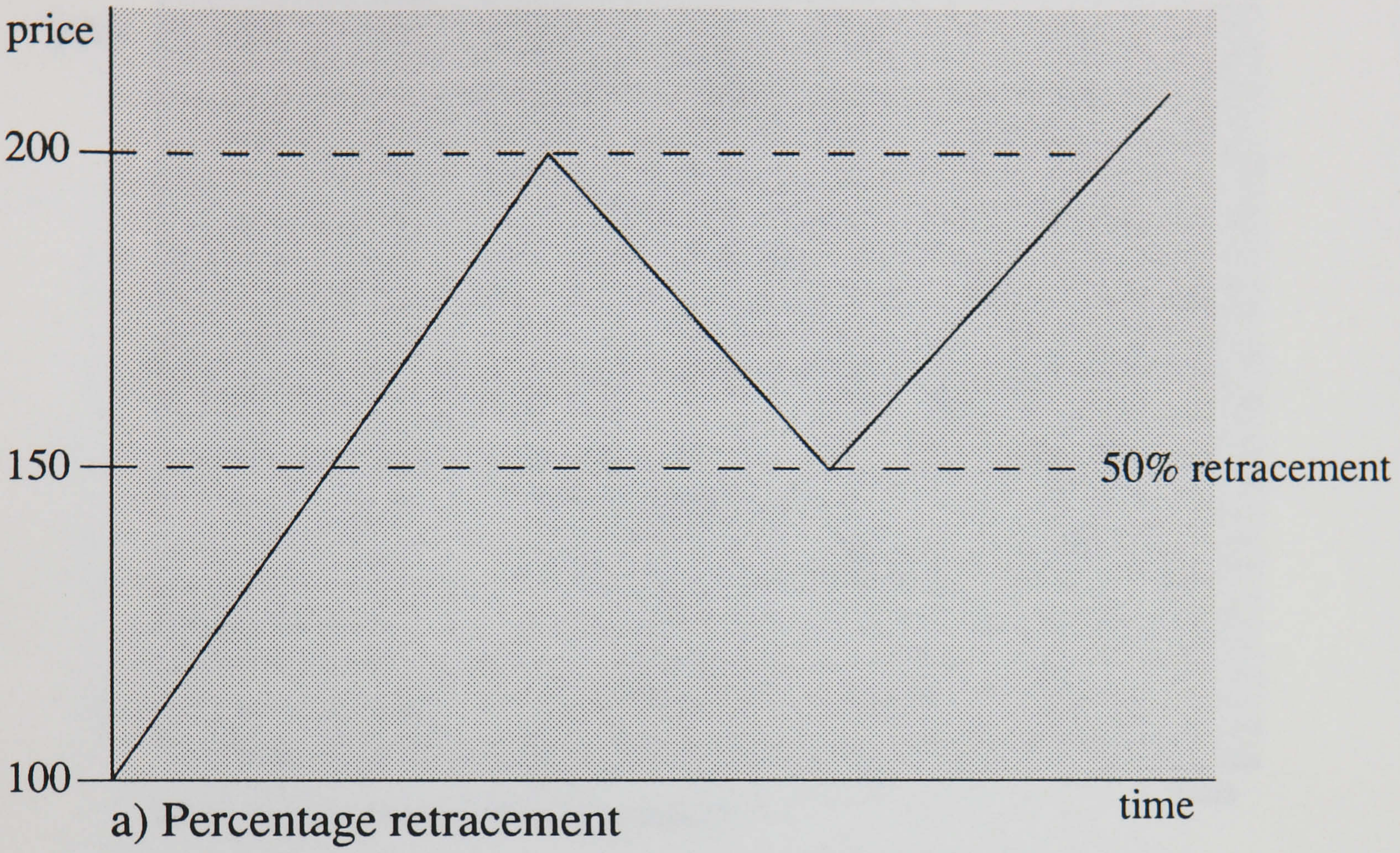
Support and resistance in an uptrend

Chart 2.10: The fan principle

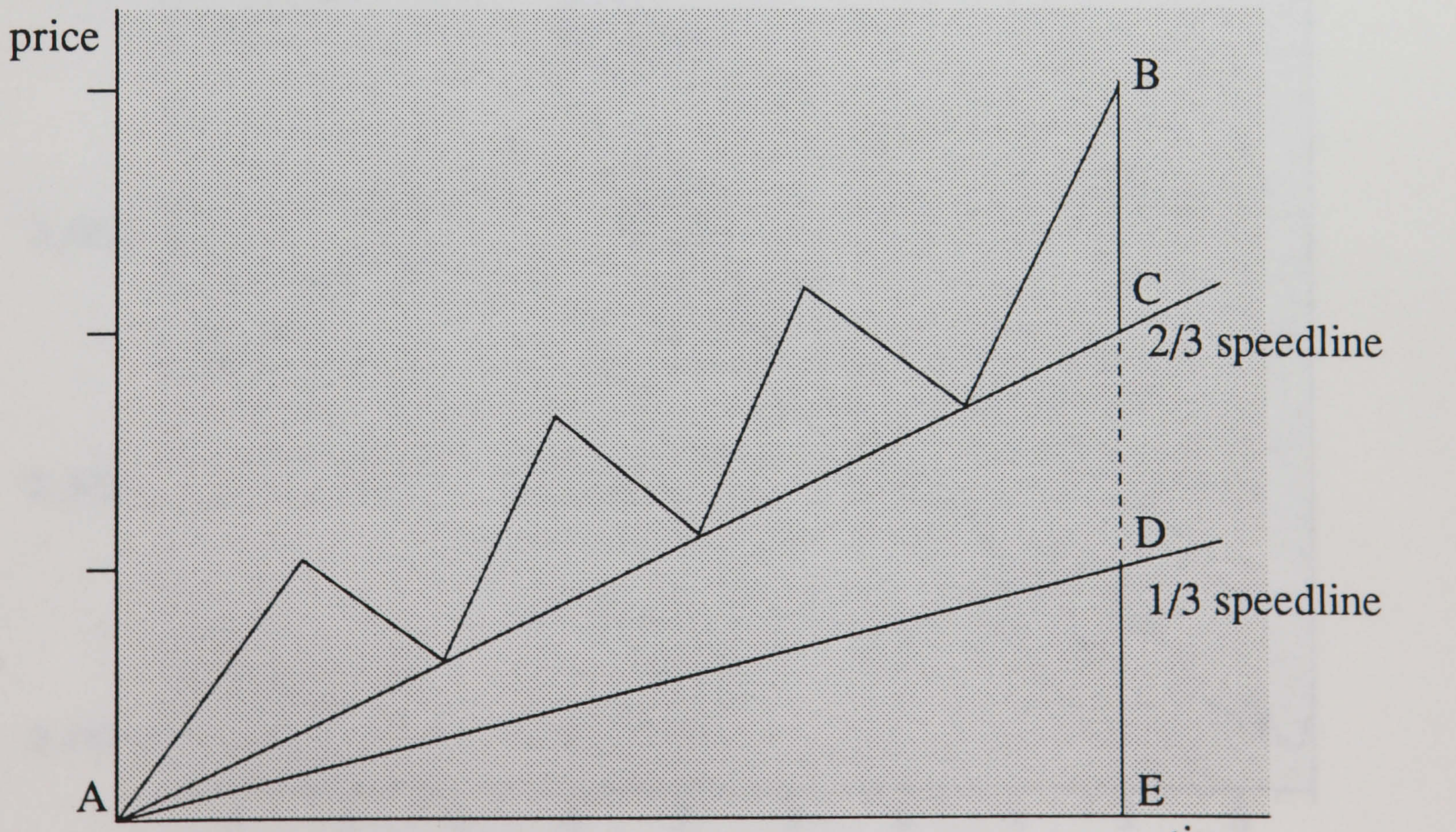


The fan principle

Chart 2.11: Trend measurement

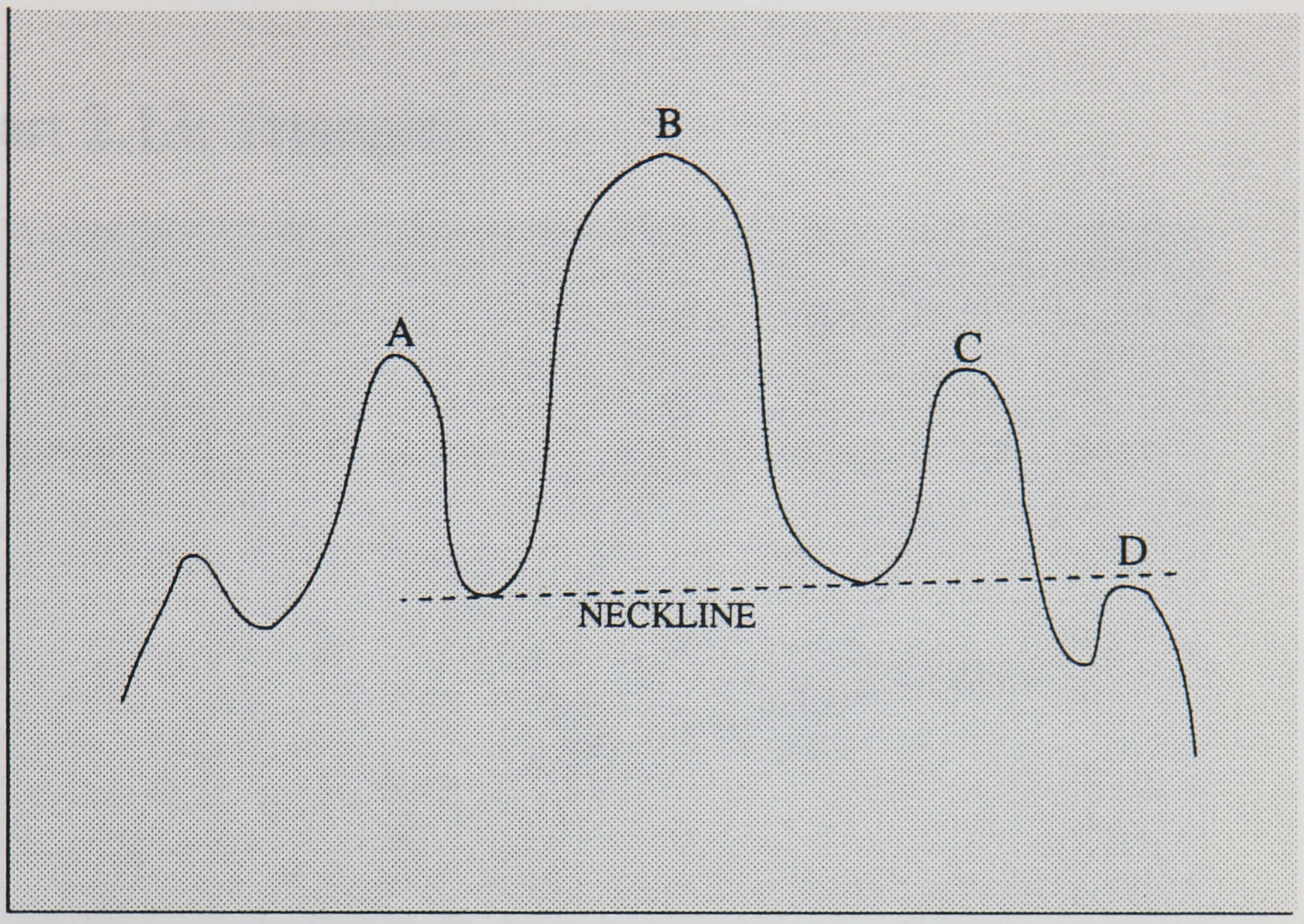


a) Percentage retracement

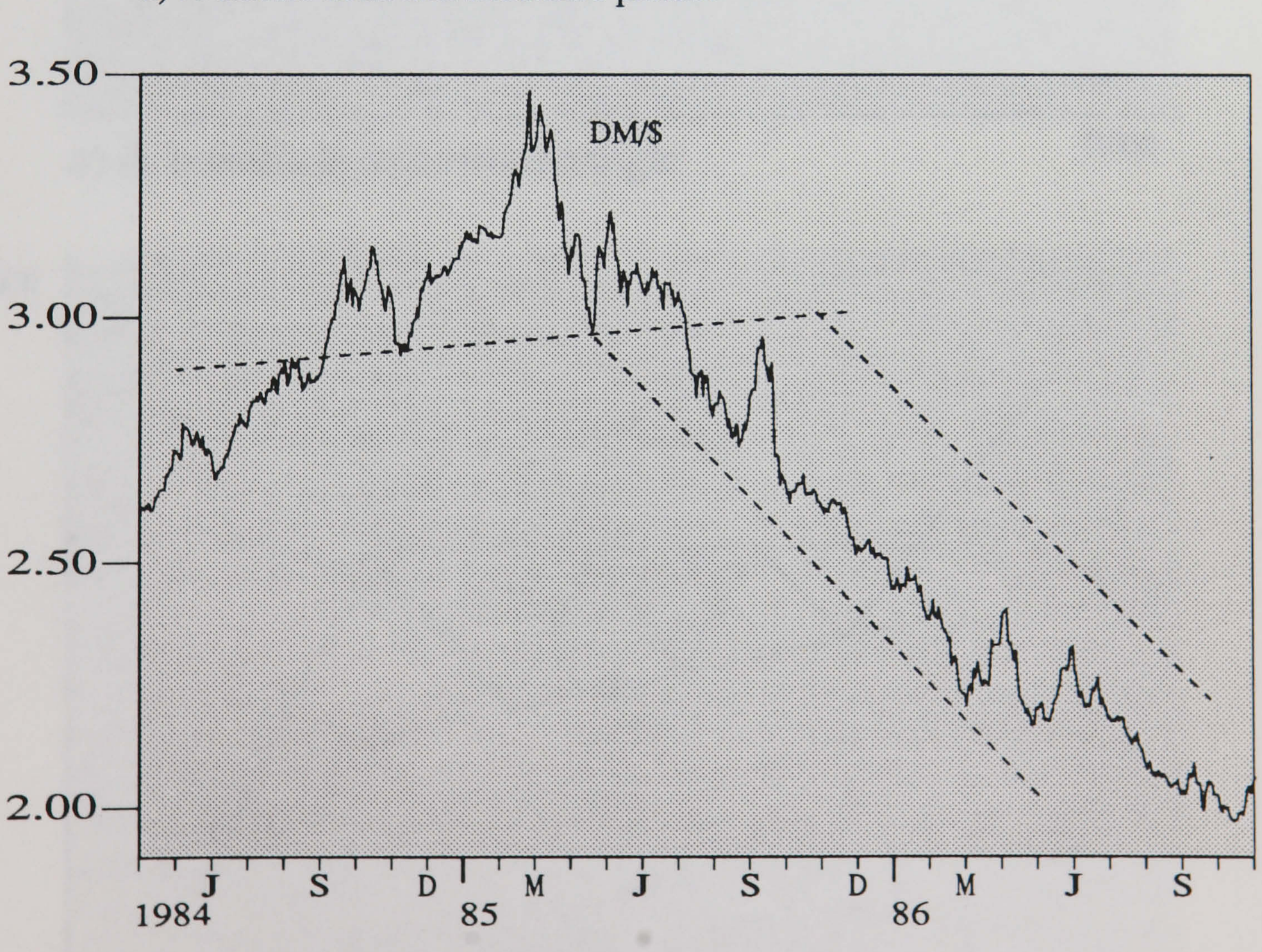


b) Speed resistance lines in an uptrend

Chart 2.12: The head and shoulders reversal pattern



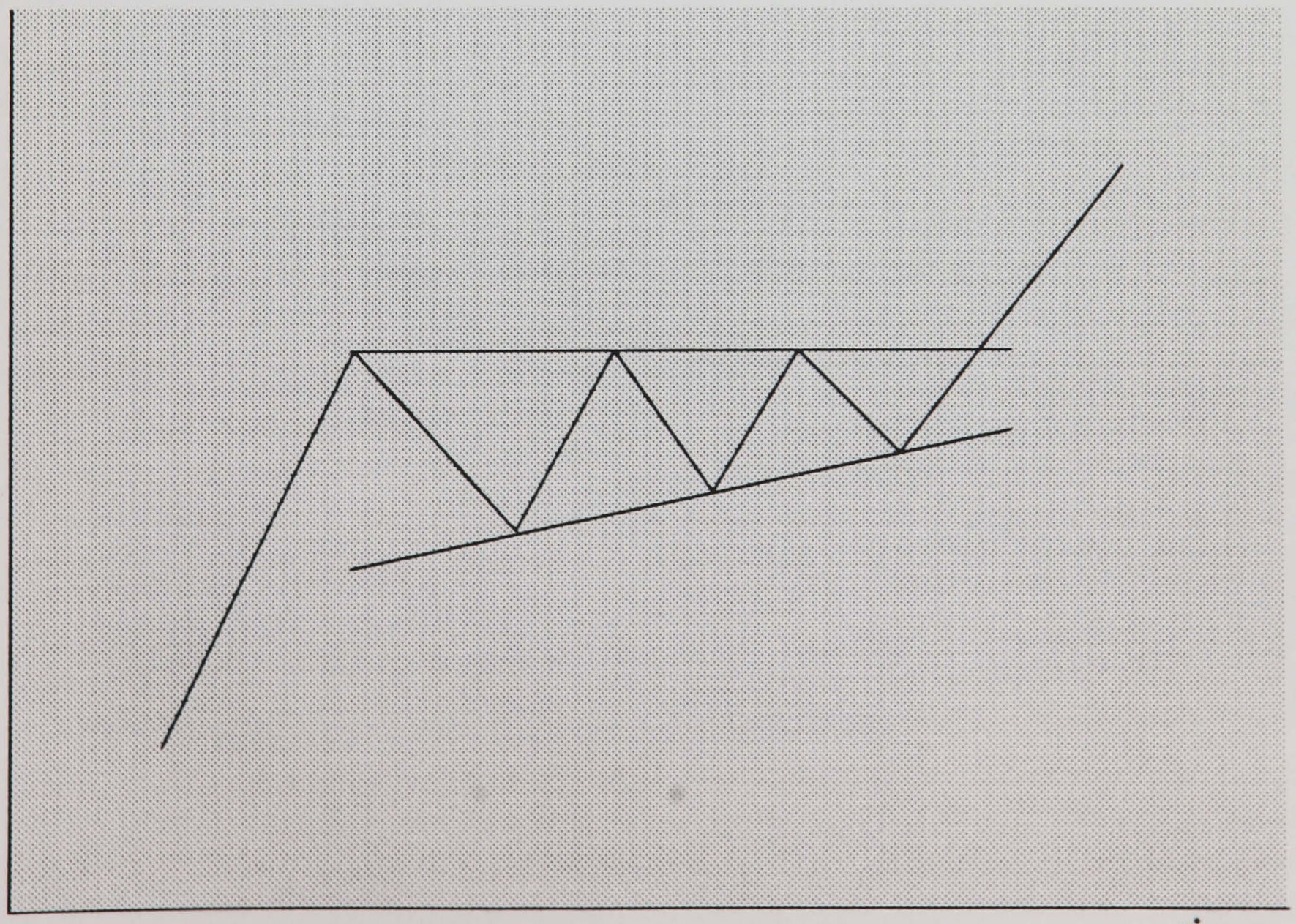
a) A classic head and shoulders pattern



b) A supposed head and shoulders in the DM/$ rate (daily data)

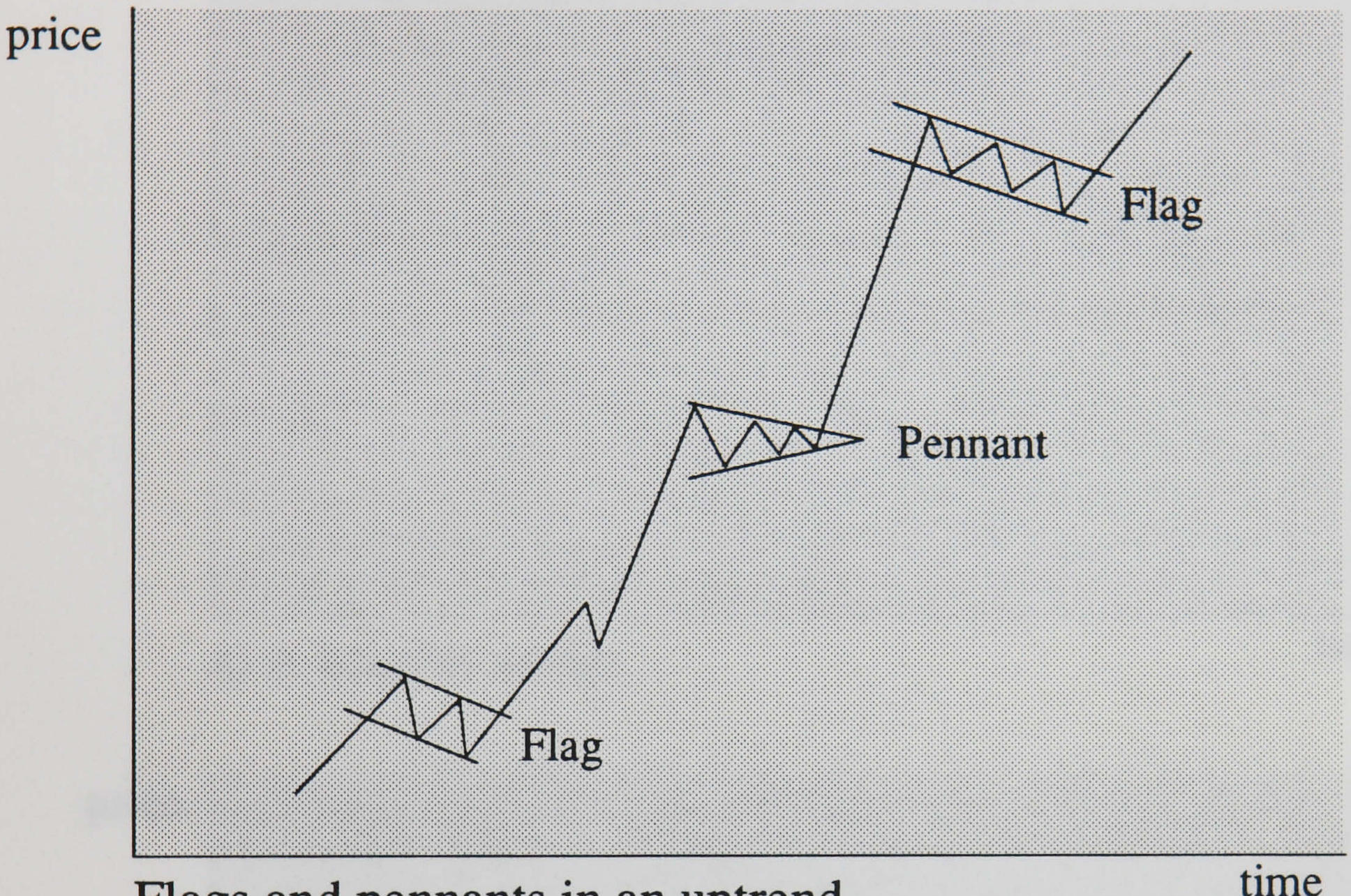
Chart 2.13: Triangles

a) A bullish symmetric triangle



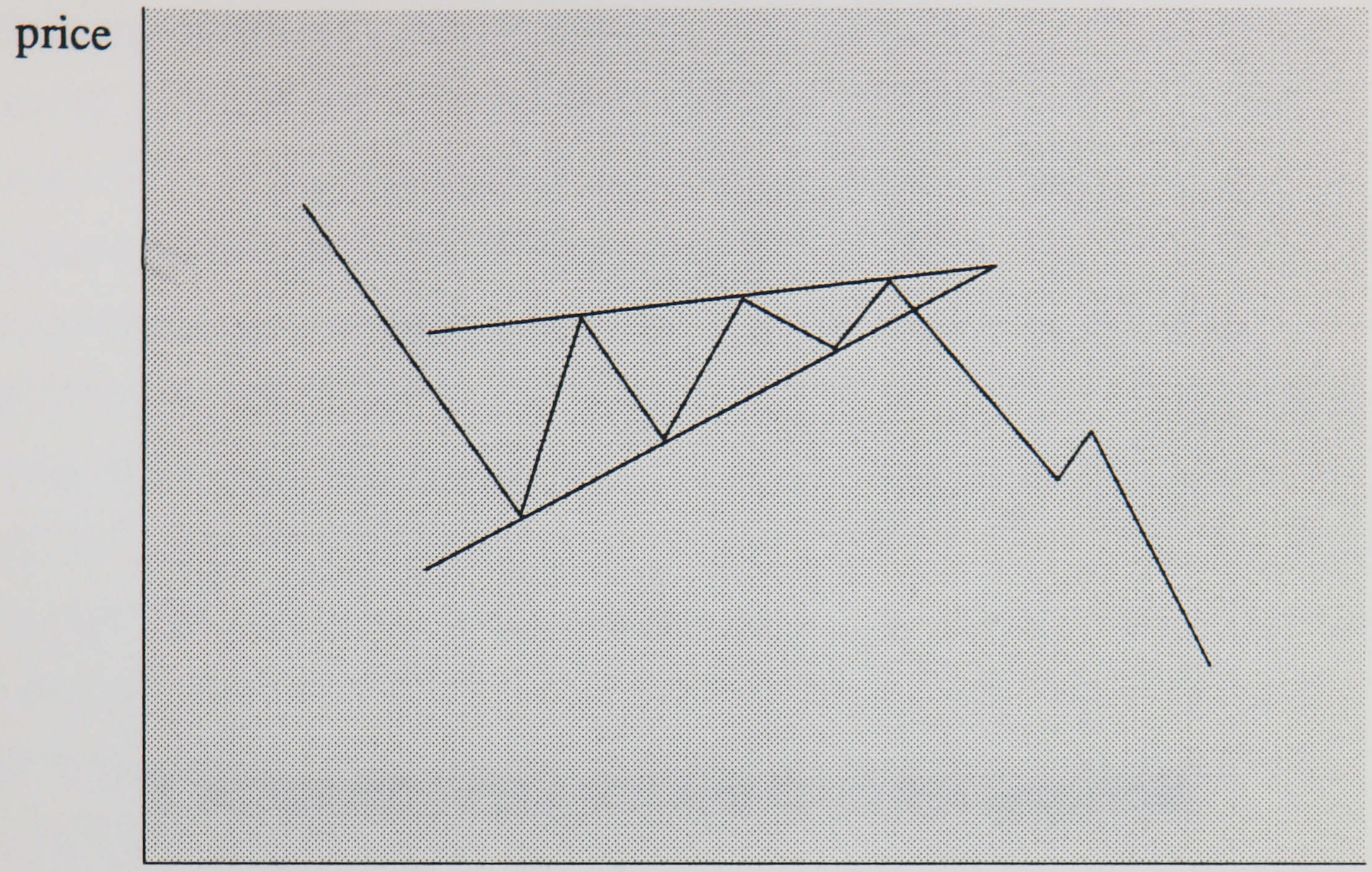
b) An ascending triangle

Chart 2.14: Flags and pennants

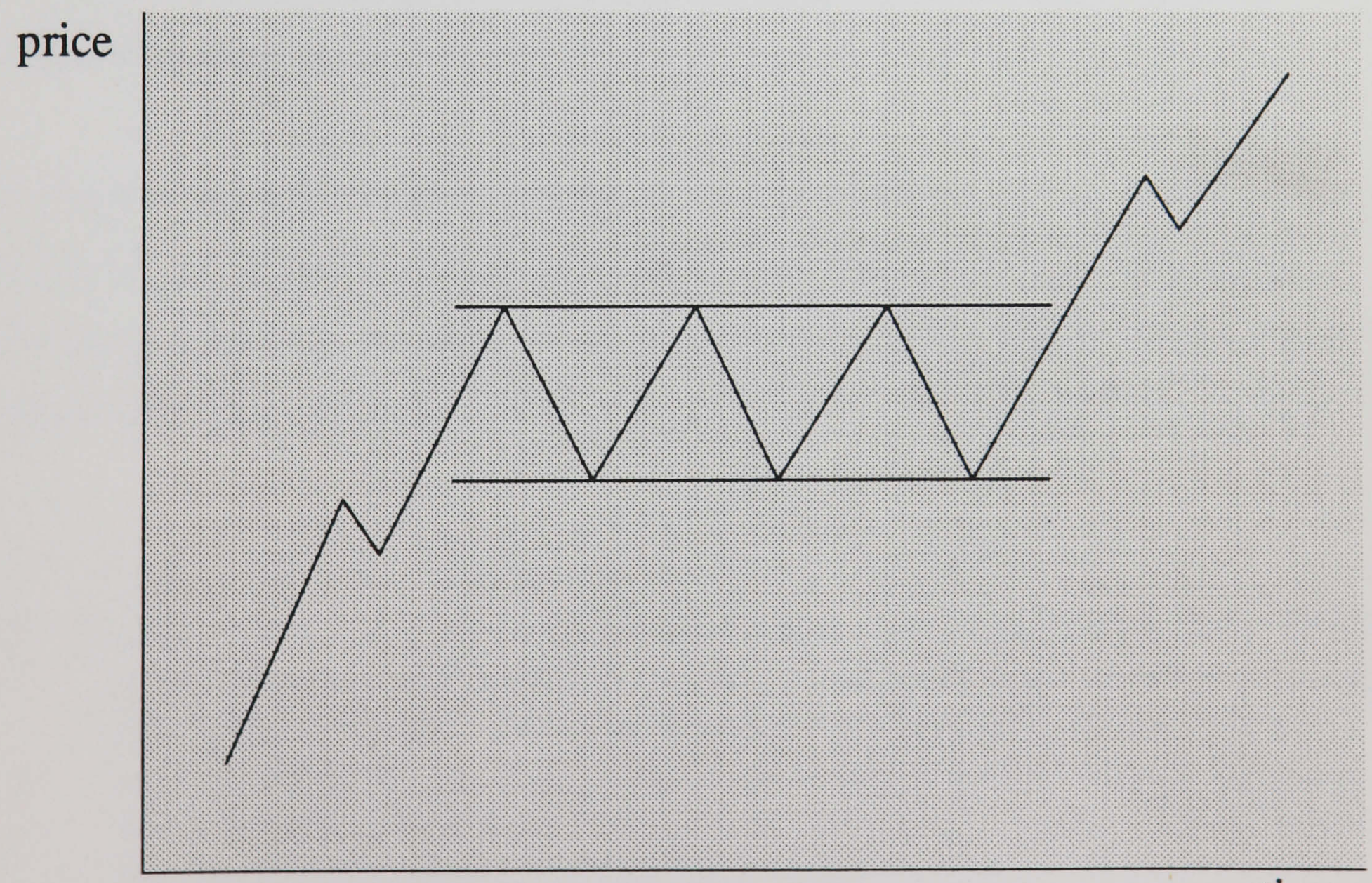


Flags and pennants in an uptrend

Chart 2.15: Wedges and rectangles



a) A bearish wedge



b) A bullish rectangle in an uptrend

3 ACADEMIC RESEARCH AND CHARTIST ANALYSIS

3.1: Introduction: The movement towards non-fundamentals

One of the most well-known descriptions of how non-fundamental factors may play a significant role in determining prices in financial markets is probably Keynes' (1936, Chapter 12) likening of investment speculation to a 'beauty contest'.(13) There have, however, been remarkably few serious academic studies of non-fundamental technical analysis. There are numerous fundamental-based academic studies of determination and forecasting of exchange rates and other asset prices (see eg MacDonald and Taylor 1989a for a survey) and a large number of textbooks essentially detailing the technical approach (eg Edwards and Magee 1966, Kaufman 1978, Pring 1985, Murphy 1986, Plummer 1989), but very little bridging between the two camps. In the case of the foreign exchange market, this may be partly explained by the relatively short recent period (only since the early 1970s) over which the major currencies have been traded in broadly 'flex-price' markets. Nevertheless, although efficient market type theories (see Fama 1970 for a review) have been pursued extensively in the last twenty years or so, the evidence against them has mounted.

Empirical research on asset markets has highlighted numerous empirical anomalies 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 rates optimally to predict future spot

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(13) As Keynes wrote in his analogy, "It is not a case of choosing those which ... are really the prettiest, nor even those which average opinion generally thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practise the fourth, fifth and higher degrees." Keynes 1936, Chapter 12.

rates[14] (see eg the survey by MacDonald and Taylor, 1989a). The extreme volatility of exchange rates during the recent float (Dornbusch and Frankel, 1987) along with evidence revealing the poor performance of asset market models of the exchange rate (Meese and Rogoff 1983a,b, Hacche and Townend, 1981) further point to the disillusioning results of fundamental, particularly 'efficient market' based, approaches.

It is probably true to say that such approaches in any case run somewhat counter to the beliefs of financial practitioners. To quote the Financial Times, 5 April 1988 p16, "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."[15]

Probably in response to this continuing undiluted scepticism and mounting empirical evidence of the inadequacy of purely fundamental models, academic researchers have recently been displaying a heightened interest in the impact of non-fundamentals, and particularly chartism, on markets. The literature of the 1980s examining the possibility of speculative bubbles and rational expectations solutions other than the market fundamentals solution (see eg

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(14) The possibility that risk premia, rather than inefficiencies, drive a wedge between forward rates and expected spot rates, has met with little empirical success. See eg Domowitz and Hakkio, 1985, Fraser and Taylor 1990, MacDonald and Taylor 1989b.

(15) 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 would 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.'

Flood and Garber, 1980, Blanchard and Watson, 1982a,b, Diba and Grossman, 1983) has mainly, however, concentrated on rational bubbles. As Blanchard and Watson (1982a, p 1) write, "Some may object to our dealing with rational bubbles only. There is little question that most large historical bubbles have elements of irrationality ... Our justification is the standard one: it is hard to analyse rational bubbles. It would be much harder to deal with irrational bubbles."

West (1988), however, argues that the theory of rational bubbles implies conditions probably too stringent for their existence. He suggests that findings such as those of Singleton (1980) of excess volatility in finitely lived assets cannot be caused by bubbles, since in the market of these assets, such as bonds, transversality conditions mean that there cannot be a bubble in the period a bond matures, hence by backwards recursion there cannot be a bubble in any earlier period. Assessing the sum of his evidence, West closes his discussion of rational bubbles by concluding that the theory of rational bubbles (albeit at a preliminary stage) suggests, "conditions for bubbles that are too stringent to make bubbles particularly attractive." (op.cit, p650).

It is interesting to observe that, to a large extent, the debate between fundamentalists and chartists mirrors the debate in the economics profession between econometric modellers and users of pure time series (ARIMA) analysis (Box and Jenkins 1971, 1976) - see eg Hendry 1985. Indeed it has been argued that chartist analysis in itself is a form of 'eyeball Box-Jenkins' analysis, or may at least be proxied by it. Frankel and Froot (1986b), for example, suggest that an ARIMA type system may be an appropriate way to model chartists' expectations. (In Chapter 5 evidence is presented to suggest that chartism is in fact richer than standard Box-Jenkins analysis).

The following sections, 3.2 and 3.3 highlight two strands of the academic literature (random walk models and the efficient market approach) which have pertained to the issues surrounding chart analysis. It then goes on (section 3.4) to consider several branches of the more recent work which look directly

at non-fundamental chart analysis itself as a joint exchange rate determinant with fundamental factors. Surveyed in this section are analyses of markets in which there are both chartists and fundamentalists; the effect of noise traders on financial markets; models which take explicit account of the transmission of views between participants; and work which examines the return available from following technical trading rules. In section 3.4, there is mention of related work which seems pertinent to chartism but has not yet been fully integrated with the subject, and in section 3.5 the evidence available from analysing surveys of foreign exchange market expectations is considered. Section 3.6 concludes.

3.2: Random walks and asset prices

The claim that asset price behaviour approximates to a random walk - ie that the expected change in any financial asset price is zero - has a long history. The first proposition that (stock) price changes are independent of all prior fluctuations was presented by Bachelier (1900), an interest renewed by Working (1934), who argued that random walk patterns look like patterns of stock prices. This random walk proposition predates the development of the efficient markets models and was empirically tested on stock prices by Kendall (1953) and Granger and Morgenstern (1963), was demonstrated by theoretically Samuelson (1965) and Mandelbrot (1966) and has been popularised by Malkiel (1985)[16] among others.

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(16) Malkiel (1985, pp 129-132) claims that a randomly generated series produces a line which is indistinguishable from charts of genuine price movements, and describes how he misled chartists using an artificial chart.

Such an assertion regarding the stock market might be justified as starting from the proposition that a share price, p_t say, should be equal to the discounted present value (dpv) of its expected value next period, p^e_{t+1} plus the dpv of the dividend expected to be announced next period, d^e_{t+1}:

$$p_t = (1+r)^{-1} p^e_{t+1} + (1+r)^{-1} d^e_{t+1} \qquad (3.1)$$

where r is the rate of return. For short enough sampling periods (say weekly or daily data), both d^e_{t+1} (the expected dividend) and r may be very close to zero, so that (3.1) approximates closely to

$$p_t = p^e_{t+1}$$

which is the random walk hypothesis.

For the foreign exchange market, it is hard to derive a theoretical justification for the random walk model, although since the late 1970s the idea that the exchange rate could be well approximated by a random walk has been a 'stylised fact', with several authors noting that exchange rates are largely unpredictable, eg. Cornell (1977) and Frenkel (1981). Mussa (1979 p 10) writes, "The natural logarithm of the spot exchange rate follows approximately a random walk." In addition, Goodhart (1988 p 438) points out that the nominal exchange rate generally approximates closely to a random walk, and goes on to demonstrate that the forward rate contains no additional information on the path of future spot rates which is not discounted in the current spot rate.

With regard to modelling the exchange rate, there is a large (and growing) amount of empirical evidence which examines how existing exchange rate models compare with a random walk. This began with the startling evidence

of Meese and Rogoff (1983a) in which they demonstrate that a naive random walk consistently outperforms a number of standard fundamental exchange rate models in post-sample forecasting tests, for a variety of exchange rates.

The technique employed by Meese and Rogoff is to compute 'rolling regressions'. Their full data set is monthly from March 1973 to June 1981, on which the equations are estimated using data up to November 1976, and forecasts are made for 1, 3, 6 and 12 months ahead. The data for the next month (December 1986) is then included in the original dataset, the equations re-estimated and another set of forecasts made for the four time horizons. The rolling regression procedure is continually repeated and various statistical measures of the forecast errors of the models computed. The clear result is that none of the models tested can outperform a comparable random walk forecast in terms of out-of-sample forecasting on the criterion of the root mean square error.

Largely resulting from attempts to pinpoint the precise cause of the damning Meese-Rogoff result, various subsequent studies have emerged along similar lines. See, inter alia, Woo 1985, Somanath 1986, who find that by various modifications to the models (these authors both added partial adjustment mechanisms), revised formulations could outperform a random walk over certain periods in Meese-Rogoff type exercises. It has also been argued that the Meese-Rogoff result may be due to the failure to account for parameter instability; the work of Wolff (1987) and Schinasi and Swamy (1989) has produced some evidence to support this case.

This question of whether asset prices do in fact follow a random walk, or at least whether they are best predicted by one, is an issue very close to the debate of the efficacy of chartism or fundamentalism. If asset prices are indeed best modelled by a random walk - and the evidence on this has been seen to be unable conclusively to refute this proposition - then chartism may

well be a pragmatic approach to the circumstances. Some academic work conducted to evaluate such forecasts is presented in the next section, results which cannot dismiss the chartist approach.

3.3: Market efficiency and evaluation of forecasts

Were markets fully efficient in the sense of Fama (1970), chartist trading rules of the type discussed in Chapter 2 should be unable to produce abnormal profits. Using the criteria of Fama, a market may be said to be efficient if it 'fully reflects' all the information in the relevant information set instantly: hence a trader should be unable to construct a strategy which yields abnormal profits. (The macroeconomic importance of efficient asset markets derives from the fact that they can be shown to be conducive to an optimal allocation of resources - Fama 1970, 1976).

There is a marked similarity between the above definition of efficiency and one of the central tenets of chart analysis, discussed in Chapter 2, that 'the price discounts everything'. This also highlights a logical flaw in much of the chartist literature in that if markets were fully efficient, then it should be impossible to construct profitable trading rules a priori (at least, after allowing for risk considerations). Thus, insofar as chartist analysis is successful, then it provides evidence against the market efficiency hypothesis and hence against one of its own central tenets. (See also the Grossman-Stiglitz paradox, discussed in Chapter 2 section 2.2.1.2 in relation to Dow theory).

Much of the earliest academic work on aspects of technical analysis involved testing the profitability of various mechanistic trading rules as a test of foreign exchange market efficiency. Several such studies, some of which are discussed below, provided some of the earliest evidence against the efficient markets hypothesis by demonstrating the existence, albeit over limited periods, of profitable trading strategies which, according to theory, should have been arbitraged away in an efficient market - although the results

summarised here have not been entirely destructive to the efficient market hypothesis. More recent work by Schulmeister 1988 (discussed in section 3.4.4) has explored these avenues further with respect to chartist rules, and has provided further such evidence (somewhat stronger than presented here) against foreign exchange market efficiency.

Goodman (1979, 1980) carried out ex post evaluations of the implied profitability of exchange rate forecasts provided both by technical and econometric/judgement based services. A major finding of his study was that the advisory services based on technical analysis outperform the forward rate in qualitative tests while the forward rate itself outperformed econometric/judgement based forecasts over the period considered - (between eighteen and thirty-six months in the period January 1976 to June 1978). The Goodman (1980) analysis was published in Euromoney, which has for several years conducted annual surveys of various aspects of the foreign exchange market. Its review of the accuracy of currency forecasting services has produced some mixed results over time, however, - for example in the summary of the 1983 results (Goodman and Jaycobs, 1983) the advice was given, (p 132), 'Don't rely on a service just because it's been accurate in the past; there are wide fluctuations in the performance of services over time'. This emphasises that results for isolated sample periods should not be overstated.

Bilson (1981) conducted test of the hypothesis of non-zero speculative profits, and rejected the hypothesis that there are no predictable profits to be made from foreign exchange speculation (using a simple forecasting rule and public information). Bilson could not, however, use his results to make inferences about the efficiency of the foreign exchange market since the profits could have been nullified by transactions costs or risk considerations.

Cornell and Dietrich (1978) assessed the profitability of chartist trading rules over the period March 1973 - September 1975, and for three of the six currencies considered found some evidence of inefficiency in that statistically significant profits could have been earned by following trading rules over the period. They concluded that, on balance, however, their results did 'not support the hypothesis of large departures from market efficiency'. (p120).

The forecast accuracy of nine individual foreign exchange advisory services was analysed by Levich (1980), with forecasts over various periods and frequencies ranging from 1974 to 1979. Analysis of the mean-squared errors showed that most forecasters were less accurate than the forecast rate, although there was evidence of the services having outperformed the forward rate in earlier periods, but the resultant profits implied may not have been abnormal after adjusting for risk considerations.

To conclude this section, there clearly is some evidence of departure from market efficiency which has emerged from the study of forecasting services and certain trading rules, although the results cannot be interpreted as an unambiguous rejection of market efficiency. Clearly results can differ between periods and currencies and are affected by whether allowance is made for risk premia and transactions costs. Probably largely because of these considerations, results can be prone to reverse, as the quotation from the Euromoney survey showed. Despite these caveats, however, there have clearly been sufficient instances of abnormal profits being made to suggest that there may be significant violation of market efficiency.

3.4: Charts and fundamentals as joint exchange rate determinants

Recent academic work has begun to consider explicitly the role of non-fundamentals, particularly chartism, in exchange rate rate determination. The amount of interest generated over the very recent past contrasts with prevailing previous attitudes. As Marris (1989 p 1) writes, 'Until quite recently

economists treated technical analysis - or chartism - with undisguised scorn; indeed again until quite recently, they had not even bothered to look at what chartists were doing.' Yet interest in technical analysis is well documented: for example a questionnaire was conducted by the Group of 30 (1985) which showed (p15) that 97% of banks and 87% of securities houses believed that the use of technical models has had a significant impact on the market.(17)

The previous sections, however, point to influences leading away from pure fundamentals and towards an examination of non-fundamental influences. Numerous empirical exchange rate anomalies have also been documented, features of the market which are empirically well established but do not appear in standard models (see, inter alia, Goodhart 1988, Frankel and Froot 1986b, Dornbursch and Frankel 1987). For example, continued appreciation of currencies have occurred despite all the fundamental evidence and survey evidence pointing to depreciation; in the medium term there remain major misalignments from some 'fundamental PPP'; markets seem to be more volatile than is justified by the role of news, yet apparently under-react to the news itself.

The academic work generated largely by differences between observed exchange rate behaviour and what theory would predict is discussed in the following sections.

3.4.1: Balance of chartist and fundamentalist views

More recent work on exchange rate determination has considered the effects of the interaction of agents in the market with different methods of expectation formation. There are, however, precursors to this line of thinking. For example, de Grauwe (1983) developed a model of exchange rate oscillations

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(17) Further references to this study are made in Chapter 4.

and catastrophe theory which employed both regressive and destabilising expecatations. More recently, there has been a tendency to describe aspects of the foreign exchange market in terms of both chartist and fundamental market participants. Goodhart (1988) presents a descriptive explanation of the observed behaviour and how misalignments in the exchange rate might occur, by assuming that the value of the exchange rate in the market is determined by some balance of fundamental and random walk (chartist) views.

This model of Goodhart's concurs with the more detailed earlier work of Frankel and Froot (1986b, 1986d, 1987b) - the thrust of their work being to develop an explanation of exchange rate determination which explicitly awards a role to chartist players, and demonstrates the existence of a speculative bubble that is not constrained by the assumption of rational expectations. Their model has three types of players: portfolio managers, fundamentalists and chartists, each being to a degree rational in that they behave in a specific way. The fundamentalists form their views on the exchange rate according to an economic model, the chartists use some extrapolation of the price history while the portfolio managers, who actually buy and sell the assets, form their expectations by a weighted average of the predictions of chartists and fundamentalists. The portfolio managers' weights are updated according to whether the chartists or fundamentalists have recently been the more successful. The basis of Frankel and Froot's work can be summarised by starting with a general model of exchange rate determination:

$$s_t = c\,\Delta s^{m}_{t+1} + z_t \qquad (3.2)$$

where s_t is the logarithm of the spot rate, Δs^{m}_{t+1} is the one-period ahead rate of depreciation expected by the 'market' and z_t represents other contemporaneous determinants. This is a very general model with the first term representing speculative factors and the z_t term as fundamentals. For example in the early flex-price monetary model, such as Mussa 1976, Frenkel

1976, z_t would be a function of relative monetary velocity. Clearly, according to equation (3.2), an increase in the expected rate of future depreciation reduces current demand for the currency, and hence causes it to depreciate at the current time.

Frankel and Froot develop the above general model by replacing the standard assumption of rational expectations with the idea that the portfolio managers' market expectations are determined by a weighted average of the expectations of two groups of advisers - chartists and fundamentalists - according to:

$$\Delta s^{m}_{t+1} = \omega_t \, \Delta s^{f}_{t+1} + (1-\omega_t) \, \Delta s^{c}_{t+1} \qquad (3.3)$$

where superscripts f and c denote 'fundamentalist expectation' and 'chartist expectation' respectively and ω_t is the weight given to the fundamentalists' views, $0<\omega<1$. The model therefore embeds a form of market expectations following (3.3) into the standard asset pricing model given by (3.2). A variety of assumptions can then be made concerning the determination of chartist and fundamentalist expectations. One straightforward approach for modelling fundamentalist expectations is to assume that they are determined by the deviation of the current spot rate from the long-run equilibrium rate (according to fundamentals), $\bar{s}$ say:

$$\Delta s^{f}_{t+1} = v \, (\bar{s}-s_t) \qquad (3.4)$$

and v is the speed of regression from s to $\bar{s}$

In the sticky-price monetary ('overshooting') model of Dornbusch (1976) for example, in which goods prices adjust slowly, equation (3.4) would be the rational form for expectations to take if there were no chartists in the market (ie $\omega_t = 1$). In general, however, this formulation implies irrationality, given the

complete model. Frankel and Froot demonstrate standard ways in which fundamentalists' expectations can be a function of the deviation from equilibrium exchange rates: as a function of the interest differential and as a function of net external assets.

As for the chartists' expectations, s^c_{t+1} , Frankel and Froot assume that chartists use time series methods, and examine the very simple case where the chartist forecast is identical to the random walk forecast[18] , ie $\Delta s^c_{t+1} = 0$, (although they do suggest in their conclusion (1986b) that a richer class of predictor may be useful, eg. ARIMA models). Thus, equation (3.3) can be written as:

$$\Delta s^m_{t+1} = \omega_t \Delta s^f_{t+1} \qquad (3.5)$$

and hence, using (3.4),

$$\Delta s^m_{t+1} = \omega_t v (\bar{s} - s_t) \qquad (3.6)$$

Frankel and Froot assume that the weight the portfolio managers give to fundamentalists' views evolves according to

$$\Delta\omega_t = \delta (\hat{\omega}_{t-1} - \omega_{t-1}) \qquad (3.7)$$

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(18) Both this, and other work considered later (eg. Kirman 1989) use what are clearly naive time-series methods for proxying the behaviour of chartists. To this extent, the precise label 'chartist' may be too specific - <u>any</u> type of market operator using simple time series methods would be equally well represented by these models.

where $\hat{\omega}_{t-1}$ is the (ex post) weight that would have accurately predicted, ie

$$\Delta s_t = \hat{\omega}_{t-1} v (\bar{s} - s_{t-1}) \qquad (3.8)$$

Frankel and Froot then go on to model the dynamics of the portfolio managers' expectations, which is dependent on the changing weight they put on the fundamentalists' views, according to equation (3.7). The dynamic development of two differential equations[19] following on from equations (3.6) and (3.7) depends on the choice of the basic parameter values, but with a choice of plausible parameter values, Frankel and Froot are then able to simulate the path of the dollar and are able to illustrate a path which captures the features of the overvaluation and subsequent collapse of the dollar during the 1984-85 period.

They offer these results as an explanation (1986b, p 33) for why sustained dollar appreciation may occur (a 'bubble' path) even though all agents expect depreciation:

> 'The equilibrium spot rate appreciates along its bubble path even though none of the actors expect appreciation. This result is due to the implicit stock adjustment taking place. As portfolio managers reject their fundamentalist roots, they reshuffle their portfolios to hold a greater share in dollar assets. For fixed relative asset supplies, a greater dollar share can be obtained in equilibrium only by additional appreciation. This unexpected appreciation, in turn, further convinces portfolio managers to embrace chartism. The rising dollar becomes self-sustaining. In the end, when the spiral finally levels off at $\omega(t) = 0$, the level at which the currency becomes stuck represents a fully rational equilibrium: portfolio managers expect zero depreciation and the rate of change of the exchange rate is indeed zero.'

Using a model based on the path of the US's stock of net external assets and their erosion by continued current account imbalances leading to US securities and therefore the dollar being perceived as increasingly risky, Frankel and

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(19) These are equations 16, 17 and 19, 20 in Frankel and Froot (1986b)

Froot were also able to suggest a method by which the unsustainability of the dollar's position could be included in the model.

> 'During the initial phases of the dollar appreciation, the current account, which responds to the appreciation with a lag, does not noticeably affect the rise of the dollar. But as ω becomes small, the spot rate becomes more sensitive to changes in the level of the current account, and the external deficits of 1983-85 quickly turn the trend. When ω is small and portfolio managers observe an incipient depreciation of the dollar, they begin to place more weight on the fundamentalists, thus accelerating the depreciation initiated by the current account deficits. There is a 'fundamentalist revival'. '

Indeed, calculations by Frankel and Froot using survey data produce results consistent with ω (the weight given to fundamentalists' views) falling from near 1 in 1976-79 to 0 in 1985 - a path borne out by the actual course of the dollar.

Frankel and Froot's work represents a significant step forward in the analysis of exchange rates and their work surely accords more closely with market practitioners' views of the world than do some more traditional economic models which suggest that all agents follow a single 'true' model.

They explicitly acknowledge that chartists' views, (albeit simply defined in their model) should be accounted for, and that time-varying interaction between fundamental and non-fundamental pressures on the exchange rate can produce paths which explain apparent paradoxes observed between the actual path of the exchange rate and market views.

3.4.2: Noise trading

It is only relatively recently than work in financial economics has explicitly assigned a role to the irrational or so-called 'noise' traders: work by Shiller (1984), Black (1986), Kyle (1985) Campbell and Kyle (1987) and De Long et al (1987, 1988, 1989) has been in the vanguard. The work of De Long et al

(1987, 1988, 1989), considered here, has continued to consider the role of noise traders, examining the implications of them co-existing in markets with rational speculators, and has shown that noise traders will not necessarily be driven out of the market by the rational agents.

De Long et al, (1987, 1988) use a two-period overlapping generations model with two classes of player: irrational noise traders with erroneous stochastic beliefs and rational speculators. They show that the noise traders will not be driven out of the market by the rational speculators, contrary to what fundamental-based theory would predict. This is because some noise traders may invest heavily in risky assets and so may, potentially, earn higher expected returns than sophisticated traders. Additionally, noise traders' unpredictable changes in whims serve to make assets in which they invest even more risky, thus discouraging rational speculators from investing in them unless compensated by a risk premium for both fundamental and noise trader created risk. If this reduces the price and increases the return on the assets they buy, it means that 'economic selection' may operate even more strongly in their favour - counter to the view that such speculators would be driven out of the market.

The authors are able to show that noise traders can achieve a profitable position in the market and that their presence together with that of sophisticated investors can account for a variety of otherwise puzzling market phenomena, such as excess price volatility and deviations from fundamental values. They emphasise in their conclusion that models with noise traders are not ones in which 'anything can happen' - the model has clear, identifiable consequences.

De Long et al (1989) continue the research to assess the welfare implications of noise trading. Highlighting the significant degree of stock market volatility which cannot be explained by movements in fundamentals (eg. Shiller, 1981,

French and Roll, 1986, Campbell and Shiller 1987) they suggest the effect may be due to market response to 'noise trading' and focus on the possible size and incidence of losses thereby induced.

Concern has long been expressed that such trading may act to reduce welfare - Wojniloweer (1980) wrote of a 'gambling mentality' and 'casino' instincts in financial markets and suggested that links with the real side mean that, 'the real economy pays the price'. De Long et al develop a formal model to evaluate the size and incidence of losses from noise trading, with particular regard to capital formation.

Their method is to use a two-period overlapping generations model. Investors live for two periods, in the first they earn exogenous labour income and invest it all, allocating the wealth between the two assets of safe, fixed bonds or risky stocks, ownership of a stock unit carrying with it ownership of a unit of productive physical capital. In the second period individuals sell all their investments and consume the proceeds. There are two types of traders in the model - rational investors and noise traders. Rational investors have rational expectations, and so accurately perceive the returns on all investments. Noise traders accurately perceive the return on bonds but to some extent misperceive the stock prices. Noise trader risk - the risk of changes in noise trader opinion - is the driving force of the model.

One of the implications of the model is that the additional risk caused by the noise trading can reduce the capital stock and the consumption of the economy, and that part of this cost may fall on rational investors. De Long et al (1989) argue that while noise traders may provide both a profitable opportunity for the rest of the economy (in that skillful rational investors can exploit their behaviour) and a cost by the increased element of risk (both in making consumption excessively volatile around its expected value and by

actually reducing consumption via reducing levels of investment and the capital stock), the loss due to noise traders can significantly outweigh the gain.(20) They conclude that the full welfare cost of noise trading may be large if the magnitude of noise in aggregate stock prices is as large as is suggested by, for example, the work of Campbell and Kyle (1988) on excess stock market volatility.

Work on noise trading appears to be a rapidly expanding area of economic literature: its explanations for several empirical phenomena such as the presence of non-fundamental traders in the market and excess volatility findings is reason in itself to expect that the area will be, and should be, expanded further.

3.4.2.1: Fads

While there is little conclusive evidence for fads - a term used to indicate short term, mean reverting excursions from fundamentals (see eg Shiller 1984, Summers 1986) - several commentators argue that they appear to explain certain features of asset markets more plausibly than do more traditional models. The empirical evidence is, however, limited.

In their 1987 paper, Poterba and Summers examine the statistical evidence on whether a significant proportion of the variance in stock market returns can be accounted for by transitory components. Conducting tests of returns over a (maximum) period of 1871-1986, they find evidence that transitory

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(20) De Long et al do stress, however, that noise trading does not always damage the economy - for example if noise traders were very bullish and over-invested in stocks leading to the cost of capital being low and its quantity high, it would be beneficial to the economy as a whole although harmful to the noise traders themselves.

components appear to account for more than half the variance in (monthly) returns. While they admit that a full examination and explanation of this phenomenon would be complex, they suggest that noise trading provides a more plausible account of this transistory component than does the possibility that such effects are the result of fundamental influences. Their preferred explanation of their statistical findings that of slowly decaying 'price fads' which could cause stock prices to deviate from fundamentals for perhaps periods of up to several years.

West (1988) also argues that the consideration of fads better explains features of asset markets than do more traditional models. If noise trading does indeed play a role in stock price determination, it would potentially lead to wider variations in expected returns; if one interprets the effects of these noise traders as 'fads', then fads would simply add a 'noise-trading' factor to what the fundamental price would be. To the extent that noise traders trade every asset, the risk would be 'non-diversifiable': sophisticated investors would have to take it into account. Fads can further be interpreted as meaning that even after allowing for risk consideration, profitable opportunities could exist (West 1988): ie. implying that markets are inefficient.

So, while there is both anecdotal (eg Keynes' beauty contest) and more formal evidence of fads (eg De Bondt and Thaler 1985 and 1987, who find that a contrarian strategy of selling high performing and buying low performing shares can yield high returns), West (p654) argues that the evidence is not yet sufficient to 'sway someone unsympathetic to fads models'. As Leroy (1989 p1608) writes, ' ... it is not clear that anything is gained by characterising an unexplained variation in prices as a fad ... precisely because [the additional movement] is unobserved, one is free to accept or reject the interpretation; nothing is at stake either way.'

So, while it is possible to characterise hitherto unexplained variation in asset prices as fads, there is (as yet) insufficient evidence to make the case stand conclusively. Furthermore, the evidence and academic discussion to date refers virtually exclusively to the stock, and not the foreign exchange, market, although many of the observations are equally applicable to both.

3.4.3: Transmission of opinions between market participants

In Frankel and Froot's (1986b) model, while the numbers of chartists and fundamentals is constant, the opinions of portfolio managers change over time. In the models of De Long et al (1988, section III), the proportion of new noise traders rises when their returns exceed those of the sophisticated traders. Agents with differing views and/or the possibility of conversion between camps is now a feature frequently incorporated into economic models of financial markets. (See Varian, 1987, for a survey).

An explicit model of the transmission of and conversion of views, features which have generally been absent from exchange rate models, is presented by Kirman 1989. The basis of Kirman's work is the idea that people may tend to follow the prevailing market view rather than attempt to form their own individual view and act accordingly. This idea itself is not new: Keynes (1936 Chapter 12) writes, 'Investment based on genuine long-term expectation is so difficult to-day as to be scarcely practicable. He who attempts it must surely ... run greater risks than he who tries to guess better than the crowd how the crowd will behave; and, given equal intelligence, he may make more disastrous mistakes.'

Assuming this type of behaviour to be the case, Kirman cites three conditions which are necessary for transmission of opinions to operate - that agents watch each others' behaviour, that they hold differing opinions and that there is the possibility of them converting their opinions. There are several examples of economic literature which discuss or even incorporate these

features into economic models. For example, the models of De Long et al (1987, 1988, 1989) suggest a world in which there are different types of traders - the rational sophisticated traders and 'noise' traders and, as mentioned above, the proportion of noise traders can rise when they are making higher returns than the sophisticated traders.

Kirman's (1989) model adopts an 'epidemic' approach in that the opinions of agents may be changed after meeting people with differing views.(21) He defines a specific recruitment/conversion model in which there is a world with two prevalent views, and when individuals with different views meet, there is some probability of conversion. The players also observe (with noise) the majority opinion and act accordingly, hence the market as a whole only responds to changes in opinion when the majority switch. Thus, majority opinion dominates the path of the market and so the individuals are rational in that by following market opinion they forecast correctly. The resulting movement of the exchange rate would be characterised by periods of definite movement representing the prevailing view, interspersed by brief periods of vacillation.

Modifying Frankel and Froot's (1986b) model, Kirman's two types of agents are fundamentalists whose expectations are formed by the belief that movements in the exchange rate tend to bring it to some equilibrium value (as in equation 3.4 above) and the chartists who extrapolate naively, according to:

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(21) Kirman states that the model was in fact suggested by the reported behaviour of a certain species of ant: when two identical food sources were placed near to the ants' nest and replenished so as to maintain them at a constant level, the ants did not forage from the two piles equally. Rather, they tended to be heavily concentrated on one pile, and from time to time would suddenly switch to the other pile.

$$\Delta s^{c}_{t+1} = s_t - s_{t-1} \qquad (3.9)$$

The proportion of fundamentalists and chartists at any one time is determined by the model of conversion by encounter, and each agent observes (with some error) the proportion of people acting like fundamentalists. Conversion is more likely to the prevalent view (the one forming the market price) and with agents only acting according to the view they hold when they perceive this to have become the majority view.

So, like the models discussed in sections 3.4.1 and 3.4.2 above, the Kirman model also has a strong element of 'real world' behaviour, of a sort generally absent from standard exchange rate models.

3.4.4: Academic analysis of technical trading rules

As mentioned in the survey of chartist methods in Chapter 2, the importance of a strong trend for profitability of mechanical trading rules is highlighted by chartists as a key consideration in their use: the danger of being 'whipsawed' and making a loss during a trading range is apparent. Evidence available so far appears to bear this out in practice. Some of the most recent evidence is that presented by Schulmeister (1988), who applies four different trading rules (double moving average, breakout rules and combinations of the two) to the DM/$ rate, and finds that the resulting profits over the period are totally inconsistent with the the zero profits that pure rational expectations would predict.(22)

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(22) Some other analyses of the profitability of technical trading rules were considered in section 3.3. The work by Schulmeister, however, is some of the most recent available, is conducted on daily data and provides analysis of specific chartist trading rules, evidence of the use and consultation of which is found in the results of the questionnaire survey, presented in the next chapter.

In this work, Schulmeister draws distinction between the pattern recognition aspect of chartism, which he terms the 'qualitative' approach, and the statistical moving average and momentum type models of technical analysis which he describes as the 'quantitative' approach. He calculates and analyses the ex post dollar returns from four (moving average/momentum[23] /hybrid models) using various parameter values, on daily DM/$ data over the period April 1973 - March 1988. Between 1973 and October 1986, the average annual return of the models is around 15%. In the later period, to 1988, most of the rules prove to be less profitable than in the preceding years, a result he attributes to the stabilising effect of the Louvre accord of February 1987.

The reported returns include neither the effect of transactions costs nor the interest differential. Schulmeister justifies this estimating the effect of the former to be negligible and that the interest costs of short positions and earnings of long positions would be roughly offsetting.

In his analysis of the results, Schulmeister identifies the precise source of the profits. It turns out that, for all the trading rules, while the number of loss making positions exceed the number of profitable ones, and although the average absolute loss or profit per day of these positions are approximately equal, the overall profitability stems from the fact that the average duration of the profitable positions is some 3 to 4 times longer than that of the unprofitable positions. This is explained by the exploitation of the runs observable in the data - it is pointed out that the general dollar appreciation in the DM/$ rate between 1980-85 was due to upward runs of an average duration of 2.6 times longer than the counter-runs, and that the depreciation from 1985 saw longer lasting downward than upward runs.

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(23) Schulmeister used the term 'momentum' models for the overbought/oversold type systems examined in Chapter 2, section 2.5.2.1.

As Schulmeister concludes, 'The profits from the correct identification and exploitation of the few, but persistent runs, which change the exchange rate most, can therefore easily compensate for the more frequent, but smaller losses stemming from the minor exchange rate fluctuations ("whipsaws")'. (Schulmeister 1988 p352).[24] He infers from these empirical results that market efficiency (in the sense of Fama, 1970) does not hold for most traded currencies.

Schulmeister's work is an important contribution to the debate about technical analysis, particularly in that it demonstrates the efficacy of trading rules, at a minimum over a certain substantial period for a major traded currency. It does, however, focus entirely on only one aspect of chartism - namely that of mechanical trading systems and as such, a large portion of chartist techniques (as surveyed in Chapter 2) and the subjective use in practice of both pattern recognition and information from mechanical systems (described in the conclusions of Chapter 2 and demonstrated via survey data in Chapter 4) is entirely missed.

Schulmeister does make several additional interesting comments on market behaviour following from expectations in the foreign-exchange market. He observes that while it is foreign exchange dealers who most directly influence the exchange rate, economic theory abstracts from them, assuming them to be only intermediary agents (p 344). He goes on to ask how it would be possible for the behaviour of dealers to result in persistent medium-term runs of the type observed in the 1980s, and suggests two hypotheses:

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(24) This demonstrated the point, made heuristically in some chartist texts (eg. Murphy 1986 p [264]) that chartists following mechanistic rules would generally make a large number of small losses on false signals but would more than offset these by the profits made on the true turning points.

i) By the interaction of a 'bandwagon' effect and a 'cash-in' effect. If the exchange rate appreciates due to some 'news' effect, a certain momentum can be achieved as agents buy, which causes appreciation, which produces buy signals on trading models, etc. The temptation to take profits ('cash-in' the paper profits) increases the longer the upward run lasts, hence agents probably become progressively more responsive to 'bad news' which could be interpreted as the approaching end of the run, and when the run finally bursts, a counter-run is often triggered.

ii) Medium-term expectational bases could act for or against currencies (eg for dollar appreciation 1980-85, or dollar depreciation 1985-87). During a prevailing positive bias traders would hold long positions of the currency for longer than a short position, a behaviour which hence leads to upward runs lasting longer than the counter-runs, and a stepwise appreciation of the currency.

Schulmeister also discusses the so-called 'winners and losers' in currency transactions. It is known that banks do make consistent profits from short-term speculative foreign exchange dealing and, by definition, global currency trade is a zero-sum game. He cites the question (p 356), 'Now, if banks, ...[etc.]... , consistently win this game, who then is the loser?' He states that the loser will be all those who deal in foreign exchange for reasons other than speculation - ie. those who trade in goods and services, using foreign exchange for international payments rather than as a financial asset. He further suggests that speculation in asset markets may lead to instability and impede activity in the goods market.

Grubel (1989) takes issue with this view that traders in the goods market lose, and, on the assumption that profitable speculation by institutions such as banks increases exchange rate stability, suggests that the speculative earnings of banks represent a payment by international goods traders for increased exchange rate stability.

This conclusion rests on the assumption that consistently profitable speculation does indeed increase exchange rate stability, a long-standing controversy which is both theoretically and empirically unproven. Friedman (1953) argues that the activities of speculators who consistently earn profits

must have the effect of stabilising the exchange rate, writing, 'People who argue that speculation is generally destabilising seldom realise that this is largely equivalent to saying that speculators lose money, since speculation can only be destabilising in general only if speculators on the average sell when the currency is low in price and buy when it is high.' (1953 p 175).

Friedman's argument has been challenged on several fronts.(25) It was questioned at the time and shortly after in several papers (eg. Stein, 1961, and a discussion in Sohmen, 1969), and the debate has continued with more recent economic concepts. Dornbusch and Frankel (1987) suggest that, ' the modern theory of rational stochastic speculative bubbles has all but demolished Friedman's claim that investors who bet on destabilising expectations will lose money. In a rational speculative bubble, investors lose money if they don't go along with the trend.' The models of De Long et al (1987, 1988, 1989), discussed above, presents a model to show that speculators could make profits by following 'noise'. The conclusive testing of the competing propositions is not, however, possible due to the lack of data and complexity of the model structures. As Grubel (1989 p 3) writes, 'Since both propositions are theoretically and logically correct, it is not possible to consider one to be more realistic than the other.'

3.4.5: Related extensions

Finally in this chapter, some related areas of the literature which do not, as yet, appear to have been fully integrated with analysis of chartism, are mentioned: the areas of chaos theory, some specialised very high frequency analysis and psychological explanations. While some of these areas are perhaps slightly

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(25) Friedman did, however add a footnote on the above quotation warning that it was a simplified generalisation of a complex problem.

tangential to the main concern of this thesis, it seems likely that further work will heighten their importance to non-fundamental exchange rate determination.

3.4.5.1: Chaos Theory

Chaos theory moves away from the popular exchange rate theories of the 1970s and 1980s in which linear models of exchange rate changes were driven by stochastic disturbances, or random pieces of 'news'. (See, inter alia, Frenkel and Mussa, 1985) In contrast, the chaos theory approach develops models which generate apparently 'unpredictable' exchange rate movements via non-linearities in the system. While these models produce results which are all but unpredictable, the origins of the movements is entirely from fundamentals. Such models were originally developed from the natural sciences, for example in physics to analyse the properties of turbulent fluid flows (eg Lorentz 1963).

Chaos theories have recently been gaining attention in the field of economics, particularly with regard to the movements of exchange rates and stock prices. Interest has become apparent in City-orientated journals, see eg. The Banker, 'Chaos theory', January 1990, pp 51-54, and Financial Weekly, 'Securities face fatal attractors of chaos', January 12 1989, p 17, and recent books on the subject, eg. Gleick 1988, Chaos - Making a New Science.

In the field of academic economics, Scheinkman (1990) reviews the work to date on non-linearities in economic dynamics. One of the latest academic papers on the subject of chaos itself is that of de Grauwe and Vansanten (1990), which highlights the failures of conventional 'news-driven' models to account for observed phenomena in exchange rates such as large changes when no news is apparent, or provide accurate forecasts, and went on to suggest that non-linear deterministic models of exchange rate behaviour

containing a mixture of both chartist and fundamentalist expectations can generate chaotic movements without the need for 'news'. This implies an inherent unpredictability in exchange rate movements, since large changes in rates could occur even in the absence of policy shocks.

3.4.5.2: Very high frequency analysis - the Olsen approach

Research developed by Richard Olsen and his company Olsen and Associates (O & A) has been entirely based on statistical analysis of the raw data. They have collected tick-by-tick data on all major exchange rates since end-1985. Their model of exchange rates is based on 'fractal theory', - that natural repetitive patterns occur in price series which can be differentiated only by their scale; and on 'intrinsic time' - whereby, for example, tick-by-tick quotes are are transformed on to a scale dependent on market activity, such that volatile periods of price movements receive higher weighting. Analysis is presented (see, for example, Muller et al, 1988) which suggests a scaling law relating the absolute value of the price changes to the time interval of the price changes. From these ideas, O & A have built up a forecasting and trading model and consultancy service (see O & A Sales Documents, 1989).

It is interesting to note that the above analysis, which is essentially based on patterns invariant of time, is not dissimilar to traditional point and figure charts - see Chapter 2, section 2.3.3 and Chart 2.4.

This work of Olsen can clearly be linked to the high frequency work of Goodhart, for example Goodhart and Figliouli (1988) and Goodhart and Giugale (1988). Both strands of work point to the importance of the analysis of high frequency data.

3.4.5.3: Psychological explanations

Recent work on cognitive psychology (see eg Hoggarth and Reder, 1987: and Leroy 1989 section viii discusses the work to date) has documented explanations of human behaviour which seems to bear some resemblance to various empirical anomalies in asset markets: for example, behaviour such as people systematically placing too much weight on current observations has been described. Plummer (1989), in his discussion of technical analysis, works on the premise that individuals are influenced by crowd behaviour, which would lead to decisions which were 'non-rational' according to economists. These psychological explanations can also be linked to the more economic-based ones: as Leroy (1989, p1608) writes in relation to fads, 'Advocacy of a fads model is perhaps best interpreted as a statement of belief that the most fruitful avenues of future research will involve social or cognitive psychology, rather than as referring to any well-formed model that is now available'.

3.5: Survey evidence on foreign exchange markets

Having surveyed various studies which include non-fundamental chartist influences in either theoretical models or simulations of foreign exchange markets, this section considers the results of various analyses of surveys of foreign exchange market expectations. Several such data sources are discussed in the next section and section 3.5.2 then goes on to consider results regarding features such as expectation formation, rationality and risk premia.

3.5.1: Sources of survey data

There are several sources of survey data on foreign exchange market expectations. The main categories which have been analysed include:

a) Godwins, a firm of financial consultants, survey the expectations of the chief investment managers of over fifty leading investment houses at the

The data collected include (among others) the

predictions of the $/£ rate, in three category response form: up, down, or same. These data are used by Taylor (1989).

b) The Economist has data back to 1981 collected every six weeks by telephone from currency traders and economists. The data from this source in combination with the AMEX and MMS data (see below) are used in the Frankel and Froot papers which analyse survey expectations - all these data are in quantitative form. See, for example, Frankel and Froot 1986a,c and 1987a.(26)

c) The American Express Bank Review (AMEX) survey consists of the exchange rate expectations of over 250 bankers, corporate treasures and economists questionned annually - at maximum the data go back to 1976. A disadvantage of this data is that it is conducted by mail, so that it is not possible to put a precise date on the expectations, nor to identify the exact information set available.

d) Data from Money Market Services (MMS) go back to 1983, and consists of weekly or twice weekly expectation of currency traders collected by telephone. This data has been widely used by researchers, see for example Dominguez (1986), MacDonald and Torrance (1988a,b), as well as in the Frankel and Froot papers mentioned above.

There are many other sources of data which have been used in analyses of market expectations, but the above cover the main sources widely available to researchers of exchange rates. There are other surveys available which examine expectations of other aspects of the economy - for example the 'Livingston' data-set has been used in numerous studies. This is a quantitative data-set, collected bi-annually since 1946, on the views of a panel of leading economists regarding price and wage expectations (these price series have

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(26) The survey data is described in several of Frankel and Froot's papers - see for example Frankel and Froot 1986a, p 4 and 1987a, p 151.

been very widely examined, see, inter alia, Turnovsky (1970), Gibson (1972), Pesando (1975)), GNP, stock prices, investment, unemployment. See Brown and Maital (1981) for an examination of these latter series.

If the survey data is only available in a non-quantitative form, such as that collected by Godwins[27] , it can be used to derive series of aggregate point expectations by several methods. The methods of Carlson-Parkin (1975) and Knobl (1974) along with those of Pesaran (1984, 1987) can be used to quantify qualitative responses.

3.5.2: Findings using survey data of foreign exchange markets

There is widespread empirical evidence that the forward rate is not an optimal predictor of the future spot rate (see Hodrick (1988) for a survey of the literature). Much of the work, though, comes to this conclusion by testing the joint null hypothesis of both risk neutrality and rational expectations on the part of agents, and there is disagreement in the literature as to which aspect is responsible for the bias. The use of survey data, however, enables these two aspects to be distinguished,[28] and the majority of studies so doing have found that it appears to be the assumption of rationality which is violated.[29]

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(27) Other UK examples of this type of data are the CBI industrial trends survey and Gallup surveys.

(28) See Taylor (1989) for a mathematical demonstration of this.

(29) This contrasts with some other (non-survey) analysis which has cited risk premia as the cause of the bias: see, inter alia, Hansen and Hodrick (1983) and Fama (1984).

Frankel and Froot (1986a) use the Economist, MMS and AMEX data to examine expectations of the ¥/$ rate and find evidence to suggest that variations in the forward premia reflect changes in expected depreciation rather than changes in the risk premium. MacDonald and Torrance (1988b), using MMS data to examine the DM/$ rate 1985-86, found that the bias in the forward rate were due to the failure of the rationality of expectations over the period, and not due to a risk premium. They did suggest, however, that this may not necessarily reflect irrationality but rather may be evidence of a situation such as a 'peso problem' (Krasker, 1980) - ie. a small probability of a large depreciation which did not occur over the sample period. In another study Froot and Frankel (1989) also found that it is expectational errors rather than the risk premium which causes the systematic prediction error in the forward discount.

An exception to the body of results such as those cited above is the findings of Taylor (1989), who used the Godwins data to examine predictions of the $/£ rate and the sterling effective index, but was unable to reject rational expectations, and his analysis suggested that the bias of the forward rate was probably due to a risk premium.

There are several arguments concerning, for example, the problems of the conversion of qualitative to quantitative data, and of the various merits or shortcomings of data from different surveys, which can be brought to bear on the apparent contradictions of such results. Overall, however, balance of opinion from analysis of foreign exchange survey data suggests that the cause of the forward rate bias is the failure of rational expectations to hold. What is very clear, however, is that the analysis of survey expectations has enabled the crucial aspects of the question to be distinguished.

Survey data of foreign exchange expectations has also been used to investigate which expectations mechanisms best describe the beliefs of market participants, given the general failure to find evidence of rationality. The usual approach is to fit alternative expectations models to the data and to

ascertain which best describes the data. Most such studies have highlighted the issue of whether agents' expectations may be a destabilising influence on the foreign exchange market: ie. whether the hypothesis of so-called 'bandwagon expectations' can be rejected.

For example, Frankel and Froot (1987a) fit a variety of models to their data and find that both the bandwagon and the static expectations hypotheses could be rejected, and showed that variables other than the contemporaneous spot rate receive weight in agents' views. This contrasts with MacDonald and Torrance (1988b) who find some evidence of destabilising behaviour, although, as discussed above, they did raise the possibility of a 'peso' type problem affecting the expectations over their sample period. Evidence presented in Chapter 7 for an analysis of chartists' expectations gives further weight to the rejection of the bandwagon hypothesis.

There does appear to be a general reluctance to attribute bandwagon expectations to foreign exchange market participants, and even those few studies which do find some evidence of it tend to suggest explanations of why it may not necessarily be a pervasive result. What does seem to emerge however, both in theoretical discussions of foreign exchange market dynamics (eg. Frankel and Froot (1986d), Goodhart (1988)) and in recent empirical work is that fundamental inputs to expectation formation may well be mixed with non-fundamental/extrapolative/chartist type approaches, with the latter perhaps being more used over shorter horizons. Some survey evidence from a questionnaire is presented in the next chapter to support this view.

3.6: Conclusion

This chapter has demonstrated how the ground has been shifting recently away from general academic scepticism of non-fundamentals to active investigation of the many observed phenomena not captured by traditional economic models. These new lines of research seem, in many cases, to be

more capable of capturing 'real-world' behaviour, and the area of investigation is clearly a growing one. Very many of these new approaches do award an explicit role to chartist players and recognise that they can, and do, (profitably) exist in the market. This is a departure from the line of thinking which suggests that these traders would be wiped out by 'smart' fundamentalists.

There is as yet, however, insufficient empirical evidence which enables the effects of such players to be distinguished conclusively or analysed fully. Hence, while many commentators do find explanation of market movements by features such as fads and noise trading appealing, belief in them as yet has to remain an informed act of faith. To some extent, fads/noise trading explanations are treated as a 'residual' hypothesis, given the failure of market efficiency and the lack of an adequate explanation of market movements in terms of rational behaviour.(30)

There does, however, still appear to be a dearth of hard empirical evidence about the actual activities of these non-fundamental players such as chartists in the market, and the next chapter helps to fill this gap.

Following the survey of chartist techniques in Chapter 2, it is not unreasonable to suppose that there are certain recurring, common threads running through chartists' approaches. In order to try to guage which of the many chartist techniques explained in Chapter 2 are particularly widely used, and to gain insights into the role and perception of chartism, a questionnaire was sent to dealing institutions throughout the City of London. The design and results of this questionnaire are the subject of the next chapter.

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(30) Indeed recalling the discussion at the beginning of this chapter, West (1988) argues that the theory of rational bubbles implied conditions too strong for their existence.

4 QUESTIONNAIRE SURVEY OF DEALERS

4.1: Introduction

As seen in the previous chapter, there has recently been increasing interest in chartism by a number of authors who have begun to examine the role of non-fundamentalist analysis on capital markets. Frankel and Froot (1986b), for example, suggested that technical analysis may have been largely responsible for overvaluation of the US dollar during the 1980s. In a similar fashion, some economists have suggested that chartist analysis may have been an important contributory factor in the international stock market crash of 1987 (see eg Artis and Taylor 1989). At a more general level, there does now seem to be a growing interest in the role of non-fundamentalist (or 'noise') traders in financial markets (such as the work of De Long et al 1987,1988,1989 discussed in Chapter 3).

Despite this growing professional interest in technical analysis and the existence of a widespread literature on chartist methodologies, some of which, as seen in previous chapters, dates back to the beginning of the century, there appears to be little or no empirical evidence on the prevalence and use of these techniques in the financial markets, although indications of the importance of these issues are not new. For example, an international questionnaire of forty large banks and other foreign exchange market participants was conducted by the Group of Thirty (1985) included returns by participants which were summarised as (p 14), 'Technical trading systems, involving computer models and charts have become the vogue', and the vast majority of those questioned believed that the use of technical models did have some effect on the foreign exchange market.

There is, however, virtually no work which specifically examines the extent to, and manner by which, chartism is used in the foreign exchange market and how it is perceived by the market participants themselves. In an attempt to provide empirical answers to these issues, it was undertaken to conduct a questionnaire survey on the use of technical analysis, with particular reference to the London foreign exchange market.

The survey was conducted among chief foreign exchange dealers in the London market. It was designed to provide answers to three basic questions. First, to determine which chartist techniques are most used in practice. Second, to ascertain the role of the chartist practitioners themselves - is their presence in dealing organisations widespread, what is their input into the trading decision, to what extent is their advice likely to be combined with fundamentals before a trade takes place? Third, how do market participants view the role of chartism? The answer to the latter question is largely manifest in the time horizon over which charts are used and the extent to which they are viewed as complementary as opposed to competing tools of analysis, while the former issues could be largely ascertained from factual enquiries. There was also space for respondents to add any general comments concerning the role of chartism in the foreign exchange market.

The next section considers factors influencing the design of the questionnaire, after which the coverage and results of the survey are examined. A final section concludes by summarising the salient points revealed in the survey. A copy of the original questionnaire forms an Appendix to this chapter.

4.2: The design of the questionnaire

Several considerations influenced, and to some extent constrained, the design of the questionnaire. On a practical level, it was felt that is should not exceed two pages of A4 paper, so as not to deter responses from busy chief dealers. Another important factor was that many (probably most) of those questioned would be non-economists, so formal economic terminology was inappropriate. Furthermore, the subject of technical analysis itself has a plethora of overlapping and sometimes confusing terminology, (eg.the terms oscillators/momentum/rate of change indicators are not always used in the

same context) so some questions had to refer to concepts by several names. Before the questionnaires were sent out, comments and suggestions were incorporated from both Bank of England and market traders and analysts.

Methodological considerations behind the design of the various types of questions are set out below. The question numbers reference the questionnaire in the Appendix.

a) Questions concerning chartist methodology. The first question (no.1) concerned which chartist methods and services were used by dealing rooms. The question posed was, "Which of the following chartist methods and services does your organisation use?" followed by three categories of chart analysis - analytical techniques, computer analysis and chartist publications.

b) Questions concerning the role of chart analysts. The next three questions asked whether the organisation used a particular chart company or analyst (no.2), and whether any in-house economists or technical analysts were employed (nos.3 and 4). The latter questions had subsidiary sections which asked whether the economists/technical analysts actually took positions or acted only as advisers, and to what extent their advice influenced foreign exchange forecasts.

c) How do market participants view the role of chartism? The emphasis market participants placed on chartism and fundamental analysis over various time horizons (no.5) and whether the two are viewed as complementary or competing tools of analysis (no.6) was the aim of the rest of the questions on the survey. The form of the questions was that of a linear 10-point scale, on which respondents could mark where they judged their approach to lie between using pure chartism or pure fundamental analysis.

The question concerning the time horizon over which chartism is used was phrased, "Please indicate the relative importance you attach to chartist/technical analysis versus fundamental (ie economic) analysis of currencies over the following forecasting horizons. (Mark scale at appropriate point.)" This question was asked for seven time horizons - intraday, 1 week, 1 month, 3 months, 6 months, 1 year and for longer horizons. Respondents could indicate the balance which they thought appropriate between charts and fundamentals by indicating a point on the linear scale (Appendix 1). There was, however the option of stating that views were not taken over particular time periods. The marking of a scale was felt to be the most objective way in which to assess a balance of market opinion. Verbal options (high/medium/low, etc.) were too open to subjective interpretation and also may have left some respondents feeling that their nuance of opinion was not adequately described.

This question format also had the advantage of enabling a distribution to be built up for the use of charts and fundamentals at each time horizon.

Similarly, each respondent was asked to indicate on a scale the extent to which they felt charts and fundamentals to be complementary or competing tools of analysis. The same considerations applied to the design of this question - plus the fact that the same style of question would minimise possible confusion among respondents.

4.3: Coverage and results of the survey

The survey was sent to every chief foreign exchange dealer in the London market, a mailing list being obtained from the Banking Supervision Department of the Bank of England. While the original mailing list had 402 named institutions, 16 were returned to sender by the Post Office (presumably the institutions had closed or moved) while 33 were returned, marked by the

institutions as being inapplicable as they had no dealing arm. Hence the sample size on which the percentages in the following chapter is based assumes a sample size of 353 (402-16-33). A total of 213 replies were received, giving a response rate of over 60%. (The 'true' response rate is believed to be somewhat greater, as several institutions to which the questionnaire was sent but not returned may also have closed, moved or may not have had an applicable section to which to send the questionnaire.) Tables 4.1 to 4.4 detail the results of the survey.

The questions to determine which chartist techniques and sources of information are most used in practice (Table 4.1) showed that by far the most widespread source of chartist analysis among the survey respondents appeared to be in the form of on-line commercial services. Over 65 % 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. Additionally, some 21% of respondents relied on advice from outside commercial chartist companies for their chartist input (Q2), whilst 43% subscribed to particular chartist publications (Q1e).

Approximately 65% of respondents reported using trend-following systems such as moving averages in their chart analysis (Q1a) and 40% reported using some form of overbought/oversold indicators (Q1b), such as oscillators, momentum lines or rate of change indicators (Murphy 1986). Several respondents commented on which particular methods they used. The 'relative strength indicator' or RSI (Welles Wilder 1978) was cited repeatedly while several chartists stated their preferred moving average combinations for the foreign exchange market.

The enquiries into the source of chartist advice are summarised in Table 4.2. They reveal that almost exactly a quarter of respondents reported that their organisation employs in-house technical analysts (Q4), as opposed to 38% who reported having in-house economists (Q3). It did appear that more chartists took positions than did economists, though the number of respondents at this stage of the question was felt to be too low to draw more than tentative conclusions.

Turning to the questions on time horizons (Q5) and complementarity (Q6), one of the clearest results 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. The results obtained at each time horizon are shown in Table 4.3 while Chart 4.1 gives four summary distributions. 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 (Chart 4.1a).

At longer forecast horizons, of one to three months or six months to one year, the weight given to fundamentals increases (Charts 4.1b,c). At the longest forecast horizons, one year or longer (Chart 4.1d), 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. It can, however, be seen from Chart 4.1 that there is a persistent 2% of presumably 'pure' chartists who never use fundamentals at any horizon. At the same time, there is a larger persistent group (almost 10 %) of 'pure fundamentalists', who appear to use fundamentals alone, regardless of time horizon.

With regard to the question of whether survey participants regarded chartist and fundamental approaches to exchange rate analysis to be complementary or competing (Q6), only 8% 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 (Chart 4.2). Detailed figures for this question are shown in Table 4.4. A related point

(arising from interviews with chartists) was that while some may personally prefer to use exclusively charts, they still believed that in a global market sense the two methods are complementary.

This 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.(31) 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.'

Other comments explicitly highlighted the complementarity issue, linking it explicitly to the time horizon over which charts are used.

> 'Although fundamentals are the major factor when determining long dated views and positions, charts do have an advantage when determining shorter periods and spot currencies. Although effective in indicating trend

---

(31) These results on the complementarity of the two approaches concur with the summary of the Group of Thirty (1985) questionnaire which indicated different degrees of reliance on technical/fundamental approaches (p 45), 'Some state they consider both but do not rely on either: if the indications conflict, more weight is attached to fundamental factors.' This result is taken from the section questionning international industrial corporations with interest in the foreign exchange market: based on 50 replies of the 142 approached.

changes and highlighting trading opportunities, charts remain an indicator only and are used as confirmation of views/positions rather than a trading vehicle on its own.'

'Over the medium term, ie 6 months+, technical analysis is of dubious importance. Intraday, the relative strength or features of a move is more visible if one uses charts.'

'In the long term fundamentals will rule. But in the short term chartists will lead because dealers need a lead of some sort to base opinions/views on.'

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', discussed in Chapter 3, section 3.4.2.1.

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 the 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).

4.4: Conclusion

This chapter has described the design of a questionnaire sent widely to chief foreign exchange dealers in the London market, factors influencing its design and the questions to which it tried to find answers. How can the results be viewed?

The introduction to this chapter lists the three basic questions to which the questionnaire was designed to elicit answers. Probably the first and last of these were answered the most successfully - the results have shown which chartist techniques are most used in practice and given clear insights into market practitioners' views of chartism, in terms of time horizons, relation to fundamentals and (more impressionistionally) various general comments made.

The questions on the role of chartist practitioners (and economists) in the trading process yielded less clear results, partly because of the smaller response, and because it was not possible, at least in terms of the questionnaire used, to gain a precise picture of their amount and type of input into the trading decision. While it is clear that consideration of chartist opinion is widespread, any more specific conclusions as regards this have had to be drawn from the other, related, questions and from more impressionistic sources, such as interviews and the telephone survey. The main aim of the latter, however, was to build a database of actual chartist forecasts. This is described in the next chapter.

Table 4.1: Summary of responses to Questions 1 and 2.

Q1: "Which of the following chartist methods and services does your organisation use?"

a)	Moving average/trend following systems.	Y=137	N=74	NR=2
b)	Oscillators/momentum lines/ rate of change indicators	Y=85	N=126	NR=2
c)	Graphics packages	Y=76	N=132	NR=5
d)	Services	Y=138	N=74	NR=1
e)	Publications	Y=89	N=117	NR=7

Answer coding: Y = yes; N = no; NR = no response.

Q2: "Does your organisation use a particular chart company or analyst?"

Y = 45; N = 167; NR = 1

Listings of the particular services and publications specified cannot be given due to the commercial confidentiality commitments made.

Table 4.2: Summary of responses to Questions 3 and 4

Q3: "Does your organisation have any in-house economists?"

Y = 82; N = 131

(o/w 2 took positions; 74 acted only as advisers)

Q4: "Does your organisation have any in-house technical analysts?"

Y = 53; N = 160

(o/w 24 took positions, 18 acted only as advisers)

Table 4.3: Breakdown of responses to Question 5

Q5: "Please indicate the relative importance you attach to chartist/technical analysis versus fundamental (ie economic) analysis of currencies over the following forecasting horizons".

i) Percentage response for each point on scale

Scale: 0 = pure chartism to 10 = pure fundamentals

Forecast horizon		0	1	2	3	4	5	6	7	8	9	10
a)	Intraday	5.6	3.4	15.6	13.4	6.7	15.6	8.4	10.6	7.3	2.8	10.6
b)	1 week ahead	1.8	2.5	4.9	13.5	18.4	20.2	11.0	11.0	4.3	3.1	9.2
c)	1 month ahead	2.0	0.0	1.3	6.7	15.4	16.8	17.4	12.8	7.4	8.1	12.1
d)	3 months ahead	1.6	0.8	1.6	2.4	8.8	21.6	9.6	18.4	15.2	6.4	13.6
e)	6 months ahead	1.8	1.8	0.9	1.8	5.5	12.8	14.7	18.3	16.5	7.3	18.3
f)	1 year ahead	2.4	1.2	1.2	1.2	1.2	9.6	4.8	18.1	18.1	21.7	20.5
g)	Longer horizons	3.5	1.8	3.5	0.0	0.0	3.5	7.0	14.0	17.5	15.8	33.3

(ii) Listing of the total number of respondents who marked the scale at each horizon, and the number whom stated they did not take views over the particular horizon.

Forecast horizon		[A] Number marking scale	[B] Number no view	[C] Number no response (=213-A-B)
a)	Intraday	179	19	15
b)	1 week ahead	163	40	10
c)	1 month ahead	149	53	11
d)	3 months ahead	125	76	12
e)	6 months ahead	109	94	10
f)	1 year ahead	83	118	12
g)	Longer horizons	57	142	14

Table 4.4: Breakdown of responses to Question 6

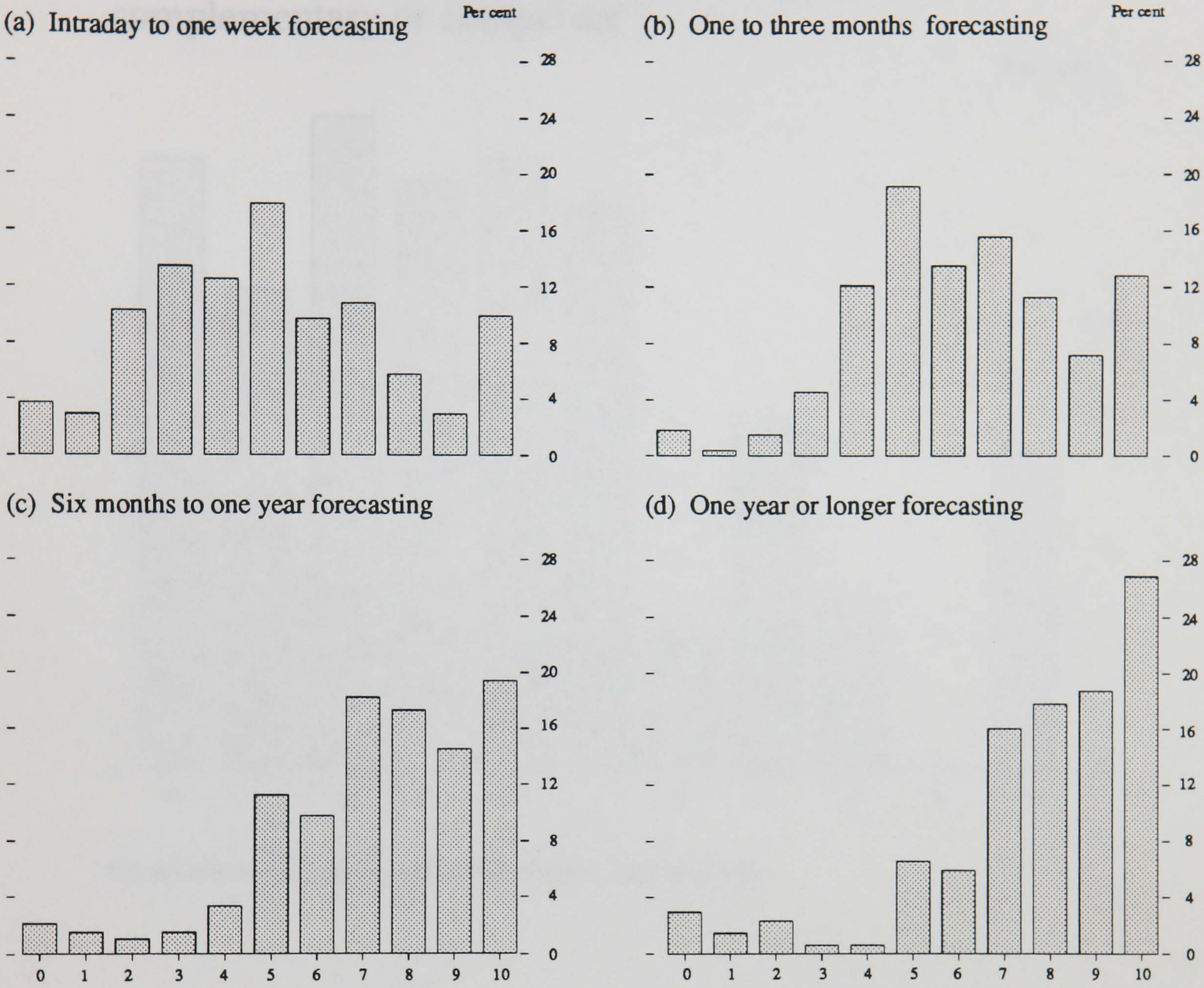
Q6: "Do you regard chartist/technical analysis and fundamental (ie economic) analysis of currencies to be complementary or competing tools of analysis?"

Scale : 0 = complementary to 10 = competing

	0	1	2	3	4	5	6	7	8	9	10
Percentages:	13.6	10.7	14.6	13.1	13.6	12.6	2.9	7.8	3.9	0	7.3

Of the 213 respondents, 206 marked the scale while 7 gave no view.

Chart 4.1
Perceived importance of chartism and fundamentals in foreign exchange forecasts (a)

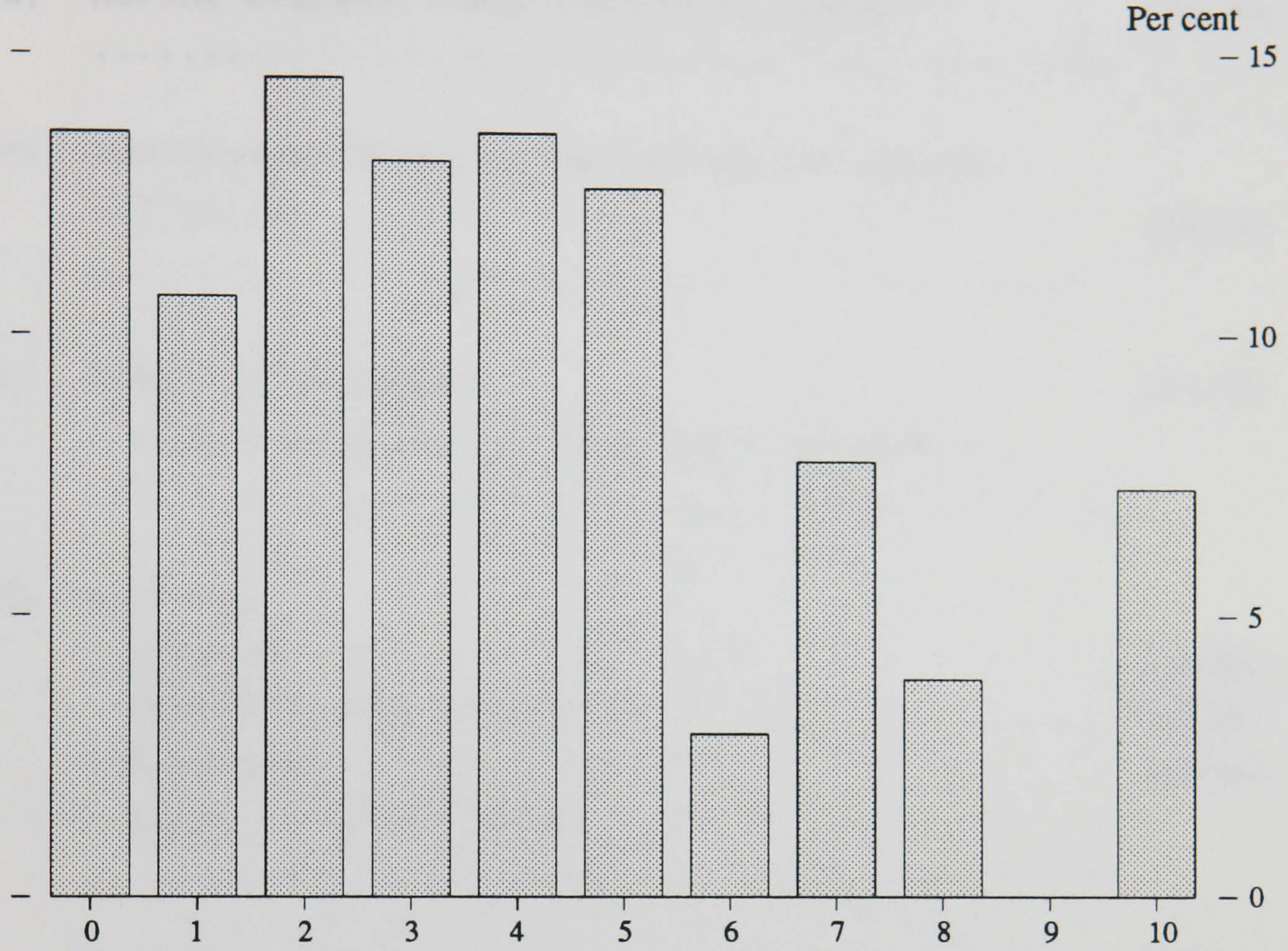


On the horizontal scale, 0 = pure chartism and 10 = pure fundamentals.

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

Chart 4.2

Is chartist and fundamental analysis regarded as complementary or competing ?



On the horizontal scale, 0=complementary to 10=competing

APPENDIX: Foreign Exchange Survey

FOREIGN EXCHANGE SURVEY - CONFIDENTIAL

1 Which of the following chartist methods and services does your organisation use? (Please feel free to add any comments which you feel to be relevant to each category.)

(a) Moving average/trend following systems Yes/No

.....

(b) Oscillators/momentum lines/rate of change indicators Yes/No

.....

(c) Graphics packages Yes/No

- please specify (eg Datastream graphics)

.....

(d) Services

- Fiamass Yes/No
- Telerate (state service) Yes/No
- Computrac Yes/No
- Other, please specify

.....

(e) Publications Yes/No

- Please specify

.....

2 Does your organisation use a particular chartist company or analyst? Yes/No

- If so, who? .....

3 Does your organisation have any in-house economists? Yes/No

- Do they take positions or act only as advisers?

- To what extent do they influence forex forecasts?

4 Does you organisation have any in-house technical analysts? Yes/No

- Do they take positions or act only as advisers?

- To what extent do they influence forex forecasts?

5 Please indicate the relative importance you attach to chartist/technical analysis versus fundamental (ie economic) analysis of currencies over the following forecasting horizons. (Mark scale at appropriate point.)

		Pure chartism — Pure fundamentals	OR: Do not take views over this period
(a)	Intraday		
(b)	1 week ahead		
(c)	1 month ahead		
(d)	3 months ahead		
(e)	6 months ahead		
(f)	1 year ahead		
(g)	Longer horizons		

6 Do you regard chartist/technical analysis and fundamental (ie economic) analysis of currencies to be complementary or competing approaches?

Complementary — Competing

7 Do you have any other comments concerning the relevance and use of chartist/technical analysis in the foreign exchange market?

Name ....

Organisation ....

Position ....Date ....

Please be assured that the name of you and your organisation will be treated in complete confidence. Please return by July 4th 1988 to: Helen Garnett, Bank of England, Economics Division 6/2 HO-4, Threadneedle Street, London, EC2R 8AH.

Many thanks for your co-operation.

5 AN ANALYSIS OF CHARTISTS' PREDICTIONS

5.1: Introduction

In the last chapter the actual practice of many chartists was analysed, from which it could be seen that practitioners draw upon a wide variety of techniques and hold differing views as to the nature and importance of chartism. While something of a broad consensus emerged regarding the weights given to charts at differing time horizons, there was sufficient heterogeneity in general to suggest that differences in views would be transmitted, and possibly magnified, in actual chartist advice. In the light of this variety of approaches to, and opinions regarding, the use of chartism, technical analysis appears to emerge as something of an art form which involves subjectively evaluating the gestalt of chartist advice and forming a view. Chartist advice surely is largely subjective and dependent in construction on the individual chartist's approach.

Nevertheless, given the perceived importance and widespread use of chartist advice in the London foreign exchange market it seemed important to analyse the characteristics of the advice itself. In order to do this it was therefore necessary to assemble a database of actual chartist advice in a form which could be analysed quantitatively, both to see the descriptive characteristics of the data and to analyse the nature of the expectations implied therein. The construction of the database and analysis of the data itself is the subject of this chapter.

The next section of this chapter describes the construction of the database and the reasons why the particular approach (a telephone survey) was adopted. The following section analyses the characteristics of the data itself using descriptive statistics with both graphical and tabular presentation, tests for unconditional bias and measures of qualitative accuracy. This is followed by analysis of the relative accuracy of the chartists in the sample using non-

parametric tests and an examination of the joint significance of forecasters' predictions. The penultimate section compares the chartist forecasts with other forecasting methods while the final section summarises and concludes.

5.2: Data construction

The above comments, and the foregoing chapters, reinforce the idea that there is no one absolute form of chartist advice/predictions. The subjective nature of the area make it unlikely that a tractable mathematical or statistical model would adequately reproduce chartist behaviour. 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). Other analysts, however, claim that they can hardly justify their positions unless they can give some specific prediction.

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, nor indeed to make one's own chart-based predictions.

In the light of these considerations, it was decided that the most representative way of collecting chartist advice was to construct a survey database of chartists' exchange rate expectations. This would enable each contributor to employ whichever methods were felt to be the most appropriate to the particular market situation.

A panel of chartists 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 described in the previous chapter.

The data collection was done by means of a weekly telephone survey, in which participants were asked to predict the level of the $/£, ¥/$ and DM/$ exchange rates one week and four weeks ahead. A telephone survey enabled the predictions to be gathered relatively quickly (mostly within an hour or so on Thursday morning), thus attempting to ensure near identical market conditions for each respondent's current information set. The time horizons over which predictors were requested (one and four weeks) were those over which chartism appeared to be most widely used as judged by (Q5 on) the questionnaire survey. (See Chart 4.1). Predictions one and four weeks ahead could also be evaluated for accuracy with relatively little time lag. The survey was conducted for nearly ten months (9 June 1988 - 2 March 1989), enabling results to be evaluated within a reasonable time horizon.

The three major bilateral rates were chosen as those to forecast since all chartists would hopefully have easy access to information about them and because they are probably the deepest markets in London. This latter point was recently evidenced by a comprehensive Bank of England survey of the London foreign exchange market. Of the business conducted throughout April 1989 (the survey period), bilateral sterling, D-Mark and yen transactions accounted for 27 %, 22 % and 15 % of principals' turnover respectively. (BEQB 1989, 'The market in foreign exchange in London', 29, 4, pp 531-535).

These arrangements, therefore, required the chartists to provide a total of six forecasts each week. While more detail may have been desirable, it was believed that too great a burden would have led to less initial cooperation and a high probability of drop-out. (In the event, only one chartist approached dropped out, after the first week).

The precise number of chartists participating in the survey, including the number involved, have to remain confidential to preserve anonymity. The number of chartists participating was between ten and twenty.

5.3: Description of the chartist forecasts.[32]

5.3.1: Graphical presentation

The sample median, high and low chartist forecast for each currency and time horizon, together with the actual rate that materialised, are shown in Charts 5.1a,b. The forecasts are shifted forward so that points vertically in line on the graphs compare predictions with actual outcomes. The precise data are listed in Tables 5.1a to 5.1c.

Several points can be made from the inspection of these figures. First, as would be expected, 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

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(32) Some of the caveats to the analysis presented should be stated. 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. All forecasters, however, 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 for or against chartists. Third, the 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, the analysis of chartist forecasts was confined to two horizons, although they would seem to cover the range over which most charts are widely used in the London foreign exchange market, as revealed by the questionnaire survey.

trending. This may well imply that chartist forecasts are more accurate in a trending market -and as such, had the survey been conducted, for example, in the period 1984-85 when the dollar was trending more markedly, the results may have shown a higher degree of accuracy. A third point is that a visual inspection of the graphs shows a tendency for the chartist to underpredict in a rising market and to overpredict in a falling market. This suggests that the average elasticity of expectations is less than unity -ie a 1% rise (fall) in the rate apppears to induce a less than expected 1% rise (fall) next period. This last point is made more formally in the next chapter.

5.3.2: Tests for unconditional bias

Statistical tests of unconditional bias[33] were performed by regressing the forecast errors on to a constant. The results for the four-week ahead predictions were computed using a method of moments correction to allow for overlapping forecast errors Hansen (1982).[34] Full results are shown in Tables 5.2a and 5.2b. All data were transformed into logarithms to produce scale-free results.

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(33) According to the so-called 'Siegel Paradox', (Siegel, 1972), forecasters cannot have unbiased expectations of both the future spot rate in terms of, say dollars per pound and in terms of pounds per dollar. Hence, $E(S_{t+4}|\Omega^t) \neq 1/E(1/S^{t+4}|\Omega^t)$. McCulloch (1975), however, showed that the operational aspects of this may be very slight, leading Siegel (1975) to reply, '...these problems should concern only the pure theorist, since, as McCulloch has shown, the distortions caused [by applying Jenson's inequality to an arbitrary choice of numeraire] are so small as to be empirically insignificant.'

(34) Since the errors in four (n) step ahead predictors are subject to a third order (n-1) moving average error, thus violating the $\Sigma = \sigma^2 I$ assumption. See further detail Appendix to Chapter 6.

This results shows whether the chartists systematically over or underpredict the future exchange rates at one and four week horizons. The hypothesis of zero unconditional bias could not be rejected at the 5 % significance level for four-week ahead forecasts, for all individuals and the median, although significant evidence of bias was shown in certain chartists' one-week predictions, particularly for the DM/$.

5.3.3: Qualitative accuracy

A guide to the qualitative accuracy of the chartist forecasts was given by calculating the number of times the direction of currency movement (ie appreciation/depreciation) was correctly predicted. The results of this analysis are tabulated in Table 5.3. The accuracy of the individual chartists for each currency at particular time horizons varied between 21 % and 69 %, with an average whole sample accuracy approximating 50 %.

Charts 5.2a and 5.2b present as a time series the aggregate qualitative accuracy of the forecasts at the one-week and four-week horizons, both for each currency and averaged across all chartists averaged across each month of the survey. These charts again suggest a tendency for 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 downtrend in the rate (Chart 5.1, DM). As the dollar shifts into an uptrend against the mark at the end of November, the average qualitative accuracy quickly shrinks for December (Chart 5.2a).

This analysis of course only measures whether the direction of movement predicted was correct and gives no indication to what extent different chartists were in general closer to or further from the true rate. The non-parametric tests reported next analyse the relative performance rankings.

5.4: Non-parametric tests of homogeneity of forecast accuracy

This section describes formal tests of whether there were systematic differences in the accuracy of forecasts among the panel. 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 (Charts 5.2a, 5.2b), 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, the (absolute) forecast errors are mapped 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. These ranks are then summed 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 (ie 2 time horizons by 3 currencies) 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.

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. (The exact value of the statistic and its degrees of freedom cannot be reported, since this would reveal the number of participants in the survey.) 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 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_1, 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 χ^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. This result, of course, should be treated with caution because of the problem of pre-test bias; there will always be a few forecasters who are apparently better than the rest purely by chance. A statistically better guide is therefore to use a test which avoids this problem of pre-test bias, and this is described in the section below.

5.5: Joint significance test of forecasters' predictions(35)

A test of the joint explanatory power of chartists was also conducted - and this test is not affected by the pre-test bias mentioned above. This involved regressing the actual change in the exchange rate on the change predicted by all individual chartists. Thus:

$$\Delta s_{t+i} = \alpha + \alpha_a \Delta s^{ae}_{t+i} + \alpha_b \Delta s^{be}_{t+i} + \ldots\ldots\ldots$$

where s_t is the (logarithm of) the spot rate of a particular currency at time t and $s_{t+i}{}^{ae}$ is the prediction of Chartist a (say) of the spot rate of that currency at time t+i.

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(35) This section was added at the suggestion of Robert Shiller.

An F-test was then performed of the significance of the whole regression. The results are reported in Tables 5.4a and b.

The results in general show siginificant rejection[36] of the null hypothesis of no explanatory power (Ho: α=0). This is clearest for the four week ahead estimates - while it holds for the one week predictions of ¥/$ and (nearly) for the DM/$, the test cannot reject the hypothesis that chartists' one week predictions of $/£ have no explanatory power.

Hence overall this test shows that the set of chartist forecasts do have explanatory power for the exchange rate, the statistical evidence suggesting that this is particularly so at the longer (four-week) horizon.

5.6: Comparison with other forecasting methods

The accuracy of chartist predictions can also be compared with various economic and statistical approaches, using the root mean square error (RMSE) of the forecasts of each. Comparisons have been made between the chartist forecasts themselves, and with forecasts generated from a random walk, the forward rate, ARIMA models and vector autoregression models. Results for the RMSEs of one and four-week ahead predictions are reported in Tables 5.5a and 5.5b respectively. This analysis was conducted with data transformed to logarithms, leaving the RMSEs in percentage terms.

5.6.1: Comparisons between chartists

The first obvious feature of Tables 5.5a and 5.5b 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

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(36) Note that Table 5.4 reports marginal significant levels: indicating rejection of the null if less than the desired significance level (say 0.05).

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 will outperform most individuals' views on aggregate.

5.6.2: Comparisons with random walk and forward rate

It is clear, however, that even the median view is generally unable to outperform a random walk. Chartist M, however, was consistently more accurate than the random walk - 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.(37) 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). This accords with findings elsewhere which point to the lack of information regarding the future spot rate which is contained in the forward rate (see Goodhart 1988).

5.6.3: Comparison with ARIMA models

The ARIMA forecasts reported were generated as follows. Six months of weekly data were used immediately prior to the forecast sample to identify and estimate initial ARIMA models (Box and Jenkins, 1971,1976). The models fitted were: $/£ ARIMA(1,1,1); DM/$ ARIMA(1,1,1); Y/$ ARIMA(1,1,0). 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

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(37) Although, as mentioned in Chapter 3, section 3.2, various studies (inter alia Wolff, 1987, and Schinasi and Swarmy, 1989) have found that by making various modifications to the models considered by Meese and Rogoff that revised formulations were able to outperform a random walk over certain periods

the survey sample, new ARIMA models were identified, and the process of successive re-estimation and forecasting was continued up to the end of the sample. The most appropriate ARIMA models for the rates up to the mid-point of the survey were ARIMA(1,1,2) for all currencies.

Re-identification and re-estimation of the ARIMA models as described above is, of course an approximation to re-identifying and re-estimating the models each time a new data point is added. In practice, however, it is unlikely that the models would change frequently under the latter method, since it would probably take a considerable weight of additional data to reject to original models. Another alternative would have been to re-estimate the models at intervals using a 'moving window' of data.

Looking at the results of the estimation according to the models described above, however, it is notable from Tables 5.5a and 5.5b that the ARIMA models estimated produced a higher RMSE than most chartists - demonstrating that chartism is more than simply an 'eye-ball Box-Jenkins' approach. Another feature of the ARIMA models was that their RMSEs exceeded that of the random walk, despite the fact that the former nests the latter. This is indicative of a time-varying process: while the ARIMA models would have performed better in-sample, its performance out of sample worsened as the data process shifted, leading to the comparative results reported.

5.6.4: Comparisons with vector autoregressions

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 - first an 'economic' VAR based upon the exchange rate, the interest rate differential (against the dollar) and relative stock market performance (against the US), and second a currency 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. Both completely unrestricted VARs and VARs employing Bayesian priors on the coefficients (Litterman, 1981) were estimated. On an unrestricted basis, the resulting forecast displayed a large error, but this was significantly reduced using the Bayesian technique. 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).

The results in Tables 5.5a and 5.5b 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.

5.7: Conclusion

This chapter has described the motivation for, and the construction of, a database of chartist forecasts. The resulting unique set of data has been subjected to a range of tests to analyse its nature and has been compared with other forecasting approaches.

The usual caveats inevitable to such a study[38] must of course be borne in mind - particularly the fact that the sample length is relatively short: as has

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(38) See section 5.3, footnote 32.

been seen (eg. in Chapter 3, section 3.3), such analytical results can differ over different periods. It is particularly felt that it would also have been interesting to observe strongly trending markets.

Bearing in mind these considerations, however, a recurring result throughout the analysis was the apparent difference in accuracy between the individual chartists. This was evidenced in both their qualitative (direction of movement) accuracy and in the size of their absolute errors. When compared with a range of other forecasting techniques, there is a range of results: with some chartists underperforming an array of standard economic and statistical approaches, while the best chartists even outperformed a random walk over the sample period. Overall, however, statistical tests show that there does appear to be information in the chartists' forecasts.

These results, suggesting a mixture of performance, can be related to the findings of the studies of the performance of forecasting services and technical trading rules discussed earlier in Chapter 3, section 3.3. These provided somewhat mixed results for the performance of services both in terms of 'market efficiency' and in comparison with other forecasting services.

Given this information, it seems logical to proceed by analysing the nature of their expectations, both individually and in aggregate. The next chapter therefore is devoted to testing the degree of rationality present in the forecasts, while the following chapter looks further into the nature of the implied expectations mechanisms.

Table 5.1a: Median and range of forecasts, $/£

$/£ week ahead estimates

DATE	TRUE(t)	MAX(t+1)	MIN(t+1)	MEDIAN(t+1)
9/6/88	1.8180			
16/6/88	1.7865	1.8500	1.7950	1.8375
23/6/88	1.7685	1.8025	1.7763	1.7895
30/6/88	1.7065	1.7775	1.7250	1.7434
7/7/88	1.7125	1.7400	1.6900	1.7100
14/7/88	1.6910	1.7500	1.7125	1.7425
21/7/88	1.7095	1.7500	1.6700	1.7030
28/7/88	1.7260	1.7700	1.6867	1.7150
4/8/88	1.7100	1.7550	1.6733	1.7260
11/8/88	1.6910	1.7450	1.6600	1.6850
18/8/88	1.6900	1.7450	1.6900	1.7133
25/8/88	1.6785	1.7150	1.6800	1.7000
1/9/88	1.6840	1.7120	1.6740	1.6840
8/9/88	1.7080	1.6970	1.6500	1.6800
15/9/88	1.6750	1.7750	1.7000	1.7100
22/9/88	1.6755	1.7970	1.6600	1.6850
29/9/88	1.6865	1.7435	1.6000	1.6675
6/10/88	1.6960	1.6950	1.6533	1.6800
13/10/88	1.7325	1.7200	1.6900	1.6995
20/10/88	1.7510	1.7600	1.7400	1.7500
27/10/88	1.7600	1.7850	1.7500	1.7700
3/11/88	1.7770	1.7850	1.7250	1.7500
10/11/88	1.7905	1.7950	1.7700	1.7850
17/11/88	1.8215	1.8200	1.7900	1.8023
24/11/88	1.8375	1.8450	1.8150	1.8400
1/12/88	1.8505	1.8500	1.8150	1.8250
8/12/88	1.8400	1.8700	1.8300	1.8500
15/12/88	1.8300	1.8700	1.8200	1.8510
22/12/88	1.8045	1.8600	1.8138	1.8350
29/12/88	1.7890	1.8400	1.8000	1.8045
5/1/89	1.8075	1.8340	1.7900	1.7998
12/1/89	1.7810	1.8300	1.7800	1.7950
19/1/89	1.7550	1.8200	1.7500	1.7900
26/1/89	1.7710	1.7900	1.7300	1.7500
2/2/89	1.7545	1.7905	1.7500	1.7650
9/2/89	1.7435	1.7700	1.7350	1.7500
16/2/89	1.7735	1.7700	1.7350	1.7600
23/2/89	1.7515	1.7830	1.7500	1.7675
2/3/89	1.7245	1.7555	1.7200	1.7500

$/£ month ahead estimates

DATE	TRUE(t)	MAX(t+4)	MIN(t+4)	MEDIAN(t+4)
9/6/88	1.818			
16/6/88	1.7865			
23/6/88	1.7685			
30/6/88	1.7065			
7/7/88	1.7125	1.8900	1.7500	1.7975
14/7/88	1.691	1.8450	1.7333	1.7548
21/7/88	1.7095	1.8000	1.7167	1.7738
28/7/88	1.726	1.7925	1.6700	1.6975
4/8/88	1.71	1.8000	1.6800	1.7000
11/8/88	1.691	1.7800	1.6500	1.7008
18/8/88	1.69	1.8000	1.6500	1.7215
25/8/88	1.6785	1.8250	1.6500	1.7450
1/9/88	1.684	1.8000	1.6200	1.6800
8/9/88	1.708	1.8000	1.5900	1.7100
15/9/88	1.675	1.7500	1.5600	1.7200
22/9/88	1.6755	1.7450	1.6200	1.6823
29/9/88	1.6865	1.7750	1.6500	1.6500
6/10/88	1.696	1.7500	1.6500	1.6800
13/10/88	1.7325	1.7100	1.6000	1.6500
20/10/88	1.751	1.7100	1.6000	1.6400
27/10/88	1.76	1.7100	1.6400	1.6875
3/11/88	1.777	1.7100	1.6700	1.6875
10/11/88	1.7905	1.7600	1.6500	1.7250
17/11/88	1.8215	1.7800	1.6900	1.7650
24/11/88	1.8375	1.8100	1.7000	1.7350
1/12/88	1.8505	1.8100	1.7500	1.7650
8/12/88	1.84	1.8300	1.7000	1.7950
15/12/88	1.83	1.8700	1.7500	1.8400
22/12/88	1.8045	1.8500	1.7000	1.8425
29/12/88	1.789	1.8900	1.7500	1.8710
5/1/89	1.8075	1.8800	1.7700	1.8550
12/1/89	1.781	1.8700	1.7800	1.8425
19/1/89	1.755	1.8500	1.7600	1.7850
26/1/89	1.771	1.8400	1.7600	1.7850
2/2/89	1.7545	1.8300	1.7600	1.7750
9/2/89	1.7435	1.8200	1.7400	1.7600
16/2/89	1.7735	1.7850	1.7000	1.7450
23/2/89	1.7515	1.8200	1.7000	1.7500
2/3/89	1.7245	1.7800	1.6900	1.7400
9/3/89	1.7200	1.7850	1.7100	1.7400
16/3/89	1.7185	1.8200	1.7400	1.7550
23/3/89	1.7225	1.8000	1.7200	1.7400

Table 5.1b: Median and range of forecasts, DM/$

DM/$ week ahead estimates

DATE	TRUE(t)	MAX(t+1)	MIN(t+1)	MEDIAN(t+1)
9/6/88	1.7185			
16/6/88	1.7530	1.7700	1.7000	1.7170
23/6/88	1.7790	1.7850	1.7425	1.7530
30/6/88	1.8290	1.8100	1.7500	1.7859
7/7/88	1.8220	1.8500	1.7783	1.8025
14/7/88	1.8450	1.8220	1.7600	1.7950
21/7/88	1.8505	1.8750	1.8100	1.8350
28/7/88	1.8490	1.8700	1.7950	1.8500
4/8/88	1.8750	1.8834	1.8350	1.8538
11/8/88	1.9155	1.9080	1.8450	1.8800
18/8/88	1.9125	1.9200	1.8450	1.8800
25/8/88	1.8920	1.9300	1.8820	1.9130
1/9/88	1.8775	1.9060	1.8550	1.8650
8/9/88	1.8430	1.9000	1.8613	1.8800
15/9/88	1.8790	1.8700	1.8000	1.8300
22/9/88	1.8745	1.9000	1.8400	1.8675
29/9/88	1.8780	1.8900	1.8625	1.8748
6/10/88	1.8625	1.8900	1.8600	1.8825
13/10/88	1.8355	1.8750	1.8500	1.8600
20/10/88	1.8110	1.8300	1.8000	1.8213
27/10/88	1.7744	1.8150	1.7900	1.8000
3/11/88	1.7785	1.8000	1.7600	1.7750
10/11/88	1.7635	1.7700	1.7400	1.7600
17/11/88	1.7230	1.7600	1.7400	1.7463
24/11/88	1.7160	1.7313	1.7000	1.7050
1/12/88	1.7360	1.7450	1.7000	1.7200
8/12/88	1.7600	1.7550	1.7200	1.7350
15/12/88	1.7370	1.7700	1.7300	1.7450
22/12/88	1.7720	1.7698	1.7300	1.7385
29/12/88	1.7895	1.7950	1.7500	1.7720
5/1/89	1.7875	1.7963	1.7675	1.7900
12/1/89	1.8285	1.8165	1.7850	1.8075
19/1/89	1.8695	1.8500	1.8100	1.8350
26/1/89	1.8430	1.9050	1.8240	1.8798
2/2/89	1.8625	1.8750	1.8000	1.8500
9/2/89	1.8720	1.8820	1.8500	1.8550
16/2/89	1.8440	1.8800	1.8350	1.8450
23/2/89	1.8355	1.8650	1.7500	1.8360
2/3/89	1.8360	1.8700	1.8000	1.8350

DM/$ month ahead estimates

DATE	TRUE(t)	MAX(t+4)	MIN(t+4)	MEDIAN(t+4)
9/6/88	1.7185			
16/6/88	1.7530			
23/6/88	1.7790			
30/6/88	1.8290			
7/7/88	1.8220	1.8000	1.6900	1.7675
14/7/88	1.8450	1.8167	1.6950	1.7663
21/7/88	1.8505	1.8333	1.7000	1.7650
28/7/88	1.8490	1.8500	1.7500	1.8050
4/8/88	1.8750	1.8400	1.7000	1.8300
11/8/88	1.9155	1.8900	1.7950	1.8060
18/8/88	1.9125	1.8750	1.7600	1.8000
25/8/88	1.8920	1.9500	1.7500	1.8200
1/9/88	1.8775	1.9300	1.8000	1.8750
8/9/88	1.8430	1.9550	1.8000	1.8730
15/9/88	1.8790	1.9800	1.8250	1.8800
22/9/88	1.8745	1.9375	1.8000	1.8550
29/9/88	1.8780	1.9500	1.7750	1.9000
6/10/88	1.8625	1.9200	1.7750	1.8400
13/10/88	1.8355	1.9250	1.8200	1.9000
20/10/88	1.8110	1.9800	1.8400	1.8925
27/10/88	1.7744	1.9200	1.8533	1.8900
3/11/88	1.7785	1.8900	1.8267	1.8700
10/11/88	1.7635	1.9000	1.7600	1.8150
17/11/88	1.7230	1.8500	1.7700	1.8100
24/11/88	1.7160	1.8200	1.7400	1.7850
1/12/88	1.7360	1.8100	1.7700	1.7800
8/12/88	1.7600	1.8500	1.7100	1.7525
15/12/88	1.7370	1.8000	1.6800	1.7125
22/12/88	1.7720	1.8000	1.6900	1.7100
29/12/88	1.7895	1.8000	1.6900	1.7175
5/1/89	1.7875	1.8000	1.7000	1.7425
12/1/89	1.8285	1.7800	1.7000	1.7425
19/1/89	1.8695	1.8220	1.7250	1.7750
26/1/89	1.8430	1.8300	1.7550	1.7875
2/2/89	1.8625	1.8250	1.7700	1.8200
9/2/89	1.8720	1.9000	1.8100	1.8450
16/2/89	1.8440	1.9250	1.8000	1.8950
23/2/89	1.8355	1.9250	1.8050	1.8625
2/3/89	1.8360	1.9500	1.8500	1.8900
9/3/89	1.8575	1.9500	1.8300	1.8800
16/3/89	1.8725	1.9500	1.8100	1.8463
23/3/89	1.8690	1.9200	1.7700	1.8550

Table 5.1c: Median and range of forecasts, ¥/$

YN/$ week ahead estimates

DATE	TRUE(t)	MAX(t+1)	MIN(t+1)	MEDIAN(t+1)
9/6/88	125.25			
16/6/88	126.20	126.25	123.50	124.75
23/6/88	128.65	128.00	125.25	126.20
30/6/88	133.70	131.50	127.00	129.75
7/7/88	133.60	135.00	128.75	131.25
14/7/88	132.90	133.60	129.50	130.00
21/7/88	133.20	135.00	131.00	132.50
28/7/88	131.65	134.00	127.50	133.10
4/8/88	132.85	134.20	130.00	131.65
11/8/88	134.45	135.50	129.50	133.00
18/8/88	134.05	134.25	129.50	132.50
25/8/88	134.30	135.00	133.00	134.50
1/9/88	136.50	136.25	131.50	132.50
8/9/88	133.65	140.00	133.38	136.75
15/9/88	134.60	135.00	127.50	133.00
22/9/88	134.20	135.00	131.25	133.65
29/9/88	134.20	135.00	133.10	134.25
6/10/88	133.45	135.00	132.50	134.50
13/10/88	128.90	138.80	130.40	133.23
20/10/88	127.30	130.00	125.00	127.00
27/10/88	125.70	128.00	124.00	126.63
3/11/88	124.55	127.00	125.00	126.00
10/11/88	124.20	126.50	123.00	124.69
17/11/88	122.50	124.00	122.50	123.00
24/11/88	121.35	123.00	120.00	121.00
1/12/88	121.90	122.25	120.00	121.50
8/12/88	123.35	124.00	121.00	121.25
15/12/88	122.70	124.50	121.00	123.00
22/12/88	124.65	124.40	121.50	122.85
29/12/88	125.40	125.50	123.00	124.65
5/1/89	125.00	125.88	123.38	125.07
12/1/89	126.10	126.25	124.75	125.87
19/1/89	128.45	126.50	125.00	126.00
26/1/89	127.75	130.00	125.60	126.23
2/2/89	129.60	130.00	126.00	128.00
9/2/89	129.65	131.50	126.90	129.00
16/2/89	126.40	130.50	126.50	127.75
23/2/89	126.55	127.50	125.00	126.40
2/3/89	128.10	129.00	121.00	126.25

YN/$ month ahead estimates

DATE	TRUE(t)	MAX(t+4)	MIN(t+4)	MEDIAN(t+4)
9/6/88	125.25			
16/6/88	126.20			
23/6/88	128.65			
30/6/88	133.70			
7/7/88	133.60	128.00	120.00	126.13
14/7/88	132.90	129.50	122.50	126.20
21/7/88	133.20	132.10	124.00	128.33
28/7/88	131.65	138.00	126.00	133.38
4/8/88	132.85	137.50	125.00	132.50
11/8/88	134.45	137.00	125.00	132.13
18/8/88	134.05	135.00	125.00	130.88
25/8/88	134.30	140.00	120.00	130.50
1/9/88	136.50	139.00	126.50	132.00
8/9/88	133.65	140.00	126.50	132.50
15/9/88	134.60	139.00	129.50	133.00
22/9/88	134.20	138.50	130.00	132.00
29/9/88	134.20	140.00	130.00	140.00
6/10/88	133.45	138.00	132.00	136.50
13/10/88	128.90	137.50	130.00	137.00
20/10/88	127.30	140.00	132.50	135.50
27/10/88	125.70	137.00	130.30	134.50
3/11/88	124.55	136.00	128.20	134.00
10/11/88	124.20	132.00	123.00	127.00
17/11/88	122.50	131.00	125.00	126.50
24/11/88	121.35	130.00	123.90	125.25
1/12/88	121.90	126.00	123.50	125.00
8/12/88	123.35	130.00	122.50	123.40
15/12/88	122.70	127.50	120.00	121.00
22/12/88	124.65	128.00	120.00	120.00
29/12/88	125.40	128.00	119.00	120.50
5/1/89	125.00	128.00	120.00	122.50
12/1/89	126.10	126.00	121.50	123.00
19/1/89	128.45	129.70	121.30	124.83
26/1/89	127.75	129.10	123.25	126.08
2/2/89	129.60	128.50	124.00	127.00
9/2/89	129.65	128.00	125.00	128.00
16/2/89	126.40	133.00	123.00	130.00
23/2/89	126.55	131.50	125.90	128.50
2/3/89	128.10	135.00	128.00	129.00
9/3/89	128.70	134.00	127.00	129.50
16/3/89	130.60	130.50	125.67	127.50
23/3/89	131.10	133.00	123.00	127.75

Table 5.2a: 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 5.2b: Testing for unconditional bias:[a]

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

	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 5.3: 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(b)	55	63	55	50	42	47
Average accuracy(b)	51	57	51	46	47	49
Standard deviation of accuracy(b)	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.

(b) Whole sample.

Table 5.4a: Testing for joint significance of forecasters' predictions: One week ahead predictions[(a)]

	R^2	DW	Q	F(excl.constant)
$/£	0.168	1.559	21.670 (0.117)	0.775 (0.598)
DM/$	0.390	2.213	11.551 (0.713)	2.447 (0.561E-1)
Y/$	0.480	2.535	8.717 (0.892)	3.538 (0.125E-1)

(a) Figures in parentheses indicate the marginal significance levels

Table 5.4b: Testing for joint significance of forecasters' predictions: Four week ahead predictions[(a)]

	R^2	DW	Q	F (excl constant)
$/£	0.502	1.089	17.103 (0.146)	55.643 (0.00)
DM/$	0.537	0.824	56.437 (0.999E-1)	99.099 (0.00)
Y/$	0.373	0.765	44.937 (0.106E-4)	12.685 (0.26E-1)

(a) Figures in parentheses indicate the marginal significance levels.

Table 5.5a: 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	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

Table 5.5b: Comparison of % RMSE of 4 week chartist forecasts with other forecasting approaches

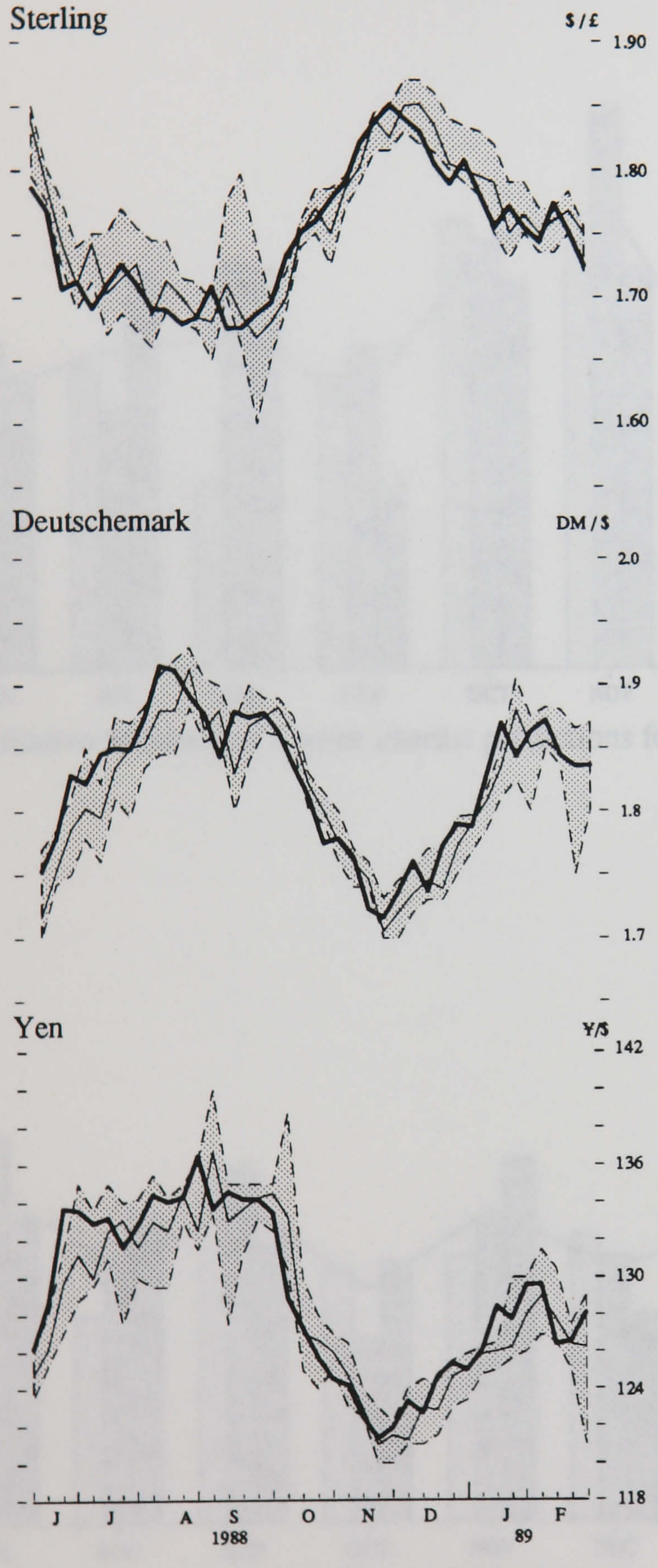
Representative selection of individual chartist forecasts and whole sample median, compared with ARIMA, random walk, four VAR approaches and the forward rate.

	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	2.81	3.18	3.12
Forward rate	2.71	3.07	3.10
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

Chart 5.1
Chartist forecasts: one week and four weeks ahead

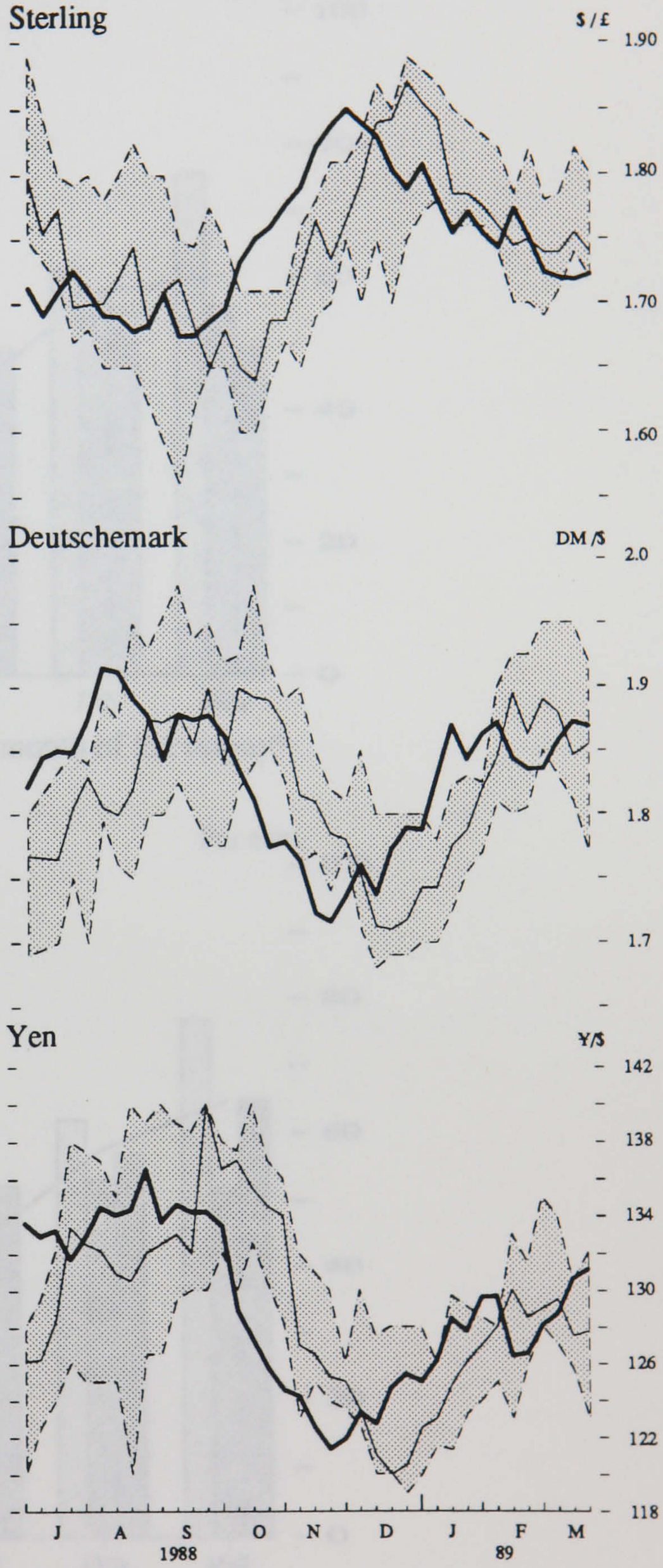
Actual rate
Median chartist forecast
Range of forecast (high to low)

One week ahead (a)



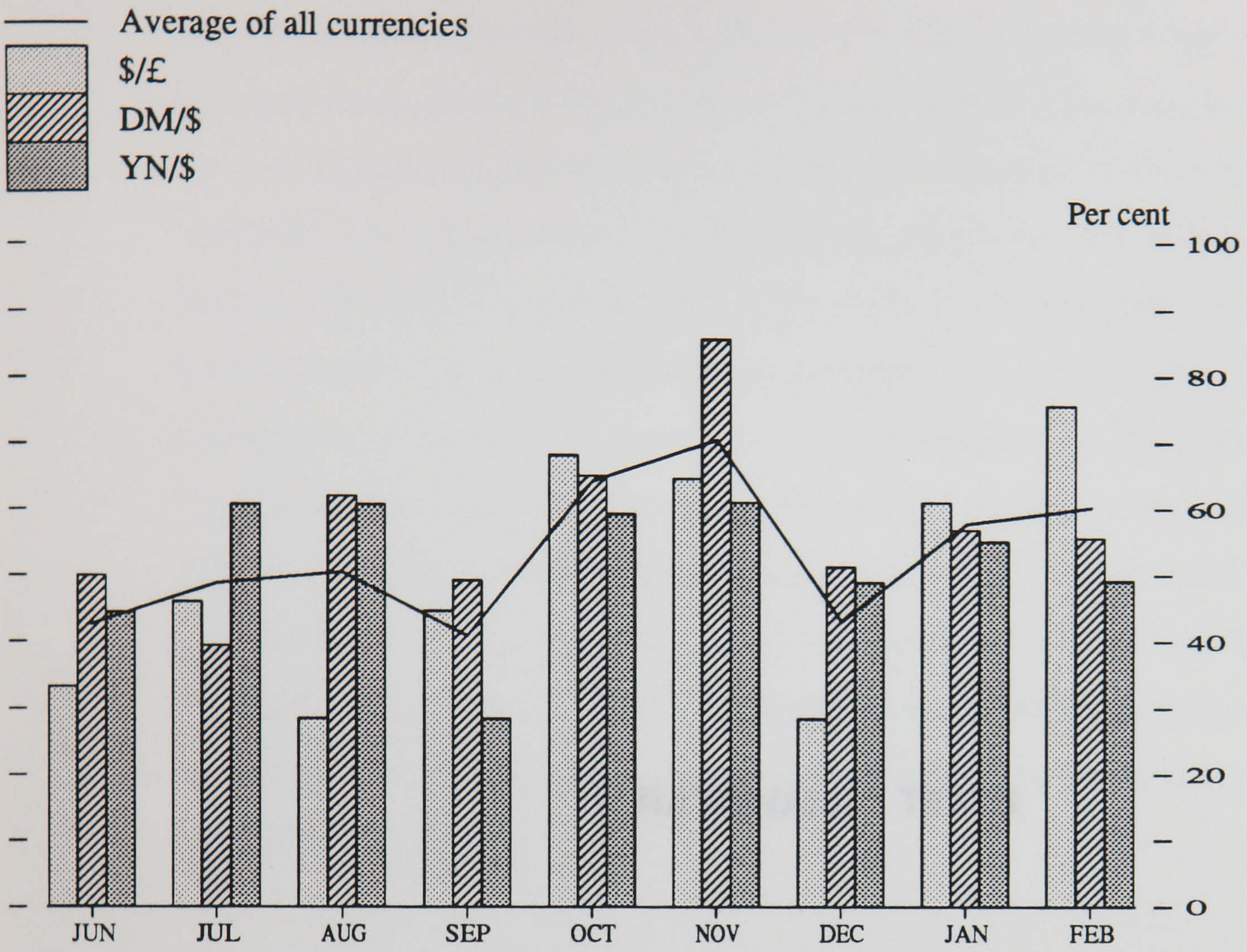
(a) Actual rate plotted at time t, forecasts plotted at time t + 1.

Four weeks ahead (b)

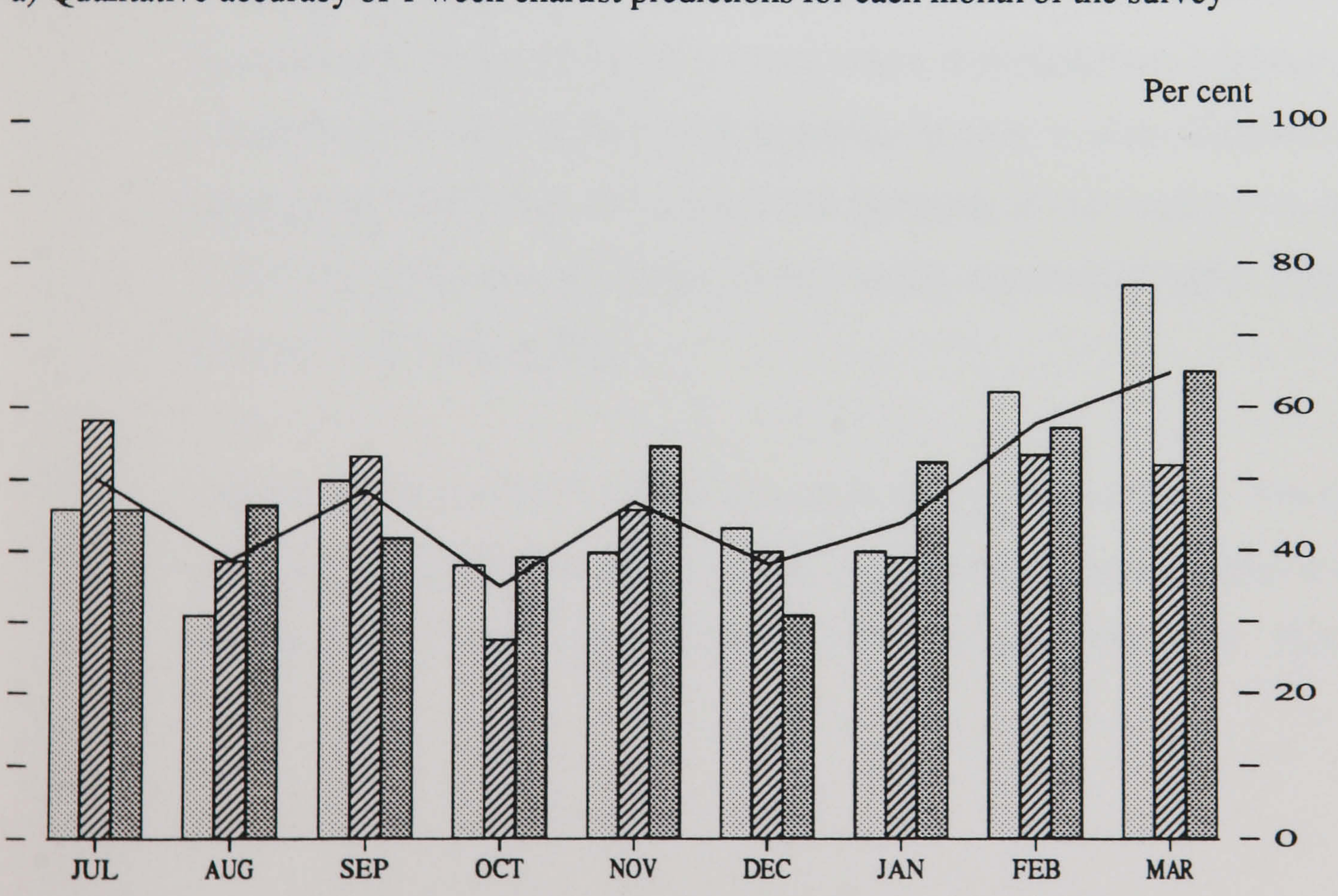


(b) Actual rate plotted at time t, forecasts plotted at time t + 4.

Chart 5.2:
Aggregate qualitative accuracy of chartist forecasts



a) Qualitative accuracy of 1 week chartist predictions for each month of the survey*



b) Qualitative accuracy of 4 weeks chartist predictions for each month of the survey*

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

6 RATIONALITY TESTS

6.1: Introduction

As was discussed in the concluding comments of the previous chapter, having subjected both the individual and aggregate chartist forecasts to an array of tests of accuracy and comparisons, it seems logical to test the degree of rationality underlying these results. The key issue is: do chartists fully utilise the available information set when they make their forecasts? There are several levels at which this issue can be investigated - (see eg. Fama (1970, 1976) for a discussion of the possible categorisations of efficient uses of information) but two questions are particularly pertinent to the current analysis. First, do chartists take full account of the past price history of the asset, by using information from their own past forecast errors in their current forecasts? Second, does this price information incorporate available fundamental information so as to support the chartist tenet that the 'price discounts everything'?

These questions of rationality are crucial to the study of chartism. The popular perception of chartism among economists is probably of it being somewhat irrational and divorced from fundamental factors, a view expressed by The Economist, 'Technical analysis is the alchemy of the modern investment world ... like any other cult [chartism] is not overly worried by logic.' (The Economist, 30.1.88 - 5.2.88, p 65).

The theory of chartism, however, would suggest otherwise: the crucial reason why chartists claim it is valid to look at price movements alone is because it is believed that all relevant information is reflected in the price. Recalling

Chapter 2, a tenet of Dow theory is that 'the averages discount everything'(39) , and more generally in chartism that, 'the price discounts everything', hence for these to be valid propositions some degree of rational behaviour as specified above ought to be evidenced.

This chapter next (section 6.2) discusses the method used to test whether the chartist forecasts did display rationality, then the ensuing empirical results are reported and their implications discussed in the third section. Section 6.4 concludes.

6.2: Method of testing rationality of forecasts

The basic method of testing for rationality is thus: if chartists are rational, accounting for available information, then their current forecast errors should be uncorrelated with their past known forecast errors (Shiller, 1978); regressing the former on (lags of) the latter should hence produce insignificant coefficients. On a wider level, fundamental information available at the time the forecasts were made should also be fully included in current forecasts - testing this tests whether the price does indeed 'discount everything'.

Given the database of chartists' expectations described in Chapter 5, it is possible to carry out these rationality tests directly both for the individual forecasters and for the median forecasts. It is unusual, when analysing survey

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(39) A quotation from Hamilton, colleague of Dow, sums up this concept. Referring to stock prices, it is claimed that they, 'take account of dear money and pig iron furnace operations, together with crop prospects, grain prices, bank clearings, merchants' collections, political prospects, foreign trade, savings bank figures, wages, volume of railroad freight and a hundred and one other things. The average price of active stocks is the result of all of this, impartially reflected in a market which no interest is big enough to influence.' (Wall Street Journal editorial, July 15 1924.) Quoted in Rhea, 1932b.

data, to be able to analyse the forecasts of individuals. Aggregation at an early stage or confidentiality requirements often preclude this. The papers of Frankel and Froot discussed in earlier chapters, for example, were restricted to using the sample median for their studies of investors' expectations using survey data from Money Market Services (MMS), American Express and The Economist, data which is discussed in Frankel and Froot, 1987a. Further, direct point estimates of specific exchange rates are not always available. For example Taylor (1988) in his study of investment managers' views had to use the Carlson - Parkin (1975) method to obtain a quantitative expectations series, since the source survey data was expressed in three-category response form (ie 'up', 'down' or 'same').(40)

Extending the framework of Fama (1970),(41) the following classification was devised to judge whether chartists' advice 'fully reflected' information available to them. Weak form rationality would not be rejected if the forecaster made efficient use of the information in the past movements of the particular rate: ie. if the information from his past forecast errors in the currency he was

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(40) Results of studies analysing survey data of foreign exchange expectations were discussed in Chapter 3, section 3.5.

(41) Fama (1970) made the following classification. Weak form tests concerned the information subset of the past price history alone. Semi-strong form tests included publically available information, while strong form tests also included the use of information to which the agent had private access.

Fama's definition of efficiency in his 1970 paper was that a market is efficient if all the information in set Φ is 'fully reflected' in securities prices. In a later book (Fama 1976), he modified this definition to state that a market is efficient if all relevant information is used to determine securities prices, and that the information is used correctly. The market would hence act as if it had rational eexpectations. A survey of the development of these arguments is given in Leroy (1989).

forecasting were efficiently used. Semi-weak form rationality would be judged by whether the chartist used information on the past movements of all rates he was forecasting: ie. his forecast errors in all currencies. Semi-strong form rationality was to be evidenced by the above plus the use of relevant, fundamental, publically available information in the form of stock market and interest differentials. These concepts can be expressed mathematically.

Let the set of the last two forecast errors at the j-week horizon, for the i-th individual and the k-th currency at time t be denoted Ω (i,j,k,t):

$$\Omega (i,j,k,t) = \{ e^{i}_{j,k,t-j} , e^{i}_{j,k,t-j-1} \}$$

Then weak rationality would imply that $e^{i}_{j,k,t}$ is orthogonal to Ω (i,j,k,t):

$$e^{i}_{j,k,t} \perp \Omega (i,j,k,t) \qquad (6.1)$$

Semi-weak rationality would require:

$$e^{i}_{j,k,t} \perp U^{n}_{k=1} \Omega (i,j,k,t) \qquad (6.2)$$

(where n currencies are considered). Let F(j,k,t) denote the set containing data on relative stock market indices and interest rates for the j-th and (j+1)-th lags:

$$F(j,k,t) = \{m_{t-j} - m^{k}_{t-j}, \; m_{t-j-1} - m^{k}_{t-j-1} , i_{t-j} - i^{k}_{t-j}, i_{t-j-1} - i^{k}_{t-j-1}\}$$

where m and i denote the stock market index and three month Euro-deposit rates for the US, and m^{k} and i^{k} denote the same variables for the country of the k-th currency. Then semi-strong form efficiency would require:

$$e^{i}_{j,k,t} \perp F(j,k,t) \cup U^{n}_{i=1} \Omega (i,j,k,t) \qquad (6.3)$$

It would be expected a priori that chartists would be at least weakly rational if they discount past price information. If it were the case that prices do 'discount everything', then they should furthermore display stronger forms of rationality.

The tests themselves were carried out using the following regressions. In order to test (6.1), the chartist's current forecast error in the particular currency was regressed upon his last two known errors in that same currency. A test of the significance of the whole regression was then conducted.(42) For semi-weak rationality (6.2), the chartist's two lagged forecasts errors from the other two currencies were included in the regressions above. Semi-strong form tests (6.3) also included (two lags of) the stock market and interest differential of the particular currency's country with the US. Thus the series of tests was fully nested. The full series of regressions is specified below.

i) For weak rationality

$$e^{i}_{j,k,t} = \alpha_0 + \alpha_1 e^{i}_{j,k,t-j} + \alpha_2 e^{i}_{j,k,t-j-1} \qquad (6.4)$$

calculated for chartists i=1,..,n; for currencies k=1,..,3 and time horizons j=1,4.

(Where, as above, $e^{i}_{j,k,t} = s_t - {}_{t-j}s^{e}_{t}$ ie the forecast error for the i-th individual at the j week horizon and the k-th currency).

ii) For semi-weak rationality

$$e^{i}_{j,k,t} = \alpha_0 + \sum_{k=1}^{3} \alpha_k e^{i}_{j,k,t-j} + \sum_{k=1}^{3} \alpha_{k+3} e^{i}_{j,k,t-j-1}$$

calculated for chartists i=1,...,n and time horizon, j=1,4

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(42) Constants were included in all regressions, but the χ^2-test of the whole regression excluded the constant.

ii) For semi-strong rationality

$$e^{i}_{j,k,t} = \alpha_0 + \sum_{k=1}^{3} \alpha_k \, e^{i}_{j,k,t-j} + \sum_{k=1}^{3} \alpha_{k+3} \, e^{i}_{j,k,t-j-1}$$

$$+\alpha_7 \, (m_{t-j} - m^{k}_{t-j}) + \alpha_8 \, (m_{t-j-1} - m^{k}_{t-j-1})$$

$$+ \alpha_9 \, (i_{t-j} - i^{k}_{t-j}) + \alpha_{10} \, (i_{t-j-1} + i^{k}_{t-j-1}) \qquad (6.6)$$

For chartists i=1,..,n and time horizons j=1, 4

(Where m and i are defined as above in the components of equation 6.3).

6.3: Results and implications

The estimation results for the one-week ahead forecasts are shown in Tables 6.1a-g and those for four-week forecasts in Tables 6.2a-f.[43] Each Table displays the results for individual chartists, moving from weak to semi-strong rationality tests. The one week ahead predictions used the White (1980) correction for heteroscedacity, while the four week ahead predictions were computed using a method of moments correction to allow for overlapping forecast errors, (Hansen 1982). See the Appendix to this chapter.

The general results apparent from these tables is that the hypothesis that the chartists are rational (the regressors have no explanatory power over the errors) cannot be rejected most often for the weak tests at the one-week horizon,[44] while the same hypothesis is rejected most often on the semi-strong tests at the four week horizon. The general pattern to emerge is that of

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(43) Note that these tables report marginal significance levels: indicating rejection of the null if less than the desired significance level (say 0.05).

(44) Of course, these tests do not escape the caveat of Shiller (1978), ie that there may be some piece of information, which is not considered, which may not be orthogonal and to the forecast error.

chartists tending to display evidence of weak rationality, but becoming markedly less rational as the information set is expanded. This pattern is common to both one and four-week forecasts, the difference between the two being that at the one week horizon the information set usually has to be larger for the rationality hypothesis to be rejected.

These results can perhaps be linked to the findings reported in Chapter 4, in which market participants' preferences for the use of chartism as opposed to fundamentals was particularly skewed towards charts for the one week or less timescale.

The results reported above hold reasonably consistently for the individual and median forecasts. It is also interesting to note that Chartist M violates rationality in a similar way to the other chartists, yet displayed a relatively high degree of accuracy in the tests reported in Chapter 5. It is clearly possible to be irrational and accurate, as well as being irrational and inaccurate. All the chartists displayed some (albeit slight) evidence of rationality at four-weeks in terms of accommodating their past errors in the currency in question, but became notably irrational once the information set was widened beyond that. For both sets of forecasts, the median appeared representative of the illustrated individuals.

It should be noted that the semi-strong rationality tests are using the same type of information as in the 'economic' VARs with which the chartist forecasts were compared in Chapter 5, section 5.6.4. The fact that some chartists outperformed the VAR (both restricted and unrestricted) yet were 'irrational' at the same four-week horizon is indicative of there being some pieces of information in the VAR which were not incorporated into their forecasts, notwithstanding the fact that their own forecasts are more efficient than the VAR forecasts.

6.4: Conclusion

The results reported offer some support for the 'weak' rationality of chartism, particularly over a very short horizon (one week), which ties in with the fact that market participants are inclined to give chartism greater weight in their decisions at the shorter horizons. At the four week horizon, however, the history of the price series and subsequent forecast errors were apparently being utilised less. This is evidence of irrationality of chartist views, even at the relatively short horizon of four weeks. Furthermore, even basic fundamental information was not being included in most forecasts, so could not have been incorporated in the price in the manner which chart theory suggests.

Overall, the result that rationality was less often rejected at the one-week horizon is further evidence to chartism having most value as a short-term forecasting tool. This supports the view of the majority of market participants surveyed in the questionnaire survey analysed in Chapter 4. On the evidence analysed here, though, the clearest result is that the hypothesis of rationality is generally rejected as the information set is expanded, and that rejection occurs sooner at the longer horizon.

In the next chapter, various alternative methods of forming expectations are examined and tested for, with particular emphasis on the question of whether there is any evidence that the use of chartism may exert a destabilising influence upon the market.

Table 6.1a: Rationality Tests for Chartist A, 1 week ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.041	2.020	9.814 (0.831)	5.963 (0.113)	1.574 (0.455)
DM	0.016	2.000	13.926 (0.531)	6.468 (0.909E-1)	0.347 (0.841)
Y	0.036	2.048	8.136 (0.918)	5.947 (0.114)	1.351 (0.509)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.172	2.026	13.026 (0.600)	0.330 (0.999)	0.212 (0.999)
DM	0.120	2.043	8.985 (0.878)	13.704 (0.567E-1)	6.538 (0.366)
Y	0.212	2.072	6.883 (0.961)	20.902 (0.392E-2)	8.541 (0.201)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.293	2.055	8.225 (0.914)	33.254 (0.478E-3)	32.501 (0.330E-3)
DM	0.218	2.081	10.164 (0.809)	18.485 (0.710E-1)	14.830 (0.138)
Y	0.279	1.986	5.762 (0.983)	35.010 (0.247E-3)	14.040 (0.171)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.1b: Rationality Tests for Chartist B, 1 week ahead predictions[a]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.005	2.004	11.445 (0.720)	1.719 (0.633)	0.216 (0.898)
DM	0.013	2.047	12.316 (0.655)	2.198 (0.532)	0.458 (0.796)
¥	0.039	2.070	13.047 (0.599)	2.419 (0.490)	1.739 (0.419)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.117	1.995	7.419 (0.945)	0.122E-2 (0.999)	0.878E-3 (0.999)
DM	0.144	1.914	15.616 (0.408)	18.520 (0.983E-2)	10.461 (0.107)
¥	0.076	2.035	8.332 (0.909)	5.504 (0.599)	3.221 (0.781)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.345	2.220	11.520 (0.715)	41.324 (0.212E-4)	39.050 (0.249E-4)
DM	0.349	2.248	18.105 (0.257)	44.962 (0.493E-5)	31.035 (0.579E-3)
¥	0.142	1.964	7.814 (0.931)	13.292 (0.275)	10.264 (0.418)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.1c: Rationality Tests for Chartist H, 1 week ahead predictions[a]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.029	1.964	18.161 (0.254)	1.306 (0.728)	1.064 (0.587)
DM	0.135	1.958	6.615 (0.967)	6.227 (0.101)	6.160 (0.460E-1)
¥	0.124	1.981	11.499 (0.717)	6.320 (0.970E-1)	5.373 (0.681E-1)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.203	2.091	10.282 (0.802)	0.198E-2 (0.999)	0.186E-2 (0.999)
DM	0.282	1.956	11.389 (0.725)	31.277 (0.553E-4)	31.264 (0.226E-4)
¥	0.215	2.077	10.807 (0.766)	18.062 (0.117E-1)	15.377 (0.175E-1)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.389	2.029	17.506 (0.299)	52.766 (0.198E-6)	52.672 (0.857E-7)
DM	0.379	1.908	10.986 (0.754)	50.743 (0.460E-6)	49.253 (0.366E-6)
¥	0.229	2.172	10.102 (0.813)	23.902 (0.132E-1)	18.989 (0.404E-1)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.1d: Rationality Tests for Chartist L, 1 week ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags on same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.319	1.879	11.028 (0.751)	16.238 (0.101E-2)	15.827 (0.366E-3)
DM	0.067	1.831	8.623 (0.896)	4.665 (0.198)	2.465 (0.292)
Y	0.141	1.991	13.473 (0.566)	4.903 (0.179)	4.287 (0.117)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.453	2.064	9.725 (0.837)	0.588 (0.999)	0.517 (0.999)
DM	0.217	1.864	10.126 (0.812)	19.182 (0.764E-2)	15.382 (0.178E-1)
Y	0.189	1.934	13.180 (0.588)	14.531 (10.425E-1)	12.656 (0.488E-1)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.542	2.037	7.093 (0.955)	196.009 (0.000)	195.777 (0.000)
DM	0.288	1.837	10.157 (0.810)	44.612 (0.568E-5)	36.288 (0.751E-4)
Y	0.270	1.947	14.385 (0.497)	36.921 (0.119E-3)	36.880 (0.594E-4)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.1e: Rationality Tests for Chartist M, 1 week ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags on same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.080	1.942	17.567 (0.286)	8.241 (0.413E-1)	3.985 (0.140)
DM	0.124	1.958	10.905 (0.759)	1.212 (0.106E-1)	5.186 (0.748E-1)
¥	0.111	1.998	14.149 (0.514)	5.912 (0.116)	5.540 (0.627E-1)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.220	2.072	18.675 (0.229)	13.721 (0.564E-1)	12.950 (0.438E-1)
DM	0.355	1.988	10.796 (0.767)	53.812 (0.000)	45.629 (0.000)
¥	0.212	1.967	12.595 (0.634)	23.642 (0.132E-2)	20.903 (0.191E-2)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast error lags in all currencies + 2 lags of stock market and interest differentials)

£	0.378	2.326	29.456 (0.140E-1)	37.668 (0.890E-4)	33.268 (0.246E-3)
DM	0.452	1.506	9.566 (0.846)	62.691 (0.000)	57.914 (0.000)
¥	0.451	1.907	20.686 (0.147)	53.179 (0.167E-6)	50.330 (0.232E-6)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.1f: Rationality Tests for Chartist P, 1 week ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.025	1.877	8.430 (0.866)	1.363 (0.714)	1.105 (0.576)
DM	0.042	2.011	5.166 (0.983)	3.470 (0.325)	1.660 (0.436)
¥	0.053	1.970	8.611 (0.855)	5.139 (0.162)	5.109 (0.777E-1)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

£	0.073	1.860	8.756 (0.846)	5.953 (0.545)	5.694 (0.458)
DM	0.301	2.108	10.318 (0.739)	22.526 (0.206E-2)	18.628 (0.484E-2)
¥	0.187	1.911	8.095 (0.884)	20.764 (0.414E-2)	18.320 (0.548E-2)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.246	0.192	10.615 (0.716)	16.879 (0.112)	16.156 (0.953E-1)
DM	0.367	2.145	10.640 (0.714)	70.482 (0.000)	50.210 (0.244E-6)
¥	0.332	2.036	7.291 (0.923)	56.866 (0.352E-7)	35.137 (0.118E-3)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.1g: Rationality Tests for median chartist forecast, 1 week ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.015	2.043	10.772 (0.769)	1.219 (0.749)	0.459 (0.795)
DM	0.047	2.059	14.387 (10.496)	5.879 (0.118)	2.049 (0.359)
Y	0.109	2.059	2.311 (0.949E-1)	10.950 (0.120E-1)	8.612 (0.135E-1)

(ii) Semi-weak rationality (Regressing forecast error lags in 2 aim forecast error lags all three currencies)

£	0.140	2.167	9.768 (0.834)	0.832 (0.999)	0.692E-3 (0.999)
DM	0.260	1.892	16.782 (0.332)	35.086 (0.108E-4)	20.791 (0.200E-2)
Y	0.193	2.016	9.030 (0.876)	14.710 (0.399E-1)	11.450 (0.754E-1)

(iii) Semi-strong rationality (Regressing forecast error on 2 aim forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.333	2.299	14.163 (0.513)	22.267 (0.224E-1)	21.880 (0.157E-1)
DM	0.367	1.897	13.348 (0.575)	61.056 (0.000)	35.530 (0.101E-3)
Y	0.247	1.868	10.337 (0.798)	22.772 (0.190E-1)	17.245 (0.691E-1)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.2a: Rationality Tests for Chartist A, 4 week ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	DW	Q		χ^2 (including constant)	χ^2 (excluding constant)
£	0.299	0.507	91.489 (0.00)	12.289 (0.646E-2)	10.433 (0.543E-2)
DM	0.188	0.498	66.89 (0.492E-1)	6.130 (0.105)	5.932 (0.515E-1)
¥	0.073	0.866	59.163 (0.164E-6)	3.673 (0.299)	2.960 (0.228)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.498	0.765	50.312 (0.541E-5)	90.480 (0.00)	59.046 (0.00)
DM	0.372	0.665	42.476	34.944 (0.115E-4)	30.401 (0.330E-4)
¥	0.330	1.152	24.140 (0.441E-1)	35.780 (0.798E-5)	21.868 (0.128E-2)

(iii) Semi-strong rationality (Regressing forecast error in 2 own forecast error lags in all currencies + 2 lags of stock market and interest differentials)

£	0.718	1.409	19.772 (0.137)	1632.662 (0.00)	880.666 (0.00)
DM	0.518	1.190	29.373 (0.930E-2)	209.186 (0.00)	150.681 (0.00)
¥	0.432	1.354	21.370 90.925E-1)	68.357 (0.00)	67.465 (0.00)

(a) Figures in parentheses are the marginal significant level.

Table 6.2b: Rationality Tests for Chartist B, 4 weeks ahead predictions[a]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags the same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.111	0.856	32.087 (0.389E-2)	10.896 (0.123E-1)	9.989 (0.678E-2)
DM	0.142	0.608	47.212 (0.177E-4)	10.954 (0.120E-1)	4.355 (0.113)
Y	0.149	0.858	66.341 (0.881E-8)	7.813 (0.500E-1)	7.242 (0.267E-1)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.208	1.086	17.395 (0.236E-1)	21.705 (0.286E-2)	19.826 (0.297E-2)
DM	0.221	0.676	43.107 (0.824E-4)	102.431 (0.00)	65.143 (0.00)
Y	0.285	1.127	32.073 (0.391E-2	23.870 (0.120E-2)	23.805 (0.567E-3)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags stock market and interest differentials)

£	0.388	1.260	16.896 (0.262)	107.531 (0.00)	47.751 (0.689E-6)
DM	0.474	1.018	32.937 (0.294E-2)	69.188 (0.00)	48.395 (0.526E-6)
Y	0.554	1.336	33.171 (0.272E-2)	932.312 (0.00)	845.332 (0.00)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.2c: Rationality Tests for Chartist H, 4 weeks ahead predictions[a]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.0956	0.696	58.947 (0.179E-6)	18.270 (0.387E-03)	3.919 (0.141)
DM	0.088	0.717	43.619 (0.682E-4)	11.161 (0.109E-1)	2.458 (0.293)
Y	0.113	0.666	66.574 (0.800E-8)	6.632 (0.846E-1)	6.614 (0.366E-1)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.257	0.928	48.782 (0.975E-5)	62.145 (0.00)	18.492 (0.511E-2)
DM	0.242	0.848	59.935 (0.120E-6)	46.768 (0.00)	14.541 (0.241E-1)
Y	0.305	0.784	58.346 (0.228E-6)	38.265 (0.270E-5)	35.922 (0.286E-5)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.483	1.094	41.530 (0.147E-3)	153.293 (0.00)	130.875 (0.00)
DM	0.536	0.836	44.603 (0.473E-4)	399.277 (0.00)	236.232 (0.00)
Y	0.716	1.277	31.427 (0.483E-2)	902.985 (0.00)	770.016 (0.00)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.2d: Rationality Tests For Chartist M, 4 weeks ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags same currency)

	R^2	DW	Q	χ^2 (Including constant)	χ^2 (excluding constant)
£	0.028	0.676	38.422 (0.131E-3)	1.891 (0.595)	1.237 (0.539)
DM	0.086	0.608	43.697 (0.172E-4)	2.460 (0.483)	2.274 (0.321)
¥	0.198	0.952	38.781 (0.114E-3)	25.120 (0.146E-4)	18.744 (0.851E-4)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags all three currencies)

£	0.509	1.503	13.463 (0.336)	44.309 (0.186E-6)	23.256 (0.715E-3)
DM	0.506	1.483	14.672 (0.260)	81.064 (0.00)	50.617 (0.00)
¥	0.477	1.091	12.338 (0.419)	44.345 (0.183E-6)	41.381 (0.00)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.633	1.626	21.287 (0.463E-1)	438.471 (0.00)	365.749 (0.00)
DM	0.673	1.642	14.653 (0.261)	399.512 (0.00)	155.867 (0.00)
¥	0.681	1.122	16.725 (0.160)	564.609 (0.00)	543.922 (0.00)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.2e: Rationality Tests for Chartist P, 4 weeks ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags on same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.054	0.613	34.399 (0.311E-3)	2.612 (0.455)	1.458 (0.482)
DM	0.022	0.536	36.425 (0.144E-3)	0.745 (0.863)	0.575 (0.750)
¥	0.028	0.748	35.280 (0.223E-3)	3.378 (0.337)	1.327 (0.515)

(ii) Semi-weak rationality (Regressing forecast error on 2 aim forecast error lags in all three currencies)

£	0.235	0.773	34.259 (0.328E-3)	50.988 (0.00)	19.745 (0.307E-2)
DM	0.122	0.639	29.305 (0.204E-2)	17.957 (0.122E-1)	11.738 (0.681E-1)
¥	0.037	0.793	34.061 (0.353E-3)	10.035 (0.187)	4.667 (0.587)

(iii) Semi-strong rationality (Regressing forecast error on 2 own forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.642	0.836	28.894 (0.236E-2)	642.478 (0.00)	498.299 (0.00)
DM	0.492	0.889	10.977 (0.445)	181.283 (0.00)	97.088 (0.00)
¥	0.627	1.310	10.664 (0.472)	6553.905 (0.00)	286.499 (0.00)

(a) Figures in parenthesis are the marginal significance levels.

Table 6.2f: Rationality Tests for median chartist forecast, 4 weeks ahead predictions[(a)]

(i) Weak rationality (Regressing forecast error on 2 own forecast error lags in same currency)

	R^2	DW	Q	χ^2 (including constant)	χ^2 (excluding constant)
£	0.600	0.595	79.634 (0.00)	1.882 (0.597)	1.866 (0.393)
DM	0.118	0.552	64.229 (0.210E-1)	3.913 (0.271)	3.866 (0.145)
Y	0.146	0.652	74.472 (10.00)	12.040 (0.725E-2)	11.452 (0.326E-2)

(ii) Semi-weak rationality (Regressing forecast error on 2 own forecast error lags in all three currencies)

£	0.331	0.813	50.102 (0.587E-5)	24.948 (0.775E-3)	23.712 (0.590E-3)
DM	0.247	0.690	66.198 (0.934E-8)	23.698 (0.129E-2)	23.440 (0.662E-3)
Y	0.204	0.719	53.888 (0.134E-5)	40.133 (0.119E-5)	40.117 (0.432E-6)

(iii) Semi-strong rationality (Regressing forecast error on 2 aim forecast errors lags in all currencies + 2 lags of stock market and interest differentials)

£	0.375	0.927	39.734 (0.281E-3)	49.139 (0.893E-6)	43.232 (0.452E-5)
DM	0.397	0.799	58.261 (0.236E-6)	53.949 (0.121E-6)	48.638 (0.474E-6)
Y	0.547	0.926	41.509 (0.148E-3)	124.651 (0.00)	113.067 (0.00)

(a) Figures in parenthesis are the marginal significance levels.

APPENDIX: Correction for heteroscedastic and moving average error terms.

The general linear model,

$$Y = X\beta + u \tag{6A.1}$$

assumes the error term to be distributed

$$u \sim N(0, \sigma^2 I) \tag{6A.2}$$

leading, by standard derivations (see any econometric text book, eg Johnston (1984)) to the ordinary least squares (OLS) estimator

$$\hat{\beta}_{ols} = (X'X)^{-1}X'Y \tag{6A.3}$$

and

$$\text{cov}(\hat{\beta}_{OLS}) = \hat{\sigma}^2 (X'X)^{-1} \quad \text{where } \hat{\sigma}^2 = \frac{1}{T-K} \hat{u}'\hat{u}$$

If, however, the error term covariance matrix is not a scalar matrix as in equation 6A.2 above, but

$$u \sim N(0, \Sigma), \quad \Sigma \neq \sigma^2 I$$

then the OLS point estimator (6A.3) remains unbiased and consistent, but its covariance matrix is now given by

$$\text{cov}(\hat{\beta}_{ols}) = (X'X)^{-1} X'\Sigma X (X'X)^{-1}$$

i) In the case of heterscedastic errors, Σ is a diagonal matrix with non-constant variance, ie

$$\Sigma = \begin{bmatrix} \sigma_1^2 & & & \\ & \sigma_2^2 & & \\ & & \ddots & \\ & & & \sigma_T^2 \end{bmatrix}$$

White (1980) shows in this case that using

$$\hat{\Sigma} = \begin{bmatrix} \hat{u}_1^2 & & & 0 \\ & \hat{u}_2^2 & & \\ & & \ddots & \\ 0 & & & \hat{u}_T^2 \end{bmatrix}, \quad \operatorname{plim}_{T\to\infty} \hat{\Sigma} = \Sigma \qquad (6A.4)$$

where $\hat{u}_t$ denotes the OLS residual, so that

$$\operatorname{cov}(\hat{\beta}_{OLS}) = (X'X)^{-1} X' \hat{\Sigma} X (X'X)^{-1}$$

gives a consistent estimator of the covariance matrix.

ii) Hansen (1982) extends this to the case where there are <u>both</u> moving average errors and time-varying autocovariances, in which case the applicable matrix is the band matrix

$$\hat{\Sigma} = \begin{bmatrix} \hat{u}_1^2 & \cdots & \hat{u}_1\hat{u}_2 & & 0 \\ \vdots & \ddots & & \ddots & \\ \hat{u}_1\hat{u}_2 & & \ddots & & \hat{u}_{T-1}\hat{u}_T \\ & \ddots & & \ddots & \vdots \\ 0 & & \hat{u}_{T-1}\hat{u}_T & \cdots & \hat{u}_T^2 \end{bmatrix} \qquad (6A.5)$$

In the case of an MA(n-1) error, there would be (n-1) non-zero bands.

These consistent covariance matrix estimators are used in conjunction with OLS in estimating the results reported in this chapter.

7 CHARTISTS' ADVICE: IS IT DESTABILISING?

7.1: Introduction

The previous chapter offered evidence which did not reject the hypothesis of chartist rationality over the one-week horizon, but offered less support, or rejection, of this for the longer period. Taking the question wider than whether chartists are rational per se, however, is the question of what type of expectations mechanism they actually employ, and, crucially for the market as a whole, whether they act in a stabilising or destabilising fashion.

This chapter presents the results of several tests to examine the implied expectation formation of the chartists, looking at the possibilities of static, extrapolative, adaptive, regressive and bandwagon expectations. Only the latter type would exert a potentially destabilising influence on the market. The next section discusses these five expectations mechanisms, which is followed in section 7.3 by an explanation of the estimation methods. Section 7.4 examines the results, while the final section concludes, with particular emphasis on the issue of stabilisation introduced above.

7.2: Expectation mechanisms

Equations (7.1) to (7.5) list five 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, $\bar{s}^t$ is the "equilibrium" exchange rate at time t and Δ is the first-difference operator (eg $\Delta x_t = x_t - x_{t-1}$):

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

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

Extrapolative expectations:

$$ {}_ts^e_{t+n} = (1-\beta)s_t + \beta s_{t-1}, \ 1 > \beta > 0 \tag{7.3}$$

Adaptive expectations:

$$ {}_{t}s^{e}_{t+n} = {}_{t-n}s^{e}_{t} + \gamma\left[s_t - {}_{t-n}s^{e}_{t}\right], \quad \gamma > 0 \qquad (7.4) $$

Regressive expectations:

$$ {}_{t}s^{e}_{t+n} - s_t = -\theta\left[s_t - \bar{s}_t\right], \quad \theta > 0 \qquad (7.5) $$

Static expectations on the part of chartists essentially means they would be assuming that the exchange rate follows a random walk:(45) this is the null hypothesis throughout. Although perhaps not immediately appealing to fundamentalists, it appears that economists have often made such an assumption. 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. In the case of static expectations, the 'elasticity of expectations' 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 instead conform to the bandwagon expectations hypothesis, (7.2), then the elasticity of expectations will be greater than unity: $(1+\alpha) > 1$. Thus, in this case, if chartists heavily influence foreign exchange dealers' behaviour, they will tend to have a destabilising effect on the market

(45) In the empirical analyses, no distinction is made between simple random walks and random walks with drift. This is because the primary concern is with slope coefficients (and hence elasticities) rather than intercepts. Intercepts are included in all estimated equations.

as, for example, dealers are advised to sell a currency, which depreciates further, which they are then advised to sell again, and so on. Market participants would essentially extrapolate the most recent trend. Describing such events, Nurkse (1944, p118) wrote, 'Exchange rates under such circumstances are bound to become highly unstable, and the influence of psychological factors may at times be overwhelming'. The debate over whether speculation has a stabilising or destabilising effect on the market was discussed in Chapter 3, section 3.4.4 - it is clearly an issue of some importance and a debate with a long history.

The other cases examined - extrapolative, adaptive and regressive expectations - all have an expectations elasticity less than unity, implying that chartist advice would have a stabilising influence on the market. Changes in the current spot rate would lead to a less than proportionate expected change in the future spot rate.

Extrapolative expectations (equation 7.3) imply that the expected future spot rate is some proportion of the current and lagged exchange rates. Adaptive expectations (equation 7.4) suggest that the expected future spot rate is formed as a weighted average of the current spot rate and the lagged expected rate. The regressive expectations formulation (equation 7.5) is perhaps best known for its application in the exchange rate overshooting model of Dornbusch (1976): the equation states that expectations of the change in the current exchange rate are formed so as to converge to their long run equilibrium values. Definitions of $\bar{s}$, the equilibrium, can vary between formulations, in this chapter the sample period is sufficiently short to assume it does not change over the period considered.

7.3: Estimation

7.3.1: Static versus extrapolative and bandwagon expectations

To test for static as against extrapolative or bandwagon expectations, reparamaterise equation (7.3) as:

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

Then, by estimating the slope coefficient in the corresponding 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), a test of the null hypothesis

$$ H_0: \alpha_1 = 0 $$

constitutes a test of static expectations (equation 7.1) while the alternative hypotheses

$$ H_1: \alpha_1 > 0 $$

and

$$ H_2: \alpha_1 < 0 $$

correspond to bandwagon and extrapolative expectations respectively.

7.3.2: Static versus adaptive expectations

Similarly, to test for static as against adaptive expectations, 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 while the alternative hypothesis

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

would correspond to adaptive expectations.

7.3.3: Static versus regressive expectations

In analysing the regressive expectations hypothesis, it is reasonable to assume that the perceived equilibrium exchange rate would remain fairly constant over the nine month or so 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

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

the null hypothesis

Ho: $\gamma_1=0$.

is again static expectations, and regressive expectations is the alternative

H_1: $\gamma_1 < 0$.

Note that as exchange rates generally follow an I(1) process, equation (7.9) is essentially the same formulation as the Dickey-Fuller test for stationarity, ie.

$\Delta x_t = c + c_1 x_{t-1} + u_t$, where the test statistic is the t-statistic on c_1.

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): see footnote to Table 7.3.

7.4: Results of estimation

These regressions were carried out using survey data collected for six individual chartists from the data base (labelled alphabetically to preserve anonymity) as well as for the whole sample median forecasts. The results are reported in Tables 7.1 to 7.3 and summarised in Tables 7.4a,b.(46)

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 exceptions are chartist M, for whom the null hypothesis is often rejected in favour of one of the inelastic alternatives, and chartist L, for whom the hypothesis of static expectations is rejected in favour of the adaptive alternative. At the four week horizon, chartist A also has strongly non-static expectations, with the null hypothesis being rejected in favour of either adaptive, regressive or extrapolative expectations, but not 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, results which bear out the informal impressions gained from a visual inspection of Chart 5.1.

7.5: Conclusion

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.

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(46) The results for the four week-ahead predictions were calculated using a method of moments correction to allow for overlapping forecast errors (Hansen 1982). See Appendix to Chapter 6.

Logically separate from these issues, 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, is that on the analysis of the chart advice presented here, the advice may at most cause mean-reverting, or stationary, deviations from the fundamentals (ie 'fads' - see eg Poterba and Summers, 1987 and discussion in Chapter 3, section 3.4.2.1).

The results presented here concur with those of Frankel and Froot (1987a) who found that (presumably fundamental based) exchange rate expectations did not exhibit bandwagon effects and hence, like the results presented here, were evidence of speculation being stabilising. This is all evidence which can be added to the debate of this issue discussed in Chapter 3, section 3.4.4.

In the same study, however, Frankel and Froot reported results which rejected the static expectations hypothesis: significant weight being given to variables other than the contemporaneous spot rate. Three possibilities could account for these differences. First, the time period examined differs. Frankel and Froot used several sources of survey data covering periods from 1976 to 1986, of expectations of up to five currencies against the dollar. Their period is obviously much longer than the one examined in this thesis, and includes several trending episodes. In contrast, there were no prolonged trends in the nine month survey examined here: as seen in Chart 5.1, rates fluctuated, only trending for a few months at most. These movements, perhaps more akin to a 'trading range', would probably incline (chartist) forecasters to follow a strategy approaching a random walk.

Second, this thesis looks explicitly at chartist forecasts; the data of Frankel and Froot was drawn from a panel of bankers, corporate treasurers and economists, most of whom, it seems safe to assume, would be fundamentalists. In a trading range, such as that examined in this thesis, chartists are probably more inclined than fundamentalists to hold a 'random walk' type view.

Third, while the median results presented in this chapter unanimously could not reject the null hypothesis of static expectations, individuals did on occasions favour one of the inelastic alternatives. Similarly, it is probably the case that some individuals comprising the median results of Frankel and Froot had implied static expectations formations.

Furthermore, the results presented in this chapter examine the implications of one week and four week forecasts separately: any implied inconsistency between the two has not been discussed. This is an issue recently examined by Froot and Ito (1989)[47] who use survey data to test whether exchange rate forecasts are consistent, ie. whether expectations of different forecast horizons lead to equivalent predictions of the exchange rate at future horizons. Hence they compare forecasts at different horizons rather than comparing forecasts with outturn. Their overall result is that expectations generally fail to be consistent - to quote their key result: 'In every one of 20 sets of time-series estimates encompassing four surveys, five forecast horizons and five currencies, shorter-term expectations overreact relative to longer-term expectations when the exchange rate changes'. (p 506).

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(47) Pesaran (1989) provides an alternative and more general derivation of Ito's and Froot's cross equation restrictions for the purpose of testing short-term and long-term expectations.

Table 7.1a: Testing for static expectations against bandwagon or extrapolative expectations, 1 week ahead forecasts[a] (Dependent variable ($_tS_{t+1}$-S_t))

	Rate	Constant	ΔS_t	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	ΔS_t	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 7.1a: (contd.)

	Rate	Constant	ΔS_t	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 7.1b: Testing static expectations against bandwagon or extrapolative expectations, 4 week ahead forecasts[(a)] (Dependent variable ($_tS_{t+4}$-S_t))

	Rate	Constant	ΔS_t	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	ΔS_t	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 7.1b: (contd.)

	Rate	Constant	ΔS_t	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 7.2a: 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)	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

	Rate	Constant	($_{t-1}S^e_t$-S_t)	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 7.2a: (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 7.2b: 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 7.2b: (contd.)

	Rate	Constant	$({}_{t-4}S^{e}_{t}-S_{t})$	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 7.3a: 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 7.3a: (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 7.3b: Testing for regressive expectations: 4 week ahead forecasts[a] (Dependent variable $_tS_{et+4} - S_t$))

	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 7.3b: (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 7.3a

Table 7.4a: 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	-	-	-	-	-	-
Median	N	N	N	N	N	N	N	N	N	N	N	N

Table 7.4b: 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	-	-	-	-	-	-
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.

8 CONCLUSIONS

8.1: Conclusions

The aim of this thesis was to enquire into the tools and techniques of chartist analysis, its perceived importance in the foreign exchange market and the nature of the advice provided. Although the results of the study are manifold, some broad themes can be seen to have emerged.

First, a recurring feature of this thesis has been evidence on the heterogenous nature of chartist advice. Chartists are far from being a homogeneous group, and the advice given can vary markedly across a sample of analysts. This was first indicated from the survey of their methods in Chapter 2, when even the calculated indices were seen to have many possible permutations, and when combined with the subjective interpretation of patterns, the possibilities for difference of interpretation widen further. Added to which, evidence from the questionnaire survey of foreign exchange dealers highlighted that chart advice is in general seen as complementary to the fundamental approach. What eventually enters the dealing decision is likely to be, at most, a diluted interpretation of chartism. Having said this, comments by market participants indicate that when chart signals and fundamental advice confirm each other, the trader is likely to take more decisive action.

It is apparent that some chartist some practitioners are better than others; and given the range of analytical tools open to them, this should not be surprising. The comparisons between individual chartists and against other forecasting methods showed a range of performance, varying from out-performing all other methods to under-performing all alternatives. To what extent this result is due to the analysis applied, or to a genuine 'feel' for the market cannot be known - but the results hopefully explode any myths about a 'homogeneous mass of chartists' in the market.

It is, however, clear from the results of the questionnaire survey that this brand of non-fundamental influence is perceived as an important force by foreign exchange market practitioners. Clearly, therefore, research on the foreign exchange market should not ignore non-fundamental influences, and some understanding of the methods used and their role in the market would seem to be essential to researchers of these areas.

A further broad theme to emerge is that of chartists' global effect on the market. The finding that chartist advice does not appear to be intrinsically destabilising (even in any individual case) is surely reassuring news to those concerned about the stability of modern financial markets. It is, however, unrealistic to draw wider conclusions from the evidence presented here concerning, for example, market regulation. The caveats (see Chapter 5) made regarding the sample size and period considered mean that the empirical results should be interpreted alongside other evidence on foreign exchange markets, and that there is considerable scope for further work on these issues.

For example, the work of Frankel and Froot (eg 1986b) suggested that here had been periods in the 1980s when market fundamentals pointed to a weakening of the dollar, yet it still continued to appreciate, implying that non-fundamental influences could be dominant by default. It is very likely that results emerging from analysing chartists expectations could differ, possibly markedly, between trending and non-trending periods of the market.

Bearing these considerations in mind, it has been clearly demonstrated in this thesis, using a variety of data sources and techniques, that consideration of chartist non-fundamental *influences* should not be precluded from work in the area of foreign exchange markets in particular, and other financial markets in general.

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