The effects of Central Bank Actions on the Euro/Dollar Volatility.

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Abstract

In this paper, we investigate the effects of the Federal Reserve and the Bundesbank actions on the euro/dollar volatility. By central bank actions, we speak about the interventions through interest rate and exchange rate policies. More precisely, the question is to test the effects of the announcements of changes in the Bundesbank and the Federal Reserve interest rates on the hand and the effects of perceived interventions, rumours of interventions in the other hand on the euro/dollar volatility. Furthermore, we consider the speeches of central bank gouvernors or finance ministers as an exchange rate policy instrument. To this aim, we rely on a new measure of volatility implied by the FIGARCH model that outperforms the traditionnally used GARCH one. It is found that .....

1 Introduction

The debate on the central banks interventions effectiveness as instruments of economic policy has aroused a great interest during the last thirty years. Intervening in the market is a mean for central banks to send information concerning the current and future positions of the monetary

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policy, which lead the agents to reconsider their expectations and the amount of money they wish to hold (Dominguez and Frankel 1993). This effect, usually called the signalling effect, should lead to movements in exchange rate level and volatility. This means that monetary and exchange rate policies are intimately linked.

A great number of studies have been made in order to analyze the effectiveness of interventions as instruments of exchange rate policies. When interventions are sterilized - which means that that the money supply stay unchanged - they could be considered as an additional economic policy instrument, irrespective of monetary policies. On the contrary, given that unsterilized interventions move proportionately the monetary base, they are linked with monetary policies. In the empirical literature, two approaches have been adopted to analyze the effects of central bank interventions on exchange rate volatility. The first approach focuses on exchange rate volatility expectation. For instance, a usual strategy makes use of measures of expected volatility derived from option prices (Bonser-Neal and Tanner 1996, Galati and Melick 1999, Beine 2001, Dauchy 2001). The second approach relies on an *ex post* measure of exchange rate volatility which is drawn from econometric models allowing the variance to change over time (Baillie and Humpage 1992, Connoly and Taylor 1994, Baillie and Osterberg 1997a,b, Aguilar and Nydhal 1998, Dominguez 1998, Beine, Bénassy-Quéré and Lecourt 2001). The main findings of the literature emphasize generally a significant increase of volatility induced by the foreign exchange rate interventions.

In the same way, other empirical studies have tried to analyze the impact of monetary policies on the short run exchange rate volatility. The objective was to determine whether interest rate movements lead to a reduction in foreign exchange market tensions. These studies concluded for the most part that interest rates announcements are associated with increases in exchange rate volatility (Booth *et al.* 2000, Boubel, Laurent et Lecourt 2001).

The object of the paper is to examine the impact of the Bundesbank and the Federal Reserve policy actions on the short run dynamics of the Deutschmark (before 1999) and the Euro (after

1999) in terms of dollar US (denoted DEM/USD and EUR/USD hereafter). We use bilateral German mark exchange rates because the Bundesbank has often been considered as the central bank of the European Union prior the introduction of the Euro. By central bank actions, we mean interventions through interest rate and exchange rate policies. More precisely, we test the effects of the Bundesbank and the Federal Reserve announcements of changes in interest rates on the first hand and the effects of perceived interventions on the other hand, on the EUR/USD daily volatility. We use reported intervention rumours to distighish anticipated interventions from non anticipated ones. Furthermore, we consider the speeches of central bank governors and ministers of finance as another exchange rate policy instrument.

To this aim, we rely on a new measure of volatility derived from the FIGARCH model introduced by Baillie, Bollerslev and Mikkelsen (1996) that outperforms the traditionally used GARCH one. This model implies a finite persistence of volatility shocks, while there is no persistence in the GARCH framework[1].

The period we examine is January 1992 through January 2001. It includes both the beginning of the E.R.M. crisis, in 1992, and the period of the European Central Bank great activity in the matter of exchange rate interventions at the end of 2000. As a matter of fact, on the 22nd September 2000, the E.C.B. intervened in concert with the Federal Reserve, the Bank of Japan and the Bank of England aiming at supporting the European single currency. In the beginning of november 2000, the ECB intervened again in the same goal but unilaterally. During this period, and especially since the birth of the Euro, many intervention rumours have aroused in the market, without being necessary followed by actual interventions.

The paper is organized as follows. Section 2 details the types of exchange market actions by central banks. Section 3 recalls the technical background of the FIGARCH model. Section 4

[1] Moreover, Beine, Bénassy-Quéré and Lecourt (2001) show that the traditional GARCH estimations used in the literature tend to underestimate the effects of central bank interventions on the *ex post* volatility of exchange rates.

presents the data. Section 5 reports the empirical results and additional tests aiming to assessing the robustness of the results.

2 The types of exchange market interventions by central banks

2.1 Interventions through interest rate policy

The monetary policy stance can be defined by the level of the operating target, usually the money market overnight rate. However, such operating targets are not always announced and the monetary policy stance has to be inferred from a set of central bank actions (for example, consisting of formal statements). In this paper, any central bank action that potentially conveys information in the market about the stance of current or future monetary policies will be classified as a policy signal.

Firstly, we describe the policy signals issued by the Board of Governors of the US Federal Reserve System (Fed) and secondly the policy signals issued by the Deutsche Bundesbank (and after January 1, 1999 the ECB).

The key variable in US monetary policy is the Federal Funds rate. The Fed influences it through direct open market purchases and sales of US government securities. The Fed Funds rate is regarded as the most useful indicator of the stance of the Federal Reserve policy. The Discount rate is also a key interest rate, although its importance has been declining over time. It is the only interest rate that the Fed formally admits to controlling. Thus, changes in the Discount rate are particularly strong statements about the Fed's intentions. The Fed's policy regarding open market operations is decided by the Federal Open Market Committee (FOMC). Discount rate changes are

initiated by the regional Reserve Banks and approved by the Federal Reserve Board. Although the formal decision procedures for the two instruments differ slightly, the people involved in the process are the same. Thus, it is reasonably safe to assume - and market participants usually do so - that Federal Reserve monetary policy is decided at FOMC meetings. Furtermore, every actual change in interest rates have occured at the end of these meetings.There are 8 meetings per year of the FOMC.

Until the end of 1993, FOMC decisions were only disclosed on Fridays, many weeks after the meeting[2]. Discount rate changes were formally announced by press releases when they become effective, but changes in the Fed Funds rate target were not. The key policy signals were the Fed's open market operations, especially on the days following FOMC meetings. Since 1994 (February), FOMC decisions have been announced at the end of the meetings through formal statements[3]. These statements represent the fundamental policy signal sent by the FED. Any change in the stance of the monetary policy is announced on the same day it is made through a statement.

The key variable in the daily management of German monetary policy is the day-to-day money market rate. The Bundesbank directly influences it by controlling a set of key interest rates. Indeed, the day-to-day money market rate is kept within a band: the ceiling being the Lombard and the floor being the Discount rate. However, the money market rate seldom reaches either of the edges of the band. It tends to follow the rate of the most recent weekly securities repurchase agreements (repo) tender, which makes the Repo rate the key operating rate for the Bundesbank. Consequently, the Repo rate is the key operating rate, but the Lombard and the Discount rates are also very important, because they highlights the basic stance of the Bundesbank's monetary policy.

[2] The delay wasof about six weeks.

[3] When no change is made at a meeting, the FOMC will normally just announce when the meeting ended and that there are no further announcements.

Monetary policy decisions are made by the Bundesbank council. The council meets every Thursdays[4]. Changes in the Lombard or Discount rates are announced at a news conference or by press release after the council meeting. The announcement of the terms of the weekly repo is usually made each Tuesday with the results of the tender being announced on the Wednesday.

2.2 Interventions through exchange rate policy

Foreign exchange market intervention is any transaction or announcement by an official agent of a government aiming at influencing the value of an exchange rate. The objective of exchange rate policies of the major central banks have changed through time. In the 1985's, the Plaza Agreement promoted central bank cooperation in order to induce a sharp depreciation of the US dollar. In 1987, the Louvre Agreement focused on eliminating excess exchange rate volatility. Since then, the major central bank interventions have been concerted. More recently, direct interventions decided at a european level aimed at limiting the sharp depreciation of the Euro against the major currencies (the USD and the Japanese yen) and, to a lesser extent to reduce its relatively high volatility.

The economic theory identifies three major channels by which the interventions can influence the exchange rate. The first is the monetary channel and involves unsterilised foreign exchange interventions. In monetary models of exchange rate determination, if purchases (or sales) of foreign currency assets are not accompanied by sales (purchases) of domestic currency assets by the central bank, these operations should modify the relative quantities of domestic and foreign currencies in circulation and, hence, the parity between the two currencies. However, central banks like the Fed and the Bundesbank generally sterilize fully and automatically their intervention operations on a daily basis.

The second is the portfolio channel, through which sterilized interventions change the currency

[4] Thera are some exceptions to this rule laike Christmas or Easter holidays.

denomination of relative assets supplies, and thereby exchange risk premiums if assets are imperfect substitutes. However, except for Dominguez and Frankel (1993), empirical studies find no evidence that intervention alters exchange rate levels through a portfolio-balance channel (Edison 1993).

The third channel operates through the signalling effect induced by intervention, through which interventions are considered as a new information. They may reveal to the market the central bank's intentions to counter exchange movements or signal news of a potential policy change. When a central bank intervenes on the exchange market, it conveys to the market a signalling effect which indicates for example a change in the future monetary policy or others economic policies susceptible to affect the actual exchange rate value. Furthermore, the effect on exchange rate volatility will depend on whether the signal sent by the central bank will be ambiguous or not. If this signal is ambiguous, such an intervention (or intervention announcement) will increase uncertainty, resulting in higher volatility; by contrast, if the objective of the operation is clearly understood by market participants, the effect on volatility may be different (Dominguez 1998).

There is a general consensus that central bank interventions, but for considerable amounts, will have a limited impact on exchange rates (volatility) by the portfolio effect and that the major channel is the signalling effect.[5] This suggests that the interventions realised in concert between monetary authorities - i.e. two or several central banks intervene in favor (or against) the same currency - should be more effective that unilateral interventions.

2.3 Interventions through speeches of central bank governors and finance ministers

To this point, we have presented quantitative central bank intervention tools. Indeed, by changing either the level of foreign exchange reserves, or the level of the monetary base, central banks have

[5] The interventions amounts, which could appear considerable, are in fact extremely small when compared to the total daily activity in the foreign exchange market, which amounted to $600bn in April 1989 and to $1500bn in April 1998 (BIS, 1999).

tried to change exchange rates dynamics. Those interventions are strictly measurable, provided that data are available. The effect of those actions has been presented in terms of tree channels, among which two have an impact on exchange rates because of quantitative reasons - relative movements between stocks or flux. However the signalling channel, mostly retained in current literature, should influence exchange rates in a qualitative way.

Another tool used by authorities to act in the foreign exchange marketis official speeches. This instrument is essential, given that it can be used either in coordination with quantitative interventions in order to precise their goal, or alone aiming at informing the market. Therefore, official speeches enables to evaluate if explicit or implicit exchange rate policies are ambiguous or not. Furthermore, when are exhaustive and clear, official speeches is a mean for authorities to improve transparency.This is of great importance, given that transparency can reduce the inflationary bias, give central banks greater flexibility to respond to shocks in the economy, and makes it easier for those institutions to build reputation (Geraats, 2001).

Although this new variable has never been tested empirically because of the difficulty to collect such data and of its qualitative nature, there is a general consensus that speeches concerning a specific policy should influence at least market uncertainty. In addition, official speeches might be more efficients when they are made by the minimum of speekers, not too numerous but exhaustive enough, and clear**??**.

In the United States, where the monetary policy is voted by the FOMC, while the exchange rate policy is the Treasury's concern, speeches should be clearly perceived by the foreign exchange market operators. Indeed, the Federal Reserve chairman speeches would inform the market on interest rate levels, while the Treasury Secretary speeches would inform on exchange reserve levels.

In Germany, until 1999, monetary policies were decided by the Bundesbank executive council. There has never been explicit exchange rate policies concerning the USD/DEM since 1973, except an implicit target under the European Monetay System. But after the breakdown of the EMS, in

1992, the deutscmark have freely floated against the dollar. Since 1999, the UEM monetary policy is constrained by the Maastricht Treaty and decided by the SEBC, while exchange rate policy doesn't exist. Consequently, while there should be a clear spokesman of the monetary policy, there is none for the exchange rate policy. Actually, we see that even for the monetary policy there is no clear spokesman, given the number of european official central bankers disagreeing with each other in the SEBC. Moreover, not only the ECB governors and the natioanl central bankers, ut also the ministers of finance express their opinion concerning exchange rates, to such a point that noboby really knows who must be listened. Too many voices, from too many institutions might increase market uncertainty.

3 Measuring exchange rate volatility

3.1 The FIGARCH model

We test whether monetary and exchange rate policies of the Bundesbank and the Federal Reserve affect the volatility of daily DEM/USD (before 1999) and EUR/USD (after 1999) exchange rates.[6] Our full investigation period ranges from January 1992 to December 2000. Contrasting the existing literature[7], the conditional variance is modelled as a FIGARCH $(1, d, 1)$. Our two-equations model is thus written as[8] :

$$r_t = \mu + \epsilon_t + a^{'} D_t, \quad \epsilon_t \mid \Omega_t \sim \Delta(0, \sigma_t^2) \tag{1}$$

$$\sigma_t^2 = \omega + \left\{1 - [1 - \beta_1 L]^{-1} (1 - \phi_1 L) [1 - L]^d\right\} \epsilon_t^2 + b^{'} D_t + c^{'} |x_t| \,, \, , \tag{2}$$

[6] Mid rates quoted respectively on the Frankfort market at 2:00 pm. Source: ???

[7] Although the purpose is quite different (the analysis deals with the forward risk premium and no effect on volatility is considered), Baillie and Osterberg (1998) also combine central bank interventions and FIGARCH innovations.

[8] The MA term captured by the ϕ_1 parameter in the skedastic function will be dropped out when it is insignificant. In this case, the basic model reduces to a FIGARCH $(1, d, 0)$.

where $r_t = 100 \ln(S_t/S_{t-1})$ is the nominal exchange rate variation (expressed in percentage) with S_t the nominal exchange rate in level (number of DEM or EUR per USD); μ is the (unconditional) mean of the process, Ω_t is the information set at time t, Δ is the conditional distribution, L is the lag operator and $\omega = \omega'[1-\beta_1 L]^{-1}$.[9] $\theta, a^{'}$, $b^{'}, c^{'}, \omega, \beta_1, \phi_1$ and d are parameters to be estimated with d being the fractional integration parameter (comprised between 0 and 1). D_t is an explanatory variable capturing the daily effects and x_t an explanatory variable which represents the central bank interventions announcements and rumors, the interest rates changes announcements and the speeches of central bank governors or finance ministers. $|x_t|$ refers to the absolute value of x_t. These variables will be defined more precisely below. Equation (1) represents the mean equation with daily effects[10], whereas equation (2) is the FIGARCH specification developed by Baillie, Bollerslev et Mikkelsen (1996).[11] The conditional variance described in (2) may be generalized to higher AR and MA orders but necessary and sufficient conditions to ensure the variance to be positive are much more difficult to derive.[12]

Interestingly, the FIGARCH$(1, d, 1)$ model nests the GARCH(1,1) model (Bollerslev 1986) for $d = 0$ and the IGARCH model (Engle and Bollerslev 1986) for $d = 1$. As advocated by Baillie, Bollerslev and Mikkelsen (1996), the IGARCH process may be seen as too restrictive as it implies infinite persistence of a volatility shock. Such a dynamics is not consistent with stylised facts. By contrast, for $0 < d < 1$, the FIGARCH model implies a long-memory behavior and a slow rate of decay after a volatility shock.[13]

Following Baillie and Bollerslev (1989) and Hsieh (1989) among others, we include a dummy

[9] Notice that ω' is the unconditional variance in the GARCH model.

[10] We have tested by means of the Schwarz Bayesian criterion (not reported here to save place) the introduction of a first MA component but it did not turn out to be supported by the data. Allowing for an AR(1) term leads to fairly similar results.

[11] We have tested too to the alternative parameterization of the FIGARCH model proposed by Bollerslev and Mikkelsen (1996) and Chung (1999):

$$\sigma_t^2 = \omega + \left\{1 - [1-\beta_1 L]^{-1}(1-\phi_1 L)[1-L]^d\right\}(\epsilon_t^2 - c^{'} D_t - f^{'} |x_t|) + c^{'} D_t + f^{'} |x_t| .$$

The estimation of this last model (results are available upon request) yields identical results, except for ω.

[12] See Baillie, Bollerslev and Mikkelsen (1996) on this point.

[13] To fully understand the different dynamic properties implied by the FIGARCH model, see Beine, Bénassy-Quéré and Lecourt (2001).

variable D_t in both the mean and the variance equations in order to account for daily effects. Indeed, it has been shown that daily exchange rate variations and volatilities often depend on the day of the week (see Hsieh 1989). However, since the estimation of the FIGARCH model requires a parsimonious structure, we follow Bollerslev and Mikkelsen (1998) and Beine, Laurent and Lecourt (2000) in using a simple specification that turns out to match relatively well the data. Hence, we have :

$$D_t^{'} = \left(\begin{array}{ccc} D_{1,t} & , & D_{2,t} \end{array} \right) \tag{3}$$

where $D_{1,t}$ and $D_{2,t}$ stand for the number of vacation days respectively before and after day t. We dropped out $D_{1,t}$ and/or $D_{2,t}$ when non significant to keep the specification as parsimonious as possible.

Like for the GARCH model, the estimation of the FIGARCH model relies on the quasi maximum likelihood (QML) procedure. Following Bollerslev and Wooldridge (1992), one performs a correction of the standard errors of the estimates. Concerning the estimation procedure, two important points need to be made. The first one concerns the choice of the underlying distribution The first one concerns the choice of the underlying distribution. As shown by Baillie et al. (1996) and Bollerslev and Wooldridge (1992), the QML estimates obtained with a Gaussian assumption behave relatively well. Nevertheless, as explained by Baillie and De Gennaro (1990) or Pagan (1996), a student-t distribution may be more appropriate to account for the leptokurticity characterizing the high frequency financial data. That's why we retain the Student distribution which modelizes quite well the leptokurticity caracterising the financial series (Bollerslev 1987, Hsieh 1989, Baillie and Bolleslev 1989 and Palm and Vlaar 1997 among others).[14] Therefore, the

[14] We have tested too the skewed Student distribution developped by Fernandez and Steel (1998) and extended by Lambert and Laurent (2001). Nevetheless, no asymetry emerges from estimation results with this distribution.

log-likelihood to be maximized becomes:

$$Ln(L_{St-t}) = T\left[\ln\Gamma\left\{(\nu+1)/2\right\} - \ln\Gamma\left\{\nu/2\right\} - 1/2\ln\pi(\nu-2)\right] - \tag{4}$$
$$1/2\sum_{t=1}^{T}\left\{\ln(\sigma_t^2) + (\nu+1)\left[\ln\left(1+\frac{\epsilon_t^2}{\sigma_t^2(\nu-2)}\right)\right]\right\}.$$

The second point concerns the minimum number of observations required to estimate the FIGARCH model. This minimum number is related to the order of the expansion of the fractional filter $(1-L)^d$ which is used in computing the coefficient of the infinite lag polynomial $\lambda(L) = 1 - [1-\beta_1 L]^{-1}(1-\phi_1 L)[1-L]^d$ in the infinite ARCH representation of (2). Because of the positive value of d, it is advised to use a sufficiently high truncation lag order. Indeed, as shown by Teyssière (1997) through Monte Carlo simulations, using a too low order induces severe biases, especially in the skedastic function. In this respect, we chose a truncation order equal to 1000.[15]

3.2 FIGARCH estimations

We estimate a FIGARCH model with daily effects (but without additional explanatory variables) for the DEM/USD (EUR/USD) exchange rate over the sample period. In order to assess the relevance of the FIGARCH specification, we also estimate a GARCH model. Table 1 provides the initial estimation results for the (stable) GARCH and the FIGARCH models with daily effects.

[15] More precisely, such a truncation procedure refers to the Approximate Quasi Maximum Likelihood (AQML) estimation procedure. Following Baillie, Bollerlev and Mikkelsen (1996), the pre-sample values of ϵ_t^2 and σ_t^2 are obtained from the (past) expected values of the squared residuals.

Table 1. GARCH and FIGARCH estimation results

	GARCH		FIGARCH	
μ	0.027		0.030	
	(0.015)		(0.015)	
a_1	-0.002		-0.005	
	(0.014)		(0.015)	
a_2	-0.007		-0.006	
	(0.015)		(0.015)	
ω	-0.002		0.880	
	(0.005)		(0.491)	*
β_1	0.957		0.763	
	(0.012)	***	(0.070)	***
ϕ_1	0.035		0.330	
	(0.008)	***	(0.071)	***
d	-		0.473	
			(0.121)	***
c_1	-0.015		0.039	
	(0.021)		(0.022)	*
c_2	0.028		0.024	
	(0.020)		(0.020)	
v	5.293		5.034	
	(0.569)	***	(0.549)	***
b_3	-0.233		-0.231	
b_4	2.053		1.979	
Q(20)	21.661		20.859	
Q^2 *(20)*	9.940		8.685	
Akaike	1.904		1.902	
Log Lik	-2160.9		-2158.4	

Standard errors of quasi maximum likeliho
estimates are in brackets.
*, ** and *** indicate rejection respectively
at the 10%, 5% and 1% level.

The results suggest that the FIGARCH specification is supported by the data. Indeed, the parameter d, i.e. the degree of fractional integration, is highly significantly different both from 0 and 1, rejecting the validity of both the GARCH and the IGARCH specifications. As suggested by Bollerlslev and Mikkelsen (1996), we use the Akaike selection criteria and the Box-Pierce test for residual autocorrelation in deciding on the correct conditional variance specification, i.e. GARCH or FIGARCH models: the Akaike criteria is in favor of the FIGARCH model whereas the Box Pierce statistics of the squared residuals ($Q^2(20)$) at lag equal to 20 is reduced for the FIGARCH specification. Moreover, simple likelihood ratio test points out that the FIGARCH model seems to be justified.[16]. We can note also that the FIGARCH$(1, d, 1)$ model is supported here since

[16] Note however that this test is significant at a 5% level.

the ϕ_1 parameter is significant at the 1% level. In addition, concerning daily effects both in the conditional mean and in the conditional variance, it is found that vacation days are followed by higher volatility, which is line with the findings of the literature emphasizing higher volatility on Mondays (Hsieh 1989).[17] Unsurprizingly, the Student-t distribution seems to be justified because the degree of freedom parameter ν is highly significant.

Finally, a set of diagnostic statistics is provided: these are skewness (b_3) and kurtosis excess (b_4)[18] values as well as the Box-Pierce statistics of the residuals ($Q(20)$) and the squared residuals ($Q^2(20)$) at lag equal to 20.[19]. For both the GARCH and the FIGARCH model, the DEM doesn't exhibit any skewness and kurtosis excess, which tends to motivate further the use of the Student-t distribution. There's no autocorrelation both in the mean and in the variance, suggesting that the FIGARCH or the GARCH models are a good specification to correct the heteroskedasticity problem present in the data.

4 The data

4.1 The central bank interventions data

4.2 Others data

5 Estimations results

6 Conclusion

[17] This variable is significant only at a 8% level. The others daily effects are not significant.

[18] In testing for excess skewness and kurtosis excess, one has to be very cautious because of the Student-t assumption. Indeed, the traditional inference procedures used in the normal case are misleading and hence, the confidence intervals have to be simulated. Therefore, we rely on the simulated critical values proposed by De Ceuster and Trappers (1992), using the estimated υ and a number of observations close to ours.

[19] As suggested by Bollerslev and Mikkelsen (1996), the critical values have to be drawn from the corresponding fractiles in the chi-square distribution with (20-$\varkappa$) degrees of freedom, where $\varkappa$ is the number of ARCH parameters in the model.