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Chapter: Economic Dimensions of Sustainable Development

STUDY ON THE MEASUREMENT OF CHINA'S MONETARY POLICY UNCERTAINTY AND ITS MACROECONOMIC EFFECTS

Zhang Kewei
E-mail: zhangkewei420@163.com
ORCID: Not provided
Affiliation: School of Economics, Southwest Minzu University, China
ROR: https://ror.org/03wppf776

Wang Wenfu
E-mail: wangwenfu@scu.edu.cn
ORCID: https://orcid.org/0000-0002-9317-290X
Affiliation: School of Economics, Sichuan University, China
ROR: https://ror.org/04t7cxd41

Annotation. Based on data from the Financial Times, this paper constructs a monthly index of China's monetary policy uncertainty from 2000 to 2023. Using a Time-Varying Parameter Structural Vector Autoregression (TVP-SV-VAR) model, the study examines the effects of monetary policy uncertainty on macroeconomic variables in a phased manner. First, monetary policy uncertainty negatively impacts the growth rate of economic levels. Second, it has been observed that the effect of monetary policy uncertainty on the inflation rate exhibits an inverted U-shape.

The impact of monetary policy uncertainty on the macroeconomy varies significantly across economic cycles. During economic upswings, increased monetary policy uncertainty drives inflation rates higher. However, during periods of economic stability and downturns, the impact of monetary policy uncertainty on inflation rates is negative. Finally, it has been also found that monetary policy uncertainty positively impacts both interest rates and exchange rates. This study reconstructs the index of China's monetary policy uncertainty and provides a reference for further research on the macroeconomic impacts of monetary policy uncertainty.

Keywords: monetary policy uncertainty, quantitative measurement, macroeconomic effects, TVP-SV-VAR model.

JEL classification: E52, E32, C32.

Introduction

In recent years, the sudden global pandemic and the outbreak of "black swan" events on the international political stage have exacerbated the uncertainty caused by the global economic slowdown and imbalanced growth. Countries around the world typically resort to implementing monetary policies to achieve economic targets and conduct macroeconomic adjustments. However, the direction, timing, and intensity of monetary policy adjustments, as well as the policy itself and the interpretations of the policy by both policymakers and economic agents, all contribute to increased policy uncertainty. Frequent changes in economic policies have become a significant factor hindering economic recovery (IMF, 2012).

China is currently facing a new normal characterised by "insufficient economic growth momentum, continuous industrial structure optimization, and ever-changing global environmental conditions". The Central Economic Work Conference has emphasized the continuation of a prudent monetary policy, with an increased focus on macroeconomic adjustments to stabilize the economic market. However, there is inherent uncertainty in the

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implementation and actual effects of these policies. Against the backdrop of complex international and domestic economic environments, the interplay of new and old economic contradictions poses significant challenges to China's monetary policy in macroeconomic regulation. Misunderstandings of monetary policy by economic agents have affected the efficiency of the policy, leading to monetary policy uncertainty.

Numerous studies indicate that increasing economic uncertainty has a negative impact on economic performance, affecting employment, output, and inflation levels. For instance, Xu and Wang (2018) used a DSGE model to simulate the impact of policy uncertainty on the economy. They pointed out that policy uncertainty shocks are equivalent to negative demand shocks. When policy uncertainty increases by one standard deviation, economic output decreases by approximately 0.15% in the short term, the price level drops by about 0.35%, and consumption and investment decline by around 0.3% and 0.1%, respectively. This demonstrates that although macroeconomic policies primarily aim to stabilise the economic market and stimulate economic growth, they can also introduce negative policy uncertainty effects, affecting how investors and consumers interpret and respond to these policies (Kuang *et al.,* 2019).

Over the past few decades, China's monetary policy has undergone multiple adjustments to ensure stable economic growth, especially during external shocks, such as the US subprime mortgage crisis. Chinese monetary policy has played a crucial role in stabilising economic growth and controlling inflation. Currently, China's monetary policy faces increasing complexity in international affairs and diverse external shocks, leading to larger adjustments. This makes it more challenging for market participants to predict the direction of monetary policy and market stability. Measuring the uncertainty of China's monetary policy is of significant importance for investors, scholars, and policymakers. Firstly, understanding and measuring monetary policy uncertainty helps investors develop more risk-averse investment strategies and reduce investment decision risks (Kuang *et al.,* 2019; Lin *et al.,* 2021). Secondly, researching monetary policy uncertainty enhances scholars' understanding of the monetary policy transmission mechanism and economic cycles, providing important references for the further development of economic theories (Xu Zhiwei, Wang Wenfu, 2018). Lastly, understanding monetary policy uncertainty and its impact on macroeconomic and microeconomic entities helps policymakers better grasp economic conditions and market expectations, thereby formulating more reasonable and effective macroeconomic policies (Zhao, Wei, 2022).

As of the end of 2020, the balance of non-performing loans in China's banking sector reached 3.5 trillion yuan[1], an increase of 381.6 billion yuan from the beginning of the year. However, under the conditions of significant uncertainties in the domestic and international environments, coupled with the impact of the Sino-American trade conflict and the COVID-19 pandemic, China's commercial banks continue to face numerous challenges in preventing and controlling credit risks. Consequently, the quantification of policy uncertainty and its impact on the macroeconomy have become a focal point for Chinese scholars. Currently, there is no consensus on the methods for measuring economic policy uncertainty. The core idea is to identify the optimal indicators that can better represent economic policy uncertainty through correlation analysis. Thanks to advancements in information processing, the sources of information, data availability, coverage, and real-time nature of indicators for calculating economic uncertainty have significantly improved, surpassing what traditional economic measurement methods can achieve in a number of aspects.

This study focuses on the measurement of China's monetary policy uncertainty and further analyses its impact on the macroeconomy. By constructing an index of monetary policy uncertainty tailored to China's specific conditions based on big data from news media texts, we aim to reveal the trends in China's monetary policy uncertainty and its mechanisms of influence on the macroeconomy. The results of this study provide more scientific and comprehensive decision-making support for the formulation and implementation of China's monetary policy. Additionally, it offers valuable reference points for investors, scholars, and policymakers.

1. Literature Review

1.1 Measurement of Monetary Policy Uncertainty

To quantify monetary policy uncertainty, it is essential to first understand the concept of uncertainty. Knight (1921) defined uncertainty as "the inability to predict the likelihood of future events". Economists have extended this concept to the field of economics (Gulen, Ion, 2016). Mainstream literature both domestically and internationally suggests that monetary policy uncertainty refers to the unpredictability or surprises that economic agents experience, which can influence their economic behaviour (Sun, 2017; Yang, 2019; Davis, 2019). In 1972, Robert Lucas proposed the "rational expectations hypothesis", which asserts that economic agents, when making decisions, use all available information to predict future values of economic variables related to their current decisions, thereby assessing the effectiveness of macroeconomic policies, known as "Lucas Critique" (Rudebusch, 2005). Therefore, scientifically measuring monetary policy uncertainty is a necessary condition for studying monetary policy uncertainty and related issues.

Although literature offers no consensus on the methods for measuring monetary policy uncertainty, there are primarily three methods in the existing literature. The first outlined method is quantification based on effective proxy variables. foreign scholars use interest rate volatility as a proxy indicator of monetary policy uncertainty (Huang, 2016). Domestic scholars use the standard deviation of the 7-day Shanghai Interbank Offered Rate (SHIBOR) as a proxy indicator for China's monetary policy uncertainty (Zhong, 2017; Yang, Xie, 2018; Yang *et al.,* 2019). Additionally, some scholars use the VIX market volatility index to measure monetary policy uncertainty. However, these single indicators only represent market participants' subjective prediction deviations for the financial market (Bloom, 2009; Caggiano, 2014), which is not comprehensive. Subsequently, text data analysis methods have been employed to measure monetary policy uncertainty. By quantifying the uncertainty implied in media reports, these methods assess monetary policy uncertainty. When unexpected or unforeseen events occur, various opinions spread widely in the market, and policy uncertainty is amplified in news media coverage (Wang *et al.,* 2019). Baker (2016) initiated a trend of measuring policy uncertainty based on news reports by constructing the US Economic Policy Uncertainty Index, which counts the number of articles in major US newspapers containing the terms "economy", "policy", and "uncertainty". Based on this, domestic scholars have developed a policy uncertainty index tailored to China's context using Chinese newspapers (Zhu, Cai, 2018; Huang, Luk, 2019). While the text-based big data approach to measuring policy uncertainty has been highly regarded by scholars, there is no consensus on the sources of data and the combinations of keywords used (Husted, 2020; Chen, Tillmann, 2021).

The second method, which is the subjective forecast-based method, requires a large amount of subjective survey data, with stringent requirements for sample selection. It relies on the definition of policy uncertainty, which posits that the essence of policy uncertainty lies in the differences and predictions in economic agents' subjective perceptions of policy. By surveying market participants about their views on policies, one can obtain cross-sectional data on current and expected policy uncertainty as subjectively perceived. The deviations in this cross-sectional data are then calculated to reflect the differences in judgments among economic participants, thereby characterising policy uncertainty. Bomberger (1996) was one of the first to apply subjective perception and forecast differences to measure economic uncertainty. Damico *et al.* (2008) extended this method by using the variance in survey respondents' economic forecasts to represent economic uncertainty. Similarly, Bloom (2009) represented economic uncertainty by calculating the standard deviation of sample companies' profits. Scotti (2012) compared the forecasted and actual values of economic indicators, and Bloom (2014) introduced GDP growth rate forecast errors into the measurement of economic uncertainty. Jurado *et al.* (2015) suggested that with increasing uncertainty, economic variables become harder to predict. If the forecast bias of economic variables decreases, it indicates a reduction in uncertainty. Therefore, forecast bias can be used to express

uncertainty. However, when using the bias in respondents' expectations as cross-sectional data, it is crucial to distinguish between two scenarios: the completely unknown forecast part should be isolated before calculations. Then, a model using the weighted average of forecast error variance (the unmeasurable part) can be constructed to measure uncertainty. Yet, the forecast deviation method necessitates a substantial amount of subjective survey data, making data collection and processing cumbersome. Single indicators struggle to cover all policy aspects, and there is no unified standard for assigning weights to multiple indicators, complicating the distribution process.

The state estimation method is the third method and is based on the principle that policy uncertainty is considered an internal state variable of policy activities. Although it cannot be directly observed, there is a certain relationship between it and observable policy indicators. If the amount of observable data is sufficiently rich, the unobservable state variable, i.e., policy uncertainty, can be estimated by recording the observable variables. Sheen and Wang (2016) selected nearly 35 economic variables, using the deviations in current and expected values of indicators, such as inflation, interest rates, stock market index, unemployment rate, nominal GDP, industrial production, new housing starts, retail sales growth, and car sales to reflect the characteristics of economic uncertainty. Wang *et al.* (2019) utilised observable values from various sub-indicators, including monetary policy, bond market, securities market, macroeconomic indicators, price levels, exchange rate market, and government levels. The scholars further constructed a nonlinear DSGE model incorporating monetary policy uncertainty and risk shocks, employing a monetary policy rule with stochastic volatility to characterise China's monetary policy uncertainty. However, the state estimation method has strict limitations regarding models and parameters. It is computationally complex and requires substantial data processing, which are significant drawbacks.

1.2 Economic Impact of Monetary Policy Uncertainty

The impact of monetary policy uncertainty is multifaceted, affecting various aspects, such as labour supply, stock markets (Li *et al.,* 2020), consumption and output levels (Carroll, Samwick, 1998; Fernández-Villaverde *et al.,* 2011; Wang *et al.,* 2019), inflation levels (Zhu, Cai, 2018), interest rates, corporate investment (Davis, 2019; Wang, 2021), and corporate behaviour (Sun, 2017; Yang *et al.,* 2019).

At the macro level, Li *et al.* (2020) conducted an empirical study on China's monetary policy using the Markov Chain Monte Carlo model. The results indicated that high monetary policy uncertainty in China leads to increased credit risk, thereby negatively impacting the country's economic development. Wang *et al.* (2019) utilised a monetary policy model with stochastic volatility to empirically analyse the uncertain factors affecting China's future economic growth. The results showed that increasing uncertainty factors had a significant impact on both economic growth and its stability. Creal and Wu (2017) demonstrated that monetary policy uncertainty affects economic growth differently across various economic cycles, influencing the overall economic growth. Fernández-Villaverde *et al.* (2011) conducted an in-depth analysis based on real options theory and other theoretical frameworks, revealing that as monetary policy uncertainty increases, residents tend to save more to hedge against risks. This behaviour reduces their consumption levels and can also lead to a wait-and-see attitude and capital outflows, which are detrimental to the steady development of a small-scale economy. Zhu and Cai (2018) provided empirical evidence showing that monetary policy uncertainty has a nonlinear effect on inflation expectations, causing them to rise in the short term while potentially leading to a decline in the long term.

At the micro level, the high degree of uncertainty in financial markets exacerbates the funding shortages faced by private enterprises in China (Davis, 2019). This issue is particularly severe for Chinese private enterprises (Wang, 2021). During this period, companies may improve the quality of their accounting information to reduce financial costs (Sun *et al.,* 2017). Additionally, due to monetary policy uncertainty, equity pledges further impact

corporate innovation behaviour (Yang *et al.,* 2019). Empirical results from Ding and Liu (2020) indicate that increasing monetary policy uncertainty leads to significant differences in market participants' judgments of various news and policies, thereby reducing their sensitivity to such information.

Additionally, empirical results from Herro and Murray (2013) indicate that as China's monetary policy uncertainty increases, significant changes occur in inflation and unemployment rates. Sinha (2016) suggests that with continuous changes in monetary policy, China's nominal interest rates will further decrease, accompanied by a reduction in economic growth. Husted *et al.* (2017) argue that increasing monetary policy uncertainty produces effects similar to those of tightening monetary policy. Kaminska and Roberts (2018) contend that within the financial system, monetary policy uncertainty impacts systemic risk. Zhong *et al.* (2017) assert that the constant changes in China's monetary policy expose the financial market to greater risks, potentially triggering financial crises within the market. Deng and Cao (2020) used a TVP-VAR model to analyse the macroeconomic impacts of two different types of uncertainty: quantity and price. Their results indicate that from a macroeconomic perspective, quantity-based uncertainty factors are more effective in regulation; however, their impact on inflation and the economy is only short-term.

Scholars have extensively studied both the measurement of monetary policy uncertainty and its economic impacts. It is important to note that obtaining the expected conclusions first requires scientific measurement of monetary policy uncertainty. It has been observed that there is still room for improvement in measuring China's monetary policy uncertainty, particularly in selecting data sources and combining keywords in newspapers that accurately reflect monetary policy uncertainty. Optimising the quantification of monetary policy uncertainty may lead to different conclusions compared to previous studies, whether for subsequent empirical or theoretical analysis. Building on the work of Baker (2016) and Huang and Luk (2019), we aim to develop a more refined measure of China's monetary policy uncertainty index based on news media reports. We selected the *Financial Times* as the data source for constructing a benchmark index of monetary policy uncertainty. Subsequently, we empirically examine the impact of China's monetary policy uncertainty on the Chinese macroeconomy using a TVP-VAR model.

2. Construction of China's Monetary Policy Uncertainty Index

This paper utilises the proxy indicator method to quantify China's monetary policy uncertainty. The challenge in using the proxy indicator method to measure China's monetary policy uncertainty lies in finding appropriate keywords and data sources to better represent the signals conveyed by monetary policy. Previous studies have used the VIX index and stock market volatility to represent economic uncertainty. However, these indicators only reflect the subjective expectation deviations of market participants regarding the financial market (Bloom, 2009; Caggiano, 2014). Given the varying frequency of news reports, the principle of the news-based approach is the reflection of the formulation and impact of economic policies, as well as economic agents' predictions about policies, in newspapers. The more predictions about policies, the more media coverage, indicating greater policy uncertainty. Using big data to statistically analyse the frequency of news reports to represent policy uncertainty is superior to traditional methods that rely on survey data.

Specifically, we refer to the methods of Baker (2016) and Huang and Luk (2019) to search for the monthly frequency of media newspaper reports and discussions on China's monetary policy to represent China's monetary policy uncertainty. This method still follows the economic agents' assessments of China's monetary policy. Baker *et al.* (2016) achieved continuous quantification of policy uncertainty based on news reports, but their estimates of the analysed uncertainty were insufficient. Building on existing literature, we have refined the selection of keywords. This paper selects news reports from the *Financial Times* from January 2000 to May 2023 as the primary source for constructing the China's Monetary Policy Uncertainty Index. The reason for this choice

is that the *Financial Times* is the only newspaper directly managed by the People's Bank of China, making it the most accurate in terms of central bank policy direction and communication. This approach reduces the errors in intermediate assessments of monetary policy by external journals and market participants.

Table 1. Selection of Keywords Related to the Measurement of China's Monetary Policy Uncertainty

Level	Main Component	Sub-Component Keywords
A	China	China/our country
B	economy	economy/finance
C	volatile/"anti" + certain / estimate /predict / forecast / foresee	Uncertain / unclear / volatile / turbulent / unsteady / unknown / obscure / ambiguous / unpredictable / difficult to predict / difficult to estimate / impossible to estimate / impossible to predict / unforeseeable / indeterminate / blurred / hard to foresee / hard to predict / hard to estimate / unable to estimate / unable to predict / unable to foresee / unpredictable / unanticipated / inestimable / incalculable
D	interest rates / exchange rates / bonds	Deposit Interest Rate / Loan Interest Rate / Interest Rate Liberalisation / Interest Rate Policy / RMB Exchange Rate / Local Government General Bonds / Interbank Market Government Bonds / Local Government Special Bonds
	monetary policy tools	Open Market Operations / Reserve Requirement / Money Supply / Money Provision / Interest Rate Hike / Interest Rate Cut / Quantitative Easing
	monetary policy	Monetary Policy / Macroeconomic Regulation / People's Bank of China / Central Bank / Monetary Liquidity / Capital Liquidity / Inflation / Deflation

Source: created by the authors.

When selecting keyword combinations, it is important to note that a mere mention of monetary policy-related descriptions in news reports does not necessarily indicate a monetary policy adjustment. In addition, a greater degree of monetary policy adjustment does not necessarily represent higher monetary policy uncertainty, as there may be anticipated elements that do not align with the concept of uncertainty. The frequency statistics of monetary policy reports in the news reflect market participants' estimates and reactions to the policy. Zhu and Cai (2018) counted news reports that simultaneously matched the keyword combination "China", "economy" and "monetary policy-related descriptions". However, this approach has a drawback, for such news reports might only provide neutral coverage of monetary policy without reflecting the assessments of economic agents or the market regarding monetary policy. Therefore, we have added descriptions of uncertainty to this basis. In our research, instead of directly using terms, such as "economic uncertainty" or "policy uncertainty", we incorporate synonymous expressions for uncertainty, such as "uncertain" / "unclear" / "volatile" / "turbulent" /" unsteady" / "unknown" / "obscure" / "ambiguous" / "unpredictable" / "difficult to predict" / "difficult to estimate" / "impossible to estimate" / "impossible to predict" / "unforeseeable". Also, reports on China's

monetary policy should primarily describe the situation in China because reports on other countries' monetary policies may introduce measurement errors. For example, Huang and Luk (2019) set their keyword combination as "economy/finance" + "uncertainty description" + "monetary policy-related terms". We establish that the keyword combination must simultaneously satisfy four levels: A, B, C, and D, namely "China/our country" + "economy/finance" + "uncertainty-related descriptions" + "monetary policy-related terms". Specific keyword selection is presented in *Table 1*.

Monetary Policy Uncertainty Index Calculation Formula is provided below. This paper modifies the method designed by Baker *et al.* (2016) as follows:

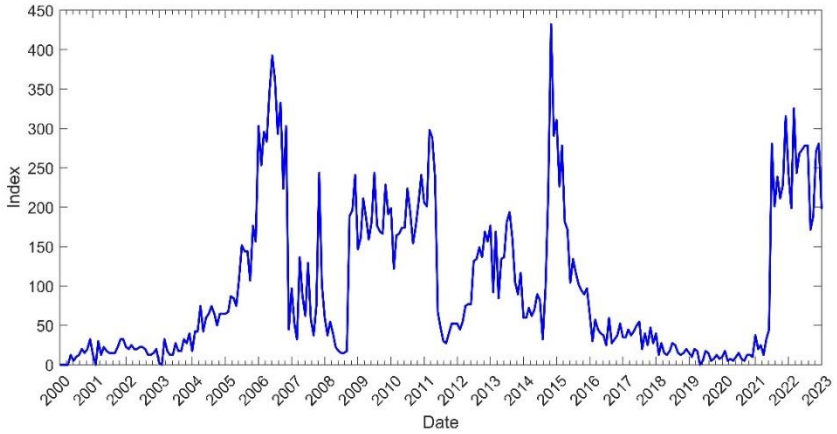
$$\bar{Y_i} = \frac{\sum_{i=1}^{T} H_{i,t}}{T}, Y_i = \frac{100}{\bar{Y_i}}, MPU_{i,t} = H_{i,t} * Y_i$$

$$MPU_t = \frac{M_{1,t} + M_{2,t} + \ldots + M_{n,t}}{n}$$

\(H_{i,t} \) represents the total frequency of reports containing monetary policy uncertainty for characteristic combination \(i \) in period \(t \) (monthly); \(T \) represents the total number of months in the time sample interval (\(T = 283 \)); \(Y_i \) represents the normalisation of the mean to 100. \(MPU_t \) represents the average monetary policy uncertainty index.

To verify the accuracy of our selected sample, we use the arithmetic average of other mainstream newspapers that report on the economy and securities markets to measure the monetary policy uncertainty index. These include *Economic Daily*, *Guangming Daily*, *China Economic Times*, *China Reform Daily*, *China Economic Herald*, *China Securities Journal*, etc.

For this research, the *Financial News* was selected, the only newspaper directly under the People's Bank of China, as the primary data source for measuring China's monetary policy uncertainty. Using Python, we crawled reports from the *Financial News* that met the four levels of keywords: A, B, C, and D. The data was then standardised, and the time series graph of China's monetary policy uncertainty was plotted, as shown in *Figure 1*.



Source: created by the authors.

Figure 1. **China's Monetary Policy Uncertainty Index**

The dynamic changes of peaks and troughs align well with the economic background. Due to the nature of periodicals and newspapers, their publication dates may lag behind the actual dates. The process of measuring monetary policy from implementation to realisation is slow, being mainly based on big data. Periodicals and newspapers analyse and interpret the societal responses following the release of policy documents. Scholars have long recognised the lagging and dynamic nature of the mechanism through which monetary policy operates (Xia, Liao, 2001), but this does not affect its response to specific economic facts. For example, since 2003, China has established a moderately tight monetary policy, raising the reserve requirement ratio and increasing the benchmark loan interest rate to maintain price stability. In 2005, a moderately neutral monetary policy was established, reclaiming foreign exchange reserves through the issuance of central bank bills and using exchange rate reform and exchange rate price controls to achieve a balance of international payments. In 2006, China returned to a moderately tight monetary policy, continuously raising the reserve requirement ratio and increasing the benchmark loan interest rate to address implicit inflation and balance international payments. This period corresponds to the continuous increase in monetary policy uncertainty around 2006, as shown in *Figure 1*. In 2008, with the outbreak of the financial crisis, the central bank implemented a tight monetary policy, rapidly and continuously raising the reserve requirement ratio and increasing interest rates to maintain domestic price stability. From 2010 to 2011, the policy returned to a steady monetary stance. In 2012, in response to the European debt crisis, a slightly accommodative monetary policy was adopted to stabilise economic growth. In August 2015, China established the RMB to USD exchange rate formation mechanism based on the "closing rate + a basket of currency exchange rate changes" (8.11 exchange rate reform), leading to another peak in monetary policy uncertainty. The global COVID-19 pandemic broke out in December 2019 and lasted for three years. In June 2020, the People's Bank of China swiftly adopted an accommodative monetary policy to counter the sudden impact of the pandemic. In 2022, the central bank conducted a 97,720 billion yuan reverse repo operation, cut interest rates twice, and reduced the reserve requirement ratio for financial institutions by 0.25 percentage points each time. Thus, the Monetary Policy Uncertainty Index reflects not only the impact of domestic and international economic events or other external shocks, but also the magnitude and intensity of national policy changes.

3. Model Specification and Results Analysis

3.1 Construction of Time-Varying Parameter Model

A TVP-VAR model is constructed to estimate the impact of China's monetary policy uncertainty on the macroeconomy. The TVP-VAR model is widely used in the study of the time-varying characteristics of the correlations between economic variables (Qi, Xi, 2015; Xu *et al.,* 2017; Chen *et al.,* 2017).

First, a standard structural VAR (Vector Autoregression) model is defined:

$$A_{y_t} = F_1 y_{t-1} + \cdots + F_s y_{t-s} + \mu_t, t = s + 1, \cdots, n \quad (4\text{-}1)$$

Here, y_t is a $k \times 1$ dimensional observation vector, A is a $k \times k$ dimensional coefficient matrix, $F_1 \cdots F_s$ are $k \times k$ dimensional lag coefficient matrices, and the disturbance term μ_t is a $k \times 1$ dimensional structural shock. Assume $\mu_t \sim N(0, \sum\sum)$, where:

$$\sum = \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_k \end{bmatrix}$$

Simultaneously, assume that AAA is a lower triangular matrix, i.e.:

$$A = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{k1} & \cdots & a_{k,k-1} & 1 \end{bmatrix}$$

The model (4-1) can be rearranged into the following simplified VAR model form:

$$y_t = B_1 y_{t-1} + \cdots + B_s y_{t-s} + A^{-1} \sum_{\varepsilon_t}$$

where $B_i = A^{-1} F_i$, $i = 1, \cdots, s$, $\varepsilon_t \sim N(0, I_k)$.

Stack the elements of each row of the coefficient matrices B_i into a $k^2 s \times 1$ vector, and define $X_t = I_k \otimes (y'_{t-1}, \cdots, y'_{t-s})$, where $\otimes$ denotes the Kronecker product. Thus, the model can be transformed into:

$$y_t = X_t \beta + A^{-1} \sum_{\varepsilon_t} \qquad (4\text{-}2)$$

where let $a_t = (a_{21}, a_{31,t}, a_{32,t}, a_{41,t}, \cdots, a_{,kk-1t})'$ be the column vector formed by stacking the non-zero and non-one elements of the lower triangular matrix A_t, and $h_t = (h_{1t}, \cdots, h_{kt})', h_{jt} = log\, \sigma_{jt}^2, j = 1, \cdots, k, t = s + 1, \cdots, n$.

$$\beta_{t+1} = \beta_t + \mu_{\beta t} \qquad (4\text{-}3)$$

$$\alpha_{t+1} = \alpha_t + \mu_{at} \qquad (4\text{-}4)$$

$$h_{t+1} = h_t + \mu_{ht} \qquad (4\text{-}5)$$

$$\begin{bmatrix} \varepsilon_t \\ \mu_{\beta t} \\ \mu_{at} \\ \mu_{ht} \end{bmatrix} \sim N\left(0, \begin{bmatrix} I & 0 & \cdots & 0 \\ 0 & \Sigma_\beta & \ddots & \vdots \\ \vdots & \ddots & \Sigma_\alpha & 0 \\ 0 & \cdots & 0 & \Sigma_h \end{bmatrix}\right)$$

where $t = s + 1, \cdots, n$, $\beta_{s+1} \sim N(\mu_{\beta_0}, \sum_{\beta_0})$, $\alpha_{s+1} \sim N(\mu_{\alpha_0}, \sum_{\alpha_0})$, $h_{s+1} \sim N(\mu_{h_0}, \sum_{h_0})$.

3.2 Variable Selection and Sources

Monetary policy uncertainty is calculated based on news media text data, primarily drawing on the methods of Baker (2016) and Huang and Luk (2019) to construct the China's Monetary Policy Uncertainty Index (MPU). The *Financial News* is used as the main data source, and the occurrences of reports containing the keyword combinations related to "China + economy + uncertainty + monetary policy" are counted. This standardised monthly frequency is used to establish the monetary policy uncertainty index. Compared to existing literature on proxy measures of monetary policy uncertainty, such as interest rate volatility and the standard deviation of money supply growth rate, (Sun *et al.,* 2017; Creal, Wu, 2017), this index can more comprehensively reflect the overall frequency of monetary policy adjustments.

In terms of macroeconomic variable selection, the year-on-year cumulative growth rate of Gross Domestic Product (GDP), the Consumer Price Index representing inflation (CPI), the weighted average interest rate of interbank lending (IBO), and the real exchange rate of the RMB (RER) are chosen as the main explanatory variables for the macroeconomy (Tong, Zhang, 2021; Huang, Yan, 2023). The data is sourced from the *Wind* database. The specific data range covers monthly data from 2000 to May 2023. Seasonal adjustments and standardisation on the data are performed prior to the conducting of the estimations.

3.3 Empirical Results Analysis

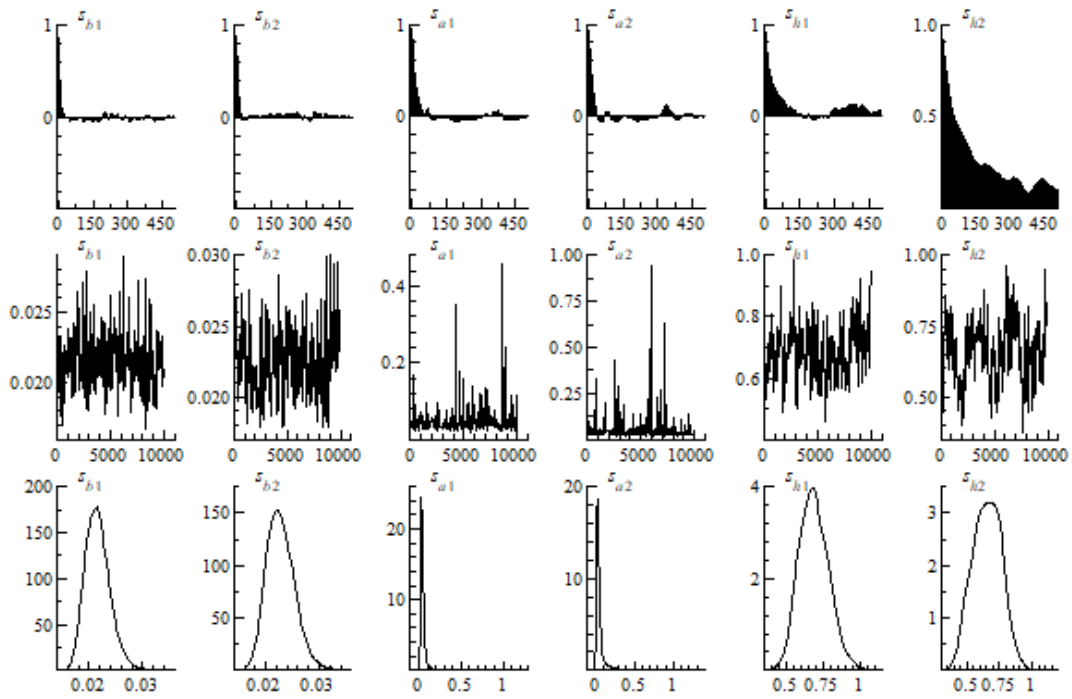
Unit root tests are conducted for both dependent and independent variables, confirming that all variables are stationary. *Table 2* presents the sample posterior mean, standard deviation, 95% confidence interval, CD statistics, and ineffective coefficient estimates calculated applying the MCMC method. The results reveal that the convergence of the parameters to the posterior distribution is not rejected at the 5% significance level of the CD statistic. In addition, the ineffective factors are all less than 100 except for sh2. All parameter CD statistics are less than 100 at the 5% significance level.

Table 2. Parameter Estimation Results

Parameter	Posterior Mean	Standard Deviation	95% Confidence Interval	CD Statistic	Ineffective Coefficient
sb1	0.0216	0.0023	[0.0177, 0.0266]	0.233	9.22
sb2	0.0228	0.0026	[0.0182, 0.0285]	0.856	16.30
sa1	0.0481	0.0536	[0.0217, 0.1399]	0.406	27.04
sa2	0.0585	0.0780	[0.0207, 0.2750]	0.057	21.28
sh1	0.6898	0.0998	[0.5135, 0.8983]	0.096	64.03
sh2	0.6555	0.1099	[0.4500, 0.8641]	0.432	150.31

Source: created by the authors.

Figure 2 depicts the autocorrelation (top), sample path (middle), and posterior density (bottom) of the samples observed in the TVP-VAR model. The autocorrelation of the samples is revealed to be very low and stable, and the sampling values path is observed to be also relatively smooth, which suggests that the samples are sufficient to ensure the validity of parameter estimation.

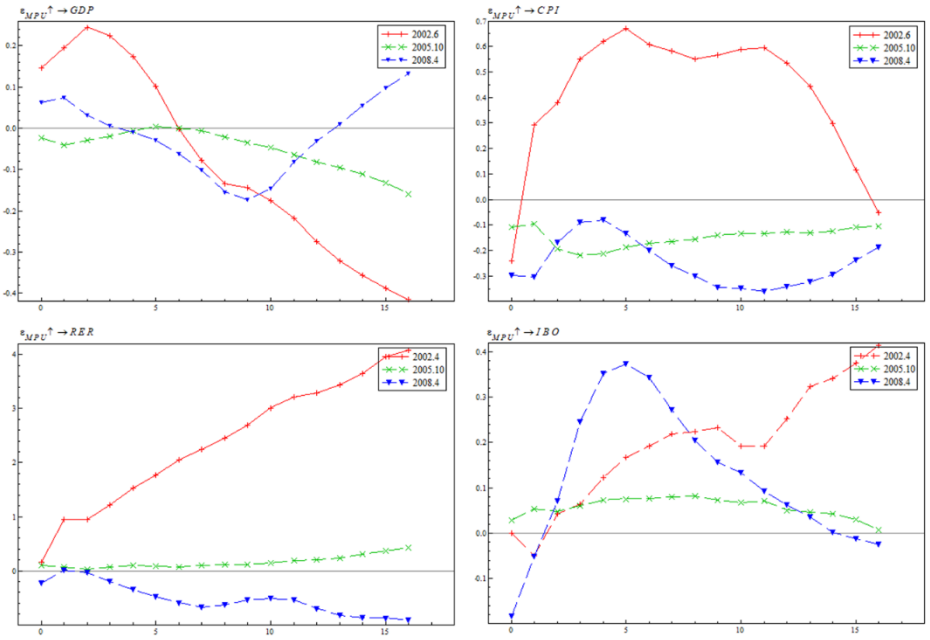


Source: created by the authors.

Figure 2. **MCMC Estimation Results of TVP-VAR Model Parameters**

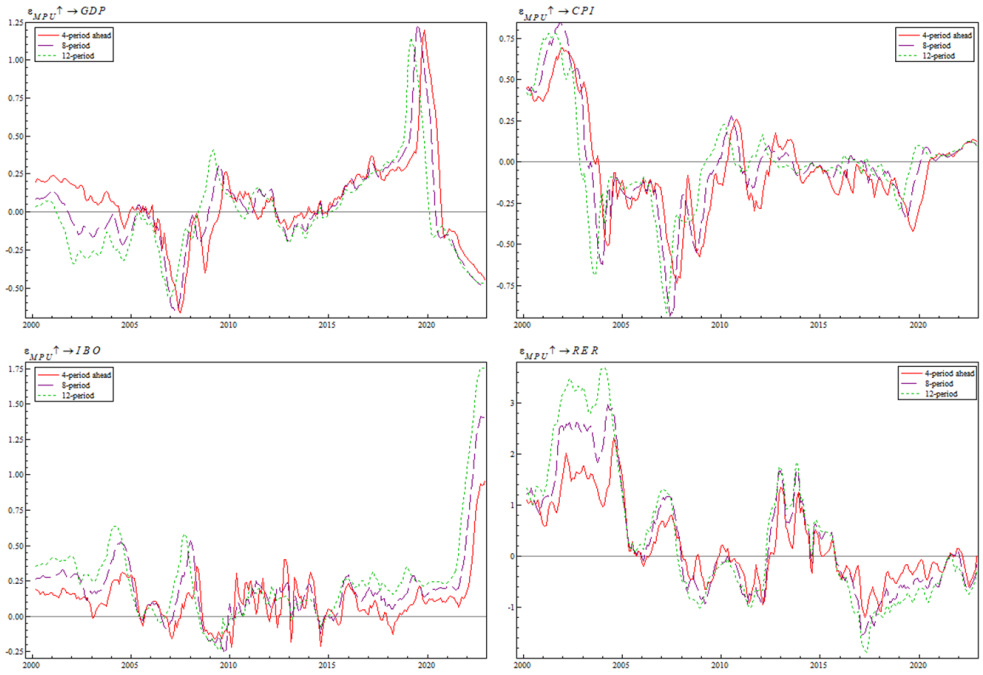
Figure 3 presents the impulse response functions at specific time points, reflecting the impulse responses to monetary policy uncertainty shocks at different time points. The selected representative time points are the second quarter of 2002, the third quarter of 2005, and the second quarter of 2008, representing periods of economic upturn, economic transition, and economic downturn, respectively. These selections aim to avoid the potential disturbances caused by external shocks.

During the economic upturn period, an increase in monetary policy uncertainty (MPU) led to a decline in the economic growth rate. In stable economic periods, the impact of monetary policy uncertainty on economic growth is observed to have been slightly delayed, but the extent of this impact is much lower than during economic upturns. During economic downturns, the impact of increased monetary policy uncertainty on the economic growth rate follows a U shape, starting with a positive shock, turning into a negative shock, and then reverting to a positive shock. In the economic upturn period, the impact of monetary policy uncertainty on the inflation rate shows an inverted U shape. During stable economic periods and downturns, monetary policy uncertainty exerts a negative shock on the inflation rate. What is more, during both economic upturns and stable periods, monetary policy uncertainty has a positive impact on interest rates and exchange rates. However, the magnitude of this impact is smaller during stable economic periods. This pattern aligns with the concept of policy uncertainty, reflecting market participants' perceptions of the current stability and expected levels of the economic market.



Source: created by the authors.

Figure 3. **Impulse Response of China's Monetary Policy Uncertainty and Various Macroeconomic Variables at Specific Time Points**



Source: created by the authors.

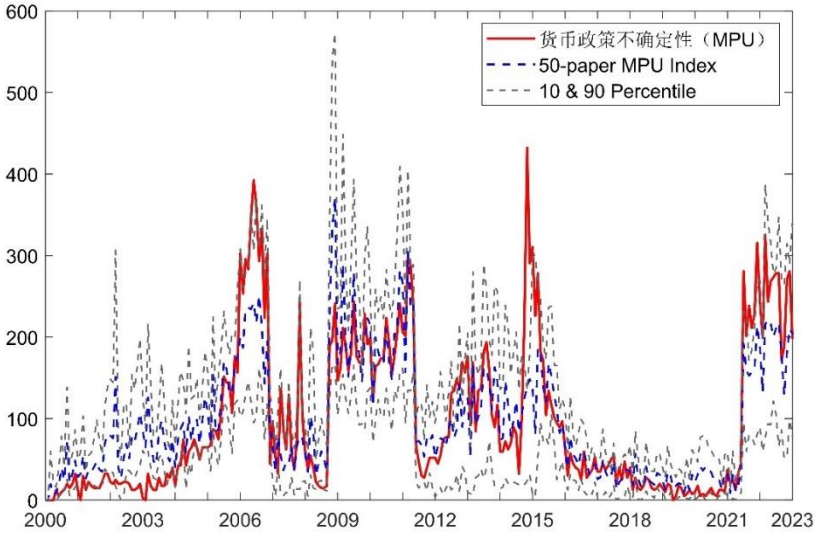
Figure 4. **Time-Varying Impulse Response Functions of China's Monetary Policy Uncertainty on Various Macroeconomic Variables at Equal Time Intervals**

Figure 4 depicts the time-varying impulse response functions (IRFs) at equal time intervals from the TVP-VAR model, illustrating the impulse responses to a unit positive shock in monetary policy uncertainty (MPU) across different lead periods. As shown in *Figure 4*, the impulse response trends of macroeconomic variables to MPU shocks are relatively similar across different lead periods, although the intensity of the responses slightly varies. The 2008 financial crisis and the 2019 global pandemic led to an increase in MPU, resulting in negative shocks to economic output, price levels, interest rates, and exchange rates. These trends align well with the realities of the Chinese economy. The attenuation trends of the impact of MPU shocks on economic output, price levels, interest rates, and exchange rates are quite similar.

From 2000 to 2002, the impulse responses were positive. In 2002, China joined the World Trade Organisation (WTO), increasing MPU, but the intensity gradually decreased and approached zero by 2006. The 2008 external shock from the Western financial crisis caused the impact of MPU on macroeconomic variables to attenuate more rapidly. After 2008, the impacts showed a low-level oscillation state.

4. Robustness Test

To verify whether the selected newspaper accurately reflects China's monetary policy uncertainty, we simultaneously selected 50 other central and private news media outlets and took their average for robustness testing. We primarily chose mainstream newspapers that report on the economy, reforms, and securities. The selection of both central and private newspapers aims to reduce potential political bias in some publications and to enhance the newspapers' understanding and interpretation of policies, thereby minimising measurement errors.



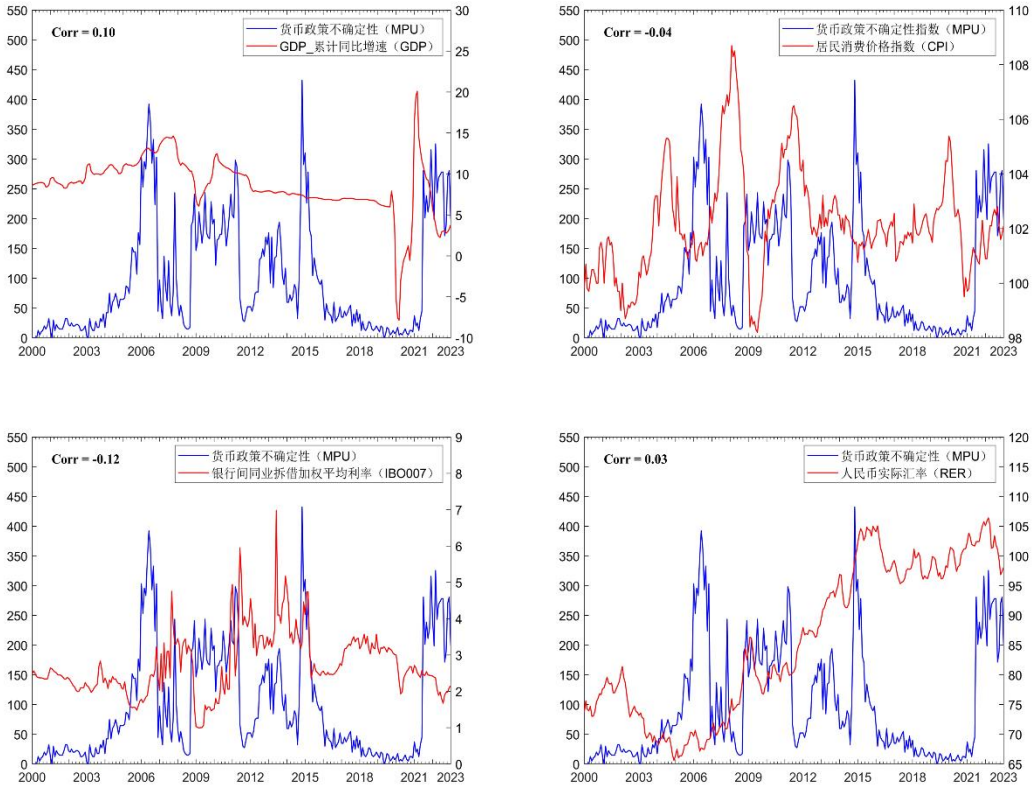
Source: created by the authors.

Figure 5. **China's Monetary Policy Uncertainty Index and the Average Monetary Policy Uncertainty Index from 50 Media Outlets**

Figure 5 shows the China's Monetary Policy Uncertainty Index measured based on the *Financial News*, the average monetary policy uncertainty index calculated from 50 domestic economic and securities-related

newspapers, and the time series plot of the 10th and 90th percentiles based on these indices. The selected media sources are mainly from mainland China, as domestic media can promptly respond to China's monetary policy and offer a more accurate understanding and interpretation of such policies. Although there is skepticism that media outlets may be subject to political oversight, leading to policy bias and distorted information. However, it should be noted that even in Western democracies, such as the United States, newspapers exhibit media bias based on their political stance (Gentzkow, Shapiro, 2010). Therefore, we primarily mitigate this by carefully selecting keywords for the reports to avoid politically influenced content and averaging data from multiple central and private newspapers to minimise errors.

In *Figure 5*, the baseline index of monetary policy uncertainty mostly falls between the 10th and 90th percentiles. The periods exceeding these bands coincide with times of external shocks, during which the magnitude and intensity of monetary policy adjustments are significant. Since the *Financial News* is the only newspaper directly supervised by the People's Bank of China, its interpretation and reporting on policies are more prominent. Therefore, during significant external shocks, the monetary policy uncertainty measured based on the *Financial News* is more pronounced. Besides, the volatility of the average index calculated from multiple newspapers is largely consistent with the baseline index and remains within the two bands. This further confirms that our selection of newspapers for measuring China's monetary policy uncertainty is reasonable.



Source: created by the authors.

Figure 6. **Time Series Plot of China's Monetary Policy Uncertainty Index and Various Macroeconomic Variables**

Figure 6 depicts the correlation analysis between China's monetary policy uncertainty and economic level, price level, interest rate, and exchange rate over time. The higher the monetary policy uncertainty, the more negatively affected GDP growth is to be. Additionally, the price level shows a similar volatility trend to monetary policy uncertainty, with the volatility of monetary policy uncertainty lagging behind the price level's fluctuations. This indicates a strong correlation between monetary policy adjustments and price level changes, confirming the objective of monetary policy to control economic inflation. Additionally, the volatility trends of monetary policy uncertainty are opposite to those of interest rates and exchange rates, and they overlap. During the early and late stages of economic growth, the fluctuations between the two gradually increase from small to large. Within the economic cycle, especially after significant external events, the adjustments in monetary policy become more pronounced, leading to an increase in monetary policy uncertainty.

Conclusions and Policy Recommendations

This paper employs text analysis to calculate the monthly index of China's monetary policy uncertainty from 2000 to 2023, with data collected from the *Financial News*, the only newspaper directly supervised by the People's Bank of China. A TVP-VAR model is constructed to empirically examine the impact of China's monetary policy uncertainty on the macroeconomy.

For the growth rate of the economic level (GDP), monetary policy uncertainty has a negative impact. When monetary policy uncertainty increases, the economic growth rate decreases. The impact of monetary policy uncertainty presents an inverted U-shaped relationship. During economic upturns, an increase in monetary policy uncertainty raises the inflation rate, but during stable and downturn periods, monetary policy uncertainty exerts a negative impact on the inflation rate. In addition, monetary policy uncertainty has a positive impact on interest rates. During economic upturns and stable periods, an increase in monetary policy uncertainty positively affects interest rates. Lastly, the impact of monetary policy uncertainty on exchange rates also has a positive effect. During economic upturns and stable periods, an increase in monetary policy uncertainty positively affects exchange rates.

Monetary policy is an important tool for maintaining economic growth and financial market stability. It adapts to changes in the market environment and external shocks. However, the dynamic adjustment of monetary policy at a high frequency can be challenging for market participants to assess, leading to monetary policy uncertainty. The macroeconomic effects of monetary policy uncertainty are significant and cannot be ignored. Therefore, in the process of policy formulation, it is essential not only to consider using appropriate monetary policy tools to regulate macroeconomic objectives but also to incorporate monetary policy uncertainty into the policy framework. This approach will help mitigate and avoid the secondary harm that monetary policy uncertainty can inflict on the market economy. Based on this, the paper offers some policy recommendations. First, the government and relevant institutions should strive to offer a stable and transparent monetary policy to reduce the negative impact of uncertainty on economic growth. It should also strengthen coordination and cooperation with fiscal policy to balance the objectives of economic growth and inflation. Second, improving the accuracy of market participants' expectations regarding the direction of monetary policy can help stabilize economic expectations and reduce the impact of uncertainty on economic variables. By enhancing information disclosure and communication, the understanding and acceptance of monetary policy decisions by the market can be improved. Lastly, it is recommended to strengthen control over the frequency of monetary policy adjustments. The frequency of changes in monetary policy is a key factor determining its level of uncertainty. Frequent changes in monetary policy to pursue short-term economic indicators can easily lead to market expectation confusion, causing market participants to act contrary to the intended policy direction. Therefore, the central bank should precisely grasp the economic situation, focus on medium- to long-term economic goals,

and make prudent adjustments to monetary policy. This approach will enhance the consistency and continuity of the monetary policy stance and minimize the uncertainty caused by frequent monetary policy adjustments.

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KINIJOS PINIGŲ POLITIKOS NEAPIBRĖŽTUMO VERTINIMO IR JO MAKROEKONOMINIO POVEIKIO TYRIMAS

Zhang Kewei, Wang Wenfu

Santrauka. Šiame straipsnyje, remiantis *Financial Times* duomenimis, pateikiamas mėnesinis Kinijos pinigų politikos neapibrėžtumo indeksas nuo 2000 m. iki 2023 m. Pasitelkus laiko kintamų parametrų struktūrinės vektorinės autoregresijos (TVP-SV-VAR) modelį, buvo etapais nagrinėjama pinigų politikos neapibrėžtumo įtaka makroekonomikos kintamiesiems. Rezultatai atskleidė, kad pinigų politikos neapibrėžtumas neigiamai veikia ekonomikos augimo lygius. Taip pat teigtina, kad šio neapibrėžtumo įtaka atvirkščiai proporcinga infliacijos lygiui. Pinigų politikos neapibrėžtumo poveikis makroekonomikai žymiai skiriasi priklausomai nuo ekonomikos ciklo. Ekonominės padėties pagerėjimo metu didesnis pinigų politikos neapibrėžtumas didina infliaciją, tačiau ekonominio stabilumo ir nuosmukio metu šio neapibrėžtumo įtaka neigiama. Taip pat nustatyta, kad šis neapibrėžtumas teigiamai veikia palūkanų normas ir valiutų kursus. Šiame tyrime rekonstruotas Kinijos pinigų politikos neapibrėžtumo indeksas ir pateikiama informacija, kuri gali būti naudinga tolesniems pinigų politikos neapibrėžtumo makroekonominio poveikio tyrimams.

Reikšminiai žodžiai: pinigų politikos neapibrėžtumas; kiekybinis vertinimas; makroekonominis poveikis; TVP-SV-VAR modelis.