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SUMMARY

The impact of official interventions on exchange-rate misalignements and volatility has been widely studied. In general, the empirical literature concludes either that interventions are inefficient, or that they work in the wrong direction. For instance, there is some slight evidence that net purchases of dollars by central banks were associated with subsequent dollar depreciation, which is often interpreted as a "leaning-against-the-wind" behaviour from the central banks, i.e. as a reverse causality, central banks buying a specific currency when it is depreciating. In addition, central bank interventions are often shown to raise exchange rate volatility. Such conclusion can be drawn from the analysis of conditional short-term volatility estimated through GARCH models, or of implied volatility computed from currency options prices.

Why do official interventions raise ex ante exchange-rate volatility? One interpretation could be that they are able to break a consensus on a “bad” equilibrium, but not to co-ordinate expectations on a new one: market expectations do react to interventions, but in a somewhat disorderly manner. Indeed, MacDonald and Marsh (1996) and Chionis and MacDonald (1997) find clear evidence of expectation heterogeneity driving both traded volumes and exchange-rate volatility. Interventions would raise volatility because it raises the heterogeneity of market expectations. Such interpretation would be broadly consistent with the microstructure literature showing that interventions may open up the dispersion of expectations.

However, if this is the way intervention works it is likely to be limited to an intra-day horizon. It does not explain the persistent effect of interventions found on exchange-rate volatility, and does not match the inter month horizon of central banks. The present paper tries to fill the gap between the macroeconomic and microstructure approaches to central bank interventions. More specifically, we show that official interventions have a positive impact on forecast heterogeneity, the latter being a persistent effect lasting more than the (intra-) daily horizon of the microstructure literature. periods.

Our analysis involves the Deutschemark (or euro)-US dollar and Japanese yen-US dollar exchange rates. More specifically, we study whether official interventions from the Federal Reserve, the Bank of Japan, the Bundesbank and the European Central Bank (ECB) had an impact on forecast heterogeneity. As a measure of the latter, we use the cross-section coefficient of variation derived from Consensus Economics monthly survey data over the periods 1990-1994 and 1996-2001. The results from SURE estimations are compared across markets (Deutschemark-euro against US dollar, Japanese yen against US dollar) and across periods.

Although data limitations prevents us from drawing very general results in terms of time and country samples, our empirical investigation shows that central bank interventions can significantly raise the heterogeneity of monthly expectations at the 1 month, 3 months and 12 months horizons in the case of official (especially unexpected) interventions (DEM-EUR/USD) or of expected interventions and "false" rumours (JPY/USD). Hence, central bank intervention can be viewed as able to move market opinions, albeit in a way which is different for the two markets.

ABSTRACT

We investigate the impact of central bank intervention in the foreign exchange market on forecast heterogeneity. Market heterogeneity is based on a sample of forecasts made by a large number of commercial banks over two distinct periods for the DEM (or EUR) and the JPY against the USD. We show that, in general, forecast heterogeneity increases as a result of interventions, whether the interventions are unexpected (DEM-EUR) or expected (JPY). Our results also emphasise the role of rumours, especially in the YEN-USD market. In sum, official interventions are shown to move market opinions, albeit differently across the two markets.

JEL Classification: F31, C42
Key Words: Central Bank Intervention; Foreign Exchange Markets; Survey Expectations; Market Micro-Structure

L'IMPACT DES INTERVENTIONS DES BANQUES CENTRALES SUR L'HÉTÉROGÉNÉITÉ DES PRÉVISIONS DE CHANGE

RÉSUMÉ

L'impact des interventions officielles sur le marché des changes a fait l'objet de nombreuses études. En général, ces études concluent soit, que les interventions sont inefficaces, soit même qu'elles agissent dans le mauvais sens. Par exemple, un achat net de dollars par les banques centrales est associé à une dépréciation du dollar. Ce résultat est souvent interprété comme un comportement délibéré des banques centrales qui agiraient à contre-courant du marché, ce qui se traduirait par une causalité inverse, les banques centrales achetant une monnaie qui se déprécie. Par ailleurs, il a souvent été montré que les interventions officielles accroissent la volatilité du taux de change. Ce résultat est fondé sur l'analyse des volatilités conditionnelles de court terme comme sur les volatilités anticipées, implicites aux prix d'options.

Pourquoi les interventions officielles accroissent-elles la volatilité des taux de change ? Une interprétation possible serait qu'elles parviennent à "casser" un consensus sur un "mauvais" équilibre, mais pas à coordonner les anticipations sur un nouvel équilibre : les marchés réagissent aux interventions, mais de manière désordonnée. Cette interprétation serait cohérente avec les résultats de MacDonald et Marsh (1996) et Chionis et MacDonald (1997) montrant que l'hétérogénéité des anticipations affecte à la fois les volumes échangés et la volatilité du taux de change. Elle serait également cohérente avec la littérature sur les microstructures de marché montrant que les interventions peuvent accroître la dispersion des anticipations.

Cependant, si c'est ainsi qu'agissent les interventions, alors leur impact devrait être limité à l'horizon intra-quotidien. Cela n'explique pas l'effet persistant des interventions sur la volatilité des taux de change, et ne cadre pas avec l'horizon des banques centrales. Le travail proposé ici tente de combler le vide entre les approches macroéconomique et microstructurelle des interventions officielles des banques centrales. Plus précisément, nous montrons que les interventions officielles ont un impact positif sur l'hétérogénéité des anticipations, ce dernier effet étant persistant bien au-delà de l'horizon (intra-) quotidien de la littérature sur les microstructures de marché.

Les taux de change étudiés sont celui du Deutschemark (puis euro) et du yen contre dollar US. Les interventions officielles sont celles de la Réserve Fédérale, de la Bundesbank (puis de la BCE) et de la Banque du Japon. L'hétérogénéité des anticipations est mesurée par le coefficient de variation des anticipations en coupe calculé à partir des données d'enquêtes mensuelles de *Consensus Economics*,, sur les périodes 1990-1994 et 1996-2001. On compare les résultats d'estimations SURE selon les marchés (DM-euro contre dollar, yen contre dollar) et selon les périodes.

Même si les données ne permettent pas de tirer des conclusions très générales en termes de périodes et de devises, les résultats empiriques montrent que les interventions des banques

centrales peuvent accroître de manière significative l'hétérogénéité des anticipations aux horizons de 1, 3 et 12 mois. Il s'agit des interventions non anticipées dans le cas DEM-EUR/USD, mais des anticipations anticipées et des "fausses" rumeurs dans le cas JPY/USD. Ainsi, les interventions sont capables de faire bouger les opinions des agents, mais d'une manière différente sur les deux marchés.

Classification *JEL* : F31, C42
Mots-clefs : Intervention des banques centrales ; marché des changes ; anticipations, données d'enquête ; micro-structure de marché

THE IMPACT OF CENTRAL BANK INTERVENTION ON EXCHANGE-RATE FORECAST HETEROGENEITY

Michel Beine [a]***, Agnès Bénassy-Quéré*** [b]***, Estelle Dauchy*** [c] ***and Ronald MacDonald*** [d]

1. INTRODUCTION

Exchange-rate misalignments and volatility are endemic features of floating exchange-rate regimes. They have consecutively justified official interventions in the foreign exchange markets. In the macroeconomic literature, foreign exchange market intervention has various channels of influences, such as the portfolio balance and signalling channels (see Mussa, 1981 or Lewis, 1995). While the former covers the direct impact of official purchases and sales on the market price of a currency, the latter channel works indirectly through moving the expectations of market agents.

The impact of official interventions on exchange-rate misalignements and volatility has been widely studied. In general, the empirical literature concludes either that interventions are inefficient, or that they work in the wrong direction (see recent surveys by Frenkel et al. 2001 or Sarno and Taylor 2001). For instance, there is some slight evidence that net purchases of dollars by central banks were associated with subsequent dollar depreciation, which is often interpreted as a "leaning-against-the-wind" behaviour from the central banks, i.e. as a reverse causality, central banks buying a specific currency when it is depreciating (see Baillie and Osterberg (1997b) for instance). In addition, it is generally found that central bank interventions are often shown to raise exchange rate volatility. Such conclusion can be drawn from the analysis of conditional short-term volatility estimated through GARCH models. Examples of this approach are Baillie and Osterberg (1997a and b), Dominguez (1998), Beine, Bénassy and Lecourt (2002), or Boubel, Dauchy and Lecourt (2002). Nevertheless, some recent developments in the literature question these results. In particular, Beine, Laurent and Lecourt (2001) show that co-ordinated interventions of the Federal Reserve and the Bundesbank between 1985 and 1995 exerted a negative impact in the case of the relatively high level of volatility. In the same spirit, Mundaca (2001) shows

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that direct interventions carried out by the Bank of Norway were stabilising if they occurred while the exchange rate was moving around the central parity of the currency band rather than near the weakest edge of the band.

Rather than focusing on the ex post dynamics of the exchange rate, a complementary strand of the literature analyses the impact of central bank interventions on the expectation of the market. In this respect, expected volatility is usually measured using implied volatilities computed from currency options prices, as illustrated by Bonser-Neal and Tanner (1996), Dominguez (1998), Galati and Mellick (1999) and Dauchy (2001). In general, these approaches also conclude to a positive effect of central bank interventions on (expected) exchange rate volatility, although some stabilizing effect has been detected over some specific sub-periods. This result is reflected in traders opinions: according to Cheung and Chinn's (2001) survey, 61% of US traders think that CBIs raise volatility.

Why do official interventions raise ex ante exchange-rate volatility? One interpretation could be that they are able to break a consensus on a "bad" equilibrium, but not to co-ordinate expectations on a new one: market expectations do react to interventions, but in a somewhat disorderly manner. Indeed, MacDonald and Marsh (1996) and Chionis and MacDonald (1997) find clear evidence of expectation heterogeneity driving both traded volumes and exchange-rate volatility. Interventions would raise volatility because it raises the heterogeneity of market expectations.

Such interpretation would be broadly consistent with the microstructure literature suggesting that interventions may open up the dispersion of expectations. For example, the fact that some agents observe central banks behaviour before others will induce a progressive spreading of information through the trading process (Evans and Lyons 2000). Other theoretical work (see, inter alia, Popper and Montgomery (2001), Bhattyacharya and Weller (1997), Vitale (1999)) is more ambiguous with respect to the direction of dispersion following on from intervention. For example, Popper and Montgomery (2001) show how central bank interventions can improve the efficiency of the aggregation of information (about future macroeconomic fundamentals, say) by serving an informational sharing role. According to Vitale (1999) or Evans and Lyons (2000), the dispersion of expectations should fall if the intervention is known, but rise if it is secret.

Using Bank of Canada intervention data D'Souza (2001) reports evidence that the effectiveness of central bank interventions is partly determined by market wide order flows which are generated subsequent to the intervention. Such flows are caused by dealers, who find that central bank interventions provide useful information about future fundamentals. It seems likely that this kind of intervention effect will increase the post intervention distribution of expectations. Indeed, Naranjo and Nimalendran (2000) have argued that dealers increase spreads at the time of interventions to protect them from greater informational asymmetry. This feature is confirmed by Dominguez (1999) who finds that some dealers receive early information on central bank intervention relative to other traders.

However, if this is the way intervention works it is likely to be limited to an intra-day horizon. It does not explain the persistent effect of interventions found on exchange-rate volatility, and does not match the inter month horizon of central banks. The present paper

tries to fill the gap between the macroeconomic and microstructure approaches to central bank interventions. More specifically, we show that official interventions have a positive impact on forecast heterogeneity, the latter being a persistent effect lasting more than the (intra-) daily horizon of the microstructure literature.

Our analysis involves the Deutschemark (or euro)-US dollar and Japanese yen –US dollar exchange rates. More specifically, we study whether official interventions from the Federal Reserve, the Bank of Japan, the Bundesbank and the European Central Bank (ECB) had an impact on forecast heterogeneity. As a measure of the latter, we use the cross-section coefficient of variation derived from Consensus Forecasts monthly survey data over the periods 1990-1994 and 1996-2001. The results are compared across markets (Deutschemark-euro against US dollar, Japanese yen against US dollar) and across periods. This allows us to draw some conclusions on the practices of the various central banks and on the possible evolution of the foreign exchange market.

One important feature of our study is that we assume that the euro's behaviour with respect to interventions is simply a continuation of the Deutschemark's behaviour. Although this assumption is perhaps questionable, it does raise the power of our tests (including those involving the yen) - which we perform with a SURE specification - and it is unlikely to affect the main tenor of our results since the Bundesbank and the Fed did not intervene on the DEM-USD market between 1996 and 1999, i.e. during the three first years of our second and last investigation period.

The outline of the remainder of this paper is as follows. Section 2 presents a discussion of our data set and in section 3 we present our empirical results. Section 4 contains some conclusions.

2. VARIABLE MEASURES AND DEFINITIONS

2.1 The dependent variable: A measure of heterogeneity

There are broadly two ways of measuring exchange-rate expectations. The first is to use option prices to derive the implicit distribution of expectations (see Breeden and Litzenberger, 1978). The advantage of this approach is that the recovered expectations are representative of what market dealers believe, rather than what they say they believe. A further supposed advantage of this approach is that, under some assumptions, the whole probability density function of the distribution can be recovered. However, the problem with this method is that the implicit expectations are conditional on the assumption of risk neutrality. If market agents are risk averse, then these calculations lead to a mixture of expectational and risk premia effects. Furthermore, option data availability and quality are of overwhelming importance, which, in turn, prevents the extraction of probability density functions over longish periods.[1]

[1] For instance detailed over-the-counter option prices are required.

An alternative measure of expectations may be derived from surveys of forecasters. Clearly, there is no guarantee that market strategies are based on these expectations. However, the fact that some analysts are paid by banks to forecast exchange rates suggests that the corresponding forecasts must at the very least be useful at some stage in the foreign exchange process. The main advantage in using a survey-based measure of expectations is that it is not conditional on a specific model of the risk premium.

In this paper we use survey data collected from Consensus Forecasts (London) for the Japanese yen, the Deutschemark and the euro against the US dollar over two periods: January 1990 to December 1994, and January 1996 to March 2001. We rely on a monthly survey in which more than 100 analysts from banks and forecasting institutions are asked their one to 24-month forecasts. The survey is conducted on the first Monday of each month, and the results are published before the 15th of the corresponding month. Although the data source is the same for the two periods, it is not possible to connect the periods because a year of data is missing between periods. It should also be noted that the names of the banks are not available for the first period.

We concentrate on the 1, 3 and 12-month forecasts. The one-month forecasts are only available for the second period, while the 3 and 12-month horizons are available for both periods. The heterogeneity of expectations across forecasters is calculated as the cross-section coefficient of variation of each kind of expectation - currency/horizon - at each date. Using the coefficient of variation facilitates a comparison of heterogeneity across currencies and it also allows us to move from the DEM to the euro.

Unfortunately, there are many missing observations in the database. There is a possibility that heterogeneity moves over time or across currencies/horizons simply because the forecasters are not the same. We attempt to tackle this problem by using two alternative measures of heterogeneity. The first relies on the whole sample at each date (a little more than 100 forecasters, depending on the currency/forecast/date). The second measure is based on a sub-sample of 25 (first period) or 24 (second period) “reliable” forecasters. Reliable forecasters are selected in the following way:

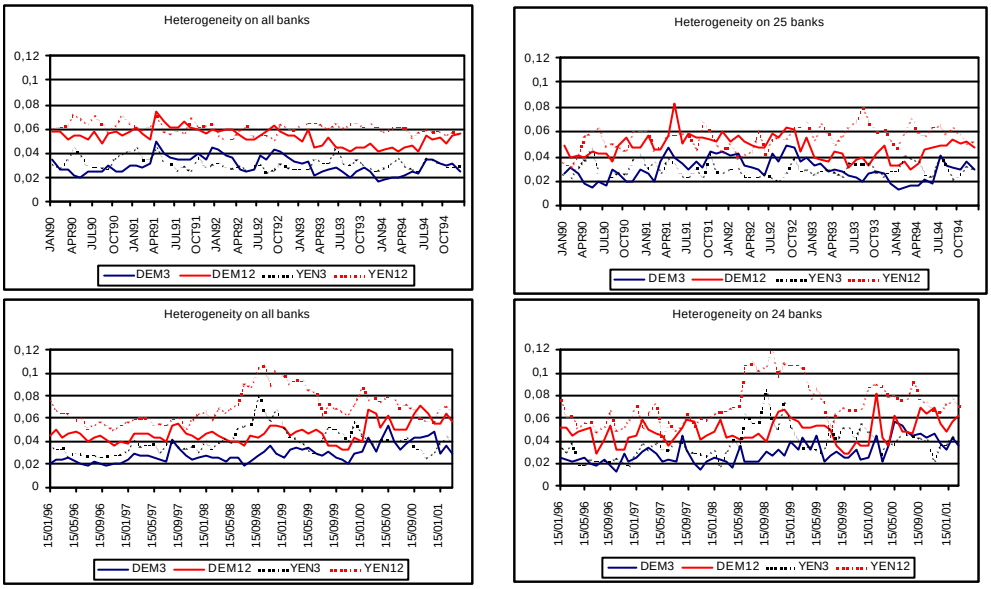
- For the first period, we select those respondents that did not fail more than 4 times (once a year on average) on each of the two markets (JPY/USD and DEM-EUR/USD) and on each horizon (3,12 months). Hence, the number of answers is generally very close to 25 for each date/currency/horizon.

- For the second period, we select 24 respondents whose forecasts were reported for the three currencies and the three horizons (1, 3, 12 months). Over the 24 forecasters, between 2 and 13 did not answer at each date, depending on the currency/horizon.

The evolution of the various measures of heterogeneity is illustrated in Figure 1. Unsurprisingly, heterogeneity is higher the longer the forecast horizon. It is also higher over the second period, especially for the JPY in 1998. Forecast heterogeneity tends to be higher for the JPY then for the DEM-EUR, especially over the 1996-2001 period, and for the 12-month horizon. Lastly, reducing the sample to a selection of “reliable” forecasters produces

measures of heterogeneity that vary to a larger extent over time, especially at the 12-month horizon.

Figure 1: Forecast heterogeneity



2.2 THE EXPLANATORY VARIABLES: MEASURES OF CENTRAL BANK INTERVENTION

In this section we consider the construction of the explanatory variables set used in this paper. Two indicators are used to represent central bank intervention in the foreign exchange market. The first is data on official interventions provided by the central banks themselves,[2] while the second is the reported interventions by the press or by wire services. We use both sources of information sequentially. Our intervention variable is the number of intervention days during the month preceding each measure of forecast heterogeneity. This choice is motivated by previous work showing that the signalling channel of interventions is more powerful than the portfolio channel (see Section 2). Hence, the amount of foreign currencies that is bought or sold by monetary authorities is less relevant than the fact that

[2] The Federal Reserve Board provides the daily amounts of its foreign currency trades on request. The Bundesbank also provides intervention data on the DEM up to the launching of the European Monetary Unification in 1999. Post 1999 the only indication that intervention has taken place in the Euro area is in the form of official statements made after each intervention. Interventions by the Bank of Japan have recently been made available on the web site of the Japanese Ministry of Finance (www.mof.go.jp).

they intervene. However, we test for the robustness of our results by subsequently using the actual amounts of interventions - which are total net purchase of USD during the month preceding the measure of forecast heterogeneity.[3]

The time series availability of the different measures of intervention is reported in Table 1. The Reuters information was recovered from the database constructed by Dauchy (2001) on the basis of news headlines.[4] For Jan 1990-Jan 1992, we use *Wall Street Journal* reports kindly provided by K. Bonser-Neal, together with an update based on the *Financial Times* (Beine *et al*., 2002).[5] Official interventions from the BoJ are supplemented with reported interventions from Jan 1990 to Feb 1991.

Table 1: Foreign exchange interventions: data availability

	Federal Reserve	Bundesbank/ECB	Bank of Japan
Official sources	Jan 1990 - Mar 2001	Jan 1990 – Dec 1998	Mar 1991 – Mar 2001
Reported interventions(*)	Jan 1990 – Mar 2001	Jan 1990 – Mar 2001	Jan 1990 – Mar 2001
Rumours	Feb 1992 – Mar 2001	Feb 1992 – Mar 2001	Feb 1992 – Mar 2001
Expected/unexpected	Feb 1992 – Mar 2001	Feb 1992 – Mar 2001	Feb 1992 – Mar 2001

(*)Dauchy (2001) since Feb 1992 (Reuters news headlines); Bonser-Neal and Tanner (*Wall Street Journal* reports) for 1990-1991; Beine et al. (2002) for Jan. 1992 (*Financial Times*).

One advantage of our Reuters' database is that it contains other announcements, including rumours, made by market operators concerning central bank interventions. Following Dauchy (2001), and Boubel, Dauchy and Lecourt (2001), we describe an intervention rumour as any news headline announcing the probability of a central bank intervening in the future, even if the intervention does not actually occur in the expected time period. Comparing rumours with actual interventions - reported or official - allows us to disentangle true rumours from false ones.

We aggregate daily dummies (official or reported interventions, rumours) or amounts (official interventions only) into monthly variables. The latter therefore represents either the

[3] This is only possible for official sources, since Reuters and press releases do not report amounts.

[4] See also Boubel, Dauchy and Lecourt (2002) for the use of this database.

[5] Reuters news headlines are in general more accurate than financial newspapers since the source is broader: it includes information from over two thousand newspapers (including the *Wall Street Journal*), for more than 130 countries.

number of days of interventions or the cumulated amount of intervention since the last measure of forecast heterogeneity.[6]

The same daily database on reported interventions is used to construct a new measure for expected interventions, defined as interventions that were preceded by rumours during the four days prior to the intervention. This calculation is made both on official interventions and on reports. Unexpected interventions are defined as the difference between the actual and expected interventions. If the foreign exchange market is efficient, the unexpected interventions should have a significant impact on heterogeneity while the expected interventions should not. Expected and unexpected intervention variables are only available from 1992 due to the time span of the Reuters' database.

Following previous studies which highlight the role of co-ordination between central banks for the success of official interventions (Catte *et al.,* 1992), we define co-ordinated interventions as simultaneous interventions carried out by the two central banks involved in the corresponding market (DEM-EUR/USD or JPY/USD). The time discrepancy is accounted for: when the Federal Reserve intervenes, on day t, after the closing-time of both the Japanese and the European market, the intervention is reported on day $t+1$ in the latter markets. The resulting variable is defined either as a number of days of co-ordinated interventions over the past month (official and reported dummies) or as the absolute value of the cumulated net purchases of dollars by the two central banks (official data only). The exact days of co-ordinated interventions are reported in Table 2.

Table 2: Co-ordinated interventions (excluding 1995)

DEM-EUR/USD		JPY/USD	
March, 1990	May, 1994	January, 1992	April, 1994
February, 1991	June, 1994	February, 1992	May, 1994
March, 1991		April, 1993	June, 1994
July, 1991	September, 2000	May, 1993	November, 1994
July, 1992		June, 1993	
August, 1992		August, 1993	June, 1998

Consistent with previous research on the impact of foreign exchange intervention on the exchange rate (Galati and Melick 1999, Dominguez 1998), we introduce money market interest rates as control variables (where interest rate variations are assumed to summarise monetary policy news). The maturities used are consistent with our expectations horizons.[7] Since the direction of interest rate variations is not relevant for market heterogeneity, we

[6] Because the direction of the intervention is irrelevant for the impact on forecast heterogeneity, we use the absolute value of cumulated net dollar purchases.

[7] The interest rate data was sourced from Datastream.

used the absolute variation of the interest rate differential between the DEM/EURO and the USD or between the JPY and the USD.

The evolution of the various measures of intervention is illustrated in the Appendix A. As forecast heterogeneity is measured at the beginning of each month, each intervention figure covers interventions carried out during the preceding month. We exclude 1995 from the graphs in order to match the availability of forecast heterogeneity measures (1990-1994 and 1996-2001). Some comments are in order.

First, over the whole period, there have been many more interventions on the JPY/USD market compared to the DEM-EUR/USD market: 196 interventions on JPY/USD compared to 80 on the DEM-EUR/USD market. This is a well-known feature of Japanese interventions, which are much more frequent than both their US and German/Euro area counterparts.

Second, although less frequent, central bank interventions have involved larger transactions in the late 1990s than in earlier periods. This reflects both a strategic change and the evolution of the foreign exchange daily turnover. The latter rose from USD bn 570 in April 1989 to a high of USD bn 1,400 in April 1998, before shrinking to USD bn 1,210 in April 2001 (BIS, 2001). Although mostly relevant for the portfolio channel of intervention, it can be argued that the signalling channel only works if the central bank shows it is ready to lose a large amount of money should the currency move in the wrong direction.[8]

Third, interventions on the DEM-EUR/USD market are concentrated in the early 1990s, whereas interventions on the JPY/USD are more evenly spread out over time, with a concentration in 1993-1994. Indeed, from January 1990 to January 2001, 82.8% of the official intervention days on the USD/DEM (or the EUR/USD) occurred before September 1992, compared to 22.5% of the interventions on the USD/JPY.

Fourth, a large proportion of interventions on the DEM/USD in the early 1990s have not been reported in the newspapers.[9] Indeed, from 1990 to September 1992, interventions on the DEM-EUR/USD have been reported on 26 days out of a total of 53 official interventions on the currency. From October 1992 to January 2001, the figure reverses to 16 days of reported interventions on the USD/DEM to a total of 11 official interventions on the currency.[10] One obvious explanation could be that the flow of information reported by newspapers (before 1992) is small compared to that reported by Reuters (from 1992). However, such a story does not fit the JPY/USD case for which official and reported

[8] We are grateful to Charles Goodhart for suggesting this point.

[9] It is worth noting that from January 1990 to January 1992, reported interventions are collected through the financial newspapers.

[10] In particular, five Bundesbank interventions since October 1992 have been unofficial. This means that either the central bank really traded the USD/DEM without acknowledging ex post this action (as an intervention aiming at influencing exchange rate dynamics), or that the central bank did not intervene while the market spread false news (Dauchy 2001, and Boubel, Dauchy and Lecourt 2001).

interventions are very close to each other. Hence, there seems to have been a change in the Bundesbank strategy, abandoning the use of "secret" interventions after 1991, and/or a growing number of "false" reports. This strategy is also consistent with the recent official intervention policy of the Fed.

Fifth, for both markets and both sub-periods, half of official interventions had been expected. However, this is no longer the case for the DEM-EUR/USD when interventions are derived from reports rather than official data: most reported interventions have been expected in the first sub-period while unexpected in the second sub-period. This is consistent with the loss of information power of Reuter's reports, already noted for this market over the second period.

Sixth, co-ordinated interventions have been more frequent for the JPY/USD (25 days of co-ordinated interventions) than for the DEM-EUR (18 days). They are concentrated on the first sub-period (1990-1994)[11], co-ordinated interventions over 1996-2001 being limited to June 1998 (JPY/USD) and September 2000 (DEM-EUR/USD).

Finally, there have been more rumours in the second period than in the first one, especially concerning interventions by the Bundesbank-ECB and the Federal Reserve. Generally, the number of false rumours is far greater than the number of true rumours.[12] In the case of the Federal Reserve nearly all the rumours turn out to be false. For the Bundesbank, only one rumour out of nine was true during the first sub-period, and almost every rumour was false during the second sub-period. During the first sub-period, four out of ten rumours concerning the Bank of Japan were true, and one out of nine were true during the second sub-period. We conclude that expectations concerning central bank interventions are very noisy, and that false rumours are an important feature of the market.

3. ECONOMETRIC STRATEGY AND EMPIRICAL RESULTS

3.1 Econometric Strategy

Three model specifications are considered. In the first, we investigate the effects of the number of official interventions (OI) in the preceding month. We also include the effect of false rumours (FR), which, by construction, are orthogonal to official interventions. As a control variable, we consider the monthly absolute change in the interest-rate differential between the currency under consideration (JPY or DEM/EUR) and the USD at the corresponding maturity (DS). As we have noted, this variable is usually interpreted in the literature on CBIs as capturing expected changes in monetary policy. According to Cheung and Chinn (2001), interest rates are continuously perceived by market agents as very relevant for the determination of exchange rates over time and this may well impact on the measure of heterogeneity.

[11] Half of the interventions in 1990 were concerted.

[12] It is worth recalling that a false intervention rumour is a rumour that is not followed by an actual intervention during the following trading days.

This first model can be written as:

$$H_t = \alpha + \beta_1 OI_t + \beta_3 FR_t + \beta_2 DS_t + \varepsilon_t , \quad (1)$$

where H_t denotes forecaster heterogeneity on the relevant currency at time t, and ε_t is an error term.

The second model is similar to the first except for the use of (the number of) reported interventions (denoted *RI*) instead of *OI*:

$$H_t = \alpha + \beta_1 RI_t + \beta_2 FR_t + \beta_3 DS_t + \varepsilon_t . \quad (2)$$

Finally, we consider a third model in which expected CBI (EI) are disentangled from unexpected ones (UI):

$$H_t = \alpha + \beta_1 EI_t + \beta_2 UI_t + \beta_3 FR_t + \beta_2 DS_t + \varepsilon_t \quad (3)$$

A priori we cannot rule out the existence of reverse causality from heterogeneity to intervention, although Galati and Melick (1999) find no evidence to suggest that the purpose of central bank interventions is to reduce market uncertainty. In any case since our measures for central bank interventions predate the heterogeneity measure, we believe that our results are robust to reverse causality.

Each model is estimated with two alternative measures of heterogeneity: the first is based on all surveyed forecasters, while the second is based on a selection of 24/25 forecasters. Three periods are considered: 1990-1994, a sub-period of the latter - 1992-1994 - for which rumours and expected/unexpected interventions are available (see Table 1) and the period 1996-2001. For the 1996-2001 period we have access to three forecasts horizons (1, 3 and 12 months) while only two (3 and 12 months) are available for the periods 1990-1994 and 1992-1994.

Following the discussion in Section 3, there is some evidence that the various central banks follow rather different intervention policies. For instance, interventions by the Federal Reserve, the Bundesbank and the ECB are somewhat scarce, whereas the Bank of Japan tends to intervene frequently with relatively small amounts (at least during the first period) so as to monitor expectations. Hence, there is no reason why forecast heterogeneity for the two markets under study (DEM-EUR/USD and YEN/USD) should react the same way to CBI.[13] Nevertheless, part of the forecast heterogeneity on both exchange rates comes from

[13] This contrasts with the necessary consistency of exchange rate determination models between DEM/USD and JPY/USD.

uncertainties concerning the USD, which affects both exchange rates. For this reason, we use a SURE estimator, which allows the residuals to be contemporaneously correlated across equations. Additionally a non-parametric correction for heteroscedasticity and serial correlation was used to correct the standard errors.[14]

Following existing evidence that CBI interventions work through the signalling channel, rather than through the portfolio one, we defined intervention variables as the number of interventions over the preceding month. Nevertheless, as suggested by the discussion in section 2.2, it is worth extending these estimations with regressions carried out using the cumulated amounts of official interventions (absolute value of net USD purchases against either the DEM-EUR or the JPY).

3.2. Econometric results

The results are reported in Appendix B. For specification (1), i.e. the model with the official measure of intervention, measured in terms of numbers of days (Tables B-1a to B-1c), they indicate a positive relationship between OI and heterogeneity for both currencies. However this relationship is only significant in the DEM-EUR case over 1992-1994 and especially over 1996-2001. It is generally insignificant for the JPY/USD. The latter result contradicts Galati and Melick (1999) who found evidence that reported interventions raise traders' uncertainty, measured by implicit density functions derived from option prices, for the yen over 1993-1996. Concerning the DEM-EUR/USD rate, the fact that the relationship is quite significant in the recent period may be a reflection of the uncertainty in the run-up to European monetary integration: as in the market microstructure model, the information imparted by official intervention may have opened up the distribution of expectations. The results from estimating equation (2), i.e. equation involving *RI* rather than *OI*, (Tables B-2a and B-2b) and are very similar to our estimates of equation (1).

Interestingly, the results change somewhat when the number of interventions during the last month is replaced with the cumulated amounts of interventions (Tables B-3a to B-3c). There is some evidence of a significantly positive relationship between cumulated intervention and heterogeneity for the DEM-EUR/USD rate over 1990-1994, whereas the relationship is generally insignificant over 1992-1994.

The results from disentangling expected interventions from unexpected ones (Tables B-4a and B-4b) show that only the latter significantly increase forecast heterogeneity for the DEM-EUR/USD in the earlier period. This seems consistent with an efficient markets interpretation. In contrast, for the JPY/USD, only expected intervention which seems to raise forecaster heterogeneity (in one instance the unexpected intervention term is

[14] We could alternatively have pooled the two currencies (JPY and DEM/EUR) into a single regression. However, preliminary tests suggested that, in many cases, individual effects were significant enough to reject the null hypothesis of a valid pooling against performing separate regressions, with respect either to the unconditional level of heterogeneity or to the reaction of heterogeneity to CBI. The results of these tests are available upon request.

significant). This would seem to indicate that the Bank of Japan used interventions quite differently over the recent period, trying to monitor exchange rate expectations.

The absolute variation of the interest-rate differential is almost never significant for the DEM-EUR/USD rate, whereas it is negative and often significant for the JPY/USD. This would seem to imply that forecasters have convergent views on the impact of monetary policy news for the latter exchange rate. This difference across currencies can be related to the mutual consistency of monetary and exchange rate policies in Japan over the 1990s (a policy attenuating the appreciation of the JPY, combined with a very loose monetary policy). In contrast, German monetary policy was driven largely by internal objectives which were more independent of the exchange rate.

The effect of false rumours, which is a conditioning variable in all model specifications over 1992-1994 and 1996-2001, appears to significantly raise forecast heterogeneity for the JPY/USD (especially over the period 1996-2001), but has little impact for the DEM-EUR/USD rate. On the whole, then, it seems that the strategy of the Bank of Japan of monitoring exchange-rate expectation through relatively frequent interventions has been somewhat successful over the 1996-2001 period. Nevertheless, the efficiency of such a strategy is reduced by the impact of false rumours over the same period (although the coefficient on false rumours is much lower than that the one relative to expected interventions). Conversely, Bundesbank interventions over 1992-1994 seem to have worked through surprises, whereas false rumours had no significant impact.

In sum, our results would seem to reveal two different strategies regarding foreign exchange intervention. First, the Bank of Japan's strategy seems to be one which involves monitoring market expectations by providing insights on future interventions. This strategy produces some noise in terms of false rumours. However, this seems to have worked over the recent period in the sense that expected interventions have an impact on forecast heterogeneity and this is supported by a consistent monetary policy. Second, the Bundesbank seems to have tried to move market expectations much more through surprise announcements. Hence, expected interventions and false rumours did not carry any relevant information, whereas unexpected interventions did raise forecast heterogeneity. The small number of interventions since 1996 prevents to conclude on the strategy of the Bundesbank/ECB, although official interventions since then seem to have had a very significant impact on forecast heterogeneity.

4. CONCLUSION

In this paper we have investigated the effect of central bank intervention on the heterogeneity of foreign exchange rate expectations using a newly constructed data set. The key question we sought to answer is the following: does central bank intervention have a significant effect on heterogeneity at the macroeconomic time horizon? A growing amount of empirical evidence, based on market micro-structural principles, suggests that all of the

effect of central bank interventions occurs within a single day. According to Dominguez (1999), for instance, the impact of an intervention on exchange-rate returns starts one hour before it is advertised and lasts a couple hours after that, the maximum impact coming 30 minutes after the intervention is made public. Although data limitations prevents us from drawing very general results in terms of time and country samples, our empirical investigation shows that central bank interventions can have a significant impact on heterogeneity at a monthly horizon. Indeed, the heterogeneity of monthly expectations at the 1 month, 3 months and 12 months horizons is shown to significantly increase in the case of official (especially unexpected) interventions (DEM-EUR/USD) or of expected interventions and "false" rumours (JPY/USD). Hence, central bank intervention can be viewed as able to move market opinions, albeit in a way which is different for the two markets.

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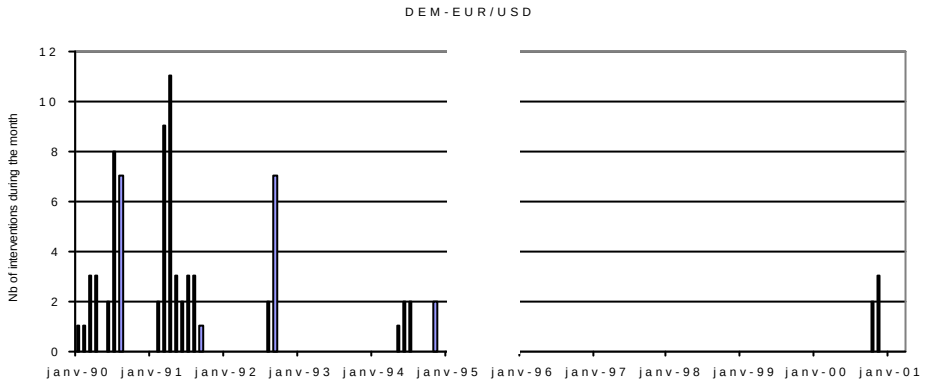
APPENDIX A：THE DISTRIBUTION OF FOREIGN EXCHANGE INTERVENTIONS

Figure A-1: Number of official interventions during previous month (excluding 1995)



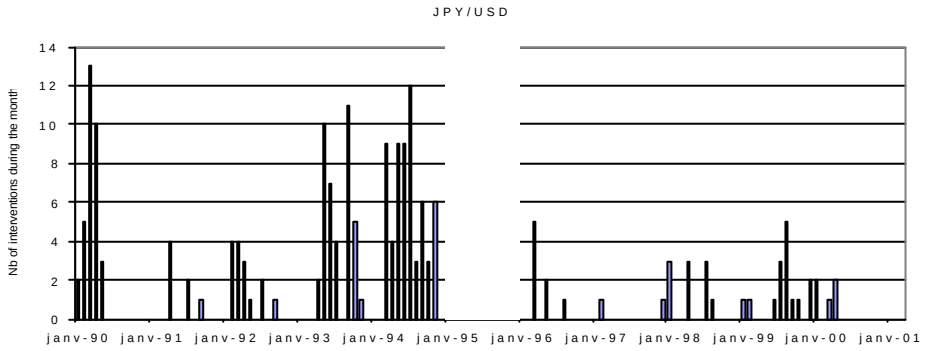
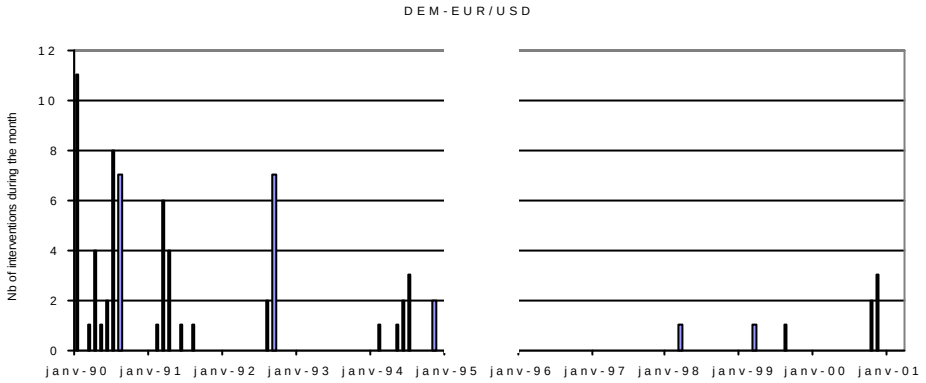


Figure A-2: Number of reported interventions during previous month



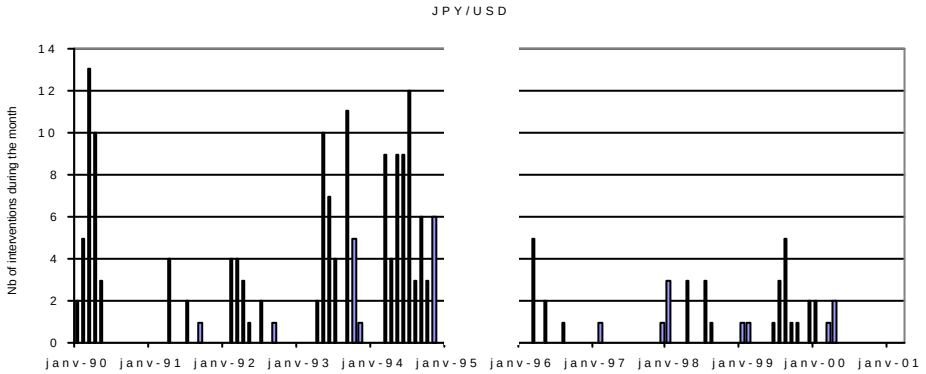
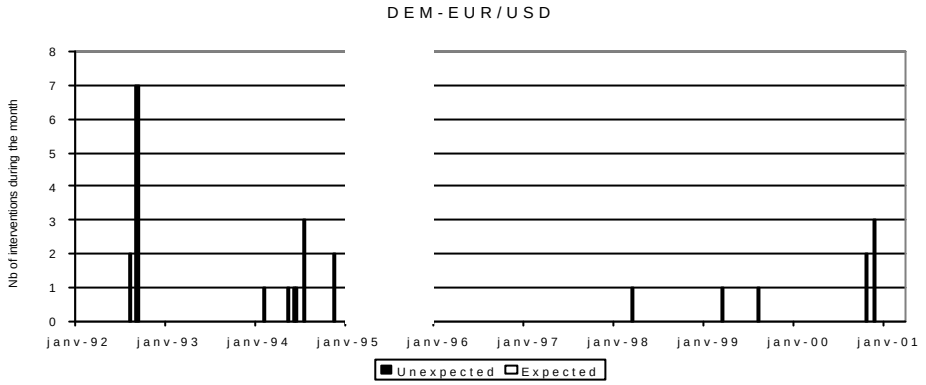


Figure A-3: Number of official interventions during previous month: expected versus unexpected



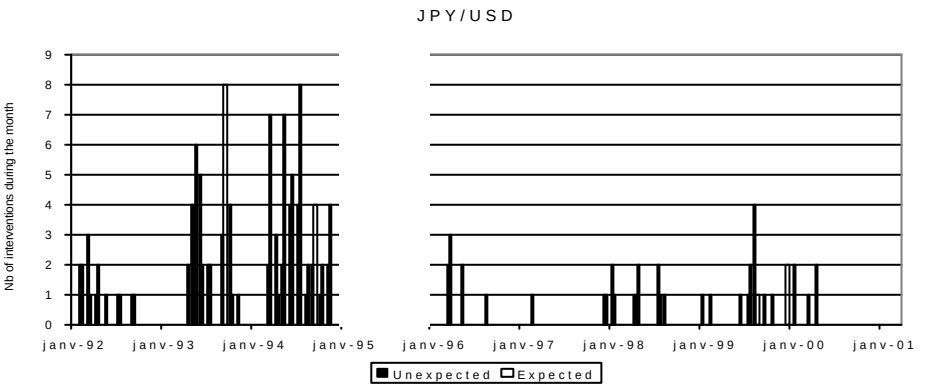
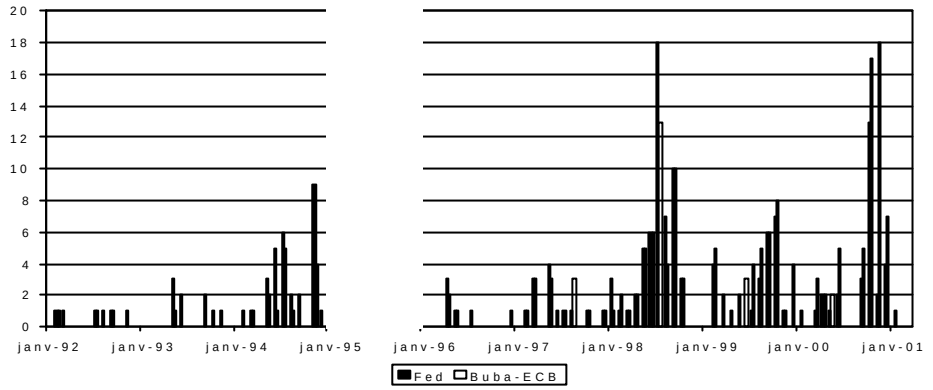


Figure A-4: Number of rumours of interventions during previous month



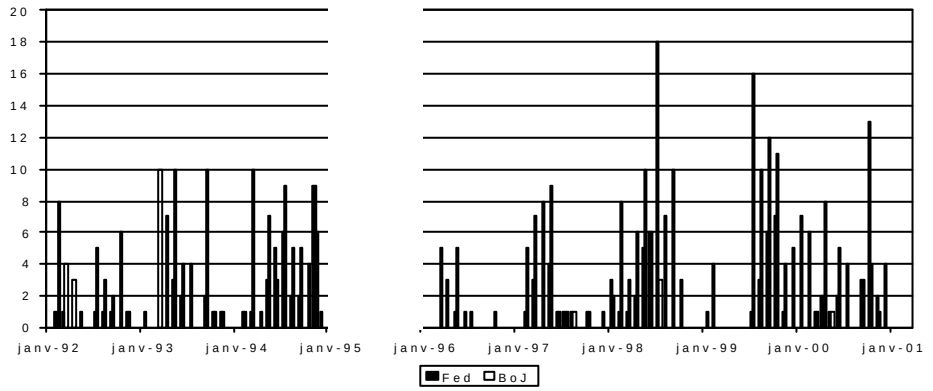
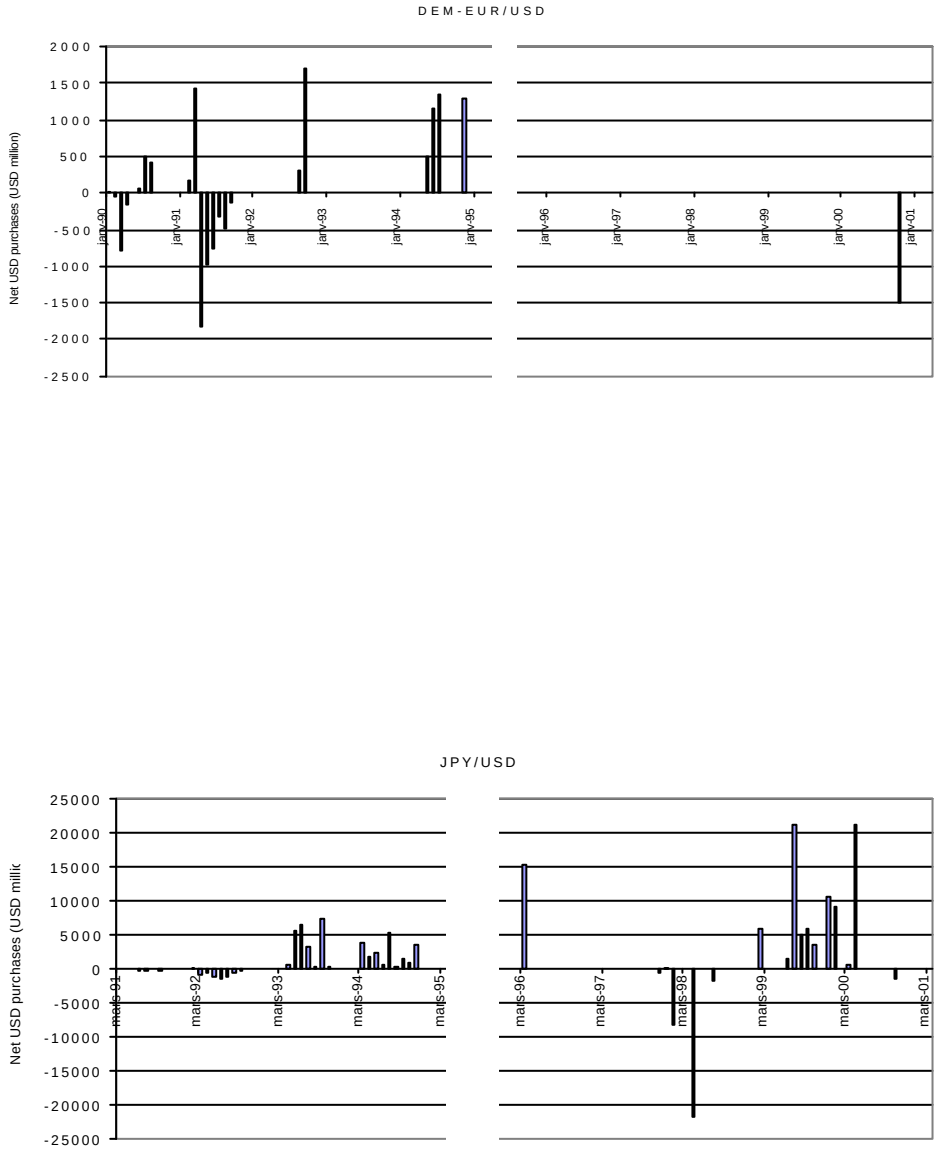


Figure A-5: Cumulated amounts of interventions during previous month (USD million)



APPENDIX B: ECONOMETRIC RESULTS

Table B-1a: The impact of official interventions (nb of days) on forecast heterogeneity, Equation (1), 1990-1994

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	0.0291***	0.0286***	0.0520***	0.0475***	-	-	0.0298***	0.0284***	0.062***	0.0538***
	-	-	[20.95]	[16.10]	[37.36]	[26.21]	-	-	[30.91]	[25.29]	[57.66]	[26.50]
OI	-	-	0.0008	0.0005	0.0014**	0.0007	-	-	0.0004**	0.0002	-0.0001	0.0004*
	-	-	[1.01]	[0.50]	[2.06]	[0.76]	-	-	[2.10]	[0.96]	[-0.68]	[1.72]
DS	-	-	0.0042	0.0082	0.0037	-0.0113	-	-	0.0210**	0.0132	-0.0142	0.0010
	-	-	[0.34]	[0.50]	[0.30]	[-0.85]	-	-	[2.53]	[1.59]	[-1.26]	[0.07]
R^2	-	-	0.117	0.019	0.120	0.030	-	-	0.126	0.029	0.036	0.035

Notes : SURE estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively.
All = all forecasters; Sub = sub-sample of 24-25 forecasters.

Table B-1b: The impact of official interventions (nb of days) on forecast heterogeneity, Equation (1), 1992-1994

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	0.0267***	0.0258***	0.0482***	0.0426***	-	-	0.0272***	0.0275***	0.0610***	0.0579***
	-	-	[16.23]	[11.63]	[33.99]	[20.19]	-	-	[29.21]	[36.74]	[52.20]	[21.07]
OI	-	-	0.0029***	0.0026*	0.0018*	0.0047***	-	-	0.0001	0.0004*	-0.0002	0.0005
	-	-	[2.92]	[1.66]	[1.70]	[6.02]	-	-	[0.25]	[1.78]	[-0.59]	[1.28]
FR	-	-	0.0002	0.0005	-0.0001	0.00003	-	-	0.0003	0.0002	0.0001	-0.000’
	-	-	[0.69]	[0.99]	[-0.22]	[0.09]	-	-	[1.19]	[0.87]	[0.50]	[-0.78]
DS	-	-	0.0122	0.0271	0.0249	0.0164	-	-	0.0045	0.0066	-0.0281**	-0.0067
	-	-	[0.75]	[1.36]	[1.63]	[0.99]	-	-	[0.29]	[0.35]	[-2.17]	[-0.27]
R^2	-	-	0.173	0.152	0.132	0.167	-	-	0.331	0.312	0.129	0.074

Notes : SURE estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively. All = all forecasters; Sub = sub-sample of 24-25 forecasters.
OI: nb of unilateral official interventions; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-1c: The impact of official interventions (nb of days) on forecast heterogeneity, Equation (1), 1996-2001

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	0.0203 ***	0.0200 ***	0.0294 ***	0.0302 ***	0.0497***	0.0506 ***	0.0235***	0.0213***	0.0375***	0.0339***	0.0712***	0.0742 ***
	[14.65]	[11.55]	[15.29]	[12.07]	[29.69]	[25.28]	[12.82]	[12.51]	[14.95]	[11.79]	[18.38]	[16.16]
OI	0.0041 ***	0.0034**	0.0052 ***	0.0062 ***	0.0078***	0.0082 ***	0.0006	0.0013	0.0007	0.0014	0.0014	0.0005
	[4.47]	[4.30]	[4.11]	[5.26]	[3.41]	[5.46]	[0.68]	[1.45]	[0.74]	[1.22]	[0.90]	[0.24]
FR	0.00007	-0.00009	0.00009	0.00002	-0.000&	-0.0003	0.00066**	-0.00051	0.0009***	0.00096**	-0.00002	0.00002
	[0.36]	[-0.54]	[0.38]	[0.13]	[-0.35]	[-1.08]	[2.52]	[-1.63]	[2.83]	[2.53]	[-0.04]	[0.05]
DS	-0.0374	0.0113	-0.0288	-0.0473	-0.028 3	-0.0212	-0.0608**	0.0774***	-0.0872	-0.0700	-0.0499*	-0.0657*
	[-1.35]	[-0.25]	[-0.63]	[-0.91]	[-1.52]	[-1.10]	[-2.23]	[-3.63]	[-1.81]	[-1.22]	[-1.82]	[-1.81]
R^2	0.084	0.015	0.079	0.057	0.115	0.071	0.107	0.015	0.141	0.136	0.028	0.061

Notes : SURE estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively. All = all forecasters; Sub = sub-sample of 24-25 forecasters.
OI: nb of unilateral official interventions; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-2a: The impact of reported interventions (nb of days) on forecast heterogeneity, Equation (2), 1992-1994

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	0.0267***	0.0257***	0.0481***	0.0424***	-	-	0.0278***	0.0268***	0.0611***	0.0576***
	-	-	[16.12]	[11.51]	[33.11]	[19.79]	-	-	[44.17]	[23.61]	[53.59]	[19.82]
RI	-	-	0.0023*	0.0027**	0.0017	0.0042***	-	-	0.0003	0.0001	-0.0003	0.0007**
	-	-	[1.74]	[1.99]	[1.57]	[3.68]	-	-	[1.22]	[0.05]	[-1.19]	[1.93]
FR	-	-	0.0002	0.0004	-0.0001	-0.0001	-	-	0.0004*	0.0003	0.0002	-0.0005
	-	-	[0.58]	[0.94]	[-0.é()	[-0.18]	-	-	[1.66]	[1.11]	[0.99]	[-1.17]
DS	-	-	0.0132	0.0278	0.0252*	0.0202	-	-	0.0032	0.0365	-0.0296**	-0.0037
	-	-	[0.81]	[1.40]	[1.66]	[1.18]	-	-	[0.21]	[1.53]	[-2.46]	[0.15]
R^2	-	-	0.152	0.136	0.122	0.128	-	-	0.231	0.045	0.129	0.094

Notes : SURE estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively. All = all forecasters; Sub = sub-sample of 24-25 forecasters.
RI: nb of reported interventions; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-2b: The impact of reported interventions (nb of days) on forecast heterogeneity, Equation (2), 1996-2001

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	0.0202***	0.0199***	0.0293***	0.0300***	0.0497 ***	0.0508***	0.0238***	0.0215***	0.0376***	0.0339***	0.0712***	0.0740***
	[14.70]	[11.54]	[15.33]	[11.90]	[28.62]	[25.35]	[12.90]	[12.61]	[14.81]	[11.71]	[18.65]	[16.15]
RI	0.0040***	0.0032***	0.0056***	0.0053**	0.0051**	0.0090***	0.0005	0.0012	0.0006	0.0015	0.0027*	0.0013
	[3.18]	[2.78]	[3.511]	[2.55]	[2.18]	[4.90]	[0.60]	[1.40]	[0.70]	[1.26]	[1.87]	[0.55]
FR	0.0001	-0.0001	0.0001	0.0000	-0.00003	-0.0004*	0.0005**	0.0004	0.0007***	0.0009***	-0.00002	0.00013
	[0.24]	[-0.73]	[0.19]	[0.01]	[-0.12]	[-1.83]	[2.17]	[1.64]	[2.69]	[3.00]	[-0.40]	[0.27]
DS	-0.0350	0.0133	-0.0212	-0.0415	-0.0336	-0.0219	-0.0476**	-0.0704***	-0.0712	-0.0638	-0.0881**	-0.0741**
	[-1.27]	[0.29]	[-0.48]	[-0.80]	[-1.61]	[-1.12]	[-2.03]	[-3.24]	[-1.61]	[-1.26]	[-2.28]	[-2.19]
R^2	0.090	0.013	0.089	0.047	0.049	0.079	0.077	0.078	0.120	0.133	0.044	0.041

Notes : SURE estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively. All = all forecasters; Sub = sub-sample of 24-25 forecasters.RI: nb of reported interventions;; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-3a: The impact of official interventions (cumulated amounts) on forecast heterogeneity, Equation (1), 1990-1994

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	0.0284***	0.0276***	0.052***	0.0466***	-	-	-	-	-	-
	-	-	[20.18]	[15.05]	[39.06]	[27.51]	-	-	-	-	-	-
OI	-	-	0.0055***	0.0064***	0.0050**	0.0064**	-	-	-	-	-	-
	-	-	[2.68]	[2.76]	[1.96]	[2.42]	-	-	-	-	-	-
DS	-	-	0.0061	0.0079	0.0047	-0.0105	-	-	-	-	-	-
	-	-	[0.50]	[0.49]	[0.41]	[60.83]	-	-	-	-	-	-
R^2	-	-	0.130	0.109	0.113	0.103	-	-	-	-	-	-

Notes : OLS estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively.
All = all forecasters; Sub = sub-sample of 24-25 forecasters.
OI: cumulated amount of official interventions during the month, in USD millions; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-3b: The impact of official interventions (cumulated amount) on forecast heterogeneity, Equation (1), 1992-1994

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	0.0270***	0.0259***	0.0483***	0.0429***	-	-	0.0278***	0.0266***	0.0604***	0.0580***
	-	-	[16.40]	[11.69]	[34.11]	[20.76]	-	-	[39.24]	[24.34]	[54.44]	[21.76]
OI	-	-	0.0004	0.0043	0.0021	0.0094***	-	-	0.0010**	0.0007	0.0002	0.0010**
	-	-	[1.08]	[0.80]	[0.52]	[2.95]	-	-	[2.22]	[1.61]	[0.42]	[1.97]
FR	-	-	0.0001	0.0003	-0.0001	-0.0005	-	-	0.0002	0.0000	-0.0001	-0.0005
	-	-	[0.20]	[0.46]	[-0.19]	[-0.91]	-	-	[0.58]	[0.01]	[-0.20]	[-0.91]
DS	-	-	0.0123	0.0291	0.0260*	0.0181	-	-	0.0055	0.0421**	-0.0210	-0.0041
	-	-	[0.76]	[1.43]	[1.67]	[1.05]	-	-	[0.33]	[2.12]	[-1.48]	[-0.18]
R^2	-	-	0.127	0.110	0.076	0.122	-	-	0.388	0.123	0.142	0.107

Notes : SURE estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively.All = all forecasters; Sub = sub-sample of 24-25 forecasters. OI: cumulated amount of official interventions during the month, in USD million; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-3c: The impact of official interventions (cumulated amount) on forecast heterogeneity, Equation (1), 1996-2001

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	-	-	-	-	0.0240***	0.0218***	0.0378***	0.0343***	0.0712***	0.0751***
	-	-	-	-	-	-	[13.77]	[13.62]	[15.29]	[12.19]	[18.40]	[15.69]
OI	-	-	-	-	-	-	0.0002	0.0003	0.0002*	0.0003*	0.0002	-0.0001
	-	-	-	-	-	-	[0.84]	[1.06]	[1.19]	[1.74]	[0.64]	[-0.18]
COI	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
FR	-	-	-	-	-	-	0.0004*	0.0004	0.0006***	0.0008***	0.0000	0.0001
	-	-	-	-	-	-	[1.86]	[1.42]	[2.28]	[2.69]	[0.001]	[0.15]
DS	-	-	-	-	-	-	-0.0551*	-0.0823**	-0.0746*	-0.0710	-0.0421*	-0.0742*
	-	-	-	-	-	-	[-1.85]	[-2.41]	[-1.72]	[-1.46]	[-1.65]	[-1.94]
R^2	-	-	-	-	-	-	0.083	0.086	0.128	0.150	0.024	0.049

Notes: OLS estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively. All = all forecasters; Sub = sub-sample of 24-25 forecasters. OI: cumulated amount of unilateral official interventions during the month, in USD million; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-4a: The impact of expected and unexpected interventions (nb of days) on forecast heterogeneity, Equation (3), 1992-1994

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	0.025***	0.025***	0.047***	0.042***	-	-	0.027***	0.027***	0.061***	0.587***
	-	-	[18.62]	[10.43]	[32.79]	[20.54]	-	-	[29.77]	[24.66]	[56.39]	[21.56]
EI	-	-	-0.0082	-0.0047	-0.0049	-0.0001	-	-	0.0001	-0.00002	-0.0001	0.0010***
	-	-	[-1.64]	[-0.67]	[-1.12]	[-0.02]	-	-	[0.24]	[-0.08]	[-0.50]	[2.63]
UI	-	-	0.0015***	0.0018***	0.0011***	0.0028***	-	-	0.0008	0.0002	-0.0002	-0.0007
	-	-	[4.80]	[3.30]	[2.85]	[7.16]	-	-	[1.58]	[0.37]	[-0.65]	[-1.09]
FR	-	-	0.0020**	0.0017	0.0010	0.0007	-	-	0.0003	0.0002	0.0010	-0.0006
	-	-	[2.21]	[1.35]	[1.37]	[0.58]	-	-	[1.23]	[1.03]	[0.55]	[-1.20]
DS	-	-	0.0159	0.0272	0.0229	0.0160	-	-	0.0046	0.0311	-0.0304**	-0.0018
	-	-	[1.00]	[1.39	[1.47]	[0.98]	-	-	[0.27]	[1.28	[-2.56]	[-0.09]
R^2	-	-	0.253	0.206	0.177	0.177	-	-	0.331	0.051	0.135	0.135

Notes : SURE estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under brackets ; ***, **, * for significance at the 1%, 5% and 10% levels respectively. All = all forecasters; Sub = sub-sample of 24-25 forecasters. EI: nb of expected interventions; UI: nb of unexpected interventions; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity.

Table B-4b: The impact of expected and unexpected interventions (nb of days) on forecast heterogeneity, Equation (3), 1996-2001

	DEM-EUR/USD						YEN/USD					
	1 month		3 months		12 months		1 month		3 months		12 months	
Sample	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub	All	Sub
Const	-	-	-	-	-	-	0.0242***	0.0221***	0.0384***	0.0353***	0.0717***	0.0754***
	-	-	-	-	-	-	[12.91]	[13.06]	[14.90]	[12.20]	[18.52]	[16.02]
EI	-	-	-	-	-	-	0.0021	0.0040**	0.0035**	0.0048***	0.0031	0.0015
	-	-	-	-	-	-	[1.42]	[1.45]	[2.34]	[3.29]	[1.46]	[0.54]
UI	-	-	-	-	-	-	-0.0007	-0.0010	-0.0015	-0.0029***	0.0003	-0.0006
	-	-	-	-	-	-	[-0.72]	[-0.95]	[-1.56]	[-2.65]	[0.11]	[-0.17]
FR	-	-	-	-	-	-	0.0004*	0.0003	0.0006**	0.0007**	-0.0001	-0.00001
	-	-	-	-	-	-	[1.65]	[1.15]	[1.97]	[2.37]	[-0.24]	[-0.02]
DS	-	-	-	-	-	-	-0.0634**	-0.1021***	-0.0947**	-0.0933*	-0.057**	-0.083**
	-	-	-	-	-	-	[-2.24]	[-3.98]	[-2.08]	[-1.88]	[-2.14]	[-2.19]
R^2	-	-	-	-	-	-	0.093	0.124	0.141	0.184	0.037	0.051

Notes : OLS estimates; standard errors robust to heteroskedasticity (White correction) and to first order serial correlation; t-statistics under b rackets ; ***, **, *for significance at the 1%, 5% and 10% levels respectively. All = all forecasters; Sub = sub-sample of 24-25 forecasters. EI: nb of expected interventions; UI: nb of unexpected interventions; FR: nb of false rumours; DS: absolute change of the interest-rate differential at the corresponding maturity

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