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Topic Modeling Analysis of Central Bank Inflation Reports with BERTopic[1]

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ABSTRACT

Between 2006 and 2024, inflation in Türkiye exhibited complex dynamics influenced by domestic and external factors. The Central Bank of the Republic of Türkiye (CBRT) implemented inflation targeting to achieve price stability, but challenges persisted due to monetary and fiscal policies, asset prices (real estate and gold), and changing consumption patterns. The CBRT's inflation reports played a critical role in shaping policies and managing economic expectations. This study analyzes CBRT inflation reports from 2006 to 2024 using BERTopic topic modeling and natural language processing (NLP) methods. BERTopic identifies key topics and their evolution, while NLP tools examine linguistic patterns and policy orientations. The analysis evaluates how CBRT's communication strategy responded to economic conditions and influenced inflation expectations. Findings will highlight the impact of CBRT's communication on economic stability and contribute to understanding the effectiveness of inflation-targeting strategies. This research also demonstrates the value of BERTopic and NLP in analyzing inflation reports.

Keywords: *BERTopic, Topic Modeling, Natural Language Processing, text analysis, Inflation Reporting.*

Merkez Bankası Enflasyon Raporlarının BERTopic Konu Modellemesi İle İncelenmesi

ÖZET

2006 ve 2024 yılları arasında Türkiye'de enflasyon, iç ve dış faktörlerin etkisiyle karmaşık dinamikler sergilemiştir. Türkiye Cumhuriyet Merkez Bankası (TCMB), fiyat istikrarını sağlamak amacıyla enflasyon hedeflemesi uygulamış, ancak parasal ve mali politikalar, varlık fiyatları (gayrimenkul ve altın) ve tüketim kalıplarındaki değişimler nedeniyle zorluklarla karşılaşmıştır. TCMB'nin enflasyon raporları, politikaların şekillendirilmesinde ve ekonomik beklentilerin

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yönetilmesinde kritik bir rol oynamıştır. Bu çalışma, 2006 - 2024 yılları arasında TCMB'nin enflasyon raporlarını BERTopic konu modellemesi ve doğal dil işleme (NLP) yöntemleriyle analiz etmektedir. BERTopic ile raporlarda öne çıkan konular ve bunların zaman içindeki değişimi tespit edilmiştir. NLP araçları, dil kalıplarını ve politika yönelimlerini inceleyerek TCMB'nin iletişim stratejisinin ekonomik koşullara nasıl tepki verdiğini değerlendirilmiştir. Bulgular, TCMB'nin iletişiminin ekonomik istikrara etkisini vurgulayarak ve enflasyon hedeflemesi stratejilerinin etkinliğine katkı sağlamıştır. Bu çalışma, BERTopic ve NLP yöntemlerinin enflasyon raporlarının analizinde kullanılabilirliğini de göstermektedir.

Anahtar Kelimeler: *BERTopic, Konu Modellemesi, Doğal Dil İşleme, Metin analizi, Enflasyon Raporlaması*

1. INTRODUCTION

Inflation in Turkey has remained on the agenda as an ongoing macroeconomic problem for years and has experienced many fluctuations due to a wide range of internal and external factors. After the adoption of Inflation Targeting (IT) as a monetary regime between 2001 and 2006, examining inflation dynamics has become even more important. Inflation targeting, which is an important milestone for the Turkish economy, aims to both reduce inflation and achieve price stability (Karahan, 2017). However, despite the positive changes created by IT, the Central Bank has encountered difficulties in achieving inflation targets due to the complexity of the response mechanism of budget policies (Bulut, 2019).

Turkey has struggled with high and persistent inflation for long periods from 2006 to the present. Although high inflation is a major macroeconomic problem, the source of the problem has varied in different periods. For example, the depreciation of the Turkish lira, the increase in public sector prices and the 2008 economic crisis caused major changes in the Turkish economy for the years between 2006 - 2009 (Saatçioğlu and Korap, 2008; Taşseven, 2008). During this period, efforts to combat inflation were hampered by non-trade inflation above 10%, global commodity price shocks, and capital inflows that caused the real exchange rate to appreciate, causing labor-intensive sectors to weaken (Culha et al., 2008). Despite the measures taken to reduce inflation, the situation where the rate cannot be reduced below a certain level, namely inflation inertia, continued between 2010 and 2014 for similar reasons, including the limited credibility of the CBRT in reaching inflation targets (Zeren & Korap, 2010; Horvath & Matějů, 2011). The existing two-way relationship between inflation and uncertainty continued, and global monetary policy shocks and relative price changes contributed to the continuation of inflation inertia (Saatçioğlu & Korap, 2009; Sekine, 2009).

In the period covering 2015 - 2019, while global effects such as relative price shocks continued to play an important role in high inflation, monetary challenges, exchange rate pass-through and import-related pressures increased inflation further (Bulut, 2016; Tugcu et al., 2019; Kapusuzoğlu et al., 2018). The struggle to increase the reliability of CBRT and the difficulty in reaching inflation forecasts caused by this highlighted the limitations of inflation

targeting (Yurdakurban & Öneş, 2017). In the period of 2020-2024, inflation pressures are seen to increase due to the disruptions in global commodity and energy prices caused by the Russia-Ukraine war, the COVID-19 pandemic and the depreciation of the Turkish lira (Deniz et al., 2020; Malakhail et al., 2023). Throughout all these years, the Phillips curve dichotomy in Turkey has emphasized the impact of relative price changes on inflation (Çatık et al., 2011; Kırca and Canbay, 2021). In summary, inflation in Turkey between 2006 and 2024 has been shaped by global shocks, exchange rate volatility and monetary challenges, as well as the ongoing credibility efforts of the CBRT (Saatçioğlu & Korap, 2008; Apergis et al., 2021).

Inflation Reports, published regularly by central banks in countries where inflation targeting regimes are implemented, play an important role in informing the public about inflation targets and forecasts. These reports are used as a basic tool in explaining monetary policy decisions and strategies, in aligning public expectations with these decisions and strategies, and in directing economic behavior towards price stability (Bulíř et al., 2008; Gavin, 2003). Although the content of the reports varies according to the basic needs and conditions of each country, the use of reports as a communication tool is of vital importance since they include central banks' assessments of national and global economies, past inflation targeting performances and the reasons underlying these performances, the justifications for monetary policy decisions taken, future inflation forecasts, and the assumptions supporting these forecasts (Kaya and Orak, 2008).

In Turkey, after the adoption of the inflation targeting regime, the CBRT's main communication tools become the inflation reports published four times a year. In addition to revealing inflation trends by comprehensively analyzing macroeconomic and financial developments, the inflation report includes CBRT's inflation forecasts, risk factors assessed for the future course of monetary policy, what the policy response might be if these risks occur, and forecasts for interest rates and medium-term inflation (Eroğlu, 2007; Kaya and Orak, 2008). The inflation forecasts included in the Inflation Reports are the most important element that distinguishes the report from the Monetary Policy Reports. When inflation forecasts change due to the changing economic conditions, current inflation forecasts and revisions that they face are emphasized in each report (Ceylan, 2013; Aksoy, 2019).

In summary, inflation reports are critical for understanding inflation dynamics and managing them effectively. These reports provide comprehensive data on both headline and core inflation and reveal the factors that determine inflation trends. They also enable policy makers and analysts to closely monitor inflation and identify emerging pressures (Apergis et al., 2021; Bayir & Orak, 2023; Kirca & Özer, 2020). Inflation reports, which allow the CBRT to evaluate monetary policies by comparing actual data with forecasts (Bulut, 2016; Bulut, 2019; Karaman & Yıldırım-Karaman, 2017), are also used as a tool to fix public inflation expectations and promote transparency and predictability in monetary policy (Güler, 2021; Armantier et al., 2015). It also provides insight into risks such as exchange rate fluctuations, commodity price shocks and supply-side constraints highlighted and provides insight into the challenges the economy may face (Tugcu et al., 2019; Kapusuzoğlu et al., 2018; Deniz et al., 2020). The regular publication of reports also helps increase elements such as

transparency, accountability and credibility of monetary policies (Karaman & Yıldırım-Karaman, 2017; Gürkaynak et al., 2006).

Applying text analytics to inflation reports provides important insights into the understanding of the period it covers and the estimation processes used in central bank communication. Pandey et al. (2021) emphasize that the use of text mining techniques in monetary policy statements can reveal the information taken into account by the central bank and the methods used in inflation estimation. Thus, the factors that determine inflation estimates and central banks' decision-making processes can be understood more deeply. Monitoring central bank communications using Natural Language Processing (NLP) techniques and using computational linguistics tools to analyze their messages contributes greatly to the growing literature in this area (Fortes & Guenedal, 2021). The application of NLP methods provides valuable insights into how financial markets and economic conditions shape central bank decision-making processes, allowing researchers to gain a deeper understanding. Applying text analytics to inflation reports can provide insights into central bank communications, improve forecast accuracy, and provide extracting the emotions embedded in monetary policy statements.

The aim of this study is to analyze the inflation reports published by CBRT between 2006 and 2024 using topic modeling techniques. This analysis aims to identify the patterns, trends and changes in the communication language, focus and policy orientation of CBRT in the specified period and to provide insight into how inflation-related communication and strategies have evolved with the changes in economic conditions and policies. The application of topic modeling techniques to a comprehensive dataset of CBRT inflation reports covering approximately twenty years prepared within the scope of the study is one of the elements supporting the originality of the study. While previous studies focused on economic indicators and policy outcomes, this study offers an innovative approach that examines the language and communication strategies of CBRT. Therefore, the contributions of the study are as follows:

a. First, this study identifies the main themes in the CBRT's inflation reports, such as inflation trends, monetary policy responses, and global economic shocks. These themes provide a comprehensive understanding of the CBRT's changing focus over the 2006-2024 period.
b. Second, the study applies topic modeling to track how the emphasis on different topics changes over time. This provides an effective analysis of how the CBRT’s communication adapts to major economic events such as financial crises, currency depreciation, and global inflationary pressures.
c. Third, the insights gained from the analysis help policy makers, researchers and economists evaluate the effectiveness of the CBRT’s communication strategies, while understanding the focus areas of the CBRT’s inflation reports provides a better understanding of how these communications are aligned with policy objectives and economic conditions.

d. Finally, this study demonstrates the applicability of BERTopic and other NLP techniques to Turkish economic texts. This methodological approach can be adapted to analyze other central bank reports or economic datasets in different languages and may fill a critical gap in non-English topic modeling research.

The organization of the study is as follows. In the second section, the relevant literature will be discussed. The third section will explain the methodology of the study. The fourth section will present the analysis results and findings. Finally, the last section will provide a discussion of the results.

2. LITERATURE REVIEW

In recent years, Natural Language Processing (NLP) and topic modeling techniques have proven to be essential tools for analyzing large text datasets, enabling researchers to uncover hidden trends and patterns across various domains. These techniques offer significant advantages in terms of flexibility, efficiency, and interpretability, making them suitable for applications in fields ranging from aviation safety to financial markets and central bank communications.

In the field of aviation safety, Kuhn (2018) applied Structural Topic Modeling (STM) to over a million reports from the Aviation Safety Reporting System (ASRS). This approach identified known issues, such as fuel pump and landing gear problems, and revealed previously unnoticed trends, like the prominence of specific approach paths. This study highlighted the potential of topic modeling for identifying latent patterns in large, text-heavy datasets.

Similarly, in space system analysis, Layman et al. (2016) used Latent Dirichlet Allocation (LDA) on 16,669 NASA problem reports. Their analysis uncovered trends in hardware, flight software, and ground station issues, underscoring the challenges of parameter selection and topic labeling. Despite these challenges, the study demonstrated the value of topic modeling for deriving actionable insights from unstructured data.

In the healthcare sector, Sarıoğlu et al. (2013) utilized topic modeling to classify Electronic Health Records (EHRs). By extracting themes from free-text CT imaging reports, the study achieved a more compact and efficient representation of data compared to traditional methods. This approach enabled faster automated processing and highlighted the efficacy of topic-based classification systems.

Topic modeling has also shown considerable utility in the analysis of Corporate Social Responsibility (CSR) reports. Goloshchapova et al. (2019) applied LDA to CSR reports from European firms, identifying key themes such as employee safety, carbon emissions, and efficient power. Their study revealed sector-specific biases and demonstrated how topic modeling can extract meaningful insights from large collections of text documents.

In the context of financial markets, Chen et al. (2023) compared LDA, Top2Vec, and BERTopic to analyze the impact of news on stock prices. Their findings showed that BERTopic outperformed other models in terms of coherence, interpretability, and computational efficiency. This study validated the feasibility of automated news impact analysis frameworks, emphasizing the role of NLP in financial research.

Focusing on construction industry reports, Jagannathan et al. (2022) employed both LDA and Non-negative Matrix Factorization (NMF) to analyze annual reports of Indian construction firms. The study identified strategic themes like revenue-focused growth and lean-focused productivity improvements, showcasing the effectiveness of NLP for sectoral analysis and policymaking.

In the domain of inflation communication, several studies have highlighted the role of topic modeling and NLP in understanding central bank narratives. Müller et al. (2022) introduced the Inflation Perception Indicator (IPI) using RollingLDA to measure media coverage of inflation in Germany. Their research revealed significant shifts in inflation perception influenced by geopolitical events and supply chain disruptions. Expanding on this, Schmidt et al. (2023) found that media narratives on inflation closely correlate with inflation expectations during periods of high media coverage, such as the financial crisis and energy price shocks. A comparative analysis of Federal Open Market Committee (FOMC) transcripts by Ruman (2023) further demonstrated the utility of LDA and keyword-in-context (KWIC) techniques. The study revealed differences in inflation communication strategies under Chairs Volcker and Powell, providing valuable insights into the Fed's monetary policy focus during high-inflation periods.

In the context of public perception of inflation, Evstigneeva and Karpov (2023) applied NLP techniques to Russian news and opinion polls, identifying key topics like inflation, economic crisis, and ruble devaluation. Their findings revealed differences in how higher and lower-income households perceive inflation, with central bank communication showing minimal impact on these perceptions. Using economic narratives to forecast inflation, Hong et al. (2024) analyzed over 880,000 Wall Street Journal articles. Their study found that narrative-based forecasts outperformed traditional benchmarks, especially during recessions, underscoring the predictive power of news topics related to inflation expectations and specific goods. On the topic of social media analysis, Born et al. (2023) developed a high-frequency inflation index derived from German tweets, demonstrating its predictive accuracy for inflation expectations. This index responded dynamically to monetary policy changes, highlighting the value of real-time sentiment analysis on platforms like Twitter. Additionally, Singh et al. (2024) and Kumar et al. (2024) analyzed the impact of the Reserve Bank of India's (RBI) monetary policy communications on Indian financial markets using BERTopic and sentiment analysis. Their results underscored the importance of topic-specific communication strategies, particularly in emerging markets where sentiment variations can influence equity markets.

Lastly, in the context of energy prices, Kastrati et al. (2023) combined transformer-based sentiment analysis and topic modeling to examine public engagement on Twitter. Their analysis of tweets during the energy price hikes of 2021-2022 revealed evolving public sentiment and widespread frustration, reflecting real-time reactions to economic challenges.

These studies collectively highlight the versatility of NLP and topic modeling techniques in uncovering trends, patterns, and sentiments across diverse domains, offering valuable insights for decision-making, policy analysis, and economic research.

In addition to these, there are studies that specifically apply BERTopic to Turkish texts, further demonstrating the method's adaptability to different languages and contexts. For instance, Koruyan (2022) employed BERTopic to analyze Turkish customer complaints in the consumer electronics sector, effectively identifying key topics and their temporal changes, demonstrating BERTopic's applicability to Turkish text data. Also, in the study by Cömert and Yücel (2023), the BERTopic method was applied to customer product reviews, enabling the extraction of meaningful themes and the analysis of customer sentiment. Likewise, Ergül et al. (2023) examined Turkish Twitter users' attitudes toward refugees and migrants by applying LDA topic modeling to a curated set of tweets, identifying 14 distinct and interpretable themes that reflect public discourse on migration-related issues. Moreover, Kadaifci et al. (2024) applied topic modeling techniques, including BERTopic, to Turkish user reviews of mobile games in order to compare user sentiments before and after the COVID-19 pandemic. Their findings revealed significant shifts in discussion themes across the two periods, illustrating how BERTopic can effectively capture nuanced topic variations in Turkish-language corpora and be adapted to other platforms with multilingual content. Additionally, Karadaş et al. (2025) proposed a framework for rapid detection of disaster impacts using social media data, applying BERT-based classification and topic modeling techniques including BERTopic and LDA. Their analysis of tweets following the February 6, 2023 earthquake revealed key disaster-related topics and highlighted differences between traditional and modern topic modeling approaches in crisis communication analysis. Research in the literature demonstrate the effectiveness of BERTopic in processing Turkish-language texts, highlighting its linguistic flexibility and expanding its applicability across diverse language contexts.

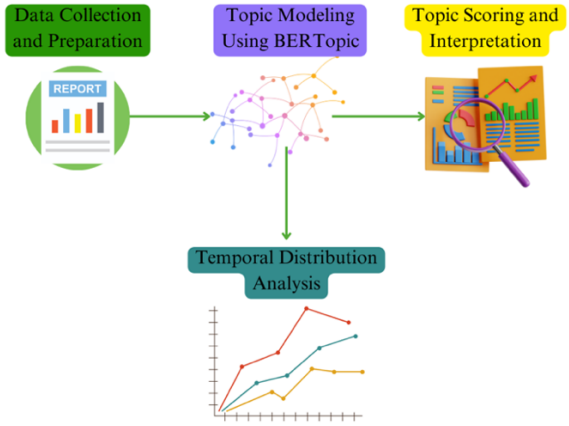
Beyond Turkish-language applications, there are also successful studies that show the effective use of BERTopic in other languages, showcasing its multilingual potential and cross-linguistic adaptability. For example, López et al. (2024) applied BERTopic to analyze over 330,000 Spanish-language online comments, revealing dominant social and political topics and high levels of toxicity in public discourse. Murayama et al. (2025) utilized BERTopic to analyze tweets in 14 languages, revealing global trends in generative AI perceptions—such as widespread positivity toward image-based tools and notable cross-linguistic differences in chatbot usage. Hellwig et al. (2024) applied BERTopic to German-language tweets from political parties and the public during the 2021 federal election, identifying key themes like climate and financial policy, with some topics showing year-long consistency and others peaking around specific events. Building on the demonstrated

versatility and cross-linguistic effectiveness of BERTopic in analyzing diverse textual data, this study employs BERTopic to systematically explore the thematic evolution of the Central Bank of the Republic of Turkey's inflation reports from 2006 to 2024, incorporating consistency checks, topic relevance scoring, and temporal visualizations to uncover meaningful patterns over time.

3. METHODOLOGY

This section outlines the steps taken to analyze the inflation reports published by the Central Bank of the Republic of Turkey (CBRT) from 2006 to 2024. The analysis was conducted using BERTopic, a transformer-based topic modeling approach, and involved consistency assessments, topic scoring, and time-series visualizations. The methodological framework of this study can be seen in Figure 1.

Figure 1. Methodological Framework



Source: Framework created by the authors to support the study's methodology.

3.1. Data Collection and Preparation

The dataset used in this study consists of inflation reports published by the Central Bank of the Republic of Turkey (CBRT) spanning the period from 2006 to 2024. Since each year includes four reporting periods, this results in a total of 2003 entries for analysis. The analysis is divided into four main periods:

2006-2009: Global Financial Crisis Period
2010-2014: Stability Period
2015-2019: Economic Fluctuations and Rising Inflation
2020-2024: Pandemic and Aftermath

The analysis specifically focused on paragraphs from the *"General Assessment"* sections of each inflation report. This section was chosen because it provides provides a comprehensive summary of the period in which the report was written and includes the general outline of the report, the inflation dynamics of the period and the economic conjuncture, was selected to apply text analytics. The General Assessment section has a rich content that provides information about the communication strategies and policy preferences of the Central Bank.

The textual data underwent several preprocessing steps to prepare it for topic modeling**.** Text Cleaning includes removal of stopwords, punctuation marks, and special characters and making the text lowercase to eliminate noise and ensure the text contained only meaningful words. Each paragraph is matched with its corresponding reporting period (year and quarter) to facilitate time-based analysis of topic trends.

Unlike traditional topic modeling techniques such as Latent Dirichlet Allocation (LDA), which rely on bag-of-words (BoW) representations and require extensive preprocessing such as lemmatization and stemming to reduce vocabulary redundancy, BERTopic utilizes sentence embeddings in combination with dimensionality reduction via UMAP and clustering through HDBSCAN. This embedding-based approach captures semantic similarity between words and documents directly, making preprocessing steps like lemmatization not only unnecessary but has potential to make topics hard to understand (Angelov, 2020). Further studies emphasize that embedding-based models like Top2Vec do not require lemmatization, or stemming, as clustering mechanisms like HDBSCAN naturally mitigate these issues (Egger and Yu 2022; Ma et al., 2021).

BERTopic also uses dimensionality reduction with UMAP and clustering with HDBSCAN. Therefore, applying lemmatization prior to BERTopic can distort sentence-level embeddings, reduce semantic richness, and hinder the model's ability to generate coherent and meaningful topics. Additionally, as Sayallar (2025) points out, there are currently no lemmatization methods for Turkish that successfully preserve word meaning. Because of these, applying lemmatization before semantic modeling could distort or remove important contextual differences between words, and lemmatization is not applied in this study.

3.2. Topic Modeling Using BERTopic

BERT (Bidirectional Encoder Representations from Transformers), introduced by Devlin et al. (2019), is a deep learning model designed for a variety of natural language processing (NLP) tasks, such as classification, summarization, question answering, and sentiment analysis. BERT's key feature is its ability to produce deep bidirectional representations by jointly conditioning on the left and right context of a given word, making it highly effective for capturing semantic meaning in text data. Due to its versatility and ease of fine-tuning, BERT has become a foundational tool in modern NLP applications.

BERTopic, developed by Grootendorst (2022), builds on the principles of BERT to create a robust topic modeling framework. It integrates clustering methods and class-based Term Frequency-Inverse Document Frequency (c-TF-IDF) to generate coherent topic representations. The process begins with constructing document embeddings using a pre-trained language model, which captures semantically meaningful representations. These embeddings are then dimensionally reduced using Uniform Manifold Approximation and Projection (UMAP) to preserve local and global data structures (McInnes et al., 2020). Subsequently, the reduced embeddings are clustered using Hierarchical Density-Based Spatial Clustering of Applications (HDBSCAN), which effectively identifies clusters while allowing noise points to remain unassigned (McInnes et al., 2017). Finally, c-TF-IDF is applied to create topic representations, highlighting terms that best define each topic (Grootendorst, 2022).

BERTopic demonstrates significant performance in both static and dynamic topic modeling. Dynamic topic modeling (DTM) allows for the analysis of how topics evolve over time by applying c-TF-IDF at each time step (Gao & Sazara, 2023; Grootendorst, 2022). This capability makes BERTopic particularly suitable for analyzing sequential data, such as central bank reports or news articles, where understanding topic evolution is critical.

One of BERTopic's advantages is its support for a broad range of embedding models, including multilingual embeddings making it applicable to multiple languages, including Turkish. This flexibility is crucial for studies focusing on non-English text data. However, BERTopic does have some limitations, such as potential challenges with embedding methods leading to excessive topic fragmentation and the lack of standardized evaluation metrics (Egger & Yu, 2022).

In this study, BERTopic is applied to the Central Bank of the Republic of Turkey's (CBRT) inflation reports published between 2006 and 2024. The goal is to uncover key themes and trends within these reports, providing insights into the CBRT's communication strategies and their evolution over time. The methodology involves creating document embeddings, reducing dimensions, clustering documents, and generating topic representations using c-TF-IDF. This approach offers a detailed and dynamic analysis of the CBRT's inflation-related communications, contributing to the understanding of central bank transparency and policy focus.

BERTopic was selected for this study due to its capability to leverage transformer-based embeddings, which provide rich, contextualized representations of text data. This makes BERTopic particularly effective for extracting meaningful and coherent topics from large corpora. The topic extraction process began by applying BERTopic to identify themes within the paragraphs of the Central Bank of the Republic of Turkey's (CBRT) inflation reports. For each identified topic, word clouds were generated to visualize the most prominent words associated with each theme, offering a clear and intuitive way to interpret the results for different periods.

To ensure the quality of the extracted topics, two primary consistency measures were employed to determine the optimal number of topics: CV (Coherence Value), which evaluates the semantic coherence of the topics, and NPMI (Normalized Pointwise Mutual Information), which measures the internal consistency of words within each topic. This approach ensured that the selected topics were both interpretable and representative of the underlying themes in the CBRT's communications.

For the Turkish word embedding method, the *bert-base-turkish-cased-mean-nli-stsb-tr* model was employed (Çelik, 2021). This model is based on BERT and is specifically designed to capture meaningful contexts and relationships within Turkish text data. Due to its robust architecture, this BERT-based model provides high performance in natural language processing (NLP) tasks involving Turkish texts. Its ability to generate semantically rich embeddings makes it an ideal choice for accurately representing Turkish text and ensuring the effectiveness of BERTopic in identifying coherent topics. In topic extraction process we applied BERTopic to identify themes present in the paragraphs. Then we generated word clouds for each period to visualize the most prominent words associated with each topic.

3.3. Topic Scoring and Interpretation

To enhance the interpretability of the extracted topics, word scores were calculated for each of the identified topics. These scores highlighted the most influential terms within each topic, helping to determine the key words that best represent the underlying themes. This scoring process ensured that the topics were grounded in the most relevant terms, making the analysis more transparent and reliable.

Following the identification of key terms, detailed descriptions were crafted for each topic, summarizing the essence of each theme based on the most influential words. The descriptions provided clear insights into the specific themes covered in the CBRT inflation reports, enabling a deeper understanding of the central bank's focus areas and communication strategies over time. This structured approach facilitated a comprehensive interpretation of the topic modeling results.

3.4. Temporal Distribution Analysis

In this step, the trends and distributions of the identified topics over time were analyzed to understand their evolution within the CBRT inflation reports. The distribution of the topics was visualized to track changes in their prominence throughout the entire 2006-2024 period. This visualization helps to identify how the importance and frequency of these topics fluctuated over time.

A focused analysis of the year 2024 was performed to capture the latest trends in the CBRT's inflation reports. A graph was generated to illustrate the frequency and prominence of topics during this year, providing a clearer view of recent developments and shifts in thematic focus.

These steps ensured a systematic examination of topic distribution across different time frames, facilitating the identification of long-term and recent trends.

4. FINDINGS

In this section, a description of the dataset is given, and preprocessing step is described. Afterward, topic modeling implementation is explained and the discovered topics are defined. Lastly, topic trends over time and recent trends for 2024 is explained.

4.1. Dataset

The dataset used in this study was created from the inflation reports published by the Central Bank four times a year between 2006 and 2024. In order for the analysis to be comprehensive and consistent, the text data was organized in a way that each paragraph in General Assesment secion of inflation reports would be an entry. This arrangement aimed to obtain more layered results on the main theme and subject of each paragraph. The paragraphs were labeled using the year and period of the report they belonged to, respectively. Thus, time-based analyses on how themes and trends changed over time were made possible. After applying pre-processing steps, the dataset was made robust and suitable for topic modeling. An example of the dataset is shown in Table 1.

Table 1. Sample Dataset

Period	Turkish	English Translation
2012-03	TCMB, para politikası stratejisini oluştururken maliye politikasına ilişkin gelişmeleri yakından takip etmektedir. Rapor'da baz senaryoda oluşturulan enflasyon tahminleri OVP'de belirlenen çerçeveyi esas almaktadır. Dolayısıyla bütçe dengesinde yılın ikinci yarısında ek bir bozulma olmayacağı ve yönetilen / yönlendirilen fiyatlarda öngörülmeyen bir artış gerçekleşmeyeceği varsayılmaktadır. Maliye politikasının söz konusu çerçeveden belirgin olarak sapması ve bu durumun orta vadeli enflasyon görünümünü olumsuz etkilemesi halinde para politikası duruşunun da güncellenmesi söz konusu olabilecektir.	*The CBRT closely monitors developments in fiscal policy while formulating its monetary policy strategy. The inflation forecasts created in the report are based on the framework established in the MTP. Therefore, it is assumed that there will be no additional deterioration in the budget balance in the second half of the year and that there will be no unforeseen increases in administered/regulated prices. Should fiscal policy deviate significantly from this framework and adversely affect the medium-term inflation outlook, the monetary policy stance may also be updated.*
2012-04	Küresel ekonomideki zayıf seyrin sürmesi enflasyon risklerini azaltırken finansal istikrar ve büyüme kaygılarını gündemde tutmaktadır. Euro Bölgesi'ne dair belirsizlikler, ABD ve Çin ekonomilerine ilişkin kaygılar ve jeopolitik riskler önemini korumaktadır. Yakın donemde	*The continuation of weak performance in the global economy reduces inflation risks while keeping concerns about financial stability and growth on the agenda. Uncertainties regarding the Eurozone, concerns about the US and Chinese*

alınan tedbirlere rağmen, küresel ekonomiye dair süregelen kırılganlıklar ve dengesizlikler risk iştahındaki oynaklığı göreli olarak yüksek seviyelerde tutmaya devam etmektedir. Bu görünüm, gelişmiş ülkelerin piyasaya sürdüğü olağanüstü bol ve düşük maliyetli likidite ile birlikte değerlendirildiğinde, kısa vadeli sermaye akımlarındaki oynaklığın yüksek seyretmesine neden olmakta ve esnek bir politika çerçevesine sahip olmanın önemini teyit etmektedir.	*economies, and geopolitical risks remain significant. Despite recent measures, ongoing vulnerabilities and imbalances in the global economy continue to keep volatility in risk appetite at relatively high levels. When this outlook is considered alongside the extraordinarily abundant and low-cost liquidity provided by developed countries, it leads to high volatility in short-term capital flows and underscores the importance of having a flexible policy framework*

Source: Prepared by authors.

4.2. Topic Extraction

All BERTopic analyses were performed using Python libraries, including BERTopic version 0.17.0, sentence-transformers, UMAP, HDBSCAN, and sklearn. The algorithms were executed on a MacBook Pro equipped with an M1 Pro chip and 16 GB of memory. The bert-base-turkish-cased-mean-nli-stsb-tr model was utilized for generating document embeddings in the analysis of the inflation dataset.Wordcloud library of Python version 1.9.4 were utilized for creating wordclouds in the study.

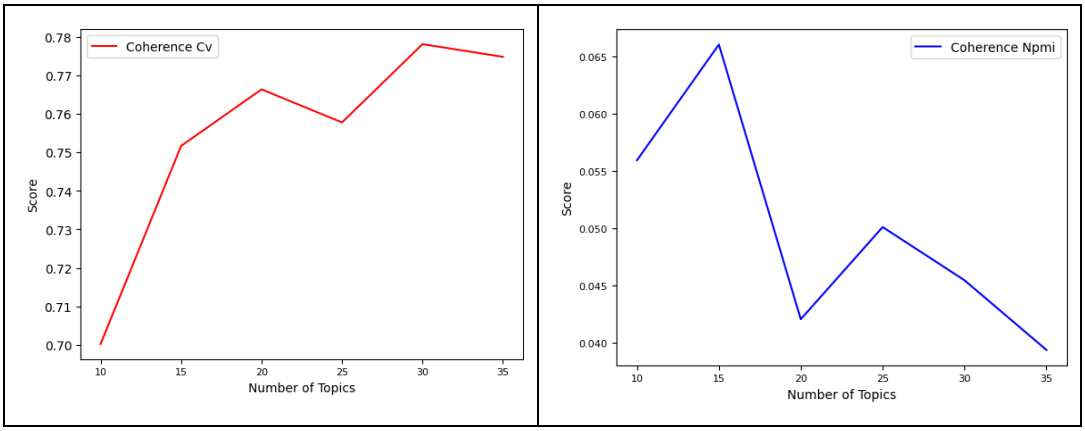
In the initial step of the topic analysis, the number of neighbors in UMAP is set as 15, and minimum cluster size in HDBSCAN is set as 10 to prevent granularity in the topics. In the initial analysis using BERTopic, the algorithm identified a total of 39 topics. Given the dataset comprises 2003 entries, having 39 topics can be excessive and may lead to difficulty in interpretation. Therefore, the number of topics needs to be reduced to achieve a more manageable and meaningful set of themes.

While BERTopic offers several advantages for topic modeling, one potential drawback is its tendency to generate an outlier topic that may include a number of documents. To mitigate this issue, we employed a c-TFIDF outlier reduction strategy. This approach calculates the class-based TF-IDF (c-TFIDF) representation for each topic and then assigns outlier documents to the topic with the most similar c-TFIDF vector, (BERTopic Documentation, 2025).

To determine the optimal number of topics, consistency measures were employed. The most commonly used consistency measures in the literature are the Coherence Value (CV) and the Normalized Pointwise Mutual Information (NPMI) (Röder et al., 2015; Bouma, 2009). In this study, consistency scores were calculated for topic numbers ranging between 10 and 35. This approach ensures that the selected number of topics maintains semantic coherence and internal consistency, providing a clearer and more interpretable set of findings.

Figure 2. Consistency Measures

CV Score	NPMI Score



As shown in Figure 2, the CV measure indicated that the most coherent results were obtained with 30 topics, while the NPMI measure suggested that the optimal number of topics was 15. To avoid redundancy and ensure consistency, 15 topics—the number yielding the highest NPMI coherence score—were selected for this study.

For these 15 topics, the BERT model identified specific themes and the representative words associated with each topic. The detailed breakdown of these topics can be found in Table 2. In Table 2, the first column displays the topic numbers, the second column shows the number of observations assigned to each topic, and the third column lists the representative words that best describe each topic. This approach ensures a clear and structured representation of the themes derived from the dataset.

Table 2 displays the dominant themes that emerged from the BERTopic analysis, with the ten most representative keywords listed for each topic. These topics were generated from a corpus focused on monetary, fiscal, and macroeconomic developments and likely correspond to Central Bank discourse or economic reports. Topic 0 is centered around the effects of food and commodity prices on inflation, frequently referencing terms like “gıda (food)”, “fiyatlarındaki (in prices)”, and “enflasyon (inflation)”. Topic 1 reflects concerns about global financial risks, with emphasis on “risk”, “emerging markets”, and “developed economies” while Topic 2 highlights the importance of domestic demand and internal economic dynamics, using terms such as “talep (demand)”, “iktisadi (economic)”, and “büyüme (growth)”. Topic 3 and Topic 6 both concern fiscal and monetary policies, including references to the Central Bank (TCMB), interest rates, and policy strategies where Topic 4 groups words related to inflation projections and mid-point targets, suggesting its association with forward-looking macroeconomic forecasts.

Table 2. Topics and Representations

Topic	Count	Representations

0	371	[food (gıda), inflation (enflasyonu), prices (fiyatlarındaki), core (temel), inflation (enflasyonun), price (fiyat), inflation rates (fiyatlarının), energy (enerji), evident (belirgin), basic (temel)]
1	256	[global (küresel), risk (risk), emerging (gelişmekte), financial (finansal), advanced (gelişmiş), continuing (devam), money (para), country (ülke), directional (yönlü), towards (yönelik)]
2	231	[domestic (yurt), economic (iktisadi), demand (talep), ongoing (devam), internal (içi), domestic demand (yurt içi), demand's (talebin), continues (etmektedir), net (net), growth (büyümeye)]
3	185	[fiscal policy (maliye), medium-term (orta vadeli), middle (orta), policy (politika), essential (esas), term (vadeli), tax (vergi), monetary policy (para politikası), money (para), directed (yönetilen)]
4	157	[end (sonunda), midpoint (orta noktası), inflation (enflasyonun), point (noktası), forecast (tahmin), range (aralığında), monetary (para), estimated (edilmektedir), expected (tahmin edilmektedir)]
5	147	[credit (kredi), commercial (ticari), loans (kredilerin), financial (finansal), growth (büyüme), ongoing (devam), macroprudential (makroihtiyati), consumer (tüketici), credits (krediler), with effect (etkisiyle)]
6	132	[CBRT (tcmb), interest rate (faiz), policy (politika), money (para), repo (repo), maturity (vadeli), monetary (parasal), month (ayında), policy (politikası), monetary policy (para politikası)]
7	127	[global (küresel), developed (gelişmiş), emerging (gelişmekte), risk (risk), directional (yönlü), money (para), ongoing (devam), downward (aşağı), economic (iktisadi), downward trend (aşağı yönlü)]
8	109	[Turkish (türk), Turkish lira (türk lirası), lira (lirası), required (zorunlu), TL (tl), CBRT (tcmb), foreign exchange (döviz), required reserve (zorunlu karşılık), reserve (karşılık), billion (milyar)]
9	79	[USA (abd), oil (petrol), prices (fiyatları), import (ithalat), dollar (doları), USD (abd doları), assumption (varsayımı), oil prices (petrol fiyatları), to the dollar (dolarına), USD-based (abd dolarına)]
10	68	[structural (yapısal), fiscal (mali), stability (istikrarı), fiscal discipline (mali disiplinin), discipline (disiplinin), permanent (kalıcı), importance (önem), contributes (katkıda), macroeconomic (makroekonomik), carries (taşımaktadır)]
11	51	[end (sonu), point (puan), upward (yukarı), directional (yönlü), estimate (tahmini), upward trend (yukarı yönlü), point upward (puan yukarı), prediction (tahminini), year-end estimate (sonu tahmini), estimate of (tahminine)]
12	33	[should be emphasized (vurgulanmalıdır), monetary policy (para politikası), money (para), expressed (ifade edilen), should not be perceived (algılanmamalıdır), news (haberin), policy (politikası), expressed (ifade), hence emphasized (vurgulanmalıdır dolayısıyla), monetary news (haberin para)]
13	30	[CBRT (tcmb), policy (politika), interest rate (faiz), other (diger), on the other hand (yandan), global (küresel), Turkey (türkiye), Republic of Turkey (türkiye cumhuriyet), term (vadeli), simplification (sadeleşme)]
14	26	[current (cari), current account (cari işlemler), transactions (işlemler), gold (altın), foreign (dış), energy (enerji), foreign trade (dış ticaret), strong (güçlü), exports (ihracat), imports (ithalatı)]

Topic 5 focuses on credit dynamics, indicating the monitoring of loan growth, especially commercial and consumer credits, and Topic 7 revisits global risks but places stronger

emphasis on downward trends in growth and investment across developed and emerging economies. Furthermore, Topic 8 deals with exchange rate management, especially concerning the Turkish Lira, required reserves, and foreign exchange interventions. Topic 9 is a specialized theme on oil price shocks and USD exchange rate assumptions, often affecting Turkey's import bills and inflation pass-through, and Topic 10 brings attention to structural fiscal measures and long-term discipline, likely advocating for macroeconomic stability frameworks. Topic 11 shows a narrow focus on upward revisions to inflation forecasts or the end-year consumer inflation targets. Topic 12 and Topic 13 are discourse-centered topics that involve the way monetary policy messages are conveyed, including policy clarity, public interpretation, and TCMB communication. Finally, Topic 14 focuses on the external balance, especially Turkey's current account deficit, exports, and gold trade. Together, these 15 topics provide a comprehensive reflection of the economic issues emphasized in the text corpus. Figure 3 supports this with visual word score distributions for each topic.

Figure 3. Topic Word Scores

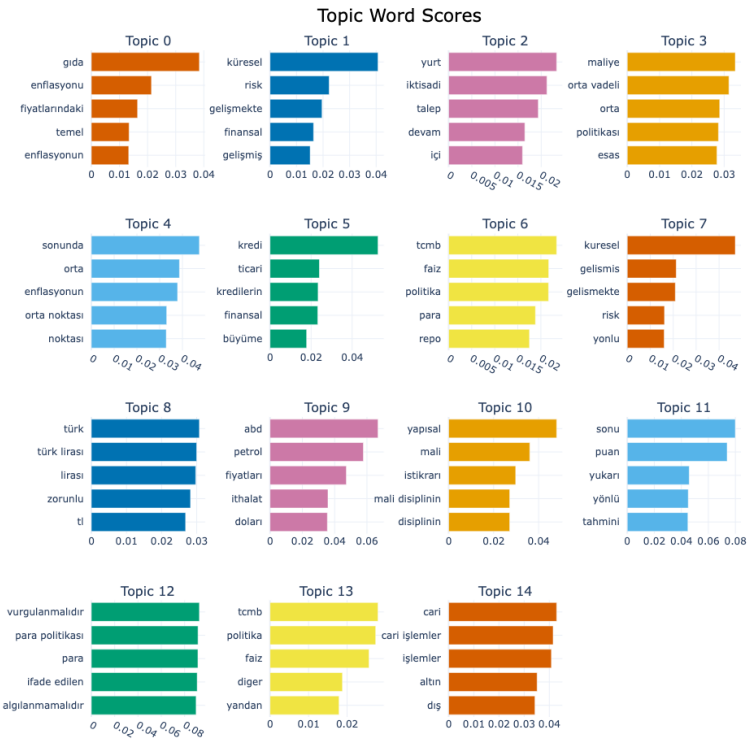


Table 3 shows the topics and their definitions that emerged by evaluating the topic word scores and representative documents. Definitions emphasize a wide range of themes such as monetary policy, inflation, economic growth and financial risks. Thus, a broad perspective was provided on which topics the Central Bank focuses on in its inflation reports through the topic modeling analysis.

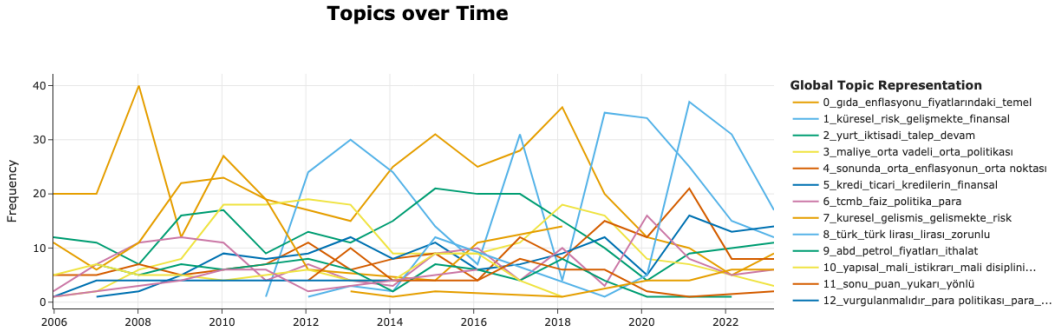
Table 3. Topics and Their Definitions

Topic	Title
Topic 0	Core food inflation and energy price trends.
Topic 1	Global financial risks and trends in developing countries.
Topic 2	Domestic economic demand and growth trends.
Topic 3	Impact of tax and policy on economic outlook and monetary stance.
Topic 4	Predicting inflation trends and monetary policy implications.
Topic 5	Commercial and consumer credit growth with macroeconomic impact.
Topic 6	Examining monetary policy impact on economy and financial markets.
Topic 7	Developed economies, downward risks, and economic policies.
Topic 8	Turkish lira, TCMB, and mandatory reserves in financial reports.
Topic 9	Global oil price trends and import assumptions based on US dollar.
Topic 10	Importance of financial discipline for macroeconomic stability and structural reforms.
Topic 11	Reports showing upward forecast adjustments based on various economic factors.
Topic 12	Exploring monetary policy implications and communication strategies in financial news.
Topic 13	Turkish monetary policy and global economic influences.
Topic 14	Trade balance, energy, and foreign trade dynamics.

Figure 4 illustrates how the frequency of selected topics in the Central Bank of Turkey's inflation reports evolved between 2006 and 2024. The time-based shifts highlight how the emphasis of the reports changed in response to domestic and global developments. While each topic has distinct content, several of them tend to peak together during critical periods, indicating shared economic contexts and possible thematic convergence. For example, in the period of 2008–2009, Topic 0 (Core food inflation and energy price trends), Topic 1 Global financial risks and trends in developing countries), Topic 7(Developed economies, downward risks, and economic policies), and Topic 9 (Global oil price trends and import assumptions based on US dollar) peaked simultaneously. This overlap reflects the combined effects of the global financial crisis, surging commodity prices, and sharp exchange rate fluctuations. These topics can be interpreted under the broader heading of "Global Shock Response". In addition, in the period of 2010–2012, Topic 2 (Domestic economic demand and growth trends), Topic 5 (Commercial and consumer credit growth with macroeconomic impact), and Topic 3 (Impact of tax and policy on economic outlook and monetary stance) saw significant increases in this period. The simultaneous rise of these topics signals a coordinated policy focus on stimulating the economy through credit channels and supportive fiscal planning. These can be considered collectively as "Domestic Growth Strategy".

Furthermore, clear convergence appears in 2018–2019, where Topic 0 (Core food inflation and energy price trends), Topic 3 (Impact of tax and policy on economic outlook and monetary stance), Topic 6 (Examining monetary policy impact on economy and financial markets), and Topic 8 (Turkish lira, TCMB, and mandatory reserves in financial reports) all peaked. These topics reflect the Central Bank's multi-dimensional response to currency depreciation, inflationary pressure, and financial instability, and are best grouped as a "Currency and Inflation Crisis Response". In 2020, Topic 1 (Global financial risks and trends in developing countries), Topic 5 (Commercial and consumer credit growth with macroeconomic impact), and Topic 6 (Examining monetary policy impact on economy and financial markets) rose together, corresponding to the COVID-19 pandemic's economic impact. This points to a clear "Pandemic Monetary-Financial Response", involving global risk monitoring, increased credit support, and monetary easing. During the period of 2021-2023 which is more recent period, Topic 11 (Reports showing upward forecast adjustments based on various economic factors), Topic 10 (Importance of financial discipline for macroeconomic stability and structural reforms), and Topic 6 (Examining monetary policy impact on economy and financial markets) became more prominent. These trends reflect ongoing adjustments in inflation expectations, structural reform efforts, and tighter monetary stances, and can be seen as a phase of "High-Inflation Policy Shift". Finally, some topics like Topic 4 (Predicting inflation trends and monetary policy implications) and Topic 12 (Exploring monetary policy implications and communication strategies in financial news) appear more consistently across time, though with lower frequency. These serve as supporting structures, reflecting the Bank's ongoing focus on institutional credibility and forward guidance, but are analytically distinct and less event-driven.

Figure 4. Topics Over Time



The words frequently used in inflation reports in the 2006 - 2009 period are shown in the word cloud in Figure 5. It is possible to obtain information about the main themes thanks to the word cloud, and the words monetary policy, medium term and high inflation stand out in this word cloud. These words show that the central bank gave importance to monetary policy and combating inflation in the specified period. Words such as high, fast and continuing

show that inflation and inflation-related risks are included in the report. However, the word domestic shows that the domestic economic situation is included in the report, while the word global is thought to be a potential emphasis on the 2008 Global Financial Crisis and the impact of the crisis on the Turkish economy. The presence of both the words upward and downward is an effect of the uncertainty and fragility in inflation in the report.

Figure 5. Word Cloud for Global Financial Crisis Period (2006-2009)

When the word cloud of the Stability period showed in Figure 6 covering the years 2010 to 2014 is examined, it is seen that the words monetary policy, medium term and domestic are frequently used in this period. Thus, it is concluded that the focus on the central bank's monetary policy strategies and medium-term economic forecasts continued in this period. The presence of the words downward and upward emphasizes that the inflation trends and possible fluctuations in economic indicators that continued in the previous period are included in the report. In addition, the frequent use of the words inflation, demand and developments expresses the inflation dynamics, domestic demand and financial changes in this period.

Figure 6. Word Cloud for Stability Period (2010-2014)

The word cloud covering the period 2015-2019 is shown in Figure 7. During this period, the words monetary policy, medium term, domestic and estimated were frequently used and gained significant space in the word cloud. This shows that medium term monetary policy strategies, domestic economic situation and inflation forecasting were the focus of the central bank during this period. The existence of the word exchange rate can be associated with

changes in exchange rate dynamics due to factors such as currency depreciation during this period. The words upward and downward continue to show the central bank's concerns about inflation trends.

Figure 7. Word Cloud for Economic Fluctiations and Rising Inflation Period (2015-2019)

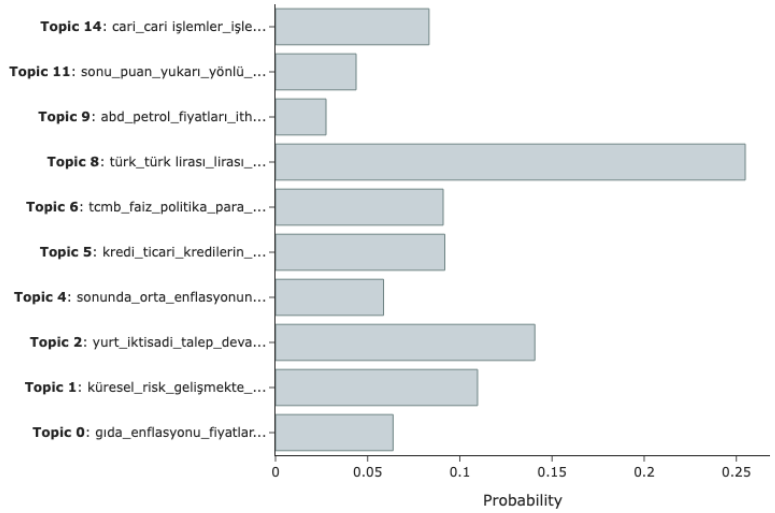
The word cloud that emerged for the years 2020 - 2024, covering the pandemic and the post-pandemic period, is shown in Figure 8. The words monetary policy, domestic and global continued to exist in this period, indicating that the emphasis on monetary policy decisions, domestic economic conditions and global effects continued. In this period, the presence of the word Turkish lira in the cloud can be matched with challenges stemming from exchange rate volatility and currency depreciation.

Figure 8. Word Cloud for Pandemic and Aftermath Period (2020-2024)

Although it is also present in other periods, the word global in this period can be associated with international economic factors originating from the pandemic, supply chain problems and geopolitical tension. Required reserves, uncertainty and risk are also directly related to the economic uncertainty and risk management issues faced by policy makers in this period. The presence of the words upward and downward in this Pandemic and Aftermath Period also emphasizes the fluctuations in inflation trends and prices.

Figure 9 shows the probability distributions of the main topics featured in the Central Bank of Turkey's 2024 inflation reports. The three most prominent topics reveal the key themes emphasized in this year's publications. The topic with the highest probability is Topic 8, highlighting issues related to the Turkish lira, required reserves, and foreign exchange policy. This indicates that the Central Bank placed strong emphasis on exchange rate management, currency stability, and liquidity tools. The prominence of this topic suggests that fluctuations in the Turkish lira and measures to maintain financial stability were central concerns in 2024. The second most likely topic is Topic 2, which centers on domestic demand, economic activity, and growth dynamics. This points to a continued emphasis on internal economic drivers such as household consumption, production trends, and investment. The reports likely assess the effects of demand-side developments on inflation and macroeconomic stability. The third prominent topic is Topic 1, which refers to global risk factors, particularly related to emerging markets and financial uncertainties. Its presence underscores the Bank's attention to external vulnerabilities and how global developments shape domestic monetary conditions. In summary, the 2024 reports primarily focused on exchange rate policy, domestic economic momentum, and global financial risks, revealing a policy agenda shaped by both internal challenges and external uncertainties.

Figure 9. Topic Distributions for 2024



5. DISCUSSION

In the subject modeling of the inflation reports published by CBRT using BERTopic, 15 main topics that successfully reflected the economic environment in this period were

revealed. As a result of the analysis, the most prominent themes in different periods were determined and CBRT's communication focus and implemented policies were emphasized. During the Global Financial Crisis Period of 2006–2009, topics such as food and energy-based inflation, global financial risks, and exchange rate fragility were found to be the determining themes of the reports. The Central Bank's focus during this period was global economic uncertainty and the fight against inflation due to external shocks. The Stability Period, covering the period between 2010 and 2014, reflected the relative calm and recovery efforts after the crisis. The dominance of topics such as domestic demand, economic growth, and credit expansion in the reports emphasizes a period in which internal economic conditions and growth strategies were prioritized. In the period 2015–2019, the topics about exchange rate management, monetary policy tools, and financial discipline were frequently mentioned. It shows that during this period, CBRT focused on policies to contain the depreciation of the Turkish lira, reduce financial volatility, and anchor inflation expectations through macroprudential and monetary interventions. In the 2020–2024 period, which covers the pandemic and its aftermath, global economic risks, domestic demand, and Turkish lira reserves emerged as key themes. It reflects the Central Bank's efforts to manage monetary and financial stability amid the COVID-19 pandemic, as well as geopolitical tensions, supply chain disruptions, and structural inflation pressures faced by Turkey.

6. CONCLUSION

In this study, the inflation reports published by CBRT between 2006 and 2024 were analyzed using BERTopic, a transformer-based topic modeling technique. The “General Assessment” sections of the published reports were examined and the study determined the themes and trends of the periods reflecting the basic communication strategies of CBRT in the eighteen-year divided into four periods. The analysis revealed that the focus was on themes such as monetary policy and inflation forecasts, exchange rate dynamics, credit policies, and global economic risks combating the challenges faced by the Turkish economy.

This paper contributes to the literature on central bank communication and inflation targeting by presenting a systematic and data-driven approach to analyze Turkish inflation reports. The study’s unique aspects include its use of BERTopic as topic modeling in a non-English corpus and its use in demonstrating BERTopic’s effectiveness in Turkish economic texts. Unlike traditional qualitative analyses, this study provides a generalizable and automated method for uncovering communication patterns in central bank reports. The article also emphasizes the importance of effective communication in achieving inflation targets and maintaining monetary stability in emerging economies.

This study has several limitations. First, only the “General Assessment” sections of inflation reports are used in the analysis, potentially limiting valuable insights from other sections. Second, while BERTopic can effectively identify key topics, relying on embedded models

can lead to topic fragmentation or redundancy, which can affect consistency. In addition, The lack of standardized assessment criteria for consistency in topic modeling is another limitation, making it difficult to objectively validate the results.

Future research can extend this work in several ways. First, sentiment analysis can be conducted to gain complementary insights into central bank communication. Integrating sentiment analysis with topic modeling can reveal the emotional tone and nuances of central bank communication. Second, other sections of the reports can be included in the dataset to analyze the analysis of inflation reports more comprehensively. In addition, a comparative analysis with reports from other central banks can be conducted to highlight differences and similarities in communication approaches across economies. Applying dynamic topic modeling can help track the evolution of topics over shorter time periods and capture more detailed policy changes, and finally, the impact of CBRT communication on market behavior and public opinion can be investigated. This can provide valuable feedback on the effectiveness of strategies in influencing economic outcomes. These future research suggestions can be addressed to provide a better understanding of central bank communication, especially in the context of emerging markets and non-English textual data.

Research and Publication Ethics Statement

All processes of this article were conducted in accordance with the research and publication ethics principles of the Journal of the Institute of Social Sciences, Manisa Celal Bayar University.

Authors' Contribution Rates

The authors contributed equally to the study.

Conflict of Interest Statement

The author declares no conflict of interest with any person or institution.

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