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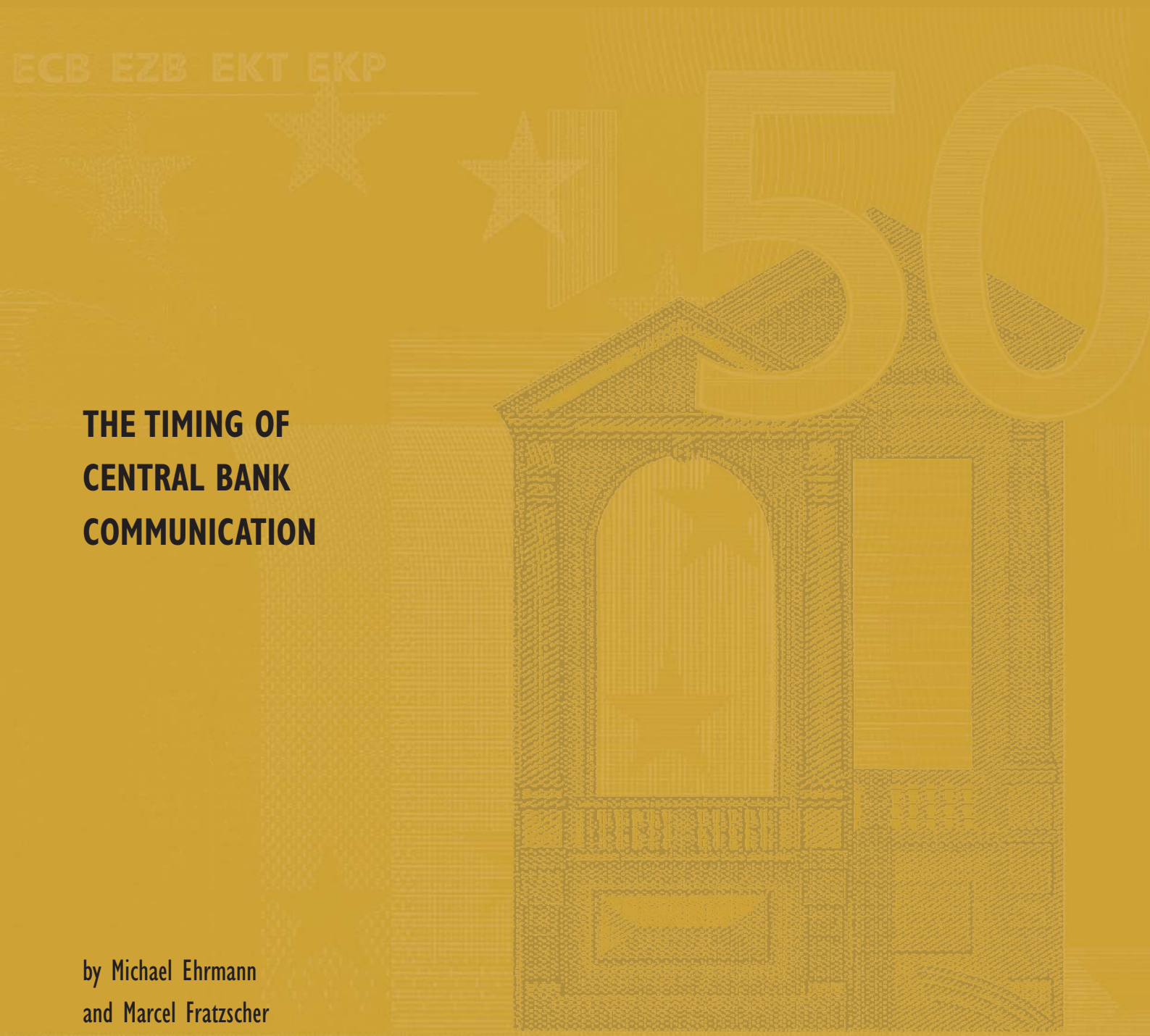

THE TIMING OF CENTRAL BANK COMMUNICATION

by Michael Ehrmann
and Marcel Fratzscher

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In 2005 all ECB publications will feature a motif taken from the €50 banknote.

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CONTENTS

Abstract

This paper explores whether there are systematic patterns as to when members of the decision-making committees of the Federal Reserve, the Bank of England and the European Central Bank communicate with the public, and under what circumstances such communication has the ability to move financial markets. The findings suggest that communication is generally seen as a tool to prepare markets for upcoming decisions, as it becomes more intense before committee meetings, and particularly so prior to interest rate changes. At the same time, markets react more strongly to communication prior to policy changes. Other instances where communication becomes more intense, or where financial markets become more responsive are also identified; even though these are more specific to the individual central banks, they are consistent with differences in the central banks' monetary policy strategies and communication policies.

JEL classification: E43, E52, E58, G12
Keywords: communication; central bank; monetary policy; timing.

Non-technical summary

Central banks frequently communicate with the public, as communication plays a central role for monetary policy making. Central banks have direct control only over a single interest rate, usually the overnight rate, while they need to influence asset prices and interest rates at all maturities in order to achieve their aims. Effective communication as much as credible policy actions are of fundamental importance for achieving these objectives. Furthermore, in particular for an independent central bank like the ECB, communication is an essential ingredient to making the central bank accountable.

This paper analyses the timing of central bank communication from two perspectives. First, it searches for systematic patterns in timing, in the sense that we look for occasions when the intensity of communication increases. We suggest several scenarios where such an increased intensity could be useful for a central bank, and explore whether communication does indeed intensify. Second, the paper tests whether central bank communication exerts differential effects on financial markets, depending on its timing or the circumstances. Again, various cases are suggested and tested. By combining these two approaches, it is possible to check whether they are interrelated; this would be the case, for example, if market reactions are stronger in times of more intense communication.

The paper analyses three of the world's major central banks: the Federal Reserve, the Bank of England and the European Central Bank (ECB). It finds that communication intensifies in various circumstances. This is most notably the case prior to interest rate changes, although we find more generally a higher frequency of communication in preparation of committee meetings, regardless of the upcoming decision. Beyond this, communication becomes more frequent also in other circumstances, although these differ across the three central banks. The detection of differences in the intensity of communication suggests that its timing is chosen endogenously.

As to the second approach, the paper finds evidence for time-varying market responsiveness. For example, asset returns respond significantly stronger to Federal Reserve and ECB communication prior to interest rate changes. Combining the increased frequency of communication and the stronger market responsiveness suggests that communication is a particularly important policy tool in such circumstances. Other differences exist; although they are more specific to individual central banks, they are consistent with differences in monetary policy strategies and communication policies.

1. Introduction

Along with, and partially due to the recent trend towards central bank independence around the globe, central banks have become remarkably more transparent in the last decades. One trigger for increased transparency has likely been the requirement for greater accountability of independent central banks (Issing, 1999). At the same time, however, it has been increasingly understood that transparency can enhance the effectiveness of policy (Blinder 1998, Woodford 2003). Accordingly, central banks put a much larger weight on their communication with the public nowadays than they used to some years ago.

This paper adds to a young, but rapidly growing literature on central bank communication by focusing on the *timing* of such communication. The paper does so from two perspectives. First, it asks the question whether the timing of communication of central banks shows some systematic patterns, in the sense that we look for occasions when the intensity of communication increases. We suggest several scenarios where such an increased intensity could be useful for a central bank, and explore whether communication does indeed intensify. Second, the paper addresses the issue whether central bank communication exerts differential effects on financial markets, depending on its timing or the circumstances. Again, various cases are suggested and tested. By combining these two approaches, it is possible to check whether they are interrelated; this would be the case, for example, if market reactions are stronger in times of more intense communication.

The paper analyses three of the world's major central banks: the Federal Reserve, the Bank of England and the European Central Bank (ECB). Based on *quantitative* measures of communication, it identifies circumstances in which communication intensifies. This is most notably the case prior to interest rate changes, although we find more generally a higher frequency of communication in preparation of committee meetings, regardless of the upcoming decision. Beyond this, communication becomes more frequent also in other circumstances, although these differ across the three central banks. The detection of differences in the intensity of communication suggests that its timing is chosen endogenously. Based on *qualitative* measures of communication, the paper finds substantial evidence about time-varying market responsiveness. For example, asset returns respond significantly stronger to Federal Reserve and ECB communication prior to interest rate changes. Combining the increased frequency of communication and the stronger market responsiveness suggests that communication is a particularly important policy tool in such circumstances. Other differences exist; although they are more specific to individual central banks, they are consistent with differences in monetary policy strategies and communication policies.

The paper starts by reviewing the literature on central bank communication in section 2. Section 3 then discusses our data source. This is followed by the empirical analysis as to the timing of communication and its ability to move financial markets in section 4. Section 5 concludes.

2. Literature on central bank communication and decision-making

Monetary policy has a relatively direct leverage over very short-term (i.e., overnight) interest rates. To steer the behaviour of economic agents, however, it is necessary to affect longer-term interest rates, where the central bank influence is much more indirect. Blinder (1998) and Bernanke (2004) emphasise the importance for communication as a means for central banks to influence these asset prices, provided that the central bank has acquired a credible reputation. In that respect, communication is an important tool for the effectiveness of monetary policy implementation (Buiter 1999, Eijffinger and Hoeberichts 2004, Issing 2005). It is important that communication manages to influence the expectations of economic agents, such that the desired reaction of longer-term interest rates is achieved.

In principle, communication can in parts even substitute policy action. Demiralp and Jorda (2004) provide evidence that by announcing changes in the intended federal funds rate since 1994, it was possible for the Federal Reserve to move the federal funds rate with a smaller volume of open-market operations, which indicates clearly that increased transparency and more communication can indeed be beneficial for the efficiency of policy implementation. Moving one step further, there might even be an effect on financial markets if the central bank communicates its views about the intended level of asset prices and signals its intention to make the necessary adjustments in policy rates if asset prices deviate from this target, a policy that has frequently been labelled "open-mouth operations" (Guthrie and Wright 2000, Thornton 2004).

Although there is a general consensus that communication is a powerful and efficiency-enhancing tool for monetary policy, several authors have argued that there might at the same time be a trade-off in that more communication need not always be optimal. King (2000) argues that a central bank should be highly transparent about its monetary policy reaction function and its target. Beyond that, however, a central bank should refrain from "creating" news – instead, news should entirely arise from information about the development of the economy. The central bank is also facing a trade-off when giving more information induces not more but less clarity and common understanding among market participants, as there are limits to how much information can be digested effectively (Kahnemann 2003, Winkler 2000). The trade-off might become even more pronounced if the central bank communicates about issues on which it receives noisy signals itself, such as the evolution of the economy (as opposed to, e.g., its intentions regarding upcoming interest rate decisions). Amato, Morris and Shin (2002) argue that such communication can co-ordinate the actions of financial market participants away from fundamentals, in the sense that they attach too much weight to the central bank's views, not taking into account that they reflect a noisy signal. On the other hand, Svensson (2005) suggests that such an outcome is rather unlikely under plausible ranges for the model's parameter values. In sum, however, it is clear that transparency is not an end in itself but merely a means to help the authority achieve its mandate (Issing 1999, Mishkin 2004).

The empirical literature on central bank communication is still in its infancy, but has been growing rapidly recently. There is a general consensus that communication is a powerful tool to move financial markets. Guthrie and Wright (2000) find this for the Reserve Bank of New Zealand, Kohn and Sack (2004) for the Federal Reserve, and Reeves and Sawicki (2005) for the Bank of England. Ehrmann and Fratzscher (2005b) compare the effect of communication by committee members for the Federal Reserve, the Bank of England and the ECB. They find that the effectiveness depends not only on the design of the communication strategy, but also on the nature of the decision-making process in the committee. The paper shows that the Federal Reserve and the ECB follow a more hands-on approach to communication, which provides more guidance to markets in the preparation for upcoming decisions than the Bank of England, which communicates much less about the future outlook for interest rates. The approach adopted by the Bank of England is consistent with the above-mentioned views by King (2000), that central banks should not create news themselves. In line with Reeves and Sawicki (2005), Ehrmann and Fratzscher (2005b) find that communication by MPC members is not very influential in moving financial markets. In contrast, they identify substantial effects on asset prices for the Federal Reserve and the ECB.

Beyond its importance in normal times, communication has been highlighted as a particularly effective tool under the zero lower bound, i.e. when nominal interest rates are close or equal to zero (Bernanke, Reinhart and Sack 2004, Woodford 2005). Finally, there is evidence that it is in particular statements including an indication about the future path of policy that move financial markets (Ehrmann and Fratzscher 2005a, Gürkaynak, Sack and Swanson 2005).

Another strand of the literature analyses the *content* of central bank communication. Gerlach (2004) develops a quantitative indicator from the assessment of inflation, economic activity and M3 growth in the editorial of the ECB's Monthly Bulletins, and finds that this indicator can explain interest-rate setting of the ECB. In a similar fashion, Rosa and Verga (2005) and Heinemann and Ullrich (2005) analyse the content of the ECB's introductory statements to the press conference following Governing Council meetings. They construct indicators for the monetary policy stance of the ECB based on the words used in the statements, and similarly show that the indicators can explain interest-rate setting, although they serve as substitutes, not as complements to macroeconomic variables in Taylor-type rules.

Finally, some authors have analysed to what extent communication is consistent across committee members. Jansen and de Haan (2004) find that statements among the individual members of the ECB's Governing Council about interest rates exhibited some degree of dispersion initially, which decreased over time, whereas they identify an increasing dispersion in statements about inflation. Ehrmann and Fratzscher (2005b) show that the importance given to personal views of committee members differs across central banks. The ECB and the Bank of England follow a collegial approach to communication, with a high degree of consistency compared to the Federal Reserve, where communication is significantly more dispersed.

3. Measuring communication

Communication of central banks has many facets (Blinder et al. 2001; Geraats, 2002). Fundamental pieces of communication relate to the publication of the central bank's monetary policy strategy and its policy target. We will abstract from this type of communication, assuming that markets already have this information, and we focus on the day-to-day operations of central banks. Under this heading, central banks might be interested to communicate their current assessment of economic developments, and possibly their thinking about the likeliness of future policy decisions. For these purposes, most central banks have a set of communication tools at their disposal. These include regular publications by the decision-making committees, such as inflation reports, Monthly, Quarterly or Annual Reports, or regular updates of economic analysis such as the Beige Book of the Federal Reserve. Another important tool consists in communication about the policy decisions. The three central banks in this study have adopted different strategies in this respect. All three release a press statement immediately following their committee meetings. The Federal Reserve and the Bank of England furthermore release minutes of the meetings somewhat later, and the Federal Reserve eventually even the transcripts. In contrast, the ECB does not publish minutes of its meetings, but provides an in-depth explanation of its decisions in a press conference immediately after the meetings, with extended Q&A sessions.

Whereas all these forms of communication are extremely important parts of the communication toolkit of each of the three central banks, their timing is generally pre-scheduled. In that sense, neither of these forms provides the flexibility to communicate changes in the committee's views to the public instantaneously. The most adequate instrument in this respect has to be seen in communication by the individual committee members in the inter-meeting period. This is the type of communication we will focus on in the context of this paper, as it is the only form that can flexibly respond to new information by adjusting its intensity or its timing.

Accordingly, we want to obtain all statements related to monetary policy by the individual committee members in the inter-meeting period. We include speeches, interviews or testimonies for all members of the FOMC,[1] the MPC, and the Governing Council of the ECB. Our sample period starts in May 1999 for the Federal Reserve, coinciding with the release of forward-looking balance-of-risks assessments immediately after each FOMC meeting. For the Bank of England, the sample starts with its independence in May 1997, and for the ECB with the start of stage three of European Economic and Monetary Union in January 1999, i.e. when the ECB started conducting monetary policy for the euro area.

The source of the data is *Reuters News*, a newswire service that is frequently used by financial market participants. We search this database for entries containing the name of the various policy

[1] We do not make a distinction between voting member and non-voting members as all 19 members participate in the FOMC meetings.

makers together with the terms "interest rates", "inflation", "monetary policy", "economy" or "economic outlook". Each hit has then been checked for its content. All statements that are forward-looking in nature have been kept, whereas backward-looking statements were discarded. For the remaining statements, we noted the day of the report in *Reuters News*, to construct a database with a daily frequency. Our aim is to assemble a *real time* database, i.e. ensure that we record reports on the day when they first arrive at financial markets in order to test their effect on asset prices on the same day. In particular, we very carefully chose only the first report in *Reuters News*, which usually comes within minutes of each statement and is mostly descriptive without providing much analysis or interpretation, and discard all subsequent reports or analysis of the same statement.

The resulting sample of *Reuters News* reports was then distinguished according to the content of each statement. Following Guthrie and Wright (2000) and Kohn and Sack (2004), we separated statements referring to the monetary policy inclination from those covering the economic outlook. Finally, in order to make this database amenable for econometric analysis, all statements were classified into their implications for the likely future path of interest rates. Statements pointing to tighter monetary policy, a stronger economic performance, higher inflationary pressure or/and higher interest rates were allocated the value of +1, neutral statements the value of 0 and finally all statements indicating a likely decrease in interest rates the value of -1, such that:

$$C_t^{EC} = \begin{cases} +1 & \textit{stronger econ. outlook} \\ 0 & \textit{unchanged econ. outlook} \\ -1 & \textit{weaker econ. outlook} \end{cases}$$

$$C_t^{MP} = \begin{cases} +1 & \textit{tightening inclination} \\ 0 & \textit{no inclination} \\ -1 & \textit{easing inclination} \end{cases}$$

This classification is therefore judgmental, based on our own reading of the newswire reports. Accordingly, misclassifications cannot entirely be ruled out. However, in line with the principles of content analysis (Holsti 1969), we reduced the chance of misclassification by having two persons analyse critical statements independently. In those cases where we were unsure about the classification of the statement, we double-checked subsequent reports about the same statement and classified them accordingly or discarded them.[2]

By using a prominent newswire as the data source, we explicitly take a financial market perspective in our analysis. This implies that we focus only on those statements that actually reach market

[2] Examples of reports and our classification decisions are provided in Ehrmann and Fratzscher (2005b).

participants, and take measure them in the way they arrive at the markets. Therefore, there could be statements by committee members that are not part of our analysis, as they are not reported by the newswire service. Furthermore, the newswire service might have misunderstood or misinterpreted the intention of the speaker, such that there could be cases where the content of the report as it arrives at financial markets is not the one intended by the speaker. For our purposes, however, it is crucial to take the perspective of the recipients and not of the sender of communication, as we are interested in testing the efficiency of communication. Finally, it is important to note that our dataset is constructed at a daily frequency. Of course, other pieces of news hit and influence financial markets every day. In order to avoid that we mis-measure the effect of communication, we control for a large number of factors in our econometric, as detailed below.[3] In the construction of the dataset, we ensure that there is no overlap with other relevant communication by the committee as a whole. To do so, we excluded any observation from our database that occurs on meeting days of the decision-making bodies of all three central banks, as well as on the publication days of the Monthly Bulletin and the Annual Report for the ECB, of the Inflation Report and the MPC minutes for the Bank of England, and of the FOMC minutes and the Beige Book for the Federal Reserve.

Overall, the database contains 114 statements by FOMC members on monetary policy, and 65 about the economic outlook. For the MPC, there are 43 monetary policy statements, and 54 about the economic outlook, and for the ECB's Governing Council, we count 204 items of communication about monetary policy, and 142 about the economic outlook.

4. The timing of communication and its effectiveness

4.1 Timing communication: when do central banks talk?

The first question this paper will address is whether we can identify a systematic pattern in the timing of central bank communication. For instance, there could be a typical variation within the inter-meeting periods, with more intense communication as the meeting comes closer, in order to prepare the public for the upcoming meeting. Alternatively, central banks might see a need for more frequent communication if interest rates had just been changed, or if they will most likely be changed at the next meeting. In all these cases, the intensity of communication would be endogenous to the central bank's decision-making. Beyond that, more intense communication might be useful in other, exogenous circumstances; for example in times of elevated uncertainty, the central bank might want to provide more guidance to financial markets and the public in general.

Looking at the typical variation over the inter-meeting periods, Figures 1.a – 1.c show the distribution of statements on the days before and after the policy meetings of the three authorities.

[3] In particular, we control for the release of important macroeconomic news, day-of the-week effects and for monetary policy surprises on the meeting days.

There is one striking similarity across all central banks: on the days immediately prior to the monetary policy meetings, there is a considerably smaller amount of communication compared to other days.[4] Furthermore, the intensity of communication is different before than after meetings for all three central banks. With the exception of the days surrounding the monetary policy meetings, there is a somewhat higher level of activity before than after meetings (which is statistically significant at the 5% level for the case of the ECB, and at the 10% level for the Bank of England), stressing the attempt of central banks to prepare markets for the upcoming meeting.

Moving from differences *within* inter-meeting periods to an analysis of the patterns that explain the intensity of communication *across* inter-meeting periods, Table 1 reports the results of some simple mean comparison tests on the basis of the communications data described above. It calculates the mean frequency of communication differentiated across occasion, and tests whether there is a significant difference in intensity. All tests are performed for the three central banks, for the entire set of communication events as well as separated according to statements regarding monetary policy and economic outlook. For instance, the first set of entries shows that on 11.9% of all days, FOMC members communicate with the public in the inter-meeting period following a change in interest rates, which is not significantly different from the 10.7% recorded in inter-meeting periods following decisions to leave interest rates unchanged. The first differentiation in panel one thus analyses whether central banks communicate more with the public *following* interest rate changes. Even though we are careful in covering only forward-looking communication in our database, central banks might see a need to communicate more intensely to the public in the aftermath of a decision to change interest rates. Given such a step, there might be a need for markets to understand whether further interest rate changes can be expected, or whether the preceding interest rate move should be considered the last in an interest rate cycle. The recent experience with the FOMC's balance-of-risks assessments makes this point clear – following each interest rate decision, the FOMC decided to immediately tune the markets in for another rate change, through the formulation that "the Committee believes that policy accommodation can be removed at a pace that is likely to be measured". However, when it comes to inter-meeting communication by committee members, no differences in the intensity of communication can be observed, neither for the Federal Reserve nor for the other two central banks analysed. Although communication about monetary policy is somewhat more frequent following interest rate changes, the differences are not statistically significant.

The picture changes when looking at the periods *prior* to interest rate changes, however. The second panel of Table 1 shows the results of the corresponding mean comparison tests. In particular for the

[4] Unsurprisingly, as all central banks have defined a black-out period prior to meeting days during which committee members generally refrain from giving interviews, etc. That our database records statements in the days prior to meetings is mainly related to other types of communication, like - in the case of the ECB - the hearings before the European Parliament.

Federal Reserve and the Bank of England, there is evidence that in such situations communication becomes more frequent. The strongest difference is observed for the Federal Reserve, where on 9.3% of all days FOMC members communicate with the public if there is no interest rate change ahead, compared to 13.9% before the federal funds target rate will be changed, a difference which is estimated significant at the 1% level. For the ECB, communication is virtually equally intense (at a high level) prior to rate changes than otherwise. These findings suggest that the Federal Reserve and the Bank of England choose to intensify the frequency of communication in order to convey their intention of an interest rate change, whereas the ECB continues its communication policy.[5]

The third and fourth panels of table 1 study whether the intensity of central bank communication is related to situations of market uncertainty. The first test proxies market uncertainty through interest rate volatility. Periods where the volatility of three-month money market rates over the past three months is above its average are defined as volatile.[6] Overall, there is relatively little evidence that central banks take periods of elevated market volatility as a reason to intensify their communication. The only exception is given by the Bank of England, where communication in general, but particularly about the economic outlook increases, an increase which appears large (from 2.75% to 4.65%, e.g., for statements concerning the economic outlook), yet is significant only at the 10% level.

A related test is performed in the last panel of table 1, where market uncertainty is proxied through the size of the surprise that occurred in the previous committee meeting. We define a surprise as large when its absolute value is above the average absolute surprise for each central bank. The idea is that if markets were surprised to a large degree in the previous meeting, they might need further guidance on what to expect for the upcoming decisions, as their expectations about the future path of policy rates needs updating. We would expect that under such a situation, central banks might be inclined to serve this need for more guidance. The only central bank where we find evidence for such an effect is the ECB, however. For the Federal Reserve, there is a counterintuitive pattern insofar as communication conveying the inclination about future monetary policy seems to be reduced under these circumstances. For the ECB, however, communication clearly intensifies. Whereas the members of the Governing Council normally talk to the public roughly every 7 (business) days, they do so more than every 5 days if there has been a large surprise at the previous meeting.

[5] It is important to note that among the three central banks, the ECB's communication is generally the most frequent, and the consistent with upcoming decisions (see Ehrmann and Fratzscher 2005b), which might imply a lesser need to intensify communication in such cases.

[6] Through this long lead in the definition, we ensure that volatility is not endogenous to central bank communication.

All in all, we conclude from this preliminary analysis that central banks intensify their communication under certain circumstances. The clearest picture emerges when it comes to preparing markets for an upcoming interest rate change, although we find that communication intensifies more generally in preparation of committee meetings. It is important to note at this stage that our analysis is restricted to a purely quantitative picture. We can only identify whether there are more incidences of communication. An equally likely possibility is that central banks similarly design a communication strategy with respect to the *content* of communication. For example, the clarity with which certain messages are conveyed, or the degree of dispersion in what the individual members of the committees say might differ.[7] Such an analysis is beyond the purpose and scope of this paper, however. Note also that the above analysis does not contain any normative implication about the different communication strategies. Indeed, in Ehrmann and Fratzscher (2005b) we find that monetary policy decisions by the Federal Reserve and the ECB are about equally predictable, and only slightly less predictable for the Bank of England. Hence the above differences in timing and frequency of communication across central banks may therefore be "optimal" given the central banks communication strategies, for instance by enhancing the predictability of decisions overall.

4.2 Communication effects: when do financial markets respond?

In this subsection, we test for the impact of communication on financial markets. As shown in Ehrmann and Fratzscher (2005b), communication is a powerful tool to move financial markets. Although the strength of the effects differs across central banks, it is estimated significantly for all three of them. For the purpose of this paper, we will analyse whether the response of asset prices to communication depends on the circumstances in which such communication arrives at the markets. Markets might seek more guidance from central banks if there has been a change in interest rates at the last meeting, or if there is large market uncertainty. Additionally, as shown in the previous section, markets might be perceptive to changes in communication frequency or content, as these could signal new information that the central bank wants to convey. Accordingly, we will also analyse whether markets react differently prior to meetings with interest rate changes, and in response to communication that "leans with" or "leans against the wind", in the sense of being in line with the last policy change or not.

We look at both the yield curve as well as at equity prices, exchange rates and inflation expectations. Interest rate data are US Treasury bill rates for the US, and interbank rates and government bond yields for the euro area and the UK. Equity returns are the daily returns of the

[7] A necessary condition in that respect is that the communication is consistent with the upcoming interest rate change. This is indeed the case for all three central banks in the sense that the number of consistent statements is significantly larger than 50%, as shown in Ehrmann and Fratzscher (2005b).

major stock market indices (the S&P500, FTSE100 and EUROSTOXX), and exchange rates (EUR/USD, UKP/USD) are closing quotes at 18.00 EST. Inflation expectations are derived from inflation-indexed five-year bonds.

The econometric model employed in this section consists of a standard exponential GARCH (EGARCH) framework, as proposed by Nelson (1991). In this framework, we model the effect of communication on asset price returns r_t, also controlling for heteroskedasticity of the series and the effects of communication on asset price volatility h_t. The model is formulated as follows:

$$\begin{aligned} r_t = \alpha + \lambda\, r_{t-1} + \beta_1^{EC}\, C_t^{EC}\, D_t + \beta_2^{EC}\, C_t^{EC}\, (1 - D_t) \\ + \beta_1^{MP}\, C_t^{MP}\, D_t + \beta_2^{MP}\, C_t^{MP}\, (1 - D_t) + \delta\, X_t + \varepsilon_t \end{aligned} \tag{1}$$

The conditional mean equation (1) relates asset price returns r_t to inter-meeting communication (C^{EC}, C^{MP}), past returns (r_{t-1}) and a vector of control variables (X). This vector X_t includes day-of-the-week effects, monetary policy shocks and the surprise component of various macroeconomic news. Monetary policy shocks are identified through the change in one-month interest rates on the day of the committee meetings.[8] To construct a surprise component of macro news, we subtract market expectations from the actually released figure. The market expectations are proxied through the median expectation obtained in surveys of market participants conducted by MMS International. We included various macro announcements that have been identified as important market movers in earlier work.[9] By entering this large number of controls, we aim to identify the pure effects of inter-meeting communication with our parameters of interest β^{EC} and β^{MP}.[10] The test whether the effects of communication depend on circumstances is conducted by adding a dummy variable D_t that distinguishes between various scenarios, and by interacting this dummy variable with the parameters of interest. To give an example, the dummy variable would be set to D_t=1 for all days in between two meetings, where interest rates are changed at the second meeting and to D_t=0 for all days of the inter-meeting periods prior to meetings without interest rate changes.

We assume that $\varepsilon_t = \sqrt{h_t} \cdot v_t$, with v_t is an i.i.d. sequence with zero mean and unit variance. The conditional variance h_t can therefore be expressed as a function of communication dummies (CD^{EC},

[8] Following Perez-Quiros and Sicilia (2002), we use one-month EONIA swap rates for the euro area, and one-month LIBOR rates for the UK and the US.

[9] See, e.g., Ehrmann and Fratzscher (2005c). The set of macro news comprises advance GDP, consumer confidence, CPI, industrial production, ISM survey, nonfarm payrolls, PPI, retail sales, trade balance and unemployment for the United States; GPD, earnings, industrial production, manufacturing production, M4, PPI, RPIX, retail sales, trade balance and unemployment for the UK; euro area business confidence and consumer confidence, German ifo business climate, industrial production, PPI, retail sales, trade balance, unemployment, CPI and GDP for the euro area.

[10] Remember that we only record communication by committee *members* on days without other communication by the *committee*, such as the announcement of policy decisions, the release of minutes etc.

CD^{MP}), the past variance (h_{t-1}) and innovations (ε_{t-1}), and the controls XD_t (entered as dummy variables, which are equal to one on the days of FOMC meetings or macro announcements and zero otherwise):

$$\ln(h_t) = \omega + \theta_1\left(\left|\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right| - \sqrt{\frac{2}{\pi}}\right) + \theta_2\left(\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right) + \theta_3 \ln(h_{t-1}) + \kappa_1^{EC}\, CD_t^{EC}\, D_t + \kappa_2^{EC}\, CD_t^{EC}\, (1-D_t) + \kappa_1^{MP}\, CD_t^{MP}\, D_t + \kappa_2^{MP}\, CD_t^{MP}\, (1-D_t) + \varphi X_t \quad (2)$$

The EGARCH approach corrects for the kurtosis, skewness, and time-varying volatility of the asset price. An additional advantage of the EGARCH approach is that we do not need to impose non-negativity constraints on the conditional second moments. The model is estimated via log-likelihood estimation of the function

$$L(\mu) = -\left(\frac{T}{2}\right)\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\left(\ln(h_t) + \frac{\varepsilon_t^2}{h_t}\right) \quad (3)$$

with μ the vector of parameters of interest and T the number of observations.

Tables 2 and 4 show the results for various differentiations of the effects of communication about monetary policy inclination, whereas Tables 3 and 5 report the corresponding results for communication on the economic outlook. The first column in table 2 analyses whether financial markets respond differently to communication in the *aftermath* of interest rate changes. Section 4.1 has shown that there is no difference in the intensity of communication in these circumstances. However, one would expect that following an interest rate change, markets need information about when and whether to expect further changes, and of what size any further changes will be. In other words, it will be important for markets to understand the views of the central bank as to the contribution of the last interest rate move to removing any risks to price stability or economic growth. Looking at financial market responses, we see that there are only a few instances where differences are estimated in a significant fashion. At the same time, however, it is clear that the parameters are generally considerably larger in the aftermath of interest rate changes for both the Federal Reserve and the ECB. In the United States, this difference is particularly substantial for three-month rates: interest rates move by nearly three times as much, namely by 2.2 basis points as opposed to 0.8 basis points otherwise. Similar, although weaker differences are found throughout the maturity spectrum.

Looking at communication about the economic outlook, the differences are particularly striking for the Federal Reserve, as reported in the first set of results in table 3. For the ECB and the Bank of

England, there is no significant differentiation, also because economic outlook communication generally moves financial markets only very little. This is in line with earlier findings, and is likely to reflect the differences in the monetary policy strategies of the three central banks.

The second test reported in table 2 tests whether there is a difference in the response of financial markets to communication in times *prior* to interest rate decisions. The differentiation applied to this test is whether interest rates change at the upcoming meeting. It has been shown in the preceding section that the intensity of communication tends to increase. If this higher frequency of communication provides signals to the markets, we should expect particularly strong effects at the short end of the maturity spectrum, which is indeed what we find. The response of financial markets to communication is substantially larger prior to interest rate changes, and significantly more so for the Federal Reserve and the ECB. In fact, 3-month interest rates react two to three times stronger to statements about the monetary policy inclinations when interest rates are indeed changed in the subsequent meeting. A similar pattern can be detected when looking at communication about the economic outlook, where we find stronger responses at the short end of the yield curve in the euro area as well as in the United States.

Finally, the last set of results reported in tables 2 and 3 relates to the effect of communication depending on its content. These tests address the question whether communication exerts larger effects if it is "leaning with" or "leaning against" the current policy stance, as measured by the direction of the last interest rate change. In order to form any hypothesis about the expected effects, it is important to know that the communication by the ECB's Governing Council members tends to be collegiate, whereas FOMC members more often express their personal and possibly deviating views in the public (see Ehrmann and Fratzscher 2005b). Under dispersed communication, markets need to understand to which positions they should attach relatively more weight. This can be achieved by identifying the more influential persons in the committee, or by aiming to identify the more influential positions at a given point in time. Tests for the former possibility have shown that financial markets in the United States attach a larger weight to statements by Chairman Greenspan (Ehrmann and Fratzscher 2005b). The results shown here suggest that also the second strategy is practiced by the markets: statements that are in line with the current stance are given more weight by markets. We find statistically significant differences for communication about the economic outlook, but not for monetary policy inclination. However, it is interesting to note that statements about the economic outlook by the Federal Reserve that lean against the policy stance are not able to move financial markets beyond the 6-month maturities at all, whereas we find that congruent statements are market movers far into the maturity spectrum. In contrast, for a more collegiate communication strategy like the ECB's, statements that are opposed to the policy stance might be particularly informative to financial markets, because they could potentially signal upcoming changes in the future policy stance. Accordingly, we should expect larger effects of such statements

relative to communication that simply repeats the current knowledge about the interest rate path, and such effects should be particularly pronounced at the intermediate maturities. This is indeed what we find, with partly remarkable differences. ECB communication that is leaning against the policy stance can change interest rates by up to 7 basis points for the intermediate maturities.

In the preceding section we had analysed whether central banks communicate more with markets under situations of *increased uncertainty*, and found only weak evidence that the intensity of communication increases under such circumstances. However, as our data are purely quantitative, it cannot be excluded that communication changes in a *qualitative* sense. In this case, it might be possible to nonetheless find a different reaction of financial markets. Furthermore, markets might seek more guidance even from an unchanged communication by the central bank. In both cases, we would expect stronger reactions under increased uncertainty. These issues are addressed in tables 4 and 5. There is substantial evidence that communication by FOMC members is used as a guide by financial markets particularly in times of elevated uncertainty: the response of financial markets to communication is generally substantially larger, and often significantly so. This effect holds for both communication about the monetary policy inclination and the economic outlook, when we proxy market uncertainty through high levels of market volatility. It also holds for economic outlook statements when the surprise component of the previous monetary policy decision has been larger than average, which can similarly be taken as indicative for increased market uncertainty. Particularly the latter case shows remarkable differences. For the Federal Reserve, whereas economic outlook communication moves markets by up to 1.7 basis points if the previous surprise has been relatively small, it shows a hump-shaped pattern along the yield curve when the previous surprise has been above average, with effects ranging from 3 basis points at the short end to even larger responses at medium- to long-term horizons. Again, these findings contrast strongly with the ones for the ECB. If anything, effects of ECB communication on financial markets are stronger under situations of low uncertainty though the differences are hardly ever statistically significant. It is hard to provide a normative interpretation to these results as they may crucially depend on the source of market uncertainty. If, for instance, interest rate volatility is due to factors that are unrelated to monetary policy, communication may have little impact on interest rates even in periods of large volatility. Nevertheless, the findings presented here are interesting in underlining some empirical differences across the three central banks.

In sum, this section has provided evidence that the response of financial markets to central bank communication differs, and sometimes strongly so, depending on the circumstances under which committee members address the public. The most consistent finding across central banks is that markets respond more strongly to communication prior to interest rate changes. Combining the increased frequency of communication and the stronger market responsiveness suggests that communication is a particularly important policy tool in such circumstances.

5. Conclusions

This paper has addressed the question whether the timing of central bank communication shows some systematic patterns. It has analysed this issue by looking at inter-meeting communication by individual committee members, the communication device that can be used most flexibly in response to changing conditions and to signal changes in views and in policy. Based on quantitative measures of communication, we identify circumstances in which communication intensifies. This is most notably the case prior to interest rate changes, although we find more generally a higher frequency of communication in preparation of committee meetings, regardless of the upcoming decision. Other findings are more heterogeneous across central banks. Communication by members of the Bank of England's MPC intensifies somewhat in times of increased market volatility, and the ECB's Governing Council members step up the frequency of communication if there is a need to explain the monetary policy decision taken in the preceding Governing Council meeting. These differences suggest that the timing of central bank communication is chosen endogenously.

As the next step of the analysis, the paper asked whether financial markets attach different weights to central bank communication, depending on circumstances. Again, the findings are affirmative on this issue. Analysing the response of financial asset returns to a qualitative measure of central bank communication at a daily frequency, there is substantial evidence about changing market responsiveness, which, however, differs substantially across the three central banks. Financial markets tend to respond significantly stronger to communication prior to interest rate changes particularly for the Federal Reserve and the ECB. Considering also that the frequency of communication is increased, communication is a particularly important policy tool in such circumstances. There is also some evidence for the Federal Reserve that markets use communication to re-evaluate their expectations about the future path of monetary policy in the aftermath of interest rate changes. An interesting difference emerges when it comes to statements that are "leaning" against the current policy direction. These are more important signals than congruent statements to markets in the euro area, whereas the opposite holds true for the United States. Finally, market reactions also differ depending on the degree of uncertainty. Particularly for the Federal Reserve, there is ample evidence that markets seek more guidance from statements by FOMC members under situations of elevated uncertainty.

The heterogeneity of financial market responses across the three central banks is consistent with three stylised facts. First, they reflect differences in the monetary policy strategies, in the sense that US markets attach considerably more importance to statements about the economic outlook. Second, they are also in line with differences in the communication strategies, in the sense that UK markets are much less responsive to communication overall, showing furthermore far fewer cases of differential responses according to the circumstances of communication. This confirms earlier findings of Ehrmann and Fratzscher (2005b) and Reeves and Sawicki (2005), and is compatible

with the views of King (2000) that central bank communication should be "boring" and not create news itself. Third, the patterns are consistent with the role that individual committee members are given in the respective communication strategies: statements that are not aligned with the current stance of monetary policy are much more influential for the ECB, where traditionally personal views play a lesser role in communication, implying that such statements are likely to reflect a consensus view and as such to convey important news about changes in the likely future stance of monetary policy.

Overall, the paper suggests that there is indeed a clear and well-defined pattern that characterises the timing of central bank communication. Moreover, the empirical findings of the paper suggest the interpretation that financial markets understand the purpose of central bank communication and its timing as they respond in ways that reflect the nature of the central banks' monetary policy strategies as well as their communication.

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Table 1: Frequency of communication

	All communication			Communication concerning monetary policy inclination			Communication concerning economic outlook		
	Interest rate change at last meeting								
	Change	No change	Δ	Change	No change	Δ	Change	No change	Δ
Federal Reserve	11.92%	10.66%		8.75%	8.50%		5.03%	4.82%	
Bank of England	5.09%	5.33%		2.79%	2.10%		2.30%	3.23%	
European Central Bank	17.86%	15.14%		17.35%	13.99%		11.73%	9.79%	
	Interest rate change at next meeting								
	Change	No change	Δ	Change	No change	Δ	Change	No change	Δ
Federal Reserve	13.91%	9.33%	***	10.15%	7.57%	*	5.83%	4.29%	
Bank of England	6.41%	4.75%	*	3.38%	1.87%	**	3.02%	2.88%	
European Central Bank	15.43%	15.54%		12.77%	14.72%		12.77%	9.65%	*
	Uncertainty: Degree of market volatility								
	High	Low	Δ	High	Low	Δ	High	Low	Δ
Federal Reserve	11.25%	11.14%		7.19%	9.05%		6.25%	4.48%	
Bank of England	7.56%	5.01%	*	2.91%	2.27%		4.65%	2.75%	*
European Central Bank	15.27%	15.60%		14.99%	14.29%		8.93%	10.43%	
	Uncertainty: Size of previous surprise								
	Large	Small	Δ	Large	Small	Δ	Large	Small	Δ
Federal Reserve	8.97%	11.64%		5.56%	9.26%	**	5.56%	4.77%	
Bank of England	5.19%	5.28%		2.50%	2.26%		2.69%	3.01%	
European Central Bank	19.16%	14.59%	**	18.47%	13.43%	**	10.80%	9.88%	

Note: This table reports the frequency of communication (measured by the share of days at which communication is recorded), depending on different circumstances and separately for the three central banks and the two types of statements and their sum. Δ denotes whether the parameters are statistically significantly different for the two possible scenarios (e.g., whether there has been an interest rate change at the last meeting or not, where ***, **, * indicate significance at the 99%, 95% and 90% levels.

Table 2: Market reaction to communication on *monetary policy inclination* -- by previous and next decision and policy direction, mean equation

	Previous decision					Next decision					Policy direction				
	No change		Change		sign.	No change		Change		sign.	Leaning with		Leaning against		sign.
Federal Reserve															
3-month interest rates	0.008 ***	*0.002*	0.022 ***	*0.005*	**	0.009 ***	*0.003*	0.023 ***	*0.005*	***	0.013 ***	*0.003*	0.009 **	*0.004*	
6-month interest rates	0.006	*0.004*	0.006	*0.004*		0.004	*0.004*	0.016 ***	*0.005*	*	0.007 **	*0.003*	0.011 **	*0.005*	
1-year interest rates	0.009	*0.006*	0.019 ***	*0.005*		0.008	*0.005*	0.019 ***	*0.005*		0.019 ***	*0.005*	0.007	*0.007*	
2-year interest rates	0.011	*0.010*	0.020 ***	*0.007*		0.023 **	*0.009*	0.010	*0.006*		0.022 ***	*0.008*	0.009	*0.007*	
5-year interest rates	0.012	*0.012*	0.022 ***	*0.008*		0.033	*0.053*	0.004	*0.053*		0.018 **	*0.007*	0.013	*0.013*	
10-year interest rates	0.006	*0.011*	0.014	*0.009*		0.020 *	*0.012*	0.003	*0.008*		0.009	*0.008*	0.010	*0.013*	
20-year interest rates	0.005	*0.010*	0.010	*0.008*		0.016 ***	*0.002*	0.004 ***	*0.001*	***	0.009	*0.007*	0.006	*0.007*	
equity market	-0.004 ***	*0.001*	-0.006 ***	*0.001*		-0.003 **	*0.001*	-0.006 ***	*0.001*		-0.003 ***	*0.001*	-0.003 ***	*0.001*	
exchange rate	-0.001	*0.006*	0.000	*0.005*		-0.001	*0.001*	0.000	*0.001*		0.000	*0.001*	0.000	*0.001*	
5-year inflation expectations	0.001	*0.009*	-0.004	*0.009*		0.000	*0.005*	-0.003	*0.013*		0.003	*0.009*	0.009	*0.011*	
Bank of England															
3-month interest rates	0.005 **	*0.002*	-0.001	*0.005*		0.005 **	*0.002*	0.009 ***	*0.003*		0.006 ***	*0.002*	-0.004	*0.005*	*
6-month interest rates	0.011 ***	*0.003*	0.004	*0.005*		0.008 ***	*0.003*	0.014 ***	*0.004*		0.008 **	*0.003*	-0.001	*0.010*	
1-year interest rates	0.014 **	*0.006*	-0.002	*0.007*		0.017 ***	*0.005*	0.005	*0.007*		0.008 **	*0.004*	-0.008 **	*0.003*	***
2-year interest rates	0.001	*0.008*	0.010	*0.009*		0.008 ***	*0.001*	-0.004 ***	*0.000*	***	0.000	*0.006*	-0.025	*0.037*	
5-year interest rates	-0.001	*0.008*	0.006	*0.009*		0.004	*0.010*	0.001	*0.008*		-0.001	*0.006*	-0.018	*0.024*	
10-year interest rates	-0.005	*0.008*	0.009	*0.010*		-0.001	*0.009*	-0.001	*0.010*		-0.004	*0.007*	-0.020	*0.023*	
20-year interest rates	-0.003	*0.008*	0.008	*0.008*		0.003	*0.008*	-0.006	*0.007*		-0.005	*0.006*	0.000	*0.025*	
equity market	-0.001	*0.002*	-0.007 ***	*0.002*	**	-0.003	*0.002*	-0.004 **	*0.002*		-0.004 ***	*0.001*	-0.003	*0.005*	
exchange rate	-0.001	*0.001*	0.001	*0.001*		-0.002 **	*0.001*	0.001	*0.001*	**	0.000	*0.001*	-0.003	*0.002*	
5-year inflation expectations	-0.003	*0.005*	0.005	*0.011*		-0.008	*0.007*	0.009	*0.006*	*	-0.004	*0.005*	-0.013	*0.017*	
European Central Bank															
3-month interest rates	0.011 ***	*0.002*	0.007 ***	*0.003*		0.007 ***	*0.001*	0.019 ***	*0.004*	***	0.008 ***	*0.002*	0.017	*0.011*	
6-month interest rates	0.013 ***	*0.003*	0.013 ***	*0.005*		0.013 ***	*0.002*	0.010 ***	*0.004*		0.017 ***	*0.003*	0.015 ***	*0.004*	
1-year interest rates	0.013 ***	*0.003*	0.022 **	*0.009*		0.021 ***	*0.003*	0.002	*0.008*	**	0.018 ***	*0.001*	0.029 ***	*0.008*	
2-year interest rates	0.023 ***	*0.007*	0.036 ***	*0.011*		0.026 ***	*0.006*	0.011	*0.024*		0.018 ***	*0.006*	0.072 ***	*0.012*	***
5-year interest rates	0.022 ***	*0.006*	0.024 **	*0.010*		0.020 ***	*0.006*	0.015	*0.012*		0.013 **	*0.006*	0.069 ***	*0.019*	***
10-year interest rates	0.012 ***	*0.005*	0.001	*0.013*		0.007	*0.005*	0.010	*0.018*		0.001	*0.005*	0.048 ***	*0.009*	***
20-year interest rates	0.011 ***	*0.004*	-0.011	*0.010*	**	0.005	*0.004*	0.007	*0.016*		-0.005	*0.004*	0.042 ***	*0.011*	***
equity market	-0.003 **	*0.001*	-0.007 **	*0.003*		-0.004 ***	*0.001*	-0.006	*0.004*		-0.005 ***	*0.002*	-0.002	*0.002*	
exchange rate	-0.002	*0.001*	-0.001	*0.002*		-0.002 *	*0.001*	-0.002	*0.003*		-0.001	*0.001*	-0.002	*0.002*	
5-year inflation expectations	0.001	*0.004*	-0.005	*0.009*		0.000	*0.005*	-0.003	*0.013*		-0.006	*0.004*	0.011	*0.007*	**

Notes: The table reports the daily reaction of financial market returns to the classified communication variables. Standard errors are shown in italics to the right of the coefficients. ***, **, * indicate significance at the 99%, 95% and 90% levels, respectively. "sign." shows whether difference between the coefficients is significant.

Table 3: Market reaction to communication on *economic outlook* -- by previous and next decision and policy direction, mean equation

	Previous decision					Next decision					Policy direction				
	No change		Change		sign.	No change		Change		sign.	Leaning with		Leaning against		sign.
Federal Reserve															
3-month interest rates	0.003	*0.002*	0.028 ***	*0.003*	***	0.004 *	*0.002*	0.017 ***	*0.005*	***	0.009 ***	*0.002*	0.001	*0.002*	**
6-month interest rates	0.007 **	*0.003*	0.032 ***	*0.004*	***	0.010 ***	*0.002*	0.018 ***	*0.006*		0.017 ***	*0.003*	0.006 *	*0.004*	**
1-year interest rates	0.018 ***	*0.005*	0.022 ***	*0.008*		0.016 ***	*0.005*	0.025 ***	*0.008*		0.021 ***	*0.005*	0.013	*0.008*	
2-year interest rates	0.024 ***	*0.008*	0.028 ***	*0.011*		0.021 ***	*0.008*	0.034 ***	*0.009*		0.022 **	*0.011*	0.021 **	*0.010*	
5-year interest rates	0.027 ***	*0.009*	0.026 **	*0.012*		0.024	*0.015*	0.027	*0.022*		0.024 ***	*0.009*	0.028 **	*0.014*	
10-year interest rates	0.022 ***	*0.008*	0.021 *	*0.012*		0.020 **	*0.009*	0.026 **	*0.011*		0.019 **	*0.009*	0.023 *	*0.012*	
20-year interest rates	0.014 **	*0.007*	0.006	*0.010*		0.008 ***	*0.002*	0.017 **	*0.007*		0.004	*0.009*	0.022 **	*0.011*	
equity market	0.003 **	*0.001*	0.005 ***	*0.002*		0.002 *	*0.001*	0.008 ***	*0.001*	***	0.005 ***	*0.001*	0.004 ***	*0.001*	
exchange rate	-0.002	*0.008*	-0.003	*0.010*		-0.002 **	*0.001*	-0.004 ***	*0.001*		-0.003 ***	*0.001*	-0.002	*0.001*	
5-year inflation expectations	0.001	*0.007*	0.017	*0.012*		0.001	*0.003*	-0.018	*0.012*		-0.003	*0.008*	-0.001	*0.007*	
Bank of England															
3-month interest rates	-0.004 *	*0.002*	0.000	*0.007*		-0.004	*0.002*	-0.006 **	*0.003*		-0.003	*0.003*	-0.005 *	*0.003*	
6-month interest rates	-0.006 **	*0.003*	-0.001	*0.014*		-0.008 **	*0.003*	-0.001	*0.005*		0.001	*0.007*	-0.013 ***	*0.004*	*
1-year interest rates	-0.003	*0.005*	0.010	*0.010*		-0.010	*0.009*	0.010	*0.009*		0.006	*0.013*	-0.003	*0.008*	
2-year interest rates	0.002	*0.007*	0.007	*0.039*		-0.008 ***	*0.000*	0.017 *	*0.010*	**	0.011	*0.016*	-0.009	*0.009*	
5-year interest rates	-0.001	*0.008*	0.012	*0.019*		0.000	*0.008*	0.006	*0.015*		0.013	*0.012*	-0.010	*0.009*	
10-year interest rates	0.011	*0.009*	0.007	*0.017*		0.007	*0.008*	0.012	*0.024*		0.022 *	*0.011*	-0.003	*0.010*	
20-year interest rates	0.001	*0.007*	0.004	*0.015*		0.005	*0.008*	-0.001	*0.020*		0.017	*0.011*	-0.009	*0.008*	*
equity market	0.003 **	*0.001*	0.012 ***	*0.004*	**	0.002	*0.002*	0.009 ***	*0.002*	**	0.006 ***	*0.002*	0.001	*0.002*	*
exchange rate	0.001	*0.001*	0.004 *	*0.002*		0.002 **	*0.001*	0.002	*0.001*		0.002 **	*0.001*	0.001	*0.001*	
5-year inflation expectations	-0.006	*0.005*	0.010	*0.012*		-0.001	*0.005*	-0.013 *	*0.008*		0.006	*0.006*	-0.013 **	*0.007*	**
European Central Bank															
3-month interest rates	0.002 ***	*0.001*	0.000	*0.002*		0.002 ***	*0.000*	0.009 ***	*0.003*	**	0.000	*0.001*	0.003 ***	*0.001*	*
6-month interest rates	0.003 ***	*0.001*	-0.003 **	*0.001*	***	0.002	*0.001*	0.004	*0.003*		0.000	*0.002*	0.004 **	*0.002*	*
1-year interest rates	0.004	*0.003*	-0.010	*0.007*	*	0.002	*0.003*	0.003	*0.005*		-0.001	*0.001*	0.006 ***	*0.001*	***
2-year interest rates	0.004	*0.005*	-0.013	*0.016*		0.002	*0.005*	0.001	*0.016*		-0.001	*0.006*	0.008	*0.008*	
5-year interest rates	0.000	*0.004*	-0.012	*0.013*		-0.006	*0.005*	0.016	*0.010*	*	0.000	*0.006*	-0.002	*0.007*	
10-year interest rates	0.002	*0.004*	-0.013	*0.011*		-0.004	*0.004*	0.016	*0.015*		0.000	*0.005*	-0.004	*0.007*	
20-year interest rates	0.001	*0.004*	-0.012	*0.011*		-0.004	*0.003*	0.017	*0.013*		0.001	*0.004*	-0.006	*0.006*	
equity market	0.001	*0.001*	0.006 **	*0.003*	*	0.002 *	*0.001*	0.002	*0.003*		0.002	*0.002*	0.002	*0.002*	
exchange rate	0.000	*0.001*	0.002 *	*0.001*	*	0.000	*0.001*	0.001	*0.002*		0.000	*0.001*	0.000	*0.001*	
5-year inflation expectations	-0.002	*0.003*	0.008	*0.009*		0.001	*0.003*	-0.018	*0.012*		0.003	*0.004*	-0.004	*0.004*	

Notes: The table reports the daily reaction of financial market returns to the classified communication variables. Standard errors are shown in italics to the right of the coefficients. ***, **, * indicate significance at the 99%, 95% and 90% levels, respectively. "sign." shows whether difference between the coefficients is significant.

Table 4: Market reaction to communication on *monetary policy inclination* -- by degree of market uncertainty, mean equation

	Uncertainty					Uncertainty				
	Low volatility		High volatility		sign.	Small previous surprise		Large previous surprise		sign.
Federal Reserve										
3-month interest rates	0.011 ***	*0.003*	0.040 ***	*0.005*	***	0.011 ***	*0.003*	0.007	*0.006*	
6-month interest rates	0.006 *	*0.003*	0.028 **	*0.011*	*	0.006 **	*0.003*	-0.005	*0.007*	
1-year interest rates	0.011 ***	*0.004*	0.024 **	*0.011*		0.014 ***	*0.004*	-0.001	*0.012*	
2-year interest rates	0.016 ***	*0.005*	0.010	*0.010*		0.018 ***	*0.005*	-0.015	*0.018*	*
5-year interest rates	0.017 **	*0.007*	0.013	*0.014*		0.015 ***	*0.006*	-0.007	*0.017*	
10-year interest rates	0.012	*0.008*	0.003	*0.018*		0.011 ***	*0.004*	-0.020	*0.029*	
20-year interest rates	0.008	*0.005*	0.003	*0.009*		0.010	*0.006*	-0.019	*0.021*	
equity market	-0.004 ***	*0.001*	-0.004 *	*0.002*		-0.003 ***	*0.001*	-0.009 ***	*0.003*	*
exchange rate	-0.001	*0.001*	0.000	*0.001*		0.000	*0.001*	0.000	*0.002*	
5-year inflation expectations	0.011	*0.008*	-0.011	*0.021*		0.009	*0.007*	-0.030	*0.025*	
Bank of England										
3-month interest rates	0.001	*0.001*	0.008	*0.008*		0.004 **	*0.002*	-0.001	*0.007*	
6-month interest rates	0.007 ***	*0.002*	0.013	*0.010*		0.003	*0.007*	0.002	*0.013*	
1-year interest rates	0.010 ***	*0.002*	0.005	*0.003*		0.014 ***	*0.004*	-0.003	*0.007*	**
2-year interest rates	0.002	*0.007*	0.011	*0.020*		0.003	*0.007*	0.003	*0.012*	
5-year interest rates	0.004	*0.007*	0.006	*0.020*		0.004	*0.007*	-0.002	*0.012*	
10-year interest rates	0.001	*0.007*	0.000	*0.015*		-0.001	*0.008*	0.000	*0.012*	
20-year interest rates	0.002	*0.006*	0.000	*0.011*		0.000	*0.007*	-0.002	*0.009*	
equity market	-0.001	*0.002*	-0.014 ***	*0.004*	***	-0.001	*0.002*	-0.008 ***	*0.002*	**
exchange rate	-0.001	*0.001*	0.002 *	*0.001*	**	-0.002 **	*0.001*	0.002 **	*0.001*	***
5-year inflation expectations	0.001	*0.005*	-0.006	*0.013*		-0.001	*0.005*	-0.001	*0.010*	
European Central Bank										
3-month interest rates	0.008 ***	*0.002*	0.003	*0.004*		0.011 ***	*0.003*	0.008 **	*0.003*	
6-month interest rates	0.017 ***	*0.002*	0.007 **	*0.003*	**	0.014 ***	*0.002*	0.008	*0.007*	
1-year interest rates	0.028 ***	*0.004*	0.009 ***	*0.001*	***	0.021 ***	*0.003*	0.035 ***	*0.012*	
2-year interest rates	0.030 ***	*0.007*	0.010	*0.010*		0.024 ***	*0.006*	0.030 ***	*0.012*	
5-year interest rates	0.027 ***	*0.007*	-0.001	*0.010*	**	0.026 ***	*0.007*	0.008	*0.010*	
10-year interest rates	0.015 ***	*0.005*	-0.019 **	*0.010*	***	0.014 ***	*0.005*	-0.001	*0.012*	
20-year interest rates	0.012 ***	*0.004*	-0.023 ***	*0.009*	***	0.011 ***	*0.004*	-0.010	*0.010*	**
equity market	-0.003 **	*0.001*	-0.009 ***	*0.003*	*	-0.004 ***	*0.001*	-0.005 *	*0.003*	
exchange rate	-0.001	*0.001*	-0.001	*0.001*		-0.002 *	*0.001*	0.000	*0.001*	
5-year inflation expectations	0.000	*0.004*	-0.003	*0.038*		-0.001	*0.005*	0.001	*0.011*	

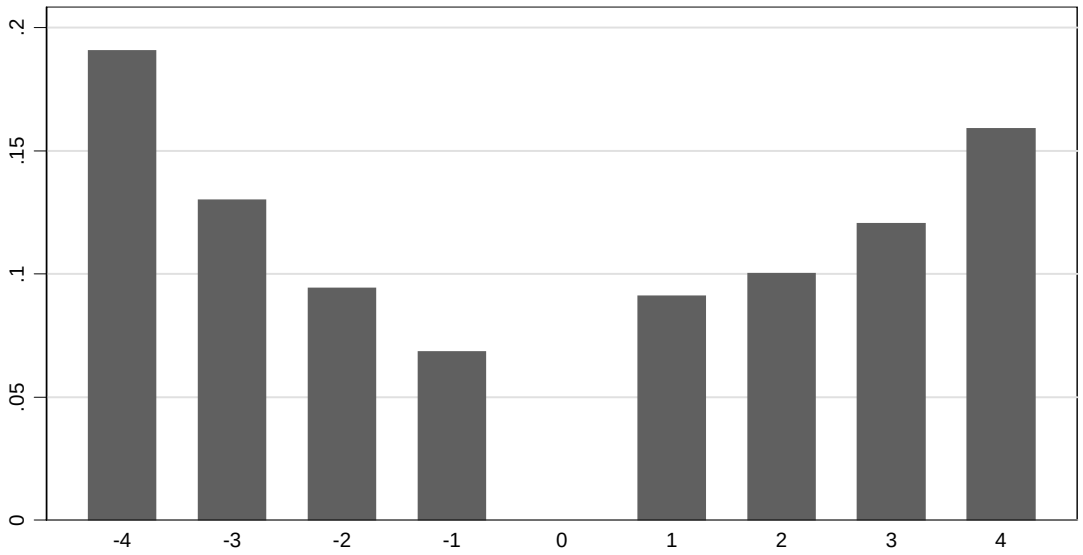
Notes: The table reports the daily reaction of financial market returns to the classified communication variables. Standard errors are shown in italics to the right of the coefficients. ***, **, * indicate significance at the 99%, 95% and 90% levels, respectively. "sign." shows whether difference between the coefficients is significant.

Table 5: Market reaction to communication on *economic outlook* -- by degree of market uncertainty, mean equation

	Uncertainty					Uncertainty				
	Low volatility		High volatility		sign.	Small previous surprise		Large previous surprise		sign.
Federal Reserve										
3-month interest rates	0.004 ***	*0.002*	0.049 ***	*0.004*	***	0.003 *	*0.002*	0.029 ***	*0.005*	***
6-month interest rates	0.010 ***	*0.002*	0.042 ***	*0.008*	***	0.010 ***	*0.002*	0.024 ***	*0.006*	**
1-year interest rates	0.016 ***	*0.004*	0.039 ***	*0.011*	*	0.017 ***	*0.004*	0.037 ***	*0.012*	
2-year interest rates	0.020 ***	*0.008*	0.038 ***	*0.011*		0.015 **	*0.007*	0.086 ***	*0.016*	***
5-year interest rates	0.028 ***	*0.008*	0.021	*0.015*		0.015 **	*0.007*	0.091 ***	*0.015*	***
10-year interest rates	0.023 ***	*0.008*	0.016	*0.014*		0.015 ***	*0.002*	0.073 ***	*0.018*	***
20-year interest rates	0.017 ***	*0.006*	0.007	*0.008*		0.007	*0.006*	0.053 ***	*0.016*	***
equity market	0.004 ***	*0.001*	0.004 **	*0.002*		0.003 ***	*0.001*	0.008 ***	*0.002*	*
exchange rate	-0.003 ***	*0.001*	-0.003 *	*0.001*		-0.002 ***	*0.001*	-0.005 **	*0.002*	
5-year inflation expectations	-0.005	*0.005*	0.012	*0.017*		-0.006	*0.005*	0.055 **	*0.025*	**
Bank of England										
3-month interest rates	-0.003 **	*0.001*	-0.005	*0.012*		-0.004 ***	*0.002*	0.002	*0.006*	
6-month interest rates	-0.006 **	*0.003*	-0.005	*0.030*		0.000	*0.008*	0.016	*0.031*	
1-year interest rates	-0.003 ***	*0.001*	0.009	*0.009*		-0.005 *	*0.003*	0.012 **	*0.006*	***
2-year interest rates	0.001	*0.008*	0.004	*0.029*		-0.001	*0.008*	0.015	*0.032*	
5-year interest rates	0.003	*0.008*	-0.004	*0.027*		-0.003	*0.008*	0.020	*0.017*	
10-year interest rates	0.012	*0.009*	-0.004	*0.019*		0.008	*0.009*	0.016	*0.017*	
20-year interest rates	0.006	*0.007*	-0.018 *	*0.011*	*	-0.002	*0.007*	0.015	*0.014*	
equity market	0.003 **	*0.001*	0.013 **	*0.006*		0.003 **	*0.002*	0.009 ***	*0.003*	*
exchange rate	0.001 *	*0.001*	0.004 **	*0.002*		0.001	*0.001*	0.002 *	*0.001*	
5-year inflation expectations	-0.003	*0.005*	-0.002	*0.016*		-0.007	*0.005*	0.010	*0.011*	
European Central Bank										
3-month interest rates	0.002 ***	*0.001*	0.003 **	*0.001*		0.002 ***	*0.000*	0.008 ***	*0.001*	***
6-month interest rates	0.003 **	*0.001*	-0.001	*0.003*		0.001	*0.002*	0.005 **	*0.002*	
1-year interest rates	0.005 *	*0.003*	0.000 ***	*0.000*	*	0.002	*0.003*	0.004	*0.010*	
2-year interest rates	0.003	*0.006*	-0.005	*0.009*		0.000	*0.005*	0.008	*0.012*	
5-year interest rates	-0.001	*0.005*	-0.004	*0.009*		-0.005	*0.005*	0.008	*0.010*	
10-year interest rates	0.000	*0.005*	-0.003	*0.009*		-0.001	*0.004*	0.000	*0.011*	
20-year interest rates	0.000	*0.004*	-0.006	*0.008*		-0.003	*0.003*	-0.002	*0.008*	
equity market	0.002 **	*0.001*	0.002	*0.003*		0.002 **	*0.001*	0.001	*0.003*	
exchange rate	0.000	*0.001*	0.000	*0.001*		0.000	*0.001*	0.001	*0.001*	
5-year inflation expectations	0.002	*0.003*	-0.020	*0.013*	*	0.001	*0.002*	-0.011	*0.010*	

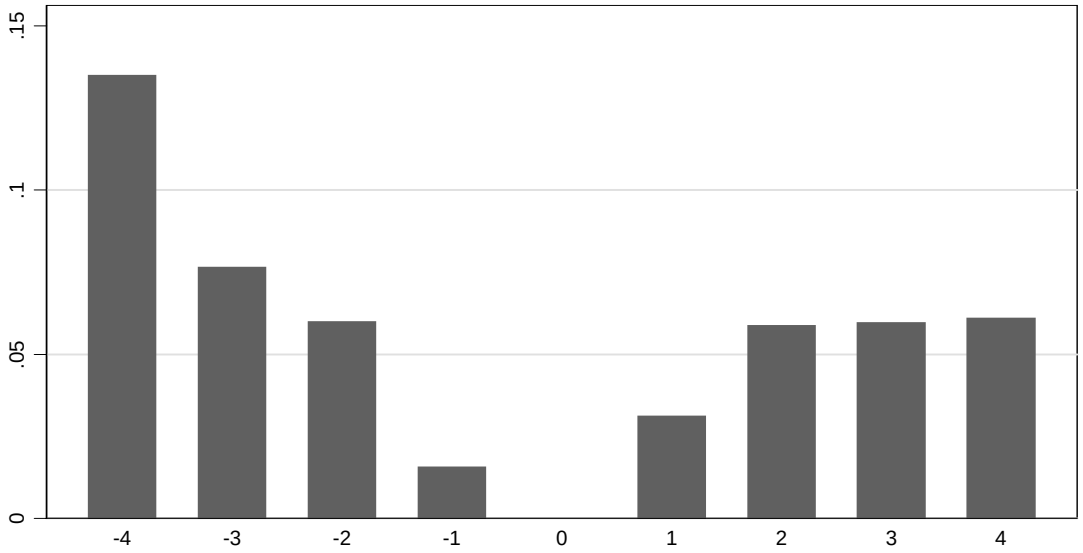
Notes: The table reports the daily reaction of financial market returns to the classified communication variables. Standard errors are shown in italics to the right of the coefficients. ***, **, * indicate significance at the 99%, 95% and 90% levels, respectively. "sign." shows whether difference between the coefficients is significant.

Figure 1.a: Frequency of communication around meetings of the Federal Reserve's FOMC



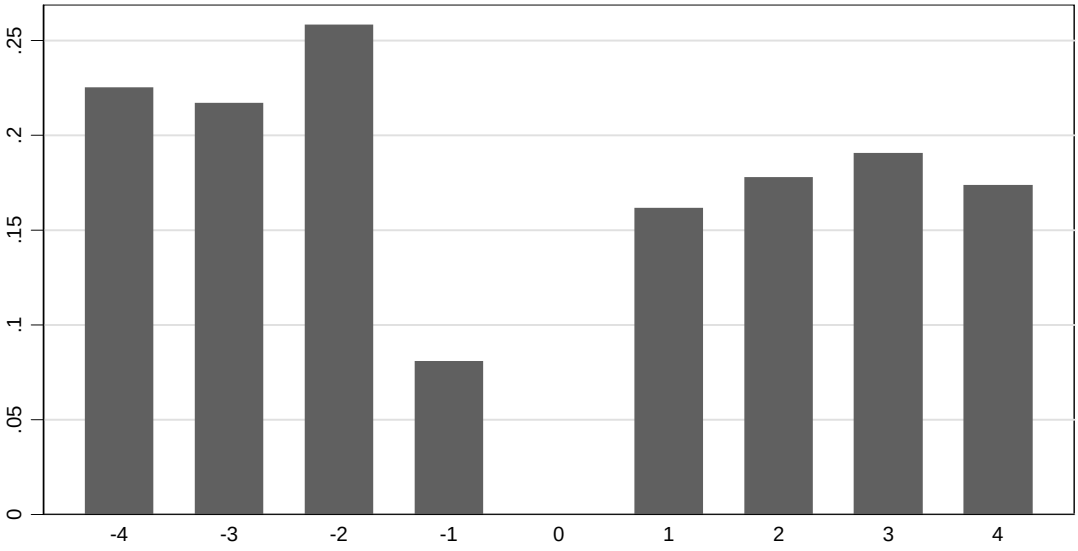
Notes: The vertical axis indicates the fraction of days in which communication takes place. The bars aggregate data from four days (i.e., bar "-1" contains days 4, 3, 2 and 1 before a meeting of the decision-making body). The first and last bars additionally contain 9 observations on days beyond ±16.

Figure 1.b: Frequency of communication around meetings of the Bank of England's MPC



Notes: The vertical axis indicates the fraction of days in which communication takes place. The bars aggregate data from three days (i.e., bar "-1" contains days 3, 2 and 1 before a meeting of the decision-making body).

Figure 1.c: Frequency of communication around meetings of the ECB's Governing Council



Notes: The vertical axis indicates the fraction of days in which communication takes place. The bars aggregate data from two days (i.e., bar "-1" contains days 2 and 1 before a meeting of the decision-making body). The first and last bars additionally contain 22 observations on days beyond ±8

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