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**Semantic Text Analysis of Central Bank
Communication:
Evidence for Spillover Effects in Foreign Exchange
Spot Markets**

Master Thesis in Business and Finance

Manuel Mazidi

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Semantic Text Analysis of Central Bank Communication: Evidence for Spillover Effects in
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Master Thesis in Banking and Finance

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Abstract

I analyze the Federal Reserve's and European Central Bank's communication to assess the immediate market reaction in foreign exchange spot prices upon communication events. Unsupervised machine learning-based topic modelling classifies textual data from FOMC Minutes and ECB Monetary Policy Accounts into their underlying discussion topics, and lexical sentiment analysis tracks the sentiment and uncertainty within each topic over time. I find that FX spot markets are sensitive to the discussion about asset purchase programmes. Currency pairs of developed countries react to uncertainty in financial market related topics and react to monetary policy related discussion regarding interest rates and inflation in ECB communication. On the other hand, currency pairs involving an emerging market currency seem to be more reactive towards discussion about macroeconomic fundamentals. These findings suggest that central banks are able to move FX spot prices via communication only, which hints towards the functioning of a *signalling* and *coordination* channel.

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Nomenclature

Latin letters

C_V	Coherence measure as proposed in Röder, Both, and Hinneburg (2015)
K	Total number of topics within a corpus of documents, predefined by the researcher

Greek letters

α	Document-topic bayesian prior determining the distribution θ
η	Topic-word bayesian prior determining the distribution ϕ
ϕ	Prior multinomial distribution of words within a topic
θ	The prior distribution of topics in a given documen

Abbreviations

<i>APP</i>	asset purchase programme
<i>BoE</i>	Bank of England
<i>BoJ</i>	Bank of Japan
<i>CPI</i>	Consumer Price Index
<i>ECB</i>	European Central Bank
<i>EM</i>	emerging markets
<i>Fed</i>	Federal Reserve
<i>FOMC</i>	Federal Open Market Committee
<i>FRED</i>	Federal Reserve Bank of St. Louis
<i>forex</i>	foreign exchange
<i>FG</i>	forward guidance
<i>FX</i>	foreign exchange
<i>GFC</i>	Great Financial Crisis
<i>LDA</i>	Latent Dirichlet Allocation
<i>LM dictionary</i>	Loughran & McDonald dictionary
<i>NPMI</i>	Normalized Pointwise Mutual Information
<i>PMI</i>	Pointwise Mutual Information
<i>QE</i>	quantitative easing
<i>SNB</i>	Swiss National Bank
<i>TF-IDF</i>	Term-Frequency Inverse-Document-Frequency
<i>ZLB</i>	Zero Lower Bound

Introduction

The global foreign exchange (forex or FX) market is the largest financial market in the world measured by daily trading activity and volume (Wooldridge, 2019). Nevertheless, ever since Rogoff and Meese's influential paper from 1983 in which they demonstrate the shortfall of forecasting power of structural exchange rate models, the consensus existed that economic fundamentals fail to explain FX movements, at least in the short term (Cavusoglu, 2011). This highlights the complex dynamics underlying the global FX market, and it is no surprise that given the age of big data and the rise of machine learning methods in the economic literature¹, researchers look for new research approaches that lay beyond the standard paradigm of economic fundamentals in structural models. This thesis presents a methodology that uses unsupervised machine learning to classify recurring central bank communication from the Federal Reserve (Fed) and the European Central Bank (ECB). In a first step, I extract different topics underlying the central bank's published statements (FOMC Meeting Minutes and ECB Monetary Policy Accounts), on top of which I conduct a sentiment analysis based on a lexical approach in order to track the *tone* and *uncertainty* within these topics over time. I test the hypothesis whether the change of tone or uncertainty within given discussion topics and within consecutive central bank meetings affects market participants' expectations and triggers measurable trading activities upon the release of these statement. If this is the case, this would be evidence in favour of the central bank's ability to move asset prices solely by communication.

Using a high-frequency intraday dataset of currency pairs on a per-minute basis, I analyze the immediate impact of central bank statement releases in the FX spot market within a 30 and 60-minute event window. I measure this impact with return volatility, directional price change and the trading range within the respective currency pair. Summarized, I am using extracted textual variables to explain the reaction of the following currency pairs for the given central bank:

- For the Federal Reserve communication: I analyze the immediate market reaction following the release of FOMC Minutes in the following currency pairs: USDEUR², USDCHF, USDMXN, USDHKD and USDTRY. I use FOMC Minutes from 2000 until 2020 for the analysis. USDEUR and USDCHF trading data are available since 2000, which allows to

¹See Athey (2019) for an assessment of the role of machine learning in economic studies.

²Throughout this thesis I use the currency notation XXXYYY where XXX is the base currency and YYY the quote currency. For example, USDCHF is the price for one Dollar in Swiss francs.

use the full textual dataset since 2000. For USDMXN, USDHKD and USDTRY, intraday trading data is available since 2010. The following topics in FOMC Minutes are identified by the topic model algorithm: *Foreign markets, business activity, Quantitative Easing (QE), economic outlook, labour market, trade & consumption, communication & forward guidance (FG), housing market, money market, financial markets, growth and inflation.*

- For the European Central Bank communication: I analyze the immediate market reaction following the release of Monetary Policy Accounts in the following currency pairs: EURUSD, EURCHF and EURTRY. ECB Monetary Policy Accounts are released since 2015, and I am using textual data up until the end of 2020, whereas intraday trading data is available for the full period. The following topics in ECB Monetary Policy Accounts are identified by my topic model algorithm: *Financial markets, asset purchase programmes (APP), interest rates, global economy & trade, credit market, structural reforms & growth and inflation.*

I find that currency pairs of the developed currency area triangle USD, EUR and CHF react to changes in tone and uncertainty within topics that are either financial market related or seem to influence interest rate expectations (specifically, those topics are *interest rates* and *inflation* for the ECB communication). Discussions regarding asset purchase programmes in the FOMC Minutes and ECB Accounts seem to have an impact in most analyzed currency pairs. On the other hand, for the emerging market (EM) currencies, topics that are more anchored to economic fundamentals (*growth, business activity*) carry explanatory power, whereas this relationship is either absent or less present for the advanced economy triangle mentioned above. Furthermore, additional results uncover the *safe-haven* characteristics of the Swiss franc as my results indicate an appreciation in the franc when discussions within the financial market topic indicate an increase in uncertainty

Significant relationships between central bank communication and the subsequent trading activity support the presence of a *coordination channel* through which central banks align the heterogeneous expectations of market participants by using communication as a monetary policy tool and triggering a timed collective reaction in the FX market (Reitz and Taylor, 2008). The presence of a *signalling channel* could further explain the significant relationship between central bank communication and trading activity as central banks can exploit this channel to hint towards future interventions or monetary policy changes that affect market participants expectations (Sarno and Taylor, 2001). The research and the understanding of this channel has become essential in the context of forward guidance at times where policy rates are already on ultra-low levels (Woodford, 2005; Hansen and Tong, 2019).

The remaining part of this thesis is structured as follows: The following section provides an overview of related literature. Section 3 explains the data and the textual analysis using Latent Dirichlet Allocation (LDA) and sentiment analysis. Section 4 discusses results and their robustness, section 5 provides further discussion regarding the methodological approach and results, followed by the conclusion in section 6.

Related Literature

Historically, research covering the link between central bank communication and FX spot prices can be dissected into two periods: Up until the Great Financial Crisis (GFC), researchers mainly focused on the functioning of the signalling and coordination channel in order to explain FX rate adjustments after central bank communication releases. During this first period, many researchers were interested in the supporting effect that oral communication attributed to actual FX interventions (Sarno and Taylor, 2001; Fratzscher, 2005; Cavusoglu, 2011; Reitz and Taylor, 2008; Beine, Janssen, and Lecourt, 2009) or even proclaimed its effectiveness in the absence of actual FX interventions (Frazscher, 2008).

The second period covers the time after the GFC. At this point, when the turmoil of the GFC unfolded, actual FX interventions have been abandoned for a long time by the major central banks: According to Fratzscher (2005), Euro Area authorities and the Fed have not been actively intervening in the FX market since the mid-nineties except for September and November of 2000. Some researchers argue this is due to the effectiveness of central bank communication and an ever-growing tendency towards central bank transparency since the early nineties (Fratzscher, 2005; Beine, Janssen, and Lecourt, 2009). Therefore, the gradual abandonment of FX interventions and the global decline of policy rates in developed countries have shifted the focus of central bank communication research away from FX interventions. From now on, researchers were interested in the effectiveness and importance of forward guidance in order to equip central banks with a policy tool that is still effective at the zero lower bound (Rosa, 2011; Égert and Kočenda, 2014; Neely, 2015).

In this context and more recently, research is conducted to answer the question of why central bank communication can affect long-term yields (Nakamura and Steinsson, 2018; Hansen and Tong, 2019) whereas traditionally, central banks implement monetary policy by setting short-term interest rates.

This section is structured in the following way: First, I briefly summarize the signalling and coordination channel mechanism as both of these channels are essential reasoning to which researchers still resort to for explaining the link between central bank communication and FX rates. Then I

cover the research focusing on (oral) FX interventions (pre-GFC research). After that, I focus on the intersection of communication, forward guidance and asset prices (post-GFC research). I close this chapter with research that explicitly focuses on applying computational linguistics and machine learning to study central bank communication. Output from this branch of research emerged primarily around 2015 and after. The methodological approach in these more recent papers is aligned with the methodology applied in this thesis.

2.1 The signalling and coordination channel

Why does central bank communication affect FX rates? Theoretical groundwork regarding this research question was written by Sarno and Taylor (2001) who described the mechanism of a signalling and coordination channel. While Sarno and Taylor focused on traditional FX interventions in the sense of a central bank selling or buying its domestic currency in the market, subsequent research with a focus on central bank communication builds upon their work and use the presence of these channels as an explanation to answer the question why oral interventions prove to be an effective monetary instrument.

The signalling theory, initially described by Mussa (1981), explains the effectiveness of FX interventions by the fact that market participants update their expectations regarding future monetary policy actions when they observe the central bank's intervention. On the other hand, a coordination channel is described by central banks publicly announcing interventions. This announcement serves as a "coordinating device" through which market participants enter the market simultaneously to achieve convergence of the FX spot rate towards a parity level. The necessity for this coordinated behaviour stems from the fact that rational investors, who build their expectations based on economic fundamentals, might be discouraged to enter trades through which they profit when misaligned FX spot rates move towards a level that is considered fair by the central bank. This scenario can occur when speculative investors heavily trade against the said position. Summarized, when a central bank considers its currency to be under a "speculative attack", the coordination channel supports interventions by aligning market participants' expectations and timing their trading activity to allow for corrective FX movements (Sarno and Taylor, 2001).

2.2 Central bank communication and FX interventions

Fratzscher (2005) documents the effectiveness of communication in oral FX interventions and concludes that communication moves FX rates even when it is not accompanied by actual interventions or simultaneously announced with monetary policy decisions. The paper shows that while the Bank of Japan (BoJ) used communication to signal future policy decisions, communication from monetary authorities in the US and the Euro Area was primarily effective by providing relevant information not directly coupled to monetary policy decisions. Fratzscher (2005) argues that central banks mainly manage market participants expectations and actions and with evidence

for the smoothing effect of communication in the FX market, this points towards the functioning of a coordination channel.

In a subsequent paper, [Frazscher \(2008\)](#) hand-labels the content of G3¹ monetary policy statements and splits the content into a strengthening, weakening or neutral outlook on the domestic currency. He concludes that oral interventions remain an effective policy tool to influence the domestic currency, but the effectiveness depends on the degree of uncertainty and positioning of market participants. Oral interventions are more effective when the level of uncertainty is high, and the valuation of the domestic currency is far from its equilibrium value. This and the result that actual oral FX interventions decrease volatility in the market are findings in favour for a coordination channel ([Frazscher, 2008](#)).

Based on the aforementioned results, [Reitz and Taylor \(2008\)](#) conduct a microstructural analysis of the German mark-Dollar FX market and find supporting evidence for the functioning of a coordination channel through which central banks can reduce speculative trading activity by using communication to inform market participants. [Beine, Janssen, and Lecourt \(2009\)](#) analyzed the G3 central banks' FX interventions in the nineties as well as their corresponding statements disclosing and explaining the intervention activity. They conclude that FX interventions are more effective when accompanied by a central bank statement and highlight the need for the central bank communication and dedication to transparency.

[Ranaldo and Rossi \(2010\)](#) also investigate the behaviour of high-frequency FX data upon central bank communication events. Upon the Swiss National Bank (SNB) communication events, they identify significant intraday patterns and conclude that traders actively monitor central bank information released in speeches and statements. Additionally, they find that the FX markets react more strongly to SNB communication than equity market prices.

[Cavusoglu \(2011\)](#) provides an extensive overview of the literature regarding actual and oral FX interventions and highlights the agreement between researchers that oral interventions can reduce volatility in the FX market and serve as a policy tool to adjust misaligned FX rates.

[Burkhard and Fischer \(2009\)](#) use high-frequency data to analyze the effect in the Swiss franc when non-sterilized² FX interventions were more frequently mentioned as a possible alternative policy tool at the time when the Swiss National Bank (SNB) policy rate approached the zero lower bound (ZLB) around 2003. They find that even though non-sterilized interventions have not been carried out during the period of their data, the announcement of non-sterilized FX interventions depreciated the Swiss franc for several hours subsequently and thus find supporting arguments for the policy effectiveness of communication.

[Sarno, Fratzscher, Gloede, Menkhoff, and Stöhr \(2017\)](#) analyze data on FX interventions from 33 countries from 1995 throughout 2011. They define a set of criteria under which the intervention can be considered successful and find that FX interventions are more successful when made public

¹In the context of currencies, the G3 consists of the three major currency areas of the United States, the Euro Area and Japan.

²Non-sterilized FX interventions refers to interventions that allow for a change in the domestic interest rate level (as opposed to sterilized interventions) ([Sarno and Taylor, 2001](#)).

and supported by communication.

2.3 Effectiveness of communication at the zero lower bound

With the turn of the decade, after the Great Financial Crisis hit the global financial system, research regarding central bank communication shifted its focus. From now on, the focus was less on the effectiveness of communication to support FX interventions but rather on assessing its functioning as an easing monetary policy tool in currency areas with an ultra-low interest rate environment. Thus, the role of communication as a policy instrument itself and the role of forward guidance emerged as a research topic.

Already in 2005, [Woodford \(2005\)](#) described the mechanism of central bank communication as a tool to ease the possible limitations that the liquidity trap imposes on policymakers. [Rosa \(2011\)](#) confirmed this by analysing the effect of Federal Open Market Committee (FOMC) communication on the equity market and points out that communication can provoke additional stimulus to ease financial conditions when interest rates are low. [Égert and Kočenda \(2014\)](#) also point out the importance of central bank communication at the zero lower bound. They analyse the Hungarian, Czech and Polish currency against the Euro and find that the currency pairs became more responsive towards central bank communication during the period of the GFC and after it.

[Campbell, Evans, Fisher, Justiniano, Calomiris, and Woodford \(2012\)](#) extensively cover the effects of forward guidance carried out by the FOMC. They distinguish between *Odyssean* forward guidance that includes specific future policy actions or forecasts (and thus implies a commitment by the central bank) and *Delphic* forward guidance in which the central bank describes possible future macroeconomic developments and accompanying central bank reactions. The authors explain that Delphic forward guidance is less binding in the sense of central bank commitment but reduces market participants' uncertainty about economic developments. [Campbell, Evans, Fisher, Justiniano, Calomiris, and Woodford \(2012\)](#) provide strong results in favour of communication as a policy tool: They find that forward guidance can substitute conventional monetary policy tools at the zero lower bound. However, this effect depends on the credibility and trust that the public offers to the central bank.

[Neely \(2015\)](#) focused on the FOMC announcement that included forward guidance components and analysed its impact on foreign yields and the USD. He finds that following the releases of the corresponding statements, foreign yields reduced and the USD depreciated significantly. Therefore, he shows that the easing effect of central bank communication spills over into other currency areas' yields.

[Nakamura and Steinsson \(2018\)](#) use high-frequency data of Fed funds futures, Eurodollar futures and Treasury inflation-protected securities to evaluate the influence of FOMC announcements on real interest rates, inflation expectation and expected output growth. Nakamura and Steinsson describe the mechanism of an *information effect* (in the related literature sometimes also called "information channel") through which the private sector not only updates its beliefs through

monetary policy-relevant announcements but also derives new expectations from the FOMC's assessment of economic fundamentals and the degree of its optimism about the economic outlook (the Delphic part in monetary policy statements according to [Campbell, Evans, Fisher, Justiniano, Calomiris, and Woodford \(2012\)](#)). Similarly, [Cieslak and Schrimpf \(2019\)](#) dissect communication of the ECB, BoJ, Fed and Bank of England into news about monetary policy and non-monetary policy news and distinguish between monetary policy shocks and growth shocks that are included in the non-monetary policy part of central bank texts. Using intraday data of equity and fixed income markets, they show that non-monetary policy news explains a substantial part of market reactions during the financial crises and the following period of economic recovery. [Cieslak and Schrimpf \(2019\)](#) argue that by this, they provide evidence for the role of Delphic forward guidance that includes central banks' outlook regarding future macroeconomic developments.

[Moessner and Rungcharoenkitkul \(2019\)](#) assess the responsiveness of short-term interest rates in the UK, EA and US to macroeconomic news after the GFC to shed light on the interaction between the ZLB and forward guidance. They find that even during periods when short-term interest rates were on track to normalise, and the probability of hitting the ZLB decreased, short-term interest rates' sensitivity with regard to economic news remained muted, even though one could expect that short-term interest rates should be more volatile when the ZLB is less binding. [Moessner and Rungcharoenkitkul \(2019\)](#) argue that the ongoing forward guidance conducted by central banks could explain why short-term interest rates remain more insensitive to economic news as market participants anchor their outlook conditional to the central bank's forward guidance rather than economic news alone.

2.4 Studying communication with computational linguistics and machine learning

As communication became an effective and widely used monetary policy tool at the ZLB, quantifying the effect of communication remained difficult due to the subjective nature of statement interpretation and perception within the public. Some researchers resorted to manually hand-label communication data in order to derive quantitative results (e.g. [Romer and Romer \(2004\)](#), [Frazscher \(2008\)](#), [Rosa \(2011\)](#)). However, this is a very labour intensive process and bears the risk of a researcher's subjectivity and bias when labelling data. To circumvent these issues, new computational linguistics and machine learning methods became popular as they can either impose labels themselves based on statistical properties underlying the textual data or stick to a clear rule-based labelling scheme.

[Heinemann and Ullrich \(2007\)](#) construct a word-frequency-based indicator that captures specific words in ECB monthly bulletins which appearances deviates significantly for different phases during a policy cycle. They construct an augmented Taylor rule with these encoded words but conclude that monetary policy forecasting based solely on this word indicator does not outperform standard

economic models using macroeconomic data.

Lucca and Trebbi (2009) parse FOMC statements since 1999 and track the semantics of these statements with a proprietary algorithm from Google and a second algorithm using the Factiva news database. In essence, they extract the semantic orientation for *hawkishness* or *dovishness* by analyzing whether individual sentences co-occur more often with terms such as "hawkishness" or "dovishness". Using a concept from information theory, the magnitude for this semantic score is calculated by *Pointwise Mutual Information* (PMI). Applying a vector autoregression model and using intraday Treasury yield data, Lucca and Trebbi (2009) find that communication is more critical than contemporaneous Fed rate decisions for Treasury yields' responses and conclude that these statements carry essential information that market participants monitor in order to form expectations.

Born, Ehrmann, and Fratzscher (2014) apply a lexical sentiment analysis through which the degree of optimism in Central Banks' Financial Stability Reports from 37 different central banks between 1996 and 2009 is calculated. They find significant evidence that the stock market on average is moved by 1% in the expected direction following such a release, concluding that stock market agents monitor the central bank's financial stability assessment. The authors argue that this mechanism between communication and stock market reactions happens through a coordination channel.

Similarly, Cannon et al. (2015) uses the Loughran and McDonald dictionary (hereafter: LM dictionary) to construct a tonal sentiment score (positive vs negative) of FOMC meeting transcripts from 1970 throughout 2009. He concludes that this extracted sentiment follows economic activity and exhibits a positive cross-correlation with economic developments.

The LM dictionary is also used in Hansen and McMahon (2016) in order to derive tonal and uncertainty scores. Additionally, they apply Latent Dirichlet Allocation (LDA) to extract topics in FOMC statements released between 1998 and 2014. This combination allows deriving topic-based sentiment and uncertainty scores, allowing for a more nuanced representation instead of a single document level score. Using this approach, they distinguish between topics describing current economic conditions and topics relevant for guidance regarding future policy. Applying a factor augmented vector autoregression, they find that forward guidance has more explanatory power for market reactions of Treasury yields and topics regarding the current economic situation are of less importance.

Jegadeesh and Wu (2017) apply the same methodology as Hansen and McMahon (2016) and combine LDA and the LM dictionary to extract topic level tonal and uncertainty scores. However, they use FOMC Minutes instead of FOMC statements. They manage to extract eight topics from the textual sample that consists of FOMC Minutes between 1992 and 2015: Policy, inflation, market, unemployment, growth, trade, consumption and investment. They study the information content of these eight topics by regressing the corresponding tonal and uncertainty measure for each topic on equity and debt market volatility and returns using high-frequency data to capture the market reaction after the Minutes' release. A majority of indicators through the range of these eight topics is either significantly relevant for short-term debt market or equity market reactions. Thus, the authors conclude that the FOMC possesses a superior information set that spills into the market

via meeting Minutes even when FOMC meeting Minutes are released several weeks after the actual FOMC meeting was held and policy changes are already communicated to the public.

In contrast, instead of using the LM dictionary, which was initially put together from Securities and Exchange Commission filings, [Picault and Renault \(2017\)](#) construct a field-specific lexicon for central bank communication using transcripts from ECB press conferences. Using an augmented Taylor rule, they find that tracking ECB communication improves to explain future ECB monetary policy decisions. Furthermore, they find evidence that a dovish (hawkish) tone and positive (negative) outlook about the economic development in the ECB press conference lowers (increases) stock market volatility.

[Park, Lee, and Kim \(2019\)](#) follow the methodology from [Picault and Renault \(2017\)](#) and create a field-specific central bank communication dictionary by using Minutes from the Bank of Korea. Again, including the extracted textual data for hawkishness and dovishness into an augmented Taylor rule outperforms a classical Taylor rule model.

[Schmeling and Wagner \(2019\)](#) extract the tone of ECB press conferences using the LM dictionary. They find a significant positive correlation between their extracted tone variable and subsequent stock market returns. They also find that central bank tone explains bond yields: Yields tend to increase (decrease) after a positive (negative) tone in ECB press conferences.

[Hansen and Tong \(2019\)](#) tackle the question of why long-run interest rates react to central bank communication and through which mechanism forward guidance affects the yield curve. They apply an LDA model on inflation reports from the BoE between 1998 and 2015 and use daily data of changes in UK government bonds. They conclude that inflation reports carry *uncertainty* signals that affect the term premia on longer-dated yields.

Methodology and Data

3.1 Methodology

I closely follow the methodology proposed by [Schmeling and Wagner \(2019\)](#), [Park, Lee, and Kim \(2019\)](#), [Hansen, McMahon, and Prat \(2018\)](#), [Hansen and McMahon \(2016\)](#), [Hansen and Tong \(2019\)](#), [Jegadeesh and Wu \(2017\)](#) and apply an LDA model on the respective corpus¹ of FOMC Minutes and ECB Monetary Policy Accounts. However, additionally to the papers mentioned above, I propose to optimize for a coherence measure C_V first described by [Röder, Both, and Hinneburg \(2015\)](#) in order to find a well-suited parameterization of the LDA algorithm. Once, the algorithm has learned about the topic distribution in the corpus, I adopted a lexical based sentiment analysis to retrieve a *tonal* and *uncertainty* measure within all topics and throughout all documents. The sentiment analysis was conducted by using the LM dictionary. These textual measures were implemented into a regression model to assess the FX market reactions within a given time window after the document release by using a high-frequency intraday dataset.

3.1.1 Text pre-processing

The raw textual data must be cleaned and processed before a topic model such as LDA can be implemented. The pre-processing steps involved in various natural language processing tasks are usually very similar; [Vijayarani, Ilamathi, Nithya, et al. \(2015\)](#) provide an overview of the reasoning and steps needed for textual data mining. In the following, I briefly explain the pre-processing steps in the order they have been conducted:

1. **Removal of stop words:** Stop words are common words that frequently appear throughout all documents but do not carry interesting semantic information. These list of words contains terms such as "the", "is", "an" and so on.
2. **Removal of punctuation:** Strip ".", ",", ":", and so on from textual data.
3. **Removal of numbers:** Numbers can carry semantically important information, but this is difficult to capture in natural language processing. Given that the input for topic models

¹Hereafter, corpus refers to the collection of all FOMC Minutes or ECB Monetary Policy Accounts.

are usually individual words, including numbers bears the risk that they heavily increase the set of individual "words" given that every number is treated as a different word. As it is common that specific numbers do not appear in other documents, this will create zeros at the index of said number when the document is transformed to a vector representation later. This sparsity can lead to model fragility. Thus, I remove numbers, even when they are written out, such as "four".

4. **Lemmatization:** Words are transformed to their base form. This includes transforming plural nouns back to the singular nouns and transforming back conjugate verbs (*expects* to *expect*). This also transforms verbs back to the present tense (*expected* to *expect*) in order to avoid having many entries in the document vector that have the same meaning. In short, this step removes the inflexion of words.
5. **Lower-casing:** This step transforms letters in upper case to lower case. Whether a word is written in upper case because it is at the beginning of a sentence does not carry any information for the topic model. "Economy" and "economy" are treated as the same word and will not enter the document vector as different entries.
6. **Bigram and trigram collocation analysis:** Some individual words are not interesting on their own but are informative when they appear together. For example, I do not want "central" and "bank" to be looked at individually as the word *central* has a different meaning on a broader and more general level. Furthermore, only *bank* would not capture the "correct" agent. Taking into account the collocation of these individual words and treat them as one "object" or individual word (*central bank*) better fits the context of the documents. Thus, given that two words (bigram) exceed a predefined threshold with which they appear together relative to how many times they appear individually, such collocated words are treated as a single *token* instead of two separate words. A token is the smallest unit in the textual analysis and usually denotes single words. However, for frequently collocated words, one does not treat the constituent words as tokens but the corresponding bi- or trigram (e.g. "European Central Bank").
7. **Tokenization:** Up to this point, the textual data is still a single string of text and word order is still intact. However, topic model algorithms work on numeric data. For this reason, documents enter topic model algorithms in a vectorized representation where each row corresponds to a word, and the value is a simple count of this word in the document. This vectorized text representation is called *bag-of-words*. Tokenization splits the text into the individual tokens so that the bag-of-words feature representation can be obtained.

3.1.2 The Latent Dirichlet Allocation algorithm

The LDA algorithm was introduced by Blei, Ng, and Jordan (2003) and they describe it as a generative probabilistic Bayesian model that can retrieve topics and topic distributions from a collection of documents. LDA does this by assuming that a number of topics (selected a priori by

the researcher) underlies the corpus and topics are formed by a distribution of underlying words. Therefore, LDA is a *hierarchical* Bayesian model where the corpus-level based *hyperparameters* α and η govern the probability distribution of topics on a document-level and words within the topic-level (Blei, Ng, and Jordan, 2003). Then, given the convergence of the topic and word distribution, if the topic model can attribute high probability to generated documents that are close to the documents in the original text collection, LDA is said to have learned a meaningful representation of the latent structure within the documents. This has the advantage that we can then observe the latent topic and word distributions which allows to infer topic labels. Summarized, the probability that a document results from LDA given its priors that determine a distribution over words and topics is:

$$P(W, Z, \theta, \phi, \alpha, \eta) = \prod_{j=1}^M P(\theta_j, \alpha) \prod_{i=1}^K P(\phi_i, \eta) \prod_{t=1}^N P(Z_{j,t}|\theta_j) P(W_{j,t}|\phi_{Z_{j,t}}) \quad (3.1)$$

where the letters describe the corresponding inputs:

- M : Number of documents in the corpus
- K : Number of topics
- N : Total number of words in all documents
- Z : The topic-assignment for a given word w
- W : Set of all words in all documents
- θ : The prior distribution of topics in a given document
- ϕ : The prior distribution of words in a given topic
- α : Document-topic bayesian prior determining the distribution θ
- η : Topic-word bayesian prior determining the distribution ϕ

One can dissect formula 3.1 in two ways that facilitate the understanding of the topic retrieval process: The first way is to distinguish between the topic-wise generative process that segments documents into topics and a word-wise generative process that allocates words into topics. The second dissection distinguishes between the different underlying distribution functions for each term, whereas the first two products follow a Dirichlet Distributions and the two latter terms are multinomial distributions. Thus, we can think of equation 3.1 in the following way:

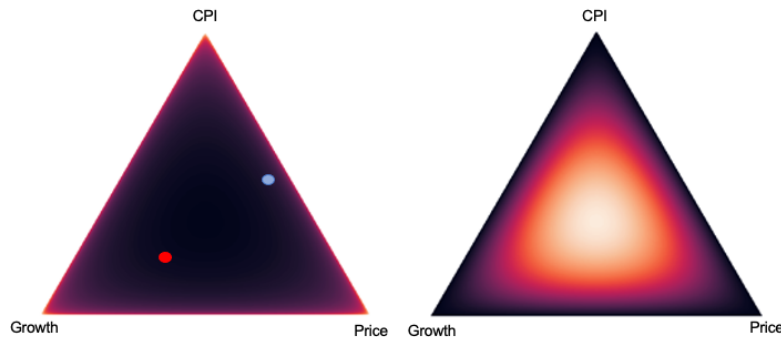
$$P(W, Z, \theta, \phi, \alpha, \eta) = \overbrace{\prod_{j=1}^M P(\theta_j, \alpha)}^{\text{Dirichlet Distributions}} \underbrace{\prod_{i=1}^K P(\phi_i, \eta)}_{\text{Word-wise}} \overbrace{\prod_{t=1}^N P(Z_{j,t}|\theta_j)}^{\text{Multinomial Distributions}} \underbrace{P(W_{j,t}|\phi_{Z_{j,t}})}_{\text{Word-wise}}$$

The LDA generative process can then be described as follows: For a single document j , a distribution of topics θ_j is selected from a Dirichlet distribution with parameter α (this is the term $P(\theta_j, \alpha)$). One can therefore think of the Dirichlet distribution as a distribution of distributions. From this topic distribution θ_j , an individual topic Z is sampled whereas the probability of a topic realization follows a multinomial distribution (this is the term $P(Z_{j,t}|\theta_j)$). The word-wise generative process follows a similar logic: Topics are associated with all other words in the corpus where some words are more characteristic for certain topics. The way of how topics are distributed along the probability space of all words follows a Dirichlet distribution that is governed by the parameter η (this is the term $P(\phi_i, \eta)$). Once a topic is selected, a word W is sampled from the corresponding multinomial distribution of words (this is the term $P(W_{j,t}|\phi_{Z_{j,t}})$).

Repeating this process results in a sequence of words and thus, generates a document. Through θ , one can extract the topic distribution for each document and by observing the distribution of words for each topic ϕ , a human can infer the the topic that is discovered in an unsupervised manner by the algorithm.

For better illustration, figure 3.1 displays two different Dirichlet distributions for $P(\phi_i, \eta)$ in a simplified case where the dictionary of an imaginary corpus only consists of three individual words: *CPI*, *price* and *growth*. On the left side, a Dirichlet distribution with an $\eta < 1$ is displayed as weight is concentrated on the corners and borders under this parametrization. The distribution on the right side displays a Dirichlet distribution with an $\eta > 1$ as weight is concentrated in the center (note that a parameter of 1 would lead to a uniform distribution where every point in the Dirichlet distribution is equally likely). Thus, an $\eta > 1$ would lead to topics that more or less equally share the vocabulary while an $\eta < 1$ leads to topics that exhibit a distinct vocabulary. Imagine a topic realization that is close to the words *CPI* and *price* and more distant to the word *growth*. This is the blue dot in the left figure in 3.1. The probabilities of the words *CPI* and *price* to occur within this topic might be 0.45 for each word while the word *growth* might occur with a probability of 0.1. This is exactly the multinomial distribution derived from $P(\phi_i, \eta)$ that selects words from the topic assignment: $P(W_{j,t}|\phi_{Z_{j,t}})$. In another case, a different topic might be more ambiguous and words are more or less equally likely to appear. Consider the topic realization of the red dot in figure 3.1 (note that with an $\eta < 1$, a topic realization in the center would be very unlikely as weight is concentrated on the borders and corners). This would be a more general topic such as *policy mandate* or *forward guidance* where the corresponding multinomial distribution for the word-generating process could be $\{0.3, 0.3, 0.4\}$ for the word set $\{\text{CPI, price, growth}\}$.

Figure 3.1: Dirichlet distributions for the topic-word generating process



Source: Figure compiled by the author

Unfortunately, the maximization problem of equation 3.1 is not tractable when trying to find the optimal hidden generating parameters θ and Z (Blei, Ng, and Jordan, 2003), but various approximate inference methods can be applied that circumvent this problem. Blei, Ng, and Jordan (2003) show how *variational Bayes* can be used to conduct inference using LDA. Griffiths (2002) shows how *Gibbs sampling* is implemented to overcome the problem of intractable integrals for the maximization problem in the context of LDA².

3.1.3 Optimizing for the coherence measure C_V

As an *unsupervised* machine learning algorithm, LDA is efficient in the sense that it discovers topics and topic distributions autonomously without requiring any labelled data. This has the advantage that a researcher does not have to label data manually beforehand, which would mean labour-intensive preparation that could fall into the researcher's subjective bias. Nevertheless, LDA requires inputs for three hyper-parameters that need to be selected actively by a researcher:

- The number of topics within the corpus: K .
- The Dirichlet parameter α that governs the topic distribution θ on a per-document level.
- The Dirichlet parameter η that governs the distribution of words on the topic-level.

These parameters are crucial for discovering the latent variables θ and Z and the validity - as well as interpretability - of topics. Unfortunately, the process of how these hyper-parameters are selected in the related literature is quite opaque and thus, the results are only reproducible when researchers disclose the hyper-parameters and the rationale of how they have been selected. To circumvent this issue and as the ultimate goal in this semantic analysis is the interpretability of

²For the inference in this thesis, I have used *Gensim*'s implementation of LDA that works by using variational Bayes by default. More information on the Gensim library can be found here: <https://radimrehurek.com/gensim/>

topics to track the topic distribution over time, I propose to optimize for a coherence measure C_V that was introduced by Röder, Both, and Hinneburg (2015). Optimizing for C_V , when selecting the hyper-parameters outlined above, has the following advantage: In information retrieval, coherence measures have been introduced to quantify the interpretability for clustered (textual) data; a topic is said to be coherent when all or some of its corresponding (most relevant) words³ are close together in the semantic space which should correlate with human interpretability (Syed and Spruit, 2018). Thus, by optimizing for C_V , one should obtain meaningful and interpretable results where individual topics are semantically distinguishable from each other. Furthermore, by optimizing for a coherence measure, one introduces a rule-based selection process for the hyper-parameters that otherwise have to be selected based on human judgement. Sticking to this rule-based selection process enhances the transparency and reproducibility of the model.

Several coherence measures emerged from the information retrieval literature, whereas the most prominent ones use *pointwise mutual information* (PMI). In essence, PMI takes the co-occurrence into account that two selected single words w_i and w_j appear together. That is, w_i and w_j share a high PMI when they frequently co-occur in documents throughout the corpus (Schütze, Manning, and Raghavan (2008). Aletras and Stevenson (2013) adopted the concept PMI and developed a coherence measure that evaluates *context vectors* for a given word w_i : For a word w_i , the surrounding words are taken into account and the PMI for the words in a given context window are calculated from which the context vector emerges. Aletras and Stevenson (2013) show that instead of PMI, *normalized PMI* (NPMI), which slightly modifies the mutual information calculation, enhances the coherence measure with human topic ratings. *Cosine similarity* as a distance measure can then be used to calculate the similarity or closeness between context vectors. The idea is that if words frequently appear together because they are characteristic for a specific topic, they should be close together in this vectors space spanned by the NPMIs (Schütze, Manning, and Raghavan, 2008).

C_V builds upon these steps. However, instead of working with individual words w_i and w_j , it uses pairs of subsets of the top words W for a given topic. That is if W^* and W' are subsets of the top words W for a topic, then $W^* \in W$ and $W' \in W$, where working with pairs of subsets was introduced by Douven and Meijs (2007). The NPMI between pairs of subsets of top words are calculated which gives rise to the context vectors. Calculating the cosine similarity of all context vectors for the corresponding subsets of top words leads to a so-called *confirmation measure* which can be thought of as a score for a single topic. Finally, taking the arithmetic mean over all confirmation measures leads to the coherence measure C_V Röder, Both, and Hinneburg (2015). I implemented a grid search approach to find the optimal combination of the number of topics, α and η that returned the highest C_V -score⁴.

³Hereafter, I will refer to these most relevant words for a topic as *top words*. These top words are important for determining the topic label. Table A1 shows the top words per topic for the ECB corpus, table A2 shows the top words for the FOMC corpus.

⁴Section A.5 displays the learning process of the LDA algorithm for the ECB and FOMC corpus. The first panel shows the C_V score for a range of possible topic numbers. The higher the C_V score, the better the interpretability.

3.1.4 Sentiment analysis

I followed the methodology proposed by [Jegadeesh and Wu \(2017\)](#) and [Hansen and Tong \(2019\)](#) and ran the LDA algorithm not on the full documents but on a paragraph-level. Therefore, topics are not simply allocated on the whole document but rather on each paragraph separately. Accounting for the length of a paragraph relative to the full document, one can obtain the document-level topic distribution. The topic analysis on a paragraph level has the advantage that each paragraph is classified into the discovered topics, and the topic vector $\theta_{i,j}$ (where i denotes the document and j to the paragraph) in the said document can be used as a weighting vector for the subsequent sentiment analysis. The idea is the following: Assuming that paragraph j in document i is classified as 80% financial markets and 20% as economic growth, then the sentiment score $S_{i,j}$ for this paragraph is attributed into these two topics given the respective weights. At a later point, one can then aggregate to the document level to obtain the sentiment for each topic in the document.

The sentiment analysis was conducted on a paragraph level using the LM-dictionary. [Loughran and McDonald \(2011\)](#) provide a dictionary that contains a list of *positive* and *negative* words. Furthermore, the dictionary contains a list of *uncertainty* words. Equipped with these lists, the sentiment is extracted by parsing through the paragraph and count the number of words from the respective dictionary list. I adopt the sentiment calculation from [Hansen and McMahon \(2016\)](#) and [Schmeling and Wagner \(2019\)](#) and calculate the tonal (positive vs. negative) sentiment $S(T)$ for paragraph j in document i in the following way:

$$S(T)_{i,j} = \frac{\text{number of positive words} - \text{number of negative words}}{\text{total number of words in paragraph } j} \quad (3.2)$$

The uncertainty score $S(U)$ is similarly:

$$S(U)_{i,j} = \frac{\text{number of uncertainty words}}{\text{total number of words in paragraph } j} \quad (3.3)$$

The topic model required to strip stop words (see section 3.1.1) from the original raw text. For the sentiment extraction, I have reintroduced these words into textual data before the sentiment analysis is conducted as these stop words can carry important information for the sentiment extraction: Some *uncertainty* words appear on stop word lists, but I want to incorporate them for the extraction of the uncertainty measure $S(U)$. Furthermore, I have implemented a negation-control. That is, whenever a word such as *no* and *not* - which are certainly stripped at the stop word removal step - appears in the text and a word from the *positive* or *negative* list appears as one of the following three words, then the polarization is inverted, meaning a positive count is attributed instead of a negative one and vice versa (e.g. *not good* is counted as negative even though *good* actually matches with the *positive* word list). In a last step, I have normalized the sentiment and uncertainty scores for each topic so that its mean is zero and variance is equal to one. This step was also implemented in [Jegadeesh and Wu \(2017\)](#) and should allow for a better comparison between sentiment and uncertainty scores of individual topics.

3.2 Data

Four types of data were used to conduct this thesis:

1. Textual data: This consists of the corpora of FOMC Minutes and ECB Monetary Policy Accounts.
2. High-frequency intraday FX data: To analyze the market impact around the event window when a statement was released.
3. The LM dictionary: I required a dictionary for the lexical approach of the sentiment analysis. Therefore, I briefly explain the choice of using the LM dictionary as it was a conscious decision to use this external source of research output.
4. Control variables for the regression model.

3.2.1 Textual data

- **FOMC Meeting Minutes:** FOMC Meeting Minutes are released with a time delay of three to eight weeks after the FOMC meeting and corresponding monetary policy statement (Federal Reserve press release). The release lag was roughly eight weeks before 2004 and was subsequently reduced to three weeks. The Minutes are released at 2:00 pm Eastern Standard time (EST) (Jegadeesh and Wu, 2017). The release dates and PDFs (or raw text in HTML) can be obtained from the Fed's website. My sample ranges from the first FOMC meeting in 2000 (02.02.2000) until the FOMC Meeting from the 5th of November, 2020 (where the Minutes were released on the 25th of November, 2020). Thus, in total, I analyzed 167 FOMC Meeting Minutes. Following the methodology in Jegadeesh and Wu (2017), I did not incorporate the full text in my analysis. Instead, I stripped the first few paragraphs from each document as these provide administrative information such as meeting participants. I did not include the reviewing part in which the past monetary policy strategy is discussed (Section: *Review of Monetary Policy Strategy*). Instead, I only incorporate text material from the section "*Developments in Financial Markets and Open Market Operations*" and onward. These sections include discussion about the current situation in financial market, economic activity, economic outlook and new policy strategies.
- **ECB Monetary Policy Meeting:** The ECB publishes the Monetary Policy Accounts with a lag of three to four week after every ECB council meeting. Unfortunately, the ECB only started publishing Monetary Policy Accounts at the beginning of 2015. Therefore, the textual sample size from the ECB is much smaller than from the Federal Reserve. In total, I analyzed 47 Monetary Policy Accounts, starting from the council meeting from the 22nd of January, 2015 (release of Monetary Policy Accounts on the 19th of February, 2015) throughout the council meeting from the 29th of October, 2020 (released on the 26th of November). Likewise, the ECB Monetary Policy Accounts are highly structured. Section 1 includes the review of

past developments. Section 2 covers the council’s discussion about economic and monetary analyses, policy considerations, policy decisions and communication. I only included the second section of each Account in my analysis. The ECB publishes its Monetary Policy Accounts at 1:30 pm Central European Time (CET).

3.2.2 Foreign exchange data

The intraday FX data that I used in this thesis was downloaded for free from the website [Hist-Data.com](#). The website provides historic intraday price data for major FX crosses since 2000 and since 2010 for emerging market currencies that it collects from various financial analysis tool providers such as MetaStock. I used 1-minute bar data from MetaStock. MetaStock retrieves financial data via DataLink which is a proprietary product from Refinitiv. Refinitiv is one of the largest primary venues for FX trading together with EBS (Electronic Brokerage Services), and is owned by Reuters and the London Stock Exchange ([Schrimpf and Sushko, 2019](#)). From the 1-minute bar data, I only took into account the close prices for each minute within the respective event window. The event window for FOMC Minutes stretches from 2:00 pm EST to 2:30 pm and from 1:30 pm to 2:00 pm CET for ECB Monetary Policy Account releases on the respective event days. The related literature influenced the choice for the size of the event window: [Jegadeesh and Wu \(2017\)](#) use a 15-minute event window, [Conrad and Lamla \(2010\)](#) use a 30-minute event window for their analysis on EURUSD FX rates. [Fleming and Piazzesi \(2005\)](#) use a 60-minute event window. Additionally, I also provide results for a 60-minute event window.

I calculate return volatilities from the 1-minute close prices, and the directional price change within the event window. Furthermore, I calculated the trading range which I define as the difference between the maximum close price and minimum close price in the event window. For the FX volatility, I follow the methodology in [Jegadeesh and Wu \(2017\)](#) and subtract the mean volatility from the previous 20 trading days at the event window from the volatility at the event day. Thus, in line with the terminology used in [Jegadeesh and Wu \(2017\)](#), I refer to *unexpected* volatility in my analysis as one can think of it as unexpected or excess volatility after stripping the mean volatility from the past 20 trading days.

3.2.3 The Loughran and McDonald dictionary

The LM dictionary can be downloaded for free from [their website](#)⁵. The *negative* word list consists of 2355 words, the *positive* lists of 354 words and the *uncertainty* list of 297 words. While it originates from an accounting background, it has been applied extensively in economic and financial research (see section 2.4). Specifically, the LM dictionary has been applied to analyze central bank communication by [Park, Lee, and Kim \(2019\)](#) and [Picault and Renault \(2017\)](#). [Park, Lee, and Kim \(2019\)](#) built a specific dictionary for communication from the Bank of Korea and concluded that the sentiment derived from the LM dictionary returned the highest correlation to their custom-built classifier from a set of control sentiments and even outperformed a Google cloud service.

⁵<https://sraf.nd.edu/textual-analysis/resources/>

Picault and Renault (2017) also test the sentiment from the LM dictionary to explain current ECB monetary policy and conclude that "when explaining current ECB monetary policy, the use of the LM dictionary seems to be sufficient to capture ECB sentiment" (Picault and Renault (2017), p.143).

3.2.4 Control variables

The regression model includes several control variables. Data on inflation, GDP growth and current account balances were taken from the [OECD data website](#)⁶. Data on policy rates were retrieved from the [Bank for International Settlements' website](#)⁷. Some data for the case of Hong Kong were taken from either the World Bank's website or the Federal Reserve Bank of St. Louis' (FRED) website. Table A4 in the appendix provides an overview of the data. Furthermore, I included a recession indicator for the US and the Euro Area. These indicators were taken from the FRED.

3.3 Regression model

The econometric model outlined in this thesis is closely aligned to the one proposed in Jegadeesh and Wu (2017). However, I do not incorporate the tonal and uncertainty scores as level data but as their corresponding first differences. The textual variables, therefore, represent the change from two consecutive communication releases. My argument is that FX market participants are less interested in the actual level of uncertainty or pessimism vs optimism narrative underlying the central bank communication but notice primarily *changes* in central bank communication. Furthermore, Jegadeesh and Wu (2017) focused on the announcement effect of FOMC Minutes in the US equity and debt market. As I focus on a different market, I also include different control variables in my model:

- In line with Jegadeesh and Wu (2017) I also include GDP growth, inflation and a recession indicator in my model. GDP growth enters the model as the differential between the currency area's growth rate, which communication I analyzed, and the second currency area in the FX pair. For example, for USDCHF, where I focus on market reactions from FOMC Minutes, the difference between the US and Swiss GDP growth serves as a control variable. The recession indicator was taken from the Federal Reserve Bank of St. Louis. For the US, the economic recession indicator is constructed by the National Bureau of Economic Research⁸. For the Euro Area, I chose a recession indicator which is provided by the OECD⁹. The recession indicator is a dummy variable that is equal to 1 whenever the criteria for an economic recession outlined by the data provider are fulfilled. I also adapt the inclusion of the policy

⁶<https://data.oecd.org/>

⁷<https://www.bis.org/statistics/cbpol.htm>

⁸Federal Reserve Bank of St. Louis, NBER based Recession Indicators for the United States, retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/USREC>, April 30, 2021.

⁹Federal Reserve Bank of St. Louis, OECD based Recession Indicators for Euro Area, retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/EUROREC>, April 30, 2021.

rate from Jegadeesh and Wu (2017), but again, I include this as the differential between the currency areas from the respective currency pairs.

- I include the differential of the current account balance from the respective economic areas. Data was retrieved from the OECD website.
- Note that all control variables but the respective recession indicators enter the model as first differences. First, this takes care of stationarity¹⁰ issues in the data. Second, I again argue that market participants react to changes in the control variable differentials.

The econometric model explains the dependent variable y_t^i where three different models were set up so that i refers to any of the three dependent variables of interest at the release date t

$$i \in \begin{cases} \text{unexpected volatility} \\ \text{directional change in the spot price} \\ \text{trading range} \end{cases}$$

within the respective event window of either 30 or 60 minutes. y_t^i is explained by the set of textual variables S_t^j where j refers to either the the change in tonal sentiment (positive vs. negative) $\Delta S(T)_{t,k}$ or the change in the uncertainty measure $\Delta S(U)_{t,k}$ for the discovered topic k so that $j \in \{\Delta S(T)_{t,k}, S(U)_{t,k}\}$. Furthermore, y_t^i is explained alongside the of set control variables X_t explained above. Thus, the econometric model can be summarized as:

$$y_t^i = \alpha + \sum_{k=1}^K \beta_k S_{t,k}^j + \gamma X_t + \epsilon_t \quad (3.4)$$

where α represents the model's intercept, k refers to the set of discovered topics by the LDA algorithm and ϵ is the error term.

¹⁰Table A5 displays the p-values for stationarity tests on the dependent variables (unexpected volatility, directional price change and trading range). As all explanatory variables are in first differences, I only show the results from stationarity tests on the dependent variables and only for variables where at least one stationarity test cannot reject non-stationarity (or rejects stationarity).

Results

4.1 Extracted textual variables

4.1.1 Fed communication

Figure 4.1 displays the topics and the corresponding topic distribution that LDA discovered for each FOMC meeting Minutes over time. The topic distribution serves as a proxy for topic *importance* as one could argue that the more important a topic is for the FOMC, the more they talk about this topic¹.

One can tell from figure 4.1 that before the GFC unfolded in 2008, economic activity (labelled *business activity* in the figure) and economic growth seemed to be of significant interest as they combined attributed to around 45% of content in FOMC Minutes. A spike in *financial markets* happens around 2007, and it remains an important topic throughout the crisis alongside the topic *money market* that has gained interest as well. Money market spikes occasionally ever since and has gained interest during the pandemic crisis in 2020, with a simultaneous sharp increase in discussion regarding financial markets. Interestingly, discussion about economic outlook has steadily gained interest ever after 2008, peaking in 2012, and has remained a prominent topic to the FOMC ever since.

Figure 4.2 displays the extracted tonal sentiment in each topic, whereas a positive (negative) score number indicates a more positive (negative) wording in the underlying topic. Most topics took a significant drop around and throughout the GFC, and the same seems to have happened when the pandemic crisis unfolded in early 2020 (except for housing market), whereas the recovery seemed to have happened much quicker during the pandemic crisis in 2020 than during the GFC.

In figure 4.3 we can see the evolution of uncertainty over time. A larger, positive number is associated with more uncertainty within a given topic. One can observe a spike in the *trade* topic

¹Section A.1 in the appendix displays the two paragraphs within the textual sample that exhibit the strongest membership within a given topic. That is, I provide the most characteristic paragraphs for each topic for the FOMC and ECB documents. This should further facilitate the comprehension for the decision of topic names as it displays what the central bank discusses within each topic

Figure 4.1: FOMC Minutes topic distribution over time



Figure 4.2: FOMC Minutes topic tonal scores over time



Figure 4.3: FOMC Minutes topic uncertainty scores over time



in 2016, a year that was marked by the Brexit referendum and the US presidential election with President Trump (tariff threats). A sharp increase in uncertainty can also be observed in *financial markets* around 2008. *Growth, labour market, money market* and *QE* spike all at the beginning of 2020 with the unclear outlook of the Covid pandemic crisis.

4.1.2 ECB communication

Fewer topics were found in the ECB's Monetary Policy Accounts. This could be explained that some topics discovered in the FOMC Minutes are less important on a supranational level but remain primarily relevant for policymakers on a national level. For example, *labour market* or *housing market* might be mentioned by the ECB, but it is not a recurring topic discussed regularly. Figure 4.4 displays the topics discovered by LDA in the Monetary Policy Account and their distribution over time. It becomes clear that the core topic of concern for the ECB (at least in the last six years) has been *inflation* as, on average, a third and sometimes up to 45% of text is dedicated to inflation. Furthermore, around 2015 and 2016, *structural reforms* was of importance. This topic talks about how growth can be accelerated in the Euro Area and explains the importance of reforms on a national level to allow for a better stimulus from ECB policies. Therefore, this topic represents also to some extent *growth*. *Interest rates* is not solely about the policy rate but also discusses *Targeted longer-term refinancing operations* (TLTROs), deposit facility and marginal lending facility.

Figure 4.5 shows the tonal trajectory within each topic. Most topics dipped in 2020 (*financial markets*, *APP*, *global economy*, *credit market* and *structural reforms* (growth)).

Figure 4.6 shows the uncertainty score attributed within a topic over time. *Financial markets*, *global economy* and *credit market* all gain uncertainty at the beginning of 2020. Furthermore, a spike in *global economy & trade* is visible in the first half of 2017. The Monetary Policy Account released at the 6th of April 2017 (Council Meeting from the 8th and 9th of March 2017) reveals that indeed the ECB's language within that topic exhibited a lot of uncertainty at that time:

"As regards the external environment, it was noted that the latest staff projections pointed to a strengthening in global growth momentum and a cyclical recovery in global trade. However, the external outlook was perceived to remain very uncertain, with reference made to a number of factors that were seen as contributing to this uncertainty, including the nature and timing of future policy choices by the new US Administration, the economic impact of the United Kingdom's withdrawal from the European Union, the transition towards lower growth and the rebalancing of demand in China, and developments in other emerging market economies. The balance of risks to the outlook for global growth was generally viewed as remaining on the downside."

– ECB Monetary Policy Account, released on 06.04.2017

Figure 4.4: ECB Monetary Policy Accounts topic distribution over time

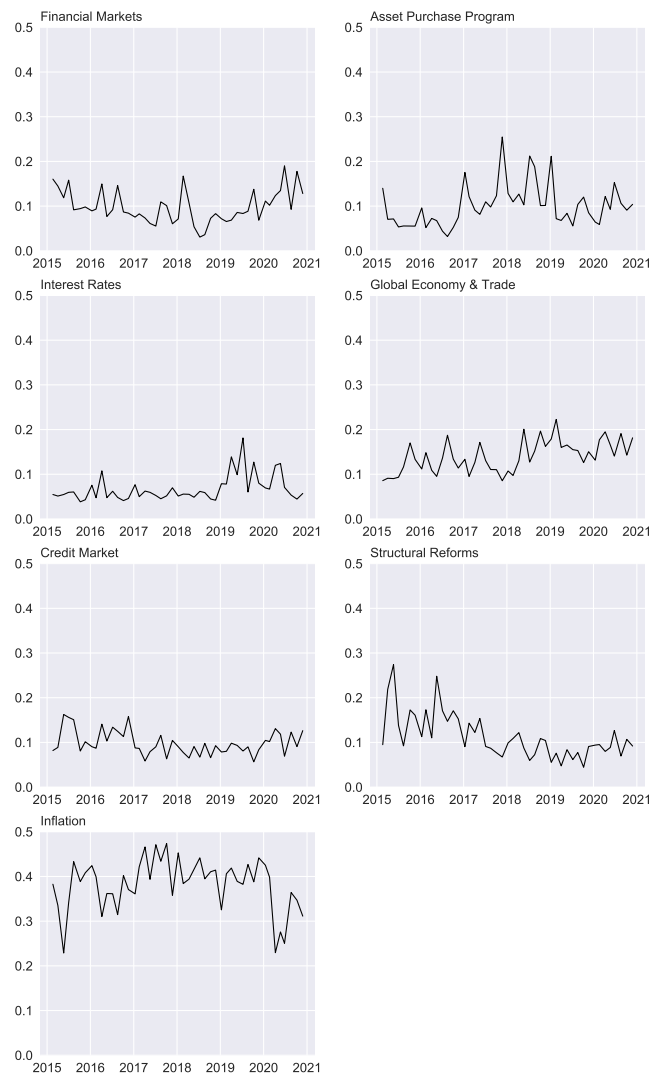


Figure 4.5: ECB Monetary Policy Accounts topic tonal scores over time

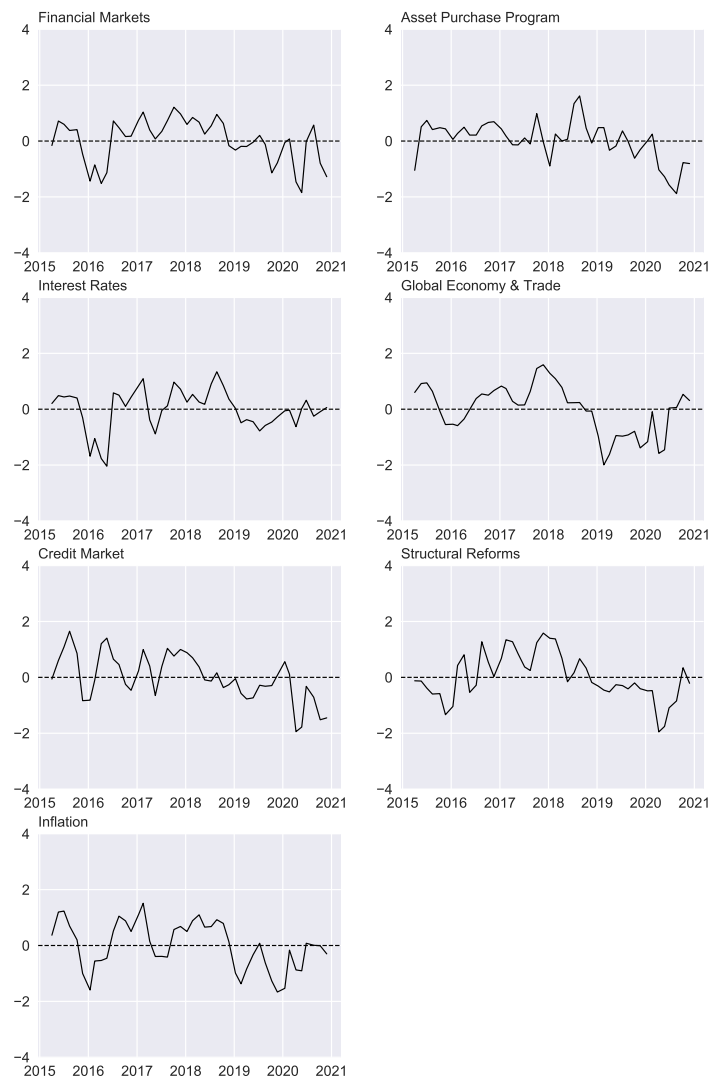
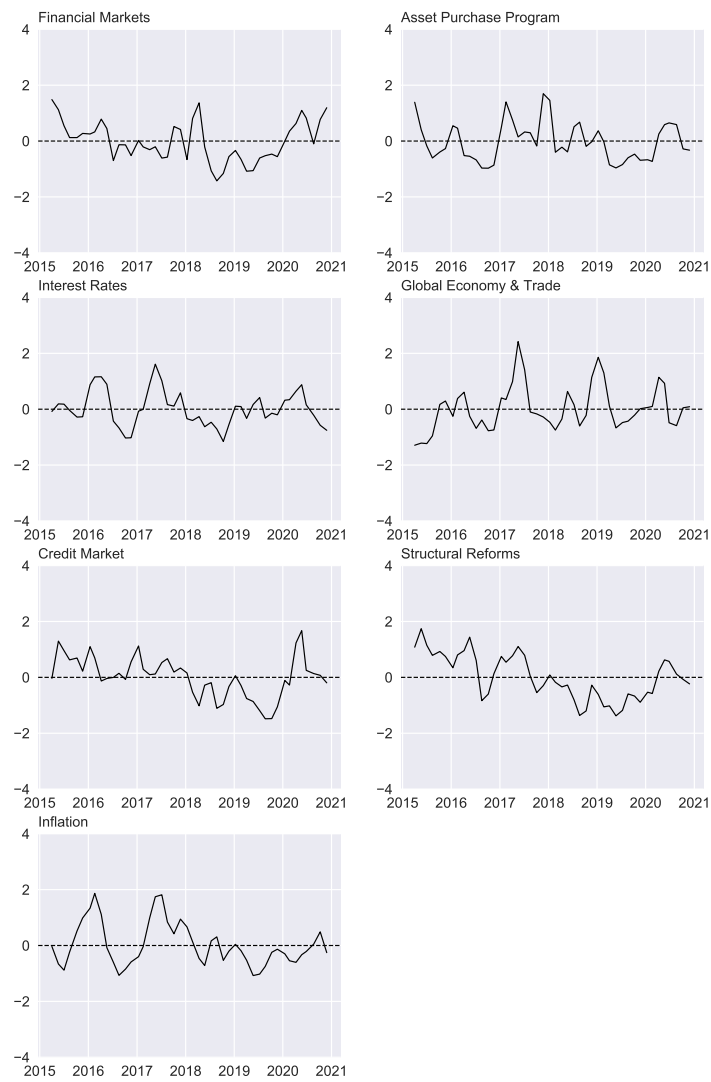


Figure 4.6: ECB Monetary Policy Accounts topic uncertainty scores over time



4.2 Regression analysis

4.2.1 Fed communication

Tonal measure

Regressing the FOMC Minutes' tonal scores on the unexpected volatility, directional price change and trading range on the intraday trading data reveals the following relationships within the respective currency pair:

- USDEUR:** The Euro seems sensitive to discussion regarding the *foreign markets* topic and appreciates when the tonal score is positive. The interpretation for the directional price change in the 1-minute dataset is as follows: A unit increase in the tonal score depreciates USDEUR by 0.0002 (or 2 pips).
 Furthermore, the Dollar appreciates against the Euro when the tonal score turns more positive in the *QE* topic (Significance for both changes on a 5% level). Return volatility picks up when the language in the *economic outlook* and *inflation* topic worsen (both significance level on 10%). The results regarding the foreign markets and QE topic remain significant [in the 5-minute dataset](#).
- USDCHF:** The franc seems rather invariant against the Dollar to tonal changes in the FOMC language. Only a positive coefficient for *business activity* and *housing market* which are significant on a 10% level, suggests that the US Dollar might appreciate against the franc when the FOMC Minutes report more positively within the respective topics ([in the 5-minute dataset](#)).
- USDMXN:** In [the 5-minute dataset](#), USDMXN seems most likely to react to news regarding the business activity topic where an increase in the tonal score (more positive language) indicates an appreciation of the Dollar against the Mexican Peso. Furthermore, USDMXN seems to be reactive regarding the *growth* topic on a 10% significance level, where again, USDMXN appreciates when the tonal scores increases.
- USDTRY:** Like USDMXN, USDTRY seems most reactive (regarding directional price change) in the business activity and growth topic, where a positive change appreciates USDTRY in the 30 minute event window with significance on the 5% level for both coefficients (both results in the [5-minute dataset](#)). In the 1-minute dataset, USDTRY trading range increases with an increase in the tonal score within the business activity topic on a 10% significance level.
- USDHKD:** No significance regarding directional price change but USDHKD return volatility picks up both in the 1- and [5-minute dataset](#) when language in the financial markets topic worsens (significance on the 5% level in the 1-minute dataset and 10% in the 5-minute dataset).

Uncertainty measure

- **USDEUR**: Changes in the uncertainty measure suggest that markets are most likely to react directional when uncertainty increases in the financial markets and QE topic (all coefficients significant on 5% in the [5-minute dataset](#)). Heightened uncertainty in QE leads to an appreciation of USDEUR within a 30-minute event window, and growing uncertainty in financial markets leads to a depreciation within a 60-minute event window. Heightened uncertainty also impacts return volatility where uncertainty regarding the financial markets topic increases return volatility, and increasing uncertainty in QE and business activity seems to reduce volatility (all results significant on 5% and in the 5-minute dataset). What could explain a reduction of volatility when uncertainty increases? One reason might be that traders halt or reduce trading activity and intensity ("wait-and-see") when they anticipate that a release leads to price corrections and surprises the market ([Rosa, 2018](#)). An increase in uncertainty in the financial markets topic increases the trading range within a 60-minute event window (significance level on 1%).

USDCHF: The franc appreciates against the Dollar when uncertainty increases within the financial markets topic (significance on 5%) and inflation topic (significant on a 10% level) in the 1-minute dataset and within the 30-minute event window. In the 5-minute dataset, heightened uncertainty regarding the inflation topic increases return volatility on a 5% significance level. [The 5-minute dataset](#) also reveals that the USDCHF appreciates with heightened uncertainty within the QE topic as it is the case for USDEUR.

- **USDMXN**: The currency pair appreciates within a 30-minute event window when uncertainty increases in the QE topic ([5-minute dataset](#), result significant on a 10% level). In the 1-minute dataset, results show significance on the 10% level in for the trading range where growing uncertainty in *economic outlook* reduces trading range and growing uncertainty in *growth* widens the trading range within the 60-minute event window in the 5-minute dataset.
- **USDTRY**: Results suggest that USDTRY trading range reduces with higher uncertainty in the economic outlook topic. The coefficient is significant on a 5% significance level in the 1-minute dataset for an event window of 30 minutes.
- **USDHKD**: The only significant coefficient regarding directional price change for USDHKD appears when uncertainty increases in the *trade* topic (significance on 10% level). Otherwise, uncertainty in the housing market topic seems to increase return volatility and is significant on a 5% level. However, this results only appears in the 1-minute dataset and is not robust in [the 5-minute dataset](#), where in turn, increased uncertainty in the foreign markets topic indicate elevated return volatility on a 5% level. In the 5-minute dataset, the trading range widens when uncertainty increases in the foreign markets topic (1% significance) and reduces with higher uncertainty in the inflation topic (5% significance).

4.2.2 ECB communication

Tonal measure

- **EURUSD**: The Dollar behaves rather invariant regarding the ECB's tonal language but reacts more strongly to changes in uncertainty. For the tonal change, EURUSD appreciates when language in the *interest rates* topic worsens (5% significance). On a 10% significance level, EURUSD return volatility seems to increase when the tonal score observes a negative change in the *APP* topic.
- **EURCHF**: No observable significance regarding directional price change for the EURCHF pair in the 1-minute dataset. A more negative tone in the growth & reforms topic seems to increase return volatility (significance on 5%) while a more positive tone in the APP topic increases EURCHF trading range (significance on 5%). In [the 5-minute dataset](#), elevated return volatility with a more positive language in the APP topic remains robust on a 5% significance level and so does increased trading range with an increased tonal score for the APP topic.
- **EURTRY**: Return volatility in EURTRY picks up with a more positive tone in APP (10% significance, [5-minute dataset](#)).

Uncertainty measure

- **EURUSD**: For the EURUSD, elevated uncertainty seems especially relevant in the *APP* topic where an increase in uncertainty indicates a depreciation of EURUSD both in the 30 and 60-minute event window (significance level of 1% for the 60-minute event window) and return volatility picks up at a 1% significance level in the 1-minute dataset. Furthermore, EURUSD depreciates when more uncertainty is attributed in the financial markets topic (10% significance in the 1-minute dataset). In [the 5-minute dataset](#), results indicate a depreciation of EURUSD with increased uncertainty in the APP topic. Also, increased uncertainty regarding the *inflation* topic is highly significant on a 1% level where the Euro depreciates against the Dollar when uncertainty picks up within the inflation topic.
- **EURCHF**: For the uncertainty measure, multiple topics are significant on a 5% level regarding directional price change: An increase in uncertainty is attributed with an appreciation of EURCHF in the inflation and credit market topics and with a depreciation in the APP and interest rate topic. Higher uncertainty in the financial markets topic appreciates the franc against the Euro significantly on a 1% level which might hint towards the safe-haven appeal of the Swiss franc. The trading range reduces significantly on a 1% level when uncertainty picks up in the APP topic. The directional price change effect persists in the financial markets topic in [the 5-minute dataset](#), and so does the effect on the trading range in the APP topic. Furthermore, the 5-minute dataset results reveal a significant reduction (5% level) in return volatility when uncertainty increases within the APP topic. The inflation topic coefficient

robust on a 5% significance level in the 5-minute dataset and indicates an appreciation of EURCHF.

- **EURTRY**: Increased uncertainty affects EURTRY spot prices in the following way: A heightened uncertainty in financial markets depreciates EURTRY significantly on 1% and depreciates the pair with heightened uncertainty in the APP topic (10% significance). The trading range reduces with a coefficient significant on a 1% level for the 30-minute event window when uncertainty increases in the APP topic. The effect on the directional price change persists for the financial markets coefficient (but not for the APP coefficient) in [the 5-minute dataset](#). However, the 5-minute dataset indicates reduced return volatility with increased uncertainty within the APP topic (significance on 5%).

4.2.3 Reaction of emerging country currency pairs versus developed country currency pairs

Comparing the communication effects between currency pairs involving only currencies from developed countries versus the currencies involving an emerging country currency reveals that not all topics seem equally crucial for the respective currency group. First, quantitative easing and asset purchase programmes seem to impact almost all currencies, no matter whether the communicating party is the Fed or the ECB. However, topics that seem more related to economic fundamentals such as growth or business activity seem to be primarily important for the Mexican Peso and Turkish Lira, but less for the Franc or Euro. On the other hand, it appears that developed market currencies are more reactive than emerging market currencies towards uncertainty regarding the financial market topics (*foreign markets* in the case of FOMC communication and the *financial markets* topic in both central banks' communication).

Discussion about inflation seems to be rather irrelevant for emerging country currencies but impacts the currency triangle Euro, Dollar and the Swiss franc for ECB communication. Thus, I find supporting evidence for the results from [Conrad and Lamla \(2010\)](#). They analyzed the content of ECB introductory statements and the corresponding Q&A session after ECB council meetings by manually labeling topics within these communication data. They conclude that the EURUSD is primarily moved by news regarding the price developments in the Euro Area. In contrast, news about economic fundamentals seem to be of less importance and do not translate in clear FX movements ([Conrad and Lamla, 2010](#)). Further results regarding the importance of the inflation topic in the case of ECB communication is provided by [Jansen and de Haan \(2007\)](#) who study the relationship between ECB communication and Euro Area inflation expectations. Their findings support the result that dovish ECB communication affects the Euro Area break-even inflation negatively, even when the ECB abstained from using its interest rate instruments, suggesting measurable market reactions from communication alone and its effectiveness as a policy tool.

4.3 Robustness

Robustness of results is accounted for in several ways: First, I use two different event windows. One takes the first 30 minutes from the release of the central bank document and the second event window takes another 30 minutes into account, totalling in a 60 minutes event window. The selection of an adequate event window is not straight forward, and my decision was based on the methodology in the related literature (see section 3.2.2). On the one hand, [Jegadeesh and Wu \(2017\)](#) argument that choosing a shorter event window reduces the risk of simultaneous and confounding data releases that affect FX spot prices. On the other hand, one might be interested in the persistence of FX spot price adjustments as a response to central bank communication and might choose a wider event window.

It is observable that sometimes directional price changes do not appear to be significant (or less significant) in the shorter event window but more so in the 60-minute event window. This is the case for *QE* in the USDEUR 5-minute dataset for tonal scores or the *inflation* topic in the ECB communication for the EURUSD pair. This might indicate that for specific topics, traders need more time for the information processing and trade orders are executed to a later point, resulting in a measurable lagged response in the more extended event window only. On the other hand, some directional price changes are only significant in the shorter event window but not in the 60 minute event window (for example the changes in uncertainty scores in the ECB communication for the EURCHF pair in the 1-minute dataset). This might indicate that prices revert quickly after an initial price shock.

For additional robustness, I also provide results for a 5-minute dataset. The idea behind this is to tackle issues resulting from market microstructure noise: While a larger sampling rate of data provides more data points which is in general desired from a statistical point of view, this also introduces more noisy elements in the data, which can distort and bias the econometric analysis when the sampling frequency exceeds a certain threshold. [Ait-Sahalia and Yu \(2008\)](#) mention several reasons why such noise can be found in high-frequency data. Specifically, they mention bid-ask bounce, discreteness of prices, variations in trade sizes and several other reasons as possible resources of frictions. The decision to downsample the data frequency to a per-five-minute basis is described in [Ait-Sahalia, Mykland, and Zhang \(2005\)](#). Admittedly, this choice of frequency appears to be somewhat arbitrary, and the aforementioned authors call it an "*ad-hoc*" method to tackle the problems that arises from market microstructure noise quickly. For less arbitrary improvement, [Ait-Sahalia, Mykland, and Zhang \(2005\)](#) show that it is advantageous to take the full high-frequency data into account when one models the noise explicitly, but this modelling imposes an additional source of potential errors when not carried out thoroughly. Therefore, I have decided to use the "*ad-hoc*" method and down-sampled the original dataset.

I have also tested for different feature representations that enter the LDA algorithm to develop an alternative for the textual analysis. As outlined in section 3.1.1, paragraphs enter the LDA

algorithm as vectors where each index represents a word, and the value of each entry is the simple count of the respective word within the paragraph. As an alternative, one could tweak this representation so that words that frequently appear in the corpus are down-weighted, whereas more unique words get a larger weighting (Thus, instead of counts of words, one can think of weights for the values of a document vector). This should have the advantage that more interesting words that appear only in specific topics are highlighted while words that appear in many documents are considered to be less interesting and are ignored. A simple measure for this weight is the *term-frequency inverse-document-frequency* measure (TF-IDF) that is frequently used in other topic modelling algorithms such as non-negative matrix factorization. Denoting *TFIDF* as the TF-IDF weighting and in line with the notation in [Bholat, Hansen, Santos, and Schonhardt-Bailey \(2015\)](#) *TFIDF* weighting of a term (a word or token) t is calculated as:

$$TFIDF_{t,d} = (1 + \log(f_{t,d})) \cdot \log\left(\frac{D}{df_t}\right)$$

where the term-frequency $f_{t,d}$ is simply the proportion of term t in document d :

$$TF(t, d) = \frac{\text{count of word } t \text{ in document } d}{\text{number of words in document } d}$$

and df_t denotes to the number of documents in the corpus in which word t occurs and D is the number of documents in the corpus.

I applied the TF-IDF weighting for an alternative representation of the documents but have not found that this leads to superior results (more interpretable) to the more standard *bag-of-words* representation. Table [A3](#) in the appendix displays the top words for each topic for the TF-IDF LDA model (ECB Monetary Policy Accounts corpus). Optimizing the number of topics for the coherence measure C_V suggests an optimal number of 10 topics. However, table [A3](#) shows that many topics result in meaningless or hard to interpret cluster of words, suggesting an overfit of the model where the model converges in less interpretable word distributions. That is, a higher proportion of words intrude topics whereas these words do not seem to be connected in any meaningful way to an easy to interpret topic (e.g. "*manner*" or "*amid*")².

Lastly, I implemented several regression models without any control variables to compare the regression coefficients regarding sign, magnitude and significance when control variables are excluded. The followig table in the appendix [A.6](#) summarizes tonal coefficients for the USDEUR 1-minute dataset, appendix [A.6](#) for the uncertainty scores in the 5-minute dataset of USDEUR. For the ECB communication, appendix [A.6](#) summarizes tonal score coefficients for the EURUSD in the 1-minute dataset and appendix [A.6](#) for the uncertainty scores in the EURUSD 5-minute dataset. Excluding the control variables for the FOMC communication does not change much the coefficients. Some

²I have not included the table for the top words for the TF-IDF model for the FOMC Minutes corpus here, but the model with corresponding word lists can be produced in the accompanying code. The TF-IDF model for the FOMC Minutes corpus exhibits similar issues regarding interpretability as for the ECB corpus.

differences appear however for the ECB communication where excluding control variables leads to more significant coefficients. In terms of F-statistics, regression models improve when excluding control variables.

Discussion

5.1 Limitations of LDA

Present research conducted to analyze the link between central bank communication and asset prices shows that market participants monitor central bank press releases. As discussion topics that central banks cover in their statements vary in length and tone over time, one might be interested in finding out which aspects seem more relevant for market participants and trigger FX spot price reactions. Latent Dirichlet Allocation is a practical algorithm to disentangle the unstructured content of textual data into multiple classes in an unsupervised fashion. Thus, it exhibits the advantage of being applied without labelling data and reducing bias induced by a researcher. On the downside, however, LDA does not *understand* the concept and meaning of words and sentences but is driven mainly by the statistical properties of word frequencies within documents and their spatial closeness or relatedness to other words (co-occurrences). Thus, it can be challenging to avoid results that might appear strange given an understanding of the underlying corpus and its historical context.

For example, the results for the FOMC Minutes suggest the presence of a *quantitative easing* topic even before it was launched to tackle the risks of a prolonged financial crisis in 2008. How can this be understood? LDA is a mixed-membership model (Zhang and Paisley, 2015) which has the advantage that discrete data (in this case, individual words) is not forced into one class but is attributed to all classes with varying strength of membership. This is reasonable as one could argue that certain words could indeed belong to several classes. If we think of the word "rate", this has a somewhat ubiquitous use in a central bank communication corpus and could appear in the context of monetary policy, labour market, financial market or in some growth context. Thus, the mixed membership property of LDA is in fact some needed softening of the too rigorous assumption of unilateral membership. Unfortunately, this has drawbacks when words that appear in the *QE* topic such as "market", "transactions" or "mortgage" also appear in other topics that preexist the GFC. Given that LDA observes the word "mortgage" or "market" in FOMC Minutes before 2008, these words might have a higher association to the "financial markets" or "housing market" topics, but LDA cannot rule out the presence of the *QE* topic, given these words appear. In fact, LDA will never attribute a probability of zero to any topic as all words appear in all topics

(although LDA attributes a very low probability of close to zero to the vast majority of words to appear in that topic).

Similarly, the most representative paragraphs for the *forward guidance and communication* topic for the FOMC Minutes suggest that this topic is primarily about forward guidance (see the top paragraphs for the FG and communication topic in the appendix A.1.1). However, figure 4.1 indicates some activity in this topic before 2006 that is comparable in activity to the level post 2012. Of course, this does not mean that forward guidance was already used before the GFC, but rather, the FOMC was already concerned about language and communication around the turn of the millennium and shortly thereafter. Given the fact that these early communication paragraphs and the later forward guidance paragraphs use the same words, this explains the activity of a *communication* topic throughout the sample period. The following are the two paragraphs before 2005 that exhibit the highest proportion in the communication topic:

“With inflation low and resource use slack, the Committee saw no need for tightening policy in the near future. However, to provide additional flexibility to adjust monetary policy at a later date once such action was deemed appropriate given economic developments, the Committee removed from its post-meeting statement the explicit reference to a “considerable period” and substituted a statement that conveyed the sense that it could be patient in removing its policy accommodation.”

– FOMC Meeting Minutes (released 06.05.2004)

“Views differed with regard to the reference in recent statements to maintaining an accommodative monetary policy “for a considerable period.” A number of members argued that its deletion would serve to enhance the Committee’s flexibility to adjust monetary policy at a later date when that was deemed appropriate on the basis of evolving economic circumstances. A majority, however, preferred to retain the phrase, at least for now. They noted that the changes in their assessment of risk would convey the evolving views of the Committee and they believed the “considerable period” reference still accurately conveyed the Committee’s policy intentions. Given the decision to retain the reference in question, all the members saw merit in associating it more clearly with economic conditions, specifically the persistence of quite low inflation and slack in resource use, as opposed to having it appear to be linked only to the passage of time.”

– FOMC Meeting Minutes (released 29.01.2004)

This issue highlights the difficulty of interpreting and pinning down what type of semantic content might provoke which market reaction when discussions have a high resemblance to each other and share a similar vocabulary set. LDA is able to disentangle topics well when the words in each topic are hardly interchangeable and belong uniquely to a topic (for example, there is a high chance that a topic is about inflation when the words *inflation* or *CPI* occur), but it falls short when topics change dynamically and might emerge over time (such as *forward guidance*). This issue is aggravated when topics share their top words with other topics.

5.2 Embedding of results in the related literature

Why does central bank communication move asset prices? This seems especially puzzling given the fact that I have looked into central bank communication that is released with a lag of several weeks from the press conference and monetary policy statements that immediately follow FOMC and ECB council meetings. On the release day, the key news, such as policy rates and new adjustments in the pace of asset purchase programmes, should already have entered the market. [Jegadeesh and Wu \(2017\)](#) who analyzed FOMC Minutes devoted a section to exactly this question. Their main line of argumentation is that central banks possess a *superior* knowledge set given the amount of non-public data that central banks monitor. While it is unlikely that any precise and quantitative clues and statements are spilt into the market due to confidentiality, [Jegadeesh and Wu \(2017\)](#) argue that it is still possible that this superior knowledge spills into the market in the form of *soft* data, hidden in natural language, when central bank decision-makers talk about the economic assessment and express their views.

Research of why central bank communication affects FX spot prices has been mainly conducted in the context of an assessment for central bank FX interventions (section 2.2). Thereby, explanations through which communication affects prices are rooted in theory regarding a signalling or coordination channel (section 2.1). However, both central banks that I cover in this thesis have abandoned active FX interventions around the turn of the millennium ([Fratzscher, 2005](#)). The question arises why central bank communication is still extensively monitored by market participants and provokes FX spot price reactions. A possible explanation might be that given the use of forward guidance and an ongoing balance sheet buildup due to extensive asset purchase programmes, central banks have steadily become a more and more influential player in the global financial market. They move asset prices by both monetary policy decisions and by providing large demand for securities and driving yields down in the market when a currency area is already confined by the ZLB.

This link between central bank communication and interest rates was the subject of research in [Hansen and Tong \(2019\)](#) who showed that communication affects long-term interest rates through *uncertainty* signals that influence term-premia. While my methodological framework of capturing uncertainty in central bank communication is less theoretical than in [Hansen and Tong \(2019\)](#), my approach allows constructing a more generic proxy for uncertainty within individual topics over time. My results are in line with [Hansen and McMahon \(2016\)](#) as I find that increasing uncertainty in central bank communication significantly affects currency pairs' spot prices. My results suggest that markets are especially susceptible to uncertainty relating Asset Purchase Programmes.

Other explanations why central bank communication affects asset prices is provided by [Nakamura and Steinsson \(2018\)](#) and [Cieslak and Schrimpf \(2019\)](#). [Nakamura and Steinsson \(2018\)](#) conclude that central banks do not only influence market participants' expectations regarding the future monetary policy decisions but also regarding the economic outlook, whereas this second *information*

channel is able to move long-term yields and asset prices, respectively. [Cieslak and Schrimpf \(2019\)](#) support these findings by concluding that financial markets react to non-monetary news, especially during crises. Thus, central bank communication can indeed serve as a coordination device when the ZLB limits traditional policy tools such as interest rates.

While I have not classified text into monetary versus non-monetary news analogous to [Cieslak and Schrimpf \(2019\)](#), I argue that my findings do support the results of [Nakamura and Steinsson \(2018\)](#) and [Cieslak and Schrimpf \(2019\)](#) nevertheless. As I analyzed financial markets' reaction to FOMC Meeting Minutes and ECB Monetary Policy Accounts - both of which are released with a lag of several weeks from the corresponding meeting - news regarding monetary policy should already have entered the market as the Fed and ECB announce rate and APP decisions shortly after the meeting was held on the same meeting day. As Fed statements and ECB statements released subsequently to any meeting are kept very short but include any relevant monetary policy decision, what is left in the FOMC Minutes and ECB Monetary Policy Accounts as *news* are the council's (or committee's) discussion regarding economic fundamentals and financial markets. In the words of [Rosa \(2018\)](#): "The FOMC minutes contain a more complete and nuanced discussion of the rationale for the Committee's decision and view of the risks to the outlook than was possible in the post-meeting announcement" ([Rosa \(2018\)](#), p.230).

Although this type of *Delphic* discussions seem outdated to the time of publication of FOMC Minutes and ECB Policy Accounts weeks later, I find significant market reactions during the studied event windows, which might hint that market participant (partly) revise their expectations upon the release of FOMC Minutes and ECB Policy Accounts. This indicates that central banks can align private-sector expectations via non-monetary policy-related news, and communication serves as a coordination device. My results suggest that in the case of FX spot prices, this mechanism works through a risk-based channel that affects market participants' expectations through uncertainty in communication (described by [Hansen and Tong \(2019\)](#) and [Schmeling and Wagner \(2019\)](#)).

However, the type of communication in my analysis exhibits a high degree of *Delphic* central bank discussion ([Campbell, Evans, Fisher, Justiniano, Calomiris, and Woodford, 2012](#)) which is why the presence of an *information* channel (described by [Nakamura and Steinsson \(2018\)](#) and [Romer and Romer \(2000\)](#)) within the FX market cannot be ruled out, especially given the fact that at the time of release, any monetary policy-related news should already be priced in. Yet, it should be noted that [Hoesch, Rossi, and Sekhposyan \(2020\)](#) tested empirically for the presence of the information channel. They conclude that the information channel has disappeared since the mid 2000s in the case of Fed communication as the Fed's forecasts of economic fundamentals does not outperform the private sector's forecasts. [Hoesch, Rossi, and Sekhposyan \(2020\)](#) argue that improved communication strategies and a trend towards transparency has led to the disappearance of the information channel.

For the Euro Area, [Andrade and Ferroni \(2021\)](#) analyze the ECB's communication and propose a methodology to differentiate between *Odysean* and *Delphic* shocks. They find that *Delphic* shocks affect inflation expectations and stock market prices and that this effect is more persistent than for *Odysean* shocks. My results complement the findings of [Andrade and Ferroni \(2021\)](#) in the

sense that I find evidence that at least for the FX market and for developed markets, the ECB's discussion regarding inflation and financial markets is monitored and affects spot prices.

Conclusion

This thesis analyzed central bank communication with respect to its semantic content by measuring the uncertainty and tonal sentiment within multiple discussion topics. The analysis was conducted by using unsupervised topic modelling and combining it with lexical sentiment analysis. I propose an optimization for a coherence measure from the information retrieval literature to enhance the interpretability of machine learning-based document classification results. In a second step, these extracted textual variables were used in a regression setting to assess the announcement effect of central bank communication on FX spot prices. The results indicate that foreign exchange spot prices react to central bank communication: I find that currency pairs of developed currencies are primarily affected by news regarding market-related topics such as domestic and foreign financial markets and especially asset purchase programmes. Discussion about monetary policy related topics such as inflation and interest rates seems to matter primarily for developed market currencies in the case of ECB communication. On the other hand, for currency pairs involving an emerging market currency, topics that are more anchored within economic fundamentals (business activity & growth) seem to be more relevant. Further research could elaborate on this difference in the reaction behaviour between currency pairs of developed countries and emerging markets. Further research could also adopt the methodology proposed in this thesis to assess the reaction of long-term interest rates to central bank communication. Given that one would find that long-term interest rates react to uncertainty within non-monetary policy-related topics, this would reconcile the results from [Nakamura and Steinsson \(2018\)](#) and [Hansen and Tong \(2019\)](#).

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Appendix

A.1 Most relevant paragraphs per topic

In the following I provide the two most prominent paragraphs per topic. That is, the following paragraphs exhibit the strongest membership to the respective corresponding topic. As discussed in section 3.1.2, LDA outputs a k -dimensional vector with the topic weights for each individual text document (in the case of this thesis, for each paragraph) where k is the number of topics. Here I show the two paragraphs in the corpus that return the highest topic weight in the corresponding topic in order to justify my topic labeling as the following paragraphs can be interpreted as the most characteristic paragraphs for the respective topic.

A.1.1 FOMC topics

Foreign Markets

The foreign exchange value of the dollar, which depreciated immediately following the FOMC's November announcement of further asset purchases, subsequently appreciated amid intensifying concerns about stresses in the euro area and some apparent reassessment by investors of the monetary policy outlook in the United States. On net, the dollar ended the intermeeting period up against most currencies, with particularly large gains against the euro. The announcement of the European Union (EU)-International Monetary Fund (IMF) financial aid package for Ireland on November 28 did little to reverse the depreciation of the euro, as investors reportedly became increasingly concerned about other euro-area economies and the adequacy of resources available to support them should they come under stress. Spreads of sovereign yields in some peripheral euro-area countries over those on German bunds rose to new highs, although they fell back near the end of the intermeeting period amid reports that the European Central Bank (ECB) had increased its purchases of Irish and Portuguese sovereign debt. Banks in the euro-area periphery continued to rely heavily on funding from the ECB, and some signs of increased dollar funding pressures emerged. Implied short-term interest rates for the coming year shifted down in the euro area, as market participants apparently scaled back the pace at which they expected the ECB to normalize policy, but rose in some other AFEs. Ten-year sovereign yields increased significantly throughout the AFEs, although by less than yields in the United States. Headline stock price indexes in the AFEs generally ended the period higher, whereas bank stocks in Europe declined.

Minute released on 04.01.2017, topic score: 0.822602

Over the intermeeting period, movements in foreign financial markets were driven by central bank communications in the United States and abroad, geopolitical risks, and changes in investors' perceptions about future U.S. fiscal and other government policies. Concerns about the outcome of the French presidential election and tensions in the Korean peninsula pushed down 10-year sovereign yields in the advanced economies for several weeks. Sentiment improved following the outcome of the first round of the French presidential election on April 23, which led to a partial retracement in yields. At their meetings on April 27, the European Central Bank and the Bank of Japan each left their policy stance unchanged. On net, foreign yields declined somewhat less than U.S. yields, contributing to a modest depreciation of the dollar against both the AFE and EME currencies. Equity indexes in most advanced and emerging economies rose. Flows to emerging market mutual funds remained strong, and spreads on emerging market debt were little changed.

Minute released on 24.05.2017, topic score: 0.805327

Business Spending

Growth in real private expenditures for business equipment and intellectual property looked to have picked up solidly in the fourth quarter. Nominal shipments of nondefense capital goods excluding aircraft rose, on balance, in October and November, while information on shipments for December was delayed; available indicators of transportation equipment spending in the fourth quarter were strong. Forward-looking indicators of business equipment spending—such as orders for nondefense capital goods excluding aircraft and readings on business sentiment—pointed to somewhat slower spending gains in the near term. Data on nominal business expenditures for nonresidential structures outside of the drilling and mining sector in November were not available. The number of crude oil and natural gas rigs in operation—an indicator of business spending for structures in the drilling and mining sector—was roughly flat in December and through most of January.

Minute released on 20.02.2019, topic score: 0.8536

Growth in real private expenditures for business equipment and intellectual property appeared to be moderating a little in the third quarter following strong gains in expenditures in the first half of the year. Nominal shipments of nondefense capital goods excluding aircraft rose briskly in July, although spending for transportation equipment investment moved down in recent months. Forward-looking indicators of business equipment spending—such as increases in new and unfilled capital goods orders, along with upbeat readings on business sentiment from national and regional surveys—pointed to robust gains in equipment spending in the near term. Nominal business expenditures for nonresidential structures outside of the drilling and mining sector declined in July, and the number of crude oil and natural gas rigs in operation—an indicator of business spending for structures in the drilling and mining sector—held about steady in recent weeks.

Minute released on 17.10.2018, topic score: 0.852487

Quantitative Easing

At the conclusion of the discussion, the Committee voted to authorize and direct the Federal Reserve Bank of New York, until it was instructed otherwise, to execute transactions in the System Account in accordance with the following domestic policy directive: "The Federal Open Market Committee seeks monetary and financial conditions that will foster price stability and promote sustainable growth in output. To further its long-run objectives, the Committee seeks conditions in reserve markets consistent with federal funds trading in a range from 0 to 1/4 percent. The Committee directs the Desk to continue the maturity extension program it began in September to purchase, by the end of June 2012, Treasury securities with remaining maturities of approximately 6 years to 30 years with a total face value of \$400 billion, and to sell Treasury securities with remaining maturities of 3 years or less with a total face value of \$400 billion. The Committee also directs the Desk to maintain its existing policies of rolling over maturing Treasury securities into new issues and of reinvesting principal payments on all agency debt and agency mortgage-backed securities in the System Open Market Account in agency mortgage-backed securities in order to maintain the total face value of domestic securities at approximately \$2.6 trillion. The Committee directs the Desk to engage in dollar roll transactions as necessary to facilitate settlement of the Federal Reserve's agency MBS transactions. The System Open Market Account Manager and the Secretary will keep the Committee informed of ongoing developments regarding the System's balance sheet that could affect the attainment over time of the Committee's objectives of maximum employment and price stability."

Minute released on 15.02.2012, topic score: 0.859035

At the conclusion of the discussion, the Committee voted to authorize and direct the Federal Reserve Bank of New York, until it was instructed otherwise, to execute transactions in the System Account in accordance with the following domestic policy directive: "The Federal Open Market Committee seeks monetary and financial conditions that will foster price stability and promote sustainable growth in output. To further its long-run objectives, the Committee seeks conditions in reserve markets consistent with federal funds trading in a range from 0 to 1/4 percent. The Committee directs the Desk to continue the maturity extension program it announced in June to purchase Treasury securities with remaining maturities of 6 years to 30 years with a total face value of about \$267 billion by the end of December 2012, and to sell or redeem Treasury securities with remaining maturities of approximately 3 years or less with a total face value of about \$267 billion. For the duration of this program, the Committee directs the Desk to suspend its policy of rolling over maturing Treasury securities into new issues. The Committee directs the Desk to maintain its existing policy of reinvesting principal payments on all agency debt and agency mortgage-backed securities in the System Open Market Account in agency mortgage-backed securities. The Desk is also directed to begin purchasing agency mortgage-backed securities at a pace of about \$40 billion per month. The Committee directs the Desk to engage in dollar roll and coupon swap transactions as necessary to facilitate settlement of the Federal Reserve's agency MBS transactions. The System Open Market Account Manager and the Secretary will keep the Committee informed of ongoing developments regarding the System's balance sheet that could affect the attainment over time of the Committee's objectives of maximum employment and price stability."

Minute released on 04.10.2012, topic score: 0.857395

Economic Outlook

Members noted that they would continue to monitor the implications of incoming information for the economic outlook, including information related to public health as well as global developments and muted inflation pressures, and that the Committee would use its tools and act as appropriate to support the economy. Members observed that, in determining the timing and size of future adjustments to the stance of monetary policy, the Committee would assess realized and expected economic conditions relative to its maximum-employment objective and its symmetric 2 percent inflation objective. They also agreed that those assessments would take into account a wide range of information, including measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial and international developments.

Minute released on 08.04.2020, topic score: 0.805938

Members agreed that they would continue to monitor the implications of incoming information for the economic outlook, including information related to public health, as well as global developments and muted inflation pressures, and would use the Committee's tools and act as appropriate to support the economy. In determining the timing and size of future adjustments to the stance of monetary policy, members noted that they would assess realized and expected economic conditions relative to the Committee's maximum employment objective and its symmetric 2 percent inflation objective. This assessment would take into account a wide range of information, including measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial and international developments.

Minute released on 20.05.2020, topic score: 0.802916

Labour Market

Total nonfarm payroll employment increased solidly in December, and the national unemployment rate remained at 4.1

percent. The unemployment rates for Hispanics, for Asians, and for African Americans were lower than earlier in the year and close to the levels seen just before the most recent recession. The national labor force participation rate held steady in December; relative to the declining trend suggested by an aging population, this sideways movement in the participation rate represented a further strengthening in labor market conditions. The participation rate for prime-age (defined as ages 25 to 54) men edged up in December, while the rate for prime-age women declined slightly. The share of workers who were employed part time for economic reasons was little changed in December and was close to its pre-recession level. The rates of private-sector job openings and quits were little changed in November, and the four-week moving average of initial claims for unemployment insurance benefits continued to be at a low level in mid-January. Recent readings showed that gains in hourly labor compensation remained modest. Both the employment cost index for private-sector workers and average hourly earnings for all employees rose about 2-1/2 percent over the 12 months ending in December.
Minute released on 21.02.2018, topic score: 0.876403

Total nonfarm payroll employment recorded a strong gain in March, and the unemployment rate held steady at 3.8 percent. The labor force participation rate declined a little in March after having risen, on balance, in the previous few months, and the employment-to-population ratio edged down. The unemployment rates for African Americans, Asians, and Hispanics in March were at or below their levels at the end of the previous economic expansion, though persistent differentials in unemployment rates across groups remained. The share of workers employed part time for economic reasons edged up in March but was still below the lows reached in late 2007. The rate of private-sector job openings in February declined slightly from the elevated level that prevailed for much of the past year, while the rate of quits was unchanged at a high level; the four-week moving average of initial claims for unemployment insurance benefits through mid-April was near historically low levels. Average hourly earnings for all employees rose 3.2 percent over the 12 months ending in March, a somewhat faster pace than a year earlier. The employment cost index for private-sector workers increased 2.8 percent over the 12 months ending in March, the same as a year earlier.
Minute released on 22.05.2019, topic score: 0.874384

Trade & Consumption

The U.S. international trade deficit narrowed slightly in September as an increase in exports more than offset higher imports. The September gain in exports primarily reflected higher exports of goods; services exports recorded moderate growth. Exports of agricultural products exhibited particularly robust growth, with both higher prices and greater volumes. Exports of industrial supplies and consumer goods also moved up smartly in September. Automotive products exports, in contrast, were flat, and capital goods exports fell, led by a decline in aircraft. The increase in imports primarily reflected higher imports of capital goods, with imports of computers showing particularly strong growth. Imports of automotive products, consumer goods, and services also increased. Imports of petroleum, however, were flat, and imports of industrial supplies fell.
Minute released on 02.01.2008, topic score: 0.845789

The U.S. international trade deficit widened slightly in October and then more substantially in November, as increases in imports in both months more than offset increases in exports. The increases in imports almost entirely reflected a jump in the value of imported oil. Non-oil goods imports were boosted by a large increase in imports of consumer goods and small increases in several other categories, which more than offset a steep decline in imports of non-oil industrial supplies. Imports of automotive products and capital goods recorded modest gains, with the increase in capital goods primarily reflecting a jump in imports of telecommunications equipment. Imports of services grew strongly. Exports in both months were boosted by higher exports of services. Exports of industrial supplies also recorded a strong gain, aided by a large increase in exports of fuels in November. Higher exports of semiconductors, aircraft, and machinery pushed up exports of capital goods, while exports of agricultural goods increased only slightly following a large jump in the third quarter. In contrast, exports of consumer goods fell from their third-quarter level.
Minute released on 20.02.2008, topic score: 0.843641

Communication & Forward Guidance

Committee participants discussed possible changes to the forward guidance that has been included in the Committee's recent post-meeting statements. Many participants thought it important to explore means for better communicating policy-makers' thinking about future monetary policy and its relationship to evolving economic conditions. A couple of participants expressed concern that some press reports had misinterpreted the Committee's use of a date in its forward guidance as a commitment about its future policy decisions. Several participants thought it would be helpful to provide more information about the economic conditions that would be likely to warrant maintaining the current target range for the federal funds rate, perhaps by providing numerical thresholds for the unemployment and inflation rates. Different opinions were expressed regarding the appropriate values of such thresholds, reflecting different assessments of the path for the federal funds rate that would likely be appropriate to foster the Committee's longer-run goals. However, some participants worried that such thresholds would not accurately or effectively convey the Committee's forward-looking approach to monetary policy and thus would pose difficult communications issues, or that movements in the unemployment rate, by themselves, would be an unreliable measure of progress toward maximum employment. Several participants proposed either dropping or greatly simplifying the forward guidance in the Committee's statement, arguing that information about participants' assessments of the appropriate future level of the federal funds rate, which would henceforth be contained in the Summary of Economic Projections (SEP), made it unnecessary to include forward guidance in the post-meeting statement. However, several other participants emphasized that the information regarding the federal funds rate in the SEP could not substitute for a formal decision of the members of the FOMC. Participants agreed to continue exploring approaches for providing the public with greater clarity about the linkages between the economic outlook and the Committee's monetary policy decisions.
Minute released on 15.02.2012, topic score: 0.855366

Participants also discussed how the forward-guidance language might evolve once the Committee decides that the current formulation no longer appropriately conveys its intentions about the future stance of policy. Most participants indicated a preference for clarifying the dependence of the current forward guidance on economic data and the Committee's assessment of progress toward its objectives of maximum employment and 2 percent inflation. A clarification along these lines was seen as likely to improve the public's understanding of the Committee's reaction function while allowing the Committee to retain flexibility to respond appropriately to changes in the economic outlook. One participant favored using a numerical

threshold based on the inflation outlook as a form of forward guidance. A few participants, however, noted the difficulties associated with expressing forward guidance in terms of numerical thresholds for some set of economic variables. Another participant indicated a preference for reducing reliance on explicit forward guidance in the statement and conveying instead guidance regarding the future stance of monetary policy through other mechanisms, including the SEP. It was noted that providing explicit forward guidance regarding the future path of the federal funds rate might become less important once a highly accommodative stance of policy is no longer appropriate and the process of policy normalization is well under way. It was generally agreed that when changes to the forward guidance become appropriate, they will likely present communication challenges, and that caution will be needed to avoid sending unintended signals about the Committee's policy outlook.

Minute released on 08.10.2014, topic score: 0.822215

Housing Market

The underlying pace of residential activity seemed to moderate in the first quarter. After unseasonably warm weather allowed a high level of single-family housing starts in January and February, starts fell in March to their lowest level in a year. New permit issuance for single-family homes also fell in March, continuing its downward trend. Multifamily starts recovered a bit in March from their low rate in February but remained well within their historical range. Home sales also declined, on net, in recent months. Although sales of existing single-family homes edged up in February and March, the level of sales for the first quarter as a whole was notably below the record high in the second quarter of last year. Sales of new homes also moved up in March, but their average in the first quarter was down substantially from the peak in the third quarter of last year. House price appreciation appeared to have slowed from the elevated rates seen over the past summer. Growth in the average sales price of existing homes in March, versus a year earlier, decelerated sharply, and the average price for new homes in March fell compared to a year earlier. In addition, other indicators, such as months' supply of both new and existing homes for sale and the index of pending home sales, supported the view that housing markets had cooled in recent months.

Minute released on 31.05.2006, topic score: 0.848328

Data from the housing sector indicated that a gradual recovery in activity was under way. Although single-family housing starts fell modestly in August, this decrease followed five consecutive monthly increases, and the number of starts in August was well above the record low reached in the first quarter of the year. In contrast, in the much smaller multifamily sector, where credit conditions were still particularly tight and vacancy rates remained high, starts continued to be down, on net, in 2009 after a significant fall in the second half of 2008. The sales data for July indicated further increases in the demand for both new and existing single-family homes. Even though new home sales remained modest, they had been sufficient, given the slow pace of construction, to pare the overhang of unsold new single-family houses: In July, the level of inventories of such homes was about one-half of its peak in the summer of 2006, and the months' supply had fallen considerably from its record high in January. Sales of existing homes in July were at their fastest pace since mid-2007, and pending home sales agreements suggested that resale activity would rise further in following months. Although sales of distressed properties remained elevated, the rise in total sales of existing homes over the summer appeared to have been driven by an increase in transactions involving nondistressed properties. The apparent modest strengthening of housing demand was likely due, in part, to improvements in housing affordability stemming from low interest rates for conforming mortgages, a lower level of house prices, and possibly the first-time homebuyer tax credit. In addition, demand may have been buoyed by a sense that house prices were beginning to stabilize. Through the end of the second quarter, many house price indexes had smaller year-over-year declines than they had shown earlier this year, and some indexes recorded positive changes for the second quarter.

Minute released on 14.10.2009, topic score: 0.846465

Money Market

Next, the staff outlined two proposals that the Committee could consider for further testing of RRP operations. In the first proposal, the Desk would vary by modest amounts the interest rate on ON RRP operations according to a preannounced schedule. Varying the spread between the ON RRP rate and the interest on excess reserves rate could provide the Committee with information about the effect of that spread on money markets and the demand for ON RRP. In addition, changes in the ON RRP rate would provide further information about the effectiveness of an ON RRP facility in providing a floor for money market rates during policy normalization. In the second proposal, the Desk would conduct a series of preannounced term RRP operations that would extend across the end of the year. In their discussion of term RRP testing, participants noted that the testing could provide information about the potential effectiveness of another of the Committee's supplementary policy tools and would help address expected downward pressures on short-term rates at year-end. But it was also noted that by conducting the term RRPs, the Committee would be losing information on how market participants might adjust and make investment arrangements prior to year-end with only the \$300 billion in ON RRP available. One participant commented that the downward pressure on rates at year-end might be more directly addressed by raising the overall size limit on the ON RRP exercise. However, it was emphasized that increasing the cap on ON RRP operations at year-end could raise the risks for financial markets that had led the FOMC to impose the cap; these concerns were seen as less pronounced with a temporary program of term RRP operations. It was also noted that the proposed term RRP operations were only a test and that the Committee had not yet decided the conditions under which such operations would be used in the future.

Minute released on 19.11.2014, topic score: 0.889301

A staff briefing outlined two proposals that the Committee could consider for further testing of term RRP operations. In the first of these proposals, the Desk would conduct a series of preannounced term RRP operations that would span the end of the first quarter. In the second proposal, the Desk would conduct small term RRP operations in February and early March, in addition to the quarter-end option presented in the first proposal. In their discussion of term RRP testing, participants noted that the testing could provide further information about the substitutability between the ON and term RRP operations, including outside year-end and quarter-end periods. A number of participants emphasized that, even if the Committee conducted additional tests, it had not yet decided whether to use term RRP operations as part of policy normalization.

Minute released on 18.02.2015, topic score: 0.878748

Financial Markets

Liquidity in the corporate bond market improved over the intermeeting period, with increases in trading volume for both investment- and speculative-grade bonds and declines in bid-asked spreads for speculative-grade bonds. Yields and spreads on corporate bonds decreased noticeably, particularly for speculative-grade firms, but spreads remained high by historical standards. Gross issuance of bonds by nonfinancial investment-grade companies remained solid, but issuance of speculative-grade bonds was limited. Conditions in the leveraged loan market remained very poor and issuance of leveraged syndicated loans was also very weak. Secondary market prices for leveraged loans stayed near record lows and the average bid-asked spread in that market continued to be very wide. The market for commercial mortgage-backed securities (CMBS) continued to show signs of strain, with the CMBX index—an index based on credit default swap (CDS) spreads on AAA-rated CMBS—widening during the intermeeting period from already very elevated levels.

Minute released on 18.02.2009, topic score: 0.8414

Financing conditions for nonfinancial firms remained accommodative, on balance, with corporate borrowing costs staying near historical lows during the intermeeting period. Gross issuance of investment-grade corporate bonds was subdued in January and December after surging in November. Issuance of speculative-grade bonds over the intermeeting period remained about in line with the average pace over December and January in recent years. Institutional leveraged loan issuance continued to be robust in December, reflecting solid refinancing activity and moderate new money issuance. Meanwhile, commercial and industrial (CI) loans on banks' balance sheets contracted in the fourth quarter. Respondents to the January 2020 Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) reported that borrower demand weakened for CI loans over the fourth quarter, and lending standards on such loans were little changed. Gross equity issuance through seasoned offerings remained robust in December, while initial public offerings continued to be quite light. The credit quality of nonfinancial corporations and the earnings outlook remained generally stable in recent months. Credit conditions for both small businesses and municipalities remained accommodative on net.

Minute released on 19.02.2020, topic score: 0.838624

Growth

The staff continued to view the uncertainty around its projections for real GDP growth, the unemployment rate, and inflation as generally similar to the average of the past 20 years. The staff viewed the downside risks to economic activity as having eased a bit since the previous forecast but still judged that the risks to the forecast for real GDP growth were tilted to the downside, with a corresponding skew to the upside for the unemployment rate. Important factors influencing this assessment were that international trade tensions and foreign economic developments seemed more likely to move in directions that could have significant negative effects on the U.S. economy than to resolve more favorably than assumed. In addition, softness in business investment and manufacturing production so far this year were seen as pointing to the possibility of a more substantial slowing in economic growth than the staff projected. The risks to the inflation projection were also viewed as having a downward skew, in part because of the downside risks to the forecast for economic activity.

Minute released on 03.01.2020, topic score: 0.816224

The staff continued to view the uncertainty around its projections for real GDP growth, the unemployment rate, and inflation as generally similar to the average of the past 20 years. The staff viewed the downside risks to economic activity as having diminished a bit further since the previous forecast but still judged that the risks to the forecast for real GDP growth were tilted to the downside, with a corresponding skew to the upside for the unemployment rate. Important factors influencing this assessment were that foreign economic and geopolitical developments still seemed more likely to move in directions that could have significant negative effects on the U.S. economy than to resolve more favorably than assumed. In addition, softness in business investment and manufacturing production last year, as well as the recent weakness in imports, was seen as pointing to the possibility of a more substantial slowing in economic growth than the staff projected. The risks to the inflation projection were also viewed as having a downward skew, in part because of the downside risks to the forecast for economic activity.

Minute released on 19.02.2020, topic score: 0.808072

Inflation

The staff continued to view the uncertainty around its projections for real GDP growth, the unemployment rate, and inflation as generally similar to the average of the past 20 years. The staff viewed the downside risks to economic activity as having eased a bit since the previous forecast but still judged that the risks to the forecast for real GDP growth were tilted to the downside, with a corresponding skew to the upside for the unemployment rate. Important factors influencing this assessment were that international trade tensions and foreign economic developments seemed more likely to move in directions that could have significant negative effects on the U.S. economy than to resolve more favorably than assumed. In addition, softness in business investment and manufacturing production so far this year were seen as pointing to the possibility of a more substantial slowing in economic growth than the staff projected. The risks to the inflation projection were also viewed as having a downward skew, in part because of the downside risks to the forecast for economic activity.

Minute released on 12.10.2016, topic score: 0.875565

The staff continued to view the uncertainty around its projections for real GDP growth, the unemployment rate, and inflation as generally similar to the average of the past 20 years. The staff viewed the downside risks to economic activity as having diminished a bit further since the previous forecast but still judged that the risks to the forecast for real GDP growth were tilted to the downside, with a corresponding skew to the upside for the unemployment rate. Important factors influencing this assessment were that foreign economic and geopolitical developments still seemed more likely to move in directions that could have significant negative effects on the U.S. economy than to resolve more favorably than assumed. In addition, softness in business investment and manufacturing production last year, as well as the recent weakness in imports, was seen as pointing to the possibility of a more substantial slowing in economic growth than the staff projected.

The risks to the inflation projection were also viewed as having a downward skew, in part because of the downside risks to the forecast for economic activity.

Minute released on 09.10.2019, topic score: 0.873766

A.1.2 ECB topics

Financial Markets

With regard to financial conditions and the monetary policy stance, members broadly shared the assessments provided by Ms Schnabel and Mr Lane in their introductions. While financial market conditions had continued to normalise since the July monetary policy meeting, with valuations of risky assets across the globe continuing to recover, the easing trend in financial conditions had been partly counteracted by the appreciation of the euro. Euro area sovereign and corporate bond yield spreads had narrowed further, while equity prices, notwithstanding some weakening in bank stocks, had remained resilient overall on the back of favourable global risk sentiment and supportive monetary and fiscal policies. It was, however, cautioned that although low equity valuations in some sectors reflected investor expectations of an extended impact of the pandemic, overall stock prices still appeared to be highly valued, for example when looking at measures such as cyclically adjusted price-to-earnings ratios. This pointed to the possibility of volatility or corrections in stock markets in the period ahead, as seen in US stock markets in the days preceding the September Governing Council meeting. At the same time, since the July Governing Council meeting the euro exchange rate had appreciated significantly against almost all advanced and emerging market currencies, reflecting in part positive risk sentiment towards the euro area, which was also supported by the agreement on the NGEU plan as well as relative monetary policy configurations in major jurisdictions. In this context, the risk of a further euro appreciation was seen as partly linked to market perceptions of the scope for further changes in monetary policy in different jurisdictions. Against this background, it was considered important to avoid complacency and the perception among investors that the direction of exchange rate movements was a one-way bet.

Accounts released on 08.10.2020, topic score: 0.766967

In this context, it was remarked that bank stock prices had been continuously declining, with low bank valuations being evident in very low price-to-book ratios. While banks had increased their provisions in view of higher expected losses, the point was made that low bank valuations could reflect a weak profitability outlook as well as doubts among investors about the quality of bank balance sheets and the adequacy of the level of provisions given expected increases in firm defaults and bankruptcies. It was also cautioned that sovereign exposures of banks had risen again since the start of the crisis, giving rise to renewed concerns about the tight nexus between banks and sovereigns. Overall, it was important to monitor the transmission of monetary policy carefully, to ensure that the liquidity injected was directed towards funding the real economy and to avoid unduly fuelling financial asset prices and reinforcing the bank-sovereign nexus.

Accounts released on 08.10.2020, topic score: 0.756861

Asset Purchase Programmes

Regarding non-standard monetary policy measures, the Governing Council confirmed that purchases under the APP would continue at the current monthly pace of 60 billion Euros until the end of December 2017 and that, from January 2018, it intended to continue to make net asset purchases at a monthly pace of 30 billion Euros, until the end of September 2018, or beyond, if necessary, and in any case until the Governing Council saw a sustained adjustment in the path of inflation consistent with its inflation aim. If the outlook became less favourable, or if financial conditions became inconsistent with further progress towards a sustained adjustment in the path of inflation, the Governing Council stood ready to increase the APP in terms of size and/or duration. The Eurosystem would reinvest the principal payments from maturing securities purchased under the APP for an extended period of time after the end of its net asset purchases, and in any case for as long as necessary. This would contribute both to favourable liquidity conditions and to an appropriate monetary policy stance.

Accounts released on 11.01.2018, topic score: 0.872541

With regard to non-standard monetary policy measures, the Governing Council confirmed that the net asset purchases, at the new monthly pace of 30 billion Euros, were intended to run until the end of September 2018, or beyond, if necessary, and in any case until the Governing Council saw a sustained adjustment in the path of inflation consistent with its inflation aim. If the outlook became less favourable, or if financial conditions became inconsistent with further progress towards a sustained adjustment in the path of inflation, the Governing Council stood ready to increase the APP in terms of size and/or duration. The Eurosystem would reinvest the principal payments from maturing securities purchased under the APP for an extended period of time after the end of its net asset purchases, and in any case for as long as necessary. This would contribute both to favourable liquidity conditions and to an appropriate monetary policy stance.

Accounts released on 22.02.2018, topic score: 0.857251

Interest Rates

The conditions on the targeted longer-term refinancing operations (TLTRO III) would be further eased. Specifically, the Governing Council decided to reduce the interest rate on TLTRO III operations during the period from June 2020 to June 2021 to 50 basis points below the average interest rate on the Eurosystem's main refinancing operations prevailing over the same period. Moreover, for counterparties whose eligible net lending reached the lending performance threshold, the interest rate over the period from June 2020 to June 2021 would now be 50 basis points below the average deposit facility rate prevailing over the same period.

Accounts released on 22.05.2020, topic score: 0.833451

Regarding the modalities of the new series of quarterly TLTROs, the Governing Council decided that the interest rate in each operation would be set at a level that is 10 basis points above the average rate applied in the Eurosystem's main refinancing operations over the life of the respective TLTRO. For banks whose eligible net lending were to exceed a benchmark, the rate applied in TLTRO III would be lower and could be as low as the average interest rate on the deposit facility prevailing over the life of the operation plus 10 basis points. Further modalities would be set out in a technical press release to be published at the end of the press conference.

Accounts released on 11.07.2019, topic score: 0.832549

Trade & Global Economy

In considering the outlook and risks for the external environment, members took note of the further slowdown in global growth and trade momentum. In particular, there were concerns about the potential impact of trade protectionism on the global outlook and the ongoing risk of an escalation of trade conflicts. Reference was made in the discussion to a number of factors, including the impact of trade tensions between the United States and China, the threat posed by a trade dispute between the European Union and the United States, and the risks surrounding a disorderly withdrawal of the United Kingdom from the European Union. Attention was also drawn to the slowdown in growth in China, as well as developments in the US economy, which was expected to slow as a result of the waning effect of the fiscal package. Against this background, the risks to the external environment were assessed to be on the downside, on account of the persistence of uncertainties related to geopolitical factors, the threat of protectionism and vulnerabilities in emerging markets.

Accounts released on 04.04.2019, topic score: 0.885731

In considering the outlook and risks for the external environment, members noted that global growth and trade momentum had slowed further. In particular, there were concerns among members about an increasing impact of trade protectionism, and an escalation of trade conflicts, on the global outlook over time. It was noted that Chinese imports at the end of 2018 had been much lower than expected, which likely reflected the negative impact of trade tensions between the United States and China. In addition, acute risks remained surrounding the United Kingdom's withdrawal from the EU. It was widely agreed that uncertainties and risks related to geopolitical factors, the threat of protectionism, vulnerabilities in emerging markets and financial market volatility had remained prominent and appeared to be exacting an increasing toll on the world economy. Against this background, the downside risks to global activity and trade were seen as having increased.

Accounts released on 21.02.2019, topic score: 0.846536

Credit Market

Loan dynamics had continued the gradual recovery observed since the beginning of 2014, with credit to both firms and households continuing to expand. This was supported by the prevailing accommodative monetary policy stance and the pass-through of the monetary policy measures in place since June 2014, which had contributed to favourable borrowing conditions and credit standards for firms and households. Credit supply constraints had receded on the part of banks. Reference was made to the survey on the access to finance of enterprises (SAFE) in the euro area, in which SMEs had signalled an improvement in the availability of external sources of finance and the willingness of banks to provide credit. This was also reflected in more favourable terms and conditions applied by banks when granting loans. Nonetheless, despite these improvements, bank lending developments continued to reflect still sluggish demand for credit, credit risk and a continued need for adjustments in financial and non-financial sector balance sheets, related in particular to still sizeable levels of non-performing loans.

Accounts released on 14.01.2016, topic score: 0.853699

With regard to the monetary analysis, members concurred with the assessment presented by Mr Praet in his introduction. Broad money (M3) had continued to expand at a robust pace. The gradual recovery in the growth of loans to the private sector, visible since the start of 2014, was proceeding amid a further pick-up in the growth of loans to NFCs and households. The expansion in credit continued to be supported by very favourable borrowing costs for firms and households across the euro area. It was nonetheless noted that deleveraging in the non-financial private sectors had progressed further according to various measures. This was seen as reassuring for the credit outlook and also from a financial stability perspective. Reference was also made to evidence from the bank lending survey for the fourth quarter of 2017, which indicated that loan growth continued to be supported by increasing demand and a further easing in overall lending conditions.

Accounts released on 22.02.2018, topic score: 0.830401

Structural Reforms & Growth

Members again emphasised strongly the need for other policy areas to contribute much more decisively, both at the national and the European levels, in order to reap the full benefits from the ECB's monetary policy measures. Structural policies were considered essential, given the continued high structural unemployment and low potential growth in the euro area. In particular, members judged that actions to raise productivity and improve the business environment, including the provision of an adequate public infrastructure, were vital to increase investment and boost job creation. Although specific reform needs differed across countries, the swift and effective implementation of structural reforms, in line with the country-specific recommendations recently published by the European Commission, would lead to higher sustainable economic growth in the euro area and make the euro area more resilient to global shocks. It was emphasised that, with the economic situation improving and demand increasing, it was an opportune time to strengthen investment in the public and private sectors. The enhancement of the current investment initiatives, including the extension of the Juncker plan, and the importance of making progress with the capital markets union were both mentioned. The role of the euro area banking sector was also considered critical. In particular, dealing with non-performing loans was seen as an important contribution to strengthening the euro area economic recovery.

Accounts released on 07.07.2016, topic score: 0.855314

Against this background, members again stressed that monetary policy on its own was not sufficient for a self-sustaining

recovery, and that there was a need for other policy areas to contribute much more decisively in supporting economic activity and potential growth. Structural reforms were necessary in all euro area countries, and implementation needed to be stepped up substantially in order to reduce the level of structural unemployment and to raise potential growth. The focus should be on actions to raise productivity and improve the business environment, including the provision of adequate public infrastructure. Higher public and private investment was considered important to raise productivity growth. The swift and effective implementation of structural reforms would not only lead to higher sustainable economic growth in the euro area, but would also make the euro area more resilient to external shocks.

Accounts released on 06.10.2016, topic score: 0.853592

Inflation

As regards longer-term inflation expectations, members noted that while market-based measures of longer-term expectations had stabilised, the ECB's September monetary policy measures had not yet had any visible positive effect, with longer-term inflation expectations continuing to stand at historically low levels and clearly below the ECB's inflation aim. In terms of market-based measures of longer-term inflation expectations, the five-year forward inflation-linked swap rate five years ahead currently stood at 1.24%, while in terms of survey-based measures, longer-term inflation expectations stood at 1.7% for the fourth quarter of 2019 in the Survey of Professional Forecasters (SPF). However, it was pointed out that most of the gap between survey-based and market-based measures of longer-term inflation expectations disappeared when adjusting for estimates of liquidity and risk premia, and that the risk of deflation was low. Moreover, a remark was made that the point estimates provided by SPF participants were still at levels consistent with the Governing Council's inflation aim and that, according to most available indicators, the degree to which longer-term inflation expectations were anchored had remained unchanged recently. At the same time, the previous declines in many of the indicators suggested close monitoring was warranted.

Accounts released on 16.01.2020, topic score: 0.937343

Looking at recent developments in long-term inflation expectations, market-based measures had broadly stabilised at low levels over the past few weeks, after some recovery in early March, while survey-based measures had been more stable. The April Survey of Professional Forecasters showed the average point forecast for inflation five years ahead at 1.8%, broadly unchanged from the previous round. All in all, financial market participants appeared to show little uncertainty that medium-term inflation would stay low, while deflation fears remained contained and visibly below the early-2015 peak.

Accounts released on 19.05.2016, topic score: 0.924407

A.2 Top words per topic

In the following, I display the top words per topic for the FOMC and ECB corpus. From the total word set from the respective corpus, LDA allocates words into topics where these words vary in the strength of association within different topics. For example, a word such as *price* might have a high association to the inflation topic and appears as a top word in that topic. I define *top words* as the 10 words with the highest score within a topic. That is, these words are salient for the corresponding topics and should help find adequate topic labels.

Table A1: Top words for ECB topics

Financial Market	APP	Interest Rates	Trade & Global Economy	Credit Market	Structural Reforms & Growth	Inflation
Market	Purchase	Rate	Risk	Bank	Growth	Inflation
Financial	Asset Purchase	Interest Rate	Euro Area	Credit	Area	Medium Term
Rate	APP	Interest Rate	Euro Area	Loan	Euro Area	Aim
Effect	End	Facility Unchanged	Area	Condition	Euro Area	Price
Condition	Net Asset	Operation	Outlook	Continue	Fiscal	Projection
Exchange	Forward	Deposit	Economy	Support	Investment	Wage
Bank	Programme	Take	Global	Lending	Support	Expectations
Exchange Rate	Necessary	Level	Uncertainty	Sector	Economic	Quarter
Euro	Asset Purchase	Account	Growth	Growth	Structural	Measure
Financial Condition	Guidance	Take Account	Downside	Measure	Recovery	Sustained

Table A2: Top words for FOMC topics

Foreign Markets	Business Activity	Quantitative Easing	Economic Outlook	Labour Market	Trade & Consumption
Market	Business Activity	Security	Inflation	Rate	Consumer
Foreign Markets	Quarter	Market	Economic	Unemployment	Quarter
Bank	Investment	Agency	Market	Labour Market	Real
Dollar	Sector	Treasury	Labour	Employment	Spending
Financial	Spending	System	Condition	Market	Increase
U.S.	Production	Treasury Security	Labour Market	Increase	Household
Yield	Capital	Mortgage	Outlook	Yield	Export
Equity	Equipment	Back	Term	Treasury	Rise
Price	Increase	Account	Purchase	Unemployment Rate	Consumer Spending
Currency	Report	Transaction	Financial	Decline	Income
Communication & FG	Housing Market	Money Market	Financial Markets	Growth	Inflation
Rate	Home	Rate	Credit	Economic	Price
Fund	Housing Market	Market	Loan	Growth	Inflation
Fund Rate	Sale	Term	Market	Economy	Energy
Target	New	Interest	Bank	Activity	Measure
Inflation	Level	Interest Rate	Condition	Risk	Expectatioin
Range	Mortgage	Operation	Commercial	Economic Activity	Core
Economic	Start	Balance	Financial Markets	Outlook	Consumer
Long	Rate	Facility	Continue	GDP	Increase
Statement	Activity	Sheet	Issuance	Effect	Inflation Expectation
Target Range	Low	Provide	Spread	Forecast	Long

Table A3: Top words for the ECB corpus but with TFIDF term weighting

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6	Topic 7	Topic 8	Topic 9	Topic 10
facility interest main_refinance marginal respectively marginal_lending facility_unchanged facility_deposit refinance proposal_president	inflation_expectation expectation market_base base survey_base long_term year_ahead survey inflation year	inflation guidance forward_guidance forward aim sustained communication inflation_aim need medium	threat_protectionism threat vulnerability_emerge geopolitical_factor protectionism uncertainty_relate vulnerability geopolitical risk_surround emerge	inflation growth projection risk price euro outlook euro_area economic area	pursue stabiliser automatic mildly prudent meet ready offset economic_activity operate	purchase monthly end asset app net principal principal_payment payment monthly_pace	bank credit fiscal loan condition lending financial purchase bank_lending support	inflation cost_pressure price annual amid mute headline headline_inflation labour utilisation	appropriate_ensure ready adjust_instrument stand_ready sustained_manner adjust manner stand move symmetry

A.3 Control variables and stationarity table

Table A4: Source and description of control variables

Variable	Source	Frequency	Comment
Policy Rate	BIS	Monthly	
Inflation Rate	OECD	Monthly	Growth Rate YoY
Current Account Balance	OECD	Quarterly	In million USD and percentage of GDP
GDP Growth	OECD	Quarterly	Real GDP, percentage change from previous period
US Recession Indicator	FRED	Monthly	NBER based recession indicator
EA Recession Indicator	FRED	Monthly	OECD based recession indicator
HK GDP	World Bank	Yearly	
HK Current Account	World Bank	Yearly	
HK Inflation Rate	FRED	Yearly	

Table [A5](#) shows the p-values for stationarity tests on the dependent variables "unexpected volatility" (UV), "directional price change" (DC) and "trading range" (TR) for each currency pair. The number 30 or 60 indicates the event window and 1M or 5M indicates the 1-minute or 5-minute dataset. For all other variables not shown in the table, both tests indicated stationarity of the series. That is, table [A5](#) only provides the p-values for the series where at least one test indicated non-stationarity. However, for almost all series, at least one test indicates stationarity.

I conducted an Augmented Dickey-Fuller (ADF) test (H_0 : non-stationarity) and a Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (H_0 : stationarity).

I do not explicitly report the stationarity test results for the explanatory variables (textual and control variables) as I have taken the first difference for all variables except the recession indicators, and thus, removed a potential trend in the data.

Table A5: P-values for stationarity tests of dependent variables

USDEUR	ADF	KPSS	USDCHF	ADF	KPSS
UV30_1M	p < 0.01	0.06956	DC30_1M	p < 0.01	0.02913
UV30_5M	p < 0.01	0.07411	DC30_5M	p < 0.01	0.08195
TR60_5M	0.01332	p > 0.1	TR30_1M	p < 0.01	0.02443
DC60_5M	p < 0.01	0.04893	UV30_5M	p < 0.01	0.06861
DC30_1M	p < 0.01	0.07028			
DC60_1M	p < 0.01	0.02592			
USDMXN			USDTRY		
UV60_5M	0.02777	p > 0.1	UV60_5M	0.02777	p > 0.1
UV60_1M	0.03228	p > 0.1	UV60_1M	0.03228	p > 0.1
TR30_5M	p < 0.01	0.03532	TR30_5M	p < 0.01	0.03532
TR60_5M	p < 0.01	0.07742	TR60_5M	p < 0.01	0.07742
TR30_1M	p < 0.01	0.02668	TR30_1M	p < 0.01	0.02668
TR60_1M	p < 0.01	0.04481	TR60_1M	p < 0.01	0.04481
USDHKD			EURUSD		
TR60_5M	0.2434	p > 0.1	UV30_5M	0.222	p > 0.1
TR30_5M	0.01702	p > 0.1	UV60_5M	0.2562	p > 0.1
TR30_1M	0.05212	p > 0.1	DC30_5M	0.0178	p > 0.1
TR60_1M	0.2011	p > 0.1	DC60_5M	0.0441	p > 0.1
UV30_5M	0.1558	p > 0.1	DC30_1M	0.01143	p > 0.1
UV60_5M	0.1558	p > 0.1	DC60_1M	0.03655	p > 0.1
UV30_1M	0.01563	p > 0.1	TR60_5M	0.04366	p > 0.1
UV60_1M	0.04518	p > 0.1	TR30_5M	0.03367	p > 0.1
DC60_5M	0.01584	p > 0.1	TR60_1M	0.05334	p > 0.1
			TR30_1M	0.1174	p > 0.1
EURCHF			EURTRY		
TR30_5M	0.6706	0.04036	UV60_5M	0.6735	p > 0.1
TR60_5M	0.6108	0.0986	UV30_5M	0.6741	p > 0.1
TR30_1M	0.528	p > 0.1	UV60_1M	0.09061	p > 0.1
TR60_1M	0.5627	p > 0.1	UV30_1M	0.06956	p > 0.1
DC30_5M	0.06499	p > 0.1	TR30_5M	0.6706	0.04036
UV30_5M	0.6741	p > 0.1	TR60_5M	0.6108	0.0986
UV60_5M	0.6735	p > 0.1	TR30_1M	0.528	p > 0.1
UV30_1M	0.06956	p > 0.1	TR60_1M	0.5627	p > 0.1
UV60_1M	0.09061	p > 0.1	DC30_5M	0.06499	p > 0.1

A.4 Missing trading data

While the intraday trading data used in this thesis is free, it comes at cost that for several event days, trading data is missing. This is mostly the case for event dates before 2015 and thus, only affects FOMC communication events. Therefore, some FOMC Minutes could not be considered for the regression analysis. Trading data is missing for the following event dates and respective currency pairs:

Table A6: Missing trading data

Currency Pair	Missing Dates (YYYYMMDD format)
USDEUR	20000323, 20000518, 20011004, 20011108, 20011213, 20020131, 20020321, 20020509, 20020627, 20030814, 20060212
USDCHEF	20000323, 20000518, 20011004, 20011108, 20011213, 20040318, 20060212, 20020131, 20020321, 20020509, 20020627
USDMXN	20100106, 20100217, 20100406, 20100519, 20100714, 20100831, 20101012, 20170222
USDTRY	20100106, 20100217, 20100406, 20100519, 20100714, 20100831, 20101012, 20170222
USDHKD	20080102, 20080220, 20080408, 20080521, 20080716, 20080826, 20081007, 20081119, 20090106, 20090218, 20090408, 20090520, 20090715, 20090902, 20091014, 20091124, 20110405, 20140820

A.5 LDA learning process

Supervision of the LDA learning process: I included four metrics to assess a suitable convergence of the LDA model. The x-axis displays the number of passes which is how many times the entire corpus is fed into the LDA model for training. This is equivalent to the terminology of *epochs* in other machine learning applications. The first window displays the achieved coherence score C_V for each number of topics. This metric served as the primary tool for choosing the number of topics and model selection. *Convergence* was added to assess model stability and is taken care of by simply allowing for a large enough number of passes for the model training. *Perplexity* is an evaluation metric from information theory that can be used for evaluation of language models. In essence, a lower perplexity is desired as this suggests better predictability of the model and the model is "less surprised" by new data (Jurafsky and Martin (2009)). As perplexity was used as an evaluation metric in the original paper that introduced LDA by Blei, Ng, and Jordan (2003), I included it as an additional metric for the sake of completeness. However, Chang, Boyd-Graber, Wang, Gerrish, and Blei (2009) showed that perplexity does not necessarily correlate with human interpretability. Therefore, I have not optimized the LDA parameters for minimum perplexity.

Figure A.1: LDA metrics for FOMC Minutes

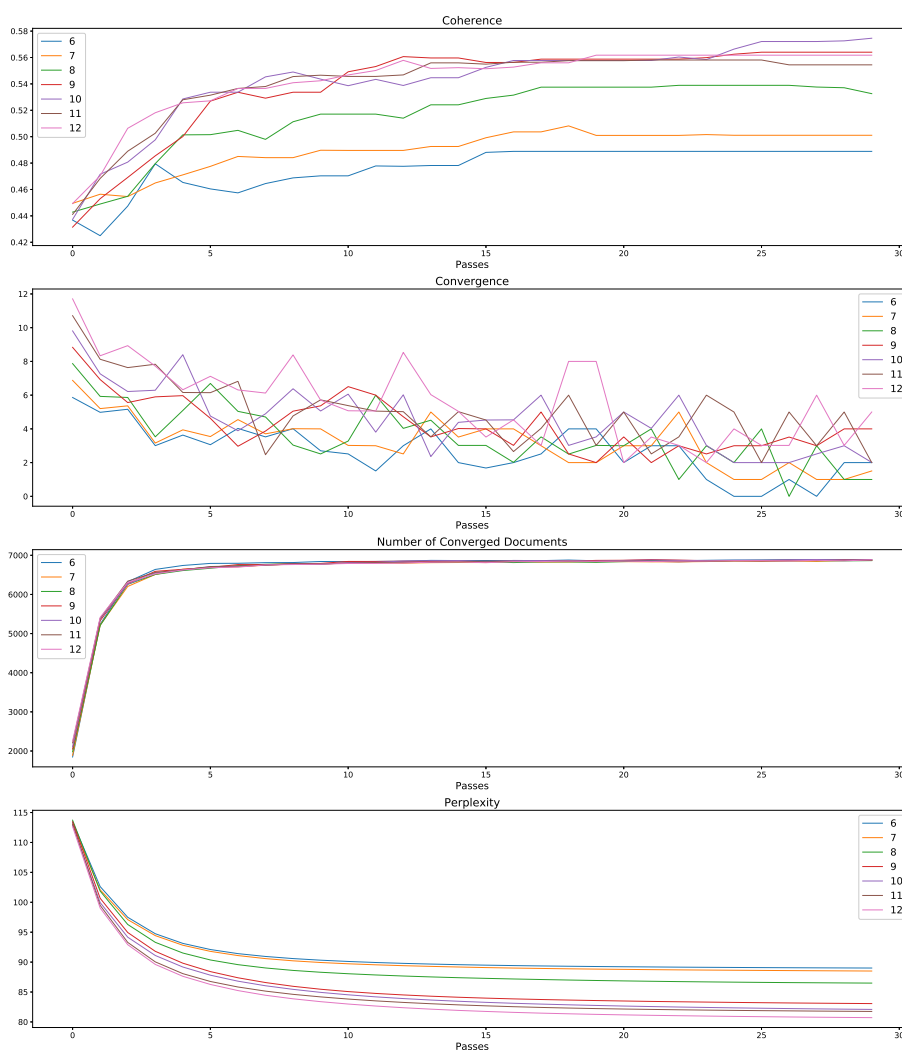
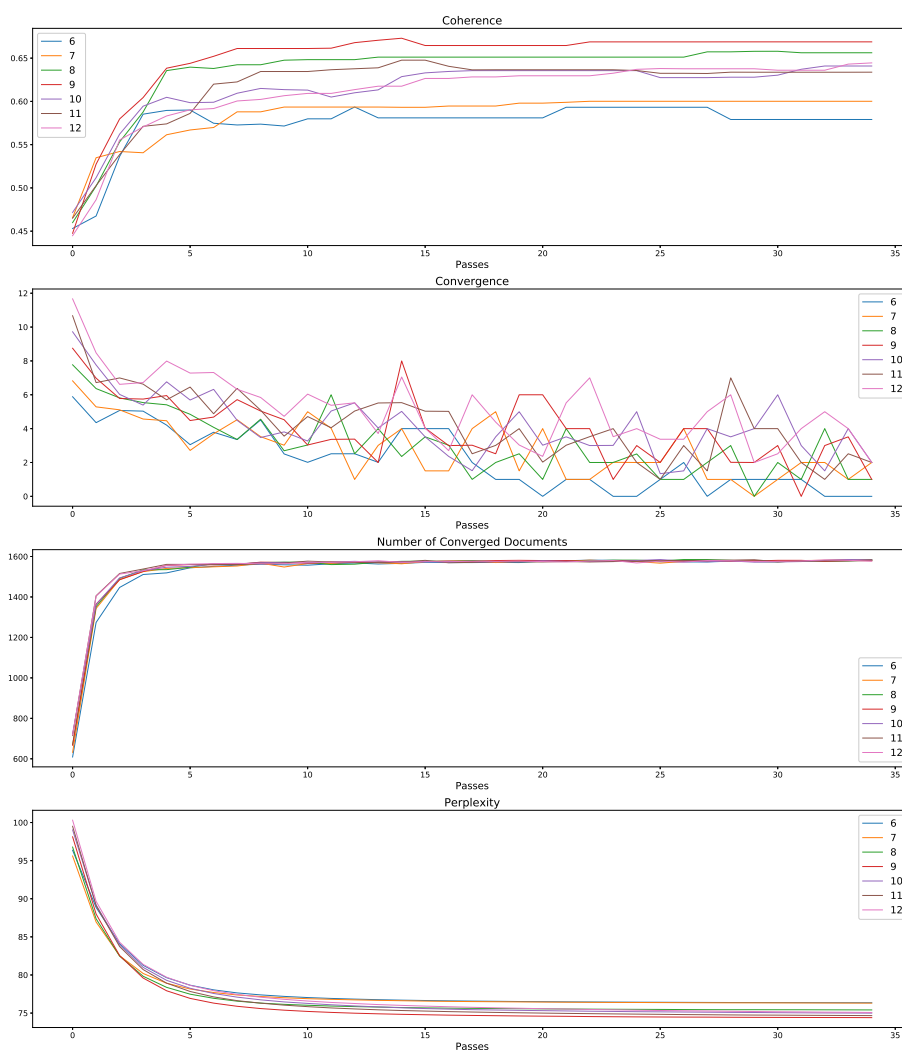


Figure A.2: LDA metrics for ECB Monetary Policy Accounts



A.6 Tables of regression results

USDEUR 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00001 (0.00002)	-0.00002 (0.00003)	-0.0002** (0.0001)	-0.0002 (0.0002)	0.00005 (0.0001)	-0.0001 (0.0001)
Business Activity	0.00002 (0.00003)	0.00002 (0.00004)	0.0001 (0.0001)	0.0002 (0.0002)	0.0001 (0.0001)	0.00003 (0.0002)
Quantitative Easing	0.00000 (0.00003)	0.00002 (0.00004)	0.0002 (0.0001)	0.0004** (0.0002)	-0.00003 (0.0001)	0.00000 (0.0001)
Economic Outlook	-0.00004* (0.00002)	-0.00004 (0.00003)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001* (0.0001)	-0.0001 (0.0001)
Labour Market	0.00002 (0.00002)	-0.00001 (0.00003)	0.0001 (0.0001)	0.0002 (0.0002)	0.0001 (0.0001)	-0.00003 (0.0001)
Trade & Consumption	0.00001 (0.00002)	0.00003 (0.00002)	-0.00002 (0.0001)	-0.0001 (0.0001)	0.00000 (0.0001)	0.0001 (0.0001)
Communication & FG	-0.00000 (0.00002)	0.00001 (0.00002)	-0.00003 (0.0001)	-0.0001 (0.0001)	-0.00001 (0.0001)	0.00003 (0.0001)
Housing Market	-0.00002 (0.00002)	-0.00002 (0.00003)	0.0001 (0.0001)	0.0002 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)
Money Market	0.00002 (0.00002)	0.00001 (0.00003)	-0.00001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Financial Markets	-0.00002 (0.00002)	0.00001 (0.00003)	-0.00001 (0.0001)	-0.0001 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)
Growth	0.00002 (0.00003)	0.00003 (0.00004)	0.0001 (0.0001)	0.0001 (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)
Inflation	-0.00003 (0.00002)	-0.0001* (0.00003)	0.00001 (0.0001)	-0.00004 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)
Inflation Rate Differential	0.0001 (0.0001)	0.00002 (0.0001)	-0.0003 (0.0003)	0.0004 (0.0005)	0.0003 (0.0002)	0.0003 (0.0004)
GDP Growth Differential	0.00001 (0.00001)	-0.00000 (0.00002)	-0.00001 (0.0001)	-0.00002 (0.0001)	0.00001 (0.0001)	-0.00002 (0.0001)
Current Account Differential	-0.00000 (0.00003)	0.00001 (0.00004)	0.00004 (0.0001)	-0.0001 (0.0002)	0.00005 (0.0001)	0.0001 (0.0001)
Policy Rate Differential	0.0001 (0.0001)	0.0002 (0.0001)	0.0001 (0.0004)	0.0003 (0.001)	0.0001 (0.0003)	0.0004 (0.0004)
US Recession Indicator	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.00003 (0.0002)	-0.00004 (0.0004)	0.00001 (0.0002)	0.0001 (0.0003)
Constant	0.0001*** (0.00002)	0.0001*** (0.00002)	-0.00003 (0.0001)	-0.0002* (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.102	0.096	0.082	0.099	0.076	0.051
Adjusted R ²	-0.010	-0.016	-0.032	-0.012	-0.039	-0.067
Residual Std. Error (df = 137)	0.0002	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 17; 137)	0.913	0.858	0.718	0.889	0.664	0.432

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDEUR 1 Minute Data - Tone - NO CONTROL VARIABLES

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00001 (0.00002)	-0.00003 (0.00003)	-0.0002** (0.0001)	-0.0002 (0.0001)	0.00004 (0.0001)	-0.0001 (0.0001)
Business Activity	0.00002 (0.00003)	0.00001 (0.00004)	0.0001 (0.0001)	0.0002 (0.0002)	0.0001 (0.0001)	0.00005 (0.0001)
Quantitative Easing	-0.00000 (0.00003)	0.00002 (0.00003)	0.0002 (0.0001)	0.0003* (0.0002)	-0.00004 (0.0001)	0.00003 (0.0001)
Economic Outlook	-0.00004** (0.00002)	-0.00004 (0.00003)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001* (0.0001)	-0.0001 (0.0001)
Labour Market	0.00002 (0.00002)	-0.00001 (0.00003)	0.0001 (0.0001)	0.0002 (0.0002)	0.0001 (0.0001)	-0.00001 (0.0001)
Trade & Consumption	0.00001 (0.00002)	0.00003 (0.00002)	-0.00003 (0.0001)	-0.00002 (0.0001)	0.00001 (0.0001)	0.0001 (0.0001)
Communication & FG	-0.00000 (0.00002)	0.00001 (0.00002)	-0.00003 (0.0001)	-0.0002 (0.0001)	-0.00001 (0.0001)	0.00003 (0.0001)
Housing Market	-0.00003 (0.00002)	-0.00003 (0.00003)	0.0001 (0.0001)	0.0001 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)
Money Market	0.00002 (0.00002)	0.00002 (0.00003)	-0.00001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Financial Markets	-0.00001 (0.00002)	0.00002 (0.00003)	-0.00001 (0.0001)	-0.00004 (0.0002)	-0.0001 (0.0001)	-0.00004 (0.0001)
Growth	0.00003 (0.00003)	0.00004 (0.00003)	0.0001 (0.0001)	0.0002 (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)
Inflation	-0.00003 (0.00002)	-0.00005 (0.00003)	0.00001 (0.0001)	-0.00002 (0.0002)	-0.00005 (0.0001)	-0.0001 (0.0001)
Constant	0.0001*** (0.00002)	0.0001*** (0.00002)	-0.00004 (0.0001)	-0.0002** (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	156	156	156	156	156	156
R ²	0.073	0.063	0.072	0.088	0.061	0.031
Adjusted R ²	-0.005	-0.016	-0.006	0.012	-0.017	-0.050
Residual Std. Error (df = 143)	0.0002	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 12; 143)	0.936	0.802	0.922	1.157	0.779	0.383

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDEUR 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00000 (0.00002)	-0.00002 (0.00003)	-0.0001** (0.0001)	-0.0001 (0.0001)	0.00000 (0.0001)	-0.0001 (0.0001)
Business Activity	0.00001 (0.00003)	0.00001 (0.00004)	0.0001 (0.0001)	0.0002 (0.0001)	0.00002 (0.0001)	0.00000 (0.0001)
Quantitative Easing	-0.00000 (0.00003)	0.00001 (0.00004)	0.0001 (0.0001)	0.0003** (0.0001)	-0.00001 (0.0001)	0.00001 (0.0001)
Economic Outlook	-0.00003 (0.00002)	-0.00003 (0.00003)	0.00002 (0.0001)	0.00002 (0.0001)	-0.0001 (0.0001)	-0.00003 (0.0001)
Labour Market	0.00002 (0.00002)	-0.00002 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	0.00003 (0.0001)	-0.0001 (0.0001)
Trade & Consumption	0.00001 (0.00002)	0.00004 (0.00002)	0.00001 (0.0001)	-0.00001 (0.0001)	0.00002 (0.00005)	0.0001 (0.0001)
Communication & FG	-0.00000 (0.00002)	0.00002 (0.00003)	-0.00001 (0.0001)	-0.0001 (0.0001)	-0.00003 (0.00005)	0.00003 (0.0001)
Housing Market	-0.00001 (0.00002)	-0.00001 (0.00003)	-0.00003 (0.0001)	0.0001 (0.0001)	-0.00002 (0.0001)	-0.0001 (0.0001)
Money Market	0.00002 (0.00002)	0.00001 (0.00003)	-0.0001 (0.0001)	-0.0002* (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Financial Markets	-0.00001 (0.00002)	0.00001 (0.00003)	-0.00001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.00002 (0.0001)
Growth	0.00002 (0.00003)	0.00002 (0.00004)	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Inflation	-0.00004* (0.00002)	-0.00005 (0.00003)	-0.00001 (0.0001)	-0.00004 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
Inflation Rate Differential	0.0001 (0.0001)	0.00002 (0.0001)	-0.0003 (0.0002)	0.0003 (0.0003)	0.0003 (0.0002)	0.0002 (0.0003)
GDP Growth Differential	0.00001 (0.00001)	-0.00000 (0.00002)	-0.00004 (0.00004)	-0.0001 (0.0001)	0.00001 (0.00004)	-0.00001 (0.0001)
Current Account Differential	-0.00001 (0.00003)	0.00001 (0.00004)	0.0001 (0.0001)	-0.0001 (0.0001)	0.00002 (0.0001)	0.0001 (0.0001)
Policy Rate Differential	0.0001 (0.0001)	0.0002* (0.0001)	-0.0001 (0.0002)	0.00004 (0.0004)	0.0001 (0.0002)	0.0004 (0.0004)
US Recession Indicator	-0.00005 (0.0001)	-0.00005 (0.0001)	-0.00004 (0.0002)	-0.0001 (0.0003)	0.0001 (0.0001)	0.0002 (0.0002)
Constant	0.0001*** (0.00002)	0.0001*** (0.00002)	-0.00002 (0.0001)	-0.0002** (0.0001)	0.001*** (0.00005)	0.001*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.108	0.092	0.096	0.101	0.079	0.058
Adjusted R ²	-0.002	-0.020	-0.016	-0.011	-0.035	-0.059
Residual Std. Error (df = 137)	0.0002	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 17; 137)	0.979	0.821	0.856	0.903	0.693	0.496

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDEUR 1 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00001 (0.00003)	0.00001 (0.00003)	0.0002* (0.0001)	0.0003 (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)
Business Activity	-0.00004** (0.00002)	0.00002 (0.00002)	0.0001* (0.0001)	-0.00001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)
Quantitative Easing	-0.00003 (0.00003)	-0.0001* (0.00003)	0.0001 (0.0001)	0.0001 (0.0002)	-0.0001 (0.0001)	-0.0002 (0.0001)
Economic Outlook	-0.00001 (0.00004)	-0.00003 (0.0001)	0.0002 (0.0002)	0.0003 (0.0003)	-0.0001 (0.0002)	-0.0001 (0.0002)
Labour Market	0.00001 (0.00002)	0.00000 (0.00003)	0.00000 (0.0001)	0.0002 (0.0002)	0.00000 (0.0001)	-0.00005 (0.0001)
Trade & Consumption	0.00002 (0.00002)	0.00001 (0.00002)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Communication & FG	0.00001 (0.00002)	-0.00002 (0.00003)	0.0001 (0.0001)	0.0002 (0.0001)	0.00000 (0.0001)	-0.0001 (0.0001)
Housing Market	0.00000 (0.00002)	-0.00004* (0.00002)	-0.0001* (0.0001)	-0.0001 (0.0001)	-0.00003 (0.0001)	-0.0002* (0.0001)
Money Market	0.00002 (0.00002)	0.00003 (0.00003)	0.00001 (0.0001)	-0.0001 (0.0001)	0.00005 (0.0001)	0.00004 (0.0001)
Financial Markets	0.00003 (0.00002)	0.0001** (0.00003)	-0.0002* (0.0001)	-0.0003* (0.0002)	0.0002* (0.0001)	0.0003** (0.0001)
Growth	-0.00001 (0.00002)	-0.00000 (0.00003)	-0.0001 (0.0001)	-0.00005 (0.0001)	-0.00004 (0.0001)	-0.00003 (0.0001)
Inflation	-0.00002 (0.00002)	0.00003 (0.00003)	-0.0001 (0.0001)	-0.0003* (0.0002)	-0.00003 (0.0001)	0.0001 (0.0001)
Inflation Rate Differential	0.0001 (0.0001)	0.0001 (0.0001)	-0.0005 (0.0003)	0.0003 (0.0005)	0.0004 (0.0003)	0.001 (0.0004)
GDP Growth Differential	-0.00000 (0.00001)	-0.00001 (0.00002)	0.00002 (0.0001)	0.00001 (0.0001)	-0.00003 (0.0001)	-0.0001 (0.0001)
Current Account Differential	-0.00000 (0.00003)	0.00000 (0.00003)	0.0001 (0.0001)	0.00005 (0.0002)	0.00003 (0.0001)	0.0001 (0.0001)
Policy Rate Differential	0.0001 (0.0001)	0.0002** (0.0001)	0.0002 (0.0003)	0.0004 (0.001)	0.0003 (0.0003)	0.001 (0.0004)
US Recession Indicator	-0.0001 (0.0001)	-0.00004 (0.0001)	0.00003 (0.0002)	0.00003 (0.0004)	0.00005 (0.0002)	0.0002 (0.0003)
Constant	0.0001*** (0.00002)	0.0001*** (0.00002)	-0.00004 (0.0001)	-0.0002* (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.112	0.144	0.131	0.093	0.091	0.128
Adjusted R ²	0.002	0.038	0.023	-0.019	-0.022	0.020
Residual Std. Error (df = 137)	0.0002	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 17; 137)	1.017	1.361	1.215	0.829	0.806	1.186

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDEUR 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00001 (0.00003)	0.00001 (0.00003)	0.0001* (0.0001)	0.0002 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Business Activity	-0.00004** (0.00002)	0.00003 (0.00002)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001* (0.00005)	0.0001 (0.0001)
Quantitative Easing	-0.00003 (0.00003)	-0.0001* (0.00003)	0.0002** (0.0001)	0.0002 (0.0001)	-0.0001 (0.0001)	-0.0002 (0.0001)
Economic Outlook	-0.00000 (0.00004)	-0.00003 (0.0001)	-0.00001 (0.0001)	0.0001 (0.0002)	-0.00002 (0.0001)	-0.0001 (0.0002)
Labour Market	0.00003 (0.00002)	-0.00001 (0.00003)	0.00000 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00001 (0.0001)
Trade & Consumption	0.00002 (0.00002)	0.00001 (0.00002)	-0.00002 (0.00005)	-0.0001 (0.0001)	0.00003 (0.00004)	-0.00001 (0.0001)
Communication & FG	0.00000 (0.00002)	-0.00002 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00001 (0.0001)	-0.0001 (0.0001)
Housing Market	0.00000 (0.00002)	-0.00004* (0.00002)	-0.0001 (0.0001)	0.00001 (0.0001)	-0.00001 (0.00005)	-0.0002* (0.0001)
Money Market	0.00002 (0.00002)	0.00002 (0.00003)	0.00000 (0.0001)	-0.0001 (0.0001)	0.00003 (0.0001)	0.00000 (0.0001)
Financial Markets	0.00003 (0.00002)	0.0001** (0.00003)	-0.0001* (0.0001)	-0.0002** (0.0001)	0.0001* (0.0001)	0.0003*** (0.0001)
Growth	0.00000 (0.00002)	0.00001 (0.00003)	-0.00002 (0.0001)	-0.00000 (0.0001)	-0.00000 (0.0001)	0.00001 (0.0001)
Inflation	-0.00001 (0.00002)	0.00004 (0.00003)	-0.0001 (0.0001)	-0.0002* (0.0001)	-0.00003 (0.0001)	0.0001 (0.0001)
Inflation Rate Differential	0.0001 (0.0001)	0.0001 (0.0001)	-0.0005** (0.0002)	0.0001 (0.0004)	0.0004* (0.0002)	0.0005 (0.0003)
GDP Growth Differential	-0.00000 (0.00001)	-0.00001 (0.00002)	-0.00001 (0.00004)	-0.00003 (0.0001)	-0.00002 (0.00004)	-0.00004 (0.0001)
Current Account Differential	-0.00001 (0.00003)	-0.00000 (0.00003)	0.0001 (0.0001)	0.00004 (0.0001)	-0.00000 (0.0001)	0.0001 (0.0001)
Policy Rate Differential	0.0001* (0.0001)	0.0002** (0.0001)	-0.00002 (0.0002)	0.0001 (0.0004)	0.0002 (0.0002)	0.0005 (0.0003)
US Recession Indicator	-0.00004 (0.0001)	-0.00003 (0.0001)	0.00001 (0.0002)	-0.00001 (0.0003)	0.0001 (0.0001)	0.0002 (0.0002)
Constant	0.0001*** (0.00002)	0.0001*** (0.00002)	-0.00002 (0.0001)	-0.0002** (0.0001)	0.001*** (0.00005)	0.001*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.125	0.155	0.162	0.100	0.105	0.146
Adjusted R ²	0.016	0.050	0.058	-0.012	-0.006	0.040
Residual Std. Error (df = 137)	0.0002	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 17; 137)	1.151	1.480	1.553*	0.895	0.945	1.380

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDEUR 5 Minute Data - Uncertainty - NO CONTROL VARIABLES

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00001 (0.00003)	0.00001 (0.00003)	0.0002** (0.0001)	0.0002 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Business Activity	-0.00004** (0.00002)	0.00003 (0.00002)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.00005)	0.0001 (0.0001)
Quantitative Easing	-0.00003 (0.00002)	-0.0001* (0.00003)	0.0001* (0.0001)	0.0002* (0.0001)	-0.00003 (0.0001)	-0.0002 (0.0001)
Economic Outlook	-0.00001 (0.00004)	-0.00003 (0.0001)	0.00002 (0.0001)	0.0001 (0.0002)	-0.00003 (0.0001)	-0.0001 (0.0002)
Labour Market	0.00003 (0.00002)	-0.00000 (0.00003)	-0.00001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	0.00001 (0.0001)
Trade & Consumption	0.00002 (0.00002)	0.00001 (0.00002)	-0.00003 (0.00005)	-0.0001 (0.0001)	0.00004 (0.00004)	0.00003 (0.0001)
Communication & FG	-0.00000 (0.00002)	-0.00003 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00001 (0.0001)	-0.0001 (0.0001)
Housing Market	0.00000 (0.00002)	-0.00004* (0.00002)	-0.0001 (0.0001)	0.00000 (0.0001)	-0.00001 (0.00005)	-0.0001* (0.0001)
Money Market	0.00003 (0.00002)	0.00002 (0.00003)	-0.00002 (0.0001)	-0.0001 (0.0001)	0.00004 (0.0001)	0.00002 (0.0001)
Financial Markets	0.00002 (0.00002)	0.0001* (0.00003)	-0.0001 (0.0001)	-0.0002** (0.0001)	0.0001 (0.0001)	0.0003** (0.0001)
Growth	0.00000 (0.00002)	0.00001 (0.00003)	-0.00002 (0.0001)	-0.00001 (0.0001)	-0.00001 (0.0001)	0.00000 (0.0001)
Inflation	-0.00001 (0.00002)	0.00004 (0.00003)	-0.0001 (0.0001)	-0.0002* (0.0001)	-0.00003 (0.0001)	0.0001 (0.0001)
Constant	0.00004** (0.00002)	0.0001*** (0.00002)	-0.00002 (0.00005)	-0.0002** (0.0001)	0.001*** (0.00004)	0.001*** (0.0001)
Observations	156	156	156	156	156	156
R ²	0.075	0.104	0.117	0.098	0.065	0.109
Adjusted R ²	-0.003	0.029	0.043	0.022	-0.013	0.034
Residual Std. Error (df = 143)	0.0002	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 12: 143)	0.960	1.386	1.585	1.288	0.830	1.454

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDCHF 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00000 (0.00003)	0.00002 (0.00004)	0.00000 (0.0001)	0.0001 (0.0002)	0.00003 (0.0001)	0.0001 (0.0002)
Business Activity	0.00002 (0.00004)	-0.00002 (0.00005)	0.0002 (0.0001)	0.0001 (0.0002)	0.0001 (0.0001)	0.00001 (0.0002)
Quantitative Easing	0.00001 (0.00003)	0.00002 (0.00005)	0.0001 (0.0001)	0.0003 (0.0002)	-0.00003 (0.0001)	0.00000 (0.0002)
Economic Outlook	-0.00002 (0.00003)	-0.00003 (0.00004)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0002)
Labour Market	0.00001 (0.00003)	-0.0001 (0.00004)	0.0001 (0.0001)	0.0002 (0.0002)	0.00002 (0.0001)	-0.0002 (0.0002)
Trade & Consumption	0.00002 (0.00002)	0.00003 (0.00003)	-0.0001 (0.0001)	-0.00001 (0.0001)	0.00003 (0.0001)	0.0001 (0.0001)
Communication & FG	-0.00002 (0.00002)	0.00002 (0.00003)	0.00004 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.00004 (0.0001)
Housing Market	-0.00001 (0.00003)	-0.00001 (0.00004)	0.0001 (0.0001)	0.0003 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0002)
Money Market	-0.00001 (0.00003)	-0.00002 (0.00004)	-0.00003 (0.0001)	-0.0001 (0.0001)	0.00001 (0.0001)	-0.00002 (0.0001)
Financial Markets	-0.00001 (0.00003)	0.00000 (0.00004)	-0.00004 (0.0001)	-0.0002 (0.0002)	-0.0001 (0.0001)	-0.00003 (0.0002)
Growth	0.00004 (0.00004)	0.0001 (0.00005)	-0.0001 (0.0001)	-0.0002 (0.0002)	0.0001 (0.0001)	0.0002 (0.0002)
Inflation	-0.00000 (0.00003)	-0.00002 (0.00004)	0.00001 (0.0001)	-0.00000 (0.0002)	0.00004 (0.0001)	-0.00003 (0.0002)
Inflation Rate Differential	-0.00003 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0004)	0.0003 (0.0005)	-0.00002 (0.0004)	-0.0002 (0.001)
GDP Growth Differential	0.00004 (0.00003)	0.00003 (0.00004)	0.0001 (0.0001)	0.0002 (0.0002)	0.00003 (0.0001)	-0.00000 (0.0002)
Current Account Differential	0.00001 (0.00001)	0.00000 (0.00001)	-0.00001 (0.00002)	0.00000 (0.00003)	0.00001 (0.00002)	0.00001 (0.00003)
Policy Rate Differential	0.0001 (0.0001)	0.0001 (0.0001)	0.0003 (0.0004)	0.001 (0.001)	0.0001 (0.0004)	0.0001 (0.001)
US Recession Indicator	-0.0001 (0.0001)	-0.0002* (0.0001)	0.00002 (0.0003)	0.0002 (0.0004)	0.0001 (0.0003)	-0.00003 (0.0004)
Constant	0.0001*** (0.00002)	0.0001*** (0.00003)	-0.0001 (0.0001)	-0.0003** (0.0001)	0.001*** (0.0001)	0.002*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.076	0.097	0.062	0.099	0.032	0.033
Adjusted R ²	-0.039	-0.015	-0.055	-0.013	-0.088	-0.087
Residual Std. Error (df = 137)	0.0003	0.0004	0.001	0.001	0.001	0.002
F Statistic (df = 17; 137)	0.663	0.863	0.531	0.888	0.270	0.278

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDCHF 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00001 (0.00003)	0.00002 (0.00004)	0.00003 (0.0001)	0.0001 (0.0002)	0.00001 (0.0001)	0.00003 (0.0001)
Business Activity	0.00001 (0.00003)	-0.00003 (0.0001)	0.0002* (0.0001)	0.0001 (0.0002)	0.00000 (0.0001)	-0.00005 (0.0002)
Quantitative Easing	0.00000 (0.00003)	0.00002 (0.00005)	0.0001 (0.0001)	0.0003 (0.0002)	-0.00003 (0.0001)	0.00001 (0.0002)
Economic Outlook	-0.00000 (0.00003)	-0.00002 (0.00004)	0.00005 (0.0001)	0.00003 (0.0001)	0.00001 (0.0001)	-0.00003 (0.0001)
Labour Market	0.00002 (0.00003)	-0.0001 (0.00004)	0.0001 (0.0001)	0.0001 (0.0002)	0.00004 (0.0001)	-0.0002 (0.0001)
Trade & Consumption	0.00002 (0.00002)	0.00004 (0.00003)	-0.0001 (0.0001)	-0.00003 (0.0001)	0.00005 (0.0001)	0.0001 (0.0001)
Communication & FG	-0.00002 (0.00002)	0.00003 (0.00003)	0.00005 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)
Housing Market	0.00000 (0.00003)	-0.00001 (0.00005)	0.0001 (0.0001)	0.0003* (0.0002)	-0.00002 (0.0001)	-0.0001 (0.0002)
Money Market	-0.00001 (0.00002)	-0.00002 (0.00004)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.00003 (0.0001)	-0.00003 (0.0001)
Financial Markets	-0.00001 (0.00003)	0.00001 (0.00004)	-0.0001 (0.0001)	-0.0002 (0.0002)	-0.00005 (0.0001)	0.00000 (0.0001)
Growth	0.00003 (0.00003)	0.0001 (0.00005)	-0.00005 (0.0001)	-0.0001 (0.0002)	0.0001 (0.0001)	0.0002 (0.0002)
Inflation	-0.00001 (0.00003)	-0.00002 (0.00004)	-0.0001 (0.0001)	-0.0001 (0.0002)	-0.00001 (0.0001)	-0.0001 (0.0001)
Inflation Rate Differential	-0.00002 (0.0001)	-0.0002 (0.0001)	0.00004 (0.0003)	0.0004 (0.0005)	0.0001 (0.0002)	-0.0001 (0.0004)
GDP Growth Differential	0.00004 (0.00003)	0.00003 (0.00004)	0.0001 (0.0001)	0.0002 (0.0002)	0.00001 (0.0001)	-0.00000 (0.0001)
Current Account Differential	0.00000 (0.00001)	-0.00000 (0.00001)	-0.00002 (0.00002)	-0.00000 (0.00003)	0.00001 (0.00001)	-0.00000 (0.00003)
Policy Rate Differential	0.0001 (0.0001)	0.0002 (0.0001)	0.0002 (0.0004)	0.0004 (0.001)	0.0002 (0.0003)	0.0002 (0.001)
US Recession Indicator	-0.0001 (0.0001)	-0.0002* (0.0001)	0.0001 (0.0002)	0.0003 (0.0004)	0.0001 (0.0002)	-0.00004 (0.0003)
Constant	0.0001*** (0.00002)	0.0001*** (0.00003)	-0.0001 (0.0001)	-0.0003*** (0.0001)	0.001*** (0.0001)	0.002*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.098	0.110	0.080	0.101	0.034	0.032
Adjusted R ²	-0.013	0.00001	-0.035	-0.011	-0.086	-0.088
Residual Std. Error (df = 137)	0.0003	0.0004	0.001	0.001	0.001	0.001
F Statistic (df = 17; 137)	0.879	1.000	0.697	0.904	0.281	0.264

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDCHF 1 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.00001 (0.00003)	-0.00003 (0.00004)	-0.00001 (0.0001)	0.0001 (0.0002)	-0.00002 (0.0001)	-0.0001 (0.0002)
Business Activity	-0.00003 (0.00002)	0.00001 (0.00003)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)
Quantitative Easing	-0.00005 (0.00003)	-0.00003 (0.00004)	0.0001 (0.0001)	0.0001 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0002)
Economic Outlook	0.00000 (0.0001)	-0.0001 (0.0001)	0.0003 (0.0002)	0.0003 (0.0003)	-0.0001 (0.0002)	-0.0003 (0.0003)
Labour Market	0.00001 (0.00003)	0.0001* (0.00004)	0.0001 (0.0001)	-0.00001 (0.0002)	0.00001 (0.0001)	0.0002 (0.0002)
Trade & Consumption	0.00002 (0.00002)	0.00004 (0.00003)	-0.00004 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.0002 (0.0001)
Communication & FG	0.00001 (0.00003)	-0.0001* (0.00004)	0.0001 (0.0001)	0.0002 (0.0001)	0.00001 (0.0001)	-0.0002 (0.0002)
Housing Market	0.00001 (0.00002)	-0.00004 (0.00003)	-0.00004 (0.0001)	0.0001 (0.0001)	0.00002 (0.0001)	-0.0002 (0.0001)
Money Market	0.00003 (0.00002)	0.00001 (0.00003)	-0.00001 (0.0001)	0.00004 (0.0001)	0.0001 (0.0001)	0.00004 (0.0001)
Financial Markets	0.00001 (0.00003)	0.00003 (0.00004)	-0.0002** (0.0001)	-0.0003* (0.0002)	0.0001 (0.0001)	0.0001 (0.0002)
Growth	-0.00001 (0.00003)	-0.00001 (0.00004)	-0.00004 (0.0001)	-0.00004 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
Inflation	0.00001 (0.00003)	0.0001* (0.00004)	-0.0002* (0.0001)	-0.0003 (0.0002)	0.0001 (0.0001)	0.0003* (0.0002)
Inflation Rate Differential	-0.00002 (0.0001)	-0.0002 (0.0001)	-0.00001 (0.0003)	0.0004 (0.0005)	-0.00004 (0.0003)	-0.0003 (0.0005)
GDP Growth Differential	0.00004 (0.00003)	0.0001 (0.00004)	0.0001 (0.0001)	0.0001 (0.0001)	0.00005 (0.0001)	0.0001 (0.0002)
Current Account Differential	0.00001 (0.00001)	-0.00000 (0.00001)	-0.00002 (0.00002)	-0.00001 (0.00003)	0.00001 (0.00002)	0.00000 (0.00003)
Policy Rate Differential	0.0001 (0.0001)	0.0001 (0.0001)	0.0002 (0.0004)	0.0005 (0.001)	0.0002 (0.0004)	0.0001 (0.001)
US Recession Indicator	-0.0001 (0.0001)	-0.0002* (0.0001)	0.00004 (0.0003)	0.0002 (0.0004)	0.0001 (0.0003)	-0.00001 (0.0004)
Constant	0.0001*** (0.00002)	0.0001*** (0.00003)	-0.0001 (0.0001)	-0.0003** (0.0001)	0.001*** (0.0001)	0.002*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.084	0.155	0.081	0.088	0.039	0.086
Adjusted R ²	-0.030	0.050	-0.033	-0.025	-0.080	-0.027
Residual Std. Error (df = 137)	0.0003	0.0004	0.001	0.001	0.001	0.001
F Statistic (df = 17; 137)	0.736	1.478	0.710	0.779	0.327	0.761

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDCHF 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.00002 (0.00003)	-0.00003 (0.00004)	0.00001 (0.0001)	0.0001 (0.0002)	-0.00001 (0.0001)	-0.0001 (0.0001)
Business Activity	-0.00004* (0.00002)	0.00001 (0.00003)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)
Quantitative Easing	-0.00004 (0.00003)	-0.00002 (0.00004)	0.0002* (0.0001)	0.0002 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)
Economic Outlook	0.00000 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0002)	0.0002 (0.0003)	-0.0001 (0.0001)	-0.0003 (0.0002)
Labour Market	0.00001 (0.00003)	0.0001* (0.00004)	0.0001 (0.0001)	-0.00002 (0.0002)	0.00003 (0.0001)	0.0002* (0.0001)
Trade & Consumption	0.00001 (0.00002)	0.00003 (0.00003)	-0.00004 (0.0001)	-0.0002 (0.0001)	0.00002 (0.0001)	0.0001 (0.0001)
Communication & FG	0.00001 (0.00003)	-0.0001* (0.00004)	0.0001 (0.0001)	0.0002 (0.0001)	0.00001 (0.0001)	-0.0002 (0.0001)
Housing Market	0.00002 (0.00002)	-0.00005 (0.00003)	-0.00000 (0.0001)	0.0001 (0.0001)	0.00002 (0.0001)	-0.0002 (0.0001)
Money Market	0.00002 (0.00002)	0.00001 (0.00003)	-0.0001 (0.0001)	-0.00002 (0.0001)	0.00005 (0.0001)	0.00000 (0.0001)
Financial Markets	0.00001 (0.00003)	0.00003 (0.00004)	-0.0002* (0.0001)	-0.0003 (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)
Growth	0.00000 (0.00003)	0.00000 (0.00004)	-0.00001 (0.0001)	0.00001 (0.0001)	-0.00000 (0.0001)	-0.00001 (0.0001)
Inflation	0.00001 (0.00003)	0.0001** (0.00004)	-0.0002* (0.0001)	-0.0003* (0.0002)	0.00003 (0.0001)	0.0003* (0.0001)
Inflation Rate Differential	-0.00001 (0.0001)	-0.0002 (0.0001)	0.0001 (0.0003)	0.001 (0.0005)	0.0001 (0.0002)	-0.0002 (0.0004)
GDP Growth Differential	0.00003 (0.00003)	0.00005 (0.00004)	0.00003 (0.0001)	0.00005 (0.0001)	0.00000 (0.0001)	0.0001 (0.0001)
Current Account Differential	0.00000 (0.00001)	-0.00000 (0.00001)	-0.00003 (0.00002)	-0.00002 (0.00003)	0.00001 (0.00001)	-0.00000 (0.00003)
Policy Rate Differential	0.0002 (0.0001)	0.0001 (0.0001)	0.0001 (0.0003)	0.0004 (0.001)	0.0002 (0.0003)	0.0001 (0.0005)
US Recession Indicator	-0.0001 (0.0001)	-0.0002** (0.0001)	0.0001 (0.0002)	0.0003 (0.0004)	0.0001 (0.0002)	-0.00004 (0.0003)
Constant	0.0001*** (0.00002)	0.0001*** (0.00003)	-0.0001 (0.0001)	-0.0003*** (0.0001)	0.001*** (0.0001)	0.002*** (0.0001)
Observations	155	155	155	155	155	155
R ²	0.103	0.172	0.091	0.098	0.029	0.104
Adjusted R ²	-0.008	0.069	-0.022	-0.014	-0.092	-0.007
Residual Std. Error (df = 137)	0.0003	0.0004	0.001	0.001	0.001	0.001
F Statistic (df = 17; 137)	0.930	1.673*	0.804	0.878	0.237	0.939

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDMXN 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.00003 (0.001)	-0.001 (0.001)	-0.0001 (0.0002)	-0.0002 (0.0003)	0.001 (0.002)	-0.001 (0.004)
Business Activity	0.001 (0.001)	0.001 (0.002)	0.0005 (0.0003)	0.001 (0.001)	0.008 (0.005)	0.007 (0.008)
Quantitative Easing	-0.0003 (0.001)	-0.0002 (0.001)	0.00005 (0.0002)	0.0003 (0.0003)	0.0004 (0.003)	0.002 (0.005)
Economic Outlook	-0.001 (0.001)	-0.001 (0.001)	0.00003 (0.0001)	0.0001 (0.0002)	-0.001 (0.002)	-0.002 (0.003)
Labour Market	-0.0001 (0.001)	-0.0004 (0.001)	-0.0001 (0.0002)	0.0001 (0.0003)	-0.001 (0.003)	-0.001 (0.005)
Trade & Consumption	-0.0002 (0.001)	0.001 (0.001)	0.00001 (0.0002)	-0.0002 (0.0003)	-0.004 (0.002)	-0.003 (0.004)
Communication & FG	-0.0002 (0.001)	-0.001 (0.001)	-0.0002 (0.0001)	-0.0004* (0.0002)	0.0004 (0.002)	-0.001 (0.003)
Housing Market	-0.0001 (0.001)	0.0004 (0.002)	-0.0001 (0.0003)	0.0002 (0.0004)	-0.0003 (0.004)	0.001 (0.006)
Money Market	0.0003 (0.001)	0.001 (0.001)	0.0001 (0.0001)	-0.0001 (0.0002)	-0.001 (0.002)	0.002 (0.003)
Financial Markets	0.0001 (0.001)	0.00004 (0.001)	0.0001 (0.0002)	-0.0001 (0.0003)	-0.004 (0.003)	-0.005 (0.004)
Growth	0.001 (0.001)	0.002 (0.002)	0.0003 (0.0002)	0.001 (0.0004)	0.002 (0.003)	0.003 (0.006)
Inflation	-0.0001 (0.001)	-0.0004 (0.001)	-0.0002 (0.0002)	-0.0004 (0.0003)	-0.0003 (0.002)	0.0003 (0.004)
Inflation Rate Differential	-0.006 (0.005)	-0.005 (0.009)	-0.0001 (0.001)	-0.001 (0.002)	-0.036* (0.019)	-0.040 (0.032)
GDP Growth Differential	0.0002 (0.0002)	-0.0002 (0.0004)	-0.00003 (0.0001)	-0.00004 (0.0001)	0.001 (0.001)	0.001 (0.002)
Current Account Differential	-0.001 (0.001)	-0.001 (0.001)	-0.0001 (0.0001)	-0.0001 (0.0002)	-0.001 (0.002)	-0.003 (0.003)
Policy Rate Differential	0.001 (0.004)	0.001 (0.006)	0.0002 (0.001)	0.001 (0.002)	-0.027** (0.013)	-0.031 (0.023)
US Recession Indicator	-0.005** (0.002)	-0.012*** (0.004)	-0.001** (0.001)	-0.002* (0.001)	0.020** (0.009)	0.015 (0.016)
Constant	0.001** (0.001)	0.002 (0.001)	0.0001 (0.0002)	0.0002 (0.0003)	0.029*** (0.002)	0.045*** (0.004)
Observations	80	80	80	80	80	80
R ²	0.153	0.191	0.180	0.186	0.329	0.159
Adjusted R ²	-0.080	-0.031	-0.045	-0.037	0.146	-0.071
Residual Std. Error (df = 62)	0.005	0.009	0.001	0.002	0.019	0.032
F Statistic (df = 17; 62)	0.657	0.861	0.801	0.833	1.791**	0.690

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDMXN 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.0002 (0.001)	-0.001 (0.001)	-0.001 (0.003)	-0.003 (0.005)	0.001 (0.002)	-0.001 (0.004)
Business Activity	0.001 (0.001)	0.001 (0.002)	0.011** (0.005)	0.014 (0.009)	0.005 (0.004)	0.005 (0.008)
Quantitative Easing	-0.001 (0.001)	-0.0004 (0.001)	-0.002 (0.003)	0.002 (0.005)	0.001 (0.003)	0.002 (0.005)
Economic Outlook	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.002)	0.003 (0.004)	-0.002 (0.002)	-0.003 (0.003)
Labour Market	-0.0002 (0.001)	-0.0004 (0.001)	-0.002 (0.003)	0.002 (0.005)	-0.001 (0.002)	-0.002 (0.004)
Trade & Consumption	-0.00005 (0.001)	0.001 (0.001)	0.0002 (0.003)	-0.003 (0.004)	-0.003 (0.002)	-0.003 (0.004)
Communication & FG	-0.0003 (0.001)	-0.001 (0.001)	-0.002 (0.002)	-0.004 (0.004)	-0.0001 (0.002)	-0.001 (0.003)
Housing Market	-0.0003 (0.001)	0.0003 (0.002)	0.0002 (0.004)	0.004 (0.007)	-0.0002 (0.003)	0.001 (0.006)
Money Market	0.0004 (0.001)	0.001 (0.001)	-0.0002 (0.002)	-0.002 (0.004)	0.0003 (0.002)	0.002 (0.003)
Financial Markets	0.0002 (0.001)	-0.00005 (0.001)	0.001 (0.003)	-0.003 (0.005)	-0.003 (0.002)	-0.004 (0.004)
Growth	0.001 (0.001)	0.003 (0.002)	0.007* (0.004)	0.010 (0.007)	0.001 (0.003)	0.004 (0.006)
Inflation	-0.0005 (0.001)	-0.0003 (0.001)	-0.003 (0.003)	-0.006 (0.005)	-0.001 (0.002)	-0.001 (0.004)
Inflation Rate Differential	-0.001 (0.006)	-0.001 (0.009)	-0.001 (0.020)	-0.017 (0.035)	-0.016 (0.016)	-0.021 (0.030)
GDP Growth Differential	0.0001 (0.0003)	-0.0002 (0.0005)	-0.001 (0.001)	-0.001 (0.002)	0.001 (0.001)	0.0003 (0.002)
Current Account Differential	-0.001 (0.001)	-0.001 (0.001)	-0.002 (0.002)	-0.002 (0.004)	-0.001 (0.002)	-0.003 (0.003)
Policy Rate Differential	0.002 (0.004)	0.003 (0.007)	0.008 (0.015)	0.013 (0.025)	-0.018 (0.012)	-0.023 (0.022)
US Recession Indicator	-0.005* (0.003)	-0.013*** (0.005)	-0.020* (0.010)	-0.030* (0.018)	0.018** (0.008)	0.012 (0.015)
Constant	0.001* (0.001)	0.002 (0.001)	0.0005 (0.002)	0.003 (0.004)	0.022*** (0.002)	0.038*** (0.004)
Observations	80	80	80	80	80	80
R ²	0.144	0.196	0.235	0.209	0.264	0.120
Adjusted R ²	-0.090	-0.025	0.026	-0.008	0.062	-0.121
Residual Std. Error (df = 62)	0.006	0.009	0.021	0.035	0.016	0.031
F Statistic (df = 17; 62)	0.615	0.886	1.123	0.964	1.308	0.499

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDMXN 1 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.0004 (0.001)	0.001 (0.001)	0.0001 (0.0002)	0.0004 (0.0003)	-0.0003 (0.003)	0.001 (0.005)
Business Activity	0.001 (0.001)	0.0005 (0.001)	-0.0001 (0.0002)	-0.0002 (0.0004)	0.001 (0.003)	0.002 (0.005)
Quantitative Easing	0.00002 (0.001)	-0.0003 (0.001)	0.0002 (0.0002)	0.0001 (0.0003)	0.001 (0.003)	0.0005 (0.005)
Economic Outlook	-0.002 (0.001)	-0.001 (0.002)	-0.0002 (0.0003)	0.00004 (0.001)	-0.009* (0.005)	-0.010 (0.008)
Labour Market	-0.0003 (0.001)	0.0003 (0.001)	0.0001 (0.0002)	0.0003 (0.0004)	-0.0004 (0.003)	0.0002 (0.005)
Trade & Consumption	0.0002 (0.001)	0.0001 (0.001)	-0.00004 (0.0001)	-0.0002 (0.0002)	0.001 (0.002)	-0.0001 (0.003)
Communication & FG	0.0001 (0.001)	0.0003 (0.001)	-0.00005 (0.0002)	-0.0001 (0.0003)	0.001 (0.002)	0.004 (0.004)
Housing Market	0.0003 (0.001)	-0.001 (0.001)	-0.0001 (0.0002)	-0.0001 (0.0003)	-0.001 (0.002)	-0.006 (0.004)
Money Market	0.0004 (0.001)	-0.0002 (0.001)	0.0001 (0.0001)	0.0001 (0.0002)	0.0005 (0.002)	-0.002 (0.003)
Financial Markets	0.0002 (0.001)	0.00003 (0.001)	-0.0002 (0.0002)	-0.0004 (0.0003)	0.003 (0.002)	0.004 (0.004)
Growth	-0.0001 (0.001)	0.001 (0.001)	0.0002 (0.0002)	0.0001 (0.0003)	0.001 (0.003)	0.007 (0.004)
Inflation	0.0002 (0.001)	0.0004 (0.001)	0.0002 (0.0002)	0.0004 (0.0004)	0.002 (0.003)	0.001 (0.005)
Inflation Rate Differential	-0.005 (0.005)	-0.004 (0.008)	-0.0001 (0.001)	-0.001 (0.002)	-0.038** (0.018)	-0.051* (0.030)
GDP Growth Differential	0.0002 (0.0003)	-0.0001 (0.0005)	-0.00001 (0.0001)	-0.00001 (0.0001)	0.001 (0.001)	0.0005 (0.002)
Current Account Differential	-0.001 (0.0005)	-0.001 (0.001)	-0.0001 (0.0001)	-0.0001 (0.0002)	-0.002 (0.002)	-0.002 (0.003)
Policy Rate Differential	0.001 (0.003)	0.001 (0.006)	0.001 (0.001)	0.0004 (0.001)	-0.029** (0.013)	-0.034 (0.021)
US Recession Indicator	-0.005* (0.003)	-0.011** (0.005)	-0.001* (0.001)	-0.002 (0.001)	0.021** (0.010)	0.018 (0.016)
Constant	0.001* (0.001)	0.002 (0.001)	0.0001 (0.0002)	0.0002 (0.0003)	0.029*** (0.002)	0.045*** (0.004)
Observations	80	80	80	80	80	80
R ²	0.124	0.143	0.204	0.154	0.310	0.212
Adjusted R ²	-0.116	-0.091	-0.014	-0.078	0.121	-0.004
Residual Std. Error (df = 62)	0.005	0.009	0.001	0.002	0.019	0.031
F Statistic (df = 17; 62)	0.515	0.610	0.935	0.663	1.640*	0.982

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDMXN 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.001 (0.001)	0.001 (0.001)	0.003 (0.003)	0.007 (0.006)	-0.001 (0.003)	0.002 (0.005)
Business Activity	0.0002 (0.001)	0.00002 (0.002)	-0.002 (0.003)	-0.002 (0.006)	0.00002 (0.003)	0.001 (0.005)
Quantitative Easing	-0.00004 (0.001)	-0.0003 (0.001)	0.006* (0.003)	0.004 (0.006)	0.001 (0.003)	-0.0003 (0.005)
Economic Outlook	-0.001 (0.001)	-0.0004 (0.002)	-0.003 (0.005)	-0.0001 (0.009)	-0.006 (0.004)	-0.007 (0.007)
Labour Market	-0.00002 (0.001)	0.0004 (0.002)	0.002 (0.003)	0.005 (0.006)	0.001 (0.003)	0.001 (0.005)
Trade & Consumption	0.0002 (0.001)	-0.00005 (0.001)	-0.001 (0.002)	-0.002 (0.004)	0.0005 (0.002)	-0.001 (0.003)
Communication & FG	-0.0002 (0.001)	0.0003 (0.001)	0.001 (0.003)	0.00003 (0.005)	0.0004 (0.002)	0.003 (0.004)
Housing Market	0.0002 (0.001)	-0.002 (0.001)	-0.004 (0.003)	-0.004 (0.005)	-0.001 (0.002)	-0.006 (0.004)
Money Market	0.0004 (0.001)	-0.0002 (0.001)	-0.0004 (0.002)	0.001 (0.004)	0.0003 (0.002)	-0.002 (0.003)
Financial Markets	0.0001 (0.001)	0.0002 (0.001)	-0.003 (0.003)	-0.006 (0.005)	0.002 (0.002)	0.004 (0.004)
Growth	0.0001 (0.001)	0.002 (0.001)	0.004 (0.003)	0.003 (0.005)	0.001 (0.002)	0.007* (0.004)
Inflation	0.0004 (0.001)	0.0001 (0.002)	0.002 (0.003)	0.004 (0.006)	0.002 (0.003)	0.001 (0.005)
Inflation Rate Differential	-0.0001 (0.006)	0.0004 (0.009)	0.002 (0.019)	-0.011 (0.034)	-0.021 (0.015)	-0.033 (0.028)
GDP Growth Differential	0.0001 (0.0003)	-0.0001 (0.0005)	-0.001 (0.001)	-0.001 (0.002)	0.001 (0.001)	0.00001 (0.001)
Current Account Differential	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.002)	-0.002 (0.004)	-0.001 (0.002)	-0.002 (0.003)
Policy Rate Differential	0.002 (0.004)	0.003 (0.006)	0.012 (0.014)	0.006 (0.024)	-0.019* (0.011)	-0.024 (0.019)
US Recession Indicator	-0.005 (0.003)	-0.012** (0.005)	-0.018* (0.010)	-0.027 (0.018)	0.019** (0.008)	0.015 (0.015)
Constant	0.001 (0.001)	0.002 (0.001)	0.0001 (0.002)	0.002 (0.004)	0.022*** (0.002)	0.037*** (0.003)
Observations	80	80	80	80	80	80
R ²	0.098	0.170	0.238	0.143	0.252	0.184
Adjusted R ²	-0.150	-0.058	0.029	-0.092	0.047	-0.039
Residual Std. Error (df = 62)	0.006	0.009	0.020	0.036	0.016	0.029
F Statistic (df = 17; 62)	0.395	0.745	1.137	0.610	1.231	0.825

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDTRY 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.0001 (0.001)	-0.001 (0.001)	-0.0001 (0.0002)	-0.0002 (0.0003)	0.001 (0.003)	-0.001 (0.004)
Business Activity	0.002 (0.001)	0.003 (0.002)	0.001* (0.0003)	0.001 (0.001)	0.008* (0.005)	0.009 (0.008)
Quantitative Easing	0.0001 (0.001)	0.0004 (0.001)	0.0001 (0.0002)	0.0004 (0.0003)	-0.0003 (0.003)	0.001 (0.005)
Economic Outlook	-0.001 (0.001)	-0.001 (0.001)	0.00002 (0.0001)	0.0001 (0.0002)	-0.001 (0.002)	-0.002 (0.004)
Labour Market	0.0001 (0.001)	0.0002 (0.001)	-0.0001 (0.0002)	0.0002 (0.0003)	-0.001 (0.003)	-0.001 (0.005)
Trade & Consumption	-0.001 (0.001)	0.0001 (0.001)	-0.00005 (0.0002)	-0.0003 (0.0003)	-0.004 (0.002)	-0.004 (0.004)
Communication & FG	-0.0004 (0.0005)	-0.001 (0.001)	-0.0002 (0.0001)	-0.0004* (0.0002)	0.001 (0.002)	-0.001 (0.003)
Housing Market	-0.001 (0.001)	-0.001 (0.002)	-0.0002 (0.0002)	0.0001 (0.0004)	0.001 (0.004)	0.001 (0.006)
Money Market	0.0003 (0.001)	0.001 (0.001)	0.0001 (0.0001)	-0.00004 (0.0002)	-0.001 (0.002)	0.002 (0.003)
Financial Markets	0.00003 (0.001)	-0.0003 (0.001)	0.0001 (0.0002)	-0.0001 (0.0003)	-0.004 (0.003)	-0.006 (0.005)
Growth	0.001 (0.001)	0.002 (0.002)	0.0003 (0.0002)	0.001 (0.0004)	-0.00005 (0.004)	0.001 (0.006)
Inflation	-0.0002 (0.001)	-0.0003 (0.001)	-0.0002 (0.0002)	-0.0004 (0.0003)	-0.001 (0.003)	0.0001 (0.004)
Inflation Rate Differential	0.0004 (0.001)	0.001 (0.001)	0.0001 (0.0002)	0.00002 (0.0003)	-0.0003 (0.003)	-0.0002 (0.004)
GDP Growth Differential	-0.0003 (0.0002)	-0.001*** (0.0003)	-0.00005 (0.0001)	-0.00004 (0.0001)	0.0003 (0.001)	-0.001 (0.001)
Current Account Differential	-0.0002 (0.0004)	0.0001 (0.001)	-0.0001 (0.0001)	-0.00003 (0.0002)	-0.0002 (0.002)	0.001 (0.003)
Policy Rate Differential	0.0003 (0.0004)	0.001 (0.001)	0.0001 (0.0001)	0.0001 (0.0002)	0.0001 (0.002)	0.001 (0.003)
US Recession Indicator	-0.004* (0.002)	-0.011*** (0.004)	-0.001* (0.001)	-0.002 (0.001)	0.025*** (0.009)	0.019 (0.015)
Constant	0.001** (0.001)	0.002* (0.001)	0.0001 (0.0002)	0.0002 (0.0003)	0.028*** (0.002)	0.044*** (0.004)
Observations	80	80	80	80	80	80
R ²	0.160	0.282	0.187	0.176	0.229	0.126
Adjusted R ²	-0.070	0.085	-0.036	-0.049	0.017	-0.114
Residual Std. Error (df = 62)	0.005	0.008	0.001	0.002	0.020	0.033
F Statistic (df = 17; 62)	0.697	1.430	0.838	0.781	1.082	0.524

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDTRY 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.0001 (0.001)	-0.001 (0.001)	-0.002 (0.003)	-0.003 (0.005)	0.001 (0.002)	-0.001 (0.004)
Business Activity	0.002 (0.001)	0.002 (0.002)	0.013** (0.005)	0.015* (0.009)	0.006 (0.004)	0.008 (0.008)
Quantitative Easing	-0.0002 (0.001)	0.0003 (0.001)	-0.001 (0.003)	0.004 (0.005)	-0.00001 (0.002)	0.001 (0.004)
Economic Outlook	-0.001 (0.001)	-0.002 (0.001)	0.001 (0.002)	0.003 (0.004)	-0.001 (0.002)	-0.003 (0.003)
Labour Market	0.0002 (0.001)	0.0004 (0.001)	-0.002 (0.003)	0.002 (0.005)	-0.001 (0.002)	-0.001 (0.004)
Trade & Consumption	-0.0002 (0.001)	0.0003 (0.001)	-0.001 (0.002)	-0.005 (0.004)	-0.002 (0.002)	-0.003 (0.004)
Communication & FG	-0.0004 (0.001)	-0.001 (0.001)	-0.002 (0.002)	-0.005 (0.004)	0.0001 (0.002)	-0.001 (0.003)
Housing Market	-0.001 (0.001)	-0.001 (0.002)	-0.003 (0.004)	0.001 (0.007)	0.001 (0.003)	0.001 (0.006)
Money Market	0.0003 (0.001)	0.001 (0.001)	-0.0001 (0.002)	-0.002 (0.004)	-0.0001 (0.002)	0.002 (0.003)
Financial Markets	0.0002 (0.001)	-0.0003 (0.001)	0.001 (0.003)	-0.003 (0.005)	-0.003 (0.002)	-0.005 (0.004)
Growth	0.001 (0.001)	0.003 (0.002)	0.008** (0.004)	0.011 (0.007)	-0.0002 (0.003)	0.003 (0.006)
Inflation	-0.001 (0.001)	-0.0001 (0.001)	-0.003 (0.003)	-0.006 (0.005)	-0.002 (0.002)	-0.001 (0.004)
Inflation Rate Differential	0.001 (0.001)	0.001 (0.001)	-0.001 (0.003)	-0.001 (0.004)	0.001 (0.002)	0.001 (0.004)
GDP Growth Differential	-0.0003 (0.0002)	-0.001** (0.0004)	-0.002* (0.001)	-0.001 (0.001)	0.0001 (0.001)	-0.001 (0.001)
Current Account Differential	-0.0002 (0.0004)	0.0001 (0.001)	-0.001 (0.002)	-0.0002 (0.003)	-0.0003 (0.001)	0.0004 (0.002)
Policy Rate Differential	0.0002 (0.001)	0.001 (0.001)	0.002 (0.002)	0.002 (0.003)	-0.0005 (0.001)	0.001 (0.003)
US Recession Indicator	-0.004 (0.003)	-0.012*** (0.004)	-0.015 (0.009)	-0.025 (0.016)	0.021*** (0.008)	0.015 (0.014)
Constant	0.001* (0.001)	0.002* (0.001)	0.001 (0.002)	0.003 (0.004)	0.021*** (0.002)	0.037*** (0.004)
Observations	80	80	80	80	80	80
R ²	0.176	0.273	0.251	0.205	0.212	0.115
Adjusted R ²	-0.050	0.073	0.045	-0.012	-0.004	-0.128
Residual Std. Error (df = 62)	0.006	0.009	0.020	0.035	0.017	0.031
F Statistic (df = 17; 62)	0.780	1.366	1.219	0.943	0.981	0.473

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDTRY 1 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.001 (0.001)	0.0001 (0.001)	0.0001 (0.0002)	0.0003 (0.0004)	-0.001 (0.003)	-0.001 (0.005)
Business Activity	0.0003 (0.001)	0.0004 (0.001)	-0.0002 (0.0002)	-0.0003 (0.0004)	-0.0004 (0.003)	0.002 (0.005)
Quantitative Easing	-0.0002 (0.001)	-0.0003 (0.001)	0.0002 (0.0002)	-0.00001 (0.0003)	0.003 (0.003)	0.003 (0.005)
Economic Outlook	-0.001 (0.001)	-0.001 (0.002)	-0.0001 (0.0003)	0.00003 (0.001)	-0.010** (0.005)	-0.011 (0.008)
Labour Market	0.0001 (0.001)	0.001 (0.001)	0.0002 (0.0002)	0.0004 (0.0004)	-0.001 (0.003)	0.0005 (0.005)
Trade & Consumption	0.0004 (0.001)	0.0004 (0.001)	-0.00001 (0.0001)	-0.0001 (0.0002)	-0.0002 (0.002)	-0.001 (0.004)
Communication & FG	0.0001 (0.001)	0.0004 (0.001)	-0.0001 (0.0002)	-0.0001 (0.0003)	0.001 (0.003)	0.005 (0.004)
Housing Market	0.0005 (0.001)	-0.001 (0.001)	-0.0001 (0.0002)	-0.00003 (0.0003)	-0.001 (0.003)	-0.006 (0.004)
Money Market	0.0004 (0.001)	0.00003 (0.001)	0.0001 (0.0001)	0.0002 (0.0002)	0.001 (0.002)	-0.001 (0.003)
Financial Markets	0.0001 (0.001)	0.00000 (0.001)	-0.0002 (0.0002)	-0.0004 (0.0003)	0.004 (0.003)	0.005 (0.004)
Growth	-0.0001 (0.001)	0.001 (0.001)	0.0002 (0.0002)	0.0001 (0.0003)	-0.0001 (0.003)	0.006 (0.004)
Inflation	0.0001 (0.001)	0.0001 (0.001)	0.0002 (0.0002)	0.0004 (0.0004)	0.002 (0.003)	-0.001 (0.005)
Inflation Rate Differential	0.00001 (0.001)	0.0005 (0.001)	0.00004 (0.0002)	-0.0001 (0.0003)	-0.002 (0.003)	-0.002 (0.004)
GDP Growth Differential	-0.0003 (0.0002)	-0.001** (0.0004)	-0.00005 (0.0001)	-0.0001 (0.0001)	0.0002 (0.001)	-0.001 (0.001)
Current Account Differential	-0.0002 (0.0004)	0.0003 (0.001)	-0.00005 (0.0001)	0.00000 (0.0002)	0.0001 (0.002)	0.002 (0.003)
Policy Rate Differential	0.0003 (0.0004)	0.001 (0.001)	0.00002 (0.0001)	-0.00001 (0.0002)	-0.0004 (0.002)	0.001 (0.003)
US Recession Indicator	-0.004 (0.002)	-0.011*** (0.004)	-0.001 (0.001)	-0.001 (0.001)	0.027*** (0.009)	0.020 (0.015)
Constant	0.001* (0.001)	0.002* (0.001)	0.0001 (0.0002)	0.0002 (0.0003)	0.028*** (0.002)	0.044*** (0.004)
Observations	80	80	80	80	80	80
R ²	0.116	0.225	0.200	0.149	0.217	0.165
Adjusted R ²	-0.127	0.013	-0.019	-0.084	0.002	-0.064
Residual Std. Error (df = 62)	0.005	0.009	0.001	0.002	0.020	0.032
F Statistic (df = 17; 62)	0.477	1.060	0.913	0.639	1.010	0.721

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDTRY 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.001 (0.001)	0.0005 (0.001)	0.002 (0.003)	0.005 (0.006)	-0.001 (0.003)	0.001 (0.005)
Business Activity	-0.00000 (0.001)	0.0001 (0.002)	-0.002 (0.003)	-0.004 (0.006)	-0.001 (0.003)	0.001 (0.005)
Quantitative Easing	-0.0003 (0.001)	-0.0005 (0.001)	0.005 (0.003)	0.003 (0.005)	0.002 (0.002)	0.002 (0.004)
Economic Outlook	-0.001 (0.001)	-0.0001 (0.002)	-0.003 (0.005)	-0.001 (0.009)	-0.007 (0.004)	-0.008 (0.007)
Labour Market	0.0004 (0.001)	0.001 (0.002)	0.003 (0.003)	0.006 (0.006)	0.001 (0.003)	0.001 (0.005)
Trade & Consumption	0.001 (0.001)	0.0003 (0.001)	-0.00004 (0.002)	-0.002 (0.004)	0.0001 (0.002)	-0.001 (0.003)
Communication & FG	-0.0003 (0.001)	0.0004 (0.001)	0.001 (0.003)	0.001 (0.005)	0.001 (0.002)	0.003 (0.004)
Housing Market	0.0003 (0.001)	-0.002 (0.001)	-0.004 (0.003)	-0.003 (0.005)	-0.001 (0.002)	-0.006 (0.004)
Money Market	0.001 (0.001)	-0.0001 (0.001)	0.00004 (0.002)	0.001 (0.004)	0.001 (0.002)	-0.001 (0.003)
Financial Markets	-0.00001 (0.001)	0.00002 (0.001)	-0.003 (0.003)	-0.006 (0.005)	0.003 (0.002)	0.005 (0.004)
Growth	0.0003 (0.001)	0.002 (0.001)	0.004 (0.003)	0.003 (0.005)	0.001 (0.002)	0.006 (0.004)
Inflation	0.0003 (0.001)	-0.0002 (0.002)	0.002 (0.003)	0.004 (0.006)	0.001 (0.003)	-0.00000 (0.005)
Inflation Rate Differential	0.0005 (0.001)	0.001 (0.001)	-0.001 (0.003)	-0.003 (0.005)	-0.001 (0.002)	-0.001 (0.004)
GDP Growth Differential	-0.0004 (0.0003)	-0.001** (0.0004)	-0.001 (0.001)	-0.002 (0.002)	-0.0002 (0.001)	-0.001 (0.001)
Current Account Differential	-0.0003 (0.0005)	0.0004 (0.001)	0.00004 (0.002)	0.001 (0.003)	-0.0003 (0.001)	0.002 (0.002)
Policy Rate Differential	0.0002 (0.001)	0.0004 (0.001)	0.001 (0.002)	-0.00003 (0.003)	-0.001 (0.001)	-0.00002 (0.003)
US Recession Indicator	-0.004 (0.003)	-0.012*** (0.004)	-0.017* (0.009)	-0.027 (0.017)	0.023*** (0.008)	0.016 (0.014)
Constant	0.001* (0.001)	0.002* (0.001)	0.0004 (0.002)	0.002 (0.004)	0.021*** (0.002)	0.037*** (0.003)
Observations	80	80	80	80	80	80
R ²	0.114	0.237	0.242	0.155	0.201	0.166
Adjusted R ²	-0.129	0.028	0.034	-0.077	-0.018	-0.062
Residual Std. Error (df = 62)	0.006	0.009	0.020	0.036	0.017	0.030
F Statistic (df = 17; 62)	0.468	1.134	1.165	0.670	0.916	0.727

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDHKD 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.0000 (0.00001)	0.00001 (0.00001)	-0.00000 (0.00001)	-0.00000 (0.00001)	-0.00001 (0.00004)	-0.00002 (0.00005)
Business Activity	0.00000 (0.00002)	0.00001 (0.00002)	-0.00000 (0.00001)	0.00001 (0.00001)	0.00002 (0.0001)	0.00004 (0.0001)
Quantitative Easing	-0.00000 (0.00001)	0.00001 (0.00001)	0.00000 (0.00001)	0.00000 (0.00001)	-0.00002 (0.00004)	0.00000 (0.0001)
Economic Outlook	-0.00000 (0.00001)	0.00001 (0.00001)	-0.00000 (0.00001)	0.00000 (0.00001)	-0.00003 (0.00003)	-0.00002 (0.00004)
Labour Market	0.00000 (0.00001)	-0.00001 (0.00002)	0.00000 (0.00001)	0.00001 (0.00001)	0.00003 (0.00004)	0.00001 (0.0001)
Trade & Consumption	0.00001 (0.00001)	0.00000 (0.00001)	-0.00000 (0.00001)	-0.00000 (0.00001)	0.00001 (0.00004)	0.00000 (0.00005)
Communication & FG	-0.00000 (0.00001)	-0.00002 (0.00001)	-0.00000 (0.00000)	0.00000 (0.00001)	0.00001 (0.00003)	-0.00002 (0.00004)
Housing Market	-0.00000 (0.00002)	0.00000 (0.00002)	0.00000 (0.00001)	-0.00000 (0.00001)	-0.00002 (0.0001)	-0.00001 (0.0001)
Money Market	0.00000 (0.00001)	0.00000 (0.00001)	0.00000 (0.00001)	0.00000 (0.00001)	-0.00004 (0.00003)	-0.00002 (0.00004)
Financial Markets	-0.00003** (0.00001)	-0.00004** (0.00001)	-0.00000 (0.00001)	-0.00001 (0.00001)	-0.0001* (0.00004)	-0.0001* (0.0001)
Growth	0.00002 (0.00002)	0.00001 (0.00002)	-0.00000 (0.00001)	-0.00000 (0.00001)	0.00001 (0.0001)	-0.00001 (0.0001)
Inflation	-0.00001 (0.00001)	-0.00001 (0.00001)	0.00000 (0.00001)	0.00000 (0.00001)	0.00004 (0.00004)	0.0001 (0.00005)
Inflation Rate Differential	-0.00005** (0.00002)	-0.00002 (0.00003)	0.00002* (0.00001)	0.00001 (0.00001)	-0.0002*** (0.0001)	-0.0002** (0.0001)
GDP Growth Differential	-0.00000 (0.00000)	-0.00000 (0.00000)	0.00000 (0.00000)	-0.00000 (0.00000)	-0.00001 (0.00001)	-0.00002 (0.00002)
Current Account Differential	-0.00000 (0.00001)	0.00001 (0.00001)	0.00000 (0.00001)	0.00001 (0.00001)	-0.00002 (0.00004)	0.00002 (0.00005)
Policy Rate Differential	0.0002*** (0.0001)	0.0002** (0.0001)	0.00001 (0.00004)	0.00003 (0.00005)	0.001** (0.0003)	0.0005 (0.0004)
US Recession Indicator	0.00002 (0.00004)	0.00001 (0.00005)	-0.00000 (0.00002)	-0.00000 (0.00002)	-0.00004 (0.0001)	-0.0001 (0.0002)
Constant	-0.00002 (0.00001)	-0.00003** (0.00001)	-0.00000 (0.00001)	-0.00000 (0.00001)	0.0003*** (0.00003)	0.0005*** (0.00004)
Observations	80	81	82	82	82	82
R ²	0.278	0.253	0.090	0.105	0.263	0.209
Adjusted R ²	0.080	0.052	-0.151	-0.133	0.067	-0.002
Residual Std. Error	0.0001 (df = 62)	0.0001 (df = 63)	0.00005 (df = 64)	0.0001 (df = 64)	0.0003 (df = 64)	0.0004 (df = 64)
F Statistic	1.402 (df = 17; 62)	1.256 (df = 17; 63)	0.374 (df = 17; 64)	0.441 (df = 17; 64)	1.345 (df = 17; 64)	0.993 (df = 17; 64)

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDHKD 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	-0.00001 (0.00002)	-0.00001 (0.00002)	-0.00003 (0.00003)	-0.00003 (0.00004)	-0.00000 (0.00003)	-0.00002 (0.00004)
Business Activity	0.00000 (0.00003)	0.00000 (0.00003)	0.00000 (0.0001)	0.00005 (0.0001)	0.00002 (0.0001)	0.00004 (0.0001)
Quantitative Easing	0.00001 (0.00002)	0.00001 (0.00002)	0.00001 (0.00004)	0.00001 (0.0001)	-0.00002 (0.00003)	0.00001 (0.00005)
Economic Outlook	0.00000 (0.00001)	0.00000 (0.00001)	-0.00003 (0.00003)	-0.00001 (0.00004)	-0.00001 (0.00002)	-0.00000 (0.00004)
Labour Market	0.00000 (0.00002)	0.00000 (0.00002)	0.00004 (0.00004)	0.0001 (0.0001)	0.00003 (0.00003)	0.00000 (0.00005)
Trade & Consumption	-0.00000 (0.00001)	-0.00000 (0.00001)	-0.00000 (0.00003)	0.00001 (0.00004)	-0.00001 (0.00003)	-0.00001 (0.00004)
Communication & FG	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.00001 (0.00003)	-0.00000 (0.00004)	0.00002 (0.00002)	-0.00001 (0.00003)
Housing Market	0.00000 (0.00002)	0.00000 (0.00002)	-0.00001 (0.0001)	-0.0001 (0.0001)	-0.00001 (0.00004)	-0.00001 (0.0001)
Money Market	-0.00001 (0.00001)	-0.00001 (0.00001)	0.00000 (0.00003)	0.00000 (0.00004)	-0.00003 (0.00002)	-0.00000 (0.00004)
Financial Markets	-0.00003* (0.00002)	-0.00003* (0.00002)	-0.00002 (0.00004)	-0.0001 (0.0001)	-0.0001 (0.00003)	-0.0001 (0.0001)
Growth	0.00001 (0.00002)	0.00001 (0.00002)	0.00002 (0.0001)	-0.00000 (0.0001)	-0.00003 (0.00004)	-0.00001 (0.0001)
Inflation	0.00001 (0.00002)	0.00001 (0.00002)	0.00002 (0.00004)	0.00001 (0.00005)	0.00004 (0.00003)	0.0001 (0.00004)
Inflation Rate Differential	-0.00005 (0.00003)	-0.00005 (0.00003)	0.0001 (0.0001)	0.00002 (0.0001)	-0.0001** (0.0001)	-0.0001* (0.0001)
GDP Growth Differential	-0.00000 (0.00000)	-0.00000 (0.00000)	0.00001 (0.00001)	-0.00000 (0.00001)	-0.00001 (0.00001)	-0.00002 (0.00001)
USD_HKD_ca	0.00000 (0.00002)	0.00000 (0.00002)	0.00001 (0.00004)	0.00004 (0.00005)	-0.00001 (0.00003)	0.00002 (0.00004)
Policy Rate Differential	0.0001 (0.0001)	0.0001 (0.0001)	0.0002 (0.0003)	0.0004 (0.0003)	0.0004* (0.0002)	0.0003 (0.0003)
US Recession Indicator	-0.00004 (0.0001)	-0.00004 (0.0001)	-0.00001 (0.0001)	-0.00001 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0002)
Constant	-0.00000 (0.00001)	-0.00000 (0.00001)	0.00001 (0.00003)	0.00005 (0.00004)	0.0002*** (0.00003)	0.0004*** (0.00004)
Observations	81	81	82	82	82	82
R ²	0.175	0.175	0.080	0.083	0.196	0.154
Adjusted R ²	-0.047	-0.047	-0.164	-0.160	-0.017	-0.070
Residual Std. Error	0.0001 (df = 63)	0.0001 (df = 63)	0.0003 (df = 64)	0.0004 (df = 64)	0.0002 (df = 64)	0.0003 (df = 64)
F Statistic	0.787 (df = 17; 63)	0.787 (df = 17; 63)	0.329 (df = 17; 64)	0.343 (df = 17; 64)	0.920 (df = 17; 64)	0.687 (df = 17; 64)

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDHKD 1 Minute Data - Uncertainty

	Dependent variable:					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.0002 (0.00001)	0.0000 (0.00002)	0.0000 (0.00001)	-0.0000 (0.00001)	0.0001** (0.00004)	0.0001** (0.0001)
Business Activity	-0.00002 (0.00001)	-0.00002 (0.00002)	0.00001 (0.00001)	0.0000 (0.00001)	-0.00003 (0.00005)	0.0000 (0.0001)
Quantitative Easing	-0.00000 (0.00001)	-0.00001 (0.00002)	0.0000 (0.00001)	0.0000 (0.00001)	-0.00003 (0.00005)	-0.00003 (0.0001)
Economic Outlook	0.00001 (0.00002)	0.00004 (0.00003)	-0.00000 (0.00001)	-0.00001 (0.00001)	0.00002 (0.0001)	0.0001 (0.0001)
Labour Market	0.00001 (0.00001)	0.00002 (0.00002)	-0.00001 (0.00001)	-0.00000 (0.00001)	0.0001 (0.00004)	0.0001 (0.0001)
Trade & Consumption	-0.00001 (0.00001)	-0.00002 (0.00001)	0.00001 (0.00000)	0.0000 (0.00001)	0.0000 (0.00003)	-0.00002 (0.00004)
Communication & FG	-0.00002 (0.00001)	-0.00002 (0.00001)	0.00001 (0.00001)	0.00001 (0.00001)	0.00001 (0.00004)	0.00003 (0.00005)
Housing Market	0.00001 (0.00001)	0.00003** (0.00001)	-0.00001 (0.00001)	-0.00000 (0.00001)	-0.00004 (0.00004)	-0.00003 (0.00005)
Money Market	0.0000 (0.00001)	0.00001 (0.00001)	-0.00000 (0.00000)	-0.00001 (0.00001)	0.00002 (0.00003)	0.00003 (0.00004)
Financial Markets	0.00002* (0.00001)	0.00001 (0.00001)	-0.00000 (0.00001)	0.0000 (0.00001)	0.00004 (0.00004)	0.00001 (0.00005)
Growth	-0.00001 (0.00001)	-0.00002 (0.00002)	0.0000 (0.00001)	0.00001 (0.00001)	0.0000 (0.00004)	-0.00002 (0.00005)
Inflation	-0.00002 (0.00001)	0.0000 (0.00002)	-0.00000 (0.00001)	0.0000 (0.00001)	-0.0001* (0.00004)	-0.0001 (0.0001)
Inflation Rate Differential	-0.00004* (0.00002)	-0.00003 (0.00003)	0.00002** (0.00001)	0.00002 (0.00001)	-0.0002*** (0.0001)	-0.0002*** (0.0001)
GDP Growth Differential	-0.00000 (0.00000)	-0.00000 (0.00000)	0.0000 (0.00000)	-0.00000 (0.00000)	-0.00001 (0.00001)	-0.00001 (0.00001)
USD_HKD.ca	-0.00000 (0.00001)	0.00001 (0.00001)	0.0000 (0.00001)	0.00001 (0.00001)	-0.00003 (0.00004)	0.0000 (0.00005)
Policy Rate Differential	0.0002** (0.0001)	0.0001 (0.0001)	0.00001 (0.00004)	0.00002 (0.00004)	0.0001 (0.0002)	-0.00001 (0.0003)
US Recession Indicator	0.00001 (0.00004)	-0.00000 (0.00005)	-0.00000 (0.00002)	-0.00000 (0.00002)	-0.0001 (0.0001)	-0.0002 (0.0002)
Constant	-0.00002 (0.00001)	-0.00003** (0.00001)	-0.00001 (0.00001)	-0.00000 (0.00001)	0.0003*** (0.00003)	0.0005*** (0.00004)
Observations	80	81	82	82	82	82
R ²	0.332	0.260	0.181	0.144	0.385	0.301
Adjusted R ²	0.148	0.060	-0.037	-0.083	0.222	0.116
Residual Std. Error	0.0001 (df = 62)	0.0001 (df = 63)	0.00004 (df = 64)	0.00005 (df = 64)	0.0003 (df = 64)	0.0004 (df = 64)
F Statistic	1.809** (df = 17; 62)	1.300 (df = 17; 63)	0.832 (df = 17; 64)	0.633 (df = 17; 64)	2.361*** (df = 17; 64)	1.623* (df = 17; 64)

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

USDHKD 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign Markets	0.00004** (0.00002)	0.00004** (0.00002)	0.00002 (0.00004)	-0.00002 (0.0001)	0.0001*** (0.00003)	0.0001** (0.00005)
Business Activity	0.00000 (0.00002)	0.00000 (0.00002)	0.00004 (0.00004)	0.00003 (0.0001)	-0.00002 (0.00003)	0.00001 (0.0001)
Quantitative Easing	0.00000 (0.00002)	0.00000 (0.00002)	0.00001 (0.00004)	0.00001 (0.0001)	-0.00003 (0.00003)	-0.00003 (0.0001)
Economic Outlook	0.00003 (0.00003)	0.00003 (0.00003)	0.00003 (0.0001)	-0.0001 (0.0001)	0.00001 (0.00005)	0.0001 (0.0001)
Labour Market	0.00003 (0.00002)	0.00003 (0.00002)	-0.00000 (0.00004)	0.00001 (0.0001)	0.00002 (0.00003)	0.00004 (0.00005)
Trade & Consumption	-0.00001 (0.00001)	-0.00001 (0.00001)	0.0001* (0.00003)	0.00002 (0.00004)	0.00000 (0.00002)	-0.00003 (0.00003)
Communication & FG	0.00001 (0.00001)	0.00001 (0.00001)	0.00001 (0.00003)	0.00001 (0.00005)	0.00004 (0.00002)	0.0001 (0.00004)
Housing Market	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.0001 (0.00003)	-0.00004 (0.00005)	-0.00002 (0.00002)	-0.00001 (0.00004)
Money Market	0.00000 (0.00001)	0.00000 (0.00001)	-0.00001 (0.00003)	-0.00003 (0.00004)	0.00001 (0.00002)	0.00000 (0.00003)
Financial Markets	0.00000 (0.00001)	0.00000 (0.00001)	-0.00005 (0.00003)	-0.00001 (0.00005)	0.00004 (0.00002)	0.00002 (0.00004)
Growth	-0.00002 (0.00002)	-0.00002 (0.00002)	-0.00000 (0.00004)	0.0001 (0.00005)	0.00003 (0.00003)	-0.00001 (0.00004)
Inflation	-0.00002 (0.00002)	-0.00002 (0.00002)	-0.00005 (0.00004)	-0.00001 (0.0001)	-0.0001** (0.00003)	-0.00005 (0.0001)
Inflation Rate Differential	-0.0001* (0.00003)	-0.0001* (0.00003)	0.0001 (0.0001)	0.00002 (0.0001)	-0.0001* (0.00005)	-0.0001* (0.0001)
GDP Growth Differential	-0.00000 (0.00000)	-0.00000 (0.00000)	0.00001 (0.00001)	-0.00000 (0.00001)	-0.00000 (0.00001)	-0.00001 (0.00001)
USD_HKD_ca	-0.00000 (0.00002)	-0.00000 (0.00002)	0.00003 (0.00003)	0.0001 (0.00005)	-0.00002 (0.00003)	0.00000 (0.00004)
Policy Rate Differential	0.00002 (0.0001)	0.00002 (0.0001)	0.0001 (0.0002)	0.0002 (0.0003)	0.0001 (0.0002)	-0.00003 (0.0003)
US Recession Indicator	-0.0001 (0.00005)	-0.0001 (0.00005)	-0.00000 (0.0001)	-0.00001 (0.0002)	-0.0001 (0.0001)	-0.0002 (0.0001)
Constant	-0.00000 (0.00001)	-0.00000 (0.00001)	0.00001 (0.00003)	0.00004 (0.00004)	0.0002*** (0.00002)	0.0004*** (0.00004)
Observations	81	81	82	82	82	82
R ²	0.277	0.277	0.198	0.082	0.388	0.287
Adjusted R ²	0.081	0.081	-0.015	-0.162	0.226	0.097
Residual Std. Error	0.0001 (df = 63)	0.0001 (df = 63)	0.0003 (df = 64)	0.0004 (df = 64)	0.0002 (df = 64)	0.0003 (df = 64)
F Statistic	1.417 (df = 17; 63)	1.417 (df = 17; 63)	0.932 (df = 17; 64)	0.337 (df = 17; 64)	2.388*** (df = 17; 64)	1.513 (df = 17; 64)

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURUSD 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0002)	0.0001 (0.0002)	0.00003 (0.0002)	-0.0001 (0.0002)
Inflation	0.0001 (0.0001)	0.00005 (0.0001)	-0.0002 (0.0002)	0.0001 (0.0003)	0.0001 (0.0002)	0.0001 (0.0003)
Asset Purchase Programmes	-0.0001* (0.0001)	-0.0001* (0.0001)	0.0001 (0.0001)	0.0002 (0.0002)	0.00003 (0.0001)	0.0002 (0.0002)
Interest Rates	-0.00005 (0.0001)	-0.00003 (0.0001)	0.00004 (0.0002)	-0.0002 (0.0002)	-0.0001 (0.0002)	-0.00003 (0.0002)
Global Economy & Trade	-0.0002 (0.0001)	-0.0001 (0.0001)	-0.00001 (0.0002)	0.0001 (0.0002)	-0.0003 (0.0002)	-0.0003 (0.0002)
Credit Market	0.00003 (0.0001)	0.00002 (0.0001)	-0.0001 (0.0002)	0.00002 (0.0002)	0.0001 (0.0002)	0.0001 (0.0002)
Structural Reforms & Growth	0.0001 (0.0001)	0.0001 (0.0001)	-0.00004 (0.0002)	-0.0002 (0.0002)	0.0001 (0.0002)	0.00004 (0.0002)
Inflation Rate Differential	0.0002 (0.0004)	0.0002 (0.0003)	0.001 (0.001)	0.00005 (0.001)	-0.0001 (0.001)	0.0002 (0.001)
GDP Growth Differential	-0.0001 (0.00005)	-0.00003 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00003 (0.0001)	-0.0001 (0.0001)
Current Account Differential	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0002)	-0.00004 (0.0002)	0.00001 (0.0002)	0.0001 (0.0002)
Policy Rate Differential	-0.001** (0.0004)	-0.001** (0.0003)	-0.001 (0.001)	-0.001 (0.001)	-0.0001 (0.001)	-0.0004 (0.001)
EA Recession Indicator	0.00002 (0.0002)	0.0001 (0.0001)	0.001* (0.0003)	0.001 (0.0004)	0.00002 (0.0003)	-0.00005 (0.0004)
Constant	-0.00000 (0.0001)	-0.00002 (0.0001)	-0.001*** (0.0002)	-0.001** (0.0002)	0.001*** (0.0002)	0.002*** (0.0002)
Observations	46	46	46	46	46	46
R ²	0.370	0.355	0.203	0.243	0.104	0.136
Adjusted R ²	0.142	0.120	-0.087	-0.032	-0.221	-0.179
Residual Std. Error (df = 33)	0.001	0.0004	0.001	0.001	0.001	0.001
F Statistic (df = 12; 33)	1.618	1.512	0.700	0.883	0.321	0.431

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURUSD 1 Minute Data - Tone - NO CONTROL VARIABLES

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.0002** (0.0001)	0.0001** (0.0001)	0.0001 (0.0002)	0.0001 (0.0002)	0.0001 (0.0002)	-0.0001 (0.0002)
Inflation	0.0001 (0.0001)	0.00005 (0.0001)	-0.0001 (0.0002)	0.0001 (0.0003)	0.0001 (0.0002)	0.0001 (0.0002)
Asset Purchase Programmes	-0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.0003 (0.0002)	0.00003 (0.0001)	0.0002 (0.0002)
Interest Rates	-0.0001* (0.0001)	-0.0001 (0.0001)	-0.00000 (0.0002)	-0.0003 (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0002)
Global Economy & Trade	-0.0001 (0.0001)	-0.00001 (0.0001)	0.0001 (0.0002)	0.0001 (0.0002)	-0.0003* (0.0002)	-0.0003 (0.0002)
Credit Market	0.00003 (0.0001)	0.00002 (0.0001)	-0.00000 (0.0002)	0.00004 (0.0002)	0.00005 (0.0001)	0.0001 (0.0002)
Structural Reforms & Growth	0.0002 (0.0001)	0.0001 (0.0001)	-0.0001 (0.0002)	-0.0002 (0.0002)	0.0002 (0.0002)	0.0001 (0.0002)
Constant	0.00001 (0.0001)	0.00001 (0.0001)	-0.0003** (0.0002)	-0.0002 (0.0002)	0.001*** (0.0001)	0.002*** (0.0002)
Observations	46	46	46	46	46	46
R ²	0.259	0.236	0.069	0.145	0.100	0.114
Adjusted R ²	0.122	0.095	-0.103	-0.013	-0.066	-0.049
Residual Std. Error (df = 38)	0.001	0.0004	0.001	0.001	0.001	0.001
F Statistic (df = 7; 38)	1.894*	1.674	0.401	0.919	0.600	0.701

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURUSD 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.00003 (0.0001)	-0.00003 (0.0001)	0.0002 (0.0002)	0.0001 (0.0002)	0.0001 (0.0001)	-0.0001 (0.0002)
Inflation	0.00001 (0.0001)	-0.00002 (0.0001)	-0.0001 (0.0002)	0.0003 (0.0002)	0.00000 (0.0001)	-0.00002 (0.0002)
Asset Purchase Programmes	-0.00004 (0.00004)	0.00002 (0.00004)	0.0001 (0.0001)	0.0002 (0.0002)	-0.00001 (0.0001)	0.0002 (0.0001)
Interest Rates	0.00001 (0.00005)	0.00003 (0.00005)	-0.0001 (0.0001)	-0.0004** (0.0002)	-0.00003 (0.0001)	-0.00004 (0.0001)
Global Economy & Trade	-0.0001 (0.0001)	-0.00003 (0.0001)	0.0001 (0.0002)	0.0001 (0.0002)	-0.0002 (0.0001)	-0.0002 (0.0002)
Credit Market	-0.00001 (0.00004)	0.00000 (0.00004)	-0.0001 (0.0001)	0.00000 (0.0002)	0.00004 (0.0001)	0.0001 (0.0001)
Structural Reforms & Growth	0.0001 (0.0001)	0.00002 (0.0001)	-0.0001 (0.0002)	-0.0003 (0.0002)	0.0002 (0.0001)	0.00004 (0.0002)
Inflation Rate Differential	0.0001 (0.0002)	0.0002 (0.0002)	0.001* (0.001)	0.0001 (0.001)	0.0002 (0.0005)	0.001 (0.001)
GDP Growth Differential	0.00000 (0.00003)	-0.00000 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00000 (0.0001)	-0.00004 (0.0001)
Current Account Differential	0.00001 (0.00005)	0.00004 (0.00005)	0.0001 (0.0001)	-0.00003 (0.0002)	-0.00003 (0.0001)	0.0001 (0.0001)
Policy Rate Differential	-0.0003 (0.0002)	-0.0005** (0.0002)	-0.001 (0.001)	-0.001 (0.001)	0.0004 (0.0005)	0.0003 (0.001)
EA Recession Indicator	0.0001 (0.0001)	0.0001 (0.0001)	0.001** (0.0003)	0.001* (0.0004)	-0.0001 (0.0002)	-0.0001 (0.0003)
Constant	-0.00002 (0.0001)	-0.0001 (0.0001)	-0.001*** (0.0002)	-0.0005** (0.0002)	0.001*** (0.0001)	0.001*** (0.0002)
Observations	46	46	46	46	46	46
R ²	0.175	0.247	0.334	0.363	0.131	0.164
Adjusted R ²	-0.125	-0.027	0.092	0.131	-0.185	-0.140
Residual Std. Error (df = 33)	0.0003	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 12; 33)	0.583	0.903	1.381	1.566	0.414	0.540

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURUSD 1 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	-0.00002 (0.0001)	-0.00002 (0.0001)	-0.0002* (0.0001)	-0.0001 (0.0002)	0.0001 (0.0001)	0.0001 (0.0002)
Inflation	0.00003 (0.0001)	0.00001 (0.0001)	0.0001 (0.0002)	-0.0002 (0.0002)	-0.0002 (0.0002)	-0.0001 (0.0002)
Asset Purchase Programmes	0.0002*** (0.0001)	0.0001** (0.00005)	-0.0003** (0.0001)	-0.0004*** (0.0001)	-0.0001 (0.0001)	-0.0002 (0.0002)
Interest Rates	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0002)	0.0001 (0.0002)	0.0001 (0.0002)	0.0001 (0.0002)
Global Economy & Trade	-0.00002 (0.0001)	-0.00002 (0.0001)	0.0001 (0.0001)	0.00005 (0.0002)	-0.00001 (0.0002)	-0.0001 (0.0002)
Credit Market	-0.00004 (0.0001)	-0.00002 (0.0001)	0.0001 (0.0001)	-0.0001 (0.0002)	-0.00004 (0.0002)	0.0001 (0.0002)
Structural Reforms & Growth	0.0001 (0.0001)	0.00004 (0.0001)	0.0001 (0.0001)	0.0002 (0.0002)	-0.00001 (0.0002)	0.00000 (0.0002)
Inflation Rate Differential	0.0003 (0.0003)	0.0003 (0.0002)	0.001 (0.001)	0.00004 (0.001)	-0.0004 (0.001)	0.00001 (0.001)
GDP Growth Differential	-0.0001 (0.00005)	-0.00004 (0.00003)	0.0001 (0.0001)	0.00004 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
Current Account Differential	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	0.00001 (0.0002)	-0.00002 (0.0002)	0.0001 (0.0002)
Policy Rate Differential	-0.001*** (0.0003)	-0.001*** (0.0002)	-0.001 (0.001)	-0.001 (0.001)	0.0001 (0.001)	-0.0002 (0.001)
EA Recession Indicator	0.00002 (0.0002)	0.0001 (0.0001)	0.001** (0.0003)	0.001* (0.0003)	-0.0001 (0.0003)	-0.0001 (0.0004)
Constant	0.00000 (0.0001)	-0.00002 (0.0001)	-0.001*** (0.0002)	-0.001** (0.0002)	0.001*** (0.0002)	0.002*** (0.0002)
Observations	46	46	46	46	46	46
R ²	0.411	0.404	0.438	0.455	0.098	0.123
Adjusted R ²	0.197	0.187	0.234	0.257	-0.230	-0.196
Residual Std. Error (df = 33)	0.0005	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 12; 33)	1.923*	1.865*	2.147**	2.296**	0.299	0.387

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURUSD 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.00002 (0.00004)	0.00003 (0.00004)	-0.0002 (0.0001)	-0.0001 (0.0001)	-0.00001 (0.0001)	0.00004 (0.0001)
Inflation	-0.00002 (0.00005)	0.00002 (0.00005)	-0.0001 (0.0001)	-0.0005*** (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)
Asset Purchase Programmes	-0.00002 (0.00004)	-0.00004 (0.00003)	-0.0002** (0.0001)	-0.0003** (0.0001)	-0.00003 (0.0001)	-0.0001 (0.0001)
Interest Rates	-0.00003 (0.0001)	-0.00003 (0.00005)	0.00002 (0.0001)	0.0003 (0.0002)	0.0001 (0.0001)	0.0001 (0.0002)
Global Economy & Trade	0.00001 (0.00005)	-0.00001 (0.00004)	0.0001 (0.0001)	0.00005 (0.0002)	0.00005 (0.0001)	-0.00002 (0.0001)
Credit Market	0.00001 (0.00004)	0.00003 (0.00004)	0.00002 (0.0001)	-0.0002 (0.0002)	-0.0001 (0.0001)	0.00003 (0.0001)
Structural Reforms & Growth	0.00000 (0.00005)	0.00000 (0.00004)	0.00004 (0.0001)	0.0002 (0.0002)	0.00001 (0.0001)	-0.00000 (0.0001)
Inflation Rate Differential	0.00003 (0.0002)	0.0001 (0.0002)	0.001 (0.0005)	-0.0001 (0.001)	-0.00002 (0.0004)	0.0004 (0.001)
GDP Growth Differential	-0.00001 (0.00003)	-0.00000 (0.00002)	0.0001 (0.0001)	0.00000 (0.0001)	-0.00002 (0.0001)	-0.00004 (0.0001)
Current Account Differential	0.00001 (0.00005)	0.00005 (0.00004)	0.0001 (0.0001)	0.00000 (0.0002)	-0.0001 (0.0001)	0.00005 (0.0001)
Policy Rate Differential	-0.0003 (0.0002)	-0.0004** (0.0002)	-0.001 (0.0005)	-0.001 (0.001)	0.0005 (0.0004)	0.0003 (0.001)
EA Recession Indicator	0.0001 (0.0001)	0.0001 (0.0001)	0.001** (0.0002)	0.001* (0.0003)	-0.0002 (0.0002)	-0.0001 (0.0003)
Constant	-0.00000 (0.0001)	-0.0001 (0.0001)	-0.001*** (0.0001)	-0.0004* (0.0002)	0.001*** (0.0001)	0.001*** (0.0002)
Observations	46	46	46	46	46	46
R ²	0.137	0.270	0.479	0.499	0.101	0.115
Adjusted R ²	-0.177	0.005	0.290	0.316	-0.226	-0.207
Residual Std. Error (df = 33)	0.0003	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 12; 33)	0.436	1.019	2.528**	2.736**	0.308	0.356

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURUSD 5 Minute Data - Uncertainty - NO CONTROL VARIABLES

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.00001 (0.00004)	0.00002 (0.00004)	-0.0002 (0.0001)	-0.0001 (0.0001)	0.00001 (0.0001)	0.00004 (0.0001)
Inflation	-0.00002 (0.00005)	0.00001 (0.00005)	-0.0002 (0.0001)	-0.0005*** (0.0002)	-0.0001 (0.0001)	-0.0001 (0.0001)
Asset Purchase Programmes	-0.00003 (0.00003)	-0.0001 (0.00004)	-0.0002** (0.0001)	-0.0003** (0.0001)	-0.00002 (0.0001)	-0.0001 (0.0001)
Interest Rates	-0.00001 (0.00005)	0.00001 (0.00005)	0.0001 (0.0001)	0.0003* (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)
Global Economy & Trade	0.00001 (0.00004)	-0.00002 (0.00005)	0.0001 (0.0001)	0.00002 (0.0002)	0.0001 (0.0001)	-0.00002 (0.0001)
Credit Market	-0.00001 (0.00004)	-0.00002 (0.00004)	-0.0001 (0.0001)	-0.0003** (0.0001)	-0.00003 (0.0001)	0.0001 (0.0001)
Structural Reforms & Growth	0.00000 (0.00004)	-0.00001 (0.00005)	0.00002 (0.0001)	0.0002 (0.0002)	0.00002 (0.0001)	-0.00001 (0.0001)
Constant	0.00003 (0.00004)	-0.00001 (0.00004)	-0.0003** (0.0001)	-0.0002 (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.067	0.101	0.317	0.418	0.048	0.079
Adjusted R ²	-0.105	-0.064	0.192	0.311	-0.127	-0.090
Residual Std. Error (df = 38)	0.0003	0.0003	0.001	0.001	0.001	0.001
F Statistic (df = 7; 38)	0.387	0.613	2.524**	3.901***	0.275	0.468

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURCHF 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	-0.00002 (0.00005)	-0.00001 (0.00003)	0.00002 (0.0001)	0.00001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
Inflation	0.0001 (0.0001)	0.00003 (0.00004)	-0.0001 (0.0001)	0.0001 (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)
Asset Purchase Programmes	0.0001* (0.00004)	0.00005* (0.00002)	0.00003 (0.0001)	0.00003 (0.0001)	0.0002** (0.0001)	0.0002** (0.0001)
Interest Rates	-0.0001 (0.00004)	-0.00003 (0.00003)	0.0001 (0.0001)	0.00005 (0.0001)	0.00001 (0.0001)	0.0001 (0.0001)
Global Economy & Trade	0.00002 (0.00005)	0.00003 (0.00003)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.00002 (0.0001)	-0.0001 (0.0001)
Credit Market	-0.00000 (0.00004)	-0.00001 (0.00003)	0.00003 (0.0001)	-0.0001 (0.0001)	0.00004 (0.0001)	-0.00001 (0.0001)
Structural Reforms & Growth	-0.0001** (0.0001)	-0.0001* (0.00004)	-0.0001 (0.0001)	-0.0002 (0.0002)	-0.0002* (0.0001)	-0.0001 (0.0001)
Inflation Rate Differential	0.00000 (0.0001)	-0.00004 (0.0001)	-0.001 (0.0003)	-0.001** (0.0004)	-0.0002 (0.0003)	-0.0001 (0.0004)
GDP Growth Differential	0.00001 (0.00002)	0.00001 (0.00001)	-0.00000 (0.00004)	-0.00002 (0.0001)	-0.00003 (0.00004)	-0.00001 (0.0001)
Current Account Differential	-0.00001 (0.00001)	-0.00001 (0.00001)	-0.00004 (0.00002)	-0.00005 (0.00003)	-0.00001 (0.00002)	-0.00002 (0.00003)
Policy Rate Differential	0.009 (0.007)	0.004 (0.005)	-0.004 (0.015)	-0.010 (0.020)	0.009 (0.014)	0.002 (0.018)
EA Recession Indicator	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0002)	0.00000 (0.0002)	-0.0001 (0.0002)	-0.00002 (0.0002)
Constant	-0.00004 (0.0001)	-0.00003 (0.00004)	0.0001 (0.0001)	0.00004 (0.0002)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.212	0.214	0.321	0.296	0.190	0.211
Adjusted R ²	-0.074	-0.072	0.074	0.039	-0.105	-0.076
Residual Std. Error (df = 33)	0.0002	0.0002	0.001	0.001	0.0005	0.001
F Statistic (df = 12; 33)	0.742	0.748	1.301	1.154	0.643	0.736

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURCHF 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	-0.00002 (0.00003)	-0.00003 (0.00004)	-0.00001 (0.0001)	-0.00002 (0.0001)	-0.0001 (0.0001)	-0.00004 (0.0001)
Inflation	0.00002 (0.00004)	0.00002 (0.00004)	-0.00002 (0.0001)	0.0002 (0.0002)	0.0001 (0.0001)	0.0001 (0.0001)
Asset Purchase Programmes	0.00003 (0.00002)	0.0001** (0.00003)	0.00004 (0.0001)	0.00004 (0.0001)	0.0001** (0.0001)	0.0001* (0.0001)
Interest Rates	0.00002 (0.00003)	0.00002 (0.00003)	0.0001 (0.0001)	0.00003 (0.0001)	0.00000 (0.0001)	0.0001 (0.0001)
Global Economy & Trade	0.00002 (0.00003)	-0.00000 (0.00003)	-0.0001 (0.0001)	-0.0001 (0.0001)	0.00002 (0.0001)	-0.0001 (0.0001)
Credit Market	0.00000 (0.00003)	0.00000 (0.00003)	0.00004 (0.0001)	-0.0001 (0.0001)	0.00001 (0.0001)	-0.0001 (0.0001)
Structural Reforms & Growth	-0.0001 (0.00004)	-0.00004 (0.00004)	-0.0002 (0.0001)	-0.0002 (0.0001)	-0.0001 (0.0001)	-0.00003 (0.0001)
Inflation Rate Differential	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0004 (0.0003)	-0.001** (0.0004)	-0.0002 (0.0002)	-0.0002 (0.0003)
GDP Growth Differential	-0.00001 (0.00001)	-0.00000 (0.00001)	0.00003 (0.00004)	0.00000 (0.0001)	-0.00002 (0.00003)	-0.00001 (0.00004)
Current Account Differential	-0.00000 (0.00001)	-0.00000 (0.00001)	-0.0001** (0.00002)	-0.0001* (0.00003)	-0.00001 (0.00002)	-0.00002 (0.00002)
Policy Rate Differential	0.002 (0.005)	0.002 (0.005)	-0.012 (0.014)	-0.019 (0.019)	0.011 (0.010)	0.003 (0.015)
EA Recession Indicator	0.00003 (0.0001)	0.0001 (0.0001)	-0.00004 (0.0002)	0.0001 (0.0002)	-0.0002 (0.0001)	-0.0001 (0.0002)
Constant	-0.00001 (0.00003)	-0.00003 (0.00004)	0.00001 (0.0001)	-0.00000 (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.189	0.263	0.359	0.339	0.205	0.230
Adjusted R ²	-0.106	-0.006	0.125	0.098	-0.084	-0.050
Residual Std. Error (df = 33)	0.0002	0.0002	0.001	0.001	0.0004	0.001
F Statistic (df = 12; 33)	0.641	0.979	1.538	1.409	0.708	0.821

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURCHF 1 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.00002 (0.00004)	0.00001 (0.00003)	-0.0002*** (0.0001)	-0.0001 (0.0001)	0.00001 (0.0001)	0.00004 (0.0001)
Inflation	-0.0001 (0.0001)	-0.00004 (0.00003)	0.0002** (0.0001)	-0.0001 (0.0001)	-0.00000 (0.0001)	0.0001 (0.0001)
Asset Purchase Programmes	0.00001 (0.00003)	-0.00001 (0.00002)	-0.0001** (0.0001)	-0.0001 (0.0001)	-0.0002*** (0.0001)	-0.0002** (0.0001)
Interest Rates	0.0001 (0.00005)	0.00004 (0.00003)	-0.0002** (0.0001)	-0.0002 (0.0001)	0.0001 (0.0001)	0.00001 (0.0001)
Global Economy & Trade	-0.00003 (0.00004)	-0.00001 (0.00003)	0.00004 (0.0001)	0.0001 (0.0001)	-0.00004 (0.0001)	0.0001 (0.0001)
Credit Market	-0.00005 (0.00004)	-0.00003 (0.00003)	0.0002** (0.0001)	0.00001 (0.0001)	0.00005 (0.0001)	0.00005 (0.0001)
Structural Reforms & Growth	0.00001 (0.00004)	0.00001 (0.00003)	0.0001 (0.0001)	0.0002 (0.0001)	-0.00000 (0.0001)	-0.00004 (0.0001)
Inflation Rate Differential	-0.00002 (0.0001)	-0.0001 (0.0001)	-0.001** (0.0002)	-0.001*** (0.0003)	-0.0001 (0.0003)	-0.0001 (0.0004)
GDP Growth Differential	0.00000 (0.00002)	0.00000 (0.00001)	0.0001* (0.00003)	-0.00001 (0.0001)	-0.00001 (0.00004)	0.00000 (0.0001)
Current Account Differential	0.00000 (0.00001)	-0.00000 (0.00001)	-0.0001*** (0.00002)	-0.0001* (0.00003)	-0.00001 (0.00002)	-0.00002 (0.00003)
Policy Rate Differential	0.010 (0.006)	0.005 (0.004)	-0.020* (0.011)	-0.009 (0.016)	0.009 (0.012)	0.006 (0.017)
EA Recession Indicator	-0.0001 (0.0001)	-0.0001 (0.0001)	0.00001 (0.0001)	0.00002 (0.0002)	-0.0001 (0.0001)	-0.00000 (0.0002)
Constant	-0.00004 (0.0001)	-0.00003 (0.00004)	-0.00002 (0.0001)	0.00003 (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.164	0.157	0.598	0.423	0.275	0.212
Adjusted R ²	-0.141	-0.149	0.451	0.213	0.011	-0.075
Residual Std. Error (df = 33)	0.0003	0.0002	0.0004	0.001	0.0005	0.001
F Statistic (df = 12; 33)	0.538	0.513	4.085***	2.017*	1.041	0.738

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURCHF 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.00000 (0.00003)	-0.00000 (0.00003)	-0.0002*** (0.0001)	-0.0001 (0.0001)	0.00001 (0.0001)	0.00001 (0.0001)
Inflation	0.00001 (0.00003)	0.00004 (0.00004)	0.0002** (0.0001)	-0.0001 (0.0001)	-0.00005 (0.0001)	0.00002 (0.0001)
Asset Purchase Programmes	-0.00005** (0.00002)	-0.0001** (0.00002)	-0.0001 (0.0001)	0.00001 (0.0001)	-0.0001*** (0.00005)	-0.0001* (0.0001)
Interest Rates	0.00000 (0.00003)	-0.00001 (0.00003)	-0.0002* (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	-0.00000 (0.0001)
Global Economy & Trade	-0.00002 (0.00003)	0.00000 (0.00003)	0.00003 (0.0001)	0.0001 (0.0001)	-0.00001 (0.0001)	0.0001 (0.0001)
Credit Market	0.00002 (0.00002)	0.00002 (0.00003)	0.0001* (0.0001)	-0.00004 (0.0001)	-0.00000 (0.0001)	0.00001 (0.0001)
Structural Reforms & Growth	0.00000 (0.00003)	0.00000 (0.00003)	0.0001 (0.0001)	0.0002 (0.0001)	-0.00001 (0.0001)	-0.0001 (0.0001)
Inflation Rate Differential	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0005** (0.0002)	-0.001** (0.0004)	-0.0002 (0.0002)	-0.0002 (0.0003)
GDP Growth Differential	-0.00000 (0.00001)	0.00001 (0.00001)	0.0001*** (0.00004)	0.00001 (0.0001)	-0.00002 (0.00003)	-0.00001 (0.00004)
Current Account Differential	-0.00000 (0.00001)	-0.00000 (0.00001)	-0.0001*** (0.00002)	-0.0001* (0.00003)	-0.00000 (0.00002)	-0.00002 (0.00003)
Policy Rate Differential	0.003 (0.004)	0.001 (0.004)	-0.028** (0.011)	-0.016 (0.017)	0.015* (0.008)	0.010 (0.014)
EA Recession Indicator	0.00004 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0002)	-0.0002* (0.0001)	-0.0001 (0.0002)
Constant	-0.00002 (0.00003)	-0.00005 (0.00004)	-0.0001 (0.0001)	-0.00001 (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.222	0.248	0.549	0.381	0.297	0.204
Adjusted R ²	-0.061	-0.026	0.385	0.155	0.042	-0.085
Residual Std. Error (df = 33)	0.0002	0.0002	0.0004	0.001	0.0003	0.001
F Statistic (df = 12; 33)	0.785	0.905	3.350***	1.689	1.164	0.705

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURTRY 1 Minute Data - Tone

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.0000 (0.00004)	0.0000 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
Inflation	0.0003 (0.0001)	0.0001 (0.00004)	-0.0002 (0.0001)	0.0004 (0.0002)	0.0001 (0.0001)	0.0001 (0.0002)
Asset Purchase Programmes	0.0005 (0.00004)	0.0003 (0.00003)	-0.00001 (0.0001)	-0.00001 (0.0001)	0.0002** (0.0001)	0.0002** (0.0001)
Interest Rates	-0.00004 (0.00004)	-0.00002 (0.00003)	0.0001 (0.0001)	-0.00002 (0.0001)	0.00003 (0.0001)	0.0001 (0.0001)
Global Economy & Trade	0.0002 (0.0001)	0.0002 (0.00003)	-0.0001 (0.0001)	-0.0001 (0.0002)	-0.00004 (0.0001)	-0.0001 (0.0001)
Credit Market	-0.00004 (0.00004)	-0.00003 (0.00003)	-0.00004 (0.0001)	-0.0001 (0.0001)	0.00004 (0.0001)	0.00001 (0.0001)
Structural Reforms & Growth	-0.0001 (0.00005)	-0.0001 (0.00003)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.00003 (0.0001)
Inflation Rate Differential	0.0004 (0.00004)	0.0003 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
GDP Growth Differential	-0.00001 (0.00002)	-0.00001 (0.00001)	-0.00000 (0.00004)	0.00002 (0.00005)	0.00002 (0.00003)	0.00004 (0.00004)
Current Account Differential	-0.00000 (0.00002)	-0.00001 (0.00001)	-0.00002 (0.00004)	-0.00005 (0.0001)	0.00001 (0.00004)	-0.00000 (0.00005)
Policy Rate Differential	-0.00001 (0.00003)	-0.00000 (0.00002)	-0.00004 (0.0001)	0.00002 (0.0001)	0.00004 (0.0001)	0.00005 (0.0001)
EA Recession Indicator	-0.0001 (0.0001)	-0.00004 (0.0001)	-0.00001 (0.0002)	0.0001 (0.0002)	-0.00005 (0.0002)	0.00004 (0.0002)
Constant	-0.0001 (0.00005)	-0.00004 (0.00003)	0.00001 (0.0001)	-0.00001 (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.198	0.193	0.267	0.213	0.180	0.219
Adjusted R ²	-0.093	-0.101	0.001	-0.074	-0.118	-0.066
Residual Std. Error (df = 33)	0.0002	0.0002	0.001	0.001	0.0005	0.001
F Statistic (df = 12; 33)	0.681	0.657	1.002	0.743	0.605	0.769

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURTRY 5 Minute Data - Tone

	<i>Dependent variable:</i>					
	UV_{30}	UV_{60}	DC_{30}	DC_{60}	TR_{30}	TR_{60}
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	-0.00001 (0.00003)	-0.00002 (0.00003)	0.00003 (0.0001)	0.00005 (0.0001)	-0.00002 (0.0001)	-0.00000 (0.0001)
Inflation	0.00001 (0.00004)	0.00001 (0.00004)	-0.0001 (0.0001)	0.0001 (0.0002)	0.00004 (0.0001)	0.0001 (0.0001)
Asset Purchase Programmes	0.00002 (0.00003)	0.00005* (0.00003)	0.00001 (0.0001)	0.00001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Interest Rates	0.00002 (0.00003)	0.00002 (0.00003)	0.0001 (0.0001)	-0.0001 (0.0001)	0.00002 (0.0001)	0.0001 (0.0001)
Global Economy & Trade	0.00001 (0.00003)	-0.00001 (0.00004)	-0.00005 (0.0001)	-0.0001 (0.0002)	-0.00001 (0.0001)	-0.0001 (0.0001)
Credit Market	-0.00001 (0.00003)	-0.00001 (0.00003)	-0.00001 (0.0001)	-0.0001 (0.0001)	-0.00003 (0.0001)	-0.0001 (0.0001)
Structural Reforms & Growth	-0.00004 (0.00003)	-0.00002 (0.00004)	-0.0002 (0.0001)	-0.0002 (0.0001)	-0.0001 (0.0001)	0.00002 (0.0001)
Inflation Rate Differential	-0.00001 (0.00003)	-0.00000 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00001 (0.0001)	0.00003 (0.0001)
GDP Growth Differential	0.00000 (0.00001)	0.00001 (0.00001)	-0.00002 (0.00003)	-0.00000 (0.00005)	0.00002 (0.00002)	0.00003 (0.00003)
Current Account Differential	0.00000 (0.00001)	-0.00000 (0.00001)	-0.00002 (0.00004)	-0.00004 (0.0001)	-0.00000 (0.00003)	-0.00002 (0.00004)
Policy Rate Differential	0.00000 (0.00002)	0.00000 (0.00002)	-0.0001 (0.0001)	0.00000 (0.0001)	0.00001 (0.00004)	-0.00001 (0.0001)
EA Recession Indicator	0.0001 (0.0001)	0.0001 (0.0001)	0.00001 (0.0002)	0.0001 (0.0002)	-0.0001 (0.0001)	-0.00004 (0.0002)
Constant	-0.00003 (0.00003)	-0.00005 (0.00003)	-0.00002 (0.0001)	-0.00003 (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.157	0.239	0.271	0.213	0.152	0.231
Adjusted R ²	-0.150	-0.037	0.006	-0.073	-0.156	-0.049
Residual Std. Error (df = 33)	0.0002	0.0002	0.001	0.001	0.0004	0.001
F Statistic (df = 12; 33)	0.512	0.864	1.024	0.746	0.494	0.825

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURTRY 1 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.00003 (0.00004)	0.00002 (0.00002)	-0.0002*** (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Inflation	-0.00003 (0.00005)	-0.00002 (0.00003)	0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.00001 (0.0001)
Asset Purchase Programmes	0.00003 (0.00004)	0.00001 (0.00003)	-0.0002* (0.0001)	-0.0001 (0.0001)	-0.0002*** (0.0001)	-0.0002* (0.0001)
Interest Rates	-0.00001 (0.00003)	-0.00000 (0.00002)	-0.00001 (0.0001)	-0.00001 (0.0001)	0.00003 (0.0001)	0.0001 (0.0001)
Global Economy & Trade	-0.00001 (0.00004)	-0.00001 (0.00003)	-0.00004 (0.0001)	0.00001 (0.0001)	-0.00003 (0.0001)	0.0001 (0.0001)
Credit Market	-0.00003 (0.00004)	-0.00003 (0.00002)	0.0001 (0.0001)	-0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Structural Reforms & Growth	0.00001 (0.00005)	0.00000 (0.00003)	0.0001 (0.0001)	0.0002 (0.0001)	-0.00002 (0.0001)	-0.00004 (0.0001)
Inflation Rate Differential	0.00004 (0.00004)	0.00002 (0.00003)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00004 (0.0001)	0.00001 (0.0001)
GDP Growth Differential	0.00000 (0.00002)	0.00000 (0.00001)	-0.00001 (0.00003)	0.00002 (0.00005)	0.00001 (0.00003)	0.00002 (0.00004)
Current Account Differential	-0.00000 (0.00002)	-0.00001 (0.00001)	-0.00002 (0.00004)	-0.00002 (0.0001)	0.00002 (0.00003)	0.00000 (0.00005)
Policy Rate Differential	-0.00000 (0.00003)	0.00000 (0.00002)	-0.00002 (0.0001)	0.00001 (0.0001)	-0.00001 (0.00005)	-0.00004 (0.0001)
EA Recession Indicator	-0.0001 (0.0001)	-0.00004 (0.0001)	0.00002 (0.0002)	0.0001 (0.0002)	-0.0001 (0.0001)	0.00003 (0.0002)
Constant	-0.0001 (0.0001)	-0.00004 (0.00003)	-0.00001 (0.0001)	-0.00002 (0.0001)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.105	0.116	0.320	0.217	0.267	0.251
Adjusted R ²	-0.220	-0.205	0.073	-0.068	0.001	-0.022
Residual Std. Error (df = 33)	0.0003	0.0002	0.001	0.001	0.0005	0.001
F Statistic (df = 12; 33)	0.324	0.361	1.295	0.761	1.002	0.920

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.

EURTRY 5 Minute Data - Uncertainty

	<i>Dependent variable:</i>					
	<i>UV</i> ₃₀	<i>UV</i> ₆₀	<i>DC</i> ₃₀	<i>DC</i> ₆₀	<i>TR</i> ₃₀	<i>TR</i> ₆₀
	(1)	(2)	(3)	(4)	(5)	(6)
Financial Markets	0.00000 (0.00002)	0.00000 (0.00002)	-0.0002** (0.0001)	-0.0001 (0.0001)	0.00003 (0.00005)	0.00004 (0.0001)
Inflation	0.00001 (0.00003)	0.00002 (0.00003)	0.0001 (0.0001)	-0.0002 (0.0001)	0.00002 (0.0001)	-0.00003 (0.0001)
Asset Purchase Programmes	-0.0001** (0.00002)	-0.00005* (0.00002)	-0.0001 (0.0001)	0.00001 (0.0001)	-0.0001** (0.0001)	-0.0001 (0.0001)
Interest Rates	0.00002 (0.00002)	0.00002 (0.00002)	-0.00002 (0.0001)	-0.00002 (0.0001)	0.00003 (0.00004)	0.0001 (0.0001)
Global Economy & Trade	-0.00002 (0.00003)	0.00000 (0.00003)	-0.00005 (0.0001)	0.00001 (0.0001)	0.00000 (0.0001)	0.0001 (0.0001)
Credit Market	0.00002 (0.00002)	0.00001 (0.00002)	0.0001 (0.0001)	-0.0001 (0.0001)	0.00003 (0.0001)	0.00002 (0.0001)
Structural Reforms & Growth	0.00000 (0.00003)	0.00001 (0.00003)	0.0001 (0.0001)	0.0002 (0.0001)	-0.00002 (0.0001)	-0.00004 (0.0001)
Inflation Rate Differential	-0.00001 (0.00002)	0.00001 (0.00002)	0.0001 (0.0001)	0.0001 (0.0001)	-0.00001 (0.0001)	0.0001 (0.0001)
GDP Growth Differential	0.00000 (0.00001)	0.00000 (0.00001)	-0.00003 (0.00003)	0.00002 (0.00005)	0.00001 (0.00002)	0.00002 (0.00003)
Current Account Differential	0.00001 (0.00001)	0.00000 (0.00001)	-0.00001 (0.00004)	-0.00002 (0.0001)	0.00000 (0.00003)	-0.00001 (0.00004)
Policy Rate Differential	-0.00000 (0.00002)	-0.00001 (0.00002)	-0.00005 (0.0001)	-0.00001 (0.0001)	-0.00001 (0.00004)	-0.0001 (0.0001)
EA Recession Indicator	0.00005 (0.00005)	0.0001 (0.0001)	0.0001 (0.0002)	0.0002 (0.0002)	-0.0001 (0.0001)	-0.00004 (0.0002)
Constant	-0.00003 (0.00003)	-0.00005 (0.00003)	-0.00004 (0.0001)	-0.00004 (0.0002)	0.001*** (0.0001)	0.001*** (0.0001)
Observations	46	46	46	46	46	46
R ²	0.228	0.265	0.240	0.190	0.225	0.257
Adjusted R ²	-0.052	-0.003	-0.037	-0.104	-0.057	-0.013
Residual Std. Error (df = 33)	0.0002	0.0002	0.001	0.001	0.0004	0.001
F Statistic (df = 12; 33)	0.814	0.990	0.867	0.646	0.798	0.953

Note: Dependent variables are *unexpected volatility* (UV), *directional price change* (DC) and *trading range* (TR). Number in index indicates event window size (either 30 or 60 minutes from the release of the document). ***, ** and * denote significance at the 1, 5 and 10% levels, respectively. All textual and control variables in first difference except for recession indicators.