

Are Europe Interest Rates led by FED's Announcements?*

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Abstract

This paper investigates the degree and nature of economic and monetary policy relations among the United States, the euro area, and the British area. Using daily interest rates, we estimate the impact of monetary policy announcements of a Central Bank on its domestic market and in what measure they are able to influence other financial markets. In particular, we analyse the effect of the FED's, ECB's, and BoE's monetary policy announcements on their own market, and in the others.

JEL classification: E4, E43, E52, F42

1 Introduction

In a global world — like today, also in the scandals, the finance has been involved in — how many central banks are there? The question is not rhetoric because who works on financial markets knows all too well that some Central Banks are more important than others and therefore their behaviour can be more significant.

The hypothesis that we want to verify is very simple: in the last five years, the activity of a new central Bank - the ECB for the twelve countries - has not been enough to establish a correspondent monetary sovereignty. By sovereignty we mean the ability of a central Bank not only to decide its own interest rate, but also to influence its yield curve for all maturities.

In the European Monetary Union, all the preparatory period has been employed to recover equilibrium in macroeconomic conditions, i.e. the respect of the five parameters

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established in the Maastricht Treaty, which were necessary to give stability to the value of the new currency. The reduction of the deficit and the debt; the reduction of both inflation rate and interest rates; the exchange rate stability: the respect of these five conditions has been necessary to give sovereignty to the new born Central Bank, and its monetary policy. In our opinion not enough attention has been paid to the necessary financial market integration, on the contrary each country has maintained its respective Stock Exchange; so the integration of each country and the adoption of the same rules and procedures for all the financial markets has not been realized. A paradoxical result - also because the liberalization process were not limited to the countries of the Monetary Union - was a monetary integration that cannot be distinguished by the globalization process of financial markets.

On the other hand, how market interest rates respond to central Bank actions is a topic of great interest to financial market participants and policymakers alike. Operators want to know how monetary policy can condition their choice, and the Central Bank is interested in knowing how its decision on interest rates is transmitted to the market.

In the recent years, many studies¹ have concentrated on monetary policy transmission mechanisms, and they have outlined two main aspects. The first one is that Monetary Authority with its decisions controls well the first part of the yield curve, while the control on the longer expires is lower.

The second characteristic is that the Central Bank uses a transparent monetary policy. In fact the Monetary Authority tries to give their intention to the market in advance, with respect to the moment in which decisions will be taken. In this situation, operators can adequately adjust their decisions. Further, an element which characterizes transmission mechanism of monetary policy it is the rational expectation hypothesis. Another aspect on the connection between monetary policy announcements and money market response is the use of derivative instruments to extrapolate the expectations of operators.

The aim of this study is to examine how announcements of a Central Bank are reflected on its domestic market and in what measure they are able to influence other financial markets. In particular, we analyse the effects of the FED's, ECB's, and BoE's monetary policy announcements on their own market, and in the others. In this analysis we consider the yield curve until 12 month (money market) and over (financial market). This analysis seeks to verify the particular market's characteristics on which these three Central Banks work, and show their connections: is there an ordering and a particular dependent relationship? Alternatively, are we in a global market where the operators are continuously looking at every Central Bank? In the past few years, every Central Bank made investments on reputation and credibility - and effectively, the yield curve

¹ See Lange, J., Sack, B., Whitesell, W., 2003.

is, more than the past few years, under the central Bank's control. The question is, are these gains on sovereignty extended to the European Central Bank, or the incomplete integration on which the ECB works has for instance reduced that effectiveness?

2 Transmission channel

One important issue that has been given little attention in the literature so far is the relevance of news spillovers across markets. In principle, there are three channels through which foreign announcements may affect domestic markets. First, foreign news may be relevant for domestic monetary policy authorities, like when they target "external" variables, such as the exchange rate. A tightening of monetary policy in the target country, for instance, may force domestic authorities to adjust their own monetary policy stance in order to maintain the exchange rate target. In conclusion, foreign announcements may be important for domestic monetary policy via this direct channel of targeting of external variables.

The second way is related to the integration of global financial markets and arbitrage arguments. In fact, change in monetary policy in one country will affect other monetary and financial markets via capital flows and the elimination of arbitrage possibilities.

The third way is related to the real variables. In fact, foreign announcements may reveal important information about domestic macroeconomic conditions. For example, an economic outlook may give information about the conditions of another monetary area, and help to predict future moves of monetary policy of that Central Bank. In literature there are some works on money market's interdependence, for example Gravelle and Moessner (2001) find that Canadian interest rates are strongly influenced by US macroeconomic news but only much less by Canadian ones. They interpret these findings as reflecting the close integration between Canada and the US, but also revealing some market uncertainty about the reaction function of Canadian monetary policy; Kim and Sheen (2000) show similar results for Australian interest rates, which are found to be strongly affected by US news, in particular at the short end of the yield curve. Ehrmann and Fratzscher (2002) analyse the interdependence between the Euro area and the US. The two authors find evidence for a tight interdependence between the Euro and the US area. In our work that interdependence, as we will show, is labelled dependence because there is evidence for spillover asymmetric effects caused by the FED's monetary policy announcements.

3 A review of earlier studies

The first paper to assess markets' reaction to monetary policy actions is by Cook and Hahn² (1989), who examined the one-day response of bond rates to changes in the target Fed Funds rate from 1974 through to 1979, which was at a time when the Federal Reserve was targeting the funds rate. Cook and Hahn begin by compiling a record of the changes in the Federal Reserve's target over this period. They examine both the records of the Federal Reserve Bank of New York (which implemented the changes) and the reports of the changes in "The Wall Street Journal". As Cook and Hahn describe it, the actual Federal funds rate moves closely with the Federal Reserve's target. Moreover it is highly improbable that the Federal Reserve is changing the target in response to factors that would have moved the funds rate in absence of the policy changes, i.e. it is unlikely that in the absence of the Federal Reserve's actions the funds rate would move by discrete amounts. Their procedure was to regress the change in the bill, note, and bond rates on the change in the Fed's target funds rate for a sample consisting of 75 days during which the Fed had changed the funds rate target. They find that the response to the target rate increases is positive and significant at all maturities, but reasonably smaller at the long end of the yield curve. In addition, Cook and Hahn examine the relationship between change in interest rates and future changes in the target, but they find little evidence that the target rate changes were anticipated. In contrast with this research, Roley and Sellon³ (1995), using Cook and Hahn's eventstudy approach to the 1987-1995 period, find a statistically insignificant bond rates' response to changes in the target funds rate. Later on, more sophisticated econometric procedures were used. In particular some authors, such as Edelberg and Marshall⁴ (1996), using a Vector Autoregressive to study monetary policy, find a large and significant response of bill rates to policy shocks, and a small response of bond rates. Recently, understanding the importance of the market's expectation, some authors have paid attention to derivative instruments. These instruments can be used to extrapolate the expectation of the operators.

In 2001, using the Federal Funds future to separate changes in funds rate target between an expected change and a surprising one, Kuttner⁵, estimated the impact of monetary policy on bill, note, and bond yields. The author showed that the response of interest rates to expected changes is insignificant, while the response to unexpected change is statistically significant and relevant to explain the movements of the inter-

²See Cook, T., Hahn, T., 1989.

³Roley, V.V., Sellon, G.H., 1995.

⁴Edelberg, W., Marshall, D., 1996.

⁵Kuttner, K.N., 2001.

est rates to monetary policy changes. These results confirm the hypothesis of rational expectations of the economic agents.

In 2002, Perez-Quiros and J. Sicilia⁶ examine the predictability of the monetary policy of the ECB and analyse the impact of monetary policy decisions on the yield curve, using daily data. As regards predictability, they have provided evidence that markets have not been surprised by monetary policy decisions of the ECB, i.e. markets have been able to predict the Governing Council's decisions on key ECB interest rates fairly accurately. As regards the transmission of the unexpected component of the monetary policy decisions to the yield curve, they provide evidence that meetings smooth out the impact of the monetary policy shocks (daily changes in short-term interest rates) which have been generated outside meeting days.

Ehrmann and Fratzscher⁷ analyse interdependence between the Euro area and the US area in the period 1993-2002⁸. In particular, they examine how the release of macroeconomic news from the Euro area and US area can influence domestic interest rates and interest rates of the other area. The authors find some spillover effects from the USA into the Euro area, specifying that we are in the presence of an increasing interdependence between these two areas. This interdependence appears very similar to what we call dependence.

In 2002, looking at the relations between the monetary policy announcements and the market's reaction, Ross⁹ makes a comparative analysis on the market's ability to understand the BCE's, FED's, and BoE's decisions. In this work it appears that the market is able to anticipate correctly the FED's and the BoE's decisions. With regards to the ECB, it seems that the market has difficulty in anticipating changes in the interest rate. The author thinks that it could be explained by the high number of meetings which can generate confusion.

3.1 Expectations using futures

Measures of monetary policy expectations are an important element of many empirical papers in macroeconomics and finance literature. Lately, a strand of literature has focused on measuring policy expectations from asset prices. In this context, market interest rates have often been used to parse out the unexpected component of policy decisions -often referred- as monetary policy shocks. An important issue is the choice of

⁶Perez-Quiros, G., Sicilia, J., 2002.

⁷Ehrmann, M., Fratzscher, M., 2002.

⁸They use data from Bundesbank for the period 1993-1998.

⁹Ross, K., 2002.

the correct asset to be used in measuring expectations. In the literature there are a lot of studies which try to measure federal funds rate expectations. For example, Kuttner (2001) and Faust, Swanson and Wright (2001) use the current month federal funds futures contract, Bomfin (2002) and Poole and Rasche (2000) use the month-ahead federal funds futures contract, Cochrane and Piazzessi (2002) use the one-month eurodollar deposit rate, Ellingsen and Soderstrom (1999) use the three-month eurodollar futures rate. In 2002 Gurkaynak, Sack, and Swanson looked at the optimal market-based measures of monetary policy expectations for up to five months. Their predictive power for the future federal funds rate is higher. In particular, a very simple method able to measure the unexpected component of monetary policy decisions consists of measuring the difference of the appropriate futures' price between the day before the announcements and the announcement day. Following this line, as described in Kuttner (2001), monetary policy surprise can be measured by the changes in the "spot month" future rate calculated on the day of monetary policy decision. This measure has to agree with the scaling factor. The scaling factor is used to adjust the measure to the days of effective change. Analytically we have:

$$\Delta r_t^u = \frac{m}{m-t}(f_{s,t}^0 - f_{s,t-1}^0) \quad (1)$$

where, r_t^u is the surprise generated by unexpected changes to the interest rates, $f_{s,t}^0$ is the spot month future rate the day t of the month s and m is the number of days in a month¹⁰.

Once we have a surprise generated by monetary policy decision we can measure market's expectation in this way:

$$\Delta r_t^e = \Delta r_t - \Delta r_t^u. \quad (2)$$

Where Δr_t^e is the expected monetary policy decision while Δr_t is the change in the interest rate operated by the monetary policy authority. In this work we use a slightly different approach. In fact, we use the futures contract with expiration one month ahead¹¹. In this way we gain a measure less sensitive to monetary policy decisions, but more importantly because this contract is the most traded. This approach is quite similar to Bomfin (2001). With this correction from Kuttner (2001) we compute the unexpected component of monetary policy decisions using (1) without the scaling factor. The criteria we use to measure expected monetary policy decision remains the same (1).

¹⁰ $\frac{m}{m-t}$ it is the scaling factor.

¹¹ In particular, see Gürkaynak, R. S., Sack, B., Swanson, E., 2002.

3.2 Measuring announcement's impact

This section explains the model we have estimated to measure the impact of monetary policy decisions. Basically we use the model described by Cook and Hahn (1989) with the improvements of Kuttner (2001). This analysis consists of an OLS regression where the dependent variable is a one-day response of interest rates, and the independent variable is the changes in the Fed funds target. Kuttner (2001) uses Cook and Hahn's model adjusted to take into account the expectations. In particular, using future contract as mentioned above, Kuttner, splits the change in target into two components: expected and unexpected monetary policy decision. We have estimated the following equation:

$$\Delta R_t = \alpha + \beta_1 \Delta r_t^e + \beta_2 \Delta r_t^u + \varepsilon_t \quad (3)$$

where R is the yield of the rate examined, β is the response to expected and unexpected changes to the target.

Like Kuttner, ΔR is computed as the one-day response to monetary policy decision. In this way we can outline market's adjustment after monetary policy decisions. The coefficient β_2 give us the possibility to measure the surprise component. This measure is very useful to understand if the market believes that it is important news while β_1 "expected response" represents the information already known by operators. This econometric exercise permits us to gain indications on the ability of a Central Bank to control its yield curve, and to analyse the behaviour of non-domestic markets in relation to announcements of another Central Bank. We expect a value of α very close to zero, a value of β_1 statistically not significant and close to zero, and a β_2 statistically significant and close to one. These theoretical results are obtained from the rational expectation model which postulates market response only to new information.

4 The Sample for the money market analysis

The variable ΔR_t represents the yields both short and long term yields, which characterize respectively the European, the American, and the British money markets. The time series of the interest rates examined are Euribor one month, and one year; USD LIBOR one month and one year; LIBOR one month and one year. This model examines interest rates variations between the announcement day and the next day. In this way we can verify the reaction of the market to the Central Bank's announcements. The exogenous variables are represented by the Central Bank's changes in monetary policy, which have been measured with variations in the key interest rates (directly controlled by the central Bank) for their money markets(repo for European and UK market, federal funds target for US market). To measure market expectations, we use data from

Decision	FED		ECB		BoE	
	N. Meeting	%	N. Meeting	%	N. Meeting	%
Manteined	24	60.00%	80	84.21%	43	71.67%
Change						
0.50%	1	2.50%	2	2.11%	0	0.00%
0.25%	5	12.50%	5	5.26%	5	8.33%
-0.25%	4	10.00%	3	3.16%	10	16.67%
-0.50%	6	15.00%	5	5.26%	2	3.33%
Total of Meeting	40		95		60	

Figure 1:

the futures markets. In particular, the futures on euribor with termination one month and one year, the futures on Federal funds with termination one month and one year, and the future on GBP with termination three months. The analysis covers the period between 1st January 1999 and 31st December 2003. During this period we have outlined the monetary policy meetings of the three central Banks It is important to note how we consider all the meetings and not only meetings followed by a monetary policy change. This choice is justified by the fact that every meeting gives important information that helps operators to form their expectations, influencing interest rates' trend In the period which has been analysed, the ECB had a greater number of meetings in respect of the FED and the BoE, as we see from the fig.1. The ECB had 95 meetings, in the same period the FED had 40, and the BoE 60¹².

As we can observe, the younger of the three Banks has had more meetings than the others. We have to remember that the ECB had two meetings per month. The European Central Bank during these meetings left its interest rates unchanged in 84.2% of the meetings, it raised them by half point in 2.1% of the meetings, it raised them by a quarter of a point (percent) in the 5.3% of the meetings, and it reduced them by a quarter of a point and by half a point respectively in 5.3% and 3.2% of the meetings.

The Federal Reserve left its interest rates unchanged in 60% of its meetings, it raised them by half a point and by a quarter of a point respectively in 2.5% and 12.5% of its meeting, and it reduced them by a quarter of point and by half point respectively 10% and 15% of its meetings.

The Bank of England in the same period has left its interest rates unchanged in the 71.7% of its meeting, it raised them by a quarter of point in the 8.3% of its meetings, while it did not raise them by a half of a point and it reduced them by a quarter of a point and half a point respectively in 16.7% and in 3.3% of its meetings.

¹²For FED we use unscheduled meeting as well.

The 1-day response of interest rates to changes in the MRO						
	Intercept	Response expected	Response Unexpected	Adj R^2	DW	F-Stat
Euribor 1 month	0.005	0.069	0.952	0.692	1.763	105.622
<i>t stat</i>	1.311	2.281	13.826			
Euribor 12 month	0.009	0.014	0.777	0.573	2.169	63.536
<i>t stat</i>	2.32	0.479	11.051			
US LIBOR 1 month	-0.002	0.084	0.299	0.215	2.34	13.736
<i>t stat</i>	-0.643	3.734	4.552			
US LIBOR 12 month	0.004	0.022	0.306	0.09	2.42	5.65
<i>t stat</i>	0.924	0.714	3.356			
LIBOR 1 month	-0.006	0.031	0.738	0.392	1.88	31.03
<i>t stat</i>	-1.55	1.1	7.84			
LIBOR 12 month	-0.001	0.017	1.023	0.66	1.86	91.71
<i>t stat</i>	-0.468	0.747	13.334			

Figure 2:

5 The results

The results of estimates are reported in the following figure. The figure 2 analyses the response of the European, American, and British money market

The first important point to be observed is the general statistical significance of the estimated parameters; it confirms the adequacy of the theoretical model. As we might expect, intercept and expected response are approximately equal to zero, and they are statistically insignificant. On the contrary, analysing unexpected response, we can observe how the European money market immediately responds to “monetary policy surprises” announced by the ECB, and its interest rates react to the ECB’s monetary policy decisions. In particular, we can see how short term interest rates receive almost entirely the variation happened (the coefficient of unexpected response is close to one), while the longer money market interest rates (one year) have a slightly

inferior degree of adequacy. With regards to the relations between the ECB’s decisions and the American money market there seems to be appear any relevant impact on the US interest rates, because the model has a poorly adjusted R square, and a β_2 close to zero. Finally, we analyse the British money market. This market gives us interesting results. We can observe, from a statistical point of view, how the model presents a high adjusted R-square, and a β_2 close to one; further more, differently from what happens in the European money market, these results are confirmed also for longer money market interest rates. A good explanation could be derived from the fact that the ECB’s meetings

The 1-day response of interest rates to changes in the Fed funds target						
	Intercept	Response expected	Response Unexpected	Adj R^2	DW	F-Stat
Euribor 1 month	-0.005	0.012	0.799	0.653	2.34	37.732
<i>t stat</i>	-2.132	0.875	6.342			
Euribor 12 month	-0.003	0.013	0.855	0.41	2.138	14.603
<i>t stat</i>	-0.707	0.562	3.933			
US LIBOR 1 month	-0.002	0.005	1.01	0.785	1.739	72.44
<i>t stat</i>	-0.706	0.273	11.849			
US LIBOR 12 month	-0.006	0.0625	0.752	0.371	2.38	12.505
<i>t stat</i>	-0.739	1.676	4.399			
LIBOR 1 month	-0.003	0.027	0.283	0.104	2.27	3.277
<i>t stat</i>	-0.799	1.383	2.417			
LIBOR 12 month	0.004	0.04	0.373	0.125	2.33	3.8
<i>t stat</i>	0.701	1.651	2.531			

Figure 3:

and the BoE's meetings are very often on the same days. It is useful to observe that during the period from 2002 to 2003, in 23 of the ECB's meetings, 17 have happened in the same days as those of the BoE, and 11 meetings have been followed by the same decisions

Now, we consider the Federal Reserve actions. With the aid of figure 3 we can see the response to the FED's announcement in the European, British, and American money markets.

The model which describes American interest rates' reaction to the FED's announcements appears statistically significant, with an intercept and an "expected response" close to zero, an unexpected response close to one and an R-squared also very good. Also in this case we can confirm that the FED is perfectly able to control its yields curve, in particular the shortest maturity of the money market. This control, of course, is stronger with the shorter interest rate of the analysis. Concerning possible spillover effects from FED to other markets, we confirm that European interest rates react to the FED announcements; this relation does not appear for the British ones. The result could show that the European money market takes into account decisions which are taken by the FED, and is ready to change its yield curve properly only after the FED's monetary policy decisions. A greater level of independency seems to characterize the British money market.

With the aid of figure 4 we can analyse the role of the BoE in this comparative analysis.

The 1-day response of interest rates to changes in the repo rate						
	Intercept	Response expected	Response Unexpected	Adj R^2	DW	F-Stat
Euribor 1 month	0.005	0.059	0.943	0.465	2.161	26.669
<i>t stat</i>	0.877	1.545	7.266			
Euribor 12 month	0.006	0.007	0.83	0.495	1.789	29.957
<i>t stat</i>	1.398	0.242	7.715			
US LIBOR 1 month	-0.002	0.067	1.237	0.342	2.254	16.400
<i>t stat</i>	-0.718	2.639	5.64			
US LIBOR 12 month	0.005	0.016	1.799	0.414	1.649	21.856
<i>t stat</i>	1.196	0.507	6.44			
LIBOR 1 month	-0.009	0.204	0.976	0.691	1.798	67.068
<i>t stat</i>	-1.477	4.531	11.08			
LIBOR 12 month	0.003	0.006	1.105	0.825	1.706	140.113
<i>t stat</i>	0.757	0.194	16.663			

Figure 4:

Also in this case, as in previous ones, it is confirmed by tests the significance of the estimated model. The Bank of England seems able to control its yield curve at least until the maturity of one year. The main characteristic is that, differently from other Central Banks, the influence of the BoE's decisions is stronger on the LIBOR 1 year than on the LIBOR 1 month. Of course, it is possible to justify this situation by remembering that the BoE does not use a specific target for the shorter interest rates, preferring to pay attention to the longer one. Another time, European interest rates appear sensitive to the BoE's monetary policy decisions. In fact, the Euribor one month and one year interest rates show a ready response to the unexpected monetary policy change. It is necessary to consider that a possible reason for these movements can be due to coincidence of BoE and ECB's meetings. Differently from what we outlined about the ECB, the American money market seems to consider the decisions taken by the BoE. Interest rates with a termination of one month and one year show an overreaction to the BoE's monetary policy decisions. This behaviour could be justified by the fact that American money market considers the BoE's decisions like a proxy for the future FED's decisions. It is natural in fact that, given its secular reputation, the BoE is thought of as a precursor of particular general interest for its monetary policy decisions.

6 The Interest Rates Response on the Bond Market

From the previous analysis, it appears that all three money markets (European, British, and US) respond to their Central Bank. The response of the interest rates is almost 100% (the β_2 is close to one) for the UK and the US, while for the ECB it is stronger only in the short-term interest rates, especially if we use a comparative analysis with the two other ones. Following this indication, we look at the reactions of the financial markets, or Bond markets. This analysis has been made by looking at the reactions of the European, British and American markets to the FED's, the ECB's, and the BoE's monetary policy announcements. In this comparative analysis we decide not to include the American bond market. In fact, how it is possible to see from the previous analysis, and as it has been clearly shown by a number of papers, the American Bond market responds to the Fed even though the impact of the ECB's announcements is not relevant. Furthermore, from a first overview, response of the American Bond's interest rates are affected by some apparent inconsistencies. It is possible to observe the presence of some outliers that can influence the econometric exercise¹³.

Paying attention to the results of the estimates (figure 5), we can confirm the poor ability of the ECB to influence its yield curve. In fact, also with the two years interest rates, the market makes an adjustment of 65% to the surprise which has been generated by a monetary policy announcement. This unexpected response, with the 7 years interest rates, rapidly becomes less significant with the increasing of the time-expiration. The interest rates on the British market paradoxically seem to be very sensitive to the ECB's announcements. Really, as we mentioned before, the ECB and the BoE had a lot of meetings in the same days.

Examining the reactions to the BoE's monetary policy decisions, it is possible to confirm the ability of the BoE to control its term structure of interest rates. In fact, we also observe a response in the 30 years interest rate. Finally figure 7 permits us to tell something about the FED's role. In particular, as we hypothesized, it seems that the European Market is driven by the FED's monetary policy. In fact, looking at the two years, 3 years, five years, and seven years interest rates, we observe a quite near to 100% adjustment of European Interest rates to the FED's announcements. This influence is present, but it is lower, on the British market.

¹³The FED's meeting on 3rd January 2001 represents a big outlier due to late-day activity on bond market.

7 Conclusion

The debate on the ECB's monetary policy was concentrated on two main aspects: credibility and reputation¹⁴.

For the first one, the judgement is positive, in fact the ECB has been able to control both the expected and the actual inflation's rate: monetary stability was never considered hard to obtain. Close to this positive aspect, it is possible to outline others which present more problems. For example concerning "reputation" of the new born Central Bank.

The reputation has been modelled on the Bundesbank¹⁵, and this fact can help us to understand the limited actions of the ECB¹⁶.

The independence from political power which is established with an international law; the already realised macroeconomic convergence; success which has been obtained in reaching targets of monetary stability, are not indicators of a sovereignty which has been already achieved in determining the main monetary variables¹⁷.

The common opinion that, in a global economy, the European financial markets follow the behaviour of the dominant market¹⁸, can signify "a poor quality" of Monetary Union. That is the interpretation we give to our results on the announcement's effects respectively by the ECB and the FED.

On the contrary the good quality of the American financial market, which is strictly connected with the great financial centre of New York is better than what the European financial market has been able to obtain. In fact, in spite of the official financial centre of Frankfurt, there is an effective (paradoxically offshore) capital in London, with a lot of other national financial market. We hope that this situation can become better with London's entrance in the Euro and therefore the common currency, to complete the ECB's sovereignty.

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The 1-day response of interest rates to changes in the MRO						
Maturity EU	Response			Adj R^2	DW	F-Stat
	Intercept	expected	Unexpected			
2 year	0.007	-0.016	0.653	0.249	2.189	16.591
<i>t stat</i>	1.105	-0.329	5.733			
3 year	0.009	-0.036	0.543	0.168	2.134	10.494
<i>t stat</i>	1.31	-0.693	4.581			
5 year	0.002	-0.07	0.434	0.122	1.974	7.566
<i>t stat</i>	0.435	-1.399	3.800			
7 year	-0.009	-0.035	0.212	0.025	2.155	2.230
<i>t stat</i>	-1.628	-0.776	2.059			
10 year	-0.001	-0.075	0.205	0.051	1.879	3.562
<i>t stat</i>	-0.267	-1.828	2.201			
15 year	0.002	-0.098	0.207	0.066	2.226	4.338
<i>t stat</i>	0.364	-2.323	2.144			
20 year	-0.013	-0.021	0.018	-0.018	2.28	0.140
<i>t stat</i>	-2.404	-0.517	0.194			
30 year	-0.012	-0.071	0.054	0.013	1.758	1.640
<i>t stat</i>	-2.251	-1.781	0.590			
Maturity UK	Response			Adj R^2	DW	F-Stat
	Intercept	expected	Unexpected			
2 year	0	0.004	0.895	0.509	1.927	49.796
<i>t stat</i>	0.016	0.170	9.751			
3 year	0.0076	0.009	0.754	0.319	2.040	23.090
<i>t stat</i>	1.450	0.285	6.674			
5 year	0.006	0.012	0.654	0.289	2.076	20.135
<i>t stat</i>	1.385	0.382	6.253			
7 year	0.008	0.019	0.56	0.203	2.122	13.010
<i>t stat</i>	1.571	0.591	5.067			
10 year	0.008	0.011	0.431	0.106	2.049	6.584
<i>t stat</i>	1.455	0.326	3.592			
15 year	0.005	0.001	0.346	0.079	1.997	5.083
<i>t stat</i>	1.034	0.034	3.111			
20 year	0.004	0.004	0.288	0.053	1.877	3.679
<i>t stat</i>	0.830	0.130	2.667			
30 year	0.002	0.003	0.234	0.028	1.852	2.389
<i>t stat</i>	0.558	0.096	2.147			

Figure 5:

The 1-day response of interest rates to changes in the repo rate						
<i>Maturity EU</i>	Intercept	Response expected	Response Unexpected	Adj R^2	DW	F-Stat
2 year	0.008	-0.012	0.668	0.179	1.972	7.463
<i>t stat</i>	1.073	-0.248	3.800			
3 year	0.008	-0.040	0.514	0.137	1.98	5.690
<i>t stat</i>	1.086	-0.855	3.155			
5 year	0.003	-0.061	0.442	0.108	2.103	4.596
<i>t stat</i>	0.399	-1.245	2.615			
7 year	0.003	-0.065	0.393	0.051	1.967	2.578
<i>t stat</i>	0.714	-1.065	1.879			
10 year	-0.001	-0.054	0.209	0.026	2.018	1.789
<i>t stat</i>	-0.177	-1.191	1.333			
15 year	0.002	0.014	0.451	0.091	1.985	3.960
<i>t stat</i>	0.365	0.307	2.814			
20 year	-0.0009	-0.081	-0.043	0.017	1.967	1.539
<i>t stat</i>	-0.135	-1.752	-0.271			
30 year	-0.007	-0.113	0.102	0.078	1.957	3.500
<i>t stat</i>	-1.11	-2.480	0.651			
<i>Maturity UK</i>	Intercept	Response expected	Response Unexpected	Adj R^2	DW	F-Stat
2 year	-0.0002	-0.04	0.705	0.579	1.899	41.706
<i>t stat</i>	-0.048	-0.994	8.920			
3 year	0.006	-0.066	0.574	0.383	1.936	19.341
<i>t stat</i>	0.865	-1.332	5.898			
5 year	0.004	-0.101	0.436	0.343	1.690	16.418
<i>t stat</i>	0.745	-2.264	4.992			
7 year	0.004	-0.117	0.304	0.229	1.676	9.800
<i>t stat</i>	0.732	-2.522	3.351			
10 year	0.006	-0.126	0.2	0.136	1.690	5.645
<i>t stat</i>	0.887	-2.470	2.000			
15 year	0.006	-0.105	0.163	0.097	1.617	4.160
<i>t stat</i>	0.897	-2.140	1.690			
20 year	0.005	-0.103	0.145	0.087	1.658	3.830
<i>t stat</i>	0.843	-2.129	1.534			
30 year	0.005	-0.104	0.13	0.082	1.657	3.660
<i>t stat</i>	0.773	-2.166	1.380			

Figure 6:

The 1-day response of interest rates to changes in the Fed funds target						
Maturity EU	Response			Adj R^2	DW	F-Stat
	Intercept	expected	Unexpected			
2 year	-0.003	0.01	1.034	0.284	2.390	8.752
<i>t stat</i>	-0.463	0.277	3.15			
3 year	-0.004	-0.006	1.021	0.243	2.035	7.273
<i>t stat</i>	-0.667	-0.182	3.139			
5 year	-0.0002	-0.007	0.856	0.124	2.140	3.775
<i>t stat</i>	-0.03	-0.188	2.293			
7 year	0.007	0.02	0.977	0.222	1.969	6.591
<i>t stat</i>	0.966	0.469	2.577			
10 year	-0.001	0.013	0.521	0.074	1.880	2.566
<i>t stat</i>	-0.24	0.353	1.564			
15 year	0.009	-0.024	0.267	-0.032	1.210	0.378
<i>t stat</i>	1.367	-0.68	0.84			
20 year	0.006	0.038	0.121	-0.013	2.180	0.743
<i>t stat</i>	0.724	0.773	0.28			
30 year	-0.0002	0.012	0.299	0.032	2.110	1.660
<i>t stat</i>	-0.04	0.426	1.15			
Maturity UK	Response			Adj R^2	DW	F-Stat
	Intercept	expected	Unexpected			
2 year	0.012	0.044	0.902	0.318	2.150	10.132
<i>t stat</i>	1.537	1.327	4.490			
3 year	0.014	0.055	0.766	0.195	2.180	5.739
<i>t stat</i>	1.498	1.453	3.314			
5 year	0.011	0.058	0.600	0.110	1.940	3.437
<i>t stat</i>	1.143	1.442	2.465			
7 year	0.013	0.072	0.296	0.039	2.140	1.790
<i>t stat</i>	1.306	1.717	1.172			
10 year	0.014	0.082	0.143	0.0398	2.150	1.809
<i>t stat</i>	1.299	1.899	0.547			
15 year	0.012	0.074	0.096	0.025	2.230	1.509
<i>t stat</i>	1.165	1.737	0.377			
20 year	0.011	0.069	0.048	0.017	2.300	1.342
<i>t stat</i>	1.083	1.626	0.188			
30 year	0.01	0.062	0.072	0.004	2.399	1.088
<i>t stat</i>	0.955	1.474	0.286			

Figure 7: