Policy Words and Policy Deeds: The ECB and the Euro*

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ABSTRACT

This paper examines the role of the ECB communication activities on daily Eurodollar exchange rate and interest rates. We estimate the relationship between monetary policy and the exchange rate using a technique that explicitly recognizes the joint determination of both the levels and volatilities of these variables. We also consider more traditional estimation strategies as a test of the robustness of our main results. We introduce a new indicator of ECB communications policies that focuses on what the ECB says about the future economic outlook for the euro area along five different economic dimensions. The impact of ECB communications policies is more apparent in the time series framework than in the heteroskedasticity estimator approach. Previous studies that conclude that news effects are significant at the daily frequency may have reached such a conclusion because the measurement of news was too highly aggregated. The endogeneity of the exchange rate – interest rate relationship is more apparent when the proxy for monetary policy is the euro area – US differential than when any other proxy for monetary policy is employed. Finally, interest rate changes generally have a much larger impact on exchange rate movements, and their volatility, than do ECB verbal pronouncements.

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Introduction

The brief history of the euro to date is a turbulent one. Figure 1A plots the euro/USD exchange rate at the daily frequency since 1999, the year the ECB formally took over responsibility for the conduct of monetary policy in the euro area. Figure 1B plots the volatility of the euro-USD exchange rate based on a five day moving variance. To some extent, the sharp fall in the euro against the USD, its subsequent equally rapid and steady, if volatile, rise in value against the US currency have, at least in part, been blamed on the ECB's monetary policy. Smaller currencies, such as the Canadian dollar, have also experienced the same large swings in their exchange rate vis-á-vis the USD, without the accompanying criticisms about the conduct of their exchange rate or monetary policy. Some have pointed to the fact that a new and untried monetary institution became responsible for a single monetary policy in 11 sovereign states. Others have focused on the inability of the fledgling central bank to clearly communicate its policy stance.

At first, complaints about the ECB's policies focused squarely on its credibility, or lack thereof. Later, the restrictions imposed by having to explain monetary policy to a public in different regions of the euro area came into play. Notwithstanding the current ECB President's remarks that the "…euro area has the same characteristics as the United States in terms of interregional differences relating to growth and inflation" (Trichet 2005), the institutional setting the ECB finds itself in is clearly vastly different from the situation facing the US's Federal Reserve. As a result, for some euroland economies, monetary policy became too tight while, for others, the same policy was viewed as being relatively loose. Some politicians have even gone so far as to suggest that the euro's days as a currency are numbered, at least in some parts of the euro area (e.g., Kahn and Walker 2005, Barber 2005).

On the question of credibility, many critics (e.g., Svensson 2003) argue that the ECB's two-pillars policy is confusing, if not downright inappropriate.[1] Others praised the ECB, especially under its first President, Wim Duisenberg, for trying to avoid at all costs

[1] The ECB, on its own account, conducted a review of its monetary policy strategy in 2003 (http://www.ecb.int/pub/pdf/other/monetarypolicystrategyreview_backgrounden.pdf). The two-pillars approach consists in combining a price stability objective (aiming for below but close to 2% inflation), together with a reliance on monetary indicators to help ensure that the price stability objective is being met over the medium-term (http://www.ecb.int/mopo/strategy/html/index.en.html).

the temptation to surprise markets (Sims 2004). Evidence, both of the time series and event study varieties, points to some significant impact of ECB deeds and words on the euro/USD exchange rate and a modest, but improving, credibility (e.g., Fatum and Hutchison 2002, Jansen and De Haan 2005, Fratzscher 2004, Goldberg and Klein 2005) which suggests some capacity on the ECB's part to surprise markets.

To some extent these findings appear at odds, at least with Duisenberg's attitude toward the euro. On at least two occasions he was quoted as arguing that, while the euro/USD exchange rate is an important indicator, there is little reason to influence its value as a matter of policy. Instead, the former ECB President, who left office in November 2003, did express concerns about exchange rate volatility. "I always said I am more concerned about volatility than about the precise level of an exchange rate. I am interested in stability to put it in other words" (Duisenberg 1999b). His successor, Jean-Claude Trichet, apparently feels the same way, at least if we interpret a commentary of his written for the French press. In it he outlines how the ECB's policy of ensuring price stability can best be achieved. Not a single word is uttered about the euro/USD exchange rate. Indeed, Trichet believes that too much transparency is a bad thing since, if it left future rate moves completely anticipated, ECB policies would not have the desired effect on financial markets (Trichet 2005).[2] Clearly, the implication is that the words of central bankers and, by the same token, those of politicians and other financial market participants, have taken on the aura of the "codeword", either implicitly substituting as a threat of direct action if expectations do not conform to the central banker's inflation outlook, as a means of foreshadowing future direct action on exchange rates through intervention in foreign exchange markets, or via an interest rate change at the next meeting of the monetary policy committee. "It is fair to say that the governing council has been very attentive not to use words that were at risk of having acquired more technical meaning than what the dictionary gives them" (Padoa-Schioppa, former member of the governing council, as quoted in Sims 2004).[3]

[2] Similar concerns are also being voiced in the US where minutes of the FOMC in November 2005 suggest that the Fed may provide markets with less guidance in future.To quote: "…several aspects of the statement language would have to be changed before long, particularly those related to the characterization of, and outlook for, policy." (www.federalreserve.gov/fomc/minutes/20051101.htm),

[3] The senior decision-making body of the ECB is the Executive Board, and it consists of six members. The governing council includes the heads of the central banks

In order to identify the role the ECB's monetary policy plays in explaining patterns such as those displayed in Figure 1, the investigator must deal with a well-known identification problem. An example illustrates the challenges facing researchers. In September 2000, the ECB formally intervened in foreign exchange markets in support of the euro. In September 2001, the US experienced terrorist attacks with worldwide repercussions for financial markets. Both events, one policy related the other not, had a temporary impact on the levels of the euro-USD exchange rate. In contrast, only the policy intervention by the ECB appears to have had a noticeable impact on exchange rate volatility. This suggests that one useful way of identifying the impact of central bank policies it to utilize the information contained in the volatility of exchange rate movements. This is precisely the empirical strategy followed in the paper. This study adds to a small but expanding literature that attempts to identify how the actions and statements made by ECB officials with key indicators of monetary policy.[4]

A recent flurry of papers (e.g., Fratzscher 2004, Jansen and De Haan 2005) has touched on a similar theme. Although the results in Andersen, Bollerslev, Diebold and Vega (2005) suggest that we focus exclusively on the ECB's influence on the volatility of key policy indicators, since daily data may not be suitable to uncover the role played by deeds versus words on asset price levels, we find some significant level effects at the daily frequency. However, unlike existing studies, we are perhaps more keenly aware that central bankers must compete with several other news items that have the potential of influencing agents' beliefs about the course of the exchange rate. Also, if the central bank evinces a concern for the exchange rate then its behavior cannot be divorced from the overall stance of monetary policy, even if no formal foreign exchange intervention is contemplated. Clearly then, interest rates and exchange rates are endogenously determined. Consequently, we estimate the relationship between monetary policy and the exchange rate using a technique that explicitly recognizes the joint determination of both

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(http://www.ecb.int/ecb/orga/decisions/govc/html/index.en.html). Jansen and De Haan (2005) find that the 'words' of non Executive Board members carry some weight in financial markets although their relative impact may have waned since the early days of the ECB.

[4] A Table relegated to an appendix lists days with the largest changes in implied volatilities – a forward looking indicator of exchange rate changes and it reveals roughly as many policy days as non policy days are capable of creating large changes in this series.

the levels and volatilities of these variables. We also consider more traditional estimation strategies as a test of the robustness of our main results.

Finally, studies that consider how news or central bank pronouncements affect asset prices typically rely on a rather narrow set of variables to capture surprise announcements. The universe of potential information that can have an impact on the exchange rate is undoubtedly large. Consequently, we rely on a principal components analysis to reduce the dimensionality of potential sources of news effects on the euro/USD exchange rate. [5] This strategy proves to have important implications for the significance of news events on exchange rate developments even at the daily frequency.

The rest of the paper is structured as follows. The following section reviews the relevant literature on news effects and monetary policy with particular reference to the relationship between asset prices and central bank behavior. Next, we describe the data used in the study prior to presenting some stylized facts about the data set in question. The empirical evidence is then discussed after a discussion of methodological issues. The paper concludes with a summary and questions left for future research.

News and Asset Prices: A Selective Literature Review

The literature on news and its impact on various financial asset prices is extensive. In the past, research has tended to concentrate on the impact of news releases on interest rates, exchange rates and stock returns issued primarily by the financial press (e.g., see Cochrane 2005, Campbell, Lo, and MacKinlay 1997). More recently, there is growing interest in attempting to extract a separate influence from various types of news releases emanating from central banks (e.g., Gürkaynak, Sack and Swanson 2005, Siklos and Bohl 2005).[6] There are at least three explanations for this development. First, many central banks now rely on an overnight interest rate, or a similar instrument, to guide the general level of interest rates. Second, monetary authorities in a large number of countries are now seen as more autonomous, transparent, and accountable to governments, in particular, but to markets and the public more generally (e.g., Bernanke,

[5] Siklos and Robinson (2000) demonstrate empirically the possibility of selectivity bias in studies of this kind. More recently, Dominguez and Panthaki (2005) widen the vector of variables that constitute news for foreign exchange markets to include information not typically considered fundamental in an economic sense. They conclude that the explanatory power of high frequency models of exchange rate behavior can be substantially improved with the addition of such variables.

[6] For a survey of the kinds of information now provided by central banks on a regular basis, see Siklos (2002).

Laubach, Mishkin, and Posen 1999, and Siklos 2002). In response, central banks have become more "talkative". There is growing recognition that monetary authorities can influence markets on a daily basis.[7] Finally, there is a possibility that, at times, the "words" of central bankers might substitute for direct "action" (Siklos and Bohl 2005, 2005a; Gürkaynak, Sack, and Swanson 2005). In what follows we briefly focus on four questions that have pre-occupied researchers in recent years. They are, not necessarily in order of importance: the choice of asset price, the estimation methodology employed, the measurement of news effects, and the choice of sampling frequency.

Earlier efforts aimed at estimating news effects on asset prices tended to examine on their impact on stock returns for perhaps obvious reasons. Equity market data have, for some time, been available at the daily frequency. Moreover, market efficiency considerations have long suggested that stock prices react quickly, and almost exclusively, to unexpected events, namely "news". Ehrmann and Fratzscher (2004c) is an example of a study that seeks to determine how news emanating from the U.S. Federal Reserve's Open Market Committee (FOMC) affects stock returns as measured by the performance of the S&P500 index. A separate study (Ehrmann and Fratzscher 2004b) considers broader sources of news from the US, the UK, and the euro area. Bernanke and Kuttner (2003) consider the CRSP value-weighted index in their exploration of the impact of both expected and unexpected shocks. The present study eschews an analysis of stock market reactions to ECB policies impact. These markets continue to react to local as well as euroarea wide conditions and it is only the latter that is the remit of the ECB.

More recently, attention has turned to the reaction of interest rates and exchange rate fluctuations to news. Ehrmann and Fratzscher (2004a), Fratzscher (2004), Jansen and De Haan (2005), Goldberg and Klein (2004), and Beine, Janssen and Lecourt (2004) represent just a sampling of recent empirical studies of the impact of news on exchange rate movements and their volatility. Paralleling this development, especially in the US, is the resort to extracting information from the market for fed funds futures. Fed funds futures imply expectations for the fed funds rate. Hence, differences between actual and

[7] Whether this is a desirable outcome is open to question as a central bank can easily be accused of developing a form of tunnel vision if it concerns itself too much with day to day movements in financial asset price. For a discussion of the relevant issues, see Siklos (1999).

expected funds rates are said to represent a source of unexpected changes in monetary policy. Cochrane and Piazessi (2002), Kohn and Sack (2003), Poole, Rasche and Thornton (2002), and Fatum and Scholnick (2005), are just a few of the studies, relying on changes in yields on fed funds futures, that estimate the link between news and its effects on forward-looking behaviour. While countries other than the US do not have precisely the same financial instrument, a few studies (e.g., Connolly and Kohler 2004, Rigobon and Sack 2004, Siklos 2003) use interest rate futures or forward exchange rates to proxy forward-looking sentiment in financial markets. Not to be forgotten, however, are studies that examine changes in (spot) exchange rates and their reaction to news, as reported by the financial press, central banks, or both (e.g., Ehrmann and Fratzscher 2003, Siklos 2003).

Estimation often proceeds by regressing the change, or expected change, in the financial asset price of interest on proxies for unexpected events since this is what is believed to constitute "news". The relevant proxies are themselves generated in a variety of ways, as will be explained below. However, most objective measures of news or surprises are defined in the following fashion:

$$s_{k,t} = \frac{A_{k,t} - E_{k,t}}{\sigma_{k,t}}$$

where $s_{k,t}$ is the surprise component of an announcement type *k*, at time *t*, which is evaluated as the difference between the announced value of the economic indicator in question (*A*) and its median or mean expected value (*E)* based on forecast or survey data. Dividing by the sample standard deviation (σ) of announcements of the same variety standardizes $s_{k,t}$, and permits a comparison of regression coefficients across different kinds of announcements.

Most of the estimated models tend to be univariate regressions, possibly with other added controls. Since Engle's (1982) seminal work, it is now customary to argue that unexpected events can simultaneously influence the volatility of asset prices, and not just their levels. This has led most researchers to resort to conditional volatility models, usually of the GARCH(1,1) or EGARCH(1,1) variety, since they are often successful specifications aimed at capturing the time-varying nature of volatility in asset returns. Almost all of the papers cited earlier can be characterized as adopting either or both

estimation strategies in question. A few studies (e.g., Rigobon and Sack 2004) have also recognized that asset markets for different financial assets are linked and, at least in part, possibly jointly determined and have proposed an alternative estimation strategy to deal with the endogeneity problem. [8] Thus, for example, a connection between stock returns and bond yields has long been thought to exist (e.g., Gürkaynak, Sack, and Swanson 2005, Rigobon and Sack 2004). [9] Similarly, there is the well-known uncovered interest parity relationship between exchange rates and interest rates differentials or the link between the slope of the yield curve and economic fundamentals. Each of these approaches has produced a voluminous literature.

All these studies share a common feature, namely reliance on time series modeling. In contrast, the finance literature has often relied on event type studies wherein the reaction of a financial asset price is measured within a somewhat arbitrarily defined window of time. While such studies can be useful, they do suffer from the fact that, however narrow the window, other factors that can influence the link between news and asset price returns are not necessarily adequately controlled for. [10] We return to this issue below.

Until recently, relatively less concern has been expressed to explaining what is exactly meant by news. At the risk of oversimplifying matters, there are two types of variables that are thought to represent news. Governments, and other private institutions, at regular intervals, release a heavy flow of data. [11] Some are initial estimates of current economic conditions others are revised figures from earlier data releases. Almost simultaneously, both current forecasts and ones over some specified future horizon, are also released. Hence, the difference between a current release and the relevant forecast, serves as a proxy for a surprise announcement. For the US alone, the Bloomberg service reports at least 83 announcements on a regular basis, usually monthly or, occasionally, quarterly (see below). Some authors (e.g., Andersen, Bollerslev, Diebold and Vega 2005)

[8] The link can also be geographical in nature, thereby premitting spillovers from one region of the world to another, as the burgeoning literature on contagion effects, for example, attests. See, for example, Dungey et.al. (2003) for a survey.
[9] The relevant literature has a long history, though the evidence sorting out the most empirically relevant links is unclear, as several hypotheses exist relating stock market behavior to interest rate movements. For example, see Canova and De Nicolo (2000).
[10] MacKinlay (1997) reviews the event-study literature. Also, see Leroy (2004).
[11] Often, such announcements arrive during the first two weeks of each month.

differentiate between positive, or favorable, and negative, or unfavorable, news events. Generally, news effects are found to be asymmetric with bad news in good times having a larger impact on asset prices than when good news is released under the same economic circumstances. However, there are no systematic attempts to explain how the selection of news releases for analysis is chosen. For example, Ramchander et.al. (2005) rely on 23 separate releases of US macroeconomic indicators, in a study of news effects on bond yields, while Connolly and Kohler (2004) use only 12 announcement types from the same source. This implies that most studies of news effects that rely on announcement type data resort to a form of censoring. Although the degree of censoring is an empirical question, there is little doubt that some announcements may, or may not, consistently affect asset markets, and the exchange rate in particular, even if the announcement in question is deemed to be one that markets are believed to react to on a regular basis.[12]

More recently, and in line with the burgeoning interest in the impact of central bank policies on asset price developments, several authors have sought to quantify, typically via the specification of dummy variables, the significance or meaning of statements, press releases, speeches, and other announcements emanating from central bank officials. In some cases (e.g., the US Fed, the ECB, and the Bank of England) the mere fact that officials who set the course of monetary policy meet at regular, pre-announced, intervals gives rise to the possibility of news around meeting days. Ehrmann and Fratzscher (2004b), Fratzscher (2004), Jansen and De Haan (2005), Kohn and Sack (2003), Siklos (2003), and Beine, Janssen and Lecourt (2004) are studies that attempt to classify words and deeds of central bankers alongside other sources of news. While many of the news sources are of the objective variety, that is, they are quantifiable, others are subject to the interpretation of the researcher who is attempting to determine from a particular statement, or speech, whether a central bank official is calling for higher or lower future interest rates, or some other financial asset price such as the exchange rate or

[12] Consider, for example, the following item in the 3 August 2005 Marketwatch item in the *Wall Street Journal Europe* (page M3): "The dollar was lower yesterday afternoon, its steepest decline coming against the yen after upbeat comments from a Japanese central bank official. … Dollar trading showed little reaction to U.S. data on incomes and spending. The past several positive U.S. economic reports haven't been enough to shake the dollar from its downward correction seen in the wake of China's currency revaluation last month." Why some news appears to be ignored is unclear but the foregoing is perhaps illustrative of the possibility that the choice and definition of the news variable may have a separate effect on empirical studies of the kind conducted here.

stock prices. As Alan Greenspan once said, responding to a politician seeking reassurance that an earlier comment by the US Fed Chairman was indeed clear: "I guess I should warn you, if I turn out to be particularly clear, you've probably misunderstood what I've said." Consequently, as noted previously, there is clearly potential either for bias or for interpreting statements differently in hindsight. It is also conceivable that statements are deliberately meant to obscure a central bank's likely course of action. Another example that is highly relevant for this paper comes from the early years of the ECB when the euro began to depreciate. Then ECB President Wim Duisenberg was repeatedly asked about the central bank's attitude toward the euro/USD exchange rate. Once, he replied: "There will, of course, not be any neglect, neither malign nor benign neglect, of the exchange rate" (Duisenberg 1999a). A few months later he repeated the statement with a slight difference, opining that: "Not having an exchange rate policy, and we have no policy, does not meant that there is benign or malign neglect. *For the time being* [italics added] there is neglect" (Duisenberg 1999b). By the time of his passing, his words would be reinterpreted: "Mr. Duisenberg quipped that his central bank's policy was 'not benign or malign neglect [toward the euro], just neglect" (Buchan 2005). This interpretation may, in fact, be the correct one but it is not what Duisenberg actually said. What is less obvious is whether such statements impact asset price levels, volatility, or both. Nevertheless, to the extent that the central bank is reasonably transparent about what it deems to be the future outlook for the economy, such statements, together with the publication of inflation reports and staff forecasts, can be reasonably said to contain some information about likely central bank actions.[13] Just as important, there is a conscious attempt to identify statements that signal tighter versus looser future monetary policy or a stronger or weaker future value for the exchange rate (e.g., Fratzscher 2004, Fatum and Hutchison 2002). Hence, asymmetries in the conduct of monetary policy are explicitly recognized. Another form of asymmetry comes from the geographic source of news events. Hence, for most countries, news from US sources would have a significant independent influence on other countries' financial markets (e.g., Connolly and Kohler 2004). Regardless of how qualitative statements are measured, they are typically assumed

[13] Depending upon whether market participants read complete statements from central bank officials, instead of a selection published in, say, a particular newspaper source, this will have consequences for the possibility of media spin or bias (see Mullainathan and Shleifer 2004).

to have, at most, a temporary same day effect on the asset return in question, in keeping with the notion that news effects dissipate quickly.

This last point brings us to the question of sampling frequency. Goodhart, Hall, Henry, and Pesaran (1993), and Andersen, Bollerslev, Diebold and Vega (2005), among others, find that news events dissipate within a matter of hours. Hence, estimating news effects on asset prices at, say, the daily frequency will generally under estimate the short-run effect of unexpected events on asset prices. The recent evidence of Gürkaynak, Sack, and Swanson (2005) would appear to support such a view. Dominguez and Pathanak (2005) also consider intra-daily news effects but conclude that previous studies define news rather narrowly. As a result, they are unable to conclude that there is no useful information content at the daily frequency. Ehrmann and Fratzscher (2004a,b) also defend the resort to daily data on the grounds that intra-daily data capture an overreaction to news events[14] which does not entirely eliminate the possibility that news effects are longer lived than some believe. Others (e.g., Chan 2003) believe that investors underreact to information, especially of the bad variety. Moreover, there is a presumption that markets react to the same news at the same time. Not only is news transmitted to different markets with a delay, albeit a short one, there is considerable evidence that agents censor information or may react to it with a lag that exceeds a few hours, if only to decide whether the shock in question is transitory or with more permanent consequences. In addition, central banks communicate not only to financial markets but to the public more generally. If using ultra-high frequency data, should we rely on the exact timing of the release of information to newswire, or rather rely on the timing of when the information (e.g., as in a speech) is actually released? Also, once intra-daily data are used, the investigator must choose a window (e.g., 5 minutes or 20 minutes) and there is the possibility that such a choice can bias findings about the strength of the connection between news and exchange rate behavior.

Lastly, the focus on asset price developments ignores the information content in the volume of transactions and this aspect cannot entirely be divorced from their effect on asset price movements. Andersen and Bollerslev (1998) document the potentially

[14] This is a reflection of the so-called “irrational exuberance” phenomenon coined by Alan Greenspan, and later emphasized by Shiller (1999).

important role of the volume of transactions in explaining the volatility of exchange rate movements, while Evans and Lyons (2003, 2005) argue that there is information content on the order flow in currency markets. The role played by the order flow seems to be potentially more important for intra-daily data than at the daily frequency. The bottom line is that news effects need not necessarily evaporate instantaneously and so we resort to data at the daily frequency. [15]

Data

To ensure comparability with much of the recent literature on the determinants of eurozone exchange rates and the communications activities of the ECB, we rely on daily data since 1999. A separate Appendix gives more precise details of the series definitions. Exchange rate, interest rate, and other financial asset prices are from Datastream, Reuters, and Bloomberg. Data for the euro reference exchange rate vis-á-vis the US dollar are from the ECB. Interest rate data for the euro area consist of yields on repos (eurepo) and the euribor for various maturities. [16] For the US, the fedfunds, fedfunds target and fedfunds futures data were obtained from Datastream, as were forward exchange rates for the euro against the US dollar. Fed fund futures data are for overnight fed funds held for 30 days published by the Chicago Board of Trade (CBOT).

Institutional data, consisting of statements from central bankers, the dates of meetings of the FOMC (Federal Open Market Committee), and the ECB's governing council, are from the web sites of the US Board of the Governors of the Federal Reserve System (www.federalreserve.gov) and the ECB (www.ecb.int). Results from the Reuters Poll of ECB interest rate expectations were obtained from Reuters. Also from Reuters are the implied volatilities for 'at the money' foreign currency options for a variety of maturities ranging from one week to one year. Although the jury is out on whether implied volatilities provide relatively superior forecasts of future volatility, financial market participants find them to be a useful way of gauging large price changes primarily because of liquidity concerns. Hence, implied volatilities may be especially useful in

[15] They also allude to a possible additional advantage of relying on daily data, namely that this is the highest frequency at which the exchange rate can be described as a martingale. By contrast, exchange rates tend to be mean reverting at ultra-high frequencies.

[16] The euribor (euro interbank offer rate) and EONIA (euro overnight index average yield) are the benchmark money market instruments for the euro area (www.euribor.org).

capturing information about "high stress" events.[17] Forecasts for inflation and real GDP growth for the US, the euro area, and individual euro area countries are from Consensus Economics (www.consensuseconomics.com). Consensus economics surveys panelists during the first two weeks of each month when there is generally a heavy flow of data announcements which are most likely to lead to revisions of forecast. Data for macroeconomic announcements, consisting of an expectation based on a survey of economists, together with actual, prior values for the indicator in question, as well as revisions to previous data releases, were obtained from Bloomberg. The figures that are reported are averages. Some of the data used in this study were also used in Laakkonen (2004) from which they were adapted for use in this study.[18] Business cycle information for the US is obtained from the NBER (www.nber.or/cycles.html) while, for the euroarea, these data are available from the euroarea business cycle network (www.eabcn.org). Lastly, we searched Factiva (www.factiva.com), a news retrieval service for news reports that cited "ECB" and "monetary policy", "interest rate", or "exchange rate" in the headline and lead paragraph and counted the references. This count data is a useful companion to the announcements data as it can be informative about the intensity with which news reports draw attention to central bank actions and words.[19]

This paper also introduces new series that quantify statements issued by the ECB and Federal Reserve, based on information contained in press releases, although other central bank publications were also consulted (e.g., monetary policy, inflation reports, minutes of meetings, if available). Each press release is dated and interpreted for context as well for whether it contains statements that reflect positively or negatively on the economic outlook along five dimensions. They are: the exchange rate, output, asset prices, fiscal policy, and international developments or considerations.[20] A positive outlook signifies that higher real GDP growth, lower inflation are forecast, or an

[17] Applications that rely on implied volatilities include Maltz (2000), and Rogers and Siklos (2003), and references therein.
[18] A separate Appendix gives the list of indicators used from the US, Germany, the UK, Japan, and the euro zone.
[19] The count data exclude republished news, recurring pricing and market data, obituaries, sports, and calendars. In spirit at least, our count data is similar to the keyword count variable created by Cecchetti (2003) to proxy the concerns of the US Fed about stock market developments and the possibility of a bubble. While count data is a useful indicator, I does not discriminate between news items that look back versus news that relates to the economic outlook for the variables of interest.
[20] A separate Appendix provides a table with the coding used for the ECB and the FOMC.

appreciating currency, or that financial asset prices more generally are considered to be at fundamentally sound levels. Dummy variables were then created for each of the media releases taking on a value of +1 in the case of a favorable development, a -1 in the event of a negative development, and zero otherwise for each of the six categories previously mentioned. When a press release mentioned more than one of the aforementioned categories all such references were recorded. Consider the following example: "In addition, any relaxation of fiscal policies would negatively affect the price climate as well as the credibility of the Stability and Growth Pact" (ECB, 7 January 1999). This was interpreted as implying a negative outlook for future inflation. "…the euro area has appreciated against the currencies of the euro area' most important trading partners. The Governing Council considers the development to be a step in the right direction" (ECB, 14 December 2000). This statement suggests a positive outlook for the exchange rate. This practice was also followed for FOMC statements. There are other interpretations of central bank press releases in the literature, such as the oral interventions variables constructed by Fratzscher (2004). In contrast, Fratzscher's (2004) scale focuses exclusively on the connection between monetary policy and exchange rate developments. A +1 is assigned to a statement advocating an appreciation of the euro, a -1 for a depreciation, and a zero when the statement is ambiguous. One difference between Fratzscher's indicator and ours is that we were more interested in isolating statements about future outlook for the economy. After all, it is unlikely a priori that statements about the exchange rate can be divorced from other related economic indicators such as interest rates and inflation. Moreover, our classification parses statements into several different categories. As a result, none of the statements were felt to be ambiguous about some indicator of economic activity.

It needs be emphasized that our coding of the words of central bankers need not be superior in every respect, as the interpretation of words is not unique. For example, Jansen and de Haan (2005) code statements by all central bankers in the euro area, and not only ones emanating from the ECB. Nevertheless, only the comments dealing with the euro are classified. Similarly, Rosa and Verga (2005) focus on the contents of ECB press release alone in order to derive a measure that represents the likelihood of an official interest rate change, and the resulting ordered scale that translates the same types

of ECB documents considered here into "risk for price stability" and "economic growth" categories.

Stylized Facts

Although the ECB communicates frequently, it is more likely to do so around the time of the meetings of its Governing Council. To the extent that its meetings, and subsequent press conference,[21] influence financial markets this ought to affect the volatility of monetary policy and exchange rate shocks. As noted previously, the story of the euro/USD exchange rate cannot be divorced from monetary policy in the US. Figure 2 plots the ECB main refinancing operations rate and its proximate US equivalent, namely the fed funds rate for the 1999-2004 sample covered in this study. For roughly the first half of the sample the US policy rate was higher than the comparable rate for the euro area. After 2001 the situation is reversed. By the end of 2004 the fed funds rate began to edge up over the ECB reference rate. Hence, the sample covers a long enough sample wherein the monetary policy stances and economic outlook of the two central banks appear to have changed substantially over time.

Figure 3A plots the standard deviation for selected series around specific event days.[22] They are: the rate of change in the euro/USD exchange rate, the change in the EONIA, the differential between the EONIA and the fed funds rate, and the change in the implied volatilities for one week options. The events chosen are: days when the ECB's Governing Council meets but does not set the policy rate, the day before the Governing Council meets, days when the ECB President testifies at the European Parliament (EP), and days when the so-called EMU poll of interest rate forecasts is released. For most proxies there are considerable differences in the volatility of the underlying series but this is only suggestive of the role of ECB words and deeds as these event days also overlap with other news releases. For example, the implied volatilities are substantially more volatile on days when the ECB President testifies before the European Parliament (EP). Similarly, the EONIA- fed funds rate differential is most volatile around the time of the

[21] The Governing Council usually meets twice a month. At its first monthly meeting, the policy rate is set while the second meeting is held to discuss other aspects of ECB policy making. The table to be discussed below assumes that volatility is potentially affected by the first meeting date. We return to this issue below.
[22] Complete details for all the series considered in this paper are relegated to an appendix.

release of the EMU Poll of ECB interest rates. Nevertheless, unconditional volatilities give only a partial picture of what drives changing volatilities.

Turning to the US evidence, as illustrated by Figure 3B, events in the US on days when the FOMC meets versus the preceding days also show a modest impact on the euro/USD exchange rate volatility, with more noticeable effects on implied volatilities and the EONIA/fed funds interest rate differential. Also shown is the relatively higher volatility of fed funds futures reported by several other researchers.[23]

Figure 4 provide two illustrations. It shows changes in the euro area – US interest rate differential against the rate of change in the euro/USD exchange rate. Presumably, on non-policy days, fundamentals and non monetary policy related shocks dominate whereas, on days when the Governing Council meets, it is the ECB's reaction function that predominates. As seen in the top portion of Figure 4, the bulk of the scatter suggests no obvious connection between changes in the interest rate differential and the rate of appreciation or depreciation in the exchange rate on non-policy days. Turning to the same relationship on days when the ECB sets its policy rate, there are stronger indications that changes in the interest rate differential are negatively related to changes in the exchange rate.[24] Choosing other pairs of variables does not fundamentally change the story.

We now turn to a description of the announcements data, usually the workhorse variable for measuring surprises in high frequency data. As noted previously, some of the data were obtained from Laakkonen (2004) and updated from sources listed in her study. We include announcements from the US, the UK, Japan, the European Union (or euro area), and Germany. The total number of available announcements are as follows: US (83), UK (82), Japan (92), the EU (75), and Germany (101). Because a continuous data for all available announcements covering the entire sample in this study (1999-2004) were unavailable, or many did not include a survey component preventing the calculation

[23] This result simply may simply indicate that FOMC meeting days are more newsworthy than non-meeting days. Poole and Rasche (2000), Poole, Rasche and Thornton (2002) and Kuttner (2001), find that the Fed had become more transparent over time. Indeed, recursive estimates of the mean surprise based on fed funds futures are not statistically different from zero after the end of 2000. Between August 1997 and April 1999, Fed directives announced a numeric value of the "intended fed funds rate". Since May 1999, the Fed issues a press statement following each FOMC meeting. In February 2000 the Fed replaced its "policy bias" statement with announcement suggesting a "balance of risks".

[24] Indeed, while the covariance between the two series is negative in the two samples, it is almost 16 times larger on policy setting days than on non-meeting days.

of a surprise component, the fraction of the universe of available announcements actually used was as follows: US (34%), UK (22%), Japan (20%), the EU (17%), and Germany (13%). Consequently, a total of 91 announcements are used, a number far higher than in comparable studies of this kind. Given the sheer number of announcements a useful way of reducing the dimensionality of the announcements variables, while preserving the essential information content of the surprise series, is to resort to a principal components analysis. This was done for the vector of announcements for each country separately. This approach permits us to reduce the effective number of announcements to 12. Table 1 provides summary statistics as well as listing the individual announcements that receive the highest weights. For the US and the UK, three principal components were found while two principal components characterize the data for Germany, Japan, and the euro area. Several of the US studies cited earlier also find that the producer price index, payroll data and hours worked are salient announcements but, as can be seen from Table 1, several other major economic announcements also matter. More generally, with the exception of the EU, announcements about price and output developments are clearly the most important though we note, importantly, that the widely reported IFO business climate index is among the announcements that included among the principal components. Also interesting to note is the fact that there is an asymmetry of sorts over the sample considered in that the average standardized values of the principal components of the announcements is positive with the notable exception of Japan, where it is negative. Generally, the distribution of the sizes of the surprises is fairly similar across countries though the UK and the US have experienced a small number of relatively large negative announcements and, with the exception of Japan, the fraction of bad news announcements is larger than for the eurozone or European Union.[25]

We conclude by briefly describing some of the more qualitative variables. Several features of the data readily stand out. First, while the ECB regularly comments on the euro exchange rate, no comparable statements could be found in FOMC statements while the ECB has done so on a regular basis. Second, during the period considered, the FOMC did not provide an outlook for fiscal policy or the exchange rate (at least the euro/USD

[25] The eurozone and European Union are not the same but it was not always clear from the data which geographical region the announcement refers to.

exchange rate). Second, the ECB produced not only relatively more commentary about the outlook for inflation but it did so more intensively than the Fed. On the other hand, both central banks regularly commented on real economic developments (viz., output and output growth). The same is true for commentary about the outlook based on foreign developments (viz., primarily the US, but also Asia). Lastly, there was relatively little mention by either central bank about asset prices, although the ECB became relatively more talkative beginning in 2001.[26]

Finally, Figure 5 provides some information about the content of the Reuters Poll of expectations regarding the ECB reference rate. We compare the expected size of ECB reference rate changes to the actual changes made in the ECB's main refinancing operations rate since 1999. The expected value simply represents a weighted average of poll respondents' views about the likely value of the ECB's policy rate where the weights are the fraction of respondents' who anticipated either no change, a 25 bp rise or fall, or a 50 bp rise or fall, these being the categories used in the poll. The Figure reveals that, in 2000 and 2001, the Reuters poll participants largely predicted the direction of change in the ECB's key rate even if they somewhat underestimated the size of the change. The same is generally true of expectations after 2001, with expected changes settling very close to zero by the end of 2003, when the ECB ceased to change its policy rate, at least until the end of our sample. Nevertheless, there is considerable volatility in expected changes in the ECB policy rate based on the polling data. In the empirical work to follow we make use of this and other features noted above to determine what drives the euro/USD exchange rate since 1999 and the role of ECB spoken words.

Estimation Strategy and Econometric Issues

As argued above it is likely that exchange rate and interest rates are jointly determined. Moreover, there is the possibility that additional biases are introduced if variables, not easily captured by the econometrician, that reflect, say, expectations or the information available to different market participantsare omitted. If we define Δe_t to represent the rate of change in the (nominal) euro/USD exchange rate, MP_t is a indicator of monetary policy, such as an interest rate or an interest rate differential, while C_t

[26] One should not conclude, of course, that while the FOMC was less vocal, in terms of the frequency of utterances about asset price developments, that its words had less impact. The opposite could well be correct.

summarizes the information content of press releases and other forms of communications emanating from the ECB, we can write the relationship of interest as follows:

$$(1) \quad MP_t = \beta \Delta e_t + \delta C_t + \gamma Z_t + \varepsilon_t$$
$$(2) \quad \Delta e_t = \alpha MP_t + \theta C_t + Z_t + \eta_t$$

where Z_t represents a vector of other variables (normalized to one in equation (2)) that influence monetary policy and the exchange rate such as news announcements, day of the week effects, and so on, assumed to be exogenous. All other variables were previously defined. Equation (1) is a policy reaction function while equation (2) contains the parameters of interest, namely α and θ. The parameter α measures the impact of monetary policy on the exchange rate while θ captures the effect of ECB communications on the euro/USD exchange rate. The errors ε_t and η_t are, respectively, the shocks to monetary policy and the euro/USD exchange rate. The disturbances are assumed to be serially uncorrelated, $E(\varepsilon_t, \eta_t) = 0 \; and \; E(\varepsilon_t, Z_t) = E(\eta_t, Z_t) = 0$. As in Rigobon and Sack (2004), equations (1) and (2) impose a minimum of structure on the data. However, these same equations cannot be consistently estimated using OLS because of the simultaneity issue discussed earlier. Instead, Rigobon and Sack (2004) recommend identifying two sub-samples, such that

$$(3) \; \sigma_\varepsilon^P > \sigma_\varepsilon^{NP}$$
$$(4) \; \sigma_\eta^P = \sigma_\eta^{NP}$$
$$(5) \; \sigma_Z^P = \sigma_Z^{NP}$$

where σ^P and σ^{NP} refer to the volatility of the series of interest in "policy" (P) and "non-policy" (NP) samples. These sub-samples are defined below in greater detail. Expressions (3) to (5) represent identification assumptions where it is hypothesized that policy shocks are greater on policy days that on non-policy days (inequality (3)). The combination of interest rate announcements and economic outlook information contained in press releases explain such an inequality. Inequalities (4) and (5) assume that shocks to asset prices and to other exogenous influences on Δe_t and MP_t are the same on policy and non-policy days. As argued in Rigobon and Sack (2004), inequalities (3) to (5) represent a weaker set of inequalities than in the traditional event-study approach where it is

assumed that the variability of policy shocks is strictly greater than the variance of either exogenous influences on MP_t and Δe_t or those in the exchange rate equation (i.e., σ_η).

Rigobon and sack (2004) discuss how α and θ can be estimated by implementing instrumental variable estimation. Define the following variables to include a proxy for monetary policy and the exchange rate on policy and non-policy dates such that all days in the sample may be included:

$$MP_t \equiv \{MP, t \in P\} \bigcup \{MP, t \in NP\}$$
$$\Delta e_t \equiv \{\Delta e, t \in P\} \bigcup \{\Delta e, t \in NP\}$$

which are both 2T x 1 vectors (where T is the number of policy dates). Now define the following instruments:

$$w_{MP} \equiv \{MP, t \in P\} \bigcup \{MP, t \in NP\}$$
$$w_{\Delta e} \equiv \{\Delta e, t \in P\} \bigcup \{-\Delta e, t \in NP\}$$

Rigobon and Sack's (2004) approach implies that estimates for α can be obtained by regressing the change in the in the exchange rate, Δe_t, on the MP proxy (or its change) over the combined P and NP samples, using instrumental variables estimation where w_{MP} and $w_{\Delta e}$ are the instruments. They further demonstrate that w_{MP} and $w_{\Delta e}$ are valid instruments for estimating α under the assumptions that the parameters in (1) and (2) are stable, that asset price shocks are homoskedastic, and that monetary policy shocks are heteroskedasctic.[27] The framework also permits testing whether the relatively more stringent assumptions of the traditional event study approach can be rejected. As demonstrated by Rigobon and Sack (2004), a Hausman type specification test is used to test the null that the event study assumptions hold.

While the discussion so far has focused on the impact of monetary policy and indicators of central bank communications on the exchange rate, there is widespread acceptance of the notion that the endogenous relationship depicted in (1) and (2) extends to the conditional variances. If we take equation (2), the focus of our investigation, it is

[27] The sets P and NP are assumed to have the same number of observations. If the number of observations in these sets differs, Rigobon and Sack (2004) argue that the instruments and the variables have to be divided by the square root of the number of dates.

convenient to model the conditional variances via an EGARCH(1,1) model which is written:

$$(2A) \quad \ln(h_t) = \tau_0 + \tau_1(\xi_{t-1} / h_{t-1}^{0.5}) + \lambda \left| \xi_{t-1} / h_{t-1}^{0.5} \right| + \alpha' MP_t + \theta' C_t + \tau_2 \ln(h_{t-1})$$

where h_t is the conditional variance and all other terms have already been defined. The EGARCH(1,1) formulation has a number of advantages over the popular GARCH(1,1) alternative, including the fact that h_t can never be negative, the standardizing of ξ_t, as well as the possibility of testing for asymmetry depending on whether τ_1 is positive or negative. Many in the related literature have resorted to the EGARCH for the same reasons enumerated above. Equation (1) would similarly have an EGARCH(1,1) representation. Estimates of α' and θ' could then be similarly identified using the Rigobon-Sack procedure outlined above.

Finally, it is worth comparing the results from the foregoing identification approach against estimates from traditional time series estimation. This would consist in jointly estimating equations (2) and (2A) for the full sample.[28]

Empirical Results

In what follows, only the salient results are discussed as it is impractical to present the large number of estimates generated. For the most part, the results were similar across the various exchange rate – interest rate combinations examined, as we shall see. Table 2 then shows a selection of coefficient estimates from equation (2) and (2A), estimated in the time series framework. Due to the possibility of endogeneity discussed earlier, we first conducted a Hausman test[29] on the mean equation. Results (not shown) suggest that OLS estimates are inconsistent (that is, the null of unbiasedness and consistency is rejected) unless equation (2) is conditioned on the principal components of news and our proxy for ECB statements.[30] However, when equation (2) includes both of these variables the Hausman test rejects the null of consistency in only 4 of 31 cases

[28] Alternatively, (1) and (2) could be jointly estimated as a VAR or as a multivariate GARCH model. These extensions are not considered here since estimation of (2) and (2A) permit comparisons with the empirical results reported in the extant literature which has tended to follow this estimation strategy.

[29] This consists in estimating equation (2) and estimating an auxiliary equation where the residuals from (2) enter as a separate regressor. If the estimated coefficient is statistically significant, then the null of consistency of OLS coefficient estimates is rejected.

[30] A total of 31 proxies for MP were considered. An appendix provides summary statistics and definitions for all of the series.

examined.[31] Since the Hausman test is not definitive, we proceed with the assumption that MP and Δe are jointly determined and implement an additional Hausman-type test described in Rigobon and Sack (2004) to determine whether the usual event study assumptions are valid.

It is apparent that not all EC statements have a statistically significant effect on Δe. Interestingly, statements that specifically focus on exchange rate developments are the only ones generally found to be statistically significant. The only exceptions were the eurepo rate with a one year maturity and for some maturities in the euro area – US interest rate differential. In these instances, ECB comments relative to developments in asset prices were also found to be statistically significant. As shown in the Table, we also experimented with a proxy for the impact of ECB statements that aggregates all of the five categories of statements defined above. Aggregation turns ECB statements into an insignificant variable in the various regressions. Clearly, there is some added value in disaggregating statements according to the economic variable being discussed by the central bank.

An additional notable result is that commentary by the ECB concerning the euro/USD exchange rate always leads to a depreciation of the euro. In contrast, commentary about asset prices (usually stock prices but, occasionally, also housing prices) always leads to an appreciation of the euro, in the few cases where this variable was found to be statistically significant. Indeed, the effect of these statements is seen as essentially offsetting those that specifically deal with the exchange rate. These results point to the possibility that previous studies purporting to show that news events have relatively small effects in levels, at the daily frequency, may have reached such a conclusion because they did not sufficiently disaggregate the source of news.

The count variable that proxies the intensity with which reports about the euro and interest rates in the euro area are reported in the media is also statistically significant, and always negative, in 4 of the 6 cases reported in Table 2. This suggests that more frequent reporting of news items dealing with MP and Δe lead to an appreciation of the

[31] They are: the two week eurepo rate, the 12 month, 9 month, and overnight euro area – US interest rate differential. When only C appears in (2), OLS is inconsistent in all 31 cases; when news (i.e., Z) only appears in the regressionm the null of consistency of OLS estimates is rejected in 19 of 31 cases considered.

currency, though the coefficient is relatively small.Three other results are noteworthy. First, as theory would predict a rise in euro area interest rates or in the euro area – US interest differential leads to an appreciation of the euro in all cases displayed in the Table, save one (the one day euro area – US interest rate differential). In two instances, namely when MP is proxied by the change in the EONIA and the one day euro area – US interest rate differential, the estimated coefficients essentially offsets the impact arising out of ECB commentary dealing with the exchange rate. At longer maturities, such as one year, the impact of interest rate changes on the exchange rate dwarfs those from ECB statements by a wide margin. It is also worth noting that a rise in the implied volatility of foreign exchange options, an indication that markets are bearish about the euro, is indeed seen as leading to a depreciation of the currency.

Second, US interest rate developments also impact separately on the rate of change in the euro/USD exchange rate. The estimated coefficients can only be understood as an indication that contemporaneous increases in some US rates, in particular Libor rates set in London, lead to an expectation of higher euro area rates and hence to a current appreciation of the euro. This interpretation is also consistent with the notion that interest rates and exchange rates are indeed jointly determined.

Third, in half the cases shown, estimates of foreign exchange reserves published by Reuters are significant with the negative sign implying that positive foreign exchange reserve growth portends an appreciation in the euro, presumably because accumulating reserves can then serve as a means to raise the value of the euro currency.

Turning to the EGARCH(1,1) estimates, once again some interesting results emerge. In over half the cases shown, particularly ones that focus on the outlook for the euro, ECB statements lead to a diminution of exchange rate volatility. This suggests that such statements can be construed as being informative in the sense that these reduce the risks surrounding exchange rate developments. An increase in the frequency of news count dealing with exchange rate and interest rate developments is also seen as reducing exchange rate volatility and the same result holds for positive growth in foreign exchange reserves. In both cases, however, the coefficients are much smaller than those capturing the impact of ECB commentary and interest rates on exchange rate volatility. Finally, it is interesting to observe that statements from the FOMC, constructed in the same manner as

the ones used to construct the proxies for ECB communications activities, have almost no separate impact on the euro/USD exchange rate.

Next, we turn to the results of the implementation of the Rigobon-Sack (2004) procedure. Four separate definitions of "policy" (P) and "non-policy" days (NP) are considered. They are: days when the ECB's Governing Council meets, the day before these same meetings,[32] days when the ECB President delivers a speech about developments and prospects concerning the euro exchange rate, and days when the FOMC meets to set the target for the fed funds rate. Table 3 shows estimates of α and θ from equation (2) while Table 4 provides selected estimates of the same coefficients when $h_t^{\Delta e}$ from equation (3) replaces Δe in equation (2).

Table 3 presents coefficient estimates for all versions of equation (2) estimated according to the Rigobon-Sack (2004) approach. Estimates of α and θ are statistically significant in most cases when P is defined as the day before the Governing Council meets. There is no statistically reaction when P consists of days when the ECB sets its policy rates or when the FOMC meets in Washington. Only a handful of coefficients are statistically significant when P includes days when the ECB President delivered speeches that deal with the outlook for the euro area. The six cases highlighted in bold characters are the ones where an earlier Hausman test rejected the consistency of OLS estimates suggestive of the endogeneity of MP and Δe.

If we focus on days when P is defined as the day before Governing Council meetings then we conclude that ECB statements lead to a depreciation of the exchange rates. Turning to the impact of MP on Δe we typically find that tighter policies lead, as would be expected, to an appreciation of the euro. The column labelled p_H gives the p-value for the Hausman test of the null that the heteroskedastic and event study estimators are equal.[33] In the vast majority of cases the null cannot be rejected. However, the three rejections of the null occur when MP is measured by a euro area – US interest rate differential. Finally, Table 4 shows, for a few selected cases, estimates of α' and θ' when h_t^{MP} and $h_t^{\Delta e}$ are used. Results for the remaining cases are broadly similar and are,

[32] This mainly, though not always, coincides with the release of the Reuters poll of interest rate expectations.

[33] P-values are given for one case only as they are broadly similar for the other definitions of P and NP considered.

consequently not shown to conserve space. The estimated coefficients suggest that ECB communications raise exchange rate volatility, as do rising interest rates but that the impact of interest rates on exchange rate volatility is relatively larger than the impact of ECB outlook statements.

Conclusions

This paper has presented estimates of the impact of interest rates and ECB communication policies on the euro/USD exchange rate. We introduce a new indicator of ECB communications policies that focuses on what the ECB says about the future economic outlook for the euro area along five different economic dimensions. Both time series and event study approaches are employed, as well as the heteroskedasticity estimator proposed by Rigobon and Sack (2004). Three broad conclusions emerge. First, the impact of ECB communications policies is more apparent in the time series framework than in the heteroskedasticity estimator approach. Indeed, whereas the ECB statements about the economic outlook are found to reduce volatility in an EGARCH(1,1) model the opposite was found when the Rigobon-Sack estimator is used. Second, previous studies that conclude that news effects are significant at the daily frequency may have reached such a conclusion because the measurement of news was too highly aggregated. When news effects are disaggregated they are often found to be individually statistically significant. Third, the endogeneity of the exchange rate – interest rate relationship is more apparent when the proxy for monetary policy is the euro area – US differential than when any other proxy for monetary policy is employed. Finally, interest rate changes generally have a much larger impact on exchange rate movements, and their volatility, than do ECB verbal pronouncements. As a result, policy deeds can be interpreted as having a bigger impact on the euro than policy words.

Table 1 Summary of Principal Components Analysis

	Size of Standardized Announcement				
Country/Region	[-40,30)	[-20,-10]	[-10,0)	[0,10)	[10,20)
	% of total sample				
US 1	0.06	0.26	6.83	92.72	0.13
US 2		0.26	8.88	90.61	0.26
US 3		0.13	7.73	92.08	0.06
Announcements with largest weights	US 1: industrial production, capacity utilization, producer price index, current account balance, business inventories; US 2: average weekly hours, change in manufacturing payrolls, change in non-farm payrolls, wholesale inventories; US 3: new home sales, GDP deflator, GDP, unemployment rate				
GER 1		0.32	2.94	96.62	0.13
GER 2		0.06	6.13	93.74	0.06
Announcements with largest weights	GER 1: unemployment change, unemployment rate; GER 2: construction orders, IFO business climate index, import price index, harmonized CPI				
UK 1	0.06	0.26	6.83	92.72	0.13
UK 2		0.26	8.88	90.61	0.26
UK 3		0.13	7.73	92.08	0.06
Announcements with largest weights	UK 1: industrial production, manufacturing prodiction; UK 2: RPI index, RPI ex mortgage payments				
EA 1		0.13	3.96	95.85	0.06
EA 2		0.06	5.36	94.51	0.06
Announcements with largest weights	EA 1: consumer confidence, retail trade (EU 15), eurozone retail trade, unemployment rate; EA 2: business climate indicator, unemployment rate, eurozone retail trade, retail trade (EU 15), consumer confidence				
JA 1		0.13	91.19	8.25	0.45
JA 2		0.13	90.29	9.45	0.13
Announcements with largest weights	JA 1: unemployment rate, CPI; JA 2: construction orders, housing starts, job to applicant ratio, vehicle sales, workers' household spending				

Notes: US is United States, GER is Germany, UK is the United Kingdom, EA is the eurozone or European Union, JA is Japan. The numbers in column 1 refer to the principal component. Appendix 2 provides the complete list of announcements.

Table 2 Coefficient Estimates: Mean and Variance Equations

(A) Mean Equations

Variable	Coefficient	Standard Error	t-stat	p-value	News: Principal Components	
EONIA	***-0.36607***	0.146336	-2.50158	**0.0125**	DE_2	US_2
FEDFUNDS	-0.03357	0.1209	-0.27765	0.7813		US_3
ECB_ALL	0.038079	0.029804	1.277669	0.2016		
FOMC_ALL	-0.01186	0.04058	-0.29223	0.7702		
ECB_NEWSCOUNT	***-0.0011***	0.000625	-1.758	**0.0789**		
ECB_RESERVES	***-0.01165***	0.005697	-2.04525	**0.041**		
Memo						
ECB_ER	***0.31369***	0.14103	2.224279	**0.0263**		
EUREPO 12 MONTHS	***-4.38851***	1.105577	-3.9695	**0.0001**	US_4	
US LIBOR 12 MONTHS	***-4.45359***	0.816687	-5.45324	**0**		
ECB_ALL	-0.02274	0.041558	-0.54714	0.5845		
FOMC_ALL	0.053831	0.093894	0.573319	0.5666		
ECB_NEWSCOUNT	0.000456	0.000983	0.463768	0.643		
ECB_RESERVES	0.003551	0.010463	0.339369	0.7344		
Memo						
ECB_A	***-0.39813***	0.139032	-2.86361	**0.0043**		
ECB_ER	***0.258793***	0.122291	2.116209	**0.0347**		
EURO–US INT DIFF O/N	***-0.36607***	0.146336	-2.50158	**0.0125**	DE_2	US_2
FEDFUNDS	***-0.39964***	0.19044	-2.0985	**0.036**		US_3
ECB_ALL	0.038079	0.029804	1.277669	0.2016		
FOMC_ALL	-0.01186	0.04058	-0.29223	0.7702		
ECB_NEWSCOUNT	***-0.0011***	0.000625	-1.758	**0.0789**		
ECB_RESERVES	***-0.01165***	0.005697	-2.04525	**0.041**		
Memo						
ECB_REL_ER	0.31369	0.14103	2.224279	**0.0263**		
EURO-US INT DIFF 12 MONTHS	***-1.9828***	0.581861	-3.40768	**0.0007**	DE_2	
US LIBOR 12 MONTHS	-5.29736	0.509777	-10.3915	**0**		
ECB_ALL	0.030188	0.028637	1.054168	0.292		
FOMC_ALL	-0.0336	0.042299	-0.79439	0.4271		
ECB_NEWSCOUNT	***-0.00105***	0.000604	-1.731	**0.0837**		
ECB_RESERVES	***-0.01099***	0.005499	-1.99779	**0.0459**		
Memo						
ECB_A	***-0.26156***	0.161003	-1.62454	**0.1045**		
ECB_ER	***0.268749***	0.131294	2.046917	**0.0408**		

EURO-US INT DIFF 1 DAY	-0.19917	0.254131	-0.78372	0.4335	US_3	
FEDFUNDS	0.147545	0.438141	0.336752	0.7364	US_4	
ECB_ALL	-0.03234	0.039997	-0.80853	0.4191		
FOMC_ALL	0.100259	0.131894	0.760146	0.4474		
ECB_NEWSCOUNT	0.000329	0.000966	0.340956	0.7332		
ECB_RESERVES	-4.04E-05	0.011963	-0.00338	0.9973		
IMPLIED VOL 12 MONTHS	***0.524849***	0.176675	2.970708	**0.003**	DE_2	
US LIBOR 12 MONTHS	***-4.42823***	0.475773	-9.30743	**0**		
ECB_ALL	0.030369	0.027821	1.091567	0.2752		
FOMC_ALL	-0.03384	0.038326	-0.88297	0.3774		
ECB_NEWSCOUNT	***-0.00093***	0.000556	-1.67048	**0.095**		
ECB_RESERVES	-0.00881	0.005839	-1.50862	0.1316		
Memo						
ECB_ER	***0.288497***	0.131572	2.192683	**0.0285**		

(B) Conditional Variance Equation

Asymmetry term	0.003924	0.013629	0.287949	0.7734	EA_1	US_1
EONIA	-0.0042	0.213158	-0.0197	0.9843	EA_2	US_2
FEDFUNDS	***0.689671***	0.237875	2.899297	**0.0037**	JA_1	
ECB_ER	***-0.20201***	0.106218	-1.90183	**0.0572**	JA_2	
FOMC_ALL	-0.06934	0.04291	-1.61587	0.1061		
ECB_NEWSCOUNT	***-0.00046***	0.000268	-1.73039	**0.0836**		
ECB_RESERVES	***-0.00671***	0.001977	-3.39454	**0.0007**		
Asymmetry term	-0.06503	0.114939	-0.56577	0.5716	UK_1	
EUREPO 12 MONTHS	***-0.33853***	0.165756	-2.04235	**0.0411**	UK_2	
US LIBOR 12 MONTHS	-2.76214	1.875171	-1.47301	0.1407		
ECB_A	-0.93499	0.856264	-1.09194	0.2749		
ECB_ER	-1.47951	0.995178	-1.48668	0.1371		
FOMC_ALL	-0.0358	0.504261	-0.07099	0.9434		
ECB_NEWSCOUNT	-0.00159	0.003842	-0.41482	0.6783		
ECB_RESERVES	-0.0199	0.06275	-0.31709	0.7512		
Asymmetry term	0.003969	0.013641	0.290922	0.7711	EA_1	US_1
EURO-US INT DIFF O/N	-0.00146	0.213171	-0.00687	0.9945	EA_2	US_2
FEDFUNDS	***0.691305***	0.297747	2.321785	**0.0202**	JA_1	
ECB_ALL	***-0.20258***	0.106169	-1.90812	**0.0564**	JA_2	
FOMC_ALL	***-0.06976***	0.042942	-1.62438	**0.1043**		
ECB_NEWSCOUNT	***-0.00046***	0.000268	-1.73036	**0.0836**		
ECB_RESERVES	***-0.0067***	0.00197	-3.40193	**0.0007**		

Asymmetry term	0.057575	0.035555	1.619319	0.1054	JA_2	US_4
EURO-US INT DIFF 12 MONTHS	***-0.83773***	0.055364	-15.1314	**0**	UK_1	
US LIBOR 12 MONTHS	1.420835	0.918589	1.546758	0.1219	US_2	
ECB_REL_A	-0.20645	0.264741	-0.77983	0.4355		
ECB_REL_ER	***-0.76783***	0.452219	-1.69792	**0.0895**		
FOMC_REL_ALL	-0.07856	0.103989	-0.75545	0.45		
ECB_NEWSCOUNT	-0.00091	0.001684	-0.53975	0.5894		
ECB_RESERVES_D	-0.03606	0.025674	-1.40447	0.1602		
Asymmetry term	***-0.15358***	0.049959	-3.07418	**0.0021**	UK_3	
EURO-US INT DIFF 1 DAY	-0.32647	0.556572	-0.58656	0.5575	US_3	
FEDFUNDS	-0.39513	0.993773	-0.39761	0.6909		
ECB_ALL	-0.77156	0.712791	-1.08245	0.2791		
FOMC_ALL	-0.17401	0.333381	-0.52197	0.6017		
ECB_NEWSCOUNT	-0.0051	0.0032	-1.59362	0.111		
ECB_RESERVES	-0.09718	0.072901	-1.33306	0.1825		
Asymmetry term	-0.02974	0.037009	-0.80364	0.4216		
IMPLIED VOLATILITIES 12 MONTHS	**1.702054**	0.213681	7.965415	**0**		
US LIBOR 12 MONTHS	0.240815	0.781535	0.308131	0.758		
ECB_ER	-0.58433	0.562364	-1.03906	0.2988		
FOMC_ALL	-0.11628	0.228477	-0.50895	0.6108		
ECB_NEWSCOUNT	-0.00306	0.002653	-1.15252	0.2491		
ECB_RESERVES	-0.03275	0.030591	-1.0705	0.2844		

Notes: See Table 1 for principal components analysis. Time series estimates of equations (2) and (2A). Not all coefficients estimated are shown to conserve space. Only coefficients on MP, and C, and a list of the news variables (principal components) that were statistically significant at least at the 10% level. Statistically significant coefficients are in bold characters. Under *Memo*, only the coefficients on C where alternative definitions of C that were found to be significant are shown. ECB_ALL and FOMC_ALL are dummy variables that capture the aggregated outlook for five economic aggregates. The text provides definitions. The same applies to ECB_ER (exchange rate), ECB_A (asset orices). ECB_NEWSCOUNT is a count variable for news items as described in the text while ECB_RESERVES are the Reuters estimates of ECB foreign exchange reserves, available on a weekly basis.

Table 3 Estimates of Reaction of MP_t to Δe_t and C_t

Monetary Policy Variable	*P=ECB GC meeting days*			*P=Day before RCB GC meeting*		*P=Speeches on the euro*		*P=FOMC Meeting days*		
MP proxy	α	θ	p_H	α	θ	α	θ	α	θ	p_H
EONIA	-.42(.75)	.05(.15)	.15	-.62(.75)	**.30(.15)**	.32(.37)	-4.57(4.58)	-.14(1.99)	.18(.47)	.92
Euribor 12 months	1.98(6.63)	.07(.13)	.99	-5.32(3.89)	**.34(.15)**	**-10.55(2.67)**	-4.19(4.13)	7.47(3.52)	.19(.92)	.00
Euribor 3 months	-11.4(19)	.07(.16)	.44	-.73(1.63)	**.32(.15)**	2.26(2.40)	-4.58(4.58)	-1.63(16.20)	-.45(1.50)	.90
Euribor 6 months	1.17(2.16)	.08(.13)	.45	2.86(1.73)	**.35(.16)**	**6.97(3.03)**	-4.23(4.18)	-18.44(46.65)	1.67(4.22)	.63
Euribor 9 months	-2.54(2.51)	.03(.14)	.80	1.75(1.35)	**.37(.17)**	1.82(1.86)	-4.62(4.63)	-11.46(19.76)	-.98(1.61)	.53
Euribor 1 month	-2.18(7.53)	.08(.21)	.48	-1.18(6.31)	-.30(.30)	5.90(5.36)	-1.33(1.28)	-188.1(197.2)	-.06(.67)	.32
Euribor 1 week	-5.75(7.65)	-.01(.16)	.21	-1.80(1.18)	**.32(.15)**	.96(1.64)	-4.66(4.68)	.18(4.28)	.33(.86)	.76
Eurepo 1 month	-51.31(48.79)	-.24(.59)	.45	**-19.84(10.23)**	.02(.15)	-8.48(5.66)	-1.28(1.25)	-22.90(48.07)	2.76(3.42)	.66
Eurepo 1 week	-10.71(10.54)	.05(.19)	.86	-2.83(2.87)	-.15((.22	-11.31(5.00)	-1.29(1.24)	.85(32.46)	.66(.53)	.93
Eurepo 2 weeks	-38.95(30.58)	-.15(.28)	.61	-6.55(6.57)	)-.08(.19)	-.88(9.39)	-1.38(1.36)	17.75(41.49)	1.28(1.96)	.69
Eurepo 3 months	-14.71(13.49)	.06(.12)	.91	-13.18(10.08)	.03(.13)	-7.14(5.26)	-1.29(1.24)	-20.85(23.89)	2.24(2.58)	.68
Eurepo 12 months	87.37(277.8)	.04(.96)	.90	-10.52(7.10)	.09)(-.20)	-11.64(4.11)	-1.15(1.03)	-3.51(7.75)	2.47(2.49)	.53
Euro Area – US Int. rate Diff. O/N	1.38(1.11)	.17(.18)	**.01**	.29(.41)	**.36(.16)**	.16(.38)	-4.65(4.67)	-.29(1.93)	.64(1.77)	.86
Euro Area – US Int. rate Diff. 12 months	-7.74(9.37)	.12(.17)	**.09**	-3.54(2.51)	**.37(.17)**	.01(2.56)	-4.63(4.65)	.24(3.11)	.14(.73)	.74
Euro Area – US Int. rate Diff. 1 day	-14.61(29.09)	-.35(.81)	.77	-3.30(2.69)	-.11(.18)	-1.90(7.37)	-1.37(1.33)	-2.56(2.35)	1.86(2.23)	.65
Euro Area – US Int. rate Diff. 3 months	-1.75(1.05)	.06(.13)	.34	**-2.21(.91)**	.33(.15)	-1.93(6.12)	-4.67(4.68)	-1.70(5.52)	.24(.77)	.57
Euro Area – US Int. rate Diff. 9 months	-3.96(5.34)	.08(.14)	**.02**	**-4.44(2.37)**	**.37(.16)**	1.62(2.36)	-4.64(4.65)	-.76(3.38)	.23(.75)	.57
Euro Area – US Int. rate Diff. O/N[1]	.94(1.08)	.05(.54)	.12	-.20(.53)	-.17(.52)	-27(.41)	-2.09(2.04)	1.64(3.02)	-.28(.55)	.64
Implied Volatilities 12 months	.95(1.94)	.04(.16)	.66	.42(.48)	**.33(.15)**	-1.07(.84)	-4.38(4.36)	.81(1.14)	.38(.86)	.60
Implied Volatilities 1 month	.75(.77)	.18(.20)	.12	.32(.33)	**.41(.18)**	-.60(.37)	-3.97(3.86)	-.20(.75)	.32(.86)	.44
Implied Volatilities 1 week	.51(.46)	-.11(.29)	.39	.12(.10)	**.31(.13)**	-.21(.18)	-4.48(4.44)	.04(.35)	.36(.88)	.61
Implied Volatilities 3 months	.99(1.52)	.002(.21)	.89	.22(.27)	**.32(.15)**	.41(.39)	-4.40(4.38)	-.52(.96)	.25(.87)	.22
Implied Volatilities 6 months	4.38(10.43)	-.11(.54)	.96	.28(.42)	**.32(.15)**	**-2.05(1.05)**	-4.78(4.69)	.20(.81)	.34(.84)	.23
Implied Volatilities 9 months	-.99(3.25)	.14(.27)	.94	.07(.63)	.24(.13)	-.96(.81)	-4.33(4.31)	.07(.90)	.34(.86)	.29
Fed funds rate	-.49(.42)	.09(.14)	.41	-.56(.42)	.36(.16)	.26(.70)	-4.59(4.60)	-.36(.54)	.001(.51)	.91
Fed funds Options	-1.18(1.23)	.05(.12)	**.10**	**-2.73(1.43)**	**.30(.13)**	-1.29(3.55)	-4.64(4.65)	-.65(5.20)	-.06(1.00)	.95
US Libor 3 months	1.30(1.31)	.08(.13)	1.00	.67(1.16)	**.34(.16)**	1.47(5.84)	-4.49(4.49)	-8.61(14.19)	-.35(.63)	.94
US Libor 1 month	.93(1.14)	.08(.13)	1.00	.74(1.02)	**.33(.16)**	.03(.31)	-4.66(4.68)	4.67(48.03)	-.23(.44)	.80
US Libor 6 months	.48(4.91)	.07(.14)	.45	-.66(2.03)	**.32(.15)**	.85(3.35)	-4.56(4.57)	-.81(11.46)	.18(.79)	.60
US Libor 12 months	.26(5.81)	.07(.15)	.41	-.74(1.77)	**.31(.15)**	.29(2.48)	-4.62(4.64)	-1.53(8.80)	1.08(1.20)	.58
US Libor O/N	-.29(.56)	-.03(.50)	.71	-.58(.60)	-.44(.75)	.63(.11)	-2.01(1.96)	-.65(4.20)	.02(1.55)	.95

Note: Estimates in bold are statistically significant at least at the 10% level significance level. p_H is the p-value for the Hausman test whether the estimates using the heteroskedasticity estimator is significantly differ from the event study estimator. P represents polcy days; the remaining days in the sample are the non-policy days (NP). ECB GC refers to the ECB's Governing Council.

Table 4 Estimates of Reaction of $h_t^{\Delta e}$ to Δe_t and C_t

Monetary Policy Variable	α'	θ'	p_H
MP	*P=ECB GC meeting days*		
EONIA	**1.41e-006(2.75e-009)**	**.51(.14)**	**.00**
Euro Area – US Int. Rate Diff. O/N	**2.92(1.26)**	**.39(.12)**	**.05**
Euro Area – US Int. Rate Diff. 1 day	**4.91(1.50)**	**.03(.02)**	.60
Implied Volatilities 12 months	**3.12(2.02)**	**.06(.02)**	.69

Note: See Table 3 for definitions.

Figure 1A The euro/USD Exchange Rate since 1999

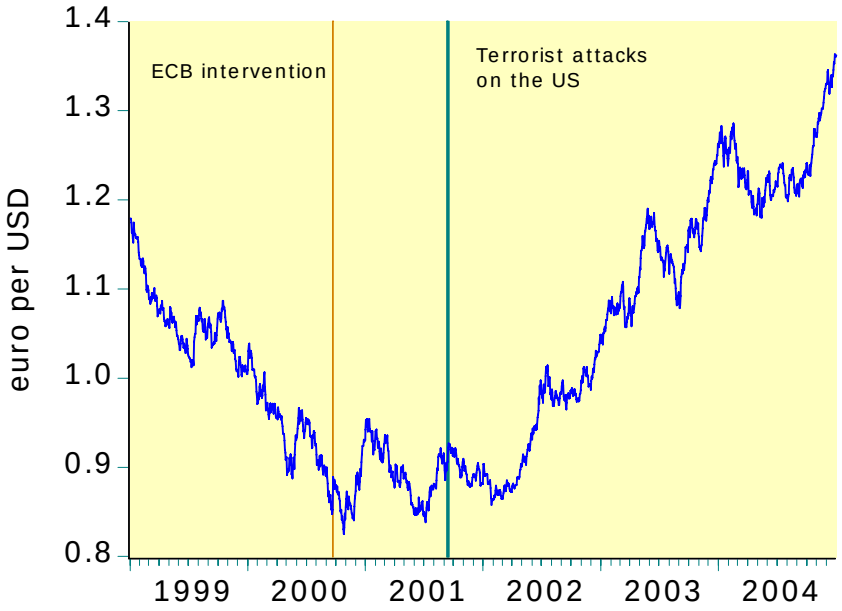
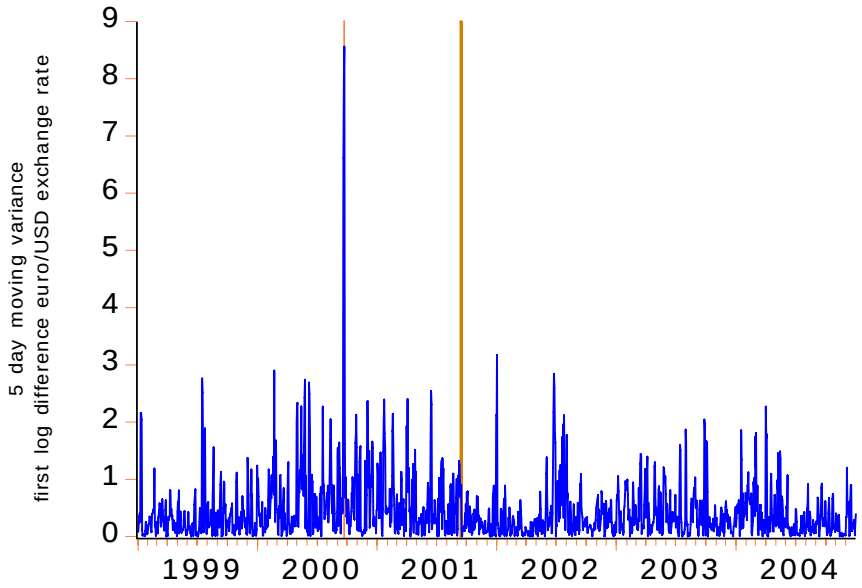
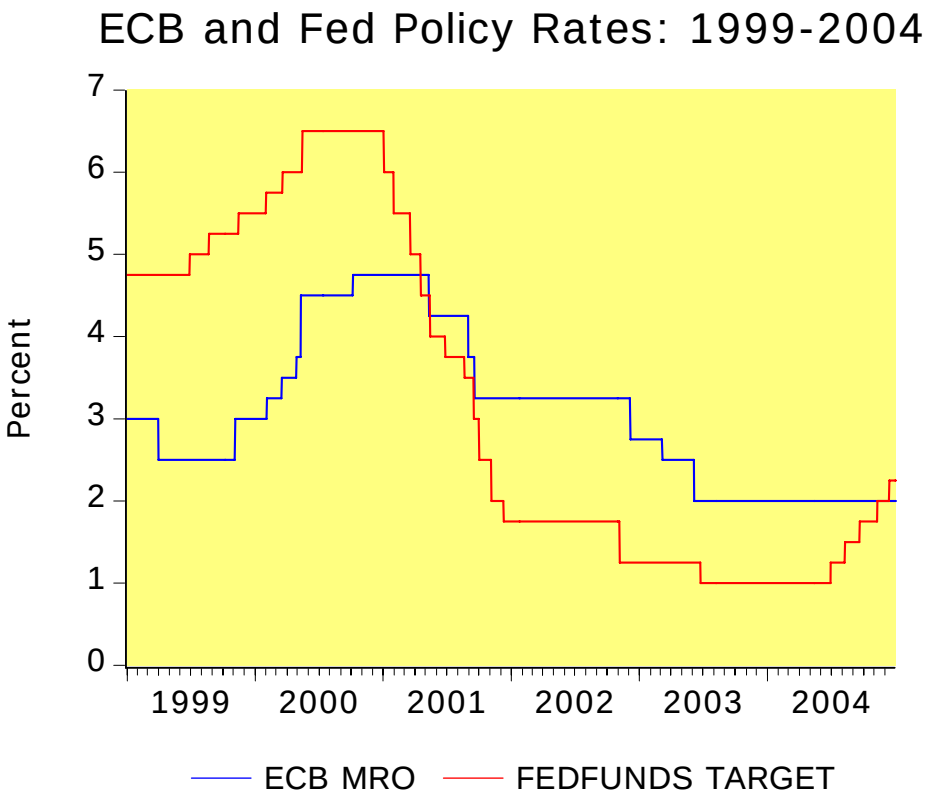


Figure 1B euro/USD Exchange Rate Volatility since 1999



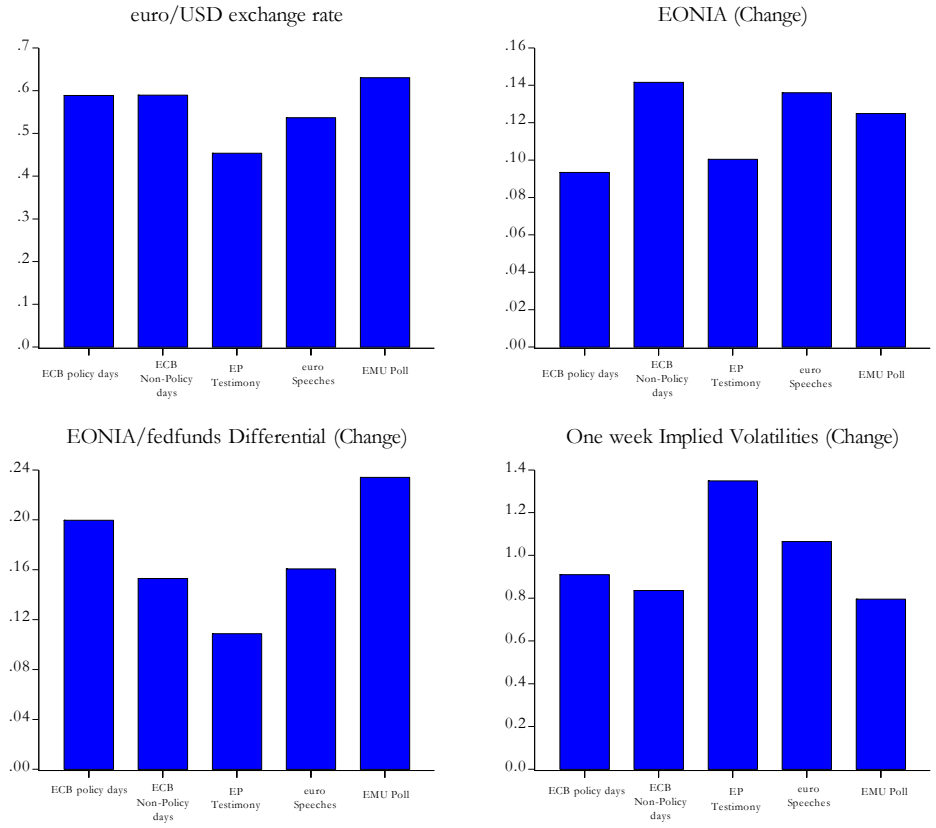
Note: euro reference rate per USD, from the ECB. Volatility is evaluated as a 5 day moving variance of the rate of change (first log difference) in the euro/USD exchange rate as defined in Figure 1A. The first vertical bar marks ECB forex intervention in September 2000; the second represents the September 2001 terrorist attacks on the US.

Figure 2 Key Interest Rates in the Eurozone and US

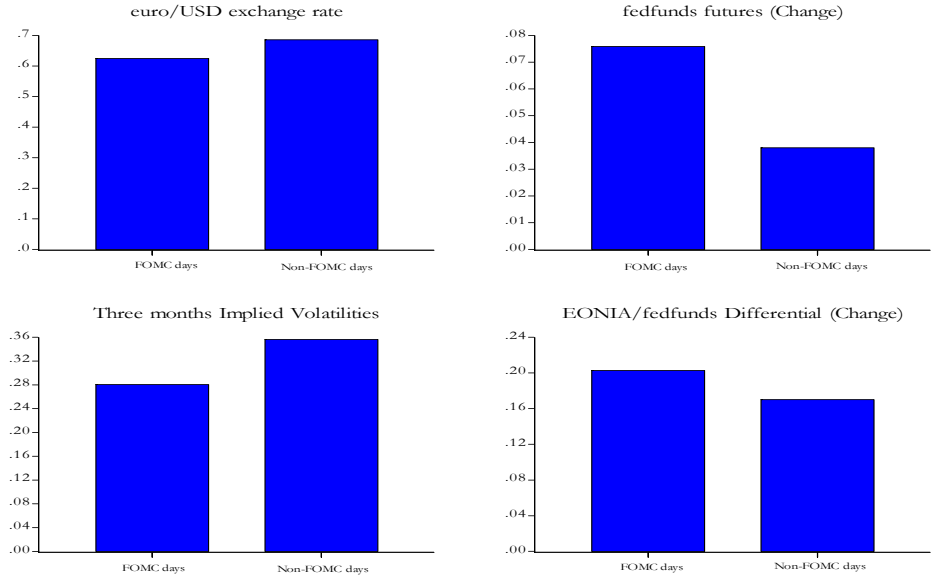


Source: See text. ECB MRO is the ECB's Main Financing Operations rate, FEDFUNDS TARGET is the US Federal Reserve's target for the fed funds rate.

Figure 3 Stylized Facts: Volatility on Event and Non-Event Days
(A) euro area events

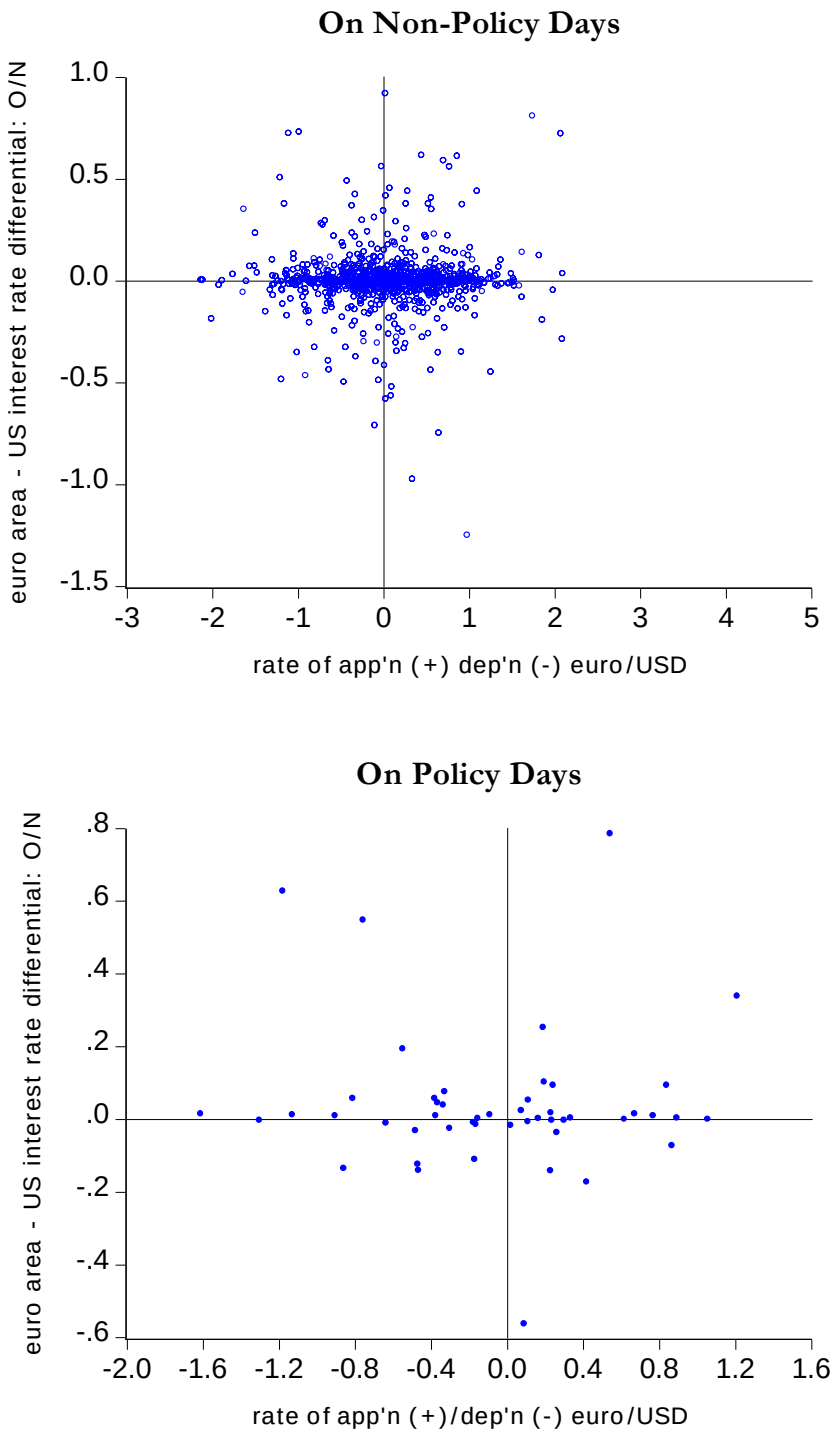


(B) US events



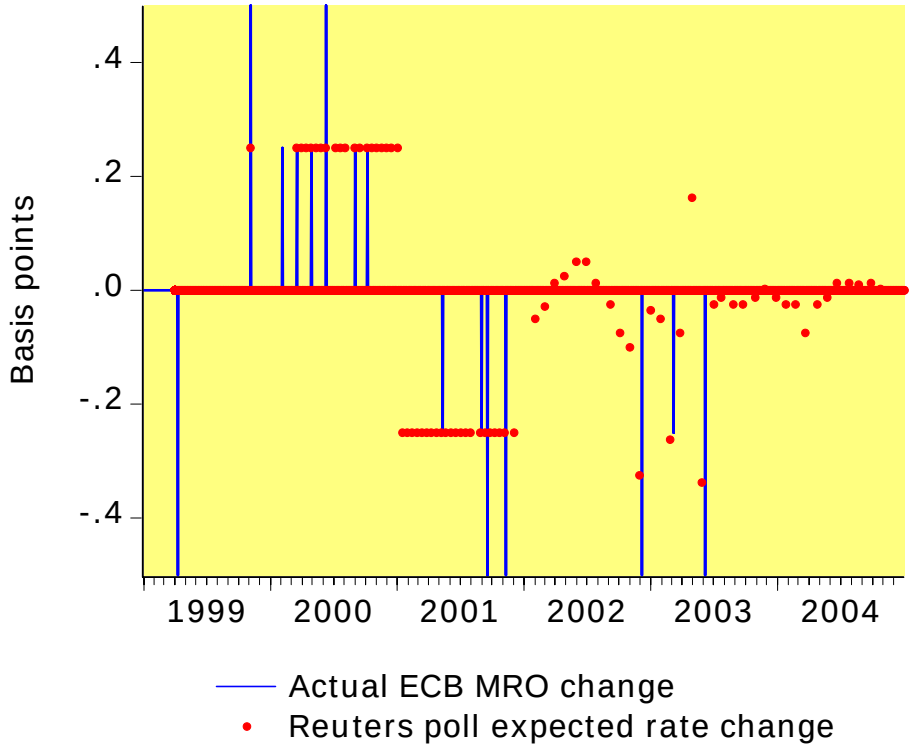
Note: The vertical axes are the variances of the relevant series over the event days listed under each bar**.** Details about the dating of events and sources are in the text or in the appendix.

Figure 4 Stylized Facts: Volatility on Policy and Non-Policy Days



Note: O/N is the overnight rate. Data definitions and sources are in the text as well as in an appendix.

Figure 5 The Reuters Poll of ECB Policy Rate Forecasts Against Actual Policy Rate Changes



Note: See Figure 1. Reuters poll expected rate is $.25f^{25} + .50f^{50} - .25f^{-25} - .50f^{-50} + .00f^{0}$, where f^{i} is the fraction of poll respondents who expect an i% change in the ECB's key policy rate, and i=.25,.50,-.25,.-.50,.00. Prior to 2002, data for f^{i} were not published, only aggregate sentiment concerning the direction and size of the expected change in the ECB's key policy rate.

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