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Intervention, Interest Rates, and Charts: Three Essays in International Finance

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Abstract

This paper contains essays on sterilized intervention, on covered interest rate parity, and on chartist analysis in financial markets. Each essay contains a definition, brief survey of the empirical evidence and overall assessment of each topic.

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1/ These essays were written as contributions to the New Palgrave Dictionary of Money and Finance, edited by Peter Newman, Murray Milgate, and John Eatwell, to be published by MacMillan in 1992. The author is grateful for comments received from Michael Dooley, Richard Haas, Peter Isard, Paul R. Masson, Steven Symansky, Robert Flood, Graham Hacche, Richard Agénor, Bankim Chadha, Peter Bofinger, Rex Ghosh, Amir Yaron, and Charles Goodhart on earlier drafts of the essays, although responsibility for any remaining errors rests with the author.

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Summary

This paper contains essays on sterilized intervention, covered interest rate parity, and chartist analysis in financial markets.

Official intervention in foreign exchange markets occurs when the authorities buy or sell foreign exchange, normally against their own currency. Sterilized intervention occurs when the authorities take action to offset or "sterilize" the effects of the resulting change in official foreign asset holdings on the domestic monetary base. It may influence the exchange rate by changing the relative supplies of assets, or by signaling policy intentions. Sterilized intervention operations may on occasion effectively stabilize the foreign exchange market, but this stability can be translated into the longer term only if the exchange rate is consistent with underlying economic fundamentals and with appropriate monetary and fiscal policy.

The covered interest parity theorem states that the interest differential between two assets, identical in all respects except currency of denomination, should be zero once allowance is made for cover in the forward foreign exchange market and the relevant transactions costs. After a discussion of the reasoning behind covered interest parity as an equilibrium condition, a review of the evidence concludes that there is strong empirical support for this condition.

Chartist, or "technical" analysis, examined in the third essay, involves using charts of financial asset price movements to infer the likely course of future prices and so construct forecasts and trading strategies. This analysis is used in financial, particularly foreign exchange, markets, as a short-term complement to fundamental economic analysis. The essay concludes that chartists, by working with the minutiae of market price movements, may be able to "get a feel" for local approximations to processes that are too complex, short term, or nonlinear to be captured adequately by the current state of financial economics.

I. Introduction

This paper is composed of three essays, one each on: sterilized intervention, the covered interest rate parity theorem, and chartist analysis in financial markets

II. Sterilized Intervention

Official intervention in foreign exchange markets occurs when the authorities buy or sell foreign exchange, normally against their own currency and in order to affect the exchange rate. 1/ Sterilized intervention occurs when the authorities--simultaneously or with a very short lag--take action to offset or "sterilize" the effects of the resulting change in official foreign asset holdings on the domestic monetary base.

Consider Table 1, which gives a stylized representation of the balance sheet of a country's monetary authorities (that is, the central bank and exchange-stabilization authorities combined):

Table 1: Monetary Authorities' Balance Sheet

Assets	Liabilities
Net foreign assets (NFA)	Monetary base (MB)
Net domestic assets (NDA)	Net Worth (NW)

The monetary base comprises currency and deposit liabilities to banks. Net worth of the financial authorities includes accrued spending surpluses, and accumulated net interest receipts and capital gains on their holdings of net domestic and foreign assets. It follows from Table 1 that:

$$MB = NFA + (NDA - NW)$$

$$= NFA + DC$$

where DC, defined as net domestic assets less net worth, represents the stock of domestic credit made available by the monetary authorities.

Foreign exchange market intervention by the monetary authorities will involve a purchase or sale of foreign assets. The intervention is sterilized when domestic credit is altered such that

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1/ Occasionally, the authorities may intervene with the objective of boosting reserves rather than specifically affecting the exchange rate.

$$\Delta DC = - \Delta NFA$$

so

$$\Delta MB = \Delta NFA + \Delta DC$$

$$= 0$$

Normally, intervention would be sterilized by sales or purchases of domestic-currency bills or bonds by the monetary authorities so that the effects on the monetary base of changes in the holdings of net foreign assets are in fact offset one-for-one by the effects of changes in net domestic asset holdings: 1/

$$\Delta NDA = -\Delta NFA$$

1. The influence of sterilized intervention

Logically, sterilized intervention may influence the exchange rate through two possible channels: by changing the relative supplies of assets, and by signaling policy intentions. The first channel can be analyzed within the framework of the portfolio balance model of exchange rate determination. 2/ By altering the relative supplies of domestic and foreign bonds, sterilized intervention necessitates a change in the market clearing expected rates of return (and hence prices) of these assets. Since the monetary base is held constant, there will be little or no movement in domestic interest rates. Hence, the spot exchange rate must shift in order to affect the domestic value of foreign bonds and the expected return to holding them. For example, an increase in the supply of mark assets in the hands of the public relative to that of dollar assets necessitates a fall in the relative price of mark assets.

If, however, domestic and foreign bonds are regarded by agents as perfect substitutes in financial portfolios, then sterilized intervention can have no effect--through the portfolio balance channel--on the exchange rate. This follows because agents will be indifferent as to the relative amounts of domestic and foreign assets they are holding--they will care only

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1/ In the United Kingdom (and in many other countries), sterilization of intervention has generally operated almost automatically, since the Exchange Equalization Account buys (or sells) Treasury bills with the proceeds of (or in order to finance) intervention operations (see Taylor (1990), Chapter 3). Note that, in some countries (e.g. Canada) sterilization has largely taken place through movements in government deposits held in the commercial banking system, rather than through open market operations.

2/ See MacDonald and Taylor (1991a) for a recent exposition of the portfolio balance model.

about the total amount--and so no change in market-clearing prices or quantities is required. 1/

Even if perfect substitutability holds, however, it is possible for sterilized intervention to affect the exchange rate through the expectations or signalling channel (Mussa (1981)). This might happen if agents, observing the sterilized intervention, revise their expectations concerning the future exchange rate. This would then alter the expected rate of depreciation and hence the return to foreign bond holding, necessitating a rebalancing of portfolios. In the limiting case of perfect substitutability, the current exchange rate would jump to the new expected future level in order to set the expected rate of depreciation to zero (assuming no change in domestic interest rates). Because unsuccessful intervention is costly, it might be argued that making policy intentions known through intervention operations rather than by simple announcements provides added credibility. At any one time, however, a government will be pursuing many macro-policy goals, so that the relevant trade-offs amongst these will be highly complex. Moreover, the cost to the authorities of foreign exchange loss will depend upon the size of the loss relative to the current public sector deficit. For these reasons, the public will in practice find it extremely difficult to judge the time consistency of exchange rate policy. Stein (1989) presents a model in which the market has incomplete information about the authorities' utility trade-off between the exchange rate target and a domestic policy target. Stein shows that, in order for policy to be time consistent, the authorities must announce a range of future exchange rate targets since the announcement of any precise target would not be credible.

2. Empirical evidence

Empirical work on the efficacy of sterilization via the portfolio balance channel has generally taken one of three forms. First, researchers have directly estimated structural asset demand equations of portfolio balance models (Obstfeld (1983); Blundell-Wignall and Masson (1985); Kearney and MacDonald (1986); Lewis (1988)). Secondly, researchers have estimated inverted asset demand equations where the ex post difference in the rate of return between domestic and foreign assets is regressed onto a range of variables: under the joint null hypothesis of perfect substitutability and rational expectations, the estimated regression coefficients should be

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1/ Note that, in a Ricardian world where private agents offset expected future tax payments (which will be required to service extra government debt) against current holdings of domestic bonds, imperfect substitutability would no longer be a sufficient condition for sterilized intervention to influence the current exchange rate (Frankel (1979), Obstfeld (1982), Backus and Kehoe (1988)). Calvo (1990) argues that, in the context of a high-inflation stabilization program, sterilization of capital inflows may jeopardize program credibility as agents expect the authorities to stage a "surprise" devaluation as a result of the increased debt burden.

insignificantly different from zero (Rogoff (1984); Danker et. al (1987); Loopesko (1984)). A third approach involves estimating asset demand equations derived in a specific optimization framework, such as mean-variance analysis (Frankel (1982, 1986); Frankel and Engel (1984); Engel and Rodriguez (1989)).

A common finding in this literature, as in the literature on foreign exchange market efficiency more generally (MacDonald and Taylor (1991b)), is that the joint hypothesis of rational expectations and perfect substitutability is rejected. This does not, by itself, imply that sterilized intervention is effective, however, since the joint hypothesis may be rejected because of nonrational expectations when domestic and foreign assets are close or even perfect substitutes. Recent studies that have tested the perfect substitutability and rational expectations hypotheses individually using survey data--(Frankel and Froot (1987); Froot and Frankel (1989); Taylor (1989); MacDonald and Torrance (1990))--have generally rejected both hypotheses, however.

Nevertheless, in general, researchers have found difficulty in rejecting the hypothesis that the exchange rate effects of sterilized intervention--through the portfolio balance channel--are statistically insignificant or quantitatively very small. This, indeed accords with the general conclusion of the study of the Working Group on Exchange Market Intervention--the Jurgensen Report (1983)--commissioned by the 1982 G-7 Economic Summit of Heads of Government at Versailles. The Working Group's conclusions were as follows: first, sterilized intervention is generally less effective than unsterilized intervention; second, sterilized intervention may be effective in the short run; third, sterilized intervention has little long-run impact; fourth, coordinated intervention operations are likely to be more effective than uncoordinated ones.

Tests of the influence of sterilized intervention through the signalling channel involve testing for the significance of intervention variables in equations relating to exchange rate expectations. Studies have either assumed rational expectations (Humpage (1989)), or have used survey data on expectations (Dominguez and Frankel (1990)). Humpage (1989) finds evidence that intervention can have a short-term signalling effect on exchange rates, and Dominguez and Frankel (1990) find that the signalling effect is both statistically and quantitatively significant. 1/

3. Summing up

While the empirical evidence on the effects of sterilized intervention is somewhat mixed, it does seem difficult to disagree with the conclusion of the Jurgensen Report that sterilized intervention--in the absence of

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1/ Dominguez and Frankel also find a statistically significant portfolio balance effect, the quantitative importance of which depends upon certain structural parameters in their model.

appropriate international economic policy coordination--can have at most transitory effects on the exchange rate. Through the portfolio balance channel, stock adjustments cannot be used indefinitely to offset flow disequilibria--such as large current account imbalances--which reflect the economic fundamentals. Through the signalling channel, it also seems clear that sterilized intervention will only be effective in the long run if it is consistent with the underlying stance of monetary and fiscal policy and other economic fundamentals (Obstfeld (1988)). Otherwise, the authorities will damage their reputation (which will therefore limit the signalling effect) or--worse--as forward-looking agents attempt to solve a system for which there is no consistent solution a speculative attack on the currency may be triggered (see e.g., Calvo and Guidotti (1991)), or other asset market instabilities may ensue. 1/

It is, perhaps, possible to be a little more sympathetic with the argument that sterilized intervention should be used to "iron out" short-term volatility in the nominal and hence--given the relative stickiness of wages and goods prices--the real exchange rate. Such an argument might be based on the view that the foreign exchange market is efficient but prone to overshooting of the "equilibrium" exchange rate; or else on a view that the market is from time to time dominated by noneconomic factors such as the actions of ill-informed speculators or chart analysts (see, e.g., Allen and Taylor (1990), MacDonald and Taylor (1991b)), which generate short-term excursions--or "fads"--away from the fundamentals. Such arguments are, however, predicated on a belief that short-term exchange rate volatility is by itself welfare reducing, and the empirical evidence in this respect (reviewed in Artis and Taylor (1988b)) is at best mixed.

A related argument is that inefficiencies and nonfundamental influences in the market may generate not only short-term deviations from the equilibrium exchange rate, but sustained deviations or misalignments, the welfare-reducing significance of which is likely to be greater (Williamson (1983, 1985), De Grauwe (1987)). However, to move from the premise that the recent float has been characterized by exchange rate misalignments to the conclusion that sterilized intervention alone should be used to correct such misalignments is to presuppose that, in the first place, a reliable, unique estimate of the equilibrium rate can be constructed, and that, in the second place, the intervention will be effective in the absence of sustained macro-policy coordination. On the first issue, there is at present no clear consensus among economists on the appropriate concept of the equilibrium exchange rate (Krugman (1990)). On the second issue, we again return to our

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1/ Artis and Taylor (1988a), for example, argue that at least one contributory factor in the stock market crash of 1987 was that the decision of the G-6 (the G-5 plus Canada) to hold the value of the U.S. dollar at its early 1987 level (the Louvre Accord) was inconsistent with the large U.S. current account deficit combined with a loose U.S. fiscal policy and tight monetary policy (see also Feldstein (1988)).

initial argument that sterilized intervention cannot be used as a substitute for monetary and fiscal policy adjustment. 1/

The Exchange Rate Mechanism (ERM) of the European Monetary System provides a striking example of a situation where intervention arrangements have been successful (Artis and Taylor (1988b)). In this case, however, intervention has been only one element in an overall package of policy coordination (MacDonald and Taylor (1991c)). Indeed, it is easily shown that sterilized intervention by each member of a pegged exchange rate union will tend to lead to explosive reserve behavior (De Grauwe (1977)). Within the ERM, there is in fact some evidence that the German authorities have sterilized intervention operations much less often than other ERM members (Mastropasqua, et al. (1988))--a situation which will have facilitated convergence on the German standard.

More generally, concerted exchange rate management--much of it through sterilized intervention--among the large industrial nations has at times been a feature of the international monetary system since the September 1985 Plaza Hotel agreement among the Group of Five industrial nations that "exchange rates should better reflect fundamental economic conditions than has been the case." 2/ Obstfeld (1988) argues that sterilized intervention--in itself--has not played an important role in promoting exchange rate realignment in the ensuing period. Rather, realignments have occurred as the result of appropriate macro-policy coordination.

To sum up, the present state of knowledge indicates that sterilized intervention operations may on occasion be effectively used as a short-term stabilizing factor in the foreign exchange market, but that this stability can only be translated into the longer term if the exchange rate is consistent with the underlying economic fundamentals and, in particular, the stance of monetary and fiscal policy. Moreover, the chances of achieving longer-term stability are greatly enhanced within a framework of consistent international macro- policy coordination.

1/ An example in this respect is afforded by the U.K.'s attempt to "shadow" the German mark in late 1987 and early 1988. Because the U.K. authorities were unwilling to coordinate their monetary policy with that of Germany (in particular, to bring interest rates down), strong upward pressure on sterling was experienced which they were ultimately unable to resist (Artis (1990)). Greene (1983a,b) discusses U.S. intervention during the 1970s and concludes similarly that it is ineffective unless combined with the appropriate mix of economic fundamentals.

2/ Funabashi (1988) provides a fascinating account of the Plaza Hotel meeting and the subsequent implementation of the agreement. Obstfeld (1988) provides a chronological discussion of the evolution of cooperative exchange rate management since 1985.

III. Covered Interest Rate Parity

> ... forward quotations for the purchase of the currency of the dearer money market tend to be cheaper than spot quotations by a percentage per month equal to the excess of the interest which can be earned in a month in the dearer market over what can be earned in the cheaper (Keynes (1923), Chapter 3).

The covered interest parity (CIP) theorem states that the interest differential between two assets, identical in every relevant respect except currency of denomination, should be zero once allowance is made for cover in the forward foreign exchange market and the relevant transactions costs.

Algebraically, the CIP condition is usually expressed (ignoring transactions costs):

$$(1) \quad \frac{F}{S} = \frac{1 + i^*}{1 + i}$$

where i and i* are, respectively, the domestic and foreign interest rates on similar assets of a certain maturity, S is the spot exchange rate (foreign price of domestic currency) and F is the forward rate (i.e., the rate agreed now for an exchange of currencies in the future) of same maturity as the interest rates.

A standard story as to why CIP should hold is that market deviations from (1) will result in arbitrage activity which will force the equality to hold. Suppose, for example (1) did not hold because of a low domestic interest rate:

$$(2) \quad i < (S/F)(1 + i^*) - 1$$

If (2) held, arbitragers could make a riskless profit by borrowing the domestic currency, selling it spot for the foreign currency, lending the foreign currency, and selling the foreign currency proceeds (principal plus interest) in the forward market against the domestic currency. Such arbitrage will tend to drive i up, i^* down, S down and F up, and will continue until (1) holds. On reflection, however, it should be clear that no such arbitrage need logically occur for (1) to hold, since any lender of domestic funds at an interest rate which satisfies (2) must be irrational, ill-informed, or both. This follows because either a higher rate could have been extracted (demand for domestic funds should be perfectly elastic so long as (2) holds), or else a rate equivalent to

$$(3) \quad (S/F)(1 + i^*) - 1$$

could have been earned by selling the domestic funds spot, lending the foreign currency and selling the proceeds forward. Clearly, similar reasoning could be applied to any of the four arguments of (1).

An approximation to (1) is also sometimes used:

$$(4) \quad f - s = i - i^*$$

where f and s denote the natural logarithms of the forward and spot exchange rates respectively.

Professional interest in the CIP condition stems from at least three sources. First, deviations from CIP may indicate profitable arbitrage opportunities which may be taken as evidence of market inefficiency. Empirical investigations of CIP thus form part of an ongoing research program on the efficiency of the foreign exchange and international capital markets (see MacDonald and Taylor (1991) for a survey).

A second, related source of interest on CIP is that it is sometimes used much as an identity in testing other international parity conditions. For example, given CIP, then the uncovered interest parity condition (i.e., the condition that the domestic-foreign interest differential is equal to the expected rate of depreciation) implies that the forward rate should act as a spot rate predictor (MacDonald and Taylor (1991)).

A third motivation for examining international parity conditions in general arises from their explicit or implicit use in the construction of theoretical and empirical models of exchange rate determination (see e.g., Mussa (1984)). Empirically, modern exchange rate models have performed rather poorly (MacDonald and Taylor (1991)), and examination of their underlying assumptions is therefore warranted.

In any computation of CIP, it is clearly important to consider home and foreign assets which are comparable in terms of maturity, and also in terms of other characteristics such as default and political risk (Aliber (1973); Dooley and Isard (1980); Frankel and MacArthur (1988)). For this reason, empirical analyses of CIP have most often employed interest rate data on Euro-deposits: "Since Eurocurrency deposits are comparable in terms of issuer, credit risk, maturity and all other respects except currency of denomination, they offer a proper test of [CIP]" (Levich (1985), p. 1027).

Essentially two types of empirical tests of CIP have been conducted. The first relies on computing the actual deviations from interest parity to see if they differ 'significantly' from zero. The significance is usually defined with respect to a neutral band, which is determined by transactions costs. For example, Frenkel and Levich (1975, 1977), for a selection of currencies, demonstrate that around 80 percent of apparent profit opportunities lie within the neutral band when Treasury bills are used and almost 100 percent when Euro-rates are considered. Furthermore, in Frenkel and Levich (1977) it is demonstrated that in periods of turbulence a much smaller percentage of deviations from CIP may be explained by transactions costs; this is interpreted as reflecting higher financial uncertainty in such periods. Clinton (1988) demonstrates that deviations from covered interest parity should be no greater than the minimum transaction costs in

one of three markets: the two underlying deposit markets (e.g., Euro-marks and Euro-dollars) and the foreign exchange swap market (i.e., the market in which a currency can be simultaneously bought and sold forward against another currency). On the basis of analysis of data for five major currencies against the U.S. dollar "taken from mid morning quotes on the Reuter Money Rates Service from November 1985 to May 1986," Clinton finds that the neutral band should be within $\pm$ 0.06 percent per annum from parity and that although the hypothesis of zero profitable deviations from parity can be rejected, "empirically, profitable trading opportunities are neither large enough nor long-lived enough to yield a flow of excess returns over time to any factor".

By questioning the quality of the data used by Frenkel and Levich, various researchers have arrived at different conclusions. For example, McCormick (1979) finds on using higher quality data that most of the deviations from CIP (70-80 percent) lie outside the neutral band for U.K.-U.S. Treasury bills. Taylor (1988, 1989), however, goes further than McCormick and argues that in order to provide a true test of CIP it is important to have data on the appropriate exchange rates and interest rates recorded at the same instant in time at which a dealer could have dealt. Taylor uses high quality-high frequency, contemporaneously sampled data for spot and forward dollar-sterling and dollar-mark exchange rates and corresponding Euro-deposit interest rates for a number of maturities and makes allowance for bid-ask spreads and brokerage costs in his calculations. He finds, inter alia, that there are few profitable violations of CIP, even during periods of market uncertainty and turbulence. One interesting feature of Taylor's work is the finding of a maturity effect--the frequency, size and persistence of profitable arbitrage opportunities appear to be an increasing function of the length of the period to maturity of the underlying financial instruments. A rationale is offered for this in terms of banks' prudential credit limits. Since banks impose prudential limits on the amount of outstanding liabilities they have with other parties, arbitraging at the shorter maturities will result in limits being filled for shorter periods, leaving dealers on average freer to take advantage of other profit opportunities as they arise.

A second method for testing the validity of CIP has been the use of econometric regression analysis. Thus, if CIP holds, and in the absence of transaction costs, estimation of the following equation:

$$(5) \quad f_t - s_t = \alpha + \beta(i-i^*)_t + u_t$$

(where u_t is the regression error) should result in estimates of α and β differing insignificantly from zero and unity respectively and a non-auto-correlated error (see equation (4)). Equation (5) has been tested by a number of researchers for a variety of currencies and time periods (see, for example, Branson (1969); Marston (1981); Cosandier and Liang (1981); and Fratianni and Wakeman (1982)). The main conclusion to be drawn from this line of research is that, broadly speaking, CIP is supported in that

although there are significant deviations of α from zero (reflecting perhaps non-zero transaction costs) the estimates of β differ insignificantly from unity in the majority of cases. It is not clear, however, what regression-based analyses of CIP are actually testing. For example, it may be that a researcher cannot reject the hypothesis that $\alpha=0$ and $\beta=1$ in equation (5) but that the fitted residuals themselves represent substantial arbitrage opportunities. Put another way, such a test may suggest strongly that CIP held on average over a period when in fact it did not hold at any instant during the period. Thus, although regression-based tests may be useful for testing the broad stylized fact of CIP (which may be of interest, for example, in exchange rate modeling) they can say virtually nothing about market efficiency. However, in spite of this caveat we summarize the econometric evidence as suggesting that CIP does appear to be reasonably well supported by the data, especially if Euro-deposit interest rates are considered.

Overall, therefore, and with the qualifications noted above, the conclusion which emerges from empirical studies of the CIP condition is that it is one of the very few international parity conditions which receives strong empirical support.

IV. Chartist Analysis 1/

Chartist, or "technical" analysis involves using charts of financial asset price movements--often with the aid of additional descriptive statistics--to try to infer the likely course of future prices and so construct forecasts and trading strategies. The trends and patterns that chartists look to identify in this connection are generally arrived at by loose inductive reasoning. Perhaps the most famous example of a chartist pattern (indicating a trend reversal) is the "head and shoulders" formation popularized by Edwards and Magee (1966) (Charts 1 and 2). Often, chartists will use trends and patterns to try to identify broad ranges within which exchange rates or asset prices are expected to trade, attempting to "set the parameters" for price movements. Chartist analysts may also employ one or more mechanical indicators when forming a general view. These might be trend-following (e.g., based on moving averages) or nontrend-following (e.g., transactions volume measures and rate of change indicators, or "oscillators" used with the assumption that there is a tendency for markets to "correct" when an asset has been "overbought" or "oversold"). In practice, chartist analysis tends to be a pragmatic combination of pattern

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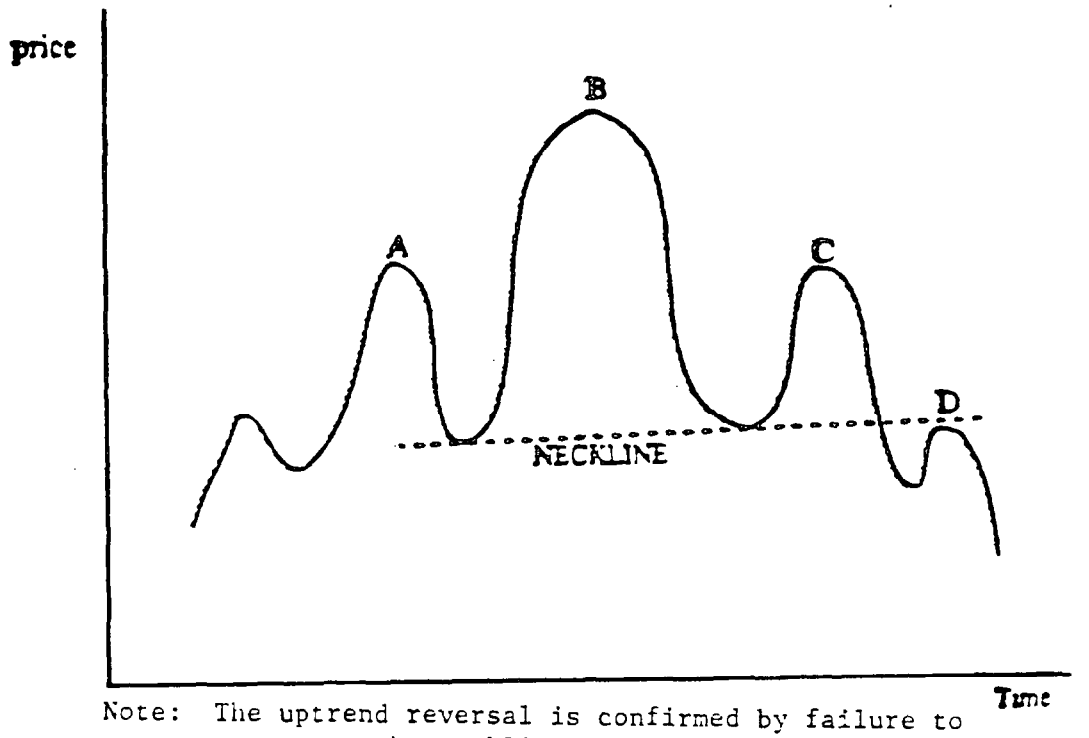
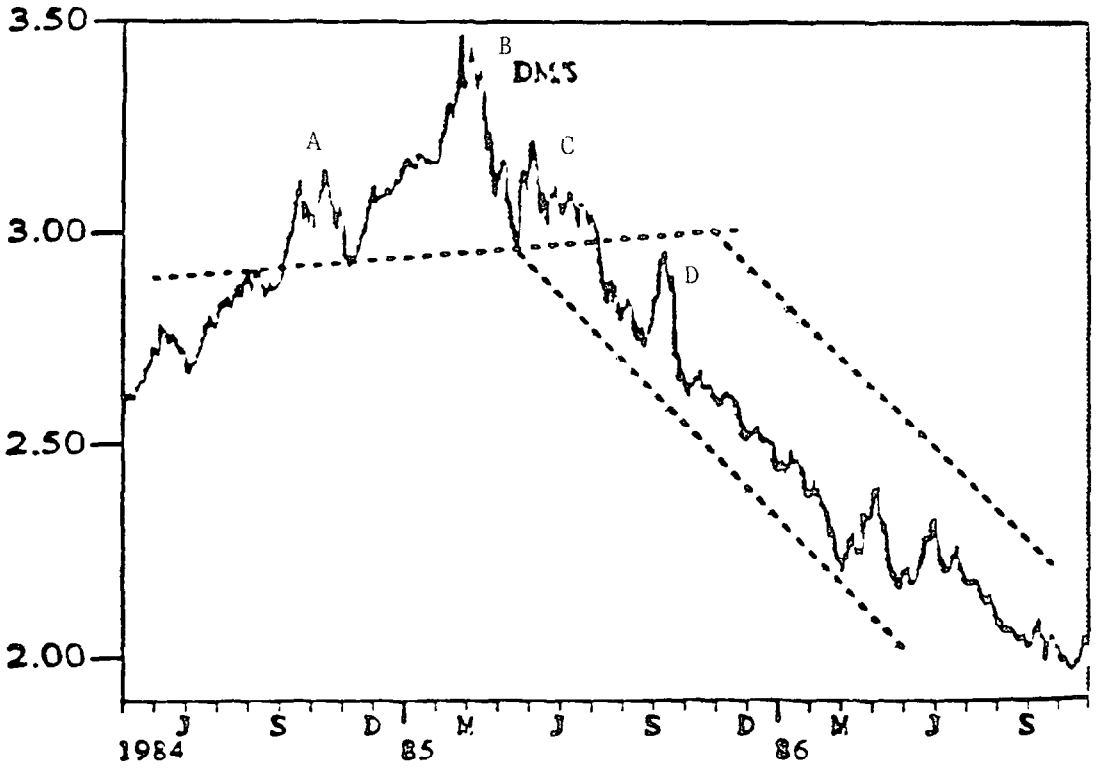
1/ This essay was coauthored with Helen Allen of the Bank of England.

Chart 1: A Classic Head and Shoulders Pattern



Note: The uptrend reversal is confirmed by failure to penetrate the neckline at D.

Chart 2: Chartism in Practice



Note: It takes a trained eye to spot the head and shoulders reversal in the DM/$ exchange rate.

and trend recognition, along with information from statistical indicators, to produce an overall prognosis. 1/

1. The origins of chartist analysis

Many of the techniques employed by modern chartist analysts can be traced back to work done in the early part of the twentieth century by Charles H. Dow in a number of Wall Street Journal (WSJ) editorials between 1900 and 1902. His stock market observations were first dubbed "Dow Theory" by Nelson (1902). William P. Hamilton 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 1922 (Hamilton (1922)). The first formalized account of Dow Theory was due to Rhea (1932a,b), who took as his source the total of 252 WSJ editorials of Dow and Hamilton and related writings.

The basic tenets of Dow theory are often formalized into several fundamental statements, the first and best-known of which is that "the averages discount everything." This means that information on past and expected future money supply and other "fundamentals" should already be discounted into asset prices, enabling the chartist to ignore them for the purposes of analysis. 2/ Financial economists will, however, be aware of the parallel between this statement and the Grossman-Stiglitz (1976) paradox: if all fundamental information is already discounted in the price, then there is no incentive to study the fundamentals, so it is hard to see how the information is imported into the market in the first place. The statement cannot be literally true (Grossman and Stiglitz (1976, 1980)). Moreover, even it were, a further problem arises: if fundamental information is already discounted into the price, why not chartist information also?

The second major influence in the development of modern chartist analysis may be broadly categorized under the heading of Elliott wave

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1/ "A common and convenient name for analysis of stock-market patterns is 'technical analysis'. Perhaps no one in the financial world completely ignores technical analysis--indeed, its terminology is ingrained in market reporting--and some rely intensively on it. Technical analysis includes many different approaches, most requiring a good deal of subjective judgement in application. In part these approaches are purely empirical; in part they are based on analogy with physical processes, such as tides and waves" (Roberts (1959)).

2/ Or as expressed in Rhea (1932a), "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."

theory. This theory attempts to go beyond Dow to provide an overall perspective on market movements in which trend reversals are anticipated rather than merely confirmed (Frost and Prechter (1978)). The basic Elliott wave principle was presented by Ralph N. Elliott, who described it as "a much needed complement to Dow Theory" in a series of twelve articles in the Financial World magazine in the late 1930s and was originally applied to stock market indices (Elliott (1938, 1946)). The basis of the theory is that financial markets are claimed to follow a repetitive cycle of a five wave advance followed by a three wave decline (Chart 3).

The choice of the numbers five and three appears to be based on a belief in the importance of the Fibonacci number sequence in financial markets. The Fibonacci sequence is constructed such that the sum of any two consecutive numbers equals the next number. 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 that the ratio of any element to the next highest element approaches 0.618 via a damped oscillatory path and similarly, the ratio of any element to its next lowest element approaches 1.618. This is the so-called "golden ratio," which has known applications in many areas of human activity such as classical architecture and fine art (Borissavlietch (1958), Michell (1988)) and has also been observed in aspects of science and nature (Ghyka (1977), Stevens (1976)). As in much of technical analysis, however, there seems to be no hard empirical evidence which supports the importance of the Fibonacci sequence in financial markets. Apart from the application of the Fibonacci sequence in Elliott wave theory, elements of the sequence are commonly used by technical analysts more generally--for example in the choice of length of moving averages (combinations of 5 and 13 days or 5 and 21 days being common). 1/

2. The prevalence, use and nature of chartist analysis in practice

Whilst observation suggests that the use of chartist analysis in the major financial markets is widespread, evidence on its use has largely been anecdotal (e.g., Malkiel (1990)).

However, Robert Shiller (1987), in a survey study of both individual and institutional U.S. stock market investors carried out immediately after the stock market crash of October 1987, found that about a third of respondents claimed to be influenced by prices dropping through a long-term

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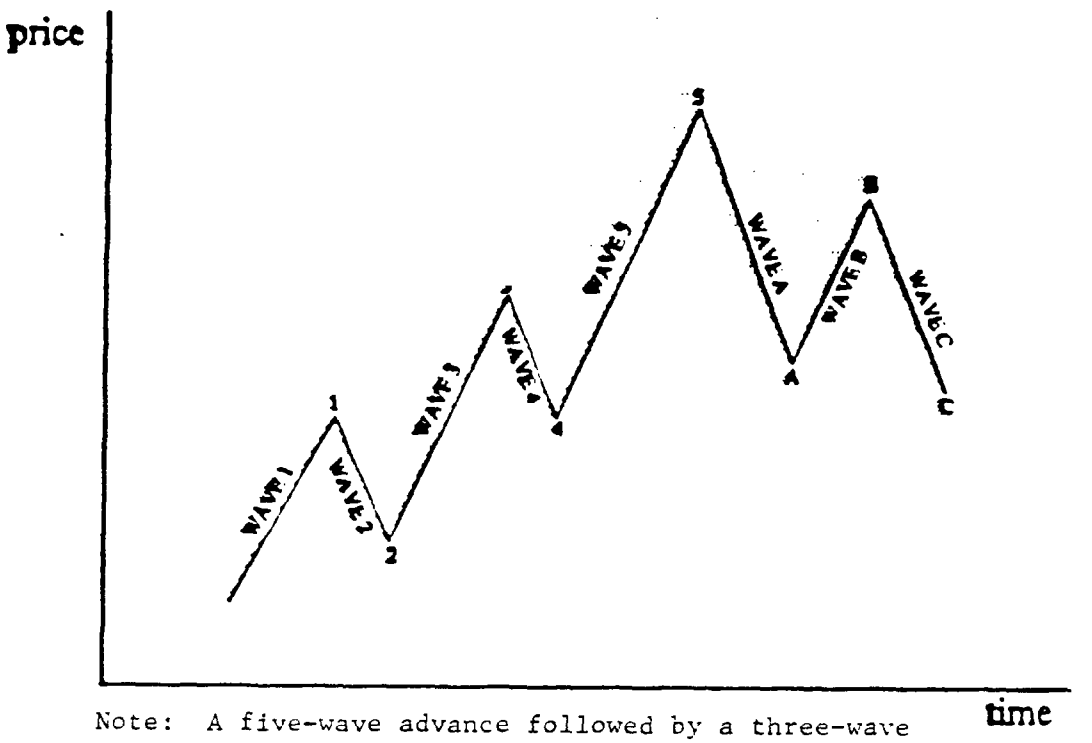
1/ The properties of the Fibonacci sequence were first examined by the early thirteenth century mathematician it is named after--Leonardo of Pisa, better known as Fibonacci--in his Liber Abaci (Book of Calculations) of 1202. Interestingly, Fibonacci originally developed the sequence from a study of the reproductive behavior of rabbits. Vorob'ev (1963) provides a discussion of the extensive mathematical properties of the Fibonacci sequence.

Chart 3: The Basic Elliott Wave Pattern



Note: A five-wave advance followed by a three-wave decline.

trend line. 1/ A questionnaire survey conducted by the Group of Thirty (1985) reported that 97 percent of banks and 87 percent of securities houses believed that the use of technical analysis has a significant impact on the foreign exchange market.

Recent applied work on the use of technical analysis includes that of Helen Allen and Mark P. Taylor (Allen and Taylor (1989, 1990); Taylor and Allen (1992)), who carried out a study of the London foreign exchange market on behalf of the Bank of England. They conducted a questionnaire survey, sent to over 400 chief foreign exchange dealers in the London market, in November 1988, which achieved a response rate of over 60 percent (Taylor and Allen (1992)). The survey asked dealers questions concerning which chartist methods are most used in practice, the role of chartists within organizations and attempted to elicit views (both quantified and impressionistic) on how market participants view the role of chartism. A broad consensus emerged regarding the weights given to chartist analysis at differing time horizons. At time horizons of intraday to one week, approximately 90 percent of respondents reported using some chartist input when forming their exchange rate expectations, with 60 percent judging charts to be at least as important as fundamentals. At longer forecast horizons from one month to one year, the weight given to economic fundamentals increased. At the longest forecast horizons, of one year or longer, the skew towards fundamentals was most pronounced with around a third of respondents relying on pure fundamentals and some 85 percent judging fundamentals to be more important than charts. It appeared, moreover, that there was a persistent 2 percent or so of respondents who apparently never used fundamental economic analysis at any horizon. Other findings of the Taylor-Allen study were that dealers perceived chartist analysis and fundamental (economic) analysis to be complementary approaches, and that a significant proportion viewed technical analysis as self-fulfilling.

In addition, Allen and Taylor (1990) analyze the accuracy of a number of individual technical analysts' one-week and four-week ahead forecasts of three major exchange rates. They find that some individuals were able to outperform a range of alternative forecasting procedures over a ten-month period, including a random walk model, vector autoregressions and univariate autoregressive moving average time series models. Interestingly, however, Allen and Taylor (1990) also report a significant degree of heterogeneity among chartists forecasts--not all chartists see the same signals (or interpret them in the same fashion) at the same point in time; given the multiplicity of possible patterns and trends and interpretation of statistical measures, this is perhaps not altogether surprising.

1/ An early interview study by the U.S. Securities and Exchange Commission (1947) reported that 13 percent of interviewees ascribed the 6.1 percent fall in New York Stock Exchange Prices on September 3, 1946 to Dow theory.

Earlier studies by Goodman (1979, 1980) of the profitability of exchange rate forecasts provided both by chartist and by fundamentals based services found that the chartist services' forecasts outperformed the forward rate in qualitative tests, while the forward rate outperformed the fundamentals based services.

More recently, Curcio and Goodhart (1991) report the results of a controlled experiment in which university students participated in simulated financial asset trading either with or without the use of a certain proprietary chartist computer software product. Although Curcio and Goodhart find no significant difference in the level of notional profitability between subjects using the chartist software and those not using it, the variance of the level of notional profits was significantly lower among the group using the chartist software.

At the very least, therefore, the empirical evidence suggests that the attitude of many financial economists towards chartist analysis--that "technical strategies are usually amusing, often comforting, but of no real value" (Malkiel (1990), p. 154)--should not be held with one hundred percent confidence.

3. Academic analysis of the influence of chartist analysis

Analysis of non-fundamental influences in financial markets is a growing area of academic literature, and the ground has been shifting away from widespread academic skepticism of non-fundamentals to active investigation of the many phenomena not captured by traditional economic models. While analyses of the stock market have recently begun to analyze the influence of non-fundamental factors generally (e.g., Shiller (1984); De Long et al. (1989)), studies which specifically consider the role of chartism have so far largely been confined to the foreign exchange market.

Goodhart (1988) presents a discussion of how exchange rate misalignments might occur by considering the possibility that the rate is determined by the balance of chartist and fundamentalist predictions. 1/ A similar approach is developed more formally by Frankel and Froot (1990b), who explain the sharp rise in the demand for the U.S. dollar over the 1981-85 period as a shift in the weight of market opinion away from fundamentalists and towards chartists. This shift is modelled as a Bayesian response to the inferior forecasting performance of the economic fundamentalists. Kirman (1991) presents a further development of the

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1/ Shiller (1984) suggests a simple model of the stock market in which the equilibrium price depends on the balance between fundamentalists (smart money) and ordinary investors who subscribe to popular models.

Frankel-Froot model in which agents' opinions may change after meeting agents with different views--so that epidemics of chartism may develop. 1/

4. What to make of it all?

While talk of Fibonacci sequences and head and shoulders reversals will invariably bring a smile to the lips of financial economists, the smile is perhaps becoming a little nervous. The major reason for this is that financial economics has proved remarkably unreliable either as a predictor or as an explanation of financial asset price movements. As one eminent researcher in the field recently noted: "The origins of price movements are poorly known in all speculative markets: markets for corporate stocks, bonds, homes, land, commercial structures, commodities, collectibles, and foreign exchange" (Shiller (1989), p. xi).

Whilst it seems inexorable that economic fundamentals will eventually win through in the longer term, it is likely that short-term price movements may be dominated by "popular" models and theories, one of which is chartist analysis. Clearly, simple reliance on extrapolation and inductive reasoning, as in chartist analysis, is ultimately unsatisfactory. It may be that chartists (and dealers in general), by working with the minutiae of market price movements, are able to "get a feel" for local approximations to processes which are too complex, short-term or non-linear to be captured adequately by the current state of financial economics. In any event, the fact that chartist techniques are subscribed to by large numbers of financial market practitioners implies that chartism should not be lightly dismissed either by other practitioners or by researchers. 2/

V. Conclusion

This paper has presented essays on sterilized intervention, covered interest parity and chart analysis in financial markets.

In the first essay we concluded that although sterilized intervention may at times be effective, it is at best a short-term palliative unless backed up by the economic fundamentals, in particular, appropriate monetary and fiscal policy.

1/ As noted by Shiller (1984), diffusion processes for news or rumor have been modeled by mathematical sociologists, drawing on the mathematical theory of epidemics (Bailey (1957)).

2/ Malkiel (1990, chapter 6) suggests that chartists are hired by brokers largely in order to generate trades and hence commissions. Even given this, however, one might expect the results of such a policy to manifest themselves as self-fulfilling chartist strategies. De Long et al. (1991) provide a theoretical model of the survival of non-fundamentals based traders in financial markets.

In the second essay, we concluded that covered interest rate parity is one of the few international parity conditions which receives strong empirical support.

In the final essay, we concluded that chartist analysis, although clearly unsatisfactory in its subjectivity and its reliance on extrapolation and inductive reasoning, is still widely used by market practitioners. At the same time, financial economics has performed poorly either as a predictor or as an explanator of financial market prices. Further research on chartist analysis is therefore warranted.

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