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### **THE FOREIGN EXCHANGE MARKET: STRUCTURE, INTERVENTION AND LIQUIDITY**

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**ABSTRACT:** This paper examines the structure and functioning of the foreign exchange market in order to address two questions: what is the appropriate role of official exchange market intervention and what are the implications for the efficiency of the market of the expanded use of netting in the settlement of foreign exchange deals? Evidence relating to the structure of the market is consistent with the proposition that exchange market intervention may not be futile because of the existence of two distinct classes of agents: professional traders with short-term horizons and "ultimate customers" influenced by more "fundamental" factors. On the other hand, the cross sectional evidence on transactions costs and turnover examined in this study suggests that further increases in the volume of business made possible by practices such as netting will not greatly reduce transactions costs.

**KEY WORDS:** Foreign exchange, Market structure, Netting, Volatility



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One of the more intriguing paradoxes in international monetary economics is that the scale of official intervention in the exchange market has expanded substantially in recent years despite virtual unanimity among policy makers and academic observers alike that it is bound to be of little avail if not entirely futile.<sup>1</sup> Another puzzling, but much more salutary feature of the exchange market is its apparent robustness in the face of serious and repeated financial and real shocks. In the past few years equity markets have been buffeted to a degree without precedent since the 1930s, but foreign exchange markets have been unusually stable despite large swings in real and nominal exchange rates.

The following paper examines the structure and operation of the foreign exchange market to shed some light on the twin issues of the appropriate role of intervention and the impact of market structure on efficiency and stability. It attempts to assess what role intervention can legitimately be expected to play as an instrument of central bank policy. A second aim is to consider what consequences some proposed new practices such as the extensive netting of exchange rate contracts may have on the operation of the market.

The strategy is to look behind the broad macro-economic determinants of exchange rates into the anatomy of the market. In other words the paper is based on the presumption that understanding the micro-structure of the market is essential both for assessing the appropriate role for intervention and for analysing the robustness of the market.

The paper is organised in the following manner. The first section describes the structure and functioning of the market, focusing in particular on how its organisation affects price formation, transactions costs and liquidity. The second section briefly and selectively reviews the vast literature on exchange rates and the exchange market. The relationship between turnover, volatility and bid-ask spreads is examined in the third section, and the fourth and final one draws a few conclusions about the role of intervention and the effects of increasing turnover which might follow upon changes in market practices.

## 1. The foreign exchange market

The foreign exchange market can justifiably be considered the deepest and most active international financial market in the world.<sup>2</sup> In April 1989 total turnover amounted to \$650 billion per day, having grown by over 100% in the three years since the volume of transactions in this market was previously gauged (see Tables 1 and 2). Impelled by

1 "... intervention solely on its own can at best only stabilise short term situations and does not have a permanent impact on exchange rates." Alan Greenspan, Humphrey Hawkins testimony before the US House of Representatives, July 1990.

2 See BIS (1989) for information on the size and nature of transactions in the foreign exchange market in April 1989 and a comparison with turnover in March 1986.

**Table 1**  
**Foreign exchange market activity in April 1989**

Countries and items	Net turnover <sup>1</sup>	Of which: <sup>2</sup>			Net spot turnover <sup>1</sup>	Ratio of exchange market turnover to:	
		Business with customers	Net domestic interbank operations	Cross-border interbank operations		foreign trade	international banking assets
	average daily turnover in billions of US dollars						
United Kingdom . . . . .	187 <sup>3</sup>	28	54 <sup>3</sup>	107 <sup>3</sup>	(119)	69	3.2
United States . . . . .	129 <sup>3</sup>	10	45 <sup>3</sup>	71 <sup>3</sup>	81	25	4.5
Japan . . . . .	115	34	31	47	46	37	1.8
Switzerland <sup>4</sup> [85%] . . . . .	57	9.0	11	36	30	83	9.0
Singapore . . . . .	55	(6.0)	8.0	(41)	(31)	138	4.8
Hong Kong . . . . .	49	5.4	11	33	(30)	78	3.0
Australia . . . . .	30	6.0	7.0	15.0	18	59	-
France <sup>4</sup> [95%] . . . . .	26 <sup>3</sup>	5.0	6.0 <sup>3</sup>	15 <sup>3</sup>	(15)	12	1.4
Canada . . . . .	15	4.0	2.7	7.8	6.1	12	4.0
Netherlands . . . . .	13 <sup>3</sup>	1.5	3.1 <sup>3</sup>	8.5 <sup>3</sup>	7.2	11	1.8
Denmark <sup>4</sup> [90%] . . . . .	13	1.3	1.8	10	(6.4)	36	12.4
Sweden . . . . .	13	1.6	1.4	8.7	9.5	23	4.9
Belgium <sup>4</sup> [90%] . . . . .	10	1.3	1.6	7.6	5.2	9	1.1
Italy <sup>4</sup> [75%] . . . . .	10	1.4	0.8	8.0	7.6	6	2.0
Other countries <sup>5</sup> . . . . .	22	1.6	4.4	15	16	13	2.8
<b>Total . . . . .</b>	<b>744</b>	<b>114</b>	<b>189</b>	<b>431</b>	<b>428</b>	<b>32</b>	<b>3.0</b>
Adjustment for cross-border double-counting . . . . .	204				123		
<b>Total reported net turnover . . . . .</b>	<b>540</b>				<b>305</b>		
Estimated gaps in reporting . . . . .	100				55		
<b>Estimated global turnover . . . . .</b>	<b>640</b>				<b>360</b>		

Note: Figures in parentheses are rough estimates. Totals may not tally owing to rounding.

1 The figures for individual countries indicate turnover net of double-counting arising from local interbank business. The totals at the foot of the table are estimates of turnover net of double-counting arising from both local and cross-border interbank business. 2 The items do not always sum to total net turnover because the classification is not exhaustive. 3 Based on estimates of domestic and cross-border interbank business arranged through brokers. 4 No adjustment for less than full coverage; estimated market coverage is given in square brackets. 5 Bahrain, Finland, Greece, Ireland, Norway, Portugal and Spain.

Source: BIS (1990).



**Table 2**  
**Growth of foreign exchange market transactions,  
 foreign trade and international banking activity**

Countries	Exchange market turnover: percentage changes between March 1986 and April 1989			Exports and imports of goods and services: percentage changes between first quarter 1986 and first quarter 1989	International claims of BIS reporting banks: percentage changes between end-March 1986 and end-March 1989
	Net turnover	Transactions with customers	Spot transactions		
United Kingdom ...	108	221	81	62	40
United States .....	120	134	134	39	39
Japan .....	140	111	142	82	203
Canada .....	58	38	53	44	4
<b>Total .....</b>	<b>116</b>	<b>136</b>	<b>104</b>	<b>54</b>	<b>76</b>

the continuing liberalisation of exchange control, by the increasing sophistication of other market participants in managing their risks and by major advances in telecommunications and data processing technology, total foreign exchange market turnover expanded at a much faster pace than either world trade or international banking activity. Transactions presumably have continued to grow since the 1989 survey, but anecdotal evidence suggests that the pace has slackened.

The market in foreign exchange is predominantly a wholesale market, with transactions between banks and other market makers accounting for a good four-fifths of total turnover. Partly for this reason most exchange market transactions are financially rather than commercially driven. Decisions on how to fund particular activities and how to deploy financial wealth often generate exchange market deals. Other foreign exchange transactions are the result of various hedging, arbitrage and position-taking activities. Moreover, since liquidity is ensured by the continuous quotation of two-way prices by dealers, some transactions occur when individual traders attempt to square their positions after executing orders they receive in their capacity as market makers. The substantial volume of transactions of financial character suggests that there are a large number of traders with heterogeneous expectations.

Given the significance of financially related transactions, it should not be surprising that foreign trade can account for only a small fraction of total exchange market business. In April 1989 exchange market turnover exceeded foreign trade by a factor of about ten to one in countries with inactive exchange markets and by a factor of well over a hundred

to one in some of the offshore financial centres. In countries with the largest foreign currency markets, turnover exceeds foreign trade by a factor of 25 to 85.

The US dollar is by far the most important currency in the market. It figures in about 90% of all transactions, leaving only 10% for deals not involving the dollar on either side of the transaction (see Table 3). One of the reasons why the dollar bulks so large in the market is that it serves as the vehicle currency. Since those who wish to buy or sell third currencies, particularly minor ones, must first buy or sell dollars, its share in total transactions is far greater than would be warranted by its role as an invoicing currency or as a currency of denomination in international banking and capital market transactions.

At first sight the use of a vehicle currency seems rather wasteful since at least two deals are needed for any "final transaction", irrespective of whether it is undertaken for commercial, financial or risk management purposes. However, a vehicle currency is used for essentially the same reasons that money is employed as a medium of exchange in national economies. It eliminates the necessity for the "double coincidence of wants" required for barter. It greatly reduces search costs and waiting time and makes for greater depth in the market for the vehicle currency, thus lowering transactions costs and facilitating decentralised transactions between pairs of individuals.<sup>3</sup>

The dollar became the vehicle currency in the post-World War II years because it was the only major currency not hampered by extensive exchange controls. It could be freely used in exchange market transactions even though foreign trade was often denominated in other currencies. The dollar's replacement of sterling as the principal vehicle currency had started in the post-World War I period and can be attributed to the geopolitical ascendancy of the United States. The persistent balance-of-payments deficits of the United States after World War II, first on combined current and long-term capital account and then on current account alone, ensured that there was a continuous net increase in the supply of dollar assets available to foreigners. However, the unrestricted ability to make adjustments in stocks of dollar assets and liabilities was more important than the change in the net external position of the country.

There is one further reason why the dollar dominates exchange market trading. It is the only currency in which there are deep and active markets in a full range of low-risk financial instruments. Here again a chronic deficit, this time of the central government, has played an important role. In other countries the range of government debt is much narrower and secondary markets in public sector paper are much thinner. Those who

<sup>3</sup> See Jones (1976) for a discussion of why the unconcerted action of separate individuals may lead to the emergence of a medium of exchange. His reasoning applies equally well to the use of a vehicle currency. Krugman (1980) considers the relationship between transactions costs and the deviation of cross rates from direct exchange rates. See also Chrystal (1984).

**Table 3**  
**Currency composition of foreign exchange market**  
**activity in April 1989**

Currency	Percentage share in total gross reported turnover
US dollar .....	90
Deutsche Mark .....	25
Yen .....	26
Pound sterling .....	15
Swiss franc .....	12
Australian dollar .....	4
French franc .....	3
Canadian dollar .....	2
Ecu .....	1
Other .....	22
<i>Memorandum item:</i>	billions of US dollars
Gross average daily turnover in all currencies .....	932.0

Note: Because each exchange market transaction involves two currencies, the sum of all percentage shares amounts to 200%. The figures understate the share of the Deutsche Mark and other European currencies because comparable data for Germany are not available.

Source: BIS (1990) and national surveys.

wish to use non-dollar currencies may have to hold bank claims. This exposes them to greater credit risk, risk that has been growing because of the deterioration in the quality of assets held by banks and pressure on their profits.

The operation of payments systems may also have some bearing on the attractiveness of a currency as a transactions medium in the interbank market. One of the reasons the dollar has remained competitive as a vehicle currency is that the interbank clearing and settlement systems in the United States were rationalised earlier than those in other countries. For example, CHIPS, the multilateral net settlement system for the members of the New York Clearing House Association, was established in 1971, thirteen years before CHAPS, its London counterpart. Subject to bilateral credit limits and net debit limits on each participant's position vis-à-vis the clearing house, intraday credit is available and same day settlement for deals between members has been provided since 1981.<sup>4</sup>

<sup>4</sup> See BIS (1990b).

Although the Deutsche Mark and the yen still account for only a small proportion of total transactions, their relative importance has been increasing in recent years. This is in part because direct cross-currency dealing in these two currencies has become feasible. Not only have the markets in assets denominated in these two currencies expanded in the wake of the relaxation of various restrictions and the gradual reduction of collusion among the dominant institutions in the markets, but the threshold for establishing a dealing infrastructure has been exceeded. The volume of transactions in these two currencies has grown so large that it now pays major banks to maintain desks quoting direct cross rates.

It is noteworthy that the increased use of the Deutsche Mark and the yen in the exchange market has not been accompanied by current-account deficits in the countries of issue. Indeed, both Germany and Japan have tended to run fairly large surpluses in recent years. Although the extensive use of a currency in the exchange market may, by augmenting demand for the currency as a transactions or settlement medium, make it easier (or cheaper) to finance a balance-of-payments deficit, a current-account deficit is by no means a necessary condition for the expanded use of the currency. As was indicated above, the ability to make adjustments in the stock of claims denominated in the currency in question is far more important. In fact, in the case of Germany, the country of issue of the second most important currency,<sup>5</sup> even capital-account flows have been perverse. In recent years this country has experienced a net outflow of the short-term banking funds commonly involved in exchange market transactions. However, the stock of banking assets and liabilities underlying the net balance-of-payments flow is so large that there have been sufficient Deutsche Mark assets of a suitable nature to permit the expansion of exchange market trading.

#### Market structure, price formation and transactions costs

The foreign exchange market is a market without a specific locus operating on the basis of a number of conventions and practices which have evolved over the years. It is also a truly international market in that deals always involve at least one foreign currency. Moreover, counterparties are often located in another country and may be of the nationality of a third country. Because of its international character it is largely an unregulated or, more precisely, a self-regulated market, with codes of conduct sometimes being issued by the authorities in individual centres.

Nonetheless, the exchange market is highly dependent on national institutions regulated or even administered by the authorities. For example, the delivery of the individual currencies involved in a foreign exchange transaction typically takes place through the payments systems of the two countries whose currencies are exchanged, no matter the

<sup>5</sup> The Deutsche Mark and the Japanese yen were shown to be of equal importance in the April 1989 survey of the exchange market, but Germany did not have data on exchange market turnover in that month, and the figures understate the importance of the Deutsche Mark.

location or nationality of the counterparties to the deal. For example, a transaction involving the US dollar generally involves transferring dollars through CHIPS and FEDWIRE from the bank account of the seller of dollars to the bank account of the buyer. The other leg of the transaction will involve a reverse transfer in, say, Germany of Deutsche Mark from the account of the buyer of dollars to that of the seller. The reliance on the payments systems of individual countries means that the stability and integrity of the global foreign exchange market depend not only on the soundness of the individual counterparties but also on the robustness of national payments systems and the maintenance of full convertibility.

The interbank foreign exchange market is what is sometimes termed a dealer's market. In other words prices are not determined by auction or open outcry. Instead bilateral deals are concluded directly between different counterparties. Brokers, who in general do not deal on their own account but quote prices only when a dealer has indicated his willingness to buy or sell a certain amount of foreign exchange at a given price, provide anonymity in the interbank market. In this way they contribute to the depth and breadth of the market. Traditionally there has been no central counterparty standing between the two principals, but the growing popularity of exchange traded currency options and futures and the recently mooted establishment of multilateral netting arrangements could alter this situation. If this were to occur, ensuring the soundness of such a central counterparty would become critical for maintaining systemic stability.<sup>6</sup>

By being willing to buy and sell at pre-announced prices, dealers or market makers provide liquidity, or what is sometimes called "immediacy", to the market. In other words they make it possible for the ultimate agent (and also other dealers) to buy and sell without an ultimate counterparty being present at the exact moment the deal is concluded. Market makers, of course, seek compensation for providing this service and earn profits through the bid-ask spread. Although this spread is quite low, the prices at which market makers undertake to buy and sell foreign exchange are not quite as good as those that, at least in theory, could be obtained by an agent willing to search for an "ultimate agent" with which to do the deal.

The nature of the good traded, the number of traders, their location and motivations for dealing and the information at their disposal all have a major bearing on the structure of a market. Dealer markets tend to emerge when the asset in question is freely negotiable, the terms are standardised and credit risk is low or can easily be ascertained.<sup>7</sup>

If there are a large number of reputable buyers and sellers actively trading in widely disparate locations, intermediaries are more likely to make markets since there is then greater likelihood that an unwanted position will be eliminated through a "spontaneous" offsetting order and it is less likely that two "ultimate agents" can find each other without the aid of an intermediary.

<sup>6</sup> See BIS (1990c).

<sup>7</sup> See Bingham (1990).

The propensity to make markets will be greatest in markets where the scope for insider dealing is limited and "uninformed" trading for liquidity, hedging or speculative purposes is extensive. When insider dealing is rampant, market makers will be compelled to set wide spreads to compensate themselves for the losses that may arise when they deal with those who have privileged information. In extreme conditions, they may even cease to make markets. On the other hand, market making will be feasible if there are many agents who wish to trade but have only publicly available information at their disposal. Not only will the likelihood of "crossed orders" grow, but market makers will have more information on order flow and potential supply and demand, which will enable them to set finer bid-ask spreads. This in turn may stimulate further trading.

Simply setting out these requirements makes it understandable why the interbank foreign exchange market is a "dealer market". The good is standardised and credit risk is negligible. Counterparty risk in the interbank market is both small and predictable.

There are a large number of agents located throughout the world wishing to conclude deals rapidly, and the scope for insider dealing is limited. Indeed, perhaps the only significant form of such dealing in the foreign exchange market is intervention purchases and sales of central banks which can be presumed to have privileged information about the future course of short-term interest rates.

The cost of transacting in the wholesale market is the bid-ask spread.<sup>8</sup> For small deals in the retail market, commissions and fees may be important; in addition there is the opportunity cost of forgone interest in the period running up to the value date and, if the account which is credited pays less than a market rate, the lost interest income from using a current account.

To be precise, the ex post cost of purchasing and then selling foreign exchange - or any other asset - is not the bid-ask spread, but the difference between the price paid and the price received. Since both bid and ask rates as well as the difference between them are constantly changing, the spread prevailing in the market at any one time will not necessarily reflect the transactions costs confronting a market participant. Indeed it will do so only under quite strict and unrealistic conditions, namely that the holding period is infinitely short or that there is no trend in the exchange rate over the holding period and the bid-ask spread remains constant.

Measuring the bid-ask spread is not as easy as might first be thought in such a deep and active market. Firstly, as was mentioned above, posted bid-ask prices are not necessarily the ones at which deals are struck. Secondly, there are many dealers quoting prices, and by the very nature of the process of competition, their prices will differ slightly from one another. The economically relevant bid-ask spread - the difference between the highest bid and the lowest ask price available within the decision period of an agent - is not necessarily reflected in the quotations of an individual bank nor on the screens of

<sup>8</sup> See Demsetz (1968) for a discussion of the cost of transacting.

**Table 4**  
**Average daily bid-ask spreads for selected currencies vis-à-vis the US dollar in April 1989**

Basis points

Currency	at 3 p.m. <sup>1</sup>	at London close <sup>2</sup>	Average <sup>3</sup>
Deutsche Mark .....	4.47	3.82	4.14
Pound sterling .....	5.87	3.97	4.92
Japanese yen .....	7.57	4.16	5.87
Swiss franc .....	6.08	4.40	5.24
Singapore dollar .....	5.13	7.95	6.54
Hong Kong dollar .....	1.28	2.02	1.65
Australian dollar .....	12.43	12.00	12.21
French franc .....	7.91	4.63	6.27
Canadian dollar .....	8.41	7.99	8.20
Dutch guilder .....	4.86	3.20	4.03
Danish krone .....	6.87	3.71	5.29
Swedish krona .....	7.86	3.81	5.83
Belgian franc .....	10.48	4.11	7.30
Italian lira .....	7.29	6.16	6.73
Spanish peseta .....	8.61	8.18	8.40
Irish pound .....	10.85	4.94	7.90
Norwegian krone .....	-	4.63	-
Finnish markka .....	-	4.77	-
Portuguese escudo .....	6.26	-	-
Greek drachma .....	3.95	-	-

1 Quotations by Barclays Bank International at 3 p.m. London time. 2 Quotations listed by Reuters Information Service at the close of the London market. 3 Mean of average daily quotations at 3 p.m. and at the close of the London market.

Source: Data Resources International.

the major quotation services. Thirdly, the bid-ask spread is not constant. Individual dealers change it depending upon whether they are aggressively trying to alter a position or simply maintaining their presence in the market. The release of a major economic indicator or an unexpected political event augmenting uncertainty can lead to quite considerable changes in bid-ask spreads over the course of a single day.

Table 4 shows interbank bid-ask spreads vis-à-vis the US dollar for a variety of currencies in April 1989, a month largely free of major macro-economic or political shocks. The data were taken from two separate sources, but relate to quotations of individual dealers, not to the prices at which trades were actually consummated nor to the market spread. Both are monthly averages of daily observations, and are snapshots of the market taken at different times of the day. To facilitate comparison across currencies, the spreads are expressed in terms of basis points rather than in the points used by foreign exchange dealers.

Several striking features of the market are evident. Firstly, spreads vary quite considerably from hour to hour even when measured as daily averages over the month. It would also appear that for most currencies the spread is lower at the close of trading in London than at 3 p.m. However, this may simply be a statistical artefact. The data for 3 p.m. are the quotations of a single London clearing bank which may not be aggressively dealing in all currencies at that hour. On the other hand, the close of business data reflect the most recent quotations of a number of different banks. Because the end-of-day quotations are drawn from a larger pool of market makers, it is more likely that they reflect the best prices available. However, it is also possible that rates quoted at the end of the day after dealers have squared their positions and passed their books on to New York are less representative than those quoted at other times of the day.

The differences across currencies in the size of the bid-ask spread are substantial. By and large, spreads tend to be smaller for the most actively traded currencies, but the relationship is not strict. They range between 3 and 6 basis points for the major currencies and extend to 8 basis points for some of the smaller ones. The spread for the yen seems fairly large in April 1989, but this may be attributed to uncertainty about the return on yen-denominated assets. There were widespread expectations that the Japanese discount rate would be raised. Although this did not occur until May, it affected exchange market trading in the preceding month.

The two outlying observations are for the Hong Kong dollar with an exceptionally small spread and the Australian dollar with an unusually large one. In both cases exchange rate variability may have been a factor. The Hong Kong dollar is pegged to the US dollar so there is virtually no risk associated with US dollar/Hong Kong dollar deals. On the other hand, the Australian dollar is considered by exchange dealers to display exceptional volatility vis-à-vis the US dollar.<sup>9</sup> The Asian market was also closed at the time

<sup>9</sup> However, when volatility is measured using the standard deviation of logarithmic differences in daily exchange rate quotations, the Australian dollar/US dollar exchange rate is no more unstable than that of the major European currencies. See Chart 2.



the spreads were measured. For minor currencies not actively traded in the three major centres, spreads widen when the local market is closed.

## 2. Exchange rate determination: theory and evidence<sup>10</sup>

Explanations of exchange rate behaviour need to account for a number of different phenomena: why the price of one currency is what it is in terms of another, why there are long-standing departures from purchasing power parity, why exchange rates show a pronounced tendency to overshoot in the medium term and sometimes display considerable short-term volatility, and what role exchange market intervention can legitimately be expected to play.

Most theories of exchange rate determination can be placed in one of two categories. Theories making use of the national income and flow of funds accounting framework are macro-economic in orientation. Examples include the early theories seeking to explain exchange rates in terms of trade flows and aggregate demand and supply conditions as well as what might be termed the current consensus model based on asset market conditions. The second class of model consists of theories that view the exchange market as any other market, where prices are determined by demand and supply but where restrictions implied by aggregation into national income accounting aggregates play no role. Work on exchange rate determination in the efficient markets tradition falls into the second category. It would of course be unjust to accuse either tradition of failing to recognise the insights of the other. Macro-economic models often exploit demand and supply relationships just as micro-economic theories do, though ones that are highly aggregate, and the monetary and portfolio balance approaches are derived from theories with solid micro-economic foundations.

### Macro-economic theories: the genealogy of the current consensus view

Models that seek to relate the exchange rate to macro-economic "fundamentals" such as trade flows or relative asset supplies have evolved as international economic relations have developed. The early theories which saw exchange rates as being determined essentially by trade flows and macro-economic conditions ("domestic absorption") were conceived of at a time when current-account transactions dominated international economic relations. They were eventually supplanted by views of exchange rate determination stressing the importance of capital flows as capital movements became more important. The theories formulated at that time, such as the ones associated with

<sup>10</sup> This section attempts to bring together in a brief and synoptic fashion the vast and sometimes contradictory literature on exchange rate determination. It makes no pretence at being exhaustive but does strive to give a fair and accurate account of the evolution of current consensus views on exchange rate determination and the effectiveness of intervention.

Mundell and Fleming which built upon the fact that the flows recorded in both the current and the capital account affect the balance of payments, were in turn supplemented by monetary models that took into account the fact that exchange rates are the relative prices of stocks of national monies and that flow equilibria of the national income accounting framework should not be viewed in isolation from stock equilibria. As international transactions in bonds and other securities increased, it was recognised that it was useful to look beyond national monies and to incorporate non-monetary assets into the analysis, particularly if agents were risk averse and not inclined to hold assets denominated in foreign currency unless they received adequate compensation for the risk of exchange rate changes.

The portfolio balance models with their long and august lineage may be viewed as the mainline, "consensus" macro-economic theory of exchange rate determination. The monetary approach, either with or without the sticky goods prices used to account for overshooting, can be seen as a special case of the portfolio balance model in which foreign and domestic bonds are perfect substitutes. Even the now defunct theories stressing imports and exports of goods can be seen as special cases of this model, as the flows of goods produced from physical capital controlled or financed by financial assets generate the exports and imports that are recorded in the current account.

As useful as they are, the macro-economic models suffer from several shortcomings. Firstly, econometric evidence suggests that their ability to explain the historical pattern and future course of exchange rates is limited.<sup>11</sup> Any one model works well for some historical periods but not for others. In particular the ability of these theories to explain exchange rate determination in conditions of generalised floating appears to be deficient. More damagingly, these models are substantially less successful than naive random walk models in generating accurate out-of-sample forecasts. Secondly, although some of the macro-economically inspired theories provide a plausible explanation of the more striking phenomena in the exchange market such as persistent departures from purchasing power parity and the medium-term overshooting of exchange rates, they often have to rely heavily on various dei ex machina such as sticky prices in the goods market.

#### Micro-economic approaches: efficiency, price formation and the micro-structure of the market

Partly because of the shortcomings of the macro-economic models, attention has been given to micro-economic explanations of exchange rate determination. Unfortunately many of these models have not been much more successful. The first studies spawned by the efficient markets literature found that the exchange market was not "efficient" on the joint assumption of risk neutrality and rationality. Efforts to flesh out the analysis by examining the intuitively appealing proposition that their failure could be attributed to risk premia demanded in a climate of considerable uncertainty about the future course

11 See e.g. MacDonald and Taylor (1989) for a review of some of the empirical evidence.

of exchange rates in the post-1973 world of floating, showed that risk premia, if they existed, were small or insignificant. For this reason attention has been shifted to the other leg of the argument: trying to find some plausible explanation for presumed "irrationality", i.e. of the fact that agents appear not to make use of all available information.

One such explanation points to speculative bubbles. It may in fact be reasonable to ignore fundamentals in the short term if prices in the market are determined by the hour-to-hour or day-to-day trading strategies of speculators or dealers. In such a market there will be multiple equilibria, each depending upon beliefs about the actions of others. Moreover, exchange rates affect consumption, investment and other real economic decisions. Exchange rates that are out of line with today's "fundamentals" may shape the course of economic events so that they are in keeping with the "fundamentals" of tomorrow. In other words, what seems initially to be an unsustainable exchange rate configuration may become sustainable if the world adjusts to it.

Such a view of the exchange market has much to recommend it. Firstly, if there are two classes of traders' "ultimate agents" who base their decisions on the fundamental economic developments and "dealers" or "noise traders" who take a very short-term view and are highly attuned to what other dealers are doing, it is possible to account for both the blatant short and even medium-term departures of exchange rates from levels that would seem justified by the fundamentals and also for the tendency for the fundamentals eventually to re-assert themselves, subject of course to the proviso that prolonged departures of exchange rates from their "economically justified" levels do not affect the underlying equilibrium.<sup>12</sup>

Secondly, it helps to explain the curious ambivalence that prevails with respect to exchange market intervention mentioned at the outset. Even though it may be of little avail in the long run, intervention may help to reduce some of the short-term volatility associated with exchange rate bubbles.<sup>13</sup> Thirdly, this view provides an alternative to the explanation of medium-term overshooting which stresses differential speeds of price adjustment in the exchange rate and the goods market.

### 3. Official intervention in the exchange market

Exchange market intervention involves the exchange by the official sector (central bank or Treasury) of domestic currency assets for assets denominated in foreign currency.

<sup>12</sup> Although this view is the current consensus conception, it was foreshadowed in Keynes' 1936 analysis of speculative markets in the General Theory.

<sup>13</sup> See Huang (1981), Meese (1986) and Wadhvani (1984) for empirical evidence on exchange rate volatility and bubbles.

Such transactions can, and frequently do, entail a change in the balance sheet of the central bank. If the exchange market transaction is not accompanied by any change in domestic monetary conditions, because for example authorities engage in offsetting open market operations, the transaction is said to be sterilised, whereas if it is accompanied by a change in monetary conditions, it is said to be unsterilised. Just what constitutes a "change in domestic monetary conditions" is, however, open to interpretation. It depends on the authorities' operating procedures and intermediate targets as well as on economic agents' expectations. In what follows we will assume for purposes of exposition that the authorities use money market interest rates as their operating target.

Moreover, even when the conceptual issues are sorted out, determining whether a given official exchange market operation is sterilised or not is not at all straightforward. In any given accounting period central banks may engage in numerous and sometimes offsetting transactions in both the foreign exchange and domestic money market, and it may not be possible to determine precisely which operation in the domestic money market "sterilises" a sale or purchase of foreign exchange. Moreover central banks may decide to alter monetary conditions for reasons of their own totally unrelated to events in the foreign exchange market so that, even if there is an ex post change in monetary conditions following official intervention, it may not mean that the exchange market operation was undertaken in order to influence domestic monetary conditions. In fact most monetary authorities make decisions about monetary conditions independently from their decisions to intervene in the foreign exchange market. The former decisions are in general strategic whereas the latter are tactical. Even in small countries according exchange rates a pivotal role, decisions about the market segment (foreign exchange or domestic money market) in which a transaction is carried out are secondary. For this reason, it is reasonable to treat exchange market intervention as sterilised, which will be the presumption in the following discussion. Such an approach provides a strong test for the effectiveness of intervention. If "sterilised" intervention is effective, a fortiori intervention that is not - intervention which affects domestic monetary conditions - is likely to be still more so.

Mention has been made of the somewhat curious ambivalence that prevails with respect to intervention. Despite the widely held view that it is devoid of any real significance, intervention has not been abandoned and is in fact one of the principal focuses of day-to-day international policy co-ordination. A flippant and somewhat cynical interpretation would be that this is very much a consequence of intervention's impotence. Countries may be willing to "co-ordinate" their policies - abdicate some of their sovereignty - for the sake of international goodwill if their concrete actions undertaken in the name of co-ordination have no real impact.

A second and more substantive explanation relates to differences in time horizons. Intervention may lack significance in the long run but may still be a serviceable tactical device for influencing the tenor of the market in the short run. Moreover, it may not be meant to alter exchange rates so much as to enable the authorities to take the pulse of the market, to maintain orderly market conditions and to provide information to major market participants about official attitudes and policies.

Channels of influence: portfolio adjustment, expectations and uncertainty

There are several ways in which intervention may affect market participants. In the portfolio balance model, domestic and foreign bonds are imperfect substitutes and will be held as long as yields adequately reflect risk. By altering relative asset supplies, sales and purchases of foreign currency by the official sector affect private sector portfolios. Private wealth-holders will cease making adjustments in their portfolios when the expected risk-adjusted returns on different assets are equal. The rate of return on domestic bonds is the domestic rate of interest while the rate of return on foreign assets consists of the interest earnings plus any foreign exchange rate gains arising from the depreciation of the home currency.

Sterilised intervention leaves interest rates unchanged but tends to alter the relative supply of domestic and foreign bonds available to the private sector when the authorities automatically offset their operations in the foreign exchange market through open market operations involving public sector debt. Assuming that there is no exogenous change in demand for bonds and that the Ricardian equivalence proposition does not hold, some change in yields will have to occur to re-establish portfolio balance in holdings of foreign and domestic bonds when the central bank engages in sterilised intervention. Since by assumption interest rates do not change, it is only the exchange rate that can adjust to clear the market.

A second way in which intervention may work is by influencing agents' expectations. In conditions where traders dominate the market in the short run and there are multiple equilibria, any action by the authorities which affects expectations can affect exchange rates. If for example traders alter their expectations about the future interest rates as a result of intervention, spot exchange rates will have to adjust because sterilised intervention by definition has no impact on (current) interest rates and because equilibrium will be maintained only if domestic interest rates equal the expected yield of assets denominated in foreign currency.

A considerable amount of empirical work has been done to determine whether and in what way intervention affects exchange rates.<sup>14</sup> Just as most of the tests of portfolio balance models suggest that risk premia are insignificant, so too do most of the studies of the transmission of sterilised intervention through asset substitution imply that intervention is not effective, or, if it is, not of any quantitative significance as a result of portfolio re-adjustment. Studies of the expectations or signalling channel have been fewer in number and more tentative in nature, but their results have been less disappointing. Their main implication is that intervention, even when sterilised, may affect market participants' expectations and thus also exchange rates.

It is useful to give some thought to just how these signalling or expectational effects are transmitted. The conventional explanation is that intervention provides information to market participants on the future course of monetary policy or on the likely impact of

<sup>14</sup> See Edison (1990) for a survey of this evidence.

future policy actions on the exchange rate. Future monetary conditions, or at least expectations of future monetary conditions, are altered. Because a change in expected future interest rates will often lead to a change in current interest rates as a result of term structure relations, the distinction between sterilised intervention working through the expectations channel and unsterilised exchange market operations affecting domestic monetary conditions is not all that sharp.

There is a third way in which the authorities' exchange market intervention may be used for policy purposes, or at least to influence the scope for monetary policy. If markets work effectively, the ability to conduct monetary policy may be limited by asset substitution and covered interest rate arbitrage.<sup>15</sup> The extent to which arbitrage is feasible depends in turn on transactions costs. In the foreign exchange market the principal component of transactions costs is the bid-ask spread, which, as will be shown below, depends on exchange rate volatility. This is because, if exchange rate volatility increases, it is more probable that the market maker will be compelled to assume an unwanted open position. He will therefore tend to seek compensation for this increased risk by widening his bid-ask spread.

By intervening in the market the authorities can attempt either to make swings in exchange rates greater or smaller. In the first instance this will tend to widen the bid-ask spread and therefore give the authorities more scope for conducting their own monetary policy. In the second case, where their actions impart stability to the market and reduce bid-ask spreads, the authorities reduce their ability to conduct monetary autonomous policy but increase the efficiency of the market. In effect they "socialise" some of the risk associated with the operation of the exchange market and thereby provide a service to the community that previously was being performed by the banks.

The decision to adopt one or the other of these two strategies - intervening to increase or to reduce exchange rate volatility - depends on views about the working of the market and the appropriate role of the authorities. If arbitrage between domestic and foreign markets reduces the ability of the authorities to conduct an autonomous monetary policy, and if such policy is felt to add to welfare, intervention which reduces exchange rate volatility will be costly. On the other hand, by decreasing the need for private agents to manage particular types of risk, intervention aimed at reducing very short-term exchange rate fluctuations may augment private sector welfare. And, if the public sector has a comparative advantage in smoothing the market, this may add to aggregate welfare.

In order to be able to assess whether intervention in the market can in fact increase or reduce exchange rate stability, it is useful to look at the actual functioning of the market. If it is already so deep and efficient that such activities are superfluous, exchange market intervention, even when undertaken merely to influence the short-term stability to exchange rates, may be futile. The following section examines the relationship between transactions costs, volatility and the volume of business.

<sup>15</sup> Allen (1977).

#### 4. Market structure, volatility and liquidity

While considerable work has recently been done on understanding the relationship between market structure and price formation in the securities markets, less attention has been given to this relationship in the foreign exchange market, no doubt because it has not displayed unusual instability whereas large and recurrent disruptions have occurred in equity markets since 1987. The following sections aim at redressing that imbalance by examining the relationship between volatility, turnover and market liquidity in the exchange market.

##### Volatility

There are a wide variety of ways in which to measure volatility, and the choice of the measure has considerable bearing on the conclusions that are drawn.<sup>16</sup> This paper relies on two simple and easily understood measures: the coefficient of variation of exchange rates and the standard deviation of logarithmic changes in exchange rates. The first measure is an indicator of the volatility of exchange rate levels, while the second one shows the volatility of relative changes in exchange rates. A currency with a clear underlying trend will display greater volatility when the first measure is used. If that trend arises because the country has a chronically higher rate of inflation and if inflation generates uncertainty, using a measure which reflects this may be appropriate. On the other hand, if the effect of inflation on exchange rate levels is correctly anticipated, a measure which is neutral with respect to trends is more suitable.

Charts 1 and 2 show the volatility of daily exchange rates of various currencies vis-à-vis the US dollar using the two different measures. Three main features stand out. Firstly, irrespective of what measure is used, volatility is affected by regime shifts. The most dramatic illustration of this was the shift in 1973 from the Bretton Woods system of fixed exchange rates to a floating exchange rate regime. There was a pronounced, steplike increase in exchange rate volatility at this time. A similar, although much less marked, increase in volatility occurred in the mid-1980s, when concern about the overshooting of the US dollar led the authorities of the principal countries to forsake their previous policy of benign neglect and to take a public stand, first at the Plaza and then two years later at the Louvre, on exchange rate levels. Although the greater willingness to intervene in exchange markets in evidence at various stages from the mid-1980s onwards might have been expected to impart greater stability to exchange rates, this did not occur. Indeed both indicators of volatility suggest it increased at this time. Uncertainty about the precise policy actions to be taken as well as the widespread doubts about the sustainability of the exchange rate configuration then prevailing appear to have led to greater short-term volatility.

The instability in this period may also be explained in terms of the second feature shown in these tables. Instability seems to be associated with overshooting. Short-term volati-

16 See Glassman (1987) and Kupiec (1990) for a discussion of variability measures in the exchange market and in asset markets more generally.

Chart 1A. Volatility of exchange rates vis-a-vis the US dollar. Coefficient of variation of daily mid-rates.

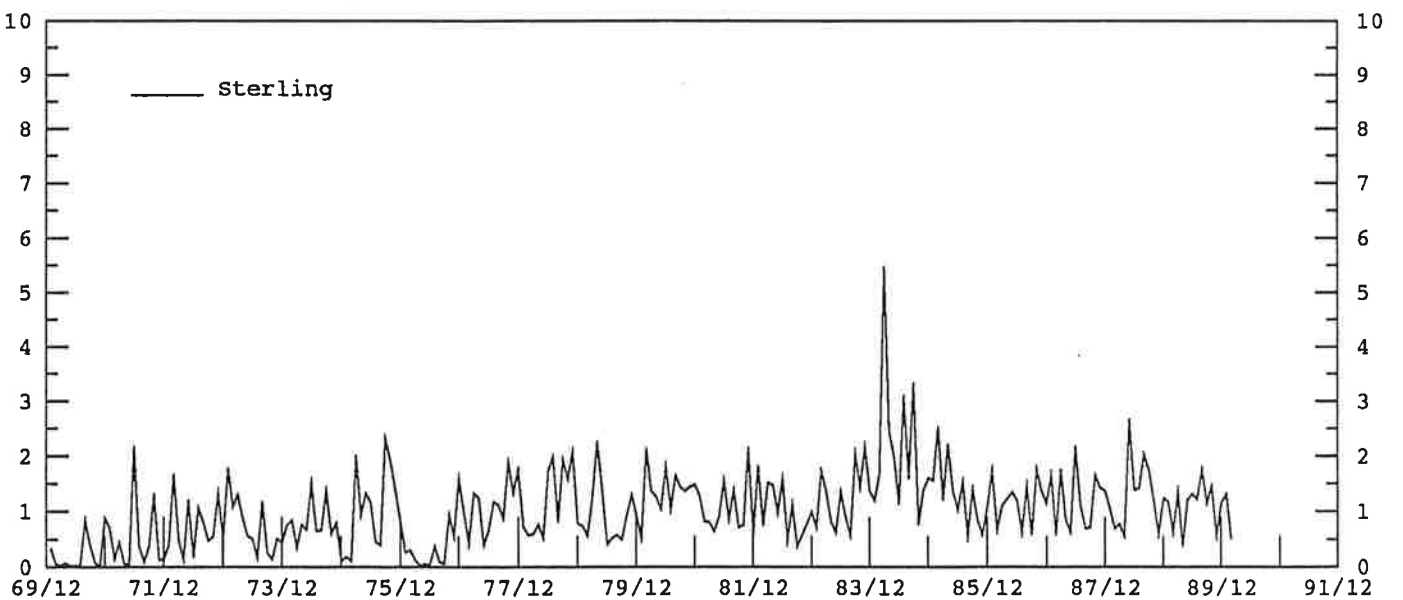
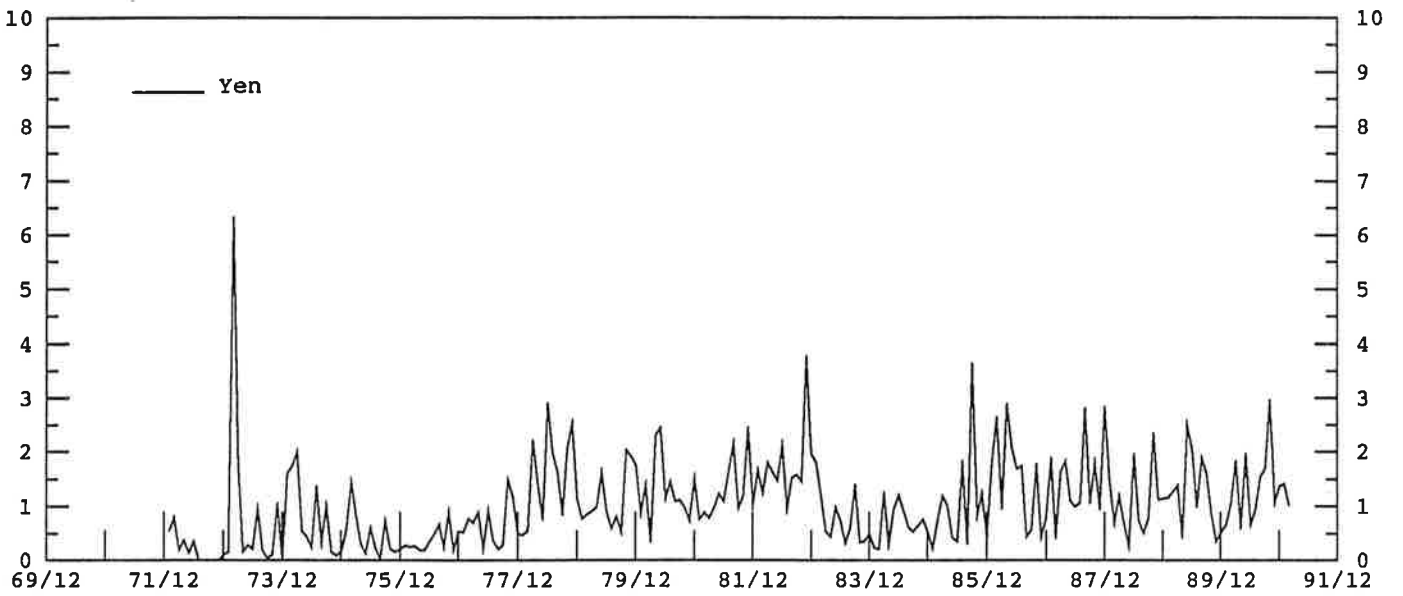
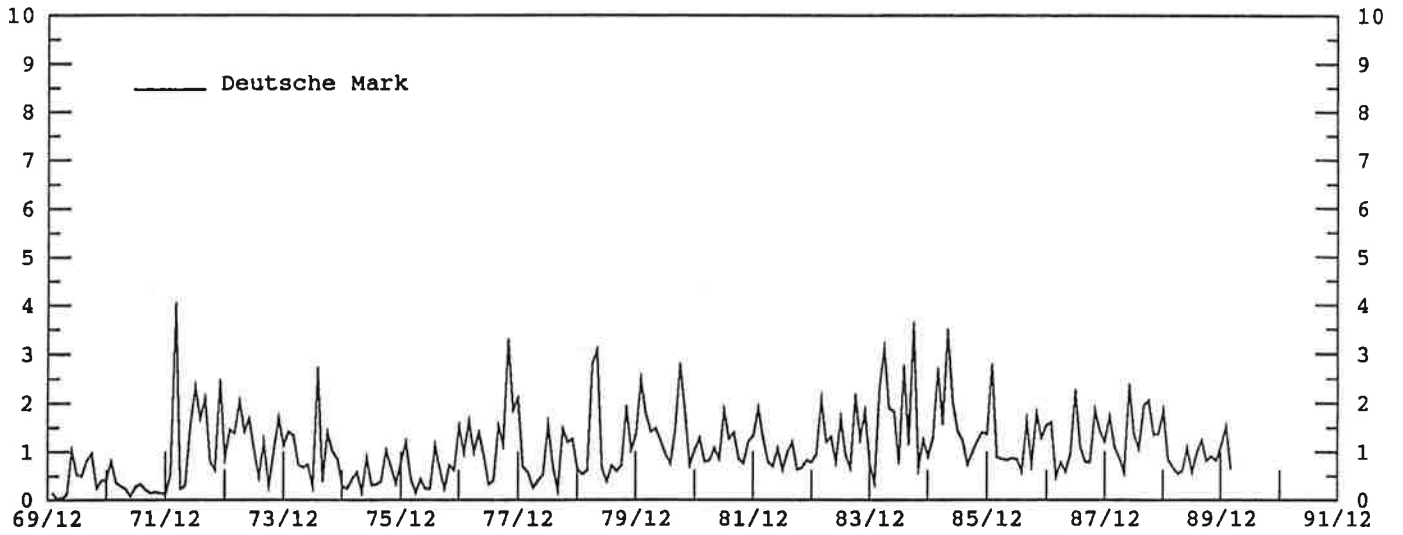




Chart 1B. Volatility of exchange rates vis-a-vis the US dollar. Coefficient of variation of daily mid-rates.

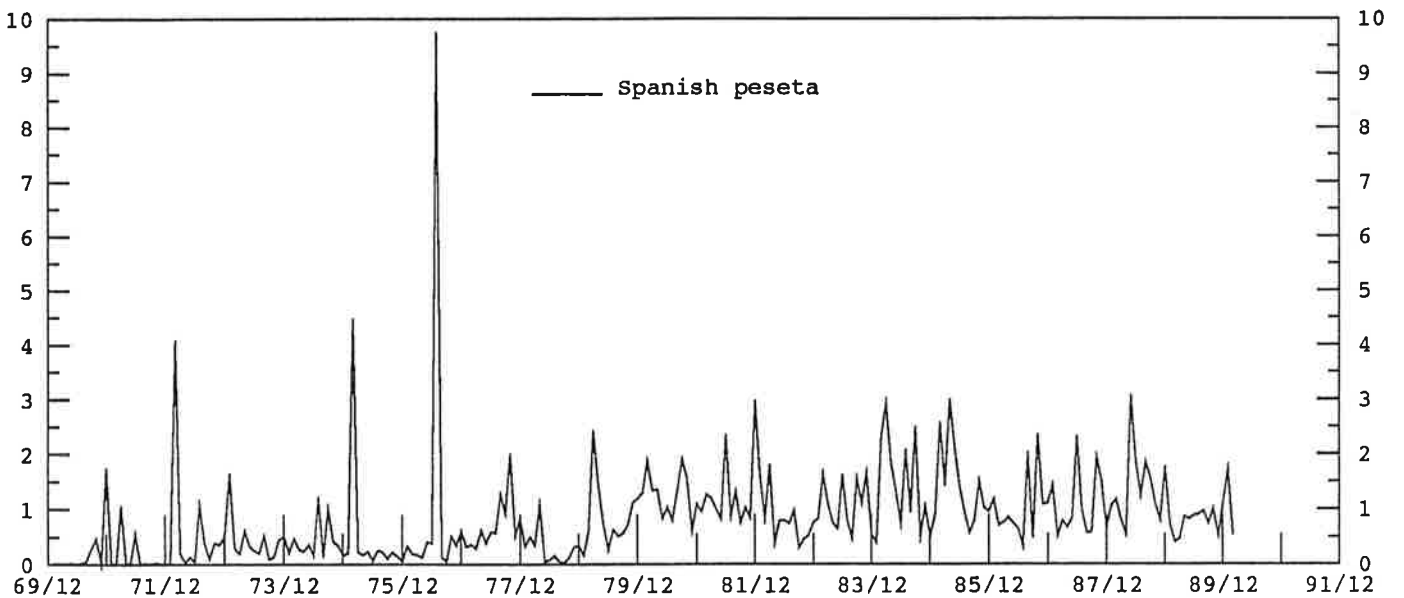
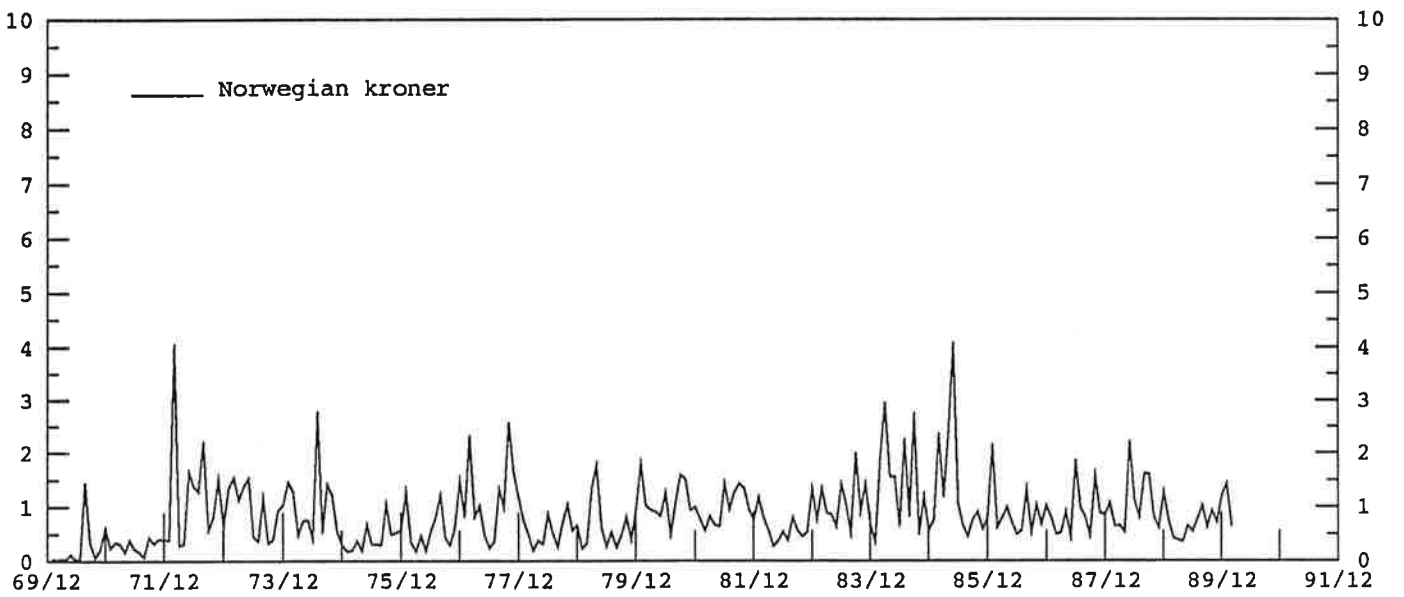
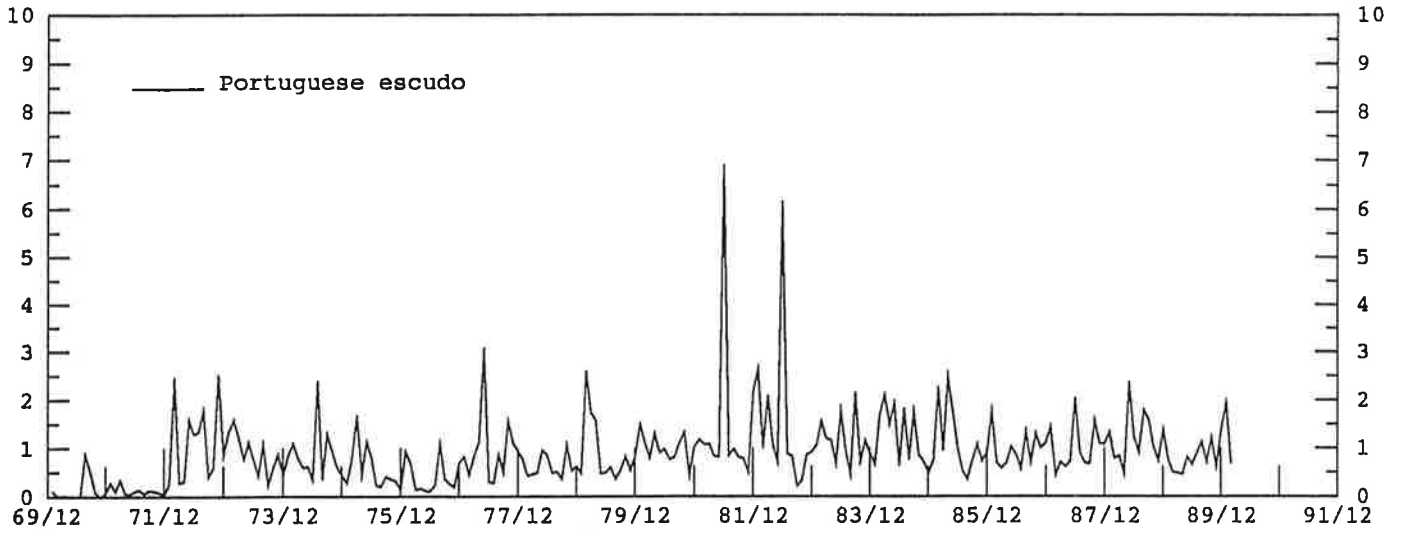


Chart 2A. Volatility of exchange rates vis-a-vis the US dollar. Standard deviation of first differences of log of daily quotations.

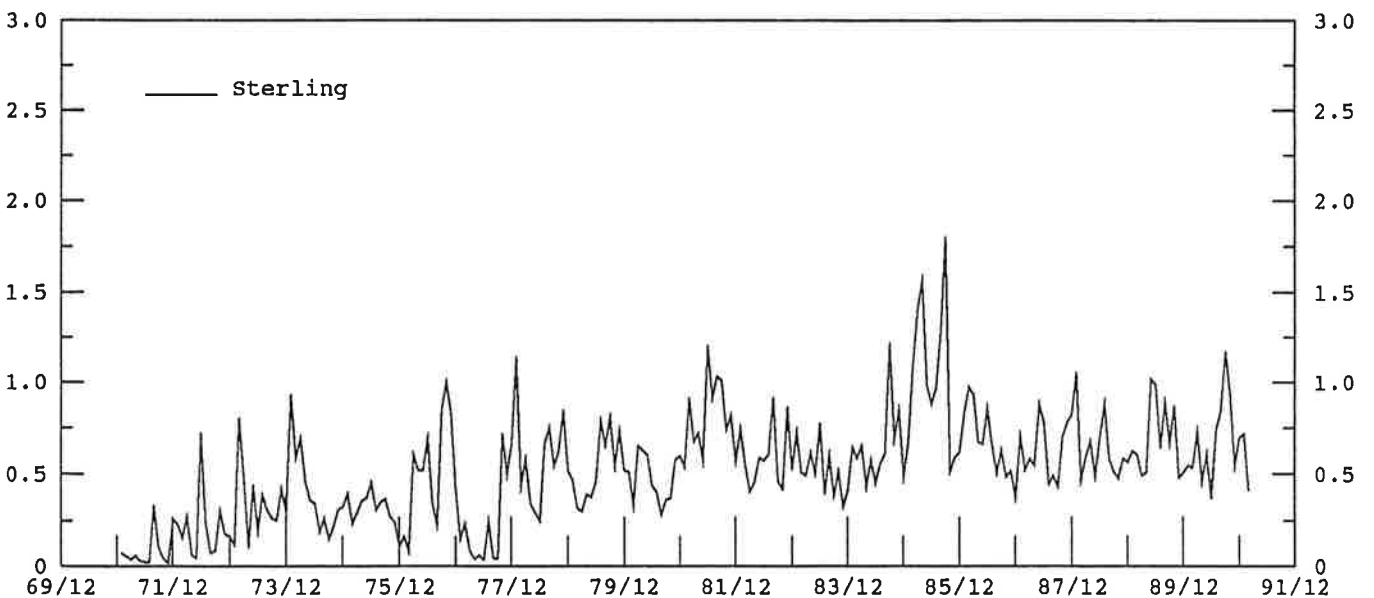
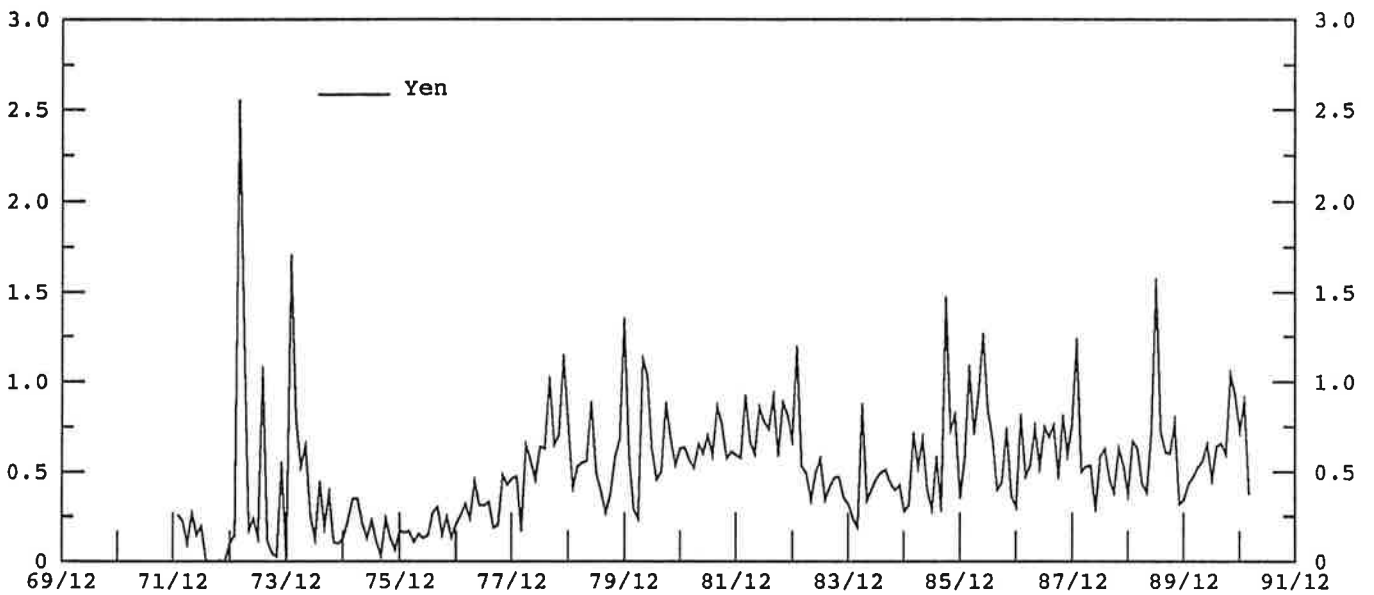
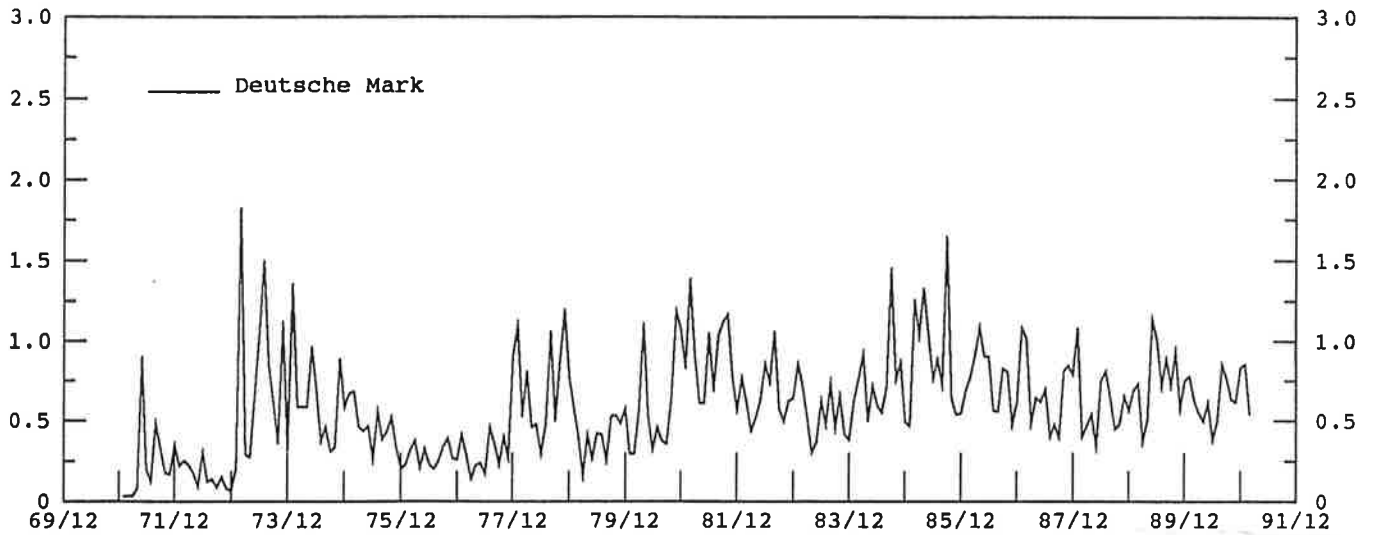
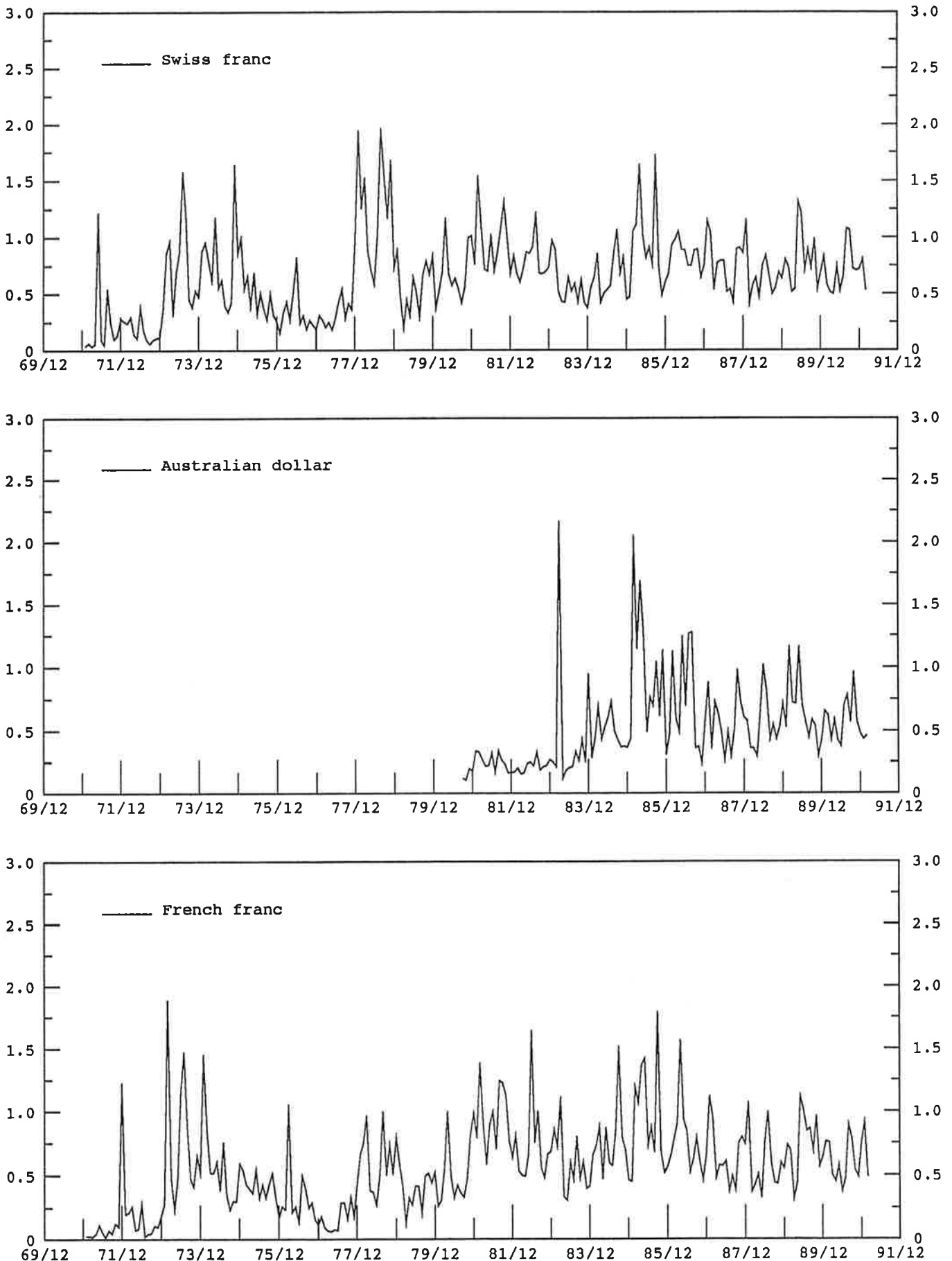


Chart 2B. Volatility of exchange rates vis-a-vis the US dollar. Standard deviation of first differences of log of daily quotations.



lity increases when an exchange rate reaches a level that is, at least with the benefit of hindsight, not sustainable. For example the Swiss franc was unusually volatile on both measures at the end of the 1970s, when it first climbed to unprecedented levels in real effective terms and then subsequently fell back.

Finally, there does not seem to be much difference in the degree of stability across currencies. Both major and minor currencies display the same degree of volatility. This suggests that increasing market depth does not dampen exchange rate fluctuations. Such a finding is somewhat surprising in that the accumulation of experience with managing exchange rate risk and the very substantial increase in turnover during this period might both have been expected to reduce volatility. The next section looks more closely at this question, examining the relationship between the turnover and the bid-ask spread.

### Turnover and transactions costs

An increased volume of transactions can be expected to reduce the bid-ask spread in the foreign exchange market for several reasons. Firstly, the likelihood that a market maker will be able to cross orders - to match various buy and sell orders - grows as the volume of transactions increases. Since the bid-ask spread is set to provide compensation both for executing the transaction as well as for the risk associated with having to assume an unwanted open position, crossed trades will be particularly profitable. Eventually, however, competition among market makers for these supernormal profits should drive spreads lower.<sup>17</sup> Secondly, the fixed costs associated with dealing will be spread over a larger volume of transactions.

<sup>17</sup> Black(1989) uses this fact together with the proposition that increased exchange rate volatility will be associated with wider spreads to derive the following relationship between the bid-ask spread ( $P_a - P_b$ ) and the volume of orders from ultimate agents who are price sensitive ( $Q$ ):

$$P_a - P_b = (a+b)\sigma_p^2/Q$$

where  $a$  and  $b$  denote the exogenous supply and demand propensities of market professionals or speculators who alter the amount of currency they offer or demand in response to differences between the price at which the trader in question is willing to deal and market expectations of mean exchange rates, and where  $\sigma_p^2$  is the variance of the price at which the dealer can close out his position around the mid rate.

In other words the spread is postulated to vary directly with the volatility of the exchange rate and inversely with the volume of transactions on the additional assumption that markets are competitive and market makers are risk neutral. See Allen (1977) and Booth (1984) for an analysis of the determination of bid-ask in a world where market makers are risk averse and where the market maker has a monopoly in dealing in foreign exchange.

Thirdly, increased dealing augments the information on order flow, reservation prices and latent demand at the disposal of the market maker and may give him an opportunity to earn greater profits on his open position. This could in turn give rise to reinforcing pressures to lower the spread further to attract additional orders and obtain more information. Fourthly, an increased volume of dealing may reduce the market spread or "touch" (the gap between the best bid price and best ask price) even if the bid-ask spread of each individual market maker remains constant. Individual dealers adjust their bid and ask prices more or less continuously as they consciously attempt to eliminate excessively large (or excessively small) open positions assumed as a consequence of accepting orders from any and all entities. The constant readjustment of open positions will tend to make the market "touch" smaller than any individual market maker's bid-ask spread, even when all dealers have the same forecast of the mid rate. An increased volume of transactions, when accompanied by more frequent readjustment by market makers, will therefore tend to compress the market spread.

A final factor affecting transactions costs is the size of the market and strength of competition. The turnover in some of the minor currencies or in cross trading between second tier currencies may be so meagre that only a few dealers can justify committing resources to market making. Various barriers to entry such as exchange controls and licensing may also influence the amount of competition. Given the importance of the foreign exchange market, it is striking just how difficult it is to determine empirically the exact relationship between transactions costs, volatility and the volume of transactions. Data on the bid-ask prices quoted by individual banks are available and can be used to measure spreads, but they suffer from the deficiencies mentioned in part 1. Information on exchange rate volatility is somewhat less problematic if one is willing to calculate volatility from mid rate quotations.<sup>18</sup> Consistent data on the volume of transactions are available only for representative months every three years, and prior to 1989 only for a restricted number of countries.

Although there is good reason to expect market liquidity to increase as the volume of transaction expands and as exchange rate volatility declines, it is useful to examine the available evidence to see whether this in fact occurs. The most promising approach is to use cross sectional data on the volume of transactions in April 1989 together with information on spreads and volatility. This is far preferable to using data on currency futures turnover to measure volume, which has been done in earlier studies.<sup>19</sup> Currency futures account for less than 1% of total exchange market turnover and, being comparatively new, have probably grown more rapidly than other types of foreign exchange market transactions. Table 5 shows the results of regressing spreads, as fairly reasonable proxy for transactions costs, on the volume of transactions and volatility in exchange rates.

18 The volatilities of the bid and ask rates for individual currencies are virtually identical, which implies that the use of the mid-rate to measure volatility does not have a material impact on the results.

19 Frankel and Foote (1990).

Two conclusions are suggested by this exercise, which is robust to the choice of the measure of exchange rate volatility. Firstly there appears to be little relationship between the depth of the market and liquidity as reflected in the width of the bid-ask spread, at least in the industrial countries with comparatively unfettered and active exchange markets. Although all the coefficients for turnover have the expected sign, none is significant. One explanation for this somewhat surprising finding is that in these countries the foreign exchange market is already so deep and that further increases in trading do not lead to falling transactions costs.

**Table 5**  
**Cross-section regression of exchange market bid-ask spreads on exchange rate volatility and turnover using data for April 1989**

Constant	Volatility		Turnover	$\bar{R}^2$	Notes
	Changes	Levels			
1.95 (1.44)	8.13 (2.89)		- 0.01 (1.25)	0.31	Volatility measured using log differences in quotations.
5.53 (8.54)			- 0.01 (0.91)	0.01	
1.70 (1.25)	7.94 (2.78)			0.28	
1.94 (1.41)	13.99 (1.69)	- 4.78 (0.76)	- 0.01 (1.30)	0.29	Volatility measured using coefficient of variation of rates.
2.69 (1.95)		5.28 (2.27)	- 0.01 (1.06)	0.20	
1.95 (1.46)	0.08 (2.92)		- 0.01 (1.26)	0.31	Volatility measured using standard deviation of percentage changes in quotations.
2.10 (1.46)	8.34 (2.87)		-0.24 (0.92)	0.28	Log transformation of volumes.

The second conclusion is that exchange rate volatility is an important determinant of transactions costs. Spreads tend to increase when exchange rate volatility grows. These two findings have some implications both for the role that intervention can play and for the consequences of the mooted introduction of netting in exchange market transactions.

## 5. Conclusions

The analysis of the preceding sections may provide some insights into the appropriate role of exchange market intervention in a world of highly efficient and closely integrated financial markets and the implications for market liquidity of a further growth in exchange market turnover which could follow the widespread adoption of netting in foreign exchange clearing and settlement. To be sure, information on the structure and functioning of the exchange market does not in itself explain the persistent tendency for exchange rates to overshoot in the medium term, but it does suggest that explanations which point to the importance of professional dealers who pay little heed to the fundamentals and pit their skills against other "noise" traders are not contradicted by the facts. The great majority of all financial transactions are interdealer trades and the average maturity of forward deals is very short. Of course this does not imply that intervention, unless used in concert with a wide range of other policy instruments, can be of any help in counteracting medium-term overshooting. However, it does suggest that intervention can play a useful role as a minor tactical weapon.

One of the principal findings of this paper is that transactions costs in the foreign exchange market depend positively on short-term (day-to-day) volatility in the market but appear to be unaffected by further increases in market depth. Although official intervention on its own cannot reasonably be expected to produce a sea change in exchange rate trends, astutely timed deals with the appropriate counterparty in the right market segment may easily affect short-term exchange rate volatility. Moreover the authorities are the only true insiders in the foreign exchange market. If their operations generate cumulative expectations on the part of others active in the market, the effects may be far larger than the size of the initial transactions would suggest. Accordingly, it would appear that intervention can be useful either as one part of the overall economic policy strategy or if used on its own as a tactical instrument to influence short-term exchange rate stability.

Having said this, it is important to note that this paper has raised, but not answered, the question of how intervention should be used within the tactical armoury. While it can reasonably be expected to affect transactions costs by altering short-term exchange rate volatility, it is not clear whether it is in the greater public good for the authorities to attempt to impart stability to rates, reduce transactions costs and foster market efficiency, or, in the diametrically opposite vein, to augment exchange rate volatility, reduce the scope for the effortless substitution of assets and thereby win slightly more room for conducting autonomous monetary policy.

The findings of this paper also offer some insights into the benefits which may accrue from the introduction of multilateral clearing arrangements or the expansion of existing bilateral procedures. By allowing dealers to reduce their intra-day exposures, these changes could lead to further expansion of short-term trading. But by placing a clearing house or a clearing mechanism between various counterparties, multilateral netting arrangements would mean that the soundness of the system no longer depends principally on the timely performance of contractual obligations by the two counterparties of an exchange market deal, but equally well on the integrity of the clearing and settlement procedures. This in turn requires the appropriate regulatory oversight. The costs of such oversight and of the establishment of a new system should be set against its benefits.

It is striking that, quite in contradiction to expectations, transactions costs do not appear to decline as turnover increases. This may well be because the markets are now so large and deep that a further expansion brings few benefits in the form of economies of scale, increased competition or improved market information. If this is the case, new structures such as multilateral netting arrangements which allow the further expansion of the trading may not generate much additional benefit in the form of greater liquidity or lower transactions costs in the exchange market itself. However, since the participants in the exchange market conduct a wide range of banking and financial business, savings in this area may ultimately have benefits outside the exchange market itself.



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