

# Dispersion of the Central Bank Communication and Effects on Market Uncertainty

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## **Abstract**

This paper explores the dispersion of Central bank communication in European Central Bank and Federal Reserve in 2005-2010. It shows that the effects of CB communication on market volatility are strongly conditional on the communication strategies and monetary policy goals in both central banks. It suggests that deviation from the communication strategy may have harmful effects on financial markets.<sup>1</sup>

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# 1 Introduction

”Diversity of views drives the (Federal Open Market) Committee to adopt an eclectic approach and thus serves to limit the risk that a single viewpoint or analytical framework might become unduly dominant” (Bernanke (2007))

”Bouts of economic and financial market turbulence over the past 25 years have shown policymakers that transparency is the best protection against contagion from such events– lucid analysis, speedy action, and consensus between experienced heads will also help minimize contagion.” (Trichet (2007))

Recent years, especially from 2008 onwards, have been challenging for the economies around the world and forced central banks (CB's) to choose unconventional monetary policy tools. After the collapse of Lehman Brother, which was consequence of the burst of the housing bubble in the U.S, financial crisis developed and spread rapidly to the real economy and financial sector by freezing the international banking system. The housing market in the U.S crashed, which had significant effects on real economy and on other major economies as well.

Federal Reserve (Fed) used both traditional and unconventional tools to avoid liquidity trap and support the economy. It made rapid decreases in the Federal funds rate and cut it by 5.25 percentage points to near zero level between September 2007 and December 2008. In addition to rate cuts it used quantitative easing in the middle of the crisis: Federal Reserve announced in November 2008 that it starts to buy worth 600 billion dollars of mortgage-backed securities. The operation was called QE1. After that, in November 2010 it told in public that it continues to reflate the economy and announced to buy worth 600 billion of treasury securities, which was named as QE2.

The financial crisis was realized in European banking system in November 2008 as the banking and insurance giant Fortis was partly nationalized. Already before that, in December 2007, the European Central Bank (ECB) started to add the funding in the banking system but the target rate reductions started not before October 2008: the ECB cut its policy rate by 3.25 percent points to 1.0 percent between October 2008 and May 2009.

The second wave of the crisis, debt crisis in Europe, began in October 2009, when Georg Papandreou, Prime Minister of Greece, told that his country's finances are in "a state of emergency". Few months later, in May 2010, Greece became the first Euro zone country to receive a bailout. During the same month, ECB announced program to buy government bonds of Euro zone members from the secondary markets. The threat of collapse in European banking sector urged the ECB to support banks by using short and

longer-term financial operations to ensure liquidity in the system.

New measures of the monetary policy and rapidly changing economic outlook have brought new elements to CB communication as well. This paper studies the dispersion of the CB communication and its influence on financial markets in 2005-2010. The sample period covers pre-crisis period and crisis period and makes therefore possible to compare communication under different economic circumstances. The basis of the study is in the assumption that although clarity of the communication is beneficial for the CB, always dispersion is not a accidental in terms of risen market uncertainty but should be assessed together with the communication strategy of the CB. On the other hand, under certain communication strategy, communication dispersion might have negative effects on financial markets. The focus is on the two major CB's in the world: European Central Bank in the Euro area and Federal Reserve System in the United States.

The global crisis hit both areas, Euro zone and United States, with significant force. It is interesting to compare these two CB's, because they have different monetary policy mandates but similar structure of the economy as both operate in developed economies. ECB has maintaining price stability as its primary objective in the monetary policy decision making, and it has set inflation goal of below but near 2 percent over the medium term. On the other hand, Federal Reserve has dual mandate which consists of promoting maximum employment and stable prices. Also moderate long-term interest rates are one of the goals of Fed.

Based on the assessment of the monetary policy goals, larger communication dispersion in Federal Reserve would be more plausible. Several goals can make the monetary policy decision-making process but also communication more diverse, as the monetary policy committee members may prefer some goals over others. Research by Ehrmann and Fratzscher (2007b) has showed that dispersion of communication was higher in Fed than in ECB in 1999-2004. Their study is the great motivation of this research. It discussed the communication strategies of the Fed and ECB in the beginning of 2000's, and concluded that effectiveness of communication is conditional on the decision making process of the CB. They found out that Fed follows individualistic communication strategy with collegial decision making strategy, while in the ECB both decision making strategy and communication strategy are collegial. The differences affect the effectiveness of communication as well: in Fed, the CB governor had greater impact on financial markets than other FOMC members, whereas in ECB all decision makers, i.e. governing council members, influenced financial markets in similar way. This research takes a step forward and studies the change of communication. It assumes that when the economic conditions are less uncertain, communication will be more challenging for the CB, which can lead to increased dispersion in communication as well. When using findings by Ehrmann and Fratzscher (2007b) as a basis, it would then mean that ECB, which is using

collegial communication strategy, would at some point deviate from its communication strategy. The hypothesis gets support from the study by Bulir, Cihak, and Jansen (2012), who argued that global financial crisis made the communication less clear in wide set of CB's, where ECB was included as well.

The main hypothesis is that deviation from the communication strategy may have risen uncertainty of the market as a consequence in ECB. On the other hand, as Fed has more than one monetary policy goals and more individualistic communication strategy, more dispersion would not increase uncertainty in market. Federal Reserve chairman Bernanke (2007) has emphasized the meaning of the diversity of views, and his positive view to dispersion as a part of communication strategy was found in the opening citation of this research. It signals that communication strategy by Fed is more creative: FOMC members are allowed - or even encouraged - to present their views in public. Market participants have therefore freedom to form their own balance of monetary policy views and expectations concerning the future monetary policy.

On the other citation the former ECB governor, Jean-Claude Trichet, wants to emphasize the importance of consensus between policy-makers as market turbulence minimizer. This kind of consensus-seeking policy is most predictable, when communication is as collegial as possible. That kind of more restrictive communication strategy on terms of content is performing well at the times when economic situation is stable, but during instable economic situation and risen uncertainty the restrictive communication strategy may face challenges.

Contradictory view to Bernanke's citation is presented also in citation by Issing (1999), which has focus on the ECB communication.

"For a new and supranational institutions like the ECB, it is particularly important that it sends clear and coherent messages to the markets and the wider public. More 'words' do not necessarily mean 'more information', and 'more information' does not necessarily and by itself contribute to greater clarity" (Issing (1999))

Issing argues that all transparency might not necessarily be beneficial, and in order to communication be successful it must be not only open, but also clear, which was the case in the first years of the ECB communication. This thesis follows Issing's view in ECB communication, but suggests that in order to have positive effects in markets, communication need not to be clear in a way that the dispersion of the policy makers' stances is as low as possible. The key in studying the benefits and costs of communication is to link the dispersion discussion to studies of communication strategies.

However, although question how to talk is in focus of this study, CB communication strategy includes also other aspects. One is timing: Ehrmann and

Fratzscher (2009) and Ehrmann and Fratzscher (2007) have examined the communication during the periods before monetary policy committee meetings. They showed that frequency of communication decreased significantly before FOMC meetings. The silence before the meeting is called *purdah* in paper by Ehrmann and Fratzscher (2007), and they define it as a guideline to communication and being a part of Fed's communication strategy. Their main finding was that communication is most effective, i.e. it increased the excessive market volatility, during the silent period before monetary policy announcements. In their another study Ehrmann and Fratzscher (2009) showed that asset returns are sensitive to the communication prior to interest rate changes in ECB and Fed. The studies by Ehrmann and Fratzscher show that deviating from the communication strategy in terms of timing can lead to increased volatility in markets. This study wants to discuss, whether deviation in terms of content of communication can have similar effects.

This paper makes several contributions to the existing communication literature. It is the first to examine the influence that communication dispersion exerts on daily financial markets volatility patterns. Secondly, it uses fresh high-frequency data set to distinguish between pre-crisis and crisis communication, which makes the comparison under different economic conditions possible.

Although the idea of dispersion studies has been introduced earlier (see for instance Rozkrut, Rybinski, Sztaba, and Szwaja (2007)), it has not been applied this way to measure if the implications of monetary policy communication clarity are positive or negative. Instead of only measuring, does the communication have effects on financial markets this study asks what kind of effects are there.

Impacts of communication unanimity is analyzed by first determining the communication styles of ECB and Fed. After that, empirical EGARCH model is used to analyze, if CB communication has predictive content on market volatility.

A central finding of this paper is that dispersion of communication can vary in time, and under altered economic conditions the message of the CB becomes less unanimous. However, the implications on the financial markets may vary significantly between central banks. The results of this study suggest that the communication dispersion, and deviation from the communication strategy, tend to predict increased market volatility in the ECB, whereas lack of unanimity in Fed communication and maintaining the communication strategy during the financial crisis, predicted lower volatility in U.S financial markets. This study suggests that unanimous communication is essential factor in conducting ECB communication strategy, which should be collegial as Ehrmann and Fratzscher (2007b) suggested. On the other hand in Fed, where communication strategy is more individualistic compared to ECB, it is easier to maintain also under the economic uncertainty and is therefore less harmful to the markets. In this sense word clarity in

the context of communication strategies has two different meanings: in ECB clarity can be enhanced by improving the clarity of the content to more collegial direction, whereas in Fed clarity means clarity of the message, i.e. that policy makers express their views explicitly.

## 1.1 Earlier literature

Over the last years, CB communication literature has grown significantly. The status of CB as important source of market reactions has motivated the communication research, because CB actions and communication are closely linked. Studies concerning CB actions have taken place a little earlier than communication research. Bernanke and Kuttner (2005) studied the effects of unanticipated Fed monetary policy changes on asset market returns. By using event study method, they found that broad stock market indices react to 0.25 % target rate reduction by increasing 1 percent. Bomfim (2003) got similar results in terms of effectiveness. He argued that positive surprises in target rate changes tend to have larger effects on stock market volatility than negative surprises.

In addition to monetary policy decision-making processes, also majority of the communication studies has had focus in the effectiveness measures. Rosa and Verga (2007) assessed the effectiveness of communication practices of the ECB in 1999-2004 and concluded that communication moves the European financial markets. Ehrmann and Fratzscher (2007b) compared the communication effectiveness of ECB and Fed in 1999-2004. In the case of ECB financial markets react to statement by all policy makers in a similar way, but in Fed governors' statements are watched more closely than other policy makers. In their other article, Ehrmann and Fratzscher (2007) concluded that not only status matters, but also content of the communication and statements which are line with the current monetary policy stance weigh more by markets. In this sense, market participants anticipate no changes in communication.

Market participants use CB communication to get information on the monetary policy stance and economic outlook. In some studies communication has become even more important factor than the actual policy decisions especially in interest rates. Kohn and Sack (2003) concluded that longer Treasury forward rates are driven more by what the Federal Open Market Committee FOMC says than what it does. In their research the power of words was even higher than power of deeds, which gave communication a great importance. Rosa and Verga (2007) got similar results while studying the ECB communication. They concluded that ECB can influence some Euribor rates more effectively by using unexpected words compared to deeds. Motivation of this research is in axiomatic importance of the CB communication. Communication is closely linked to discussion about Central Bank

transparency and credibility, because it enhances the understanding of public which are Central bank's goals and what it does to achieve these goals. Transparency has become essential topic in the monetary policy decision-making process and western CB's have improved their communication during past years. For instance Fed started to organize press conferences after the committee meetings and improved the clarity of its talk by pledging to keep the target rate at low level for a certain, pre-determined time period in 2011.

Because of imperfect information, communication is the main factor in improving transparency by informing private sector about CB's goals and anchoring the inflation expectations. Weber (2010) argues, that market participants have imperfect information about the state of the economy and about the policy preferences of the decision-makers. Communication can reduce the information gap of the private sector and CB. In that discussion, Issing (2005) emphasizes the quality of communication and argues that under imperfect information any misperceptions of monetary policy activity can cost markets dearly. Also Blinder (2004) emphasizes the clarity aspects and argues that communication may have cacophony problem, which arises from the diversity of voices. He proposes that too many conflicting messages causes a danger, which might confuse rather than inform the public. This paper uses the theoretical framework of Blinder (2004) and Issing (2005) to discuss, how CB communication strategy reveals policy-makers preferences and does the unclarity in communication have negative consequences, or costs, in financial markets.

De Haan, Eijffinger, and Waller (2005) have underlined the consistency in the monetary policy communication process. They argue that "the best way for a central bank to earn credibility is to have a history of doing what it says it will do". This consistency of words and deeds, i.e. predictability, of CB communication has been one of the main topics of communication studies. Ehrmann and Fratzscher (2007b) and Jansen and de Haan (2006) have focused on the communication predictability of the ECB and Fed (see also Rosa and Verga (2007)). Their main conclusion was that both CB's have highly predictable communication policies. Especially in the ECB the predictability has improved over time (Jansen and de Haan (2006)).

Bulir, Cihak, and Jansen (2012) studied clarity in inflation reporting of seven CB in industrialized and developing countries. Their results indicate that CB's were able to clearly explain their policies when facing a less favorable inflation outlook. Still, last global financial crisis made communication less clear.

Like Bulir, Cihak, and Jansen (2012), this paper assumes that the effects of communication are emphasized when the economic uncertainty is high. The study uses the content analysis of the CB communication and discusses, how the change in economic environment affected CB communication. In addition to that it examines, did possible noise in CB's messages added volatility

in financial market indicators.

## 2 Measuring central bank communication

Measuring central bank communication dispersion requires the analysis of the content of the communication. Before the analysis, several issues concerning research data require clarification.

This paper uses the paper by Ehrmann and Fratzscher (2007b) as a motivation and examines, is CB communication conditional on economic environment, and can it vary in time. It uses similar classification into collegial and individualistic communication and decision-making strategies as Ehrmann and Fratzscher (2007b), and focuses on the discussion of content of the communication.

Firstly, the classification must be made into types on information. Central bank communication can be divided into two, formal and informal, by distinguishing the sources of communication. Official communication includes monetary policy decisions, press conferences, minutes of the decisions and monthly bulletins. It refers to the monetary policy committee as a whole and is pre-scheduled. The main source of communication is its own channels, for instance CB's website.

Informal communication consists of committee members' statements, which are published in media, usually by international news agencies like Reuters and Bloomberg, and is therefore filtered and unscheduled information. This study focuses on the informal communication, because it adopts financial markets perspective while examining the consequences of the communication and because informal communication provides instant view from central bankers to the market. This paper assumes that financial crisis made informal communication even more important information source of market participants, because economic conditions changed rapidly and new information was needed desperately to reduce the information gap of the market participants. Evidence for the argument is shown in paper by Ehrmann and Fratzscher (2007), which suggests that the response of financial markets to CB communication is significantly larger under increased uncertainty than under "normal" times.

Informal information is here used to define the communication conventions of ECB and Fed. The purpose is to examine, how CB's communication reveals transparency, especially clarity, in practice, i.e. how consistent are policy-makers' statements in news and what kind of implications it has on market uncertainty. This paper focuses on informal side and formal information, like actual monetary policy decisions, is completely excluded from the empirical analysis.

This paper adopts the financial markets perspective to measure the infor-

mation that market participants receive from the CB. For this purpose, Reuters' archive Factiva was used in data collection and the news were filtered following what decision makers said according to the news agency.<sup>2</sup> Research material included:

- 961 news topics from Federal Reserve and
- 1212 news topics from European Central Bank in 2005-2010.

In order to get inclusive data, the research material consists of policymakers' interviews or citations in Reuters News but also quotes of other media agencies. Policymakers include FOMC's 19 members (seven governors of the Board of Governors and 12 presidents of Federal Reserve Banks). Distinction between voting members and non-voting members is not made because all of the members participates FOMC meetings. For the Governing Council of the ECB 6 Executive Board members including the president, and 14 governors of the national Central Banks are involved. Only individual statements are included in the material, and therefore statements by the FOMC or Governing council as a whole are excluded. Also statements which had undefined or anonymous source (for example "ECB official") are excluded from the research material.

In order to find out the stances of individual committee members, the statements required classifying. After collecting the information it was divided into two different categories based on the topic: views about monetary policy and economic growth. Nearly similar classification methods are used by Ehrmann and Fratzscher (2007b) and Jansen and de Haan (2006).

Classification of the each statement in both categories was made by dividing the groups into "dovish" and "hawkish" according to the stance of the news. Statements were defined as dovish, if they included sentences, which supported monetary policy easing. Specification was referred as hawkish, if it included news about tightening monetary policy. Monetary policy statements ranged from very hawkish to very dovish (range was +2,+1,0,-1,-2), but statements about economic outlook were either neutral (0) or dovish (-1). This procedure was used, because researcher wanted to emphasize the importance of monetary policy statements and it was difficult to identify and there were lack of hawkish statements about economic outlook.

Classification was completed with following enumeration.

- +2 strongly hawkish monetary policy stance

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<sup>2</sup>in the search process words ECB and Fed were used. After that, relevant news were filtered by checking the headlines and contents of the news.

- +1 hawkish monetary policy stance
- 0 neutral view of monetary policy/economic growth
- -1 dovish monetary policy stance/fear of worsening economic growth
- -2 strongly dovish stance of monetary policy

This kind of classification is often determined as content analysis <sup>3</sup>. Appendix shows some examples of used sentences and headings. The classification process is based on researcher's own interpretation about the content and therefore some subjectivity always appears in analysis. That is one limitation of the research and can affect the reliability aspects.

Because of the subjectivity there is chance of misclassification in the publishing process as well. News agency might have misinterpreted the statement already before publishing, which might affect the message of the news and sends a misleading information to the market participants. These facts must be emphasized before analysis, but they cannot be identified, because it is impossible to recognize news agency misclassification or the level of subjectivity.

Total amount of statements was 961 in the case of Fed and 1212 for the ECB. Activity of the CB communication was relatively high, and increased in 2008-2009 when both central banks made monetary policy changes. Lowest frequency was under 10 statements per month, and highest over 50 per month for ECB and over 40 for Fed. Frequency of the statements show that the communication was relatively open in both CB's during the research period.<sup>4</sup>

Amounts of statements in each group were following: 389 statements about economic outlook and 572 statements about monetary policy stance in the case of Fed and likewise 431 news about economic outlook and 781 news about monetary policy in ECB.

Majority of the news, 60,0% in Fed and 64,4 % in ECB, was policy-makers' views about the monetary policy. The popularity of monetary policy stance

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<sup>3</sup>one used measure for content analysis is heuristic measurement approach, where each sentence is assigned a subjective score. Heuristic index was discussed by Lucca and Trebbi (2009), who introduced two other measurement indicators, Google semantic score and Factiva-based score as well

<sup>4</sup>Frequency and the content of the news is controlled in this study by choosing only one statement concerning each topic, monetary policy and economic outlook, by each decision-maker per each day. That means only one statement concerning monetary policy and one about economic outlook are taken into account at the daily level for each policy-maker. By restricting the amount of statements content and frequency bias can be avoided.

is based on the view that under the pressure of financial and economic instability policy-makers were forced to act decisively to the altered and changed economic conditions. Unconventional measures added the frequency of communication as well.

## 2.1 Communication dispersion measures

This section studies the dispersion of the policy-makers' statements. It has been in interest of some of the researches in early 2000's, but there has been lack of studies with a fresh data set.

Ehrmann and Fratzscher (2007b), Rozkrut, Rybinski, Sztaba, and Szwaja (2007) and Jansen and de Haan (2006) have all studied the dispersion of the communication. Ehrmann and Fratzscher used the standard deviation as a dispersion measure to define the communication strategy of the ECB and Fed. As was earlier mentioned, they found out that ECB has more collegial communication strategy, whereas Fed uses more individualistic strategy.

On the other hand, Jansen and de Haan focused on the ECB communication after establishment of the EMU in 1999-2002. Their main conclusion was that over the years, statements concerning interest rates have become more consistent with each others. Rozkrut et al (2007) found out that CB communication strategies had effects on financial markets and on the predictability of monetary policy in Czech Republic, Poland and Hungary. They showed that when using individualistic decision-making strategy it is essential to provide information to public even if it comes at the cost of unanimous communication. Until now, their research has been the only one, which has examined the market reactions to CB communication dispersion. The purpose of this study is to fill the research gap and use high frequency data to examine the effects of dispersion, as all of the three previous studies had period between two monetary policy meeting as a time measure.

Dispersion is defined for statements concerning economic outlook and monetary policy, and there are variety of instruments to start with. Jansen and de Haan (2006) used dispersion indicator in measuring the disagreements among the policy-makers. Statements were coded as (1,0,+1) by using the classification into hawkish, dovish and neutral stances as basis. The indicator was then computed by following way:

$$Dispersion = \frac{n^+n^0 + n^0n^- + 2n^+n^-}{0.5(n^2 - d)} \quad (1)$$

where n was the total number of the statements per event window and d was 1 if n was odd number and 0 otherwise. On the other hand, while examining the different views between governors and other committee members in Hungary, Poland and Czech Republic, Rozkrut et al (2007) used consensus

ratio to measure the dispersion. It was computed by following way:

$$Consensusratio = \frac{\sum_{i=1}^n (\sum_{j=1}^k (ST_{t-i,j}^{MP}))}{\sum_{i=1}^n (SUM_{t-1}^{STMP})} \quad (2)$$

Consensus measure was net balance of monetary policy inclination statements and committee communication in relation to the total number of statements in the period between two monetary policy meetings.

Although all the measures may result to robust results, in this section regular statistical dispersion measure, standard deviation, is conducted to calculate the monthly differences of the Central bankers' views in observed time period 2005-2010. Similar measure was used also by Ehrmann and Fratzscher (2007b).

$$\omega_k^{MP} = \frac{\sqrt{N \sum_i (C_i^{MP+EC})^2 - (\sum_i C_i^{MP+EC})^2}}{N(N-1)} \quad (3)$$

$$\omega^{MP+EC} = \frac{\sum_{k=1}^k \omega_k^{MP+EC}}{k} \quad (4)$$

The standard deviation measures the sum of dispersion of central bankers' stances in certain time period. N is total number of statements and k refers to the time period, which is one month in this section. In empirical part time period is shorter, one day, which requires other methods for calculating dispersion. Letter i refers to each decision-maker in FOMC and in General Council.

Dispersion analysis can be divided into two, pre-crisis and crisis, periods. Figures 2 and 3 in Appendix indicate that before the consequences of financial crisis materialized in the end of 2007, disagreements among the policy-makers focused on the discussion about tightening monetary policy versus keeping it unchanged. On the pre-crisis period, the frequency of disagreements was lower than during crisis and was concerning issues about expansionary monetary policy vs. keeping it unchanged, i.e. the stances were either hawkish or neutral. In Fed the dispersion was at lowest level in 2006 and in the ECB in 2005.

Under the crisis in 2008-2009 dispersion was constantly higher each month, 0.4-0.9 in Fed and 0.4-0.8 in ECB, which indicates that uncertainty in policy-makers' stances affected their communication. Standard deviation of the statements fluctuated significantly and peaked in the case of Fed in July-August 2010, when economy was instantly recovering. Argument for risen dispersion can be found from the opposite views about future monetary policy stance: two groups were formed based on the opponents and supporters of quantitative easing programs. In the case of ECB dispersion decreased during 2010, although the debt crisis was already arising in the Euro area.

That's partly because the consequences of Greece situation realized not before 2011. Altogether the data shows that financial crisis in 2008-2009 increased the communication dispersion in both central banks.

When studying communication strategies Ehrmann and Fratzscher (2007b) argued that Federal Reserve is following more individualistic communication strategy, whereas ECB decision-makers use more collegial strategy. This paper's results suggest that during the crisis, both CB's leaned to individualistic approach of communication. Disagreements in the stances of policy-makers were relatively high, which indicates that the communication conventions can vary in time.

The results show that communication dispersion is dependent on the current state of the economy: weakened economic outlook increases the uncertainty concerning the policy-makers stances and the dispersion in communication in both central banks. Results indicate that although CB has monopoly in monetary policy setting and advantage of information, its policy-makers face uncertainty resulting from the weakened economic outlook. The uncertainty then increases the dispersion in the policy-makers statements. At the same time, under economic instability, market agents require new information concerning the economic and monetary policy developments, which make communication even more necessary compared to more stable economic times. Next empirical section discusses, how the change in communication affects the financial markets.

### **3 Predictability of the monetary policy**

Communication is often seen as a tool to prepare markets for forthcoming changes in the monetary policy, and therefore it is essential to discuss the predictability of the monetary policy. As previous section concluded, the dispersion of the communication among central bankers increased in financial crisis. The linkage between communication is following: if communication causes market agents to revise their expectations, this should be then reflected in higher volatility of financial markets. Ehrmann and Fratzscher (2007) argue that communication is important tool especially before interest rate changes but also in the aftermath of the changes: if market participants were surprised in the previous meeting, they may need guidance on what to expect from the future decisions, i.e. their expectations need updating (Ehrmann and Fratzscher (2007), p.133). If monetary policy is unpredictable, communication has even more essential role as a market guidance.

Predictability means the consistency of expected and actual monetary policy decisions, and with it CB can reduce noise in the market. A way to measure predictability of the monetary policy decision making is to com-

pare the actual decisions with private sector's forecasts. Here expectations were computed from the Reuters consensus figures. The research period was 2007-2010<sup>5</sup> and the data covers therefore the pre-crisis and crisis periods. Predictability is measured by firstly comparing the expectations, i.e. median forecast from Reuters consensus before the target rate decisions, to actual decisions. Secondly, range of the forecast is included to find out, if there is deviation among the individuals' expectations<sup>6</sup>. Predictability measures are collected into Table 1.

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<sup>5</sup>Extensive data from years 2005-2006 was not available

<sup>6</sup>forecast figures are usually collected from the biggest commercial banks in U.S and Euro zone. Number of pollers in U.S was 16-18 and in Euro zone approximately 80.

In both central banks, financial crisis had effects on the predictability of monetary policy decisions. As discussed before, the consequences of financial crisis had earlier effect on U.S economy. In pre-crisis period January 2007-August 2007, the forecasts were equal to actual target rate decisions and there was no range in expectations, i.e. the monetary policy was very predictable. Situation changed rapidly in September 2009 when Fed started its target rate reductions. The crisis period with widened range of forecasts continued until December 2008. There was range in forecasts altogether in 7 meetings, which signaled the increased uncertainty of pollers and was 15 % of the total meetings in 2007-2010. In addition to pre-scheduled FOMC meetings the data included 7 unscheduled conference calls. FOMC decided to decrease target rate during two conference calls, in January 2008 and October 2008. These unscheduled and unexpected decisions were naturally surprises for the market participants. The monetary policy decision was unexpected in three anticipated meetings, which also reflected the lack of information in the market.

Communication had similar fashion in ECB, where range of forecasts started to widen in July 2008. The range was unequal to zero in 8 meetings, 16 % of all meetings in the sample period. In Euro zone, the period with increased range of forecasts lasted one year until July 2009, and after that communication was again predictable with no policy surprises or ranges in forecasts. The crisis period included two monetary policy surprises and one unscheduled interest rate decision, which was at the same time with Fed in October 2008. Otherwise ECB had less unscheduled meetings than Fed.

The study indicates that monetary policy was less predictable in both CB's during the financial crisis compared to pre-crisis times. In ECB and Fed, policy was perfectly predictable during the pre-crisis periods. Naturally rapid changes in target rates were one reason to lack of information, which made the communication about future monetary policy decisions more important factor for the market participants. As Ehrmann and Fratzscher (2007) argue, markets were often surprised during the crisis, and needed further guidance on in which direction to update their forecasts. Decreased predictability of monetary policy decisions combined to increased dispersion indicate that the dispersion in the CB communication may have affected to some market expectations with risen "noise". Next section discusses the empirical results of these changes.

## 4 Empirical analysis

In order to investigate whether dispersion of the CB statements in Fed and ECB influence the expectations of the market agents, it is essential to measure the reaction of market variables on the statements. The goal is to

examine, how the level of asset prices and volatility of log returns in stock market variables (Eurostoxx, S&P500 indices), exchange rates (EUR/USD) and both short and longer-term interest rates (euribor rates with maturities of 1,3,6 and 12 months, German government bond yields with maturities of 5 and 10 years, U.S Treasury t-bills with maturities of 1,3 and 6 months and treasury bond yields with maturities of 5 and 10 years) react to the statements.

The goal is to study effects of communication by focusing both level of asset prices and degree of volatility, but the main interest is in latter aspect. Therefore the effect of communication is estimated on asset price returns  $r_t$  and asset price variance  $\sigma_t$ , which is here used to describe the uncertainty of the market. Estimation is done with exponential GARCH(1,1), or EGARCH, model introduced by Nelson (1991). It specifies the conditional variance of the dependent variable and allows negative returns. EGARCH is well fitted model to volatility estimation, because it captures the volatility clustering. Therefore it is widely used in CB communication literature<sup>7</sup> (see e.g. Ehrmann and Fratzscher (2007b), Ehrmann and Fratzscher (2009), Rozkrut, Rybinski, Sztaba, and Szwaja (2007), for overview of the methodological framework, see Greene (2002)).

The model is estimated via maximum likelihood estimation by using normal distribution. It consists of two equation, mean equation and variance equation. Conditional mean equation is formulated by using past returns  $r_{t-1}$ , and dummies DISPDUM, MACRODUM and DISPDUM\*TIMEDUM as regressors to assess the effect on asset prices. Conditional variance equation had the same regressors, but also variable of past variance,  $h_{t-1}$  and innovations,  $\epsilon_{t-1}$ , were included. It is assumed that  $\epsilon_t = \sqrt{h_t} * v_t$ , where  $v_t$  is an i.i.d sequence with zero mean and unit variance. The mean equation and variance equation are following:

$$r_t = \alpha + \delta r_{t-1} + \theta_1 DISPDUM_t + \theta_2 MACRODUM_t + \theta_3 DISPDUM * TIMEDUM + \epsilon_t$$

$$\ln(\sigma_t) = \gamma + \beta_1 \left( \left| \frac{\epsilon_{t-1}}{\sqrt{\sigma_{t-1}}} \right| - \sqrt{\frac{2}{\pi}} \right) + \beta_2 \left( \frac{\epsilon_{t-1}}{\sqrt{\sigma_{t-1}}} \right) + \beta_3 \ln(\sigma_{t-1}) + \lambda_1 DISPDUM_t + \lambda_2 MACRODUM_t + \lambda_3 DISPDUM * TIMEDUM + \lambda_4 TIMEDUM$$

DISPDUM is dummy variable, which refers to dispersion of the statements. It is defined as differences of the means of the stances on each day, and

<sup>7</sup>about the weaknesses of GARCH models, see Tsay (2002)

includes statements concerning both monetary policy and economic outlook topics.<sup>8</sup> For example, if mean of the stances was 1 (hawkish) on certain day and -1 on the following day, the difference of the means was -2.<sup>9</sup>

DISPDUM gets the value 1 if there is dispersion in statements, i.e. when the daily difference coefficient is unequal to 0. If there were days without communication, the difference was calculated from the previous day with communication. Pictures describing the mean and difference of the mean over time can be found in Appendix.

Because of the challenging times in the economy, also news concerning the real economy must be taken into account. Variety of studies has shown that macroeconomic announcements has a significant role in enhancing market movements (see for instance Andersen, Bollerslev, Diebold, and Verga (2003), about state dependency Laakkonen and Lanne (2010)). Dummy variable MACRODUM controls the economic surprises, which may affect the volatility of the market. It gets value 1 when there is surprise, positive or negative in macroeconomic indicator announcements<sup>10</sup>. Surprise is positive if the announced figure is higher than market expectations and negative if the figure is lower than expected. For the days with no data release or with no surprise the variable is set to get value 0. Market expectations were calculated for each day from Reuters consensus figures (interest was in the median expectations), which were announced before publishing the actual indicators. Monetary policy announcements were excluded from the news shocks.

Regressor DISPDUM\*TIMEDUM is computed to capture the changes on economic conditions. TIMEDUM gets value 1 at the time of crisis. As financial crisis landed to Europe later than to U.S and on the other hand ended in U.S earlier than in Europe, crisis periods were different. For U.S. crisis period was July 2007-December 2008 and for Euro area 2008-2010. With regressor DISPDUM\*TIMEDUM is therefore possible to capture, whether financial crisis changed the effects of communication somehow.

Estimation coefficients are collected into table 2 (variance equation). Because we are mostly interested in variance equation, the estimation results of mean equation are in Appendix.

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<sup>8</sup>The two classes, monetary policy and economic outlook, are combined, because this paper assumes that information about economic conditions became as important as information about future monetary policy decisions under the crisis.

<sup>9</sup>Difference of the mean is best to describe the daily dispersion, because it defines the changes in the daily level. In addition to that, dispersion measures, which are introduced earlier, would not fit to high frequency data because of lower amounts of daily statements.

<sup>10</sup>Economic indicators consisted of the following real activity indicators in both areas: industrial production, retail sales, unemployment, (in U.S non-farm payrolls), confidence indicators like consumer confidence, ISM-indices in U.S and Ifo in Euro area. Finally price development indicators, as PPI and CPI were included into MACRO variable.

## 4.1 Results

Dummy DISPDUM is the most crucial variable in interpretation of the results. The results of the mean equation show that communication dispersion did not enhance market movements when focus was on asset price levels. But the results were significant in variance equation, which described how well the communication predicted market uncertainty and was main focus in this research.

Results reported in Table 1 suggest that dispersion of monetary policy communication,  $\lambda_1$ , predicted the volatility of asset prices in both Euro area and United States, but implications were different. Communication had most significant effects on the longer interest rates, bond yields and Eurostoxx index in the Euro area, where almost all coefficients were significant. Impact was strongest in 3- and 6-month euribor rates with coefficients 0,51 and 0,26, and lower in Eurostoxx and 5 and 10 year bond yields, 0,07-0,08. It is crucial to note that in all these coefficients are positive, which indicates that dispersion in the communication increased the volatility in these market measures. There was only one exception, 1-month euribor rate, in the estimation. The results indicate that the less unanimous decision-makers are under collegial decision-making strategy, the more it adds uncertainty of the market. The results of the ECB indicate that dispersion of the communication can be harmful especially in the CB with collegial decision-making manners and therefore unanimous communication with low dispersion and clear content, as Issing (1999) suggested, is the most optimal for Euro area. In the case of Fed the implications were mostly opposite. Coefficients were negative and significant in most Treasury bills, and S&P500 index was the only exception. The coefficients were highest in 1-month t-bill, -0.34. Negative coefficients indicate that dispersion of the communication might actually decrease the volatility of the market. This implies lower uncertainty and is beneficial for the CB as it enhances the market agents understanding of the CB thinking and forming the balance of the FOMC's view based on the stances of individuals. The results support Ben Bernanke's view about the benefits of diversity of views in CB decision-making process.

The coefficients of the variable DISPDUM\*TIMEDUM,  $\lambda_3$ , showed, how volatility of market variables changes during the crisis. The coefficients were significant in 1-month t-bills as dependent variables in the case of Fed, and in all euribor rates and government bonds in ECB, which indicate that communication mattered mostly in the markets during the crisis.

Effects of the macro news,  $\lambda_2$ , were significant in majority of the market interest rates in U.S and Euro area, which indicates that economic shocks dominated the variance of market variables as well. Coefficients of macro news were mixed, as dummy variable did not include distinction between positive and negative macro news surprises.

## 4.2 Robustness

Some regular tests were made to the data to ensure the robustness of the estimations<sup>11</sup>. Firstly, estimations were tested against remaining ARCH effects in the residuals<sup>12</sup>. ARCH LM test showed that there were no effects remaining. To examine further the distribution of estimation residuals, the quantiles were plotted and checked if they were normally distributed. Also histograms were plotted to examine the normality. Secondly, data was divided into smaller samples and for instance pre-crisis and crisis samples were estimated separately. All results showed that estimation results were robust. The results showed that CB dispersion can be used to predict the volatility of the market. Still an important question is, could increased market volatility lead to more intense communication. The uncertainty concerning economic outlook was increased among the central bankers under the crisis, but as dispersion was forecaster of volatility, the results do not indicate reversed causality. Here increased uncertainty about economic outlook is not equal to volatility, because market uncertainty included other sources as well. Also testing confidence ellipses show that coefficient estimates of lagged volatility and dispersion are not correlated. The argument gets support from the article by Ehrmann and Fratzscher (2007)(p. 132), where they show that there is relatively little evidence in ECB or Fed that CB's decide intensify their communication because of elevated market volatility.

## 5 Conclusions

In this paper, two dimensions of the CB communication were discussed: the dispersion of the CB communication and its effects on the market variables. The results showed that both Fed and ECB had individualistic communication conventions during the financial crisis. The main conclusion of the empirical part was that ECB deviated from its communication strategy introduced by Ehrmann and Fratzscher (2007b), which predicted increased market volatility. Market participants received variety of stances from the CB committee members, which altered the clarity of the content of the communication and led to increased the uncertainty in the market. On the other hand, individualistic communication strategy led to set of opposite results in Fed.

The results indicate that communication of Fed is more creative, and the dispersion in the policy-makers' views enhances market participants to form the collective opinion of the FOMC by comparing the individuals views. In that sense, the results suggest that individualistic communication strategy is

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<sup>11</sup>testing procedure followed methods of Greene (2002), p.244

<sup>12</sup>for more extensive information, see Asteriou and Hall (2007), p.253

more optimal to Fed, but also that Fed has more persistent communication strategy compared to ECB. Fed maintained its communication policy also during the crisis, but ECB deviated from its collegial strategy, which had negative consequences on financial markets.

The results show that communication has significant role in monetary policy design. Choosing the communication strategy - and committing to it - is essential requirement for the CB especially when economic conditions are uncertain.

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## Appendix

### Classification codes with examples:

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#### About monetary policy

2: *"Hikes will come sooner or later"*

*"Next rate move is up"*

*"Raise rates as quickly as possible"*

*"More tightening may be needed"*

*"Economic vigor may call for rate hikes"*

*"Fed should raise rate to 1 %"*

*"Rate hikes possible"*

*"More policy firming may be needed"*

*"Policy tilts towards higher rates"*

1: *"rate hike could come sooner or later"*

*"doesn't rule out rate hikes"*

*"favors rate hike if inflation stays up"*

*"Fed would act if this threatened its goals!"*

*"Fed will act to keep inflation low"*

*"Fed must be ready to take back cuts"*

*"Possible that low rates feed bubbles"*

*"Fed to raise rates after jobless peaks"*

*"Cannot push exit off to never-never"*

-1: *"ready to act if turmoil hits economy"*

*"response needed if conditions worsen"*

*"he would back an interest rate cut if the evidence pointed to slowing economic growth, but warned that it was still too early to be sure"*

*"open minded on need for more rate cuts"*

*"gives breathing room for more rate cuts"*

-2: *"Fed will use all its weapons"*

*"Fed will do whatever it takes to help economy"*

*"Funds rate could go a little lower"*

*Fed prepared to help economy"*

*"Weighing needed for more rate cuts"*

*"policy outlook leans more to cuts"*

*"credit woes could force more rate cuts"*

*"more cuts may be needed"*

*"Cuts quite possible"*

:

#### About economic growth

-1: *"..poses risks to growth"*

*"economy weaker than expected"*

*"down turn in economy possible"*

*"US economy to go through slow period"*

*"US economy speed limit may slow"*  
*"Trade frictions threaten resilient economy"*  
*"Chances of US recession have risen"*  
*"Have to take job data seriously"*  
*"Economy weathering the storm"*  
*"Systemic economic risk still a worry"*  
*"Weak housing has curbed gdp"*  
*"economic uncertainty very high"*  
*"not confident us can avoid recession"*

Figure 1: Fed: Dispersion of statements - monthly standard deviation

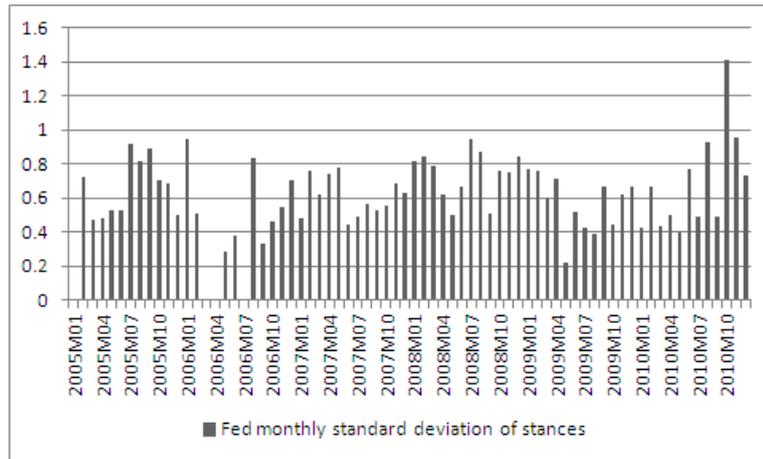


Figure 2: ECB: Dispersion of statements - monthly standard deviation

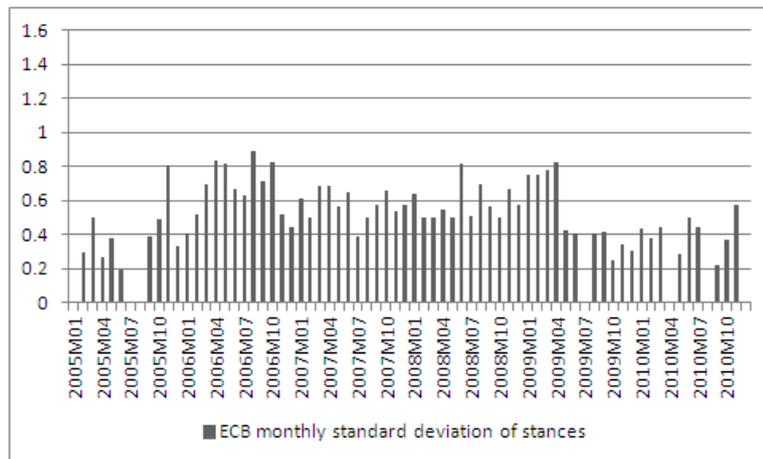


Figure 3: Daily difference of the mean in Fed

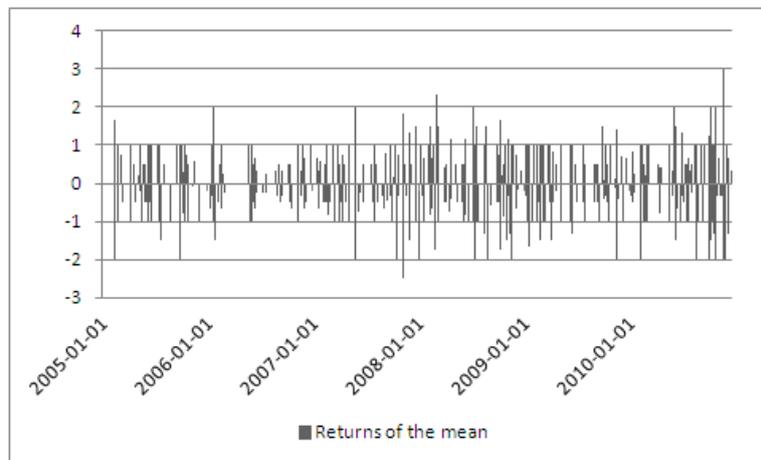


Figure 4: Daily difference of the mean in ECB

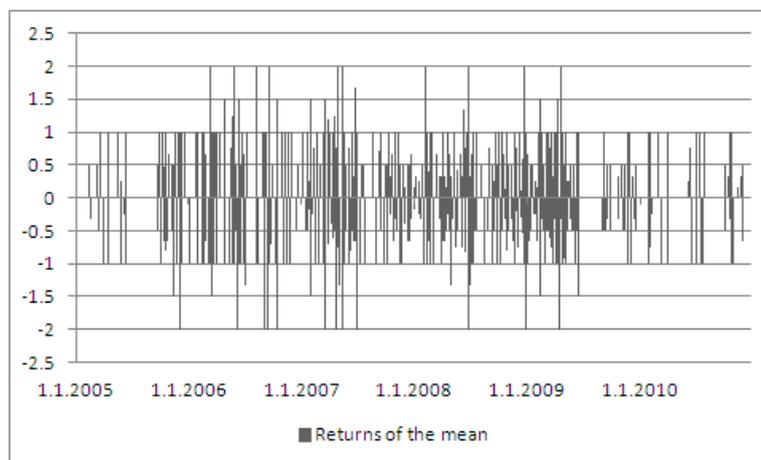


Table 1: Monetary policy meetings and expectations during the financial crisis

Fed			
Date	Median forecast	Range	Actual
18.9.2007	5.0%	4.75%/5.25%	4.75%
31.10.2007	4.5%	4.5%/4.75%	4.5%
6.12.2007 (unscheduled)			
11.12.2007	4.25%	4.25%/4.25%	4.25%
9.1.2007 (unscheduled)			
22.1.2008 (unscheduled*)			
30.1.2008	3.0%	3.0%/3.5%	3.0%
10.3.2008 (unscheduled)			
18.3.2008	2.5%	2.25%/2.5%	2.25%
30.4.2008	2.0%	1.75%/2.0%	2.0%
25.6.2008	2.0%	2.0%/2.0%	2.0%
24.7.2008 (unscheduled)			
5.8.2008	2.0%	2.0%/2.0%	2.0%
16.9.2008	2.0%	2.0%/2.0%	2.0%
29.9.2008 (unscheduled)			
8.10.2008 (unscheduled*)			
29.10.2008	1.0%	1.0%/1.25%	1.0%
16.12.2008	0.5%	0%/0.5%	0%
ECB			
Date	Median forecast	Range	Actual
3.7.2008	4.25%	4.0%/4.25%	4.25%
7.8.2008	4.25%	4.25%/4.25%	4.25%
4.9.2008	4.25%	4.25%/4.25%	4.25%
2.10.2008	4.25%	4.25%/4.25%	4.25%
8.10.2008 (unscheduled*)			
6.11.2008	3.25%	3.0%/3.5%	3.25%
4.12.2008	2.75%	2.25%/3.0%	2.5%
15.1.2009	2.0%	2.0%/2.5%	2.0%
5.2.2009	2.0%	1.5%/2.0%	2.0%
5.3.2009	1.5%	1.25%/1.75%	1.5%
2.4.2009	1.0%	1.0%/1.5%	1.25%
7.5.2009	1.0%	1.0%/1.0%	1.0%
4.6.2009	1.0%	0.5%/1.0%	1.0%
2.7.2009	1.0%	0.75%/1.0%	1.0%

Table 2: Market reaction to dispersion in central bank communication, variance equation

FED: Regressors									
Dependent variable	$\gamma$	$\beta_1$	$\beta_2$	$\beta_3$	$\lambda_1$	$\lambda_2$	$\lambda_3$	$\lambda_4$	
S&P500	-0.38*** (0.05)	0.01*** (0.01)	-0.14*** (0.01)	0.97*** (0.00)	0.09** (0.04)	0.06 (0.04)	-0.11 (0.07)	0.04*** (0.01)	
USD/EUR	-0.14*** (0.03)	0.07*** (0.02)	0.02** (0.01)	0.99*** (0.00)	0.01 (0.03)	0.02 (0.03)	0.03 (0.06)	0.00 (0.01)	
T-bill 1 month	-0.22*** (0.01)	0.18*** (0.01)	-0.31*** (0.01)	0.98*** (0.00)	-0.34*** (0.03)	0.09* (0.03)	-0.21*** (0.05)	0.08*** (0.01)	
T-bill 3 months	-0.36*** (0.02)	0.43*** (0.01)	-0.26*** (0.01)	0.99*** (0.00)	-0.06* (0.03)	0.18*** (0.04)	-0.08 (0.08)	-0.03* (0.02)	
T-bill 6 months	-0.22*** (0.02)	0.23*** (0.01)	-0.11*** (0.01)	0.99*** (0.00)	-0.17*** (0.05)	0.16*** (0.04)	-0.01 (0.06)	0.01 (0.01)	
T-bill 12 months	-0.16*** (0.02)	0.13*** (0.01)	-0.06*** (0.01)	0.99*** (0.00)	-0.03 (0.04)	0.15*** (0.03)	-0.07 (0.06)	0.03*** (0.01)	
Treasury bond 5 y	-0.10*** (0.02)	0.08*** (0.01)	-0.05*** (0.01)	1.00*** (0.00)	0.02 (0.04)	0.02 (0.03)	-0.08 (0.06)	0.02* (0.01)	
Treasury bond 10 y	-0.11*** (0.02)	0.08*** (0.01)	-0.04*** (0.01)	0.99*** (0.00)	0.02 (0.04)	0.01 (0.03)	-0.07 (0.06)	0.02* (0.01)	
ECB: Regressors									
Dependent variable	$\gamma$	$\beta_1$	$\beta_2$	$\beta_3$	$\lambda_1$	$\lambda_2$	$\lambda_3$	$\lambda_4$	
Eurostoxx	-0.54*** (0.07)	0.11*** (0.02)	-0.18*** (0.01)	0.95*** (0.01)	0.08* (0.05)	-0.01 (0.03)	0.01 (0.06)	0.04*** (0.01)	
EUR/USD	-0.17*** (0.05)	0.06*** (0.01)	-0.01 (0.01)	0.99*** (0.00)	0.01 (0.03)	0.01 (0.02)	0.03 (0.03)	0.01 (0.01)	
Euribor 1 month	-5.69*** (0.15)	1.32*** (0.03)	0.69*** (0.02)	0.48*** (0.01)	-1.02*** (0.05)	-1.92*** (0.04)	0.72** (0.09)	0.21*** (0.03)	
Euribor 3 months	-1.16*** (0.06)	0.38*** (0.02)	0.09*** (0.01)	0.94*** (0.00)	0.51*** (0.05)	-0.04 (0.03)	-0.32*** (0.06)	0.12*** (0.01)	
Euribor 6 months	-1.84*** (0.15)	0.35*** (0.03)	0.04*** (0.01)	0.89*** (0.01)	0.26*** (0.05)	0.34*** (0.06)	0.42*** (0.07)	-0.02** (0.02)	
Euribor 12 months	-2.15*** (0.23)	0.43*** (0.02)	0.00 (0.02)	0.85*** (0.02)	0.00 (0.07)	0.37*** (0.07)	0.86*** (0.09)	-0.23*** (0.03)	
German bond 5 y	-0.13*** (0.03)	0.08*** (0.01)	-0.06*** (0.01)	0.99*** (0.00)	0.07*** (0.03)	0.02 (0.02)	-0.08** (0.03)	0.02** (0.01)	
German bond 10 y	-0.15*** (0.05)	0.09*** (0.01)	-0.03*** (0.01)	0.99*** (0.00)	0.07** (0.03)	0.00 (0.03)	-0.08** (0.04)	0.01 (0.01)	

<sup>a</sup>Note: The table shows the market volatility reactions to the classified communication variables presented in the model above. Standard errors are shown in the brackets below the coefficients. \*\*\*, \*\*, \* indicates the significance p(z) at the 99%, 95 % and 90 % level.

Table 3: Market reaction to dispersion in central bank communication, mean equation

FED: Regressors		$\alpha$	$\delta$	$\theta_1$	$\theta_2$	$\theta_3$
Dependent variable						
S&P500		0.000 (0.000)	-0.070 (0.029)**	0.000 (0.000)	0.000 (0.000)	-0.001 (0.001)
USD/EUR		0.000 (0.000)	0.014 (0.027)	0.000 (0.000)*	0.000 (0.000)	0.000 (0.000)
Treasury t-bill 1 month		-0.001 (0.000)***	0.107 (0.020)***	0.001 (0.000)**	-0.002 (0.001)***	-0.001 (0.004)
Treasury t-bill 3 months		0.000 (0.000)***	0.045 (0.025)*	0.000 (0.000)	0.000 (0.000)**	0.002 (0.001)**
Treasury t-bill 6 months		0.000 (0.000)*	-0.036 (0.026)	0.000 (0.000)	-0.001 (0.000)***	0.000 (0.000)
Treasury t-bill 12 months		0.000 (0.000)	-0.018 (0.025)	0.000 (0.000)	-0.001 (0.000)**	0.000 (0.002)
Treasury bond 5 years		0.000 (0.000)	-0.014 (0.027)	0.000 (0.001)	0.001 (0.001)	-0.002 (0.001)
Treasury bonds 10 years		0.000 (0.000)	-0.017 (0.026)	0.000 (0.001)	0.001 (0.000)*	-0.001 (0.001)
ECB: Regressors		$\alpha$	$\delta$	$\theta_1$	$\theta_2$	$\theta_3$
Dependent variable						
Eurostoxx		0.000 (0.000)	-0.018 (0.029)	-0.001 (0.001)	0.001 (0.001)	0.001 (0.002)
EUR/USD		0.000 (0.000)	0.013 (0.029)	0.000 (0.000)	0.001 (0.000)	0.000 (0.001)
Euribor 1 month		0.001 (0.000)***	0.77 (0.010)***	-0.002 (0.000)**	0.000 (0.000)***	0.001 (0.000)***
Euribor 3 months		0.000 (0.000)***	0.674 (0.018)***	0.000 (0.000)	0.000 (0.000)	0.00 (0.000)***
Euribor 6 months		0.000 (0.000)	0.000 (0.000)***	0.000 (0.000)	0.000 (0.000)	0.556 (0.021)***
Euribor 12 months		0.000 (0.000)	0.430 (0.026)***	0.000 (0.000)	0.000 (0.000)	-0.001 (0.000)*
German gov't bond 5 years		0.000 (0.000)	0.041 (0.026)	0.000 (0.000)	0.000 (0.000)	0.000 (0.001)
German gov't bond 10 years		0.000 (0.000)	0.032 (0.026)	0.000 (0.000)	0.000 (0.000)	0.001 (0.001)

<sup>a</sup>Note: The table shows the market volatility reactions to the classified communication variables presented in the model above. Standard errors are shown in the brackets next to the coefficients. \*\*\*, \*\*, \* indicates the significance p(z) at the 99%, 95 % and 90 % level.