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Deconstructing the Fed's decisions: analysis of the factors influencing monetary policy in the US

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Abstract

While the impact of monetary policy on the economy is a well-researched topic, the influence of economic conditions on the monetary policy decision-making process attracts scant attention in the existing literature. In theory, monetary policy goals are well-established by legal acts, but the decision--making process conducted by the policymakers is impacted by many factors related to the real economy and financial markets. In this paper, I deconstruct the process executed by the Federal Open Market Committee by estimating a factor model on the basis of data extracted from the FOMC minutes by means of text mining. I therefore find that variables connected with financial markets, housing, and investment, as well as the global economy may cause a significant divergence of interest rates from the policy rule, as constructed on the official monetary policy goals.

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1. Introduction

Interest rates are among the most crucial indicators in today's economy. They influence the behaviour of almost all actors in the market and, therefore, they affect the economy as a whole. There is a considerable volume of literature pertinent to the impact of monetary policy on the economy, and there are several well-established theories in that regard.

When it comes to monetary policy communication, only the central bank's forward guidance has its place in the literature – just to mention McKay, Nakamura and Steinsson (2016), Del Negro, Giannoni and Patterson (2023), Rybacki (2019). This paper approaches this issue from a different perspective; it aims to understand what influences monetary policy decisions, not how these decisions impact the markets. It thus means that this paper focuses on the whole decision-making process conducted by the authorities responsible for monetary policy, with this study's goal being to find the main driving forces behind those decisions.

Monetary policy is considered an invention of the 20th century, so compared to the whole history of economics it is a relatively new concept. Moreover, in each country or monetary union it takes various forms and the specific objectives may differ. Therefore, this paper focuses on the US economy and analyses the decisions of the American monetary authority. With its longest-standing tradition dating back to 1913, when the Federal Reserve Act was passed, the Federal Reserve has been responsible for setting American monetary policy ever since. The decision-making process of the Federal Reserve, particularly the Federal Open Market Committee (FOMC), which is the Fed's organ that decides about monetary policy, has evolved over the last century. Despite a vast body of literature on the Fed's influence on the economy, the decision-making process itself is an underexplored subject and many a question on the factors influencing policymakers' decisions remain open. The Fed was often criticized for its choices, and the most striking example comes from the 1930s, when the American economy was blighted by the Great Depression. Many historians claim that the Fed not only failed to prevent the Great Depression, but it was also primarily responsible for its length and severity. It therefore begs an obvious question: What drives the Fed's decisions and which factors do policymakers take into account?

1.1. Monetary policy goals

The starting point for the monetary policy decision-making process analysis has to include a clear definition of policy goals and the idea behind constituting monetary authorities. The monetary policy authority is often associated with an institution that should care about price stability. It, in fact, holds true for many countries where the only objective of the central bank is to keep inflation on a moderate level. However, when analysing the Federal Reserve Act, in the section entitled Monetary Policy Objectives the following statement is to be found: "The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long-run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." Hence, it is possible to see the Fed's mandate more broadly and analysing it according to the last part of the sentence we could distinguish three goals of the monetary policy:

– maximum employment,
– stable prices,
– moderate long-term interest rates.

What ought to be emphasized at this point is that there is no hierarchy among these objectives. According to the Federal Reserve Act, all of them are equally important, thereby emphasizing a substantial difference between the Fed and the ECB. The Treaty on the Functioning of the European Union, which also includes articles concerning monetary policy goals, establishes a clear hierarchy of objectives for the Eurosystem, as it assigns overriding importance to price stability. The Treaty clearly stipulates that ensuring price stability is the most salient contribution that monetary policy can make in order to achieve a favourable economic environment and a high level of employment.

The equal importance of those goals provided in the Federal Reserve Act gives a significant latitude for policymakers' interpretation. However, in the Statement on Longer-Run Goals and Monetary Policy Strategy issued annually by the Fed, the interpretation of the objectives leads more towards a dual mandate. Pursuant to Debortoli (2019), the dual mandate signifies that the important aspects are confined to inflation and unemployment only. According to Mishkin (2007), the reason behind this rationale is that an economy in which people willing to take up work either already have a job or are likely to find one fairly quickly and in which the price level (i.e. a broad measure of the price of goods and services purchased by consumers) is stable, creates the conditions needed for interest rates to settle at moderate levels. In the Statement from 2019, the Fed underlines a balanced approach toward both employment and inflation, but also notes that in its reaction function it will take into account the magnitude of the deviations and the potentially different time horizons over which employment and inflation are projected to return to levels consistent with its mandate.

Furthermore, there is also the first part of the article from the Federal Reserve Act, which says that the Fed should control the growth of the monetary and credit aggregates, as well as establish it on a similar level to the economy's long-run potential to increase production. Hence, a few questions arise; first of all, what aggregates should the Fed take into account? It is a well-known fact that in a modern economy, the central bank is not directly controlling the money supply, because money is created endogenously by commercial banks. Such a reality is confirmed by Disyatat (2011), Mcleay et al. (2014), Sheard (2013), and Kapuściński (2017) and it changes the perspective on the set of tools that the Fed could use to control the quantity of money in the system. Moreover, there also exists a limitation connected with the measurement of the long-run production potential in the economy.

Another interesting document that has a strong impact on monetary policy is the Statement on Longer-Run Goals and Monetary Policy Strategy. It corroborates the three main objectives mentioned in the Federal Reserve Act, but it also adds a few other points to the discussion. First and foremost, it emphasizes the role of the clarity of decisions as a factor that reduces economic and financial uncertainty and one that increases the effectiveness of monetary policy. The second issue concerns the inflation target; several authors claim it should be symmetric, i.e. the reaction of the price index when it is below or above the target should be similar. Also, the employment objective is evaluated; according to the statement, the maximum level of employment is largely determined by non-monetary factors that affect the structure and dynamics of the labour market. Hence, the committee uses its estimates of the natural unemployment rate to evaluate the fulfilment of the objective. Notably, the authors of this act admit that monetary policy actions tend to influence economic activity and prices with a lag which is taken into account by the FOMC in the decision-making process.

1.2. Measurement of the monetary policy goals

In order to be able to assess whether the monetary authority is achieving its goals, a proper measure is necessary. Policy rules are theoretical concepts that prescribe a certain level for the policy rate, one that is commensurate with the inflation deviation from the central bank's objective and the output gap. A well-known example of such a rule is the Taylor rule, which serves as a benchmark for other similar ideas. Developed by John B. Taylor in 1993 (Taylor 1993), the rule uses the inflation rate over the previous four quarters, the percentage deviation of real GDP from a target, an inflation target equal to 2% and Taylor's approximation for the real rate equal to 2%. A simple equation with fixed coefficients yields the value of interest rate which the Fed should maintain for certain levels of inflation and output gap. After the above-mentioned seminal paper was published in 1993, many other researchers added more aspects, thus expanding the concept. A number of them attempted to estimate the parameters of the function. In the late 20th century, Judd and Rudebusch (1998) estimated the Fed's reaction functions according to which the funds rate operating target adjusts in response to changes in an implicit desired level of the Fed's funds rate, in line with the partial-adjustment dynamics. Even Taylor (1999) endeavoured to estimate the parameters of his rule again. Subsequently, further attempts were made by Clarida, Gali and Gertler (2000), and Orphanides (2001), but the aforementioned authors differ not only with respect to the assumptions and methodology, but also with respect to the results. Therefore, it poses a major challenge to find one correct specification of the policy rule that would match reality best. However, the concept of policy rules is highly useful in monetary policy analysis. By assumption, it contains two main economic variables constituting the Fed's objectives. Additionally, it could be modified with some other factors that are taken into account by the FOMC when deciding about the interest rates.

On a similar note, an interesting work by Kahn (2010) contains an analysis of the relationship between short-term interest rates and a variety of financial indicators designed to capture imbalances in the economy, making it one of the inspirations for this article. The said paper aims to answer the question of whether the monetary policy in the period leading up to the crisis leaned against or, contrarily, contributed to the building of imbalances with regard to the housing and stock markets, as well as leverage. To establish that, Kahn uses the deviation from the policy rule as an indicator of the policy being too lax or too tight. He arrives at the conclusion that lagged Taylor rule deviations appear to help predict the housing bubble and, to a lesser extent, commodity price movements.

This article goes a step back in this process and tries to find what the primary cause of the policy rule deviation is that, according to Kahn, can influence the markets.

1.3. Understanding the consequences of monetary policy decisions

The Federal Open Market Committee comprises experienced economists and researchers who have a great understanding of various aspects pertinent to monetary policy. Hence, it can be assumed that the staff can draw the conclusions emerging from the vast monetary policy literature on this topic. There are a number of impactful articles breaking down the consequences of different monetary policy actions depending on the present economic situation. Thus, an analysis of the subject-related literature provides a preliminary outlook on the issues that are taken into consideration by policymakers to make decisions on interest rates.

The seminal paper by Clarida, Gali and Gertler (1999) indicates a string of interesting issues about monetary policy and its implications for the economy. First, it suggests that, without a sound understanding of the inflation determinants, it is difficult for monetary policy to grow more efficient. Galí and Gambetti (2015) claim that persistence in inflation may be related to a sluggish adjustment of unit labour costs vis-a-vis movements in output.

Another issue concerns the problem of the zero lower bound. Recent history showed that in the analysis of historical data and in the forecasting of the Fed's future movements, the possibility of negative interest rates should be allowed to remain closer to the real economy. The third issue which could be found in Clarida, Gali and Gertler (1999) and is of relevance for this work is the discrepancy between the federal funds rate and the optimal interest rate implied by macroeconomic models. The market rate is much smoother than the highly volatile optimal rate. This should not come as a surprise, taking into account the Fed's statement mentioned in the previous section.

Important evidence concerning the decision-making process of the FOMC is also provided in the literature on the monetary transmission mechanism, which is the second topic important for this paper. As outlined in the previous section, the Fed employs a big dataset in its decision-making process. Due to the economy becoming increasingly complicated and owing to the growing availability of data, many researchers conduct analyses using many economic variables. One of the first such papers was the one by Bernanke, Boivin and Eliasz (2005), in which the authors used a FAVAR approach to measure the effects of monetary policy. They examined the dynamic effects of innovations to monetary policy using 120 economic variables. Another approach was presented by Favero, Marcellino and Neglia (2005), in which principal components and dynamic factor models were employed. An analysis on two large datasets, one from the US and one from Europe, shows that factor models naturally produce highly useful instruments for the estimation of forward-looking economic models involving future expected variables. A structural factor model approach was adopted by Forni and Gambetti (2010) to study the effects of monetary policy. The results obtained with the factor model stand in sharp contrast with those produced with the VAR model and could be considered more reliable because of a much larger amount of information included. Another usage of structural dynamic factor models was presented by Luciani (2015); the author underscored the significance of the relationship between monetary policy and the housing market. He suggested that after the 1980s there was a structural break and housing demand shocks accounted for a slightly higher portion of model variability, while the role of monetary policy in determining residential investment fluctuations slightly decreased.

A seminal paper of Christiano, Eichenbaum and Evans (1999) considers what happens after an exogenous shock to monetary policy. It is a very important question that the Fed poses when deciding about the interest rates. Most of the specification that the authors use give similar results; the consequence of a contractionary policy shock is firstly a persistent decline in the growth rate of M2 and a rise in the interest rate. Further consequences, such as a persistent decline in the GDP deflator and the prices of intermediate goods and crude materials, may be deemed the economy's reaction to increasing the interest rates by the Fed. Output, which is another important factor for the Fed, drops continually with a short delay after prices. Such results are well established in the literature and have been confirmed by many papers. It can indicate that the Fed evaluates its policy ex ante according to such a scheme. Despite its impact on the US economy, Kim (2001) shows that the Fed's decisions also influence other countries. Based on a VAR analysis, he concludes that the US expansionary monetary policy shocks lead to booms in the non-US G6 countries. Moreover, Kim examines the consequences

for international trade and, according to his results, a monetary expansion worsens the trade balance of the US in the short run, but persistently improves trade balances in the medium and the long run. Borio and Zhu (2009) stress the role of the link between monetary policy and the perception and pricing of risk by economic agents. It is also important for this paper's analysis because it places a premium on the financial sector, one of the markets that involve the greatest risk. From the analysis of the Fed's documents, it can be inferred that policymakers consider many financial variables, which may suggest that they are aware of this "risk-taking channel."

Taylor (2007), on the other hand, calls attention to the housing market and claims that thanks to an improved monetary policy during the Great Moderation, volatility of the housing market decreased significantly. However, the financial crisis showed that this sector continues to be marked with high fragility and is prone to huge fluctuations caused by many external factors, including monetary policy. This paper corroborates the role of the housing market, as it is also stressed in the Fed's minutes. A paper by English, López-Salido and Tetlow (2015) investigates in more detail the changes in the Fed's monetary policy in recent years. The authors claim that the Federal Reserve has moved closer to the "flexible inflation targeting" regime, but still the FOMC follows a balanced approach to its dual objectives and uses a flexible horizon over which the policy aims to foster its objectives. In the study, the authors employ a small New Keynesian model to calculate optimal control policies under rational expectations and full policy credibility. Their findings prove to be of significant academic interest. Firstly, simple rules failed to deliver a sufficient stimulus to satisfy the Federal Reserve's dual mandate in a reasonable period of time. Also, augmenting such rules with thresholds could generate significant and reliable improvements in macroeconomic outcomes. In addition, they find that introducing a permanent increase in the inflation target and a shift to a nominal income level target (instead of the output or unemployment gap) could improve economic outcomes as long as the change in the framework is well understood by the public and is seen as credible.

1.4. Monetary policy decision-making process records

Monetary policy decisions and their communication have as yet been researched from many different perspectives. Some articles look at social media posts and threads to capture real-time opinions on the current state of the economy and predict interest rate changes (Lüdering, Tillmann 2020; Masciandaro, Peia, Romelli, 2023). While this approach may be useful to predict short-term policy changes, it makes it very hard to sift out opinions that are not relevant for the discussion during FOMC meetings. For the purpose of the analysis in this article, an official source has been selected to serve as its basis.

After each of the FOMC meetings, the committee publishes minutes, which are the most important source of information on current monetary policy. The crucial part of this document consists of the staff review of the economic situation. In that section, the authors describe all the factors that are of significance for monetary policy decisions. They consider many aspects of both the real sector and financial markets. It is not unpopular to use minutes as a data source for text mining exercises and it has proven to allow for testing various hypotheses. Tumala and Omotosho (2019) tested the readability of the Nigerian central bank minutes, Acosta (2015) researched the FOMC's responses to calls for transparency, and Apel and Grimaldi (2012) measured the sentiment and the tone of the minutes of the Swedish central bank. One of the crucial aspects of text data analysis is a proper data cleaning procedure

and a choice of robust methods (Bholat et al. 2015). The significance of the tools used was confirmed in the research by Park, Lee and Kim (2019), where a selection of dictionaries made an important change in the results. For the purpose of this research, a dictionary by Loughran and McDonald (2011) is chosen. This dictionary was developed based on analyses of financial reports, which makes it a sound choice for the objective. It was also used for an FOMC minutes analysis in Hansen and McMahon (2016), where the authors analysed shocks to forward guidance and FOMC communication on the real economy. Since the effects they found were not very strong, in this article the overarching problem is viewed from a different perspective by looking at the economic variables that may shape the FOMC decisions.

This article follows a procedure that allows for analysing the FOMC decision-making process. The literature incorporated in this section constitutes the first step in this process. It enables an understanding of the monetary policy goals and ways to measure them, as well as the consequences of monetary policy actions that have to be taken into account by the policymakers. It also helps to have a preliminary comprehension of the potential economic factors that may be important for this research. The second step consists of a thorough analysis of the minutes published by the FOMC. By way of text mining techniques, important findings on the factors shaping the discussion can be drawn.

Section 3 includes the next step in the procedure; by building on the findings from the preceding sections it sees a model in which the deviation from the policy rule is explained by a gamut of economic variables. Section 4 contains the robustness checks confirming the credibility of the results and the last part of the article presents the conclusions.

2. Data

2.1. FOMC minutes text mining

Most central banks recognized that the communication of their policy is crucial for effective monetary policy transmission. Proper communication includes not only the publication of the decisions themselves, but also the reasoning behind those resolutions. Documents published by central banks have a cogent influence on both interest rates and inflation expectations. Among the many documents published by the FOMC and the Fed, this crucial role has to be attributed to the minutes, i.e. timely summaries of significant policy issues addressed by the FOMC meeting participants.

Minutes published after an FOMC meeting include insightful information on topics discussed by the staff, as well as a summary of their view on the current economic conditions and future economic outlook. The FOMC not only analyses the main economic indicators that are included in the official monetary policy goal, but the staff also discusses broad economic conditions and takes into consideration many an indicator concerning the financial markets, labour market, housing and investment, consumption, manufacturing sector, and foreign markets.

To capture economic variables leading to a deviation from the policy rule, which may be interpreted as a deviation from monetary policy focusing only on the main objectives, a set of minutes is analysed using text mining techniques. Since turbulent periods such as a financial crisis and the COVID-19 pandemic outbreak have to be regarded as big deviations from the monetary policy strategy, they are excluded from the sample. Hence, the corpus of FOMC minutes spans from the first meeting in 2009 till the last meeting in 2019.

The first step of the analysis involves dictionary techniques. Such an approach is used often to capture the factors driving financial markets. For example, Tetlock (2007) used daily content from *The Wall Street Journal* to measure the interaction between the media and the stock markets. Here, dictionary techniques are utilized to identify those phrases used by the committee in the minutes that may have influenced their decisions and thus deviation from policy rule. The aim of the first step of the text analysis is to recognize the most important factors behind the FOMC discussions in a sample consisting of 85 documents covering all meetings from 28 January 2009, until 11 December 2019. In order to capture important phrases, all documents are firstly lemmatized and purged of all words that are commonly used in the language but ones that do not convey relevant information. Such a cleaning procedure consists of eliminating all common words and phrases by means of stopwords R package, removing all first names based on the US census data, and clearing surnames and function names of the FOMC staff members. A cleaned text is then tokenized using single words, bigrams, and trigrams as tokens.

In order to identify factors pertinent to the FOMC discussions, several statistics are produced; the frequency of tokens occurrence is calculated on the document level in both, absolute and relative terms. While it provides important information on the terms often used in the minutes, it fails to reflect the variability of the term's frequency in the document. Also, a distribution of the term frequencies follows Zipf's law, according to which phrase frequencies are inversely proportional to their ranks which, even after cleaning data from stop words, favours commonly used phrases that give little information.

To remove this noise from the data, the term frequency-inverse document frequency (tf-idf) measure is calculated. It allows for singling out significant phrases for the content of each document by decreasing the weight for commonly used words and increasing the weight for words that are not used extensively in the corpus of documents. This method enables the paper to find phrases that were unique for each year in the sample. Analysing such phrases helps to understand the factors shaping discussions at the FOMC meetings.

$$tf - idf_{ij} = \frac{n_{ij}}{n_j} \cdot ln\left(\frac{N}{N_i}\right) \tag{1}$$

where:

n_{ij} – number of token's i occurrences in document j,
n_j – number of tokens in document j,
N – number of documents in the corpus,
N_i – number of documents containing token i.

The term frequency-inverse document frequency statistics are calculated for single-word tokens, bigrams, and trigrams. Such an unsupervised approach offers reasonable results only for *n*-grams with *n* > 1. For the purpose of the presentation and easy interpretation, documents are grouped on a year level.

The sample begins at a point in time when the Federal Fund Rate had already been at a low level after a series of interest rate cuts due to the GFC. Based on the text analysis presented in Figure 1, the FOMC was concerned with private credit market conditions and spreads. Contextual analysis shows that the "private credit" phrase was mostly mentioned in relation to the asset purchase programme performed by the Fed and its potential aftermaths for the private credit market conditions.

To better understand the true meaning of phrases used in the documents, a sentiment analysis is performed. The sentiment is checked with a lexicon by Loughran and McDonald (2011), which is designed to analyse financial texts. Based on this lexicon, the frequencies of positive and negative words in sentences containing the phrase of interest are calculated. To obtain a sentiment measure, the number of words classified as negative is subtracted from the positive ones.

Figure 2 shows that for the "private credit" token; the sentiment in 2009 was very positive. It matches the results of the contextual analysis because the Fed asset purchase programme was performed in order to improve credit conditions and provide support for credit activity.

Other frequently used phrases confirm that the main topic for the FOMC in 2009 was the asset purchase programme. The FOMC was discussing policy "stabilizing financial markets and institutions" and was also excessively mentioning "liquidity programs" of the Fed.

Since monetary policy cannot be conducted without taking into account fiscal policy – it is treated as an external factor – it is also important to look at the context and sentiment of the discussion on the federal government actions. The year 2009 saw the Car Allowance Rebate System introduced across the US. This USD 3 billion programme known also as "cash for clunkers" was introduced to boost auto sales. The FOMC in its minutes took heed of the stimulus provided by this programme and based on the sentiment measure it was positively assessed as an initiative that was picking up consumer spending more than expected.

On the other hand, 2010 was a year of a significant rebound in GDP growth after the GFC. According to the tf-idf statistics, the FOMC was discussing the economic recovery, pointing out the important rebound in spending on equipment and software that was consistent with the strengthening in indicators of business activity at that time.

In the after-GFC period, the FOMC aimed to regain the trust of the markets and put more stress on the forward guidance in the communication. Hence, the phrase "warrant exceptionally", used in the context of stable economic conditions warranting low interest for an extended period, is so popular in 2010. It appears with a very positive sentiment, which partially results from the description of improving economic conditions that allow keeping FFR stable but also shows that the FOMC intended to create an optimistic and confident narrative about future monetary policy.

The following year, the FOMC continued to implement a forward guidance policy focused on warranting low interest rates for an extended period of time. The assets purchase programme continued and as of September the "maturity extension program" was introduced, which resulted in a higher frequency of this phrase in the second half of the year. A frequency analysis also indicates that the FOMC discusses events happening outside of the US and also their implications for the US economy. Starting in April, the "chain disruption" token standing for the supply chain disruption phrase increased in frequency. It was a result of the earthquake and tsunami in Japan that caused serious damage to the country's economy and posed concerns about disruption in supply chains and production in other economies. The risk materialized in the forthcoming months resulting in even higher frequencies of the token, as it contributed gravely to low levels of automobile inventories in the US.

The discussion of the effectiveness and implications of the maturity extension program followed in 2012. It was by far the most popular topic on the FOMC meetings, according to the tf-idf statistics. A sentiment analysis showed that it was associated with a rather negative context, but it can be attributed mostly to the "downward pressure on longer-term interest rates" described as the effect of the programme. It was also a time when European financial institutions were under pressure due to

sovereign debt and the banking situation in Europe. The staff was pointing out that the strains in global financial markets stemming mostly from European institutions continued to pose significant downside risks to the economic outlook. It is another example of the importance of the international markets and foreign economies in the FOMC decision-making process.

In 2013, the FOMC discussion was focusing on the housing sector and business fixed investment. The strengthening of this sector and significant advances in investment were positively perceived by the staff. The FOMC members also extensively discussed the Fed's asset purchase programme, indicating that its extent and timing is conditional, contingent not only on the likely efficacy and costs of those purchases but also on the extent of progress toward the Committee's economic objectives that include labour market and inflation developments. Some members of the staff were so optimistic due to the outlook for the labour market implied by the wide range of economic indicators that they were suggesting slowing down the asset purchase programme in 2013 and discontinuing asset purchases by the year-end.

In 2014, the importance of interaction between fiscal and monetary policy can be observed once again. An important topic shaping the discussion was connected with the diminishing restraint from the fiscal policy, which helps to boost the economic growth.

It was one of the reasons for the discussion on the decision to reduce the pace of the asset purchases. However, the members underscored that the rate of asset purchases was not on a preset course and would remain contingent on the Committee's outlook for the labour market and inflation, as well as its assessment of the likely efficacy and costs of purchases.

In some cases, focusing solely on the quantitative text mining results may be misleading and could preclude seeing the full story. This was the case in 2015 when the phrase "non-energy import" became relatively popular. To understand the reason why it has become so popular, a broader assessment of economic data is needed. Starting in mid-2014, the energy prices in the US began to fall precipitously. In the second half of 2014, the subindex of consumer prices, including energy in the US, dropped by around 20%. This rapid decrease was aborted in January 2015, which had a great impact on both core PCE prices and the broad index of CPI. The staff was pointing out that despite the reverse trend of the energy prices, the non-energy import prices continued to decline, dampening inflation that was below the target rate. The FOMC was treating non-energy import prices as transitory and was confident that together with other disinflationary forces they would weaken, thus enabling the inflation rate to move to its target. This case gives a few important insights into the monetary policy decision-making process.

First of all, it confirms the role of international trade in shaping the FOMC discussion. Secondly, it shows that the nature of the process and the assessment of its longevity plays an important role in the action plan of the monetary authorities. External factors that are not related to the economy per se may also play their part in the monetary decision-making process. In 2017, two severe hurricanes devasted the southern states. The staff pointed out that they had a significant impact on unemployment insurance benefit claims, industrial production (through drilling, servicing, and extraction activity for oil and natural gas), consumer spending, and retail gasoline spending. In highly developed countries, such natural disasters may have significant but rather temporary effects on economic activity. Hence, the FOMC staff held talks about those matters but also highlighted that it had no impact on the long-term monetary policy.

Frequency analyses in 2018 and 2019 provided evidence that uncertainty may serve a crucial role in economic developments. Caldara et al. (2020) and Caldara et al. (2016) show that uncertainty shocks

are a fundamental source of macroeconomic disturbance, as they have a particularly adverse economic impact in situations where they elicit a concomitant tightening of financial conditions. Pursuant to this strand in literature, frequencies of the word "uncertainty" are calculated for the FOMC minutes and clustered on year levels. Since this word is a common one and appears in all documents, the relative measures of frequencies cannot apply. However, simple frequencies paint an unambiguous picture of the word's popularity – Figure 3. Since 2017, the FOMC staff has been discussing more the uncertainty related to different economic sectors. A contextual analysis shows that uncertainty was predominantly associated with trade policy (the North America Trade Agreement, trade relations between USA and China), federal government policy, and foreign outlook (Brexit).

2.2. Variables selection and real-time dataset

The text mining exercise gives a detailed insight into the topics that influence the monetary policy decision-making process. Whilst the analysis of term frequency-inverse document frequencies allowed for the identification of factors that shaped the discussion each year, in order to perform a variable selection procedure to the model explaining the FOMC deviation from policy rule, an additional step is required. The terms related to specific economic variables that have their time series available need to be identified. It thus enables the construction of a dataset that can be used to explain a deviation from the policy rule. A majority of the terms discussed in the previous section helped to understand the key factors shaping the FOMC discussion, but since their frequencies differ along the time series, their influence on the decision-making process may be asymmetric in different time periods. Hence, another list of variables is extracted from the FOMC minutes. The variables on the list available in the Appendix (Table 7) have been chosen based on the following criteria: they appear in most of the documents, they have inverse document frequency lower than 1 (which implies wide presence and frequency in the documents corpus), and they can be associated with the economic variable that is available in a time series of at least quarterly frequency.

To better understand the reasons for the FOMC veering from the policy rule, a proper timing of the model is needed. Since the biggest short-term deviation is possible after the meeting when the FOMC makes a decision on future rates, the dates of the meetings have to be included in the timing scheme, thus constructing a real-time dataset. Firstly, the time series for the chosen variables are downloaded from the ALFRED database for each vintage set on the date of the meeting. This allows for obtaining the exact series that the FOMC was looking at when analysing economic developments.

For each variable, a real-time matrix is constructed. Table 1 shows the structure of such a matrix in a general example where a one-period lag in data publication is assumed.

Provided that for modelling purposes a single vector for each variable is necessary, the real-time vector is extracted from the matrix by taking from each row only one observation from the leftmost column for which there exists a value. It gives a vector that for each meeting shows a value of the variables observed at that time by the policymakers.

All variables are used in monthly frequencies and for the variables that are originally available on quarterly levels the values from the beginning of the quarter are propagated on the next two months. Such a simple method of interpolation is chosen to account for the fact that the FOMC would still observe only the most recent data available, not any form of smoothed interpolated values.

3. The model

The goal of this paper is to find the driving forces behind the Fed's decisions on the interest rates. The first assumption is that there are three main driving forces, i.e. inflation, unemployment and the long-term interest rate. It is based on the Fed's documents and the main objectives stated there. Because the Fed is a public institution and, as a central bank, has to care about its credibility, the assumption that it follows the objectives included in its constituting legal act appears to be reasonable. According to the literature, a tool that may be used to reflect this assumption is the policy rule. It means that in this paper the policy rule, which binds the federal funds rate, inflation, unemployment, and long-term interest rate, is treated as a theoretical framework showing what the value of the interest rate would be if the Fed only cared about these three driving forces. However, as shown in Figure 4, in most of the periods there exists a discrepancy between the federal funds rate and the interest rate suggested by the policy rule. Under the assumption that the Fed has good control over the rates, it can be concluded that besides the three main variables there are also other factors that affect the Fed's decisions.

It is also confirmed by the policymakers in the minutes containing a detailed analysis of many other economic variables, as described in the previous section. Hence, the second assumption is that there is a set of variables mentioned in the minutes which may cause the deviation from the policy rule. Such a setup introduces a strict hierarchy where there are three main driving forces, which are the Fed's objectives and then, less important factors concerning consumption, the financial sector, housing, investment, manufacturing and the world economy, which complements the analysis.

To explain decisions of the FOMC, a two-step procedure is employed. The first step focuses on the concept of monetary policy rule, which takes into account the Fed's main objectives. The second step pivots around the Fed's decision unexplained by the policy rule and uses a set of variables included in the minutes from the FOMC meeting in order to check which factors are the most important for the Fed's decisions. The model presented in this paper is based on the official documents published by the Fed and the related literature described in the previous section. The starting points are the article about monetary policy objectives in the Federal Reserve Act (1913) and the concept of the monetary policy rule coined by Taylor (1993) and Bullard (2018). The aim of the first step is to establish such a rule that encompasses the three main objectives of the monetary policy described in detail in section 1, which are maximum employment, stable prices, and moderate long-term interest rates. The crucial issue here is that there is no need to find a rule that gives the "optimal interest rate", but the rule that the Fed in fact follows.

This is due to the aim of this paper being to understand the Fed's decisions, not to give recommendations on how monetary policy should be conducted. The matter whether the Fed is using any policy rule is somewhat straightforward. If it aims to meet the main objectives, it has to principally consider the three factors of inflation, unemployment and long-term interest rates. Hence, the interest rate the Fed decides upon has to be somehow connected to these three variables. This connection may be named a policy rule. The question only remains about the details and specification of such a rule. As stated before, the goal is to find the rule which is followed by the Fed, so that the best benchmark could be found in works published by the Fed's policymakers.

There are many papers published by the Fed's researchers concerning monetary policy rules and estimations of its parameters, for example Yellen (2012), English, López-Salido and Tetlow (2015) or Woodford (2003). However, the concept most suitable for this analysis was presented by Bullard (2018);

the first advantage of this approach is that it is relatively novel and takes into account the most recent changes in the monetary policy implemented by the Fed.

Secondly, this specification is in consonance with the three main characteristics of the economy in the analysed period, as stressed by Powell (2018). Firstly, the economy was under an economic regime of low interest rates, weak productivity growth and strong demand for safe assets. Moreover, the Fed appeared to successfully engineer a regime of low and relatively stable inflation expectations that are anchored near the Fed's inflation target.

Thirdly, the Philips curve relationship appeared to be very weak at that time and a decreasing unemployment rate relative to its natural rate would have a very small effect on inflation. Based on the concept proposed by the Federal Reserve Bank of St. Louis President James Bullard, the policy rule used for this paper looks as follows:

$$i_t = \varrho i_{t-1} + (1 - \varrho)\left(r_t^* + \pi^* + \varphi_\pi \pi_t^{GAP} + \varphi_u u_t^{GAP}\right) \qquad (2)$$

where:

i_t – federal funds rate,

i_{t-1} – one quarter lag of federal funds rate,

ϱ – fixed coefficient equal to 0.85,

r_t^* – natural interest rate,

π^* – inflation target equal to 2%,

π_t^{GAP} – inflation gap measured as the difference between breakeven inflation (BEI) and Fed's inflation target,

ϕ_π – inflation coefficient equal to 1.5,

u_t^{GAP} – unemployment gap measured as a difference between the unemployment rate and the FOMC SEP estimate of the natural unemployment rate,

φ_u – unemployment coefficient equal to 0.1.

First of all, the policy rule presented above contains a lagged federal funds rate. On the one hand, it is necessary because it reflects the Fed's practice of not changing the rates radically, but rather in a gradual manner. On the other hand, it is a way to include a moderate long-term interest rate objective. Big volatility of the interest rate would produce unnecessary risk, especially for the financial sector and, therefore, would increase the risk premium in the long-term interest rates on the market. Moreover, it ought to be stressed that the coefficient in front of the lagged rate is relatively high, which signifies that there is a high degree of interest rate smoothing. It is a reasonable assumption because the Fed wants the interest rates to be stable and big volatility of the rates is not desirable by the policymakers. Another difference in comparison with the classic Taylor rule is the real interest rate that varies over time. For the purpose of this paper, the estimates from the Summary of Economic Projections (SEP) published by the FOMC were chosen. To explain the decisions of the Fed, the best strategy is to use the same dataset as the one utilized by the policymakers, so this choice is well justified.

The same approach is used for the unemployment gap, whereby estimates of the natural unemployment rate also come from the FOMC SEP. The trend interest rate estimated from a Hodrick--Prescott filter of the one-year nominal constant maturity treasury yield less the four-quarter change in the Federal Reserve Bank of Dallas's trimmed mean measure of the personal consumption

expenditures (PCE) inflation rate is used as an approximation of the natural interest rate. This is the difference between a market-based measure of inflation expectations and the Fed's inflation target. A breakeven inflation rate (BEI) is used as an instrument for inflation expectations. BEI is the difference between the nominal yield on a 5-year (5Y) Treasury security and the yield on an inflation-adjusted (real) 5Y Treasury inflation-protected security (TIPS).

Figure 4 shows the fed funds rate; the Bullard rule implied the interest rate and the deviation of the fed funds rate from the rule. Throughout the whole sample, the deviation is negative, which means that the interest rate implied by the rule is above the fed funds rate. Since the Bullard rule has an autoregressive term with a relatively high weight, it reacts to rate changes very well. Such a construction of the rule mitigates the problem of the deviation arising in periods when the FOMC decides to change the policy rate and helps to refrain from understating periods characterized by stable monetary policy.

Choosing a proper policy rule and computing the deviation of the federal funds rate from this rule was the first step of the procedure employed in this paper. The deviation from the Bullard rule may be deemed to be a part of the Fed's decision that is unexplained by the main monetary policy objectives. The second step is all about explaining this deviation by a set of variables that the FOMC analyses at its meetings.

As described in the previous section, the set of regressors is chosen based on the text mining exercise that incorporates 53 variables divided into 6 categories. A comprehensive list of variables is included in the appendix (Table 7):
– consumption (6 variables),
– employment (9 variables),
– financial sector (16 variables),
– housing and investment (6 variables),
– manufacturing (6 variables),
– world economy (17 variables).

With such a large set of variables and a relatively short period of analysis (the whole sample covers the period 2009–2019), it is not desirable to run a simple OLS regression on all 53 variables; therefore, a factor analysis is employed. The next section contains a description of different approaches employed to find relationships and results of the estimations.

4. Results

4.1. Standard factor analysis

Firstly, a standard factor analysis is conducted, hence, there are no pre-estimation restrictions put on the dataset. The factors are identified on the whole sample, without splitting into categories based on the economic interpretation. It is the most common procedure that could be found in the literature, for example Lütkepohl (2007). All 53 variables are standardized, and the factors identification procedure on this dataset is employed.

A correlation matrix, KMO and Bartlett's tests show that the dataset is suitable to run a factor model. Figure 5 presents the scree plot with the factors' eigenvalues. The first 4 eigenvalues are above the threshold suggested by Kaiser (1960), which is equal to 1. Also, both the analysis of the scree plot

and parallel analysis suggest 4 factors as an optimal value. Since the aim of this model is to identify economic variables influencing the monetary policy decision-making process, the goal is to have well--identified factors with correlation schemes that allow for economic interpretation. Hence, the oblique rotation method is chosen in the construction of the factors. Figure 6 shows factor loadings on all 53 variables with a division of categories.

Based on the absolute values of loadings, an unambiguous identification of variables groups responsible for the variability of factors is impossible even with the oblique rotation employed. Even though a model estimated on these factors exhibits a strong fit, the interpretation of the results remains unfeasible.

Thus, the other method of constructing factors is proposed in the next section.

4.2. Clustered factor analysis

The standard approach did not provide interpretable results, so the way factors are constructed has to be changed. In this model, the role of the factors is to reduce the number of variables in the regression but retaining as much information about the original variables as possible. Furthermore, the results should have an economic interpretation; therefore, a dataset is divided into the 6 categories mentioned in the previous section. Among each category, a within-group factor analysis is applied. This signifies that now each factor is a combination of the original variables from only one category. The number of factors is determined by Keiser's rule. Hence, the set of factors is organized as depicted in Table 2.

Such an identification scheme of the factors allows for a much clearer interpretation and, as shown above, the share of the original variability included in the new components continues to be very high. To check the relationship between the deviation from the policy rule and the new factors, a standard OLS is employed. The results are presented in Table 3; the first specification includes only factors describing the 6 categories mentioned in the previous section. Also, the results show that coefficients for factors constructed on the basis of variables regarding the financial sector, housing and investment, and the global economy are significant at conventional levels of statistical significance.

Table 3 presents the results of the described specification in column (1). Because of the construction of the regressors, the model exhibits serial autocorrelation of errors of order one. Since the structure and timing of the model is designed to represent a state of knowledge of the FOMC in the moment of making the decision, and thus, ensuring a proper direction of causality, any changes affecting timing are not desired. Hence, the variance-covariance matrix is estimated using the Newey-West method (Newey, West 1987) and the HAC standard errors are presented in Table 3.

The relation between financial markets and monetary policy is well researched in the literature. Financial market prices reflect market expectations about future economic developments which affect monetary policy transmission channels (Hildebrand 2006; Kapuściński 2018). The willingness of the monetary authorities to follow market expectations in order not to destabilize the financial sector may be an important premise to deviate from the policy rule based on the main policy objectives. It is in fact a plausible explanation that is also confirmed by the phrase frequency analysis from Section 2, which indicates that terms describing financial markets are frequently used in the FOMC minutes.

Moreover, the policymakers realize their impact on equity markets and the banking sector, since such channels are well documented in the mainstream literature (Galí, Gambetti 2015; Wu, Xia 2016;

Smets 2014). On the other hand, the correlation observed in the results of the model may also be an effect of the opposite causality. Even in the 20th century, when the availability of market data was much lower and the FOMC did not adopt a consistent forward guidance strategy, the financial markets were able to anticipate interest rate changes. Starting in the late 1980s, longer-term interest rates and futures tended to incorporate FFR movements several months in advance (Lange, Sack, Whitesell 2003). While the problem of the reverse causality is covered by using real-time datasets, the constant run to anticipate policy changes in the financial markets makes it impossible to except this possibility.

The housing market was at the fore of the Global Financial Crisis and during this period it garnered a lot of attention from the Fed. Agnello and Schuknecht (2011) show that interest rates have a significant influence on the probability of booms and busts in the housing market. Also, investments in the economy have proved to have a great impact on the potential output in the future, thus influencing the output gap in the long term. While the output gap is one of the drivers of the policy rule, it is not surprising that the factor associated with housing and financial market variables is significantly affecting the FOMC deviation from the policy rule.

The implemented text mining exercise showed that economic developments in other countries may shape a discussion at the FOMC meetings and thus affect the monetary policy decision-making process. This finding is confirmed in the mode; factors constructed from variables including global trade, GDP, and inflation in the most important economies, as well as exchange rates to the US dollar have a significant influence on the deviation from the policy rule. Since the model is estimated on the real-time dataset, the correlation should not be attributed to the international transmission of US monetary policy shocks as described by Kim (2001) and should rather suggest that, despite being the world's leading economic power, the US authorities also take into account economic developments in other countries.

An analysis of the most frequently used economic terms appearing in the FOMC minutes helped to prepare a dataset for the model. However, the analysis presented in Section 2 pertaining to the terms that are not necessarily frequent in all documents but have high term frequency-inverse document frequency statistics gives more insights that may be used to enrich the model specification. The first important term that had a great impact on the FOMC staff's discussion involves the asset purchase programme performed after the GFC. Since the scope of the programme is also part of the monetary policy decision-making process and all other variables that were put into factors are economic conditions observed by the Fed, this variable is included separately in the model under specification (2) in Table 3. A good proxy of the QE scale may be the Fed assets that are added as an additional regressor. The parameter for the newly added variable is statistically significant and has a negative effect on the deviation from the policy rule. This suggests that extending the asset purchase programme leads to a lower deviation, which may be due to a positive effect of quantitative easing on output (Weale, Wieladek 2016; Chen, Cúrdia, Ferrero 2012) and through this channel the unemployment gap can be reduced.

Another important term identified through text mining is uncertainty. Its role in the FOMC minutes has increased since 2017 and played a crucial role in the discussions for the years to come. To account for this phenomenon, an additional variable representing the economic policy uncertainty index for United States is added. The index is computed on the basis of newspaper coverage frequency (Baker, Bloom, Davis 2016). Even though there is strong evidence in the literature pointing to the importance of uncertainty for the monetary policy (Justiniano, Preston 2010; Caldara et al. 2016) and

analysis of tf-idf statistics from the FOMC minutes, inclusion of the uncertainty measure in the model does not help to explain the deviation from the policy rule.

Further analysis may be conducted by looking at the loadings of the factors that proved to be significant in explaining the deviation from the policy rule. The correlation structure of financial factor number 2, which has a significant parameter in the first specification, shows that it is founded mostly on the TED spread, bank spread changes, VIX, and corporate bonds spread. All of those measures are connected with the market or credit risk and increase in the stress periods. Along with the fact that all variables have positive factor loadings and the factor has a positive coefficient in explaining a deviation from the policy rule, it may be stated that the higher the risk on the financial markets, the bigger the deviation of interest rates from the policy rule implied rate. This is in line with the economic intuition and the hypothesis that monetary authorities also take into account the situation on the financial markets and in stress periods they are willing to partially sacrifice the fulfilment of their main goals to ease the situation on the financial markets.

The factor associated with the housing market and investment exhibits high loadings on all variables that it is made from. Since it is mostly composed of indices reflecting new structures build and almost all variables have a similar direction of the effect on the real economy, the parameter for the factor may be easily interpreted. The coefficient in Table 3 shows a negative relation between the variable and the deviation from the policy rule.

Therefore, the higher construction spending, new houses build/sold, or investments in real estate are, the lower the deviation is. Since the policy rule suggests higher rates than observed, it means that higher activity in the real-estate market would push the FOMC to opt for higher interest rates to prevent imbalances that bring so many issues during the financial crisis.

Two out of three factors constructed based on variables connected with the global economy and trade have statistically significant parameters in the basic specification. Since loadings on the variables generating those two factors are high at least for one of the factors, a more detailed interpretation is impossible. What is surprising, though, are the loadings for China's CPI and exchange rates, as they are low for the two significant factors, which may suggest that the economic developments in this country are unimportant for the US monetary policy. On the other hand, statistics published by the People's Republic of China may not be considered reliable, thus they have little impact on the policymakers' decisions.

5. Robustness checks

The aim of the robustness checks is to show whether despite the choice of parameters in the policy rule formula the significance of factors explaining deviation from the rule remains similar. The default parameters are based on the paper by Bullard (2018), and such a specification was chosen because it should be the best in reflecting the rule that the FOMC may be following. It assigns much weight to the autoregressive term of the interest rate and clearly favours inflation over unemployment with parameters 1.5 and 0.1 respectively.

Such a considerable difference may appear to be extreme, but it reflects the superiority of inflation in monetary policy objectives.

The first test concerns the parameter for the unemployment gap (φ_u). Figure 7 shows p-values for all regressors' parameters in models where the policy rule was specified using different values of the

parameter for the unemployment gap. The significance of the parameters for factors that were under the threshold of 5% in the base specification remains almost unchanged. The deviation is still well--explained by the financial markets, housing and investment, and global market factors. Increasing the weight of the unemployment gap increases the role of the factor composed of the variables related to employment. It comes as little surprise that the variables, such as nonfarm payrolls, part-time employment, or employment cost included in the Employment Factor1 variable are significant for explaining a deviation from the policy rule which is heavily shaped by the unemployment gap.

It is not the case for the Fed, but many central banks in the world have low inflation as their only objective. To test a policy rule that is even more focused on price stability, the stability of parameters is also checked for the higher values of a parameter for the inflation gap (ϕ_π). The results presented in Figure 8 indicate that the changes in regression parameters' p-values are not high and still the same groups of factors as for the base specification play an important role in explaining deviation from the policy rule.

6. Conclusions

The goal of this paper was to understand the decision-making process of the Fed, particularly to find which economic variables are the most essential for the FOMC when taking decisions about interest rates. The whole concept of the analysis was based on the official statements published by the Fed. The identification of the three main objectives for the US monetary policy helped to design the policy rule which is used by the Fed. However, the monetary authorities do not follow strictly the rule based on the main goals. It therefore suggests that there are also other factors that are taken into account by the policymakers. The set of economic indicators that the FOMC analyses at each meeting was identified based on the documents published after the committee meetings.

A variety of text mining techniques, such as frequency, context, and sentiment analysis were employed to identify factors significant for the FOMC discussions in the period of 2009-2019. The results from the analysis of FOMC minutes showed that non-standard fiscal programmes drew much attention from the staff, especially shortly after the GFC.

The asset purchase programme introduced by the Fed was also of great importance because the policymakers were uncertain about its consequences for the economy. In particular, the housing market and financial markets were monitored for potential spillovers of these programmes. Another finding also underscored the importance of global economic developments, such as trade tensions or natural disasters, either of which were able to cause disruptions in value chains. During the analysed period the FOMC was striving to improve its communications and strengthen forward guidance by way of setting long-term projections for its future decisions. In a bid to ensure stable prices, the FOMC was also closely keeping track of the import prices that might have a strong impact on domestic inflation. An important observation of the FOMC minutes also includes the increased role of uncertainty in the staff discussions after 2017, which was related not only to the domestic factors, but also to the Brexit--inflicted international risk and relations between the US and China.

The main analysis was performed by estimating regression to explicate a deviation of the federal funds rate from the policy rule. It allowed for providing an answer to the question on the factors that make monetary authorities veer from the main objectives because the policy rule implied that the

levels of interest rates were based only on the main goals stated in the Federal Reserve Act. In order to find the driving forces of this deviation, a real-time dataset was used. It reflected the state of knowledge about the economy at each of the FOMC meetings, which helped with the causality inference. Based on the text mining exercise, a set of 53 economic indicators that were extensively discussed on the FOMC meetings was chosen to use in the model. To obtain a reasonable number of degrees of freedom in the model, the factor modelling method was chosen. A clear interpretation of the results is possible only when applying clustered factors, i.e. splitting the variable set into categories and creating factors for each category separately. The estimation results showed that factors related to financial markets, housing, and investment, as well as global markets, yield statistically significant coefficients and are important for explaining the deviation from the policy rule.

The analysis performed in this article sheds new light on the FOMC's decision-making process. It identifies major factors that influence a deviation from the policy rules, thus showing additional monetary policy objectives that are of importance for the policymakers. The empirical results showing that the FOMC cares mostly about financial markets, housing, and investment, as well as global markets in their interest rates decisions suggest future research avenues. First, the procedure proposed in this paper, based on the text mining on official documents, may be implemented in other countries, while adjusting the policy rule specification for the local regulations. Secondly, the results may be used for forecasting purposes to propose methods including policy rule deviation and variables that appeared to be significant for this deviation in forecasting experiments.

This extension may be especially promising for short-term projections since the analysis presented in this paper is based on the real-time dataset.

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Appendix

Table 1

Real-time data matrix for one variable

	$M = 2$	$m = 3$	...	$m = T$	$m = T + 1$
$t = 1$	x_1^1	x_1^2		$x_1^{T\text{-}1}$	x_1^T
$t = 2$		x_2^1		$x_2^{T\text{-}1}$	x_2^T
...					
$t = T - 1$				$x_{T\text{-}1}^1$	$x_{T\text{-}1}^2$
$t = T$					x_T^1

Notes:
t – an observation date of the variable,
m – the FOMC meeting and dates of the meeting are ordered 2, 3, ..., $T + 1$.

Table 2

Set of variables used to create clustered factors

Category	Number of variables	Number of factors	Variability explained by the factors
Consumption	6	2	76%
Employment	9	1	82%
Financial sector	12	2	72%
Housing and investment	6	1	89%
Manufacturing	6	2	88%
Global economy	14	3	78%

Table 3

Models with clustered factors

	Dependent variable: deviation from the policy rule		
	(1)	(2)	(3)
Fed assets (USD mn)		-0.083*** (0.024)	-0.076*** (0.025)
Economic policy uncertainty			0.0002 (0.0002)
Consumption – Factor 1	-0.085 (0.085)	-0.105 (0.082)	-0.100 (0.082)
Consumption – Factor 2	0.027 (0.032)	0.016 (0.030)	0.017 (0.031)
Employment – Factor 1	0.003 (0.099)	-0.021 (0.095)	-0.036 (0.099)
Financial markets – Factor 1	0.049 (0.057)	0.080 (0.058)	0.075 (0.059)
Financial markets – Factor 2	0.039** (0.016)	0.020 (0.018)	0.019 (0.018)
Housing & investment – Factor 1	-0.142*** (0.037)	-0.177*** (0.039)	-0.174*** (0.040)
Global markets – Factor 1	0.245*** (0.053)	0.277*** (0.054)	0.270*** (0.053)
Global markets – Factor 2	0.186*** (0.047)	0.227*** (0.050)	0.226*** (0.049)
Global markets – Factor 3	-0.038 (0.027)	-0.046* (0.027)	-0.043 (0.027)
Manufacturing – Factor 1	-0.0004 (0.039)	0.030 (0.041)	0.016 (0.043)
Manufacturing – Factor 2	-0.009 (0.030)	-0.019 (0.029)	-0.006 (0.031)
Constant	-0.358*** (0.005)	-0.061 (0.087)	-0.106 (0.095)
Observations	132	132	132
R^2	0.713	0.732	0.735
Adjusted R^2	0.686	0.705	0.706
Residual std. error	0.058 (df = 120)	0.056 (df = 119)	0.056 (df = 118)
F Statistic	27.072***	27.149***	25.168***

Notes:
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.
Bootstraped standard errors in paretheses.

Table 4

Factor loading for financial variables

id	Description	Factor 1	Factor 2
FBSTLRQ027S	Financial business; short-term loans including repurchase agreements	0.986	0.031
TOTALNS	Total consumer credit owned and securitized	0.959	-0.106
CRDQUSAPABIS	Total credit to private non-financial sector, adjusted for breaks, for United States	0.919	-0.063
NASDAQCOM	NASDAQ composite index	0.907	-0.235
DGS3MO	3-month Treasury constant maturity rate	0.792	0.045
DGS2	2-year Treasury constant maturity rate	0.790	0.148
TEDRATE	TED spread	0.213	0.768
DRISCFS	Net percentage of domestic banks increasing spreads of loan rates over banks' cost of funds to small firms	0.204	0.725
DGS10	10-year Treasury constant maturity rate	0.034	0.479
VIXCLS	CBOE volatility index: VIX	-0.300	0.714
BAA10Y	Moody's seasoned baa corporate bond yield relative to yield on 10-year Treasury constant maturity	-0.371	0.734
USTLLFRPD90	Total loan and lease finance receivables, past due 90 days or more and still accruing for commercial banks in United States	-0.984	-0.078

Table 5

Factor loading for housing and investment variables

	Description	Factor 1
TTLCONS	Total construction spending	0.974
PRFIC1	Real private residential fixed investment	0.961
HSN1F	New one family houses sold: United States	0.960
PERMIT	New private housing units authorized by building permits	0.948
B009RX1Q020SBEA	Real gross private domestic investment: fixed investment: nonresidential: structures	0.927
USSTHPI	All-transactions house price index for the United States	0.886

Table 6

Factor loading for international variables

id	Description	Factor 1	Factor 2	Factor 3
IMPGSC1	Real imports of goods and services	0.982	-0.012	-0.081
CLVMEURSCAB1GQEA19	Real Gross Domestic Product (euro/ECU series) for euro area (19 countries)	0.968	-0.085	-0.306
EXPGSC1	Real exports of goods and services	0.968	0.039	0.076
JPNRGDPEXP	Real Gross Domestic Product for Japan	0.883	0.147	0.102
NAEXKP01BRQ652S	Gross Domestic Product for Brazil	0.830	-0.074	0.566
CLVMNACSCAB1GQUK	Real Gross Domestic Product for United Kingdom	0.819	0.230	-0.057
IEABC	Balance on current account	-0.599	0.093	0.187
NBUSBIS	Broad effective exchange rate for United States	0.408	0.568	-0.259
EXUSEU	USD/euro foreign exchange rate	-0.341	-0.620	0.036
PALLFNFINDEXQ	Global price index of all commodities	0.235	-0.935	0.315
EXCHUS	China/US foreign exchange rate	0.126	-0.128	-0.963
JPNCPIALLMINMEI	Consumer price index of all items in Japan	0.112	0.846	0.222
EXJPUS	Japan/US foreign exchange rate	0.059	0.970	0.261
CHNCPIALLMINMEI	Consumer price index: all items for China	-0.019	-0.311	0.307

Table 7
Variables list

| id	Description	Category
PCE	Personal consumption expenditures	consumption
A489RA3Q086SBEA	Real federal government consumption expenditures: defense consumption expenditures: gross output of general government: intermediate goods and services purchased: services	consumption
FDEFX	Federal government: national defense consumption expenditures and gross investment	consumption
BPCCRO1Q156NBEA	Personal consumption expenditures excluding food and energy (chain-type price index)	consumption
ALTSALES	Light weight vehicle sales: autos and light trucks	consumption
CSCICP03USM665S	Consumer opinion surveys: confidence indicators: composite indicators: OECD indicator for the United States	consumption
PAYEMS	All employees: total nonfarm payrolls	employment
LNS14000009	Unemployment rate: Hispanic or Latino	employment
LNS14000006	Unemployment rate: black or African American	employment
LNU04032183	Unemployment rate: Asian	employment
CIVPART	Civilian labor force participation rate	employment
LNS11300060	Civilian labor force participation rate: 25 to 54 years	employment
LNS12032194	Employment level: part-time for economic reasons, all industries	employment
LMJVPRUVUSQ175S	Unfilled job vacancies in the private sector for the United States	employment
ECIALLCIV	Employment cost index: total compensation: all civilian	employment
DGS10	10-year Treasury constant maturity rate	financial markets
DGS2	2-year Treasury constant maturity rate	financial markets
DGS3MO	3-month Treasury constant maturity rate	financial markets
VIXCLS	CBOE Volatility Index: VIX	financial markets
TEDRATE	TED spread	financial markets
BAA10Y	Moody's seasoned Baa corporate bond yield relative financial markets to yield on 10-year Treasury constant maturity	financial markets
USTLLFRPD90	Total loan and lease finance receivables, past due financial markets 90 days or more and still accruing for commercial banks in United States	financial markets

Table 7 cont'd

id	Description	Category
DRISCFS	Net percentage of domestic banks increasing financial markets spreads of loan rates over banks' cost of funds to small firms	financial markets
TOTALNS	Total consumer credit owned and securitized	financial markets
CRDQUSAPABIS	Total credit to private non-financial sector, adjusted financial markets for breaks, for United States	financial markets
NASDAQCOM	NASDAQ Composite Index	financial markets
FBSTLRQ027S	Financial markets business; short-term loans including financial markets repurchase agreements	financial markets
PRFIC1	Real private residential fixed investment	housing
PERMIT	New private housing units authorized by building permits	housing
HSN1F	New one family houses sold: United States	housing
B009RX1Q020SBEA	Real gross private domestic investment: fixed investment housing: nonresidential: structures	housing
TTLCONS	Total construction spending	housing
USSTHPI	All-transactions house price index for the United States	housing
IEABC	Balance on current account	global markets
EXPGSC1	Real exports of goods and services	global markets
IMPGSC1	Real imports of goods and services global markets	global markets
EXUSEU	US/euro foreign exchange rate	global markets
EXCHUS	China/US foreign exchange rate	global markets
EXJPUS	Japan/US foreign exchange rate	global markets
NBUSBIS	Broad effective exchange rate for United States	global markets
PALLFNFINDEXQ	Global price index of all commodities	global markets
CHNCPIALLMINMEI	Consumer price index: all items for China	global markets
JPNCPIALLMINMEI	Consumer price index of all items in Japan	global markets

Table 7 cont'd

id	Description	Category
CLVMEURSCAB1GQEA19	Real gross domestic product (euro/ECU series) for euro area (19 countries)	global markets
CLVMNACSCAB1GQUK	Real gross domestic product for United Kingdom	global markets
NAEXKP01BRQ652S	Gross domestic product by expenditure in constant prices	global markets
INDPRO	Industrial production index	manufacturing
AMTMNO	Value of manufacturers' new orders for all manufacturing industries	manufacturing
DCOILWTICO	Crude oil prices: West Texas Intermediate (WTI) Cushing, Oklahoma	manufacturing
MHHNGSP	Henry hub natural gas spot price	manufacturing
AMTMVS	Value of manufacturers' shipments for all manufacturing industries	manufacturing
QFRD123MFGUSNO	Quarterly financial report: US corporations: retained earnings at end of quarter: all manufacturing industry	manufacturing

Figure 1

Bigrams tf-idf statistics
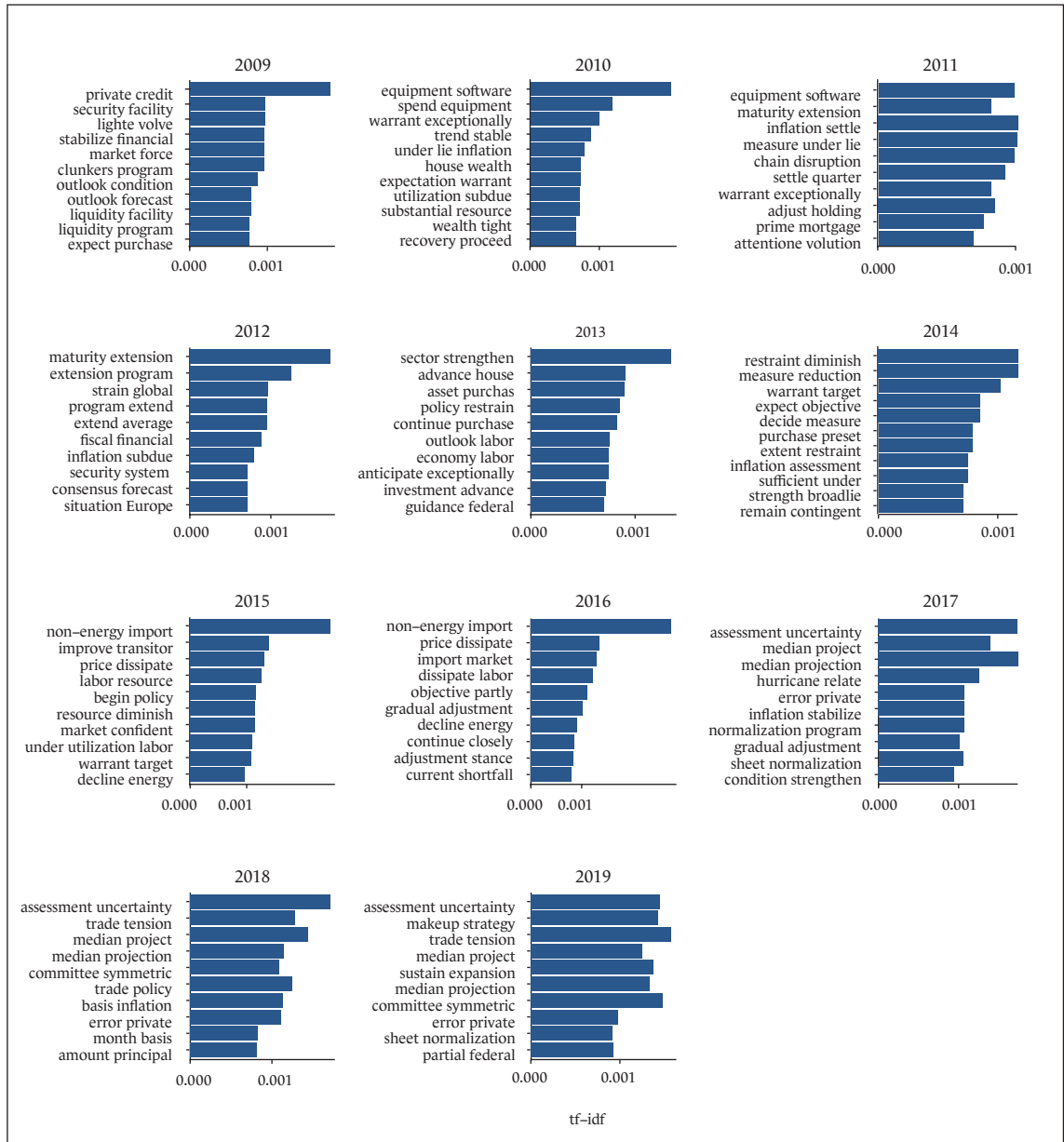
Note: phrases with the highest values of tf-idf statistic for each year are presented.
Source: own elaboration based on the minutes downloaded from www.federalreserve.gov.

Figure 2

Sentiment associated with popular phrases
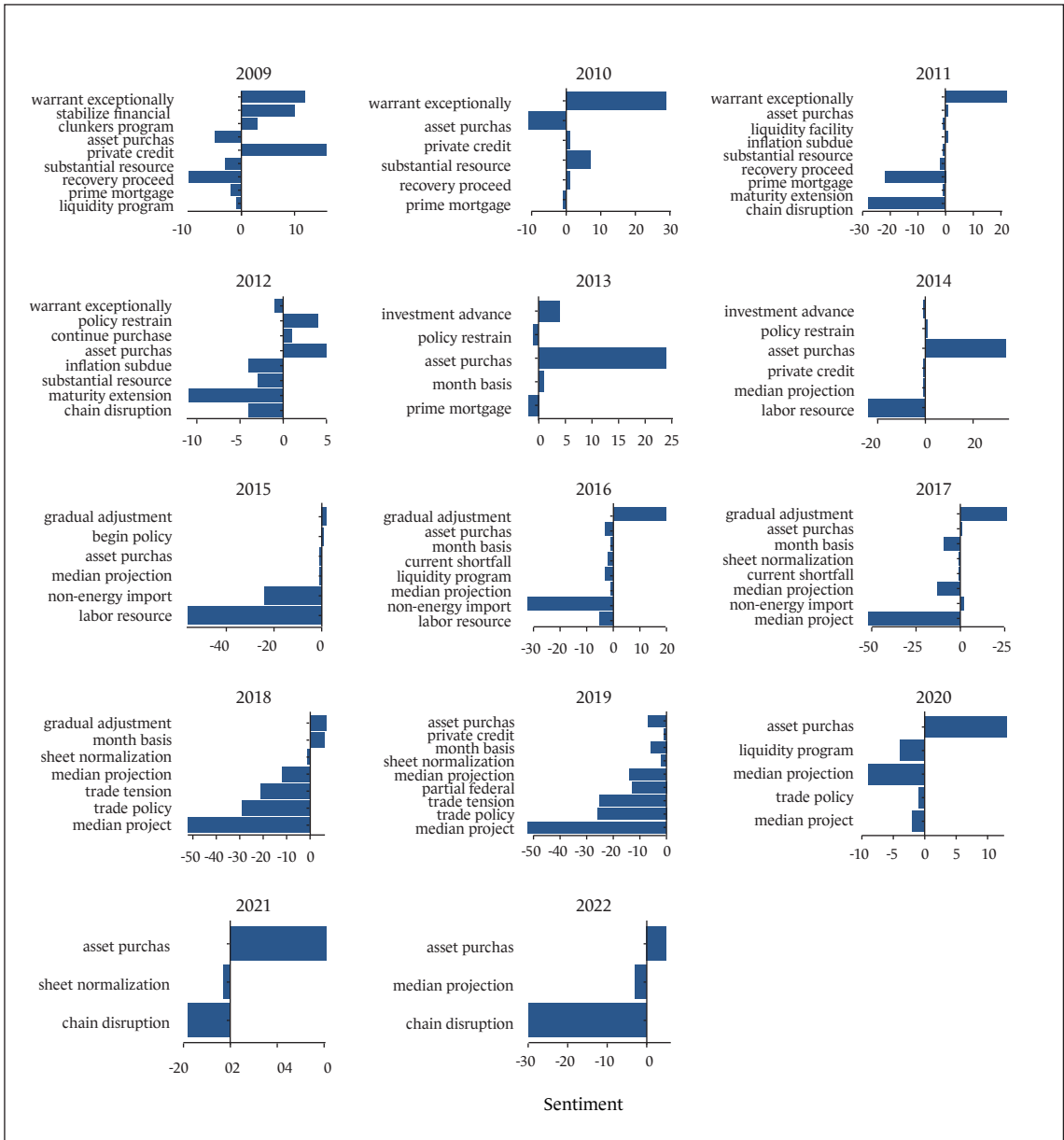
Note: phrases with non-zero sentiment scores and with top 10 tf-idf scores in each year are included.
Source: own elaboration based on the minutes downloaded from www.federalreserve.gov.

Figure 3

Frequency of the word "uncertainty" in FOMC minutes across years
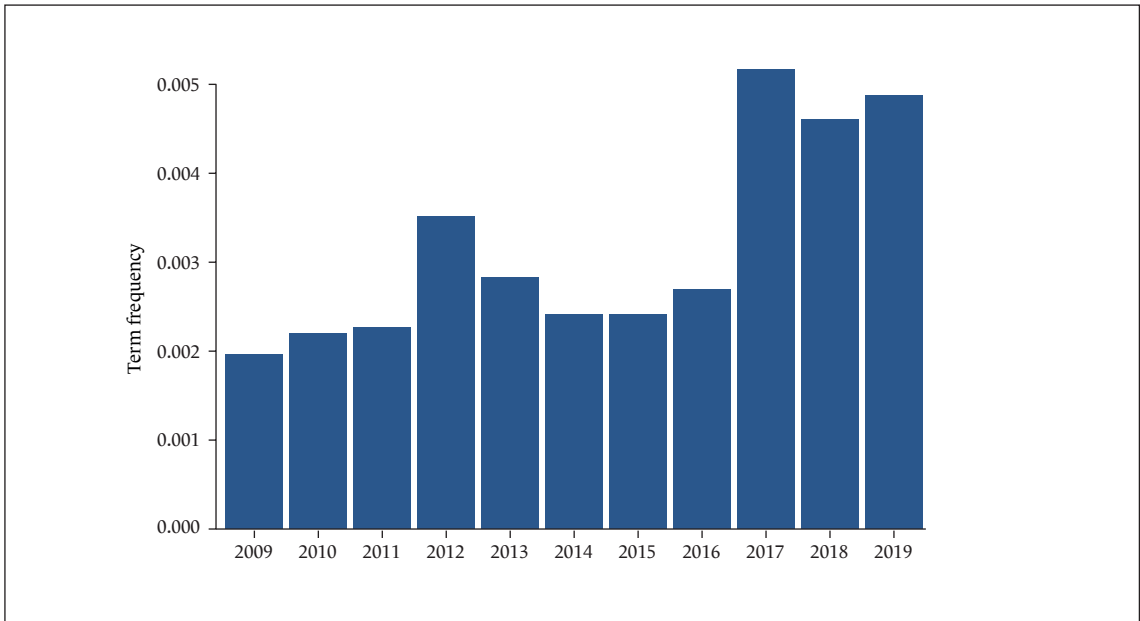
Note: own elaboration based on the minutes downloaded from www.federalreserve.gov.

Figure 4

Fed funds rate and policy rule implied interest rate
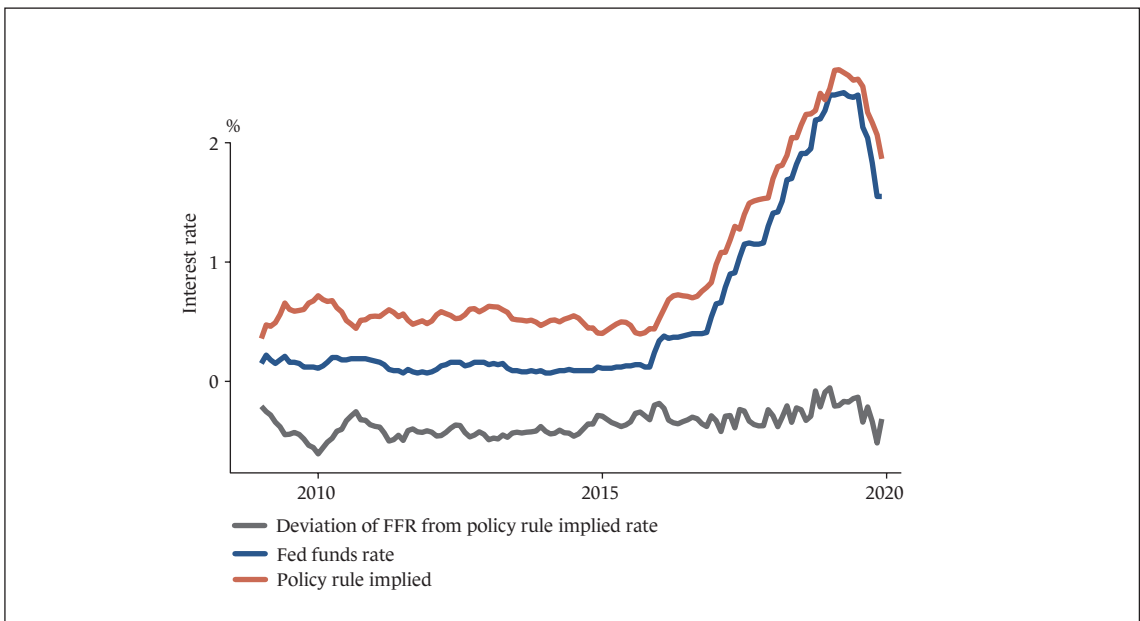
Source: own calculations based on Bullard (2018).

Figure 5

Scree plot of standard factor analysis
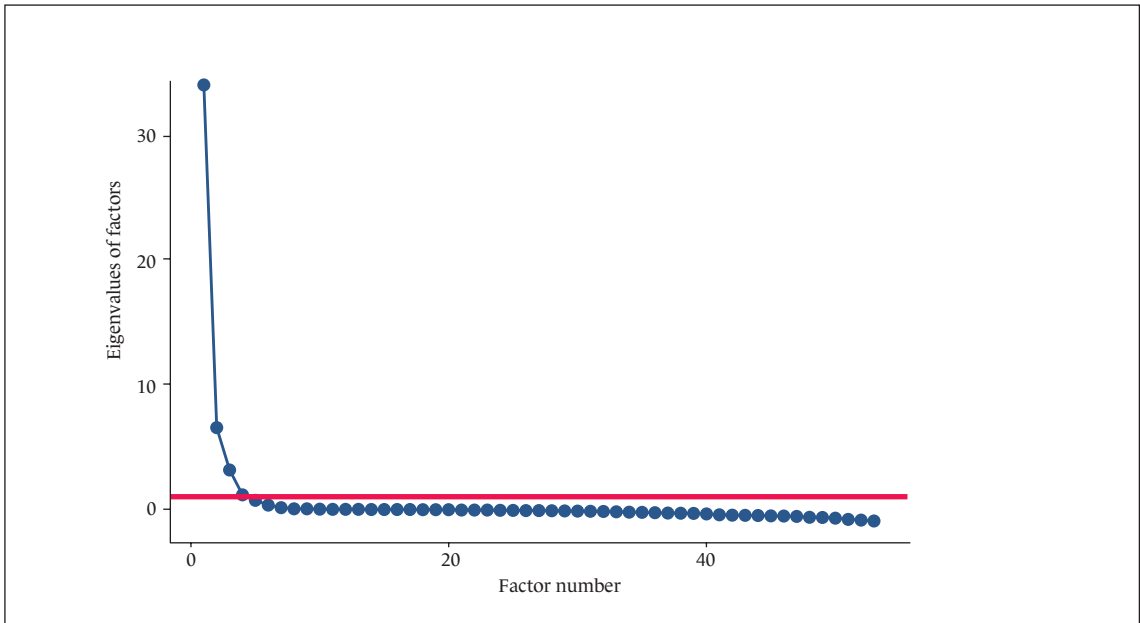
Figure 6

Absolute values of factor loadings
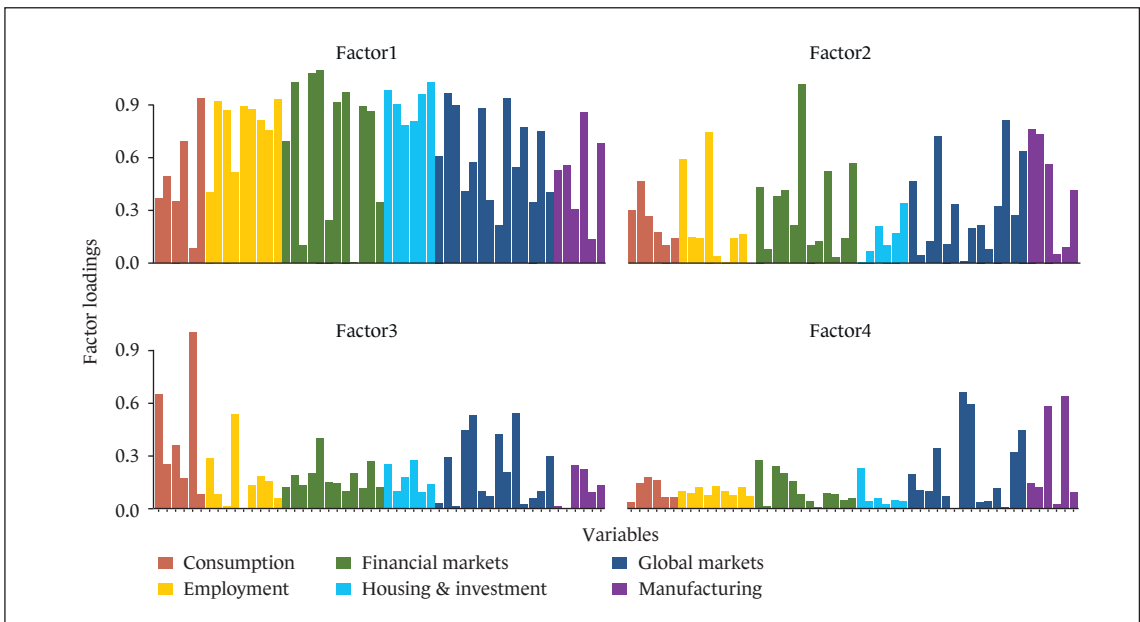
Notes:
Figure presents factor loadings for all variables that are grouped on a graph into 6 groups for easier readability. A list of all variables with assigned categories is included in the Appendix.

Figure 7

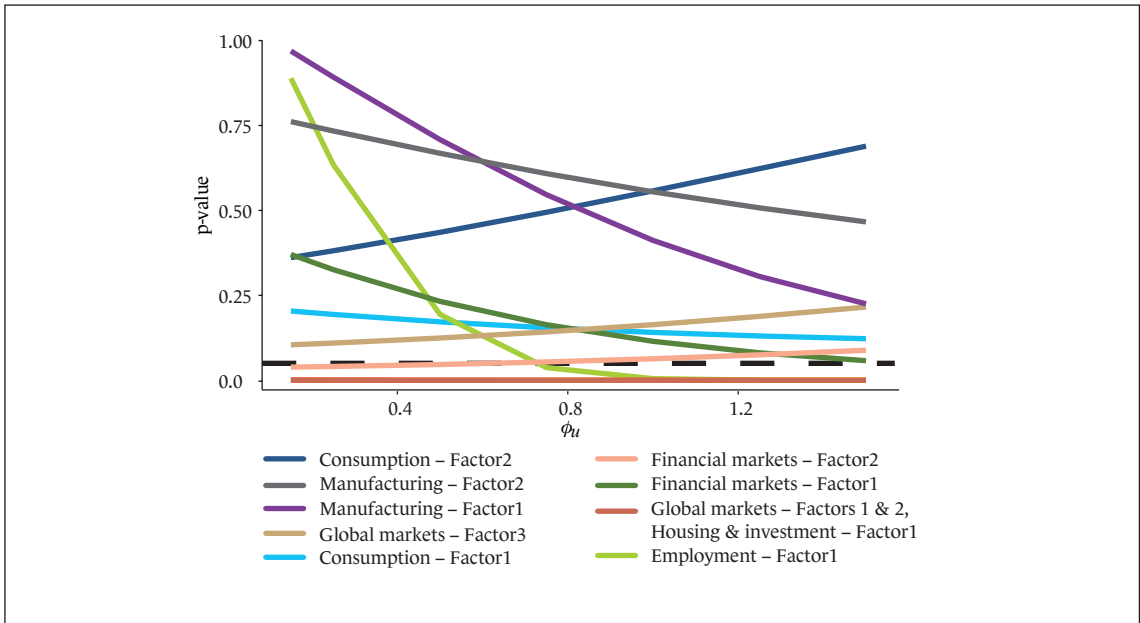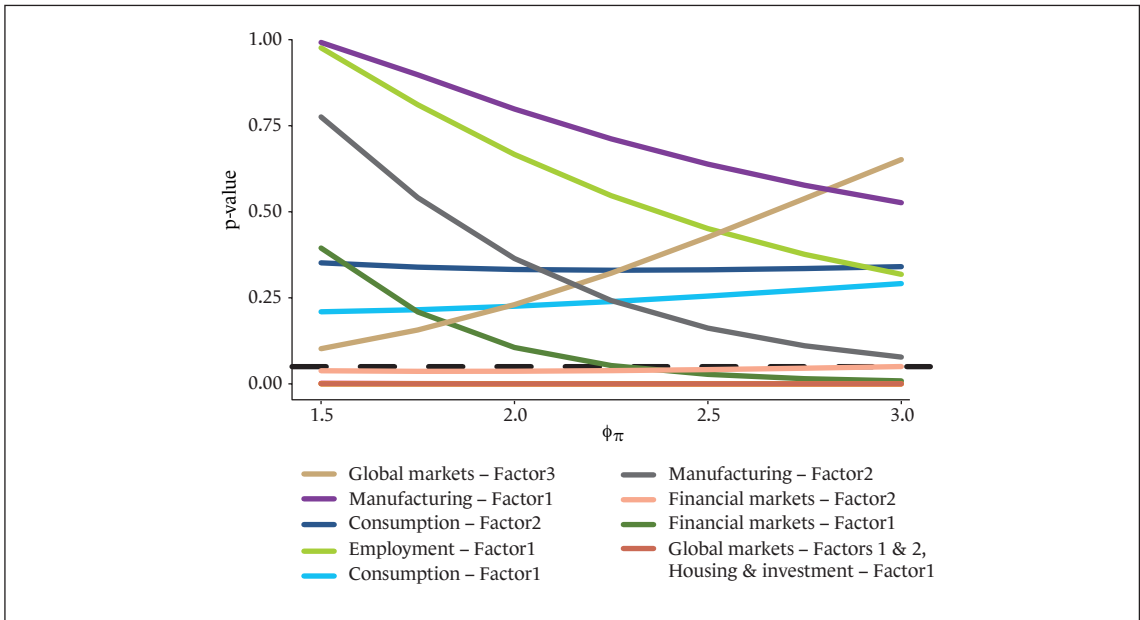Parameter's significance for different unemployment weights

Figure 8

Parameter's significance for different inflation weights

Dekonstrukcja decyzji Fed: analiza czynników wpływających na politykę pieniężną w Stanach Zjednoczonych

Streszczenie

Polityka monetarna jest tematem szeroko opisywanym w literaturze przedmiotu. Większość badań skupia się jednak na wpływie decyzji władz monetarnych na gospodarkę, kanałach transmisji polityki pieniężnej czy modelowaniu optymalnej strategii stóp procentowych. Temat procesu podejmowania decyzji przez organy odpowiedzialne za prowadzenie polityki pieniężnej nie ma natomiast odpowiedniego odzwierciedlenia w literaturze. Rozwój metod analizy tekstu oraz badania kontekstu i sentymentu na dużych zbiorach danych tekstowych otwierają nowe możliwości badawcze związane także z polityką pieniężną.

Decyzje władz monetarnych oraz komunikacja na ich temat były przedmiotem różnorodnych badań. Artykuły skupiały się jednak na analizie postów w mediach społecznościowych i predykcji zmian stóp procentowych (Lüdering, Tillmann 2020; Masciandaro, Peia, Romelli 2023) lub analizie czytelności i transparentności komunikatów publikowanych przez organy władz monetarnych (Tumala, Omotosho 2019; Acosta 2015; Apel, Grimaldi 2012). Pomimo wielu badań korzystających z metod *text mining* brakowało artykułów całościowo omawiających proces podejmowania decyzji co do stóp procentowych.

Mój artykuł łączy literaturę dotyczącą celów polityki pieniężnej oraz literaturę związaną z analizą komunikatów publikowanych przez władze monetarne. Badanie zostało przeprowadzone na danych amerykańskich i analizuje decyzje Federal Open Market Committee (FOMC) – organu kształtującego politykę pieniężną w Stanach Zjednoczonych.

Podstawowym celem artykułu jest identyfikacja czynników wpływających na decyzje władz monetarnych. Konkretne czynniki, których wpływ na decyzję FOMC zbadano, zostały zidentyfikowane dzięki analizie tekstu komunikatów publikowanych przez ten organ. Pytanie badawcze artykułu dotyczy wpływu czynników związanych z takimi kategoriami, jak: rynki finansowe, rynek pracy, konsumpcja, produkcja przemysłowa, rynek nieruchomości i inwestycje oraz rynki zagraniczne, na odchylenie stóp procentowych od poziomu określonego przez regułę polityki pieniężnej.

W celu sprawdzenia hipotez badawczych przeprowadziłem analizę zgodnie z zaprojektowaną przeze mnie procedurą:

1. Analiza aktów prawnych, której zadaniem była identyfikacja podstawowych celów polityki pieniężnej Fed. Analiza Federal Reserve Act wskazuje na główne cele polityki pieniężnej Stanów Zjednoczonych. Są nimi: maksymalizacja zatrudnienia, stabilne ceny oraz utrzymanie długookresowych stóp procentowych na umiarkowanym poziomie.

2. Konstrukcja reguły polityki pieniężnej uwzględniającej zidentyfikowane cele. Analiza nurtu dotyczącego reguły polityki pieniężnej w literaturze przedmiotu, zapoczątkowanego przez Johna Taylora w 1993 r., oraz nowocześniejszych wariacji na temat reguły Taylora pozwoliła na skonstruowanie reguły polityki pieniężnej opartej głównie na artykule Bullarda z 2018 r.

3. Do analizy tekstów komunikatów publikowanych przez FOMC w okresie 2009–2019 użyto metod *text mining* w celu identyfikacji pozostałych czynników mogących wpływać na decyzje FOMC.

Przeprowadzono:

– analizę relatywnej częstotliwości fraz pozwalającą zidentyfikować dla każdego roku czynniki istotne podczas dyskusji FOMC,

– analizę sentymentu wokół kluczowych fraz,

– identyfikację czynników odpowiadających zmiennym ekonomicznym, które z dużą częstotliwością pojawiały się w komunikatach FOMC.

4. Skonstruowano zbiór danych w czasie rzeczywistym zawierający zmienne zidentyfikowane wcześniej jako istotne czynniki wpływające na decyzje FOMC. Stworzono zbiór danych o strukturze czasowej zgodnej ze zbiorami danych, którymi FOMC dysponował podczas podejmowania decyzji na każdym posiedzeniu.

5. Przeprowadzono estymację modelu, który za pomocą stworzonego zbioru danych wyjaśniał odchylenie stóp procentowych od poziomu określonego przez regułę polityki pieniężnej. Wykorzystano model czynnikowy ze zmiennymi zaliczonymi do sześciu kategorii: konsumpcja, rynki finansowe, zatrudnienie, rynek nieruchomości i inwestycje, produkcja przemysłowa oraz gospodarka światowa.

6. Dokonano walidacji modelu i zinterpretowano wyniki.

Wyniki estymacji modelu czynnikowego wskazują, że zmienne związane z rynkami finansowymi, rynkiem nieruchomości i inwestycjami oraz globalną gospodarką mają istotny wpływ na odchylenie stóp procentowych od reguły polityki pieniężnej. Ponadto struktura korelacji czynników związanych z rynkami finansowymi sugeruje, że wzrost ryzyka rynkowego oraz kredytowego prowadzi do zwiększenia odchylenia stóp od reguły polityki pieniężnej. Potwierdza to hipotezę, że władze monetarne w okresach podwyższonego stresu rynkowego są skłonne rezygnować z wypełniania podstawowych celów polityki monetarnej, aby ograniczyć ryzyko na rynkach finansowych. Pogłębiona analiza struktury korelacji czynników związanych z rynkiem nieruchomości wskazuje, że wyższe wydatki inwestycyjne oraz większa liczba zbudowanych i sprzedanych domów wiążą się z mniejszym odchyleniem stóp od reguły polityki pieniężnej. Biorąc pod uwagę, że stopa sugerowana przez regułę jest przez większość badanego okresu wyższa niż stopa wyznaczana przez FOMC, potwierdza to chęć władz monetarnych do podwyższania stóp w sytuacji rozgrzania rynku nieruchomości. Istotny wpływ czynników związanych z globalną gospodarką, w tym dynamiki PKB oraz inflacji w największych gospodarkach świata, sugeruje, że pomimo dominacji Stanów Zjednoczonych w globalnej gospodarce władze monetarne biorą także pod uwagę rozwój sytuacji u swoich partnerów handlowych, co potwierdziła analiza tekstu komunikatów FOMC.

Rezultaty przedstawione w artykule otwierają kolejne możliwości badawcze. Po pierwsze, procedura badawcza zaprojektowana do analizy gospodarki amerykańskiej może być zastosowana wobec dowolnej gospodarki, w której jest prowadzona polityka pieniężna. Po drugie, wyniki empiryczne mogą zostać wykorzystane do ćwiczeń prognostycznych. Użycie w badaniu zbioru danych w czasie rzeczywistym sprawia, że wyniki te mogą być bardzo użyteczne w konstruowaniu krótkookresowych prognoz stóp procentowych.

Artykuł ma także swoje limitacje, do których należy zaliczyć ograniczony zbiór zmiennych wykorzystanych w modelu. Zmniejszenie liczby zmiennych było jednak konieczne, by utrzymać odpowiednią wartość stopni swobody w modelu. Kolejną limitacją jest założenie dotyczące parametrów reguły polityki pieniężnej, które zostały ustalone na podstawie analizy literatury. Ustalenie parametrów zgodnych z poglądami wszystkich członków FOMC jest niemożliwe, więc jedna z części artykułu zawiera testy odporności na zmiany parametrów.