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The similarity of ECB's communication

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ABSTRACT

This article examines the communication of European Central Bank (ECB) at press conferences and its impact on financial markets. We compare consecutive central banker conference speeches and document that the similitude of these speeches has been increasing over time. We find evidence that the similarity of ECB communication has helped stock markets learn from ECB monetary policy.

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1. Introduction

According to financial theory, stock prices rapidly incorporate all relevant information about a company (Fama et al., 1969). Among the spectrum of public news sources, monetary policy announcements convey a high degree of informational content about future economic development that can potentially impact stock markets (Funke and Matsuda, 2006). That is, monetary policy decision releases might produce a direct and immediate impact on financial markets (Bernanke and Kuttner, 2005). However, let us consider the ECB statement on May 2, 2013 announcing a reduction of its main refinancing rate and the subsequent seemingly unresponsive reaction of the Eurostoxx50 index, which

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moved up by merely 0.26%. If ECB monetary policy announcements are a major way to communicate and to provide guidance to financial markets, why do we observe such a weak stock market reaction around ECB meetings?

This study aims to provide a better understanding of ECB communications and their informational content. Recent studies have discussed the important role that central bank communication plays beyond traditional monetary policies. In Lucca and and Trebbi (2009), the authors argue that "with short-term interest rates close to the zero-nominal lower bound in many advanced economies for most of 2009, central bank communication has arguably become an even more important instrument". Although communication of ECB monetary policy also occurs in settings other than central bank meetings (e.g. speeches given by members of central banks), these events are heterogeneous and generally wider in focus (Rosa and Verga, 2007). We define a monetary policy announcement as the release of the main refinancing operations rate (MRO) by the Governing Council of the ECB. In the Eurosystem, the main refinancing operation corresponds to weekly open market operations in euros with maturities of one week. We focus on these announcements because the MRO is the main instrument under the control of Eurozone monetary policy makers (Berger et al., 2011).

We first examine how ECB communications have changed since its creation by looking at the similarity of consecutive ECB speech statements. We follow the methodology proposed by Tetlock (2011) to measure the similarity between two texts. This measure, which was first proposed by Jaccard (1901), consists of computing the number of bigrams present in the intersection of two documents, divided by the number of unique bigrams present in the union of the two texts. As an example of our linguistic quantification approach, consider the ECB statements released in April, 2013 and May, 2013 from the ECB website.[2] The 123 bigrams in the first excerpt above include: "aim of maintaining", "downside risk", "economic activity", "gradual recovery". The 95 single bigrams in the second passage include "decided to lower", "aim of maintaining", "forward to enhance", "lending facility". There are 182 unique bigrams in the union of the two paragraphs and 36 common pairings in their intersection, implying that the bigrams similarity of the two first paragraphs is 36/182 = 19.8%. These two texts are even more similar if we look at their overall bigrams, which gives a total similarity of 37.2%. Using all of the ECB statement's speeches since its establishment, we find that their similarity has increased with time. One potential explanation is that the content of new announcements has also decreased across time, which could explain why recent literature on ECB finds that Eurozone stock markets do not react to ECB announcements, even when taking into account the unexpected component of news (Bredin et al., 2009). We argue that this evidence could also point towards an increase in the consistency of the message due to the standardization of communication.

The fact that ECB's central bank speech at monthly press conferences is staled across time is consistent with central banks' focus of providing guidance for future monetary policy and, in particular, about central bank's policy on interest rates (Moessner, 2013; Detmers and Nautz, 2014). Moreover, resemblance of monthly press conference speeches should be an integral part of the ECB communication strategy since these communications are expected to provide information in the most consistent and transparent way. If ECB seeks to deliver readable information and stabilize financial market prices, the organization should provide pertinent information about the state of the economy that can be easily assimilated and interpreted by financial markets. Since the establishment of the ECB, declining absolute abnormal returns have been compatible with the theory that stock markets learn from ECB monetary policy (Filbien and Labondance, 2013).

The above evidence shows that the increase of similarity in ECB speeches could be interpreted as an integral part of the ECB strategy, one in which ECB seeks to facilitate understanding of ECB monetary policy announcements by financial markets. Learning in financial markets relies on investors adjusting their forecasting rules to match new information, which is the central mechanism in the formation of market prices. Investors' expectations about future cash flows and discount rates are continuously revisited based on the information revealed to them. For these updates to be effective in the learning process of an agent, the information acquired by the agent must come in a way that is easy to interpret. If that is the case, a proper adaptive mechanism is going to drive agents' learning schemes so that

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[2] We refer readers to Appendix A in the electronic version of the paper for consulting the two excerpts.

expectations formed by these agents eventually correspond to rational forecasts. Since ECB's mission is to maintain price stability, this entity needs to pay special attention to the way forward information is transmitted to markets, so that market disruptions are minimized and guidance to the Eurozone economy is promptly provided (Preston, 2006).

We argue that the resemblance of ECB communications facilitates the extraction of forward-looking information by investors, which is later considered for making investment decisions and determining asset values. Furthermore, we hypothesize that the similarity of ECB communication has helped reduce the magnitude of Eurozone stock market reactions to releases of new informational content. By looking at the absolute abnormal returns around ECB meetings, we find evidence that the similarity of ECB's speeches has indeed influenced the impact of ECB informational content on the stock market's reaction. We do this by examining the content of ECB speeches from a textual analysis perspective. Following Tetlock et al. (2008), we focus on the negative part of news and we measure the sentiment of news using the methodology proposed in Loughran and McDonald (2011). First of all, we observe that pessimistic speeches increase the overreaction of stock markets. Second, we observe that this effect is modulated by the similarity of ECB communication. These results show that ECB announcements have been effective over time at facilitating learning of monetary policies in the Eurozone stock markets.

This paper contributes to the finance literature in two ways. First, we provide evidence that textual analysis, and more specifically a dictionary approach, facilitates the quantitative analysis of central bank communications. Second, our results suggest that the similarity across ECB monetary policy announcements has been increasing over time, which has improved the consistency of ECB communications. This characteristic boosts the quantity and the quality of monetary policy information; enhanced informational efficiency results in greater price stability in financial markets.

The rest of this article is organized as follows: In Section 2, we describe our data and present the methodology. Section 3 discusses the empirical results and our main conclusions are summarized in Section 4.

2. Data sources and methods

We collected all the 172 introductory monthly statements made by the ECB's president around MRO announcements following the ECB Council of Governors meetings from January 1, 1999 to December 31, 2013. Information about communication dates was gathered from ECB's website. Table 1 shows the frequency of ECB monetary policy announcements and the size of MRO change announced. We observe 33 changes in MRO, including 15 increases and 18 decreases throughout the history of the entity. We also observe that out of these 33 changes, 23 were of 25 basis points in absolute value,

Table 1
Distribution of the change in ECB main refinancing operations rates announcements. This table presents the annual frequency of the change in ECB main refinancing operations rates announcements between January 1999 and December 2013.

Year	−0.75	−0.5	−0.25	0	0.25	0.5	Total
1999	0	1	0	9	0	1	11
2000	0	0	0	8	2	1	11
2001	0	1	2	8	0	0	11
2002	0	1	0	10	0	0	11
2003	0	1	1	9	0	0	11
2004	0	0	0	11	0	0	11
2005	0	0	0	10	1	0	11
2006	0	0	0	7	5	0	12
2007	0	0	0	9	2	0	11
2008	1	1	0	9	1	0	12
2009	0	2	2	8	0	0	12
2010	0	0	0	12	0	0	12
2011	0	0	2	8	2	0	12
2012	0	0	1	11	0	0	12
2013	0	0	2	10	0	0	12
Total	1	7	10	139	13	2	172

giving evidence of ECB's intention to maintain price stability within the Eurozone with the implementation of conservative monetary policies.

2.1. Learning and similarity

When investors are confronted with imperfect information about expected cash flows, they have to employ whatever information is available in order to learn the unknown process driving future cash flows. As shown in learning models such as those of Lewellen and Shanken (2002) and Pastor and Veronesi (2003), parameter uncertainty manifests itself in higher stock valuations, leading to higher price variabilities.

Learning in these models is built on the Bayes's rule, which describes the process of how new information is incorporated into the new estimate of a given parameter. To understand how the consistency of an ECB announcement can play a role on the variability of stock prices, it is sufficient to illustrate the process of inferring information from the announcement with Bayesian updating. In doing this, we are agnostic about other signals employed by investors that could potentially affect the learning process.

Let us suppose that investors infer the cash flow growth rate g_t from the ECB's announcement in order to compute stock prices. To extract this information, we suppose that investors are required to process the announcement so that they obtain a growth estimate $\widetilde{G}_t$. Moreover, we assume that the quality of this filtering process depends on the clarity of the announcement through a parameter δ_t. The higher the value of δ_t, the more precise the signal would be about g_t. We can write the announcement's filtering process as follows:

$$\widetilde{G}_t = g_t + \frac{1}{\delta_t} U_t, \tag{1}$$

with U_t being i.i.d. centered normal variables. If investors' beliefs about the growth rate g_t come from a normal prior with mean μ_{t-1} and variance σ_{t-1}^2, the updated belief about the growth rate is:

$$\mu_t = E[g_t | \widetilde{G}_t = \widetilde{g}_t] = \mu_{t-1} + \kappa_{t-1,t}(\widetilde{g}_t - \mu_{t-1}), \tag{2}$$

with $\kappa_{t-1,t} = \sigma_{t-1}^2 \delta_t^2 / (\sigma_{t-1}^2 \delta_t^2 + 1)$ representing the gain achieved from the new information extracted from the announcement. In a similar manner, the variance of the updated belief is given by:

$$\sigma_t = Var[g_t | \widetilde{G}_t = \widetilde{g}_t] = \frac{\kappa_{t-1,t}}{\delta_t^2}. \tag{3}$$

The intuition behind Eqs. (2) and (3) is straightforward: the clearer the announcement, the closer the investor's belief would be to the unknown growth rate. That is, clearer ECB announcements help investors resolve uncertainty through learning, which will produce lower price variabilities as more precise signals are included in their belief updating process.

2.2. Measuring the similarity of ECB statements at press conferences

The similarity of two successive ECB monthly statements is based on the proportion of textual information overlapping in both statements. We follow Tetlock (2011) and define similarity of two texts based on the bigram's similarity (Jaccard, 1901) between announcements i and $i - 1$ as follows:

$$Similarity_i = \frac{Bigrams_i \cap Bigrams_{i-1}}{Bigrams_i \cup Bigrams_{i-1}}.$$

This similarity measure provides a general idea about the amount of redundant information in two successive ECB statements. Large values (near one) imply that information is similar across statements, whereas small values (near zero) represent a situation in which two statements are completely different.[3]

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[3] We also obtained similar empirical results with different measures of textual similarity like the correlation measure and the cosine measure.

Before running any textual analysis on a document, we perform a series of transformations on the original text. The text is first split into a sequence of substrings (tokens) whose characters are all transformed into lower case. We remove English stopwords and stem English words using the Porter stemming algorithm, which is an iterative, rule-based replacement procedure of word suffixes.

To identify any linear trend in the similarity of ECB communication statement across time, we perform the following regression:

$$logSimilarity_i = \alpha_0 + \alpha_1 logTime_i + \beta' Control_i + \epsilon_i, \tag{4}$$

where *Time* measures the calendar time elapsed between the date of the announcement and the beginning of the sample period, expressed in days. For instance, the variable Time will take a value of 6 for the announcement made on January 6, 1999. The vector $Control_i$ stands for a set of controls associated with variables that determine open market operations of ECB. We include as controls the quarterly output gap (*Output Gap*), the change in the MRO rate (*Delta MRO*), and the Harmonised Index Consumer Prices (HICP) (*Inflation*) as proxies for inflation. The description of these variables, as well as its source, is described in Appendix B.

2.3. Measuring markets' reaction to ECB communication announcements

We focus on stock markets to measure investor's reaction to ECB announcements because they are among the most liquid asset markets in the Eurozone. In addition, valuation of these assets is affected not only by discount rate innovations, but also by growth forecast updates. We use daily closing values of the Eurozone aggregate stock market index, the DJEurostoxx50 Index, to compute a daily return on the day of the announcement. That is, the return associated to the ith announcement happening on day t is computed as $R_{i,t} = ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$, where $P_{i,t}$ is the closing price of the index.

We then calculate abnormal returns using the event study methodology introduced in Fama et al. (1969). Abnormal returns can be estimated with three different models: the constant mean return model, the market model, or the adjusted return risk market. As discussed in (Brown and Warner, 1985), the measure of abnormal return is robust to model choice. Because our focus is on index returns, we select the constant mean return model to estimate the abnormal component of stock market index returns associated with the ith ECB announcement at date t:

$$AR_{i,t} = R_{i,t} - \overline{R}_{i,t}, \tag{5}$$

with

$$\overline{R}_{i,t} = \frac{1}{201} \sum_{t=-250}^{-50} R_{i,t}, \tag{6}$$

defined as the average index return around the ith ECB announcement over the estimation window. We use an estimation window that covers 250 days to 50 days before the announcement date. Based on that estimate, we calculate the cumulative abnormal returns (CAR) by summing the abnormal returns over eleven trading days surrounding the announcement dates [−5 days; +5 days]:

$$CAR_i = \sum_{t=-5}^{5} AR_{i,t}. \tag{7}$$

This 11-day window controls for effects such as news leaks happening before the announcement date or delayed reaction from investors. On the other, this time window size also avoids overlapping events. Our measure of market reaction to the ith ECB announcement is thus given by the absolute value of the cumulative abnormal return CAR_i.

2.4. Similarity of ECB announcements and market reaction

To test whether the ECB speech similarity leads to a decrease in the market's reaction to its announcements, we first need to extract the informational content of the announcement and then

see how this information, conditional on the degree of similarity at a given point of time, impacts the market.

To quantify the informational content of ECB speeches, we follow the methodology proposed in Tetlock et al. (2008) and Garcia (2013) by taking a dictionary approach and identifying positive and negative terms in a document. We account for nuances in the finance jargon by employing a list of financial news-specific words proposed in Loughran and McDonald (2011) and Dougal et al. (2012) to construct our variables.[4] We define the variable *Pessimism* following Ferguson et al. (2013) and Garcia (2013) as:

$$Pessimism_i = \frac{NegativeWords_i - PositiveWords_i}{TotalWords_i}. \tag{8}$$

This measure represents the imbalance between the number of negative words to positive words as a proportion of the total number of words in the ith announcement. The higher its value, the higher the level of pessimistic content in the announcement.

We estimate the influence of communication similarity on market's reaction to ECB announcements with the following regression:

$$|CAR_i| = \gamma_0 + \gamma_1 logSimilarity_i * Pessimism_i + \alpha'Control_i + \eta_i, \tag{9}$$

where the vector $Control_i$ represents controls observed at the end of month i related to open market operations of the ECB. To the set of control variables that we employed before, we add the unexpected component of the announcement as measured by the variable "surprise MRO". The construction of this variable is explained in Appendix B.

The sign of the coefficient γ_1 in the previous equation captures the interaction between the informational content of the news, *Pessimism*, with the similarity level at the date of the announcement, *Similarity*. Since we argue that the likeness of ECB communications facilitates the extraction of forward-looking information by investors, we conjecture that this coefficient should be negative for this relation to be present.

3. Empirical results

3.1. Descriptive statistics

We start by looking at the evolution of ECB communication's similarity across time, which is depicted in Fig. 1. We observe that this measure has increased with time and that it has been particularly volatile after 2007. In this period, ECB has employed a number of measures to ease economic instability in the Eurozone region generated by the aftermath of the financial crisis. For instance, we observe that in Table 1 the largest negative changes in MRO occur during this period.

In Table 2, we summarize the descriptive statistics for our variables. The mean abnormal stock market reaction to the ECB MRO rate announcement, *CAR*, is close to 0, whereas the absolute cumulative abnormal returns, |*CAR*|, reaches a value of 3.28% on average. The average level of pessimism of ECB announcements is −0.26%, which reflects a rather neutral tone surrounding ECB announcement about the general state of the Eurozone and the impact of monetary policies on the economy. Regarding the inflation rate, we observe that on average this value equals 2.03%. This is coherent with the inflation rate of 2% that is targeted by the ECB interest rate policy and its general objective of maintaining price stability across the Eurozone. Finally, an output gap that is slightly positive on average during the study period confirms the relative stability that the Eurozone has experienced in terms of inflation.[5]

3.2. The similarity of ECB communication across time

In Table 3, we report OLS estimates of the model described in Eq. (4). This table shows that the trend variable has a positive and significant value at a 1% level in the regression. In other words, the speech content of ECB's central banker is more and more similar across time. This relation is robust to different macroeconomic conditions.

An increase in similarity of ECB communications goes in line with the fact that central banks in advanced economies have enhanced transparency of their actions and communications to market participants (Geraats, 2002). Central bank communication offers information not only about policy rate decisions, but also about the projections employed for putting these decisions forward. These communications constitute a new set of policy instruments that central banks can employ to exert additional

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[4] See http:www.nd.edumcdonaldWordLists.html for details.
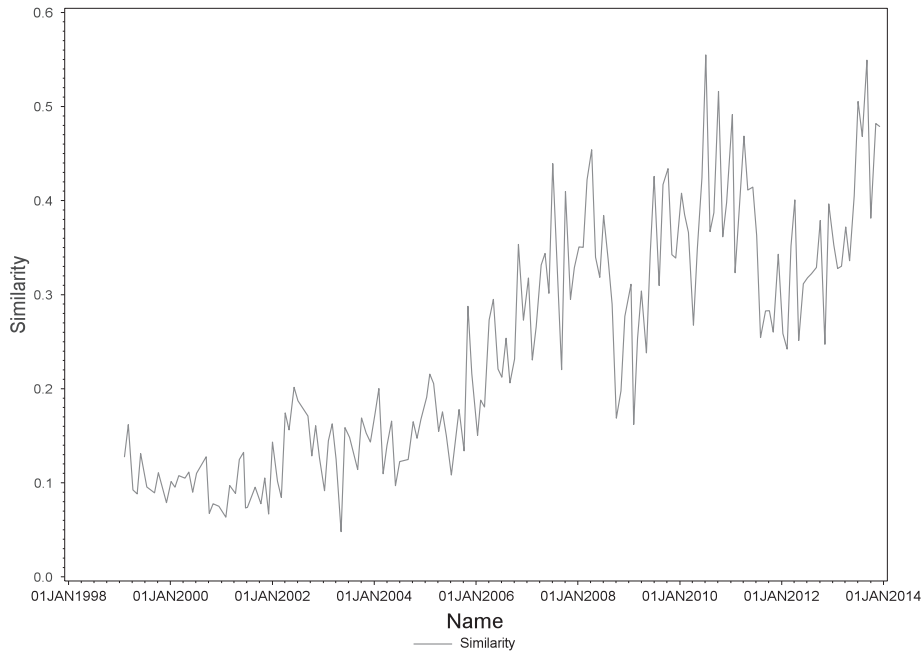[5] Table C.1 in the electronic appendix reports correlations among our variables.

Fig. 1. Similarity measure since ECB's creation.

Table 2
Summary statistics. This table presents descriptive statistics of the variables related to similarity, stock market reactions, ECB governance, and Eurozone business conditions. The sample consists of 172 ECB monetary policy announcements made between January 1, 1999, and December 31, 2013. The variable definitions are provided in Appendix B.

Variables	Mean	Std. dev.	Min.	Quartile 1	Median	Quartile 3	Max.
CAR	−0.03	4.42	−19.69	−2.48	0.32	2.41	12.54
|CAR|	3.28	2.96	0.03	1.39	2.44	4.38	19.69
Pessimism	−0.26	1.52	−4.46	−1.12	−0.19	0.56	3.84
Similarity	0.24	0.13	0.05	0.13	0.23	0.34	0.55
Output gap	0.33	1.69	−2.10	−0.78	0.00	1.46	3.79
Inflation	2.03	0.79	−0.60	1.70	2.10	2.50	4.00
Delta MRO	−0.01	0.16	−0.75	0.00	0.00	0.00	0.50

stimulus beyond the conventional open market operations (Bernanke, 2004). A higher degree of similarity in communications should facilitate the extraction of information, allowing market participants to impound their updated forecasts into asset valuations.

3.3. ECB communication similarity and market learning

Using ECB monetary policy announcements, we carry out an event study to assess whether ECB communication similarity has an effect on the market's reaction to the informational content of communication releases. We first assess the market's reaction to the informational content of announcements with the following regression:

$$|CAR_i| = \beta_0 + \beta_1 Pessimism_i + \eta_i. \tag{10}$$

Column 1 of Table 4 shows estimates of this regression. We observe that Eurozone stock markets respond to the informational content of the ECB communication, as shown by the significant and positive coefficient β_1. The higher the level of pessimism in the announcement, the higher the market's reaction should be.

We now look at the effect that variables related to conventional open market operations have on markets' reactions. The second column of Table 4 presents estimates of Eq. (9) by setting the coefficient γ_1 to zero. In this case, we observe that Eurozone stock markets are irresponsive to these variables since their coefficients are not statistically significant.

Table 3

Explaining the similarity with time: OLS regression. This table presents the results of ordinary least square regressions that explain the similarity. The dependent variable is the measure of similarity of ECB speech at press conferences. The sample consists of 172 ECB monetary policy announcements made between January 1, 1999, and December 31, 2013. The variable definitions are provided in Appendix B.

Variable	(1)	(2)	(3)	(4)
Intercept	−1.565[***]	−5.106[***]	−4.991[***]	−3.457[***]
Time	.	0.463[***]	0.493[***]	.
Time (count)	.	.	.	0.533[***]
Output gap	−0.053[*]	.	0.038[*]	0.043[**]
Inflation	0.012	.	−0.170[***]	−0.170[***]
Delta MRO	0.031	.	0.153	0.162
Adjusted R^2	0.34%	57.31%	60.20%	64.00%

[*] Statistical significance at the 10% level.
[**] Statistical significance at the 5% level.
[***] Statistical significance at the 1% level.

Table 4

Explaining absolute cumulative abnormal returns with time and similarity: OLS regression. This table presents the results of ordinary least square regressions that explain the absolute cumulative abnormal returns. The dependent variable is the Eurozone's absolute cumulative abnormal returns around MRO rate announcements. The sample consists of 172 ECB monetary policy announcements made between January 1, 1999, and December 31, 2013. The model (5) contains 145 ECB monetary policy announcement, due to the lack of availability of the *Surprise MRO* variable for some dates. The variable definitions are provided in Appendix B.

Variable	(1)	(2)	(3)	(4)	(5)
Intercept	3.440[***]	2.486[***]	3.458[***]	2.650[***]	2.434[***]
Pessimism	0.530[***]	.	.	.	.
Pessimism × similarity	.	.	−0.266[***]	−0.243[***]	−0.393[***]
Output gap	.	−0.174	.	−0.089	−0.096
Inflation	.	0.409	.	0.396	0.465
Delta MRO	.	−2.536[*]	.	−1.279	.
Surprise MRO	.	.	.	.	3.493
Adjusted R^2	1.02%	6.92%	5.10%	4.76%	9.02%

[**]Statistical significance at the 5% level.
[*] Statistical significance at the 10% level.
[***] Statistical significance at the 1% level.

The third column shows the effect of ECB communication resemblance on market's reaction: conditional on the level of similarity of the communication statement, the effect of the announcement content on the market is negative. That is, the impact of *Pessimism* is modulated by the similarity of the ECB speech since the coefficient γ_1 is negative and highly significant. Moreover, this relation is not affected by any of the control variables as shown in columns four and five. This leads us to conclude that communication's similarity decreases the dispersion of stock markets reaction to the informational content of announcements. This reduction of dispersion can be achieved since the similarity of ECB communication helps investors update their forecasts in a more precise way. In terms of predictability, the ECB's forward-looking communication policy appears successful, consistent with findings of Rosa and Verga (2007), in maintaining the stability of market prices.

4. Conclusion

The reaction of stock prices to monetary policy announcements is extremely valuable information. Investors can observe how markets react to decisions and thus gain a better understanding of central banks and their actions. Our framework is based on conjectures about learning in Eurozone stock markets, as seen through observations of ECB monetary policy information. We show that financial markets learn from the ECB when it announces its monetary policy decisions. Investors extract information from the MRO rate announcement and apply that information to their asset valuations. In this sample of ECB MRO rate announcements, the Eurozone absolute cumulative abnormal returns

have decreased over time, which indicates learning. Thus, we suggest that ECB has become increasingly predictable by stock markets.

In light of these results, it is then not surprising to find that central banks in advanced economies also signal future policy intentions through official communications. By inspecting these communications, one can identify introductory statements guiding the expectations about future monetary policies and decisions.

An interesting topic for further research would be to examine the sentiment content of central bank communications and how it is perceived by the media. More specifically, one could compare the sentiment of a central bank communication using the dictionary approach of Loughran and McDonald (2011) to the sentiment perceived by the media. Given existing evidence of the role of media sentiment of the market Tetlock (2011), it would be of interest to determine the role of media in assessing the forward-looking information transmitted by central banks.

Acknowledgments

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.frl.2014.12.006.

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