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Article

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Visnyk Nacional'noho Banku Ukraïny

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Reference: Yukhymenko, Tetiana/Sorochan, Oleh (2023). Impact of the Central Bank's communication on FX Market Dynamics. In: Visnyk Nacional'noho Banku Ukraïny (255), S. 4 - 21. https://journal.bank.gov.ua/download/article/2023/255/01/en. doi:10.26531/vnbu2023.255.01.

IMPACT OF THE CENTRAL BANK'S COMMUNICATIONS ON FX MARKET DYNAMICS[1]

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Abstract This study explores the impact of central bank communications on FX market dynamics. Our main results suggest that the NBU's statements and press releases on monetary policy issues do indeed matter. We find that exchange rate movements and volatility are negatively correlated with the volumes of publications by the NBU on its official website. However, this effect is noticeably larger for volatility than for exchange rate changes. The impact of communications on FX developments is strongest a week after a news release, and it persists further. Furthermore, these indicators turn out to be more sensitive to monetary policy announcements than NBU updates overall.

JEL Codes E58, E71, C55

Keywords central bank communications, monetary policy, FX market, text analysis

1. INTRODUCTION

The role of central bank communications has grown rapidly in recent decades. Today, central banks (CBs) use various communication tools widely in order to better manage expectations and achieve policy objectives (Casiraghi, 2022). Communications work through building greater trust in CB decisions and reducing uncertainty in the market, particularly about the future direction of monetary policy. By being more predictable for the markets, CBs make market reactions more predictable for themselves, and thereby strengthen their influence on economic developments (Blinder et al., 2008). Unsurprisingly, a wide strand of literature has already been devoted to the impact of communications on macrofinancial outcomes, including FX market dynamics. However, most studies so far have focused on the markets of advanced economies with stable macroeconomic environments and a developed financial infrastructure. Our study aims to answer whether CB communications can effectively steer market behavior in the complex and turbulent environment of an emerging market – such as that of Ukraine.

To evaluate the impact of CB communications, researchers typically examine financial market reactions. There is abundant evidence that CB communications have a significant impact on asset prices and yield moves. For instance, it has been proved that the Fed's communications through statements, minutes, and speeches affect both the volatility of U.S. asset prices and trading volumes (Hayo et al., 2008; Rosa, 2011). Monetary policy announcements may also explain variations in asset prices in other advanced markets, like the Euro area (Leombroni et al., 2021) or the UK (Mumtaz et al, 2023). However, asset market responses may be weak and uncertain in emerging markets with undeveloped or illiquid securities markets (Eklou, 2023; Kamin et al., 1998). Therefore, bond and stock price moves would be a poor proxy for evaluating CB communications in these cases. Therefore, taking into account the insufficient level of development of the Ukrainian securities market, in our study we primarily focused on the reactions of the FX market.

CBs keep a close eye on FX developments, which are extremely important for achieving policy goals. The exchange rate channel is considered to be a very powerful link of monetary transmission in emerging countries (Stone et al., 2009), and Ukraine is no exception (Zholud et al., 2019). Excessive ER volatility may be an issue of high concern, as it negatively affects a range of macroeconomic variables, including inflation, trade, and investments (Weber, 2017). Moreover, the negative impact of exchange rate volatility is exacerbated during currency crises (Brouwer, 2004), which are rather common in emerging markets. In contrast, lower ER volatility improves monetary transmission and reinforces confidence in the local currency, contributing to low and stable inflation (Velarde and Montoro, 2022). For this reason, CBs try to shape the reactions of the FX market through using both actual and verbal interventions. Many CBs use communications as

[1] The authors thank Professor Oleksandr Talavera from the University of Birmingham for the academic supervision of this paper. This research took place through the coaching program under the Bilateral Assistance and Capacity Building for Central Banks (BCC), financed by SECO, and the Graduate Institute in Geneva.
The views expressed in this paper are solely those of the authors and do not necessarily reflect those of the National Bank of Ukraine.

a primary policy instrument for reducing excessive market fluctuation (Fratzscher, 2005). Several empirical studies have shown a smoothing impact of communications on ER volatility in the Czech Republic (Fišer and Horváth, 2009), India (Goyal and Arora, 2012), China (Ning et al., 2016), and Poland (Brzeszczyński et al., 2017). We also studied whether monetary policy communications smooth sentiments on the currency market in Ukraine.

Recent scientific papers on Ukraine have already shown that there is a distinct connection between the NBU's communications and FX market behavior (Gao et al., 2023; Ivanytskyi, 2022). In particular, research by Gao et al. (2023) highlights the power of communications sentiment and its impact on overall ER volatility and the black market premium during the full-scale russian invasion of Ukraine. We extend these findings by discovering a significant correlation between the volumes of NBU publications on its official website and ER movements and volatility. Our results clearly suggest that the NBU's communications efforts contribute to smoothing sentiment on the currency market. The impact of these efforts peaks within a week of publication and persists throughout the observed horizon. Communications related to monetary policy have a greater impact on both ER movements and volatility compared to other messages. However, the general effect of communications on ER volatility turned out to be much more tangible than the effect on ER changes. This insight suggests that market factors may have a greater impact on ER fluctuations, while behavioral factors may play a larger role in determining volatility.

Another finding of our paper concerns references to the governor in the NBU's communications. Although mentioning the governor does not appear to have a clear-cut impact on volatility or ER movements, it is likely to enhance the smoothing effect on the FX market during the first week. This means that markets attribute additional weight to the governor's voice. This finding echoes the results of some other papers, which demonstrate heightened attention to market-related speeches and remarks by the governors of the ECB (Istrefi et al., 2022) and Fed (Biefang-Frisancho and Howells, 2007). The additional weight of high-ranking communications is also confirmed by other researchers. For instance, in the United States, the financial markets react more strongly to a statement from the chairman than to ones from other Fed officials (Ehrmann and Fratzscher, 2005), while the vice chairman's voice has more influence compared to other Board members, and voting regional Fed presidents affect markets more than non-voting ones do (Hayo et al., 2008). While the influence of the governors' words also depends greatly on their personalities (Narain and Sangani, 2023), their potential to attract more market attention is undisputed and should be used judiciously in communications.

The findings presented here have significant implications for both policymakers and financial market participants. Policymakers can use this insight to strategically craft and disseminate communications – particularly those related to monetary policy – to mitigate potential fluctuations in the currency market. Furthermore, the study's results propose straightforward and practical measures to enhance the effectiveness of central bank communications. Specifically, the NBU should publish monetary policy news more frequently at the start of the week if they are not linked to the Monetary Policy Committee's decision schedule. In addition, including references to the governor in the messages augments the impact of communications.

The paper is organized as follows. Section 2 briefly describes communications in the NBU. Section 3 covers data exploration and the methodology applied to assess the impact of communications on the FX market dynamics. Empirical results on this impact are provided in Section 4. Section 5 provides a summary.

2. NBU COMMUNICATION INSIGHTS

Since the adoption of inflation targeting and the transition to a floating exchange rate in 2015, the NBU has seen communications as an important instrument for achieving policy goals. Transparency, consistency, proactivity, and clarity of communications have been integral principles of the NBU's strategy. Given that, the NBU's communications toolkit has been significantly improved and expanded in recent years. The current arsenal includes monthly *Macroeconomic and Monetary Reviews*, quarterly *Inflation Reports*, semiannual *Financial Stability Reports*, *Annual Reports*, press briefings on key decisions, monetary policy releases, *Summaries of MPC* discussions, commentaries on inflation and GDP, and other publications. The NBU also holds regular meetings with experts, market participants, the business community, and foreign investors. Interviews and columns by Board members and experts of the NBU, and off-record meetings with journalists are widely used for the better transmission of key messages to key audiences. Educational outreach is conducted through seminars for university professors, and lectures and contests for students. The NBU maintains a strong presence on social media platforms (Facebook, Twitter, Instagram, YouTube, Telegram), and makes layered communications to tailor content to the needs of diverse audiences. A Transparency Award from *Central Banking* marked the progress of the NBU's communications system in 2019.

Through this multifaceted approach, the NBU strives to reduce market uncertainty and promote informed decision-making. This is crucial in the turbulent and rapidly changing economic landscape of Ukraine. The last decade alone brought the annexation of Crimea, subsequent russian aggression in eastern Ukraine, the COVID-19 crisis, and a full-scale russian invasion. Each of these events struck a huge blow to the Ukrainian economy. Despite these challenges, the NBU has remained committed to openness. Following the russian invasion, the NBU made some modifications to its monetary regime but maintained consistent communications practices. Consistent proactive communications were required to ease the unprecedented level of uncertainty during the war. External research has proved the effectiveness of this approach. The Semantic Index developed by Morgan Stanley shows high consistency between the words used and policy moves of the NBU during wartime (Slyusarchuk et al., 2023). For its part, congruous communications by the NBU and correct wording helped to mitigate the shocks of war, in particular by smoothing the reactions of the Ukrainian FX market (Gao et al., 2023). The NBU's broad communications toolkit and its successful implementation in a fast-changing economic environment make it a valuable case study for studying the potential of CB communications.

3. DATA AND METHODOLOGY

3.1. Data Overview

The NBU maintains a strong online presence through its official website and social media platforms, providing essential information to the public. The Wayback Machine shows that the NBU website was launched in the 1990s, initially containing limited information on banking legislation, the NBU's structure, exchange rates, etc. In 2019, the NBU launched a new website with improved functionality and expanded content. Most of the important information messages were transferred to its News section, but a significant part remains in the archive and can only be accessed through a website search.

Similarweb.com suggests that the NBU's website receives 1.4-2 million monthly users. Time spent on the NBU website increased from 100 seconds in 2022 to 200 seconds in 2023. However, 60% of visitors leave the site after viewing the first page. This could be due to the nature of the information of interest to visitors, such as the exchange rate, which is located on the home page. Thus, one-third of the visitors who are more interested in other information viewed an average of 10 pages (up from 4.2 pages in 2022). When compared to the other state organizations' websites (Figure 1), such as those of the President, the Government, and the Parliament, this website has higher results, except for the Tax Service website, which can be explained by the fact that this agency gives access to its electronic services through its website.

With such a large audience, central banks' websites provide new tools for communicating monetary policy messages to a wide range of audiences, while at the same time improving the public's access to central bank information.

This study analyzes the online presence of the NBU using Google Analytics, and uses website data as independent external variables.

Google Analytics is a web analysis service provided by Google that allows website owners to track and analyze various aspects of their online presence. This service anonymously collects and processes information about website visitors, including their geographic location, devices and browsers used, traffic sources, and specific actions taken on the website. Attempts have been made to use Google Analytics data to measure the impact of CB communications on the public's information demand, which in turn affects inflation expectations. For instance, Jung and Kühl (2021) used European Central Bank (ECB) website traffic as a proxy for visitors' engagement with its communications.

This research utilized a unique Google Analytics dataset, which includes daily views of the NBU website from January 2014 to December 2022. The dataset focuses on the *News and Official Announcements* sections of the NBU website. Data points were filtered to exclude days and pages with less than 10 views, resulting in a sample of 158,000 data points. Further refinement addressed duplication issues caused by variations in URLs. A dataset of 142,000 data points representing 7,098 news items in Ukrainian was ultimately obtained after data cleaning. The primary analysis indicates that each page received an average of 20 days of visits and was viewed approximately 3,500 times. Notably, page views experienced a surge in February 2022. Thus, specific pages related to supporting the Armed Forces of Ukraine and humanitarian aid garnered a significant portion of website views (see Appendix A, Figure 9). As this topic is specific and remote from traditional central bank functions, this section will be excluded from the study.

We collected textual data for almost every news item by using links to publications on the NBU website from Google Analytics data. Unfortunately, after the transition to the new version of the website, some of the data became unavailable in the archive. However, the share of these articles is only 5.6%, which is an acceptably low level for the research.

Various characteristics of communications, such as their content and tone, can significantly impact assessment results. Gorodnichenko et al. (2023) found that even nonverbal communications can affect various financial indicators. To investigate heterogeneity, we evaluated

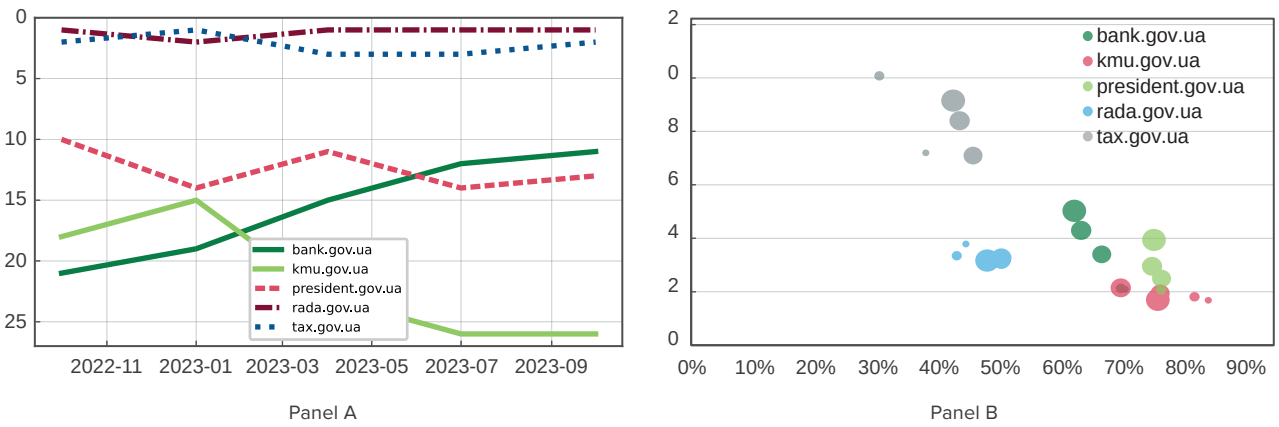

Figure 1. Ranking of Sites in Category Government in Ukraine (*panel A*) and Bounce Rate and Average Pages visited (*panel B*)

Note: The y-axis on *panel A* represents the rank of the website based on the number of visits, while the x-axis represents the date. The y-axis on *panel B* represents the number of pages opened by a single visitor per visit. The x-axis shows the bounce rate, which indicates the percentage of visitors who view only one page per visit. The larger markers denote more recent data.
Source: similarweb.com

various types of central bank communications, with regard to the topic, references to the governor in the text, the popularity of articles on the website among visitors, the stage of monetary policy, and so on. The new site features numerous articles with tags, which are specific words or phrases used in search queries to find relevant information on a particular topic or subject. These keywords include monetary policy, financial stability, numismatics, payments, and more (see Appendix B, Figure 9). In total, we identified 40 keywords, including monetary policy, financial stability, numismatics, and payments. Some articles have two or more tags, which makes it possible to trace the relationships between topics and identify more aggregated groups. In the end, we implemented a binary classification based on the proposed tags (monetary/non-monetary) to focus on monetary publications.

However, nearly 3K articles lack tags. To fix this, we utilized the BERT model (Devlin, 2019) to classify the remaining data. Due to the morphological complexity of the Ukrainian language, the text required thorough cleaning before further analysis. Therefore, the text of each article was lemmatized using the Pymorphy2 library (Korobov, 2015). Pymorphy2 returns the normal form of a word, including the nominative singular for nouns and adjectives, and the indefinite present tense for verbs. In addition, prepositions and particles were removed from the text, along with the most frequently used words using a list of stopwords. On average, articles on the NBU website contain 302 words (the median is 252 words).

The model was trained on existing data with the following characteristics: maxlen=200, max_features=100000, preprocess_mode='bert'. The validation sample size was 20%. The model appears to perform reasonably well even considering the non-uniformity of the sample (see Table 1). Additionally, the validation accuracy is slightly higher than the training accuracy, indicating that the model is generalizing well to new, unseen data. The low loss values suggest that the model's predictions closely match the true values, both in the training and validation sets. Our model classified 94 additional publications, in addition to the 472 already identified.

We also used a dictionary-based approach to distinguish articles that mention the governor.

All the publications were divided into two categories using a dictionary approach: those that mention the NBU governor's name and those that do not. The NBU website contains 762 messages that mention the governor, 74 of which are related to monetary policy.

3.2. Econometric Specification

Local projections are linear regressions that project observations of an endogenous variable at different periods over a chosen horizon onto observed exogenous variables. This method is well suited for capturing the heterogeneous effects of economic variables over time, and offers a nuanced and dynamic perspective (Jorda, 2005). In the context of our research objectives, this methodology allows for a granular examination of the impact of central bank communications on the FX market dynamics. Local projections provide the flexibility to incorporate short-term and long-term effects, capturing the multifaceted nature of economic relationships across varying temporal scales. The sensitivity of local projections to changes in the economic landscape enhances the model's ability to reflect evolving dynamics, making it an ideal choice for studying a dynamic economic system. Local projections are commonly used in economic research due to their advantages. For example, Gao et al. (2023) used local projections to prove that NBU's announcements significantly impacted FX market agents; Carrière-Swallow et al. (2023) estimated the variance of the rate of pass-through from the exchange rate to domestic prices across states of the economy.

To evaluate the effect of central bank communications on macroeconomic outcomes, we created the subsequent local projections model:

$$y_{t+h} = \theta_h CB_t + \gamma_h y_t + \varepsilon_{t+h};\ h = 0, 1,..., H, \quad (1)$$

where y is the dependent variable (the macroeconomic outcome being studied), *CB* – publications of the central bank measured as the number of released messages on the website, ε is a residual, *h* – horizon, and *t* is a point of time. θ is a coefficient vector, which according to the local projections' method is interpreted as a sequence of impulse responses to a structural shock.

We used the volume of publications on the NBU's website (expressed as a natural logarithm) as an

Table 1. Model Results of NBU Messages Classification Using BERT

	Precision	Recall	F1-score	Support
Monetary	0.71	0.56	0.63	87
Non-monetary	0.95	0.98	0.96	808
Accuracy			0.94	895
Accuracy (training)			0.91	3580
Loss			0.16	895
Loss (training)			0.24	3580
Macro avg	0.83	0.77	0.80	895
Weighted avg	0.93	0.94	0.93	895

Note: Leveraging BERT's zero-shot classification capabilities allowed the model to classify messages without needing extensive task-specific training data. The model demonstrates robust performance in classifying NBU messages, with an overall accuracy of 94% on the validation set, which exceeds the training accuracy of 91%. This suggests effective generalization to new data. The precision, recall, and F1-score metrics indicate that while the model excels in identifying non-monetary messages (precision of 0.95 and recall of 0.98), it faces challenges with monetary messages, showing a lower precision of 0.71 and recall of 0.56. The macro average scores highlight a balanced performance across classes, with an F1-score of 0.80. The loss values – 0.16 for validation and 0.24 for training – indicate that the model's predictions are closely aligned with true outcomes.

exogenous variable. Given the significant volatility of this indicator and dependence on its popularity on the day of the week (see Appendix A for more details), we use the sum of publications for seven days. The time series successfully passed stationarity tests, affirming the stability and constant statistical properties of the data over time.

The study aims to understand the intricate connections between central bank communications and economic variables. Traditional macroeconomic indicators, such as inflation or GDP, are published infrequently, either on a monthly or quarterly basis, and exhibit a considerable lag in their release. This temporal discrepancy poses challenges in isolating the distinct influence of individual central bank events on overall indicators. Furthermore, the transient nature of interest in central bank news complicates this task. Local projections are also most justified for use on high-frequency data.

Therefore, the focus of the investigation shifts to macroeconomic indicators with higher frequency. As the Ukrainian stock market remains in its early stages of development, the exchange rate of the hryvnia against foreign currencies, particularly the U.S. dollar, is used. Following Ukraine's departure from the fixed exchange rate system in 2014, a gradual relaxation of currency constraints and a shift towards inflation targeting ensued. Nonetheless, the NBU reinstated the fixed exchange rate mechanism in late February 2022 due to the large-scale military intervention by russia in Ukraine. Taking into account the very volatile nature of the grey cash exchange rate, we use it in our study (see Figure 2). The analysis utilized the change in the hryvnia/dollar exchange rate on the cash market and the seven-day volatility of the hryvnia exchange rate. The use of these variables instead of the exchange rate is also justified from the point of view of statistical properties. The volatility of the exchange rate and its change passed stationarity tests, unlike the exchange rate indicator.[2]

We estimated impulse responses by using local projections on the sample from 1 January 2014 to 31 December 2022.

4. ESTIMATION AND RESULTS

At first, we calculated impulse response coefficients for exchange rate volatility and ER change to CB messages.

The evolution of the results for the impulse response coefficient θ_h from equation 1 on ER indicators as a function of the lag length h is plotted in Figure 3. The lag parameter h ranges from 0 to 30 days after the publication date.

We found out that the publications of the NBU on its official website have a negative correlation with both exchange rate movements and volatility. The coefficient's negative sign indicates an inverse relationship between the number of CB messages on its website and ER volatility. This suggests that a 1% increase in the number of any messages by the CB is associated with a 0.4% decrease in ER volatility in one week (see Figure 3, Panel A). Publications on monetary policy have a stronger impact on both indicators than other messages. A 1% increase in the number of monetary policy messages leads to a 1.2% decrease in ER volatility in 7–10 days (see Figure 3, Panel A). This effect reaches a maximum in about a week and persists throughout the entire observed horizon. All these results are significant at the 5% level.

Therefore, the communications published by the NBU may smooth sentiment on the currency market to a noticeable extent. This can be attributed to the characteristics of the audience reading each particular news item, and to other events occurring in the economy. In particular, people who are responsible for setting the

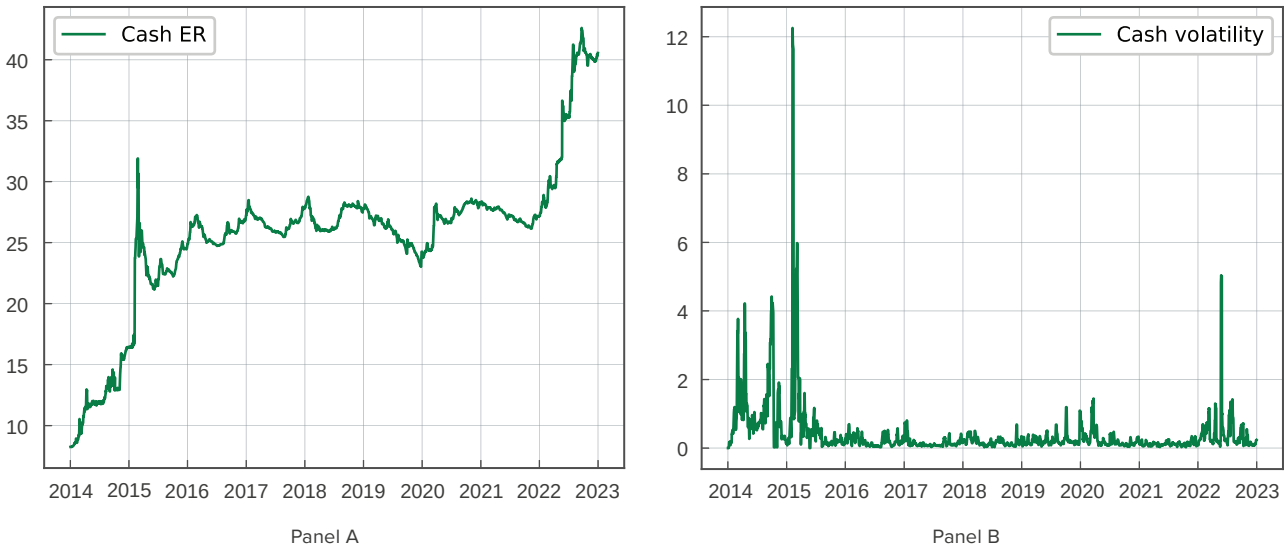

Figure 2. Cash ER (*panel A*) and ER Volatility (*panel B*)

Note: *Panel A* Shows the evolution of the UAH/USD exchange rate. After the transition to a floating exchange rate in 2014, the cash and official exchange rates were virtually identical. However, the forced fixing of the exchange rate in February 2022 due to russia's full-scale invasion led to a widening of the spread. *Panel B* shows the evolution of the seven-day volatility of the UAH/USD exchange rate.
Source: NBU, minfin.com.ua

[2] DF ER change = -10.212 (p-value = 0.000), DF ER volatility = -5.613 (p-value = 0.000).

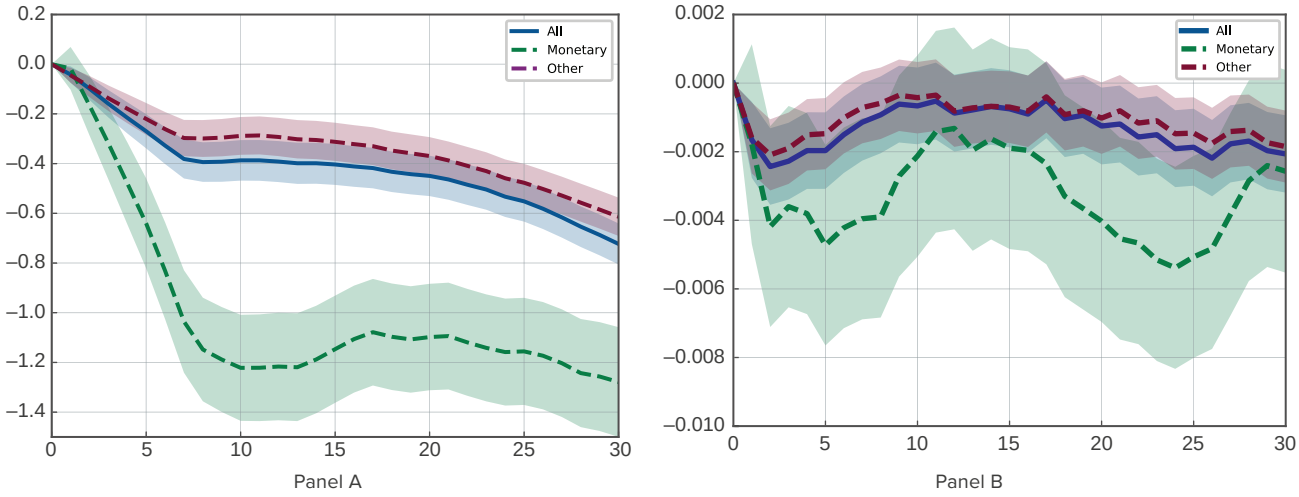

Figure 3. Daily Evolution of the Impulse Response Coefficient for ER Volatility (*panel A*) and ER Change (*panel B*) to Central Bank Messages

Note: This figure shows the results of estimating the sentiment coefficient θ from equation 1 for the time shift h varying between publication day (0) and 30 days after the announcement. The y-axis is the response to a number of publications (in logs). The x-axis is the time shift parameter. The shaded fields, show the 95% confidence interval. The dark-solid line represents the coefficients for all publications, the light-dotted line represents the coefficients for monetary publications, and the dark-dotted line represents the coefficients for monetary publications. The estimates of the coefficients can be seen in Appendix C, Table 1a-1b.

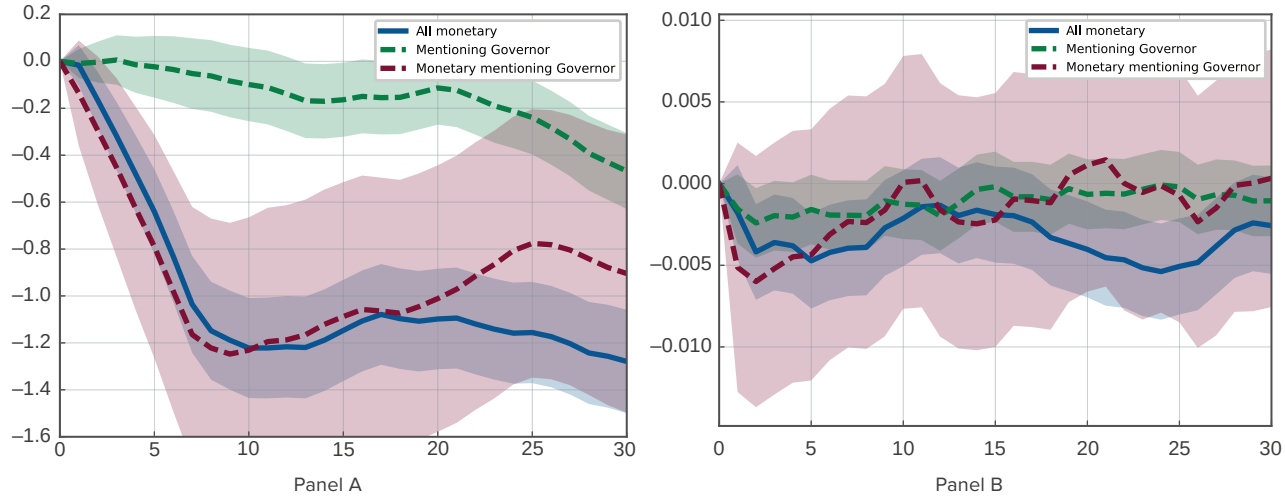

Figure 4. Daily Evolution of the Impulse Response Coefficient on CB Messages in which the Governor is Mentioned or Not Mentioned

Note: *Panel A* shows the reaction of cash ER volatility and panel B shows the reaction of change in ER. These figures show the results of estimating the sentiment coefficient θ from equation 1 for the time shift h varying between publication day (0) and 30 days after the announcement. The y-axis is the response to the number of publications (in logs). The x-axis is the time shift parameter. The shaded fields show the 95% confidence interval. The dark-solid line represents the coefficients for all publications, the light-dotted line represents the coefficients for monetary publications, and the dark-dotted line represents the coefficients for monetary publications. The estimates of the coefficients can be seen in Appendix C, Table 2a-2b.

trend in trading volumes in the forex market are more likely to read specialized news rather than news in general.

On the other hand, the effect of the NBU's news on the exchange rate changes is much smaller than for volatility. Within 3-5 days after publication, an increase of 1% in the number of overall news items, as well as monetary policy news in particular (in logarithm value terms) will reduce the exchange rate insignificantly – by 0.002% and by 0.004% respectively (see Figure 3, Panel B). This may suggest that exchange rate changes are more dependent on market factors, while volatility is more often determined by behavioral factors. This could be interpreted as an increase in transparency or effective communications by the central bank, leading to greater stability in exchange rates and reducing the impact of speculative or panic-driven behavior.

At the second stage, aimed to identify patterns and properties of publications that may affect the impact of communications on exchange rate indicators. These properties may include the content or the level of reader attention.

In particular, we assumed that the central bank governor's authority and attention to specific events could affect the assessment's results.

Figure 4 demonstrates that, in general, references to the governor in NBU communications do not have

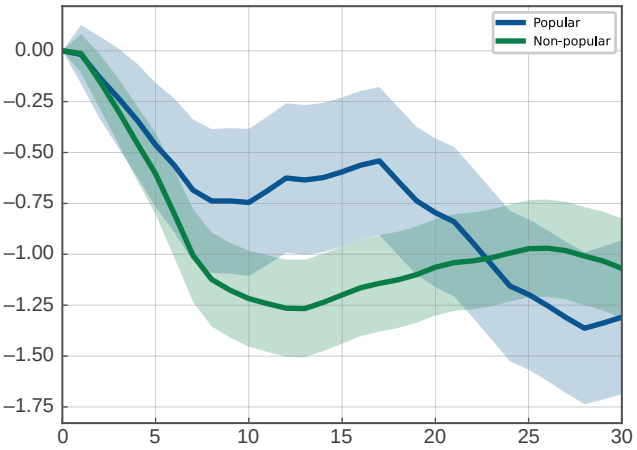

Figure 5. Evolution of the Impulse Response Coefficient to CB Messages by Popularity

Note: Figure shows the reaction of cash ER volatility. This figure shows the results of estimating the sentiment coefficient θ from equation 1 for the time shift h varying between publication day (0) and 30 days after the announcement. The y-axis is the response to a number of publications (in logs). The x-axis is the time shift parameter. The shaded fields show the 95% confidence interval. The dark-solid line represents the coefficients for all publications, the light-dotted line represents the coefficients for monetary publications, and the dark-dotted line represents the coefficients for monetary publications. The estimates of the coefficients can be seen in Appendix C, Table 3.

an impact on volatility or exchange rate movements. However, if the governor is mentioned in monetary policy news, it is likely to accelerate the smoothing effect of the NBU's publications on the FX market during the first week. The maximum effect on volatility is achieved at least one day earlier when mentioning the governor. This may indicate greater attention and trust in messages, which contain the governor's direct or indirect speech. Meanwhile, the coefficients for monetary publications that mention the governor have a high degree of uncertainty. This uncertainty is due to the limited number of observations. Nevertheless, we believe that it is a good idea to mention the governor in such publications for enhanced precision and impact. During periods of significant shocks, time can be important in offsetting the negative impact on the economy.

The news has been divided into two categories based on the number of views, below and above the median. On average, monetary policy news is viewed less frequently (see Appendix A, Figure 12). It was discovered that news with a larger number of views had a lower impact on FX market volatility (Figure 5). A 1% increase in the number of popular messages leads to only a 0.75% decrease in ER volatility in the first week. A 1% rise in non-popular news converts to a significant 1.25% drop in volatility. This may be because monetary policy news, which as we have already noted is more likely to reduce volatility, receives fewer views.

5. DISCUSSION AND CONCLUSIONS

This study examines the impact of central bank communications, specifically those published on the NBU website, on FX market indicators. Local projections, a method that captures both short-term and long-term effects, were used to identify nuanced patterns in the impact of central bank communications on various indicators. The study shows a clear correlation between the NBU's statements and press releases on monetary policy issues and the behavior of the FX market. The negative correlation between exchange rate movements, volatility, and the volume of NBU publications suggests that an increase in the central bank's communications activity is associated with a decrease in FX market volatility. Notably, monetary policy announcements have a more pronounced impact compared to overall publications, resulting in a statistically significant larger decrease in FX volatility within 7–10 days.

The analysis showed that while exchange rate changes are minimally affected in the short term, volatility experiences a more substantial reduction. We also examined the role of specific communications characteristics, such as references to the governor and message popularity, on FX market indicators. Emphasizing the importance of key figures in central bank communications, mentioning the governor in monetary policy news was found to enhance the smoothing effect on the FX market. In particular, the effect of such messages seems to be faster.

Our research confirms the results of previous studies that communications are important and can influence the behavior of financial market participants (Fratzscher, 2005; Fišer and Horváth, 2009; Goyal and Arora, 2012; Ning et al., 2016; Brzeszczyński et al., 2017; Gao et al., 2023), but also provides empirical insights into the complex relationship between central bank communications and FX market indicator dynamics. The implications of our findings are significant for policymakers and financial market participants. Policymakers can strategically shape and disseminate communications, especially those related to monetary policy, to mitigate currency market fluctuations. This is especially important in times of crisis or other shocks when it is necessary to react quickly and accurately. The importance of clear and targeted messaging is underscored by the differential influence of communications themes on inflation expectations, with monetary policy announcements playing a pivotal role. Practical measures to enhance the effectiveness of NBU communications include the more frequent publication of monetary policy news early in the week, and incorporating references to the governor in messages. These recommendations aim to improve the precision and impact of central bank communications.

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APPENDICES

APPENDIX A. GOOGLE ANALYTICS

Before the full-scale invasion, NBU webpage views rarely exceeded 200K per month. However, in February 2022, the uncertainty and open communication policy of the NBU prompted people to visit the site more often. In addition, a significant share of the views was collected by two pages "Special Account" and "Special Account for Humanitarian Aid" containing account details to support the Armed Forces of Ukraine and humanitarian aid to Ukrainians. In the 311 days from the launch of this page until the end of 2022, it was viewed almost 11 million times, which is about 43% of all views of the NBU website over nine years.

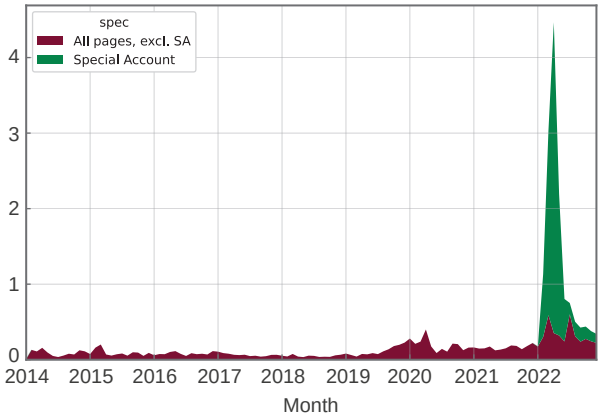

Figure 6. Total Number of Views per Month, million

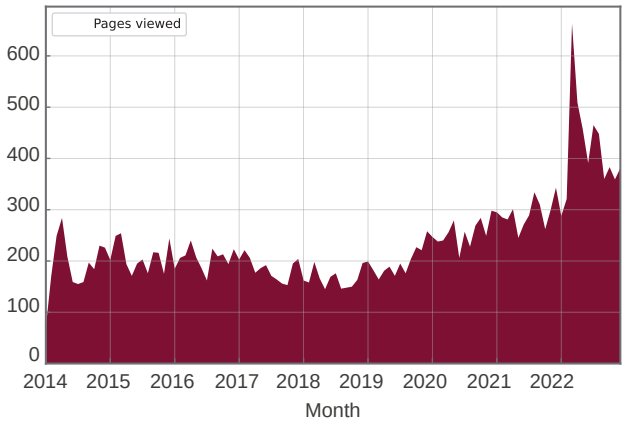

Figure 7. Pages Viewed per Month

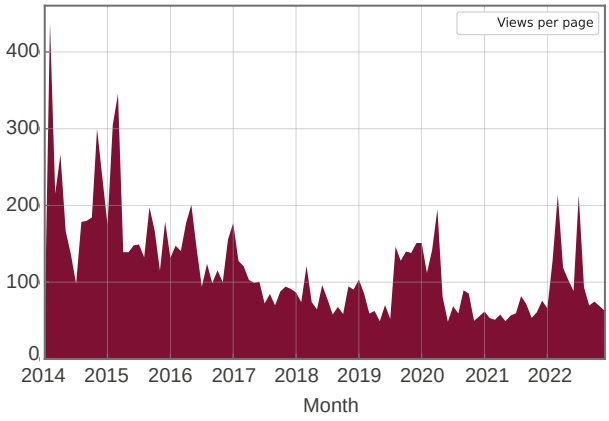

Figure 8. Average Page Views per Month (excl. Special Account Page

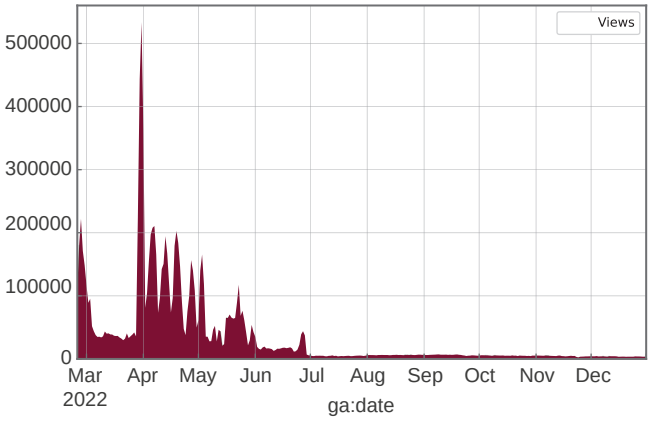

Figure 9. Views of Special Account Page per Day

Views of the NBU's pages are expected to be highest in the first days after publication on the website (Figure 10). Interestingly, on average, the next day after the publication there is a significant increase in views compared to the first day. However, this is explained by the views of 39% of articles being significantly shifted to the next day: Among other things, this can be explained by the time of publication during the day – evening news is likely to be viewed more the next day. Unfortunately, the exact date and time of publication are not available for most articles, so the issue of the exact time will not be considered in this study. Therefore, the study will be based on daily data.

Page views largely depend on the day of the week. First, on weekends, the NBU website publishes much less news. Second, the number of visitors on weekends drops sharply.

We looked at the difference between the trajectory of views of all news on the NBU website and news related to monetary policy only. On average, monetary policy news is viewed less frequently, and views drop sharply two days after publication. This can be explained by the fact that very often monetary policy news is published on Thursday, in conjunction with meetings of the monetary policy committee and the announcement of decisions. As shown in Figure 11, on weekends views are much lower for all news.

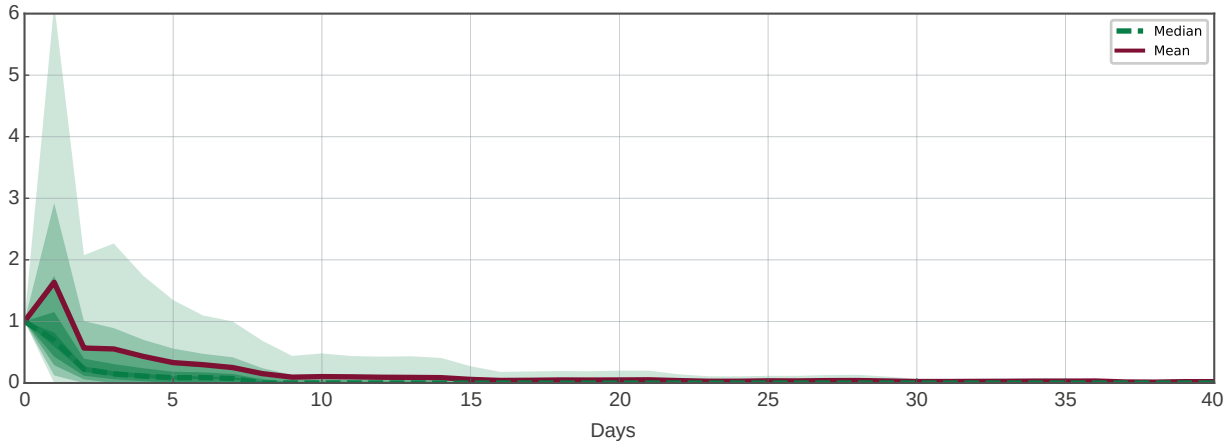

Figure 10. Average Interest on Pages by Days (publication day = 1)

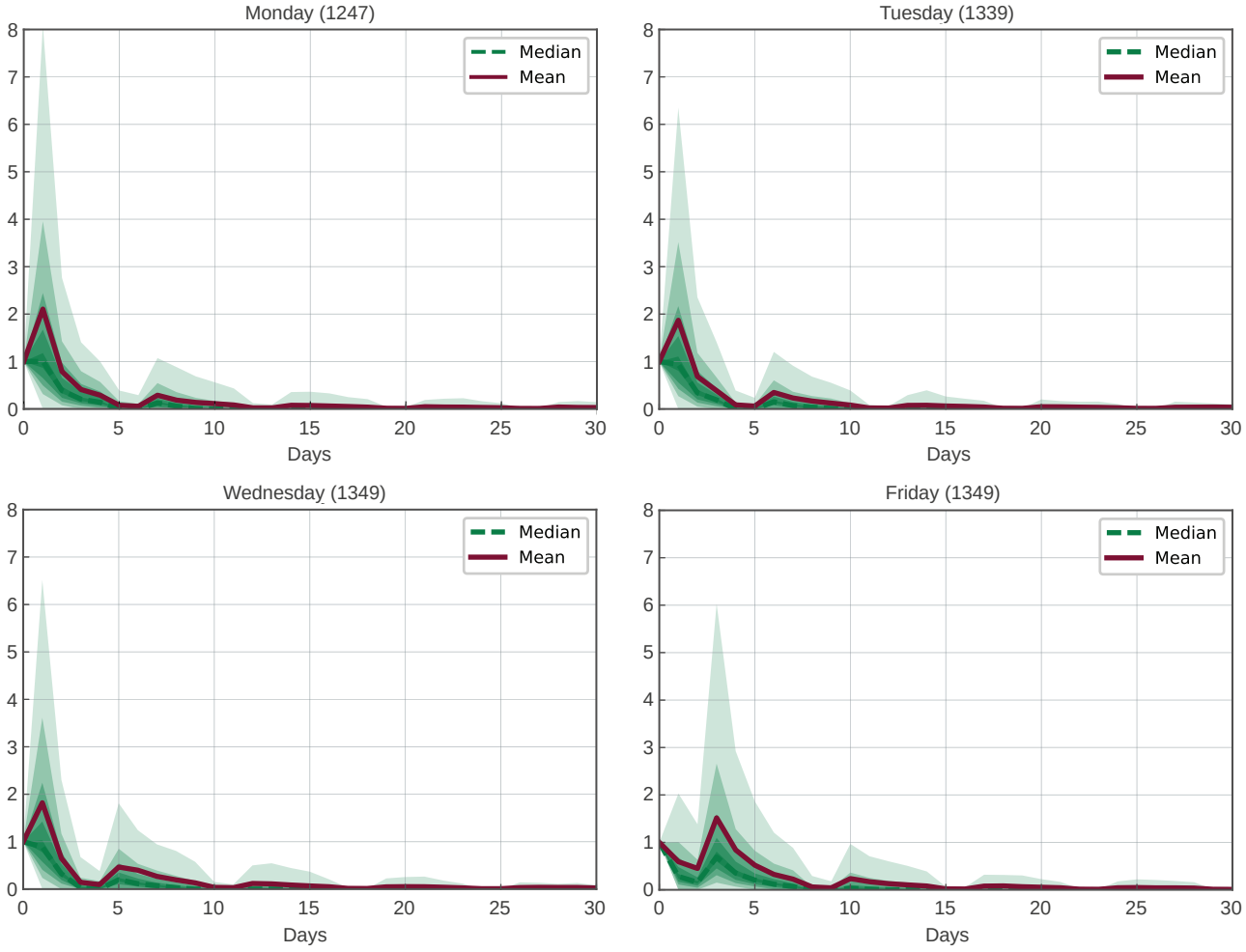

Figure 11. Average Interest in Pages by Days (publication day = 1) Depending on Day of the Week when the News was Published (number of published news in parentheses)

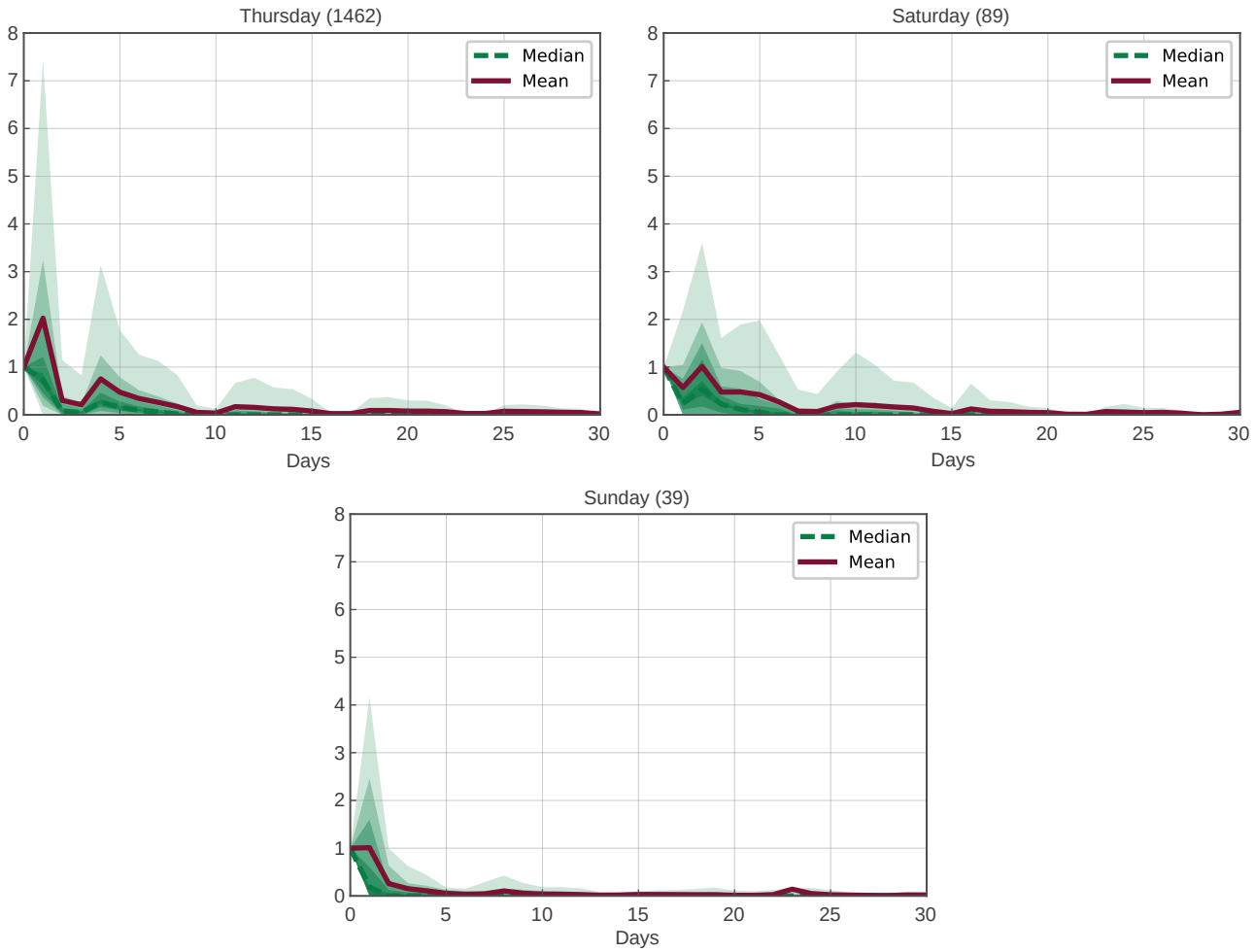

Figure 11 (continued). Average Interest in Pages by Days (publication day = 1) Depending on Day of the Week when the News was Published (number of published news in parentheses)

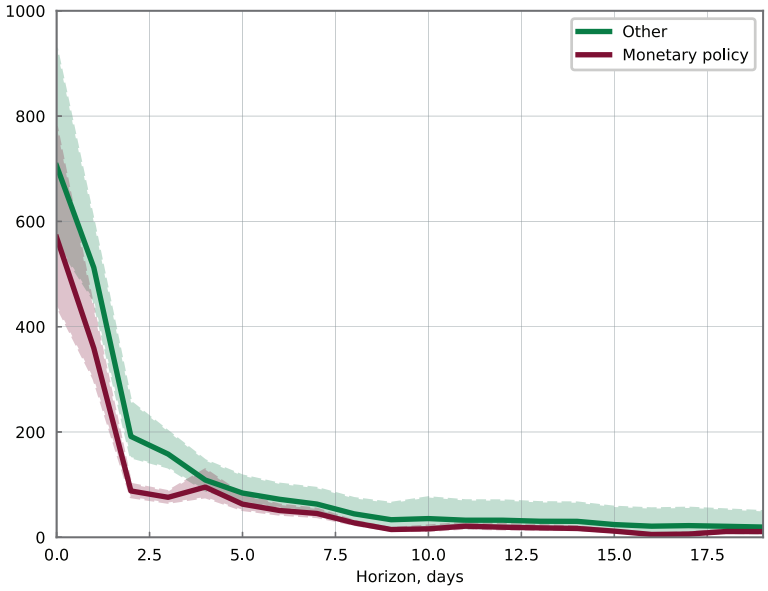

Figure 12. Average Interest in Pages by topic, views per page

APPENDIX B. WHAT THE NBU SAYS

Some keywords are very similar and occur for the same news, so we have combined them into groups (for example, monetary policy and monetary policy decisions). Nevertheless, there are significant interconnections between different topics, as shown in Figure 5.

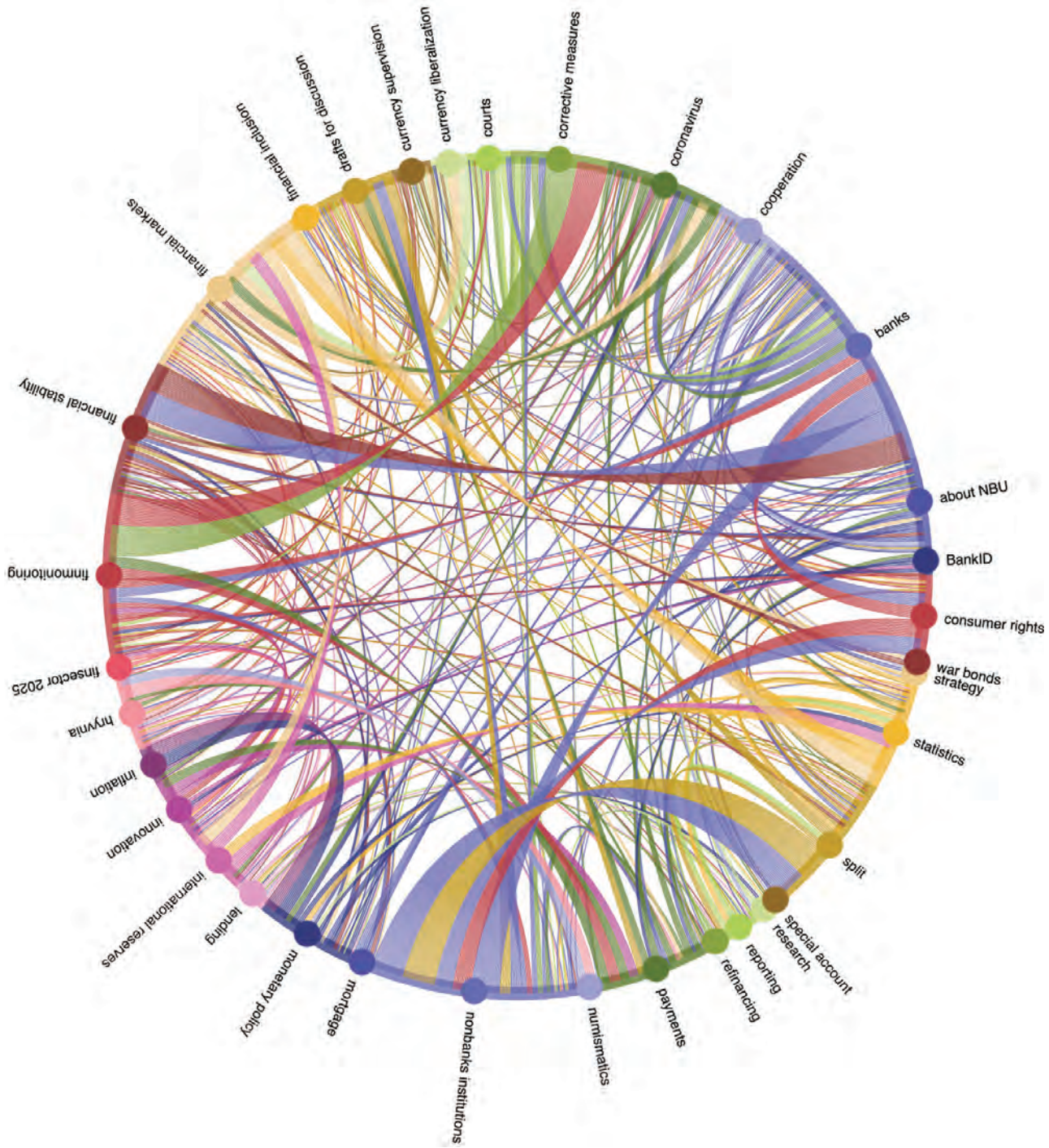

Figure 13. Chord Diagram for Keyword Interlinks between News on the NBU website (the width of the lines corresponds to the number of shared news items).

An interactive version of this diagram can be downloaded here: https://github.com/taniaghub/CB_communications/blob/main/Figure_B1.html

APPENDIX C. IMPULSE RESPONSES BY LOCAL PROJECTIONS

Table 2a. Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash Volatility

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total publications																
publications	0.000***	- 0.042**	- 0.098***	- 0.159***	- 0.216***	- 0.270***	- 0.328***	- 0.381***	- 0.394***	- 0.392***	- 0.387***	- 0.387***	- 0.392***	- 0.399***	- 0.398***	- 0.403***
p-value	(0.000)	(0.037)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	1.000***	0.928***	0.852***	0.775***	0.696***	0.616***	0.529***	0.439***	0.413***	0.389***	0.365***	0.350***	0.335***	0.327***	0.336***	0.345***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.733	0.613	0.501	0.399	0.304	0.220	0.199	0.179	0.159	0.148	0.138	0.133	0.139	0.146
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Monetary publications																
publications	0.000	- 0.017	- 0.166**	- 0.319***	- 0.479***	- 0.641***	- 0.831***	- 1.035***	- 1.148***	- 1.188***	- 1.222***	- 1.221***	- 1.217***	- 1.219***	- 1.188***	- 1.147***
p-value	(0.351)	(0.750)	(0.024)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	1.000***	0.929***	0.853***	0.776***	0.697***	0.616***	0.528***	0.437***	0.409***	0.385***	0.361***	0.345***	0.331***	0.323***	0.332***	0.341***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.733	0.612	0.499	0.398	0.303	0.221	0.202	0.184	0.166	0.155	0.144	0.139	0.144	0.149
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Other publications																
publications	0.000***	- 0.045**	- 0.090***	- 0.137***	- 0.179***	- 0.220***	- 0.261***	- 0.297***	- 0.299***	- 0.296***	- 0.288***	- 0.287***	- 0.293***	- 0.302***	- 0.305***	- 0.312***
p-value	(0.000)	(0.016)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	1.000***	0.928***	0.853***	0.776***	0.698***	0.618***	0.532***	0.442***	0.417***	0.393***	0.369***	0.354***	0.339***	0.331***	0.340***	0.348***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.733	0.612	0.500	0.397	0.301	0.215	0.193	0.173	0.154	0.142	0.132	0.128	0.134	0.141
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271

Table 2a (continued). Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash Volatility

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Total publications															
publications	- 0.411***	- 0.418***	- 0.433***	- 0.442***	- 0.449***	- 0.464***	- 0.485***	- 0.504***	- 0.533***	- 0.552***	- 0.582***	- 0.616***	- 0.654***	- 0.687***	- 0.723***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	0.352***	0.361***	0.363***	0.365***	0.366***	0.359***	0.356***	0.355***	0.354***	0.350***	0.345***	0.335***	0.324***	0.303***	0.282***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.152	0.160	0.163	0.165	0.167	0.163	0.164	0.165	0.168	0.168	0.169	0.166	0.164	0.156	0.149
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	3,256
Monetary publications															
publications	- 1.106***	- 1.078***	- 1.097***	- 1.108***	- 1.098***	- 1.094***	- 1.119***	- 1.142***	- 1.158***	- 1.156***	- 1.173***	- 1.203***	- 1.243***	- 1.257***	- 1.279***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	0.350***	0.360***	0.362***	0.364***	0.365***	0.359***	0.356***	0.355***	0.355***	0.352***	0.348***	0.338***	0.328***	0.308***	0.288***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.153	0.159	0.161	0.163	0.164	0.159	0.158	0.158	0.159	0.157	0.154	0.149	0.143	0.131	0.119
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	3,256
Other publications															
publications	- 0.322***	- 0.330***	- 0.347***	- 0.358***	- 0.369***	- 0.387***	- 0.409***	- 0.430***	- 0.459***	- 0.477***	- 0.502***	- 0.529***	- 0.557***	- 0.585***	- 0.614***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	0.356***	0.365***	0.367***	0.369***	0.369***	0.362***	0.359***	0.358***	0.357***	0.354***	0.349***	0.339***	0.328***	0.308***	0.287***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.147	0.155	0.158	0.160	0.162	0.159	0.159	0.161	0.164	0.164	0.164	0.161	0.157	0.148	0.139
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	3,256

Note: ***, **, * indicate statistical significance levels at 1%, 5%, and 10%.

Table 2b. Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash Volatility

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Total publications																
publications	0.000*	- 0.002**	- 0.002***	- 0.002***	- 0.002***	- 0.002***	- 0.002**	- 0.001*	- 0.001	- 0.001	- 0.001	- 0.001	- 0.001	- 0.001	- 0.001	- 0.001
p-value	(0.066)	(0.014)	(0.000)	(0.001)	(0.004)	(0.004)	(0.027)	(0.093)	(0.175)	(0.368)	(0.329)	(0.442)	(0.199)	(0.250)	(0.317)	(0.273)
ER change	1.000***	0.126***	- 0.059***	0.002	0.049***	- 0.090***	0.083***	0.059***	- 0.038**	- 0.057***	0.053***	- 0.001	- 0.025	0.066***	0.078***	- 0.010
p-value	(0.000)	(0.000)	(0.001)	(0.929)	(0.005)	(0.000)	(0.000)	(0.001)	(0.031)	(0.001)	(0.002)	(0.973)	(0.149)	(0.000)	(0.000)	(0.574)
R squared	1.000	0.018	0.007	0.003	0.005	0.010	0.009	0.005	0.002	0.003	0.003	0.000	0.001	0.005	0.006	0.000
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Monetary publications																
publications	0.000	- 0.002	- 0.004**	- 0.004**	- 0.004**	- 0.005***	- 0.004**	- 0.004**	- 0.004**	- 0.003	- 0.002	- 0.001	- 0.001	- 0.002	- 0.002	- 0.002
p-value	(0.226)	(0.315)	(0.019)	(0.044)	(0.033)	(0.008)	(0.018)	(0.027)	(0.029)	(0.129)	(0.234)	(0.428)	(0.460)	(0.273)	(0.362)	(0.289)
ER change	1.000***	0.127***	- 0.058***	0.003	0.050***	- 0.090***	0.084***	0.060***	- 0.038**	- 0.057***	0.053***	0.000	- 0.025	0.066***	0.078***	- 0.010
p-value	(0.000)	(0.000)	(0.001)	(0.869)	(0.004)	(0.000)	(0.000)	(0.001)	(0.031)	(0.001)	(0.002)	(0.982)	(0.157)	(0.000)	(0.000)	(0.585)
R squared	1.000	0.017	0.005	0.001	0.004	0.010	0.009	0.005	0.003	0.004	0.003	0.000	0.001	0.005	0.006	0.000
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Other publications																
publications	0.000**	- 0.002**	- 0.002***	- 0.002***	- 0.002**	- 0.001**	- 0.001	- 0.001	- 0.001	0.000	0.000	0.000	- 0.001	- 0.001	- 0.001	- 0.001
p-value	(0.012)	(0.011)	(0.001)	(0.003)	(0.017)	(0.020)	(0.109)	(0.259)	(0.354)	(0.576)	(0.502)	(0.580)	(0.198)	(0.255)	(0.284)	(0.271)
ER change	1.000***	0.126***	- 0.059***	0.002	0.050***	- 0.090***	0.083***	0.060***	- 0.038**	- 0.057***	0.053***	0.000	- 0.025	0.066***	0.078***	- 0.010
p-value	(0.000)	(0.000)	(0.001)	(0.928)	(0.005)	(0.000)	(0.000)	(0.001)	(0.032)	(0.001)	(0.002)	(0.978)	(0.147)	(0.000)	(0.000)	(0.572)
R squared	1.000	0.018	0.007	0.003	0.004	0.009	0.008	0.004	0.002	0.003	0.003	0.000	0.001	0.005	0.007	0.000
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271

Table 2b (continued). Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash Volatility

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Total publications															
publications	- 0.001	0.000	- 0.001	- 0.001	- 0.001*	- 0.001*	- 0.002**	- 0.002**	- 0.002***	- 0.002***	- 0.002***	- 0.002***	- 0.002**	- 0.002***	- 0.002***
p-value	(0.185)	(0.472)	(0.130)	(0.169)	(0.066)	(0.080)	(0.021)	(0.028)	(0.005)	(0.006)	(0.001)	(0.010)	(0.013)	(0.004)	(0.003)
ER change	- 0.026	0.089***	0.028	- 0.017	- 0.084***	0.071***	0.026	0.000	- 0.059***	- 0.071***	- 0.141***	0.028	0.143***	0.009	- 0.017
p-value	(0.141)	(0.000)	(0.112)	(0.327)	(0.000)	(0.000)	(0.131)	(0.983)	(0.001)	(0.000)	(0.000)	(0.114)	(0.000)	(0.616)	(0.326)
R squared	0.001	0.008	0.002	0.001	0.008	0.006	0.002	0.001	0.006	0.007	0.022	0.003	0.023	0.003	0.003
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	3,256
Monetary publications															
publications	- 0.002	- 0.002	- 0.003*	- 0.004**	- 0.004**	- 0.005**	- 0.005***	- 0.005***	- 0.005***	- 0.005***	- 0.005***	- 0.004**	- 0.003	- 0.002	- 0.003
p-value	(0.273)	(0.187)	(0.065)	(0.041)	(0.024)	(0.011)	(0.009)	(0.004)	(0.003)	(0.005)	(0.007)	(0.033)	(0.110)	(0.181)	(0.153)
ER change	- 0.025	0.089***	0.028	- 0.017	- 0.084***	0.071***	0.027	0.001	- 0.058***	- 0.070***	- 0.140***	0.028	0.144***	0.010	- 0.016
p-value	(0.147)	(0.000)	(0.109)	(0.329)	(0.000)	(0.000)	(0.124)	(0.970)	(0.001)	(0.000)	(0.000)	(0.104)	(0.000)	(0.566)	(0.365)
R squared	0.001	0.009	0.002	0.002	0.008	0.007	0.003	0.003	0.006	0.007	0.022	0.002	0.022	0.001	0.001
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	3,256
Other publications															
publications	- 0.001	0.000	- 0.001	- 0.001	- 0.001	- 0.001	- 0.001*	- 0.001*	- 0.001**	- 0.001**	- 0.002***	- 0.001**	- 0.001**	- 0.002***	- 0.002***
p-value	(0.197)	(0.527)	(0.147)	(0.205)	(0.107)	(0.203)	(0.067)	(0.084)	(0.020)	(0.022)	(0.005)	(0.027)	(0.030)	(0.007)	(0.004)
ER change	- 0.026	0.089***	0.028	- 0.017	- 0.084***	0.071***	0.027	0.001	- 0.059***	- 0.071***	- 0.141***	0.028	0.143***	0.009	- 0.017
p-value	(0.140)	(0.000)	(0.113)	(0.327)	(0.000)	(0.000)	(0.128)	(0.974)	(0.001)	(0.000)	(0.000)	(0.113)	(0.000)	(0.619)	(0.323)
R squared	0.001	0.008	0.001	0.001	0.008	0.006	0.002	0.001	0.005	0.006	0.022	0.002	0.022	0.002	0.003
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	3,256

Note: ***, **, * indicate statistical significance levels at 1%, 5%, and 10%.

Table 3a. Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash ER Volatility Depending on Governor Mentions in Text

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Monetary publications																
publications	0.000	- 0.017	- 0.166**	- 0.319***	- 0.479***	- 0.641***	- 0.831***	- 1.035***	- 1.148***	- 1.188***	- 1.222***	- 1.221***	- 1.217***	- 1.219***	- 1.188***	- 1.147***
p-value	(0.351)	(0.750)	(0.024)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ER volatility	1.000***	0.929***	0.853***	0.776***	0.697***	0.616***	0.528***	0.437***	0.409***	0.385***	0.361***	0.345***	0.331***	0.323***	0.332***	0.341***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.733	0.612	0.499	0.398	0.303	0.221	0.202	0.184	0.166	0.155	0.144	0.139	0.144	0.149
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Governor publications																
publications	0.000**	- 0.010	- 0.003	0.006	- 0.015	- 0.023	- 0.035	- 0.052	- 0.062	- 0.084	- 0.099	- 0.112	- 0.139	- 0.168*	- 0.171*	- 0.164*
p-value	(0.020)	(0.794)	(0.948)	(0.931)	(0.839)	(0.771)	(0.684)	(0.567)	(0.501)	(0.371)	(0.297)	(0.243)	(0.150)	(0.082)	(0.077)	(0.088)
ER volatility	1.000***	0.930***	0.856***	0.781***	0.704***	0.626***	0.541***	0.452***	0.427***	0.403***	0.379***	0.364***	0.349***	0.341***	0.350***	0.359***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.732	0.610	0.496	0.392	0.292	0.205	0.182	0.163	0.144	0.133	0.123	0.117	0.123	0.130
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Monetary governor publications																
publications	0.000	- 0.136	- 0.294	- 0.453*	- 0.625**	- 0.790***	- 0.979***	- 1.164***	- 1.222***	- 1.248***	- 1.231***	- 1.194***	- 1.187***	- 1.165***	- 1.121***	- 1.088***
p-value	(0.664)	(0.320)	(0.125)	(0.051)	(0.018)	(0.006)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
ER volatility	1.000***	0.929***	0.855***	0.779***	0.702***	0.623***	0.537***	0.448***	0.423***	0.399***	0.375***	0.359***	0.345***	0.337***	0.346***	0.355***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.732	0.611	0.497	0.393	0.295	0.208	0.186	0.166	0.147	0.135	0.125	0.120	0.125	0.131
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271

Table 3a (continued). Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash ER Volatility Depending on Governor Mentions in Text

	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Monetary publications														
publications	- 1.106***	- 1.078***	- 1.097***	- 1.108***	- 1.098***	- 1.094***	- 1.119***	- 1.142***	- 1.158***	- 1.156***	- 1.173***	- 1.203***	- 1.243***	- 1.257***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ER volatility	0.350***	0.360***	0.362***	0.364***	0.365***	0.359***	0.356***	0.355***	0.355***	0.352***	0.348***	0.338***	0.328***	0.308***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.153	0.159	0.161	0.163	0.164	0.159	0.158	0.158	0.159	0.157	0.154	0.149	0.143	0.131
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257
Governor publications														
publications	- 0.150	- 0.155	- 0.154	- 0.134	- 0.114	- 0.123	- 0.156	- 0.190**	- 0.213**	- 0.239**	- 0.283***	- 0.331***	- 0.392***	- 0.430***
p-value	(0.118)	(0.104)	(0.107)	(0.159)	(0.233)	(0.196)	(0.103)	(0.047)	(0.026)	(0.012)	(0.003)	(0.001)	(0.000)	(0.000)
ER volatility	0.367***	0.376***	0.378***	0.381***	0.382***	0.375***	0.373***	0.372***	0.372***	0.370***	0.366***	0.356***	0.347***	0.328***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.135	0.142	0.144	0.145	0.146	0.141	0.140	0.140	0.140	0.138	0.136	0.130	0.124	0.112
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257
Monetary governor publications														
publications	- 1.058***	- 1.064***	- 1.073***	- 1.046***	- 1.011***	- 0.971***	- 0.915***	- 0.865**	- 0.807**	- 0.776**	- 0.782**	- 0.804**	- 0.842**	- 0.879**
p-value	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.008)	(0.013)	(0.020)	(0.026)	(0.025)	(0.022)	(0.017)	(0.014)
ER volatility	0.363***	0.372***	0.375***	0.377***	0.378***	0.372***	0.370***	0.369***	0.369***	0.367***	0.363***	0.353***	0.343***	0.324***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.137	0.144	0.146	0.147	0.148	0.143	0.141	0.140	0.140	0.138	0.135	0.128	0.122	0.109
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257

Note: ***, **, * indicate statistical significance levels at 1%, 5%, and 10%.

Table 3b. Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash ER Change Depending on Governor Mentions in Text

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Monetary publications															
publications	0.000	- 0.002	- 0.004**	- 0.004**	- 0.004**	- 0.005***	- 0.004**	- 0.004**	- 0.004**	- 0.003	- 0.002	- 0.001	- 0.001	- 0.002	- 0.002	- 0.002
p-value	(0.226)	(0.315)	(0.019)	(0.044)	(0.033)	(0.008)	(0.018)	(0.027)	(0.029)	(0.129)	(0.234)	(0.428)	(0.460)	(0.273)	(0.362)	(0.289)
ER change	1.000***	0.127***	- 0.058***	0.003	0.050***	- 0.090***	0.084***	0.060***	- 0.038**	- 0.057***	0.053***	0.000	- 0.025	0.066***	0.078***	- 0.010
p-value	(0.000)	(0.000)	(0.001)	(0.869)	(0.004)	(0.000)	(0.000)	(0.001)	(0.031)	(0.001)	(0.002)	(0.982)	(0.157)	(0.000)	(0.000)	(0.585)
R squared	1.000	0.017	0.005	0.001	0.004	0.010	0.009	0.005	0.003	0.004	0.003	0.000	0.001	0.005	0.006	0.000
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Governor publications															
publications	0.000	- 0.002	- 0.002*	- 0.002	- 0.002	- 0.002	- 0.002	- 0.002	- 0.002	- 0.001	- 0.001	- 0.001	- 0.002	- 0.001	0.000	0.000
p-value	(0.135)	(0.229)	(0.063)	(0.132)	(0.114)	(0.222)	(0.138)	(0.136)	(0.133)	(0.416)	(0.333)	(0.311)	(0.131)	(0.348)	(0.783)	(0.886)
ER change	1.000***	0.127***	- 0.058***	0.003	0.051***	- 0.089***	0.084***	0.060***	- 0.037**	- 0.057***	0.054***	0.000	- 0.025	0.066***	0.078***	- 0.009
p-value	(0.000)	(0.000)	(0.001)	(0.855)	(0.004)	(0.000)	(0.000)	(0.001)	(0.033)	(0.001)	(0.002)	(0.981)	(0.154)	(0.000)	(0.000)	(0.599)
R squared	1.000	0.017	0.004	0.001	0.003	0.008	0.008	0.004	0.002	0.003	0.003	0.000	0.001	0.005	0.006	0.000
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271
Monetary governor publications															
publications	0.000	- 0.005	- 0.006	- 0.005	- 0.004	- 0.004	- 0.003	- 0.002	- 0.002	- 0.002	0.000	0.000	- 0.002	- 0.002	- 0.002	- 0.002
p-value	(0.470)	(0.270)	(0.200)	(0.267)	(0.339)	(0.351)	(0.504)	(0.621)	(0.612)	(0.731)	(0.987)	(0.969)	(0.734)	(0.619)	(0.602)	(0.637)
ER change	1.000***	0.127***	- 0.058***	0.003	0.051***	- 0.089***	0.084***	0.060***	- 0.037**	- 0.057***	0.054***	0.000	- 0.025	0.066***	0.078***	- 0.009
p-value	(0.000)	(0.000)	(0.001)	(0.856)	(0.004)	(0.000)	(0.000)	(0.001)	(0.034)	(0.001)	(0.002)	(0.996)	(0.159)	(0.000)	(0.000)	(0.593)
R squared	1.000	0.017	0.004	0.000	0.003	0.008	0.007	0.004	0.001	0.003	0.003	0.000	0.001	0.004	0.006	0.000
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272	3,271

Table 3b (continued). Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the Cash ER Change Depending on Governor Mentions in Text

	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Monetary publications															
publications	- 0.002	- 0.002	- 0.003*	- 0.004**	- 0.004**	- 0.005**	- 0.005***	- 0.005***	- 0.005***	- 0.005***	- 0.005***	- 0.004**	- 0.003	- 0.002	0.000***
p-value	(0.273)	(0.187)	(0.065)	(0.041)	(0.024)	(0.011)	(0.009)	(0.004)	(0.003)	(0.005)	(0.007)	(0.033)	(0.110)	(0.181)	(0.000)
ER change	- 0.025	0.089***	0.028	- 0.017	- 0.084***	0.071***	0.027	0.001	- 0.058***	- 0.070***	- 0.140***	0.028	0.144***	0.010	0.000***
p-value	(0.147)	(0.000)	(0.109)	(0.329)	(0.000)	(0.000)	(0.124)	(0.970)	(0.001)	(0.000)	(0.000)	(0.104)	(0.000)	(0.566)	(0.000)
R squared	0.001	0.009	0.002	0.002	0.008	0.007	0.003	0.003	0.006	0.007	0.022	0.002	0.022	0.001	0.000
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	0
Governor publications															
publications	- 0.001	- 0.001	- 0.001	0.000	- 0.001	- 0.001	- 0.001	0.000	0.000	0.000	- 0.001	- 0.001	- 0.001	- 0.001	0.000***
p-value	(0.535)	(0.536)	(0.453)	(0.814)	(0.614)	(0.650)	(0.624)	(0.788)	(0.951)	(0.875)	(0.455)	(0.608)	(0.582)	(0.419)	(0.000)
ER change	- 0.025	0.089***	0.029	- 0.016	- 0.083***	0.072***	0.028	0.002	- 0.057***	- 0.069***	- 0.139***	0.029*	0.144***	0.010	0.000***
p-value	(0.151)	(0.000)	(0.103)	(0.350)	(0.000)	(0.000)	(0.113)	(0.924)	(0.001)	(0.000)	(0.000)	(0.097)	(0.000)	(0.556)	(0.000)
R squared	0.001	0.008	0.001	0.000	0.007	0.005	0.001	0.000	0.003	0.005	0.019	0.001	0.021	0.000	0.000
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	0
Monetary governor publications															
publications	- 0.001	- 0.001	- 0.001	0.001	0.001	0.001	0.000	- 0.001	0.000	- 0.001	- 0.002	- 0.001	0.000	0.000	0.000***
p-value	(0.843)	(0.825)	(0.804)	(0.911)	(0.809)	(0.757)	(0.997)	(0.909)	(0.979)	(0.878)	(0.619)	(0.753)	(0.982)	(0.993)	(0.000)
ER change	- 0.025	0.090***	0.029	- 0.016	- 0.083***	0.072***	0.028	0.002	- 0.057***	- 0.069***	- 0.139***	0.029*	0.144***	0.011	0.000***
p-value	(0.152)	(0.000)	(0.102)	(0.353)	(0.000)	(0.000)	(0.111)	(0.923)	(0.001)	(0.000)	(0.000)	(0.097)	(0.000)	(0.547)	(0.000)
R squared	0.001	0.008	0.001	0.000	0.007	0.005	0.001	0.000	0.003	0.005	0.019	0.001	0.021	0.000	0.000
Sample size	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257	0

Note: ***, **, * indicate statistical significance levels at 1%, 5%, and 10%.

Table 4. Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the ER Volatility Depending on the Popularity of Messages

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Popular publications (views>median)															
publications	0.000	- 0.018	- 0.131	- 0.232	- 0.340**	- 0.463**	- 0.563***	- 0.684***	- 0.738***	- 0.738***	- 0.745***	- 0.688***	- 0.625***	- 0.635***	- 0.623***
p-value	(0.151)	(0.836)	(0.285)	(0.117)	(0.044)	(0.013)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.005)	(0.005)	(0.005)
Cash_volatility	1.000***	0.930***	0.855***	0.780***	0.703***	0.624***	0.539***	0.450***	0.425***	0.401***	0.377***	0.362***	0.347***	0.339***	0.348***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.732	0.610	0.496	0.393	0.294	0.207	0.185	0.166	0.147	0.135	0.124	0.119	0.125
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272
Unpopular publications (views<median)															
publications	0.000***	- 0.013	- 0.149*	- 0.296***	- 0.453***	- 0.605***	- 0.801***	- 1.004***	- 1.123***	- 1.177***	- 1.217***	- 1.242***	- 1.265***	- 1.267***	- 1.236***
p-value	(0.000)	(0.820)	(0.066)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	1.000***	0.929***	0.854***	0.777***	0.699***	0.618***	0.531***	0.440***	0.413***	0.389***	0.364***	0.349***	0.334***	0.326***	0.335***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	1.000	0.864	0.733	0.611	0.498	0.396	0.300	0.217	0.198	0.180	0.162	0.152	0.142	0.137	0.141
Sample size	3,286	3,285	3,284	3,283	3,282	3,281	3,280	3,279	3,278	3,277	3,276	3,275	3,274	3,273	3,272

Table 4 (continued). Results of Model Estimation for Equation (1) for Different Lag Length Values of the Parameter *h* for the ER Volatility Depending on the Popularity of Messages

	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Popular publications (views>median)															
publications	- 0.595***	- 0.562**	- 0.541**	- 0.641***	- 0.738***	- 0.796***	- 0.840***	- 0.942***	- 1.049***	- 1.156***	- 1.197***	- 1.251***	- 1.310***	- 1.363***	- 1.337***
p-value	(0.007)	(0.011)	(0.014)	(0.004)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	0.357***	0.365***	0.374***	0.376***	0.378***	0.379***	0.373***	0.370***	0.369***	0.369***	0.366***	0.362***	0.353***	0.342***	0.324***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.131	0.136	0.143	0.145	0.148	0.149	0.145	0.144	0.144	0.146	0.144	0.142	0.136	0.130	0.116
Sample size	3,271	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257
Unpopular publications (views<median)															
publications	- 1.200***	- 1.164***	- 1.143***	- 1.125***	- 1.099***	- 1.064***	- 1.041***	- 1.032***	- 1.017***	- 0.994***	- 0.973***	- 0.970***	- 0.982***	- 1.009***	- 1.033***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash_volatility	0.344***	0.352***	0.362***	0.365***	0.367***	0.369***	0.362***	0.360***	0.360***	0.360***	0.358***	0.353***	0.344***	0.334***	0.315***
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R squared	0.147	0.151	0.158	0.159	0.160	0.160	0.154	0.152	0.151	0.151	0.148	0.145	0.139	0.133	0.120
Sample size	3,271	3,270	3,269	3,268	3,267	3,266	3,265	3,264	3,263	3,262	3,261	3,260	3,259	3,258	3,257

Note: ***, **, * indicate statistical significance levels at 1%, 5%, and 10%.