Measuring the ECB’s Monetary Policy Stance: A “Media-Based Automated Approach”

Francesco Pesci

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Measuring the ECB’s Monetary Policy Stance: A “Media-Based” Automated Approach

Francesco Pesci

1 Abstract

I present a new measure of the European Central Bank (ECB)’s monetary policy stance based on the content of articles published by major English-speaking written media in the days around meetings of the ECB Governing Council (GC). I study the relationship between the perception of the ECB’s stance and futures monetary policy decisions of the GC and I find it to be statistically significant. Moreover I present evidence that changes in the perception of the ECB’s stance around GC meeting days are due to new information conveyed by the press conference of the ECB President rather than by the policy rate decision of the GC. Finally, I find that changes in the perception of the ECB’s stance affect market expectations of future policy rates.

*UniCredit S.p.A, e-mail: francesco.pesci@unicredit.eu. I thank Stefano Nardelli who encouraged me to research the topic of the ECB’s communication on the monetary policy stance, participants to a seminar at the ECB, and Roberto Casarin for helpful discussions on regression techniques.
2 Introduction

This paper focuses on the perception of the European Central Bank (ECB)’s monetary policy stance and on the ECB’s own communication about the monetary policy stance. It attempts to answer to the following questions: 1) How can the perception of the ECB’s stance be measured? 2) Does the perception of the ECB’s stance predict future monetary policy decisions? 3) How much do “shocks” in monetary policy decisions and “shocks” in the ECB’s own communication affect the perception of the monetary policy stance? 4) Do changes in the perception of the ECB’s stance affect market expectations of future monetary policy decisions?

I present a new measure (index) of the perception of the ECB’s monetary policy stance. I find the relationship between the index and the ECBs subsequent monetary policy decisions to be (positive and) statistically significant. I provide evidence that changes in the index are affected by shocks in the ECB’s communication about its own stance and not by shocks in the ECB’s monetary policy decisions. Moreover I find that changes in the index affect market expectations of future monetary policy decisions. With “monetary policy decisions” I denote decisions about the level of the ECB “key interest rates” (i.e., interest/policy rates)\(^1\) taken by the ECB Governing Council (GC) at its own regular monthly monetary policy meetings.\(^2\)

I define monetary policy stance, or (interest/policy) rate stance, as a central bank’s attitude toward the levels of its own interest/policy rates in the near future relative to their present level, i.e., toward (possible) changes in its own interest/policy rates in the near future. With “near future” I denote a period which spans from one to six months after any given point in time (see sections 5 and 6). I define a hawkish stance, or hawkishness, as the willingness by a central bank to raise its policy rates in the near future and a dovish stance, or dovishness, as the willingness to decrease them. A neutral stance, or neutrality, is characterized by the absence of any readiness to change rates (or, if it makes any differences, by the tendency to keep them unchanged). I use the adjectives “hawkish”, “dovish”, and “neutral” (and the nouns “hawkishness”, “dovishness”, and “neutrality”) also with reference to (the tone of) words, expressions, and (pieces of) communication (by a central bank or related to it) which signal a hawkish, dovish, and neutral stance, respectively.

The index which I present in the paper is aimed at capturing the ECB’s stance, as perceived by written media, at two points in time (almost) every month: before and after the event represented by the announcement of the decision taken at the regular monetary policy meeting of the ECB GC and by the press conference which the ECB President holds shortly after the meeting and in which the President provides

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\(^1\)The ECB key interest rates are: 1) the one “on the main refinancing operations (MRO), which provide the bulk of liquidity to the banking system”; 2) the one “on the deposit facility, which banks may use to make overnight deposits with the Eurosystem”; and 3) the one “on the marginal lending facility, which offers overnight credit to banks from the Eurosystem” (see www.ecb.europa.eu/stats/monetary/rates/html/index.en.html).

\(^2\)In the paper I study the period between January 1999 and December 2013, during which a regular monetary policy meeting of the GC and the following press conference were held once a month (almost every month). Since January 2015 the monetary policy meetings and the following press conferences are held at six-week intervals.
reasons for the decision taken by the GC and hints about the ECB’s monetary policy stance.

In the paper I study the period between January 1999 and December 2013, which corresponds to the first 15 years of operations of the ECB and includes 175 events (almost one every month, see section 4). I compute two values of the index with reference to each monthly event: a “pre-event” value and a “post-event” one. Both are computed on the base of the content of pieces of communication represented by written media articles. The articles used to compute both values of the index are extracted from the same set of media, but were published during two different time spans: those used to compute the “pre-event” value were published during one day and a half before the event, those used to compute the “post-event” value were published during one day and a half after the event. The difference between the post-event value and the pre-event one captures the change in the perception of the ECB’s stance due to new, i.e., unexpected, information conveyed by the event.

Each event embodies two pieces of news which might convey a signal about the ECB’s stance (or, if it makes any difference, a signal consisting of two components): one is the monetary policy decision of the GC and the other is communication, i.e., the words of the ECB President at the press conference. Therefore, the perception of the ECB’s stance might be influenced both by the decision of the GC and by the words of the ECB President. It follows that the change in the perception might be affected by the unexpected information conveyed by both the decision and the words. In order to check if both signals play any role in the perception of the ECB’s stance, I study the relationship between the unexpected component of the monetary policy decision (measured by changes in Euro area interbank interest rates) and the change in the perception of the ECB’s stance (measured by the difference between the post-event value of the index and the pre-event one) and I find no evidence of correlation. For this reason, I conclude that the changes in the perception of the ECB’s stance reflects new information conveyed by communication, i.e., by the words of the ECB President, not by the monetary policy decisions (see section 6.2). Therefore, this paper can be considered also as a work on the (perception of) the ECB’s communication about its own policy stance (or at least on the communication by the ECB Presidents at the monthly press conferences), related to the stream of studies on central bank communication (see section 3).

The methodology applied to construct the index represents a novel contribution to the empirical literature on non-market measures of the ECB’s monetary policy communication. It is built on a “media-based” methodology which Lucca and Trebbi (2011) use in their analysis of the stance and the communication of the Federal Reserve and it can be described (like the methodology by Lucca and Trebbi) as an automated approach to the analysis of a set of pieces of communication, as I explain in section 3 and 4.

I use the index to perform two further types of analysis. First, as I show in section 5, I test the consistency between the perception of the ECB’s stance and the central bank’s future monetary policy decisions by focusing on short-term changes in the MRO rate, which is one of the three key interest rates set by the GC (see footnote 1). More in detail, I regress changes between the value of MRO rate set at the “current” GC meeting and values set at future meetings on the “current” post-meeting value of the index and I find (posi-
tive) and statistically significant relationships. Second, as I explain in section 6, I study how much changes in the perception of the ECB's stance due to meetings and following press conferences affect market expectations of future monetary policy decisions. I use changes in Euribor forward rates around meetings as proxies of changes in market expectations of future monetary policy decisions. I regress such changes on the difference between the post-meeting value and the pre-meeting value of the index, which measures the change in the perception of the ECB’s stance, and I control for the unexpected component of monetary policy decision taken at the meeting. I find the relationship between changes in market expectations and the changes in the perception of the ECB’s stance to be (positive and) statistically significant.

3 Related literature

This paper is related to recent literature on non-market based measures of central-bank-related information. Most of such literature focuses on measures of central bank communication, investigates its role as a monetary policy tool and relationships between central bank communication and financial variables, such as policy rates set by central banks, interest rates on (sovereign) bonds, prices of futures contracts, etc.\(^3\)

Most of the studies on central bank communication quantify the informational content of pieces of central-bank-related communication, i.e., pieces of communication either released directly by one or more central banks or related to central banks’ decisions and “direct” communication. The informational content of such communication is usually referred to the monetary policy stance in general or to some other variables which convey information on the monetary policy stance, such as inflation expectations and GDP forecasts. A numerical index is constructed to represent the possible types of information related to the variable of interest. With “measurement procedure” I denote the procedure employed by analysts to associate each piece (or set of pieces) of communication with a value of the index which represents the type of information conveyed by that piece (or set of pieces) of communication.

I distinguish between two types of measures, i.e., approaches to the quantification, of the content of central-bank-related communication, according to the characteristics of the measurement procedure. I define as subjective approaches those in which the association of pieces (or set of pieces) of communication with values of an index is left to the subjective preferences of one or more analysts. This implies that the procedure is replicable neither by different analyst(s) nor by the same one(s) thereafter, since subjective preferences may vary across analysts and the subjective preferences of the same analyst(s) may vary across time. I define as automated approaches those based on a procedure in which subjective preferences of analysts play no role in the association of pieces (or set of pieces) of communication with values of an index (although the design of the procedure is based on subjective preferences of one or more analysts). Since analysts’ preferences are not involved in the application of the procedure to the analysis of pieces of communication, they cannot be replicated by other analyst(s) or the same one(s) thereafter, since subjective preferences may vary across analysts and the subjective preferences of the same analyst(s) may vary across time.

\(^3\)For a survey of the literature until the late 2000s, see Blinder et al. (2008). Among later studies not mentioned therein, see Lucca and Trebbi (2011), on which I focus later in this section, and Ehrmann et al. (2012)
communication, the procedure is replicable across time either by different analysts or by the same one(s). Moreover it can be used (with minor modifications, if needed) to analyse “similar” pieces of communication.

Most of the studies on the ECB’s communication about the monetary policy stance rely on subjective measures of the content of central-bank-related communication: see, e.g., Musard-Gies (2006) and Berger et al. (2011), who analyse the ECB Presidents’ introductory statements to the monthly press conference, and Gerlach (2007), who focuses on the editorial of the ECB monthly bulletin.

The analysis of the ECB Presidents’ introductory statements by the KOF institute of the ETH Zürich relies on an indicator, called the monetary policy communicator (MPC), which is difficult to define as either subjective or automated on the base of the information publicly released by the institute: see KOF (2007). Conrad and Lamla (2010), Sturm and De Haan (2011), and Neuenkirch (2013) use the MPC as a measure of the hawkishness/dovishness of the ECB President’s introductory statements.

Other studies rely on measures which can be defined as partly subjective and partly automated. Rosa and Verga (2007 and 2008) compile a list of expressions contained in the ECB Presidents’ introductory statements. They assign to each expression a value denoting a (relative) level of hawkishness/dovishness and they do the same with each statement. The value of the statement is subjectively chosen by the authors on the base of those expressions (from the list) which are contained in the statement, but the mapping between the values of the expressions in the statement and the value of the statement is not applied in a “mechanical way” (Rosa and Verga, 2007).

A few works rely on automated measures of the content of ECB-related communication. Jansen and De Haan (2007) use the occurrences of the word “vigilance” (or “vigilant”) in ECB-related communication as an indicator of the ECB’s inflation expectations: a higher (lower) frequency of the word “vigilance” is associated with the ECB’s perception of a higher (lower) upward risk to price stability. Heinemann and Ullrich (2007) compile a list of expressions from the ECB Presidents’ introductory statements and investigate their potential to be informative about the ECB’s stance by testing if their average frequency differs significantly among statements belonging to different monetary policy “phases”. The authors compute an indicator of the hawkishness/dovishness of the ECB’s stance according to a formula based on the frequency in each statement of the expressions which are determined to be informative. A variant of the indicator is used by

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4 See De Haan (2008) for a survey of the studies on ECB's communication published until the late 2000s.
5 The MPC is computed by the KOF institute after every press conference following a monetary policy meeting of the GC. It is aimed at capturing information which is contained in the ECB Presidents introductory statement and refers to the direction (upward or downward) and the intensity of the risks to price stability in the Eurozone (KOF, 2007). Such information can be seen as a signal of the ECB policy rate stance, since the central bank is expected to increase its policy rates (or at least to adopt a more hawkish stance) as a reaction to upward risks to price stability and to decrease them (or at least to adopt a more dovish stance) as a reaction to downward risks (KOF, 2007). According to the information publicly released by the KOF institute, analysts divide the ECB President's introductory statement into parts and then compute the MPC by weighting the proportions of parts pointing respectively to upside and to downside risks to price stability (KOF, 2007). No details are provided about the process through which statements are divided into parts and each part is classified according to the direction of risk to which it points.
6 According to Rosa and Verga (2007), the subjective assignment of a value to any given statement is based on the mean value of the expressions contained in the statement.

The index which I present in this paper can be described as an automated measure of the ECB’s stance. It is built on a news-based approach which Lucca and Trebbi (2011) use in their analysis of the stance and the communication of the Federal Reserve. Their index is based on a word count in written media articles published in a three-days interval centered around each policy meeting of the Federal Reserve Open Market Committee (FOMC).\textsuperscript{7} For each policy meeting they calculate two values of the index: an “ex-ante” value, based on the articles published before the meeting, and an “ex-post” value, based on the articles published after the meeting. According to the authors, the difference between the ex-post and the ex-ante value represents the unexpected component of the information conveyed by the FOMC statement on the Federal Reserve policy rate stance.\textsuperscript{8}

4 An index which measures the ECB’s monetary policy stance

Let \( t \), with \( t = 1, \ldots, 175 \), denote the event represented by the \( t \)-th monetary policy meeting of the GC and the following press conference held by any of the three ECB President (Duisenberg, Trichet, and Draghi) in the period between January 1999 and December 2013. I use \( d_t \) to denote the day in which the \( t \) took place. During the period under consideration, which corresponds the the first 15 years of operations of the ECB, regular monetary policy meetings of the GC followed by a press conference were held once per month, usually on the first Thursday, almost every month.\textsuperscript{9}

For every \( t \), I consider the set \( S_t \) of the articles, originally published on newspapers/newswires, with all the following characteristics in common:

1. they are retrieved from three (mutually exclusive) digital sources: 1) the archive of Reuters, the news agency, 2) the section “Major Business Publications US” of Factiva, the database of newswire/newspaper articles, 3) the section “Major Business Publications Europe” of the same database;

2. they are written in English;

3. they contain in the title: 1) both the word “ECB” (or the words “European Central Bank”) and the word “rates” (or “rate” or both), if they are extracted from Reuters, 2) either the word “ECB” or the words “European Central Bank”, if they are extracted from Factiva;

\textsuperscript{7}Other recent studies investigate relationships between news reported by media and financial variables: see, e.g., Beetsma et al. (2013) on news and European sovereign bond spreads and Casarin and Squazzoni (2013) on bad news and stock markets during the financial crisis of 2008/2009.

\textsuperscript{8}See Lucca and Trebbi (2011) for more information on their news-based approach. Moreover the authors present in the same paper a second automated measure of the stance and the communication of the Federal Reserve. The measure is based on Google searches of words related to the Federal Reserve stance.

4. they were published in either one of two (mutually exclusive) time intervals:

(a) \( t^- \), which consists of 1) \( d_t - 1 \), i.e., the (calendar) day before \( d_t \), and 2) the hours of \( d_t \) before the announcement of the decision of the GC at around 1:45 p.m. Central European Time (CET),

(b) \( t^+ \), which consists of 1) the hours of \( d_t \) after the beginning of the press conference at 2:30 p.m. and 2) \( d_t + 1 \), i.e., the (calendar) day after \( d_t \).

Let \( S_t^- \), with \( S_t^- \subseteq S_t \), be the set of the articles published in \( t^- \) and \( S_t^+ \), with \( S_t^+ \subseteq S_t \), be the set of the articles published in \( t^+ \). Then, for every event \( t \), I compute two values of the index: \( HDN_t^- \) and \( HDN_t^+ \), which are based on a count of frequencies of hawkish, dovish, and neutral expressions in the articles in \( S_t^- \) and \( S_t^+ \), respectively. \( HDN_t^- \) should capture the perception by major English-speaking written media of the ECB’s stance just before \( t \) and \( HDN_t^+ \) the perception just after \( t \). I construct the following three sets of expressions, whose frequencies I count in the articles both in \( S_t^- \) and in \( S_t^+ \) to compute \( HDN_t^- \) and \( HDN_t^+ \), respectively:

1. \( H \), a set of hawkish expressions,
2. \( D \), a set of dovish expressions,
3. \( N \), a set of neutral expressions.

The complete list of the expressions of each set can be found in the appendix. The expressions are not explicitly referred to the ECB’s stance. In order to avoid counting occurrences which are not related to the ECB’s stance and to count as many as possible of the occurrences related to it, I limit the count to the ECB-related sentences of the articles. I define as sentence of an article any part of the article between two periods (and the part before the first period) and as ECB-related any sentence which contains any expression in the set \( E = \{ \text{European Central Bank, ECB, Duisenberg, Trichet, Draghi, Governing Council} \} \). For every \( t \), let \( E_t^- \) and \( E_t^+ \) be the sets of the ECB-related sentences in the articles in \( S_t^- \) and \( S_t^+ \), respectively. I denote the (unweighted) sums of the occurrences in the sentences in \( E_t^- \) of the expressions in \( H \), \( D \), and \( N \) as \( H_t^- \), \( D_t^- \), and \( N_t^- \), respectively, and the (unweighted) sums of the occurrences in the sentences in \( E_t^+ \) as \( H_t^+ \), \( D_t^+ \), and \( N_t^+ \), respectively.\(^\text{12}\) I compute \( HDN_t^- \) and \( HDN_t^+ \) as ratios of weighted sums on the unweighted sums of the occurrences in \( E_t^- \) and \( E_t^+ \), respectively.

\(^{10}\) Through the paper I use CET, which is the time of Frankfurt am Main, Germany, where the ECB is located and where most of the GC meetings and the following press conference are held.

\(^{11}\) For each article stored in either the Reuters or the Factiva database, both the date and the time of publication are available. Therefore it is possible to identify the articles which are published on different days and at different times of the same day.

\(^{12}\) I wrote a short computer program which divides the articles (saved as text files) into sentences, identifies ECB-related sentences, and counts occurrences of hawkish, dovish, and neutral expressions in ECB-related sentences. The program is written in Python (a programming language) and employs the tokenizer program of NTLK (a platform of Python modules, i.e., programs which help to write other programs in Python) to partition the articles into sentences. The Python interface is downloadable at www.python.org and NTLK programs at www.nltk.org.
expressions in $H$, $D$, and $N$. The weights used in the computation of the two weighted sums are $1$, $-1$, and $0$ for the occurrences of the expressions in $H$, $D$, and $N$, respectively. More formally, for every $t$, I compute

$$HDN_{t-} = \frac{H_{t-} - D_{t-}}{H_{t-} + D_{t-} + N_{t-}}$$

and

$$HDN_{t+} = \frac{H_{t+} - D_{t+}}{H_{t+} + D_{t+} + N_{t+}}.$$

Both $HDN_{t-}$ and $HDN_{t+}$ can assume any (real) value between $-1$ and $1$, i.e., $HDN_{t-}, HDN_{t+} \in [-1, 1]$. The higher the value assumed by $HDN_{t-}$ and $HDN_{t+}$, the more hawkish (less dovish) the stance signalled by that value and, conversely, the lower the value, the more dovish (less hawkish) the stance. A value of $0$ indicates a “perfectly” neutral stance.

I use $HDN_{t-}$ and $HDN_{t+}$ to compute a measure of the new information on the ECB’s stance conveyed by $t$, i.e., of the change in the perception (by major English-speaking written media) of the ECB’s stance due to new information conveyed by $t$, for every $t$. The only news which might convey information on the ECB’s stance and which systematically reach the public (i.e., media and market participants) during days $d_t$, $d_t - 1$, and $d_t + 1$, with $t = 1, \ldots, 175$, are those related to $t$, i.e., 1) the announcement of the decision taken at the GC meeting on the key ECB rates and 2) (the tone of) the words of the ECB President at the press conference. Therefore, it seems appropriate to use the difference between $HDN_{t+}$ and $HDN_{t-}$, which should capture the ECB’s stance (as perceived by major English-speaking written media) just before and after $t$, respectively, as a measure of the new information on the ECB’s stance conveyed by $t$, i.e., of the change in the perception (by major English-speaking written media) of the ECB’s stance due to new information conveyed by $t$. More formally, for every $t$, I compute

$$SN_t = HDN_{t+} - HDN_{t-}.$$

As I show in section 6.2, the new information on the ECB’s stance captured by $SN_t$ is conveyed by the words of the ECB’s president, and the announcement of the monetary policy decision does not convey (almost) any new information about the ECB’s stance (although markets take into account the decision of the GC to update their expectations of future policy rates). Therefore $SN_t$ can be considered as a measure of the tone of the words of the ECB President with reference to the ECB’s stance and, more in general, a measure of ECB communication.

5 Perception of the ECB’s stance and policy changes in the short term

I study the consistency between the ECB’s stance (as perceived by major English-speaking written media) after monetary policy meetings and following press conferences and the ECB’s actual monetary policy
decisions in the subsequent months, i.e., I test if the index $HDN_{t+}$ has predictive power on short-term movements in policy rates.

In the analysis I focus on the rate on the main refinancing operations (MROs), through which the ECB channels most of the liquidity provided to the banking system in the Euro area (see footnote 1). For every event $t$, I observe the difference between the level of the MRO rate set at the monetary policy meeting of the GC at event $t + m$, with $m = 1, \ldots, 6$, and the level set at the meeting at $t$. Then I regress the changes in the MRO rate between $t$ and the following six events on the post-$t$ value of the index. For each $m$, the regression equation is

$$MRO_{t+m} - MRO_t = \alpha_m + \beta_m HDN_{t+} + \varepsilon_{t,m},$$

where $MRO_t$ is the level of the MRO rate set by the GC at $t$ and $MRO_{t+m}$ the level set at $t + m$. Table 1 summarizes the results of the OLS estimation of the equation.

<table>
<thead>
<tr>
<th>$m$</th>
<th>$\alpha_m$</th>
<th>$\beta_m$</th>
<th>$\text{Const.}$</th>
<th>$\text{Coeff.}$</th>
<th>$\text{Std. error}$</th>
<th>$R^2$</th>
<th>$\text{Adj. } R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.228***</td>
<td>0.197***</td>
<td>0.024</td>
<td>0.024</td>
<td>(0.043)</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>2</td>
<td>-0.394***</td>
<td>0.338***</td>
<td>0.038</td>
<td>0.031</td>
<td>(0.070)</td>
<td>0.31</td>
<td>0.28</td>
</tr>
<tr>
<td>3</td>
<td>-0.546***</td>
<td>0.465***</td>
<td>0.051</td>
<td>0.051</td>
<td>(0.086)</td>
<td>0.32</td>
<td>0.31</td>
</tr>
<tr>
<td>4</td>
<td>-0.663***</td>
<td>0.561***</td>
<td>0.065</td>
<td>0.065</td>
<td>(0.105)</td>
<td>0.30</td>
<td>0.32</td>
</tr>
<tr>
<td>5</td>
<td>-0.744***</td>
<td>0.625***</td>
<td>0.078</td>
<td>0.078</td>
<td>(0.129)</td>
<td>0.27</td>
<td>0.30</td>
</tr>
<tr>
<td>6</td>
<td>-0.831***</td>
<td>0.694***</td>
<td>0.091</td>
<td>0.091</td>
<td>(0.143)</td>
<td>0.25</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Note: *, **, and *** denote significance at the 0.1, 0.05, and 0.01 level, respectively. Heteroskedasticity robust (HAC) standard errors and significance of coefficients estimated with HAC errors are reported within brackets.

Coefficient $\beta_m$ is positive and significant at the 0.01 level for each $m$. Such results suggest that the post-$t$ index $HDN_{t+}$ has predictive power over future (with respect to $t$) monetary policy decisions of the GC of the ECB, since the positive linear relationship, implied by a positive $\beta_m$, between $HDN_{t+}$ and $MRO_{t+m} - MRO_t$ means that, on average, the higher the value of $HDN_{t+}$, the more the MRO rate increases (or the less it decreases) in the months after $t$ and, conversely, the lower the value of $HDN_{t+}$, the more the MRO rate decreases (or the less it increases). This is what one would expect given that, by construction of the index, higher values of $HDN_{t+}$ signal a more hawkish (less dovish) stance, i.e, they point to a higher increase (lower decrease) of the key interest rates in the months after $t$ and, conversely, lower values signal a more dovish (less hawkish) stance (see section 4).

I use the MRO rate also as a proxy for the other two key interest rates set by the GC of the ECB: the one on the deposit facility and the one on the marginal lending facility (see footnote 1).
6 Short-term policy rates expectations and perception of the ECB’s stance

I study the relationship between the perception of the ECB’s stance and market expectations of future policy rates in the short term, i.e., I test if such expectations are affected by changes in the perception of the monetary policy stance of the ECB due to the new information conveyed by events $t$, with $t = 1, \ldots, 175$.

6.1 Expected and unexpected information conveyed by monetary policy decisions and press conferences

I assume that market participants have rational expectations, i.e., that they form expectations, including those regarding future policy rates, using all available information (and continuously update them, almost in real time, on the base of new information). Every $t$ conveys two pieces of information which might affect market expectations of future policy rates and reach market participants on $d_t$, i.e., on the day in which $t$ takes place: 1) the announcement of the decision taken at the GC meeting on the key ECB rates and 2) the perceived tone of the words of the ECB President at the press conference. Under the assumption of rational expectations:

- before $t$, market participants form expectations regarding $t$ and incorporate them into their own expectations of future policy rates, i.e., they take into account the expected informational content of $t$ to form their expectations regarding future policy rates;

- during $t$ or just afterward, market participants revise their expectations of future policy rates on the base of the new, i.e., unexpected, information, conveyed by $t$; if $t$ conveys no news, expectations remain unchanged.

The expected informational content of $t$ consists of a) the expected monetary policy decision, i.e., the expected level of the policy rates decided at the GC meeting, and b) the expected tone of the ECB president. The new, i.e., unexpected, information conveyed by $t$ consists of i) the difference between the actual level of the policy rates decided at GC meeting and the expected one and ii) the difference between the perceived tone of the ECB President and the expected one. Component ii) of the news conveyed by $t$ might affect market expectations of future policy rates as a signal of the ECB’s stance and component i) might affect expectations as news on the “current” level of policy rates, i.e., on the “current” starting point of the path of the policy rates in the following months. Therefore, an analysis of the impact of changes in the ECB’s stance on market expectations of future policy rates should include a measure of i) as a control variable. However i) might affect expectations also as a signal of the ECB’s stance. For this reason, a measure of changes in the ECB’s stance and a measure of i) could be correlated. If they were correlated and if they both appeared in a regression as independent variables, there would be a problem of multicollinearity. Therefore, I test the
presence of correlation between a measure of $i$) and a measure of changes in the ECB’s stance.

### 6.2 Measures of unexpected information conveyed by monetary policy decisions and press conferences

As a measure of the unexpected information conveyed by monetary policy decisions, I use the difference in the one-month Euribor (spot) rate between $d_t$, i.e., the day in which $t$ takes place, and $d_t + 1$, i.e., the following calendar day. As discussed by Rosa and Verga (2007), the short-term Euribor (i.e., interbank) rates can be considered good proxies of market expectations of the values of the policy rates in the short term. Namely, for any day $d$, the Euribor (spot) rate with a maturity of one month quoted on $d$ can be considered a good measure of market expectations, formed immediately before the time of the quote, of the policy rates in the one-month period starting on $d$.

Ideally the expected level of a policy rate (such as the MRO rate, see footnote 1 and section 5) decided at $t$ would be subtracted to the actual one in order to measure the unexpected component the monetary policy decision taken at the meeting. However the Euribor rates, like any other market-based measure of expectations of policy rates, incorporate a risk premium in excess of the policy rates. Therefore, in order to construct a measure of the unexpected component of monetary policy decision, it does not seem appropriate to subtract a quote of an Euribor rate to an actual level of a policy rate and it seems appropriate to use the difference between two quotes of a same Euribor rate.

Let $r_{d_t}$ be the quote for the one-month Euribor rate on $d_t$, $r_{d_t+1}$ the quote on $d_t + 1$, and

$$RN_t = r_{d_t+1} - r_{d_t},$$

the change in the one-month Euribor rate between $d_t$ and $d_t + 1$. For each $t$, since the level of the policy rates decided at $t$ is effective at least for a period of approximately one month, i.e., until the next meeting at $t + 1$, and since the Euribor rates are quoted at 11 a.m., $r_{d_t}$ should capture the expectations, formed (almost) immediately before the announcement of the monetary policy decision (which is made public at 1:45 pm), of the level of the policy rates effective from $t$ to $t + 1$. Moreover, since the Euribor rates are quoted each business day and the monetary policy meeting takes place on Thursdays, quotes $r_{d_t}$ and $r_{d_t+1}$ are both available. Therefore, since the only news on the current level of the policy rates which reach the markets between $d_t$ and $d_t + 1$ is the announcement of the monetary policy decision, $RN_t$ should measure the unexpected component of level of the policy rates decided at GC meeting.\(^\text{14}\)

As a measure of the new information on the ECB’s stance conveyed by $t$, I use $SN_t$, i.e., the difference between the post-$t$ value of the index $HDN_{t+}$ and the pre-$t$ value $HDN_{t-}$ (see section 4). As discussed

\(^{14}\)See Musard-Gies (2006) for a (slightly) different approach based on Euribor forward rates. See also Kuttner (2001), GÃŒrkaynak et al. (2005) and Lucca and Trebbi (2011) for measures of the “surprise” associated to monetary policy decisions of the FOMC of the Federal Reserve.
in section 4, for each \( t \), \( SN_t \) measures the change in the ECB’s stance, as perceived by major English-speaking written media, due to new information conveyed by \( t \) on the ECB’s stance itself. I assume either that the media perception of changes in the ECB’s stance coincides with the one by market participants or that the former influences the latter.

The correlation between \( RN_t \) and \( SN_t \) is very low, namely equal to \(-0.122\). Therefore, I conclude that, in a regression in which both \( RN_t \) and \( SN_t \) appeared as the only independent variables, there would no problem of multicollinearity. Moreover, the low level of the correlation between \( RN_t \) and \( SN_t \) implies that the unexpected component of the “current” monetary policy decision might affect expectations of future policy rates (almost) only as news on the “current” starting point of the path of the policy rates in the following months and not as a signal of the ECB’s stance. This suggests, as anticipated in section 4, that the new information on the ECB’s stance captured by \( SN_t \) is conveyed (almost) completely by the words of the ECB’s president, and, therefore, that \( SN_t \) can be considered as a measure of the tone of the words of the ECB President with reference to the ECB’s stance and, more in general, a measure of ECB communication.

6.3 Measures of changes in expectations of future policy rates

As measures of changes in expectations of future policy rates I use differences in Euribor forward rates. As discussed by Rosa and Verga (2007), the one-month Euribor \( n \)-month forward rate on day \( d \), which I denote as \( f_{d,1}^{n,1} \), can be considered a good proxy of the market expectations on the what the levels of the policy rates will be \( n \) months after \( d \). Let \( r_d^n \) and \( r_{d+1}^{n+1} \) be, respectively, the \( n \)-month and the \( n + 1 \)-month Euribor (spot) rate quoted on \( d \), and \( D_d^n \) and \( D_{d+1}^{n+1} \) the maturities, expressed in number of calendar days, for which they are respectively quoted. The formula to calculate \( f_{d,1}^{n,1} \) is

\[
 f_{d,1}^{n,1} = \left( \frac{100 + r_{d+1}^{n+1}D_{d+1}^{n+1}/360}{100 + r_d^nD_d^n/360} \right) \frac{360}{D_d^{n+1} - D_d^n}. 
\]

I calculate changes in expectation which might be affected by changes in the perception of the monetary policy stance of the ECB due to the new information conveyed by events \( t \) as

\[
 \Delta f_{d_t}^{n,1} = f_{d_t}^{n,1} - f_{d_{t+1}}^{n,1},
\]

where \( f_{d_t}^{n,1} \) and \( f_{d_{t+1}}^{n,1} \) are the one-month Euribor \( n \)-month forward rates on day \( d_t \) and \( d_{t+1} \), respectively.\(^{15}\)

6.4 Results

I test if market expectations of the ECB’s future policy rates are affected by the new information on the ECB’s stance conveyed by events \( t \) through an OLS estimation of the following equation:

\[
 \Delta f_{t}^{n,1} = \alpha_n + \beta_n RN_t + \gamma_n SN_t + u_n,
\]

\(^{15}\)See Musard-Gies (2006) for a (slightly) different approach (based on Euribor forward rates) to the measurement of expectations of future levels of ECB policy rates.
for \( n = 1, \ldots, 6 \). The results of the estimation are summarized in Table 2.

<table>
<thead>
<tr>
<th>( n )</th>
<th>Const. ( \alpha_n )</th>
<th>( R N_t ) Coeff. ( \beta_n )</th>
<th>( S N_t ) Coeff. ( \gamma_n )</th>
<th>( R^2 )</th>
<th>Adj. ( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.000</td>
<td>0.730***</td>
<td>0.010*</td>
<td>0.68</td>
<td>0.68</td>
</tr>
<tr>
<td>2</td>
<td>-0.001</td>
<td>0.577***</td>
<td>0.017***</td>
<td>0.41</td>
<td>0.41</td>
</tr>
<tr>
<td>3</td>
<td>0.000</td>
<td>0.655***</td>
<td>0.022***</td>
<td>0.41</td>
<td>0.41</td>
</tr>
<tr>
<td>4</td>
<td>0.006*</td>
<td>0.616***</td>
<td>0.032***</td>
<td>0.35</td>
<td>0.34</td>
</tr>
<tr>
<td>5</td>
<td>0.005</td>
<td>0.720***</td>
<td>0.046***</td>
<td>0.34</td>
<td>0.33</td>
</tr>
<tr>
<td>6</td>
<td>0.005</td>
<td>0.740***</td>
<td>0.038***</td>
<td>0.33</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Note: *, **, and *** denote significance at the 0.1, 0.05, and 0.01 level, respectively. Heteroschedasticity robust (HAC) standard errors and significance of coefficients estimated with HAC errors are reported within brackets.

Coefficient \( \gamma_n \) is positive for each \( n \), significant at the 0.01 level for most values of \( n \) and at either the 0.05 or the 0.1 level for the others. Such results suggest that changes captured by \( S N_t \), in the perception of the ECB’s stance due to new information conveyed by \( t \) levels of the policy rates in the short term. Namely, the positive linear relationship, implied by a positive \( \gamma_n \), between \( S N_t \) and \( \Delta f_{t+1} \) means that, on average, a stance perceived as more hawkish than anticipated (i.e., a positive \( S N_t \), due to a press conference perceived as a more hawkish than expected, see section 6.2) leads to expectations of future policy rates higher than anticipated, and, conversely, a stance perceived as more dovish than anticipated (i.e., a negative \( S N_t \), due to a press conference perceived as a more dovish than expected, see section 6.2) leads to expectations of future policy rates lower than anticipated. Moreover, the more \( S N_t \) differs from zero in absolute value, i.e., the greater the “shock” in the perception of the ECB’s stance (either in a hawkish or in a dovish direction), the greater the revision of the policy rates expectations.
7 Conclusions

In this section I briefly focus on possible lines of research which could be pursued to expand the analysis presented in the paper.

First, one could break the 1999-2013 period into shorter periods to check if the results differ across such “subperiods” (e.g., post and after the “Lehman collapse”). Second, one could check the robustness of the results to alternative measures of expectations of policy rates, such as measures based on the Eonia rate and the Eonia Swap Index. Third, one could repeat the analysis on different samples of articles, such as samples of articles published in languages other than English or in media based in specific countries, to check if the perception of the ECB press conference communication is sensitive to, so to say, “mother-tongue” and “geographical location” of media. This would require either to translate from English the list of hawkish, dovish and neutral expressions used in the present paper or to use a new list of expressions in languages other than English. Fourth, one could apply automated measures of the ECB’s stance to the analysis of events other than GC meetings and following press conferences held by the ECB Presidents, such as speeches and interview of members of the Executive Board and of the GC.
Appendix

The sets $H$, $D$, and $N$ have many elements, both single words and expressions. Listing all of them one by one would take several pages (and reading them one by one would require a lot of time). In order to present the elements of $H$, $D$, and $N$ in a more “tractable” way, I define the expressions contained in the three set as combinations of words and expressions (i.e., more precisely, combinations of sequences of letters and spaces) which are elements of smaller sets. I list here such smaller sets:

- $A_1 = \{\text{comment, remark, speech, statement, tone}\}$,
- $A_2 = \{\text{is, are, was, were, sound, sounds, sounding, sounded, more}\}$,
- $A_3 = \{\text{is considering, are considering, considered, discussed, hint at, hints at, hinted at, signal, signals, signaled, signalled, expect, expects, open to, open for, opens the door for, opens the door to, opened the door for, opened the door to, possibility of, toward, towards}\}$,
- $A_4 = \{\text{about to, poised to, prepared to, ready to, can, could, may, might, will, would}\}$,
- $A_5 = \{\text{not rule out, not ruled out, n’t rule out, n’t ruled out}\}$,
- $A_6 = \{\text{can be, could be, may be, might be}\}$,
- $Z_2 = \{\text{is not, are not, were not, not sounding, not sound, isn’t, aren’t, werent, n’t sounding, n’t sound}\}$,
- $Z_3 = \{\text{is not considering, are not considering, not considered, not discuss, not hint at, not signal, do not expect, isnt considering, arent considering, n’t considered, n’t discuss, n’t hint at, n’t signal, n’t expect}\}$,
- $Z_4 = \{\text{not about to, not poised to, not prepared to, not ready to, cannot, could not, may not, might not, will not, would not, n’t about to, n’t poised to, n’t prepared to, n’t ready to, cannot, couldn’t, won’t, wouldn’t}\}$,
- $Z_5 = \{\text{rules out, ruled out}\}$,
- $B_1 = \{\text{a, a deposit rate, an interest rate, a policy rate, a rate, deposit rate, interest rate, policy rate, rate, any, another, another deposit rate, another interest rate, another policy rate, another rate, a further, a further deposit rate, a further interest rate, a further policy rate, a further rate, further, further deposit rate, further interest rate, further policy rate, further rate, a future, a future deposit rate, a future interest rate, a future policy rate, a future rate, future, future deposit rate, future interest rate, future policy rate, future rate, more, more deposit rate, more interest rate, more policy rate, more rate}\}$,
- $B_2 = \{\text{deposit rate, interest rate, policy rate, rate, further, further deposit rate, further interest rate, further policy rate, further rate, future, future deposit rate, future interest rate, future policy rate, future rate}\}$,
- $B_3 = \{\text{deposit rate, interest rate, policy rate, rate}\}$,
- $H_1 = \{\text{hik, increas, ris, tighten, rais}\}$,
- $H_2 = \{\text{hike, increase, rise, tightening, raise}\}$,
- $H_3 = \{\text{hikes, increases, rises}\}$,
- $D_1 = \{\text{cut, decreas, reduc, eas}\}$,
- $D_2 = \{\text{cut, decrease, reduction, ease, easing}\}$,
- $D_3 = \{\text{cuts, decreases, reductions}\}$,
- $N_1 = \{\text{remain on hold, remain steady, remain unchanged, stand pat}\}$,
- $N_2 = \{\text{no change, no hint, no hurry, no move, no signal, wait and see, wait-and-see}\}$.

In what follows, let $X$ be any of the sets in the list above and $X$ be the total number of the elements of $X$. Let also $x$, with $x = 1, \ldots, X$, be any element of $X$. Given any two sets $X, Y$, with $X \neq Y$, I denote as $x, y$ an expression in which any $x$ is immediately followed a space, which is immediately followed by any $y$. Moreover, given any three sets $W, X, Y$, with $W \neq X \neq Y$, I denote as $w, (x,) y$ both an expression in which any $w$ is immediately followed a space, which is immediately followed by any $x$, which is immediately followed by a space, which is immediately followed by any $y$, and the expression in which that $w$ is immediately followed a space, which is immediately followed by that $y$. In the notation, a sequence of characters reperesenting a word or an expression might substitute either $w, x$ or $y$.

The elements of $H$ are all the expressions:

- $\text{hawkish, } a_1$,
- $a_2, \text{ hawkish,}$
- $a_2, (b_1,) h_1$,
- $a_4, h_1$,
- $a_5, (b_1,) h_1$,
- $a_5, \text{ any, } b_2, h_1$,
- $\text{imminent, } (b_3,) h_1$,
- $h_2, \text{ is on the cards,}$
- $h_2, a_6, \text{ on the cards,}$
- $h_3, a_6, \text{ on the cards,}$
• $h_3$, are on the cards,

excluding the expressions listed above if they are immediately preceded by (a space immediately preceded by) “not” or by a negative verb.

The elements of $D$ are the expressions obtained by substituting in all the expressions listed above the word “dovish” to the word “hawkish”, $d_1$ to $h_1$, $d_2$ to $h_2$, and $d_3$ to $h_3$.

The elements of $N$ are all the expressions:

• $z_2$, hawkish,

• $z_3$, (any,) $h_1$,

• $z_3$, ($b_1$,) $h_1$,

• $z_3$, (any,) $b_2$, $h_1$,

• $z_4$, $h_1$,

• $z_5$, (any,) $h_1$,

• $z_5$, ($b_1$,) $h_1$,

• $z_5$, (any,) $b_2$, $h_1$,

• no, (more,) $b_2$, $h_1$,

• no imminent, ($b_3$,) $h_1$,

• $h_2$, $z_5$, on the cards,

• $h_3$, $z_6$, on the cards,

• obtained by substituting in all the expressions listed above the word “dovish” to the word “hawkish”, $d_1$ to $h_1$, $d_2$ to $h_2$, and $d_3$ to $h_3$,

• neutral, $a_1$

• $a_2$, neutral,

• $a_4$, $n_1$,

• $n_2$. 
References


