ECONOMIC RESEARCH - EKONOMSKA ISTRAŽIVANJA
2025, VOL. 38 NO. 1, (147 - 166)
https://doi.org/10.32728/er-ei.38.1.6

Faculty of Economics and Tourism
"Dr. Mijo Mirković"

ARTICLE HISTORY
Received 03 June 2024
Accepted 04 March 2025

THE DYNAMIC SPILLOVER EFFECT OF BRICS COUNTRIES' MONETARY POLICIES ON RMB EXCHANGE RATE AND CHINA'S TRADE BALANCE ——EMPIRICAL TESTING BASED ON TVP-SV-VAR MODEL

Li Zheng, School of Economics and Management, Kunming University, Yunnan, China; ORCID: 0009-0009-1742-8410

Yu Zhou, Kunming Branch, China CITIC Bank, Yunnan, China; ORCID: 0009-0001-5712-6902

Lei Xiao*, School of Economics and Management, Kunming University, Yunnan, China; 391644664@qq.com, ORCID: 0009-0009-8410-4790

KEYWORDS:
BRICS countries, TVP-SV-VAR, spillover effect, monetary policy, RMB exchange rate

JEL CLASSIFICATION:
F31, E52, C32

* Corresponding author

ABSTRACT

Using the Time-Varying Parameter Stochastic Volatility Vector Autoregression (TVP-SV-VAR) model within a Bayesian inference framework, this study examines the spillover effects of BRICS economies' monetary policies on the Renminbi (RMB) exchange rates and China's trade balance from November 2006 to December 2022. The spillover effects are categorized into interest rate effects and monetary effects. The empirical findings reveal that, through the interest rate effect channel, the monetary policies of BRICS countries exert a detrimental spillover effect on the RMB exchange rate, while initially benefiting but ultimately harming China's trade balance in the short and long term, respectively. Conversely, under the monetary effect channel, these policies adversely impact the RMB exchange rate but beneficially influence China's trade balance. Consequently, it is imperative to develop a robust early warning system for economic policy indicators in emerging economies such as BRICS, enhance policy cooperation among BRICS nations, and foster coordinated advancement of international trade and cross-border capital flows within the BRICS consortium.

1. INTRODUCTION

The term "spillover effect" refers to the external impacts of a country or region's economic policies on the economies and finances of other countries or regions while pursuing specific economic objectives (Deng Chuang, Xi Xuwen, 2013). The intensification of global economic integration has continuously amplified the interconnections between nations, leading to stronger spillover effects from one country's economic strategies to another. Studies have revealed that following the 2008 financial crisis, developed economies implemented unconventional economic policies to manage the downturn, which had significant spillover effects on the Chinese economy (Zhu Mengnan, Yan Shuai, 2015; Fu Guangmin, 2017). As the repercussions of the financial crisis diminished in developed economies, their economic policies began to normalize. Conversely, the economic uncertainty of emerging economies escalated, along with a corresponding rise in policy unpredictability. In December 2014, the Russian ruble's exchange rate against the US dollar fell dramatically, experiencing a depreciation of up to 13% in a single day. To stabilize the currency, the Russian central bank set a 17% interest rate on ruble deposits. Brazil, aiming to curb rapidly increasing public expenditures and revive economic growth, introduced four major economic policy recommendations. In November 2016, India initiated the "banknote demonetization" plan, and in June 2017, it implemented the most extensive tax reform since gaining independence. The growing global influence and cooperation among emerging economies have fostered more frequent interactions. Currently, research on the spillover effects of economic policies on the Chinese economy primarily focuses on the influence of developed countries, with limited studies on the impact of emerging economies' policies. Post-financial crisis, the BRICS countries have become pivotal in the global economy, and their continued cooperation has been crucial. As a key member of the BRICS, examining the spillover effects of their economic policies on China's economy holds significant theoretical and practical importance for enhancing mutual understanding and cooperation among these nations. Particularly, exchange rates and foreign trade, as critical macroeconomic variables, are highly susceptible to external economic policies. Therefore, this study examines the impact of BRICS countries' monetary policies on China's exchange rate and trade balance.

2. LITERATURE REVIEW

From a historical standpoint, James Meade's (1951) theory of the "Meade conflict" is considered the earliest scholarly work to examine policy spillover effects, however, this theory primarily highlights intra-country policy conflicts. Cooper (1968) expanded on this by demonstrating that domestic policies could have external spillover effects on other nations, thus fostering international policy cooperation. In the realm of spillover effects, contemporary studies predominantly concentrate on the avenues of transmission, such as interest rate pathways, exchange rate mechanisms, and trade conduits. The interest rate mechanisms primarily scrutinize the intertwined impacts that a nation's monetary policy may exert on interest rates. Traditional international finance theories posit that fluctuations in interest rates generate disparities between national economies or modify asset valuations, thereby inducing spillover effects across different countries' economic landscapes. Kim and Yang (2012) examined the repercussions of alterations in U.S. monetary policy on East Asian nations, identifying pronounced spillover effects, particularly in economies with either floating exchange rate regimes or those that have ceded control over their monetary policies. Kazi et al. (2013) investigated the ramifications of U.S. expansionary monetary policies on Organization for Economic Co-operation and Development (OECD) nations, observing that such measures generally depress global interest rates and facilitate positive outcomes through enhanced transnational capital movements. Li Jing et al. (2024) assessed how modifications in the Federal Reserve's policies affect financing costs, constraints, and leverage dynamics, along with the debt profiles of non-financial Chinese corporations, through international capital flow mechanisms, thus influencing these firms' risk-taking behaviors in debt management. Conversely, regarding exchange rates and trade channels, the spillover impacts of a nation's monetary strategies display a divergent character. Employing the "Mundell-Fleming-Dornbusch" (MFD) model, it is inferred that a country's adoption of an expansionary monetary policy simultaneously boosts domestic consumption and output, thereby elevating its demand for foreign imports. Simultaneously, this leads to a depreciation of the national currency, which benefits the export sector. Dizioil et al. (2016) argue that China's economic growth affects the five East Asian countries through trade channels, commodity price channels, and financial market channels. A 1% decline in China's economic growth corresponds to a 0.2% to 0.5% reduction in the economic growth of these countries. Cao Wei et al. (2019), utilizing the Global Vector Autoregressive (GVAR) model, discovered that China's economic shocks have the most substantial impact on the economic growth and import/export trade of the Commonwealth of Independent States (CIS) countries, the least on Southeast Asian countries, and a noteworthy impact on the economic growth of oil-producing countries in West Asia. Regarding research methods on spillover effects, the academic community generally employs three approaches. One method involves analyzing the spillover effects of monetary policy using game theory models. Hamada (1974) was the first to apply game theory to study international monetary policy cooperation, noting that under a fixed exchange rate system, the lack of coordination among countries leads to difficulty in achieving both domestic price stability and international balance of payments simultaneously, resulting in a suboptimal equilibrium. Rogoff (1985) offers a contrasting view, beginning his analysis with the strategic interactions between central banks and the public, and developing a rational expectations model (NOEM model) under open economic conditions. He suggests that international monetary policy coordination may not necessarily enhance welfare for all parties involved and could potentially have adverse effects. Suo Yanfeng and Xu Xiaowen (2007) employed the Stackelberg game approach to study the effects of asymmetric economic shocks, corroborating Hamada's perspective. Wei Wei and Liu Xiaoshu (2024) developed a game theory framework based on a simplified Karl Walsh policy coordination model for analyzing the monetary policies of two countries. They concluded that the loss function for coordinated monetary policy was smaller than that for uncoordinated approaches, suggesting that policy coordination could lead to a Pareto improvement. Secondly, research on the spillover effects of monetary policy often utilizes macroeconomic models. Sun Guofeng and Sun Bibo (2013) applied the Dynamic Stochastic General Equilibrium (DSGE) model to assess the equilibrium RMB exchange rate, considering significant international events in 1997, 2001, and 2008, along with corresponding monetary policy adjustments. They determined that changes in the real money supply in other regions significantly influenced the equilibrium RMB exchange rate. Wang Weijun and Qiu Xiang (2016) analyzed the long-term impacts of foreign central banks' quantitative easing policies on the welfare of domestic residents and the optimal domestic monetary policy under zero nominal interest rates, employing a New Keynesian model with price stickiness and monopolistic competition. Yang Zirong et al. (2018), using the DSGE model, identified an asymmetric bidirectional spillover effect between China and the United States monetary policies, with quantitative measures having a more pronounced effect than price-based policies. They noted that China's monetary policy predominantly benefits its domestic economy. Thirdly, the spillover effects of monetary policy are also examined using various statistical and econometric methods. Borja and Goyeau (2011) analyzed the impact of monetary policy spillovers from the US and Eurozone on asset prices in these regions and five Asian Association of Southeast Asian Nations (ASEAN) countries, finding significant effects between the US and Eurozone but not on the ASEAN countries. Neri and Nobili (2010) observed that an increase in US federal interest rates had an expansionary effect on the European economy. Zhu Mengnan et al. (2020) utilized a two-block Factor-Augmented Vector Autoregressive (FAVAR) model to delve into the implications of China's monetary policy expansion, uncovering augmented trade, output, investment, and stock market activities in most nations participating in the "Belt and Road" initiative, coupled with increased inflationary pressures, underscoring the substantial spillover effects engendered by China's expansionary monetary strategy.

Extensive research has been conducted on the spillover effects of international monetary policies on China's economy. Zhuang Jia (2009) employed the Structural Vector Autoregressive (SVAR) model to illustrate that the influence of U.S. monetary policy on China's economic output is positive, exhibiting a consistent upward trend over an extended period. Yu Wenjian et al. (2012) observed that the low interest rates and quantitative easing strategies adopted by central banks such as the Federal Reserve post-crisis have significantly influenced the economic and monetary policy frameworks in China using the same model. Xie Bei (2012) conducted empirical research using a Vector Autoregressive (VAR) model to determine the impact of U.S. monetary policy on China, noting that the primary effects on China's output and price levels were mediated through trade channels, although these effects were less marked compared to those on developed Western nations. Deng Chuang and Xi Xuwen (2013) developed a Time-varying Parameter Vector Autoregressive (TVP-VAR) model to delve into the temporal dynamics of interest rate shocks on output disparities and inflation in both China and the United States, emphasizing the dual impacts of monetary policy on output and prices. They posited that China's monetary policy is increasingly acting as a "locomotive" for the U.S. economy, with the adversarial "beggar thy neighbor" effects of U.S. monetary policy on China escalating rapidly. Liu Yaocheng (2016) utilized the TVP-SV- VAR model within a Bayesian framework to analyze how shifts in monetary policies in key global currency regions, including the U.S., Japan, and Europe, have shaped China's economic landscape since the financial crisis, particularly through the mechanisms of interest rate differentials that influence the RMB exchange rate and China's trade surplus. Ouyang Zhigang and Zhang Sheng (2016) applied the SVAR model to assess the transmission mechanisms and consequences of U.S. monetary policy on the RMB exchange rate post-crisis, identifying three primary channels: interest rates, prices, and monetary expansion. Their findings confirmed the comprehensive impact of U.S. policy across all identified channels. Long et al. (2022) noted that the growing interest rate differential between China and the U.S., stemming from the tightening of U.S. monetary policy, contributed to the appreciation of the renminbi, which corroborates the theories surrounding monetary exchange rates.

In summary, the focus of existing research on the spillover effects of monetary policies predominantly revolves around the exploration of transmission mechanisms, with an emphasis on the quantitative easing strategies implemented by the United States. There appears to be a relative paucity of studies concerning the spillover effects from the monetary policies of emerging economies on China's economic landscape.

Expanding upon Nakajima's (2011) foundational work with the SVAR model, this study introduces a TVP-SV-VAR model to assess how monetary policies from the BRICS nations influence the RMB exchange rate and China's trade balance. Following the methodological approach of Ouyang Zhigang and Zhang Sheng (2016), this research categorizes the spillover effects from BRICS countries into interest rate and currency expansion channels, analyzing their individual contributions to fluctuations in the RMB exchange rate and alterations in the trade balance.

3. METHODOLOGY AND DATA

3.1. Methodology

Utilizing Primiceri's (2005) TVP-SV-VAR model, we assess the influence of BRICS monetary policy on these economic indicators. The TVP-SV-VAR model, represented as Eq. (1):

$$y_t = c_t + B_{1t}y_{t-1} + \cdots + B_{st}y_{t-s} + e_t, \quad e_t \sim N(0, \Omega_t), \quad t = s+1, \dots, n \quad (1)$$

Among them, y_t is an observable column vector of $(k \times 1)$ dimensions, $B_{1t},\dots,B_{st}$ is a time-varying coefficient matrix $(k \times k)$, and Ω_t is a time-varying covariance matrix of $(k \times k)$ dimensions. Assuming $\Omega_t = A_t^{-1}\sum_t\sum_t A_t^{'-1}$t, where A_t is a lower triangular matrix with a diagonal element of 1 in the $(k \times k)$ dimension, and $\mathrm{diag}(\sigma_{1t}, \dots, \sigma_{kt})$. β_t is the stacked column vector of $B_{1t},\dots,B_{st}$, $a_t = (a_{1t}, \dots, a_{qt})$ is the stacked column vector of the non-zero elements of the lower triangular matrix A_t, $h_t = (h_{1t}, \dots, h_{kt})$ where $h_{it} = \log\sigma_{it}^2$. Assuming the time-varying parameters follow a random walk process, as outlined in Eq. (2) and (3):

$$\begin{aligned} \beta_{t+1} &= \beta_t + u_{\beta t}, \\ a_{t+1} &= a_t + u_{at}, \\ h_{t+1} &= h_t + u_{ht}, \end{aligned} \quad (2)$$

$$\begin{pmatrix} \varepsilon_t \\ u_{\beta t} \\ u_{at} \\ u_{ht} \end{pmatrix} \sim N\left(0, \begin{pmatrix} I & 0 & 0 & 0 \\ 0 & \sum_\beta & 0 & 0 \\ 0 & 0 & \sum_a & 0 \\ 0 & 0 & 0 & \sum_h \end{pmatrix}\right) \quad (3)$$

Where $t = s + 1, \ldots, n$, $e_t = A_t^{-1} \sum_t \varepsilon_t$, $\sum_a$ and $\sum_h$ are diagonal matrices $\beta_{s+1} \sim N\left(u_{\beta 0}, \sum_{\beta 0}\right)$, $a_{s+1} \sim N\left(u_{a0}, \sum_{a0}\right)$, $h_{s+1} \sim N\left(u_{h0}, \sum_{h0}\right)$.

3.2. Data

This research further delineates monetary policy impacts into categories of interest rate and broader monetary impacts. Regarding the interest rate impacts, a three-variable TVP-SV-VAR model is utilized, incorporating interest rates from the BRICS Economic Community, the RMB exchange rate, and China's net trade. For broader monetary impacts, the model includes variables such as the broad money supply (M2), the RMB exchange rate, and China's net trade under the BRICS framework. Despite the recent expansion of the BRICS to include Saudi Arabia, Egypt, the United Arab Emirates, Iran, and Ethiopia in January 2024, this analysis continues to utilize data exclusively from the original BRICS members due to the recency of these additions and the limited availability of comprehensive data. The interest rates are calculated using a real GDP-weighted average derived from several rates including South Africa's overnight interbank offered rate, China's Shanghai interbank offered rate (SHIBOR), Brazil's federal funds rate (SELIC), Russia's federal interbank offered rate (MIACR), and India's Mumbai interbank offered rate. These five time series interest rates are then weighted and averaged based on their real GDP measured in US dollars, according to World Bank statistics. Similarly, the broad money supply indicator of the BRICS Economic Community is calculated by taking a logarithmic difference of the M2 from the five countries and averaging it, weighted by their real GDP. The RMB exchange rate indicator uses the nominal exchange rate denominated in RMB/USD, as set by the People's Bank of China, and applies a natural logarithmic difference treatment to it, utilizing its rate of change to adjust variables. The trade balance indicator utilizes the nominal trade balance, denominated in US dollars by the General Administration of Customs of China, by taking the natural logarithm and adjusting for seasonal effects. Employing US dollar valuation helps minimize the correlation between interest rates and money supply indicators in BRICS countries, while the use of nominal data ensures uniformity in statistical measurements with interest rates and money supply. The four variables—i, m, e, and nx—are presented as monthly data spanning from November 2006 to December 2022. All data referenced in this study are sourced from the CEIC database (Table 1).

Table 1. Variable Explanation

Variable	Variable symbol	Data selection	Data processing
Interest rates of BRICS economies	i	South Africa's overnight interbank offered rate, SHIBOR, SELIC, MIACR, and India's Mumbai interbank offered rate	These five time series interest rates are weighted and averaged based on their real GDP measured in US dollars, according to World Bank statistics.
Money supply of BRICS economies	m	M2 in BRICS countries: South Africa, China, Brazil, Russia, and India	Taking a logarithmic difference of the M2 from the five countries and averaging it, weighted by their real GDP
RMB exchange rate	e	The nominal exchange rate denominated in RMB/USD, as set by the People's Bank of China	Applying a natural logarithmic difference treatment to the RMB exchange rate
China's net trade	nx	The nominal trade balance, denominated in US dollars by the General Administration of Customs of China	Taking the natural logarithm and adjusting for seasonal effects

Source: The authors

4. EMPIRICAL ANALYSIS

4.1. Parameter estimation

Table 2. Parameter estimation of interest rate effect model

Parameters	Mean	Standard deviation	Lower bound of 95% confidence interval	Upper bound of 95% confidence interval	Geweke convergence diagnostic value	Invalid influencing factor
$(\sum_{\beta})_1$	0.0023	0.0003	0.0018	0.0029	0.483	6.7
$(\sum_{\beta})_2$	0.0023	0.0003	0.0018	0.0028	0.243	7.85
$(\sum_{a})_1$	0.0056	0.0016	0.0034	0.0097	0.963	48.22
$(\sum_{a})_2$	0.0056	0.0016	0.0035	0.0095	0.839	52.21
$(\sum_{h})_1$	0.4168	0.0869	0.2591	0.6054	0.995	49.22
$(\sum_{h})_2$	0.4254	0.0916	0.2688	0.6194	0.391	33.78

Source: The authors

Table 3. Parameter estimation of monetary effects model

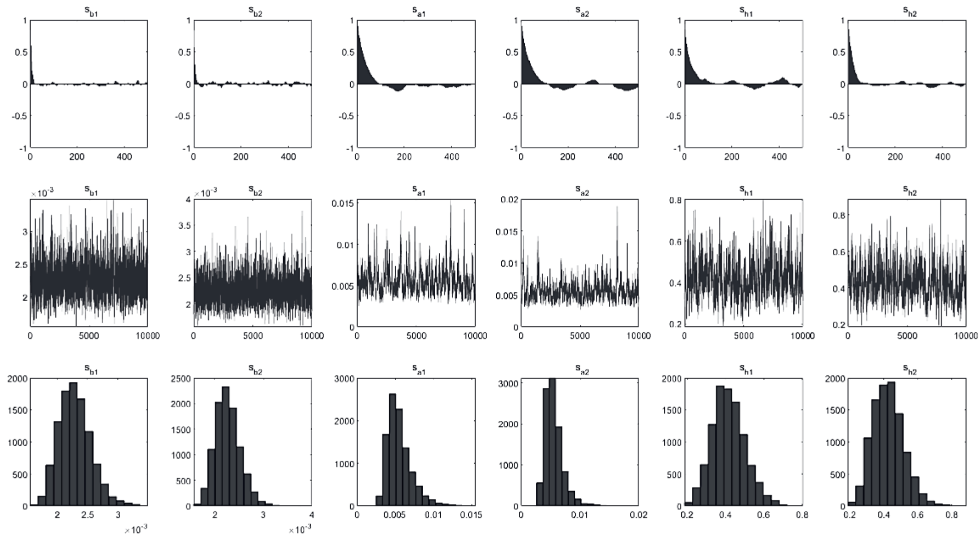
Parameters	Mean	Standard deviation	Lower bound of 95% confidence interval	Upper bound of 95% confidence interval	Geweke convergence diagnostic value	Invalid influencing factor
$(\sum_\beta)_1$	0.0023	0.0003	0.0018	0.0028	0.647	11.59
$(\sum_\beta)_2$	0.0023	0.0003	0.0018	0.0028	0.189	8.25
$(\sum_a)_1$	0.0058	0.0016	0.0035	0.0097	0.005	47.25
$(\sum_a)_2$	0.0055	0.0018	0.0034	0.0101	0.019	66.02
$(\sum_h)_1$	0.0071	0.0029	0.0038	0.0147	0.897	102.48
$(\sum_h)_2$	0.3884	0.087	0.2442	0.5827	0.587	47.82

Source: The authors

As indicated in Table 2 and Table 3, the Geweke convergence diagnostic values help assess whether the pre-simulated Markov chain converges to a posterior distribution. Additionally, the inefficiency factor is characterized by the ratio of the variance of the posterior sample mean to that of the uncorrelated sequence sample mean. This, along with other metrics, assesses the efficacy of the Markov Chain Monte Carlo (MCMC) simulations from dual perspectives. Based on Geweke's diagnostic, both models corroborate the null hypothesis of convergence to a posterior distribution, exhibiting critical values of 2.56 and 1.96 at the 1% and 5% significance levels, respectively. Regarding inefficiency factors, both models exhibit relatively low values, with the highest recorded in the monetary effect model$(\sum_h)_1$ at 102.48. This suggests that it is possible to derive approximately 98 independent samples from 10000/102.48 calculations, indicating that the sample size is sufficiently large for reliable inference of the posterior distribution.

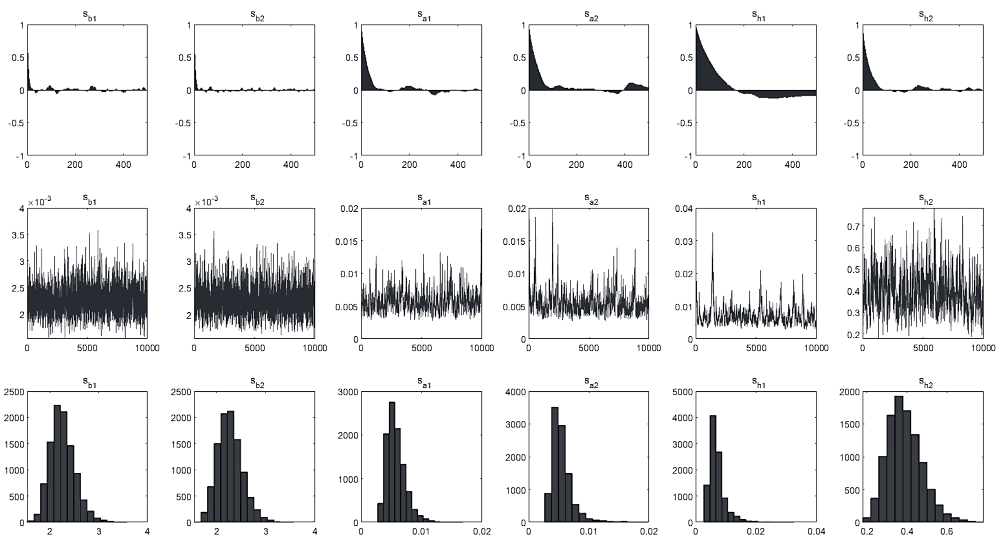
The graphical representations of the autocorrelation coefficient of parameters, the simulated variation path, and the density distributions demonstrate that the MCMC algorithm effectively simulates the posterior distribution of the parameters (Figures 1 and 2).

Figure 1. MCMC simulation parameter distribution of interest rate effect model



Source: The authors

Figure 2. Distribution of MCMC simulation parameters for the monetary effect model



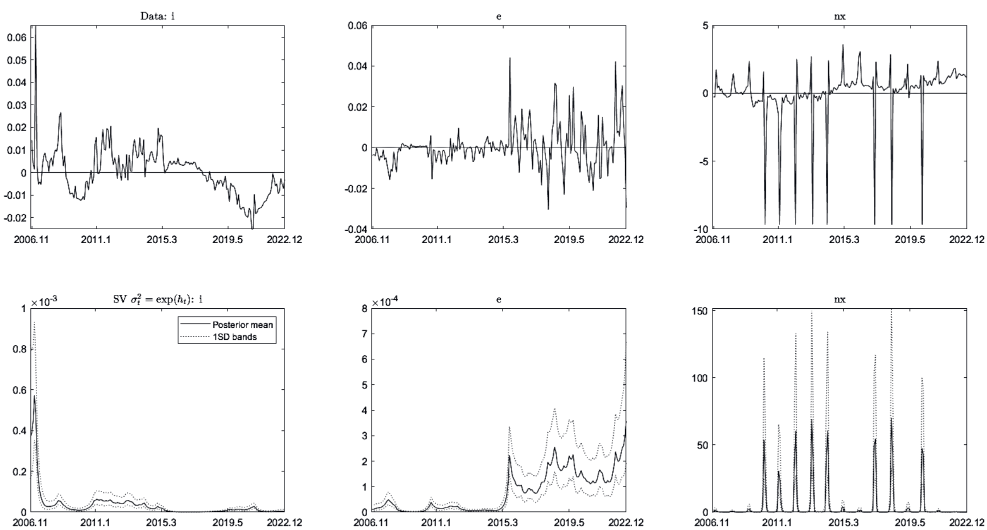
Source: The authors

From the perspective of autocorrelation coefficient and simulated variation path, the sample autocorrelation of both models decreases rapidly, and the sample paths show convergence. Regarding the simulation of distribution density, the posterior distribution density functions of both models are highly satisfactory, demonstrating that the MCMC algorithm effectively simulates the posterior distribution of parameters.

4.2. Analysis of variance of fluctuations

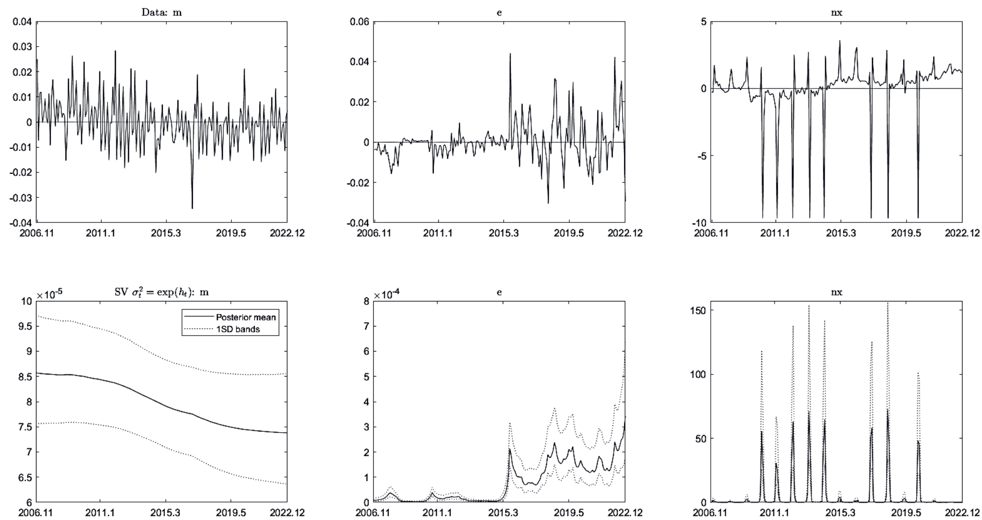
Next, we apply the unique analysis tool of the TVP-SV-VAR model, stochastic volatility, to examine the interest rate effect model and the monetary effect model (Figures 3 and 4).

Figure 3. Changes in interest rates, RMB exchange rates, trade balance, and posterior volatility under the interest rate effect model



Source: The authors

Figure 4. Changes in money supply, RMB exchange rate, trade balance, and posterior volatility under the monetary effect model



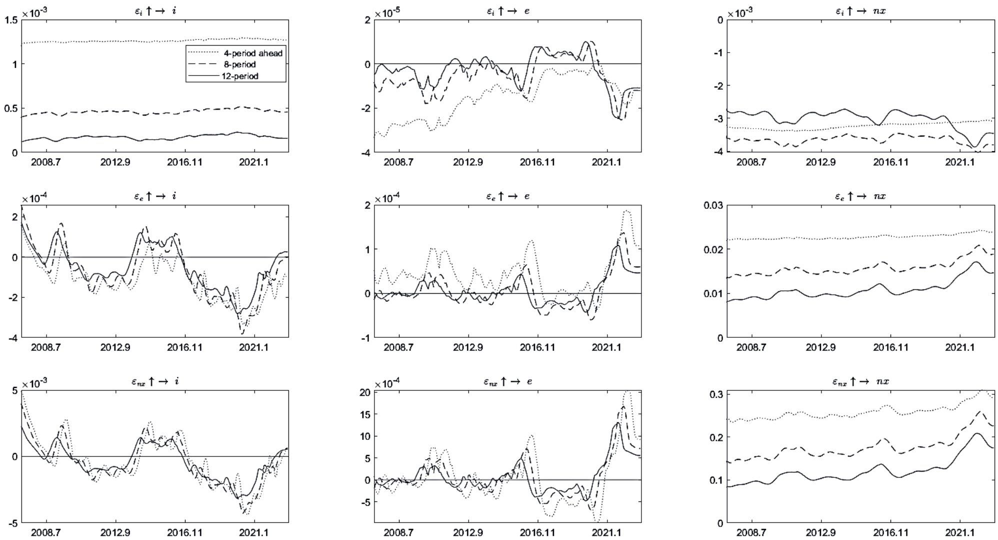
Source: The authors

Observational data indicate that the weighted interest rates, broad money supply, and RMB exchange rates of the BRICS economies exhibit relatively stable posterior volatility changes. Notably, the volatility of the broad money supply remains significant. In 2008, RMB exchange rate volatility sharply declined. Following the BRICS Foreign Ministers' Meeting, support for the RMB exchange rate eased, and its stability trend diminished from 2010 onwards. The posterior volatility of China's trade balance, nx, shows considerable variation and correlates with the fluctuation amplitude depicted in the upper half of the graph. In summary, around June 2009, the emergence of the BRICS countries as a significant economic group began impacting China. We will next use the TVP-SV-VAR model to explore the dynamic interactions between variables during this period.

4.3. Dynamic pulse response analysis

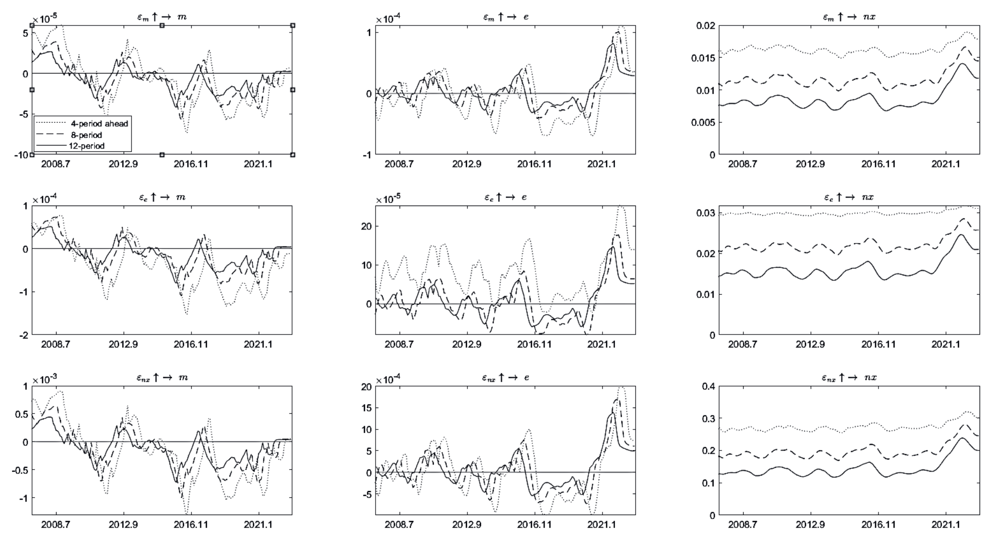
Time-varying pulse response analysis will follow. Subsequent figures will illustrate the dynamic evolution of the pulse response results over time with lags of 4 months, 8 months, and 12 months (Figures 5 and 6).

Figure 5. Time-Varying Pulse Response of Interest Rate, RMB Exchange Rate, and Trade Balance under the Interest Rate Effect Model



Source: The authors

Figure 6. Time-Varying Pulse Response of Interest Rates, RMB Exchange Rates, and Trade Balances under the Monetary Effect Model



Source: The authors

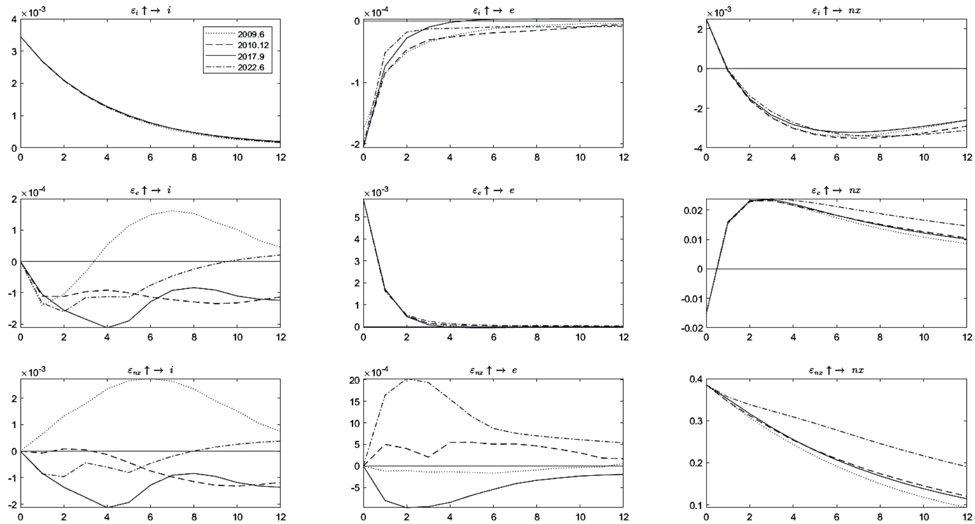
Firstly, within the interest rate effect model, we analyze the time-varying impulse response relationship of weighted interest rates in the BRICS economies. The response of weighted interest rates to self-shocks ($\varepsilon_i \rightarrow i$) is more pronounced in the short term, diminishes in the medium term, and is least significant in the long term, approaching zero but maintaining a positive impact consistently. The response of the RMB exchange rate to weighted interest rate shocks shows a significant decline ($\varepsilon_i \rightarrow e$) before May 2008. After the BRICS Foreign Ministers' Meeting in May 2008, the RMB exchange rate was effectively bolstered, returning to its initial value. Subsequent BRICS meetings have consistently led to an upward trend in the RMB exchange rate. The response of the trade balance to weighted interest rate shocks ($\varepsilon_i \rightarrow nx$) has remained relatively stable throughout the sample period, with minor short-term impacts and more substantial long-term effects, indicating a negative influence on weighted interest rates in the short term. In summary, the monetary policies of BRICS economies have significant spillover effects on the RMB exchange rate and China's trade balance.

Then, within the monetary effect model, we examine the time-varying impulse response relationship of the weighted broad money supply in the BRICS economies. The response of the weighted broad money supply to self-shocks ($\varepsilon_m \rightarrow m$) is more considerable in the short term, diminishes in the medium term, and is minimal in the long term, with overall fluctuations around the regression point during the sample period. The response of the RMB exchange rate to shocks in the weighted broad money supply mirrors ($\varepsilon_m \rightarrow e$) that of weighted interest rates, with a sharp decrease before May 2008 followed by a gradual increase after the BRICS Foreign Ministers' Meeting. After December 2010, there has been a significant rise, with every subsequent BRICS conference corresponding to a slight increase in the RMB exchange rate. The response of the trade balance to shocks in the weighted broad money supply ($\varepsilon_m \rightarrow nx$) differs significantly from that to weighted interest rate shocks, maintaining a relatively stable trend throughout the sample period. The short-term impact is greater than the long-term impact, and the trade balance is positively influenced by shocks to weighted currency. Overall, the monetary policies of the BRICS economies have profound spillover effects on the RMB exchange rate and China's trade balance.

Time Point Pulse Response Analysis. This study focuses on specific time points—June 2009, December 2010, September 2017, and June 2022—as principal observational periods, correlating with BRICS conferences that commenced in April 2010 to analyze the dynamic pulse response relationships comprehensively. In June 2009, the inaugural meeting of BRICS leaders in Russia marked the official establishment of the BRICS cooperation mechanism. December 2010 saw South Africa's admission into BRICS, broadening the cooperation among member countries. The 9th BRICS Leaders Meeting in September 2017 in Xiamen, China, introduced the "BRICS+" initiative, facilitating broader participation of emerging markets and developing countries in BRICS activities. By June 2022, the expansion of "BRICS+"

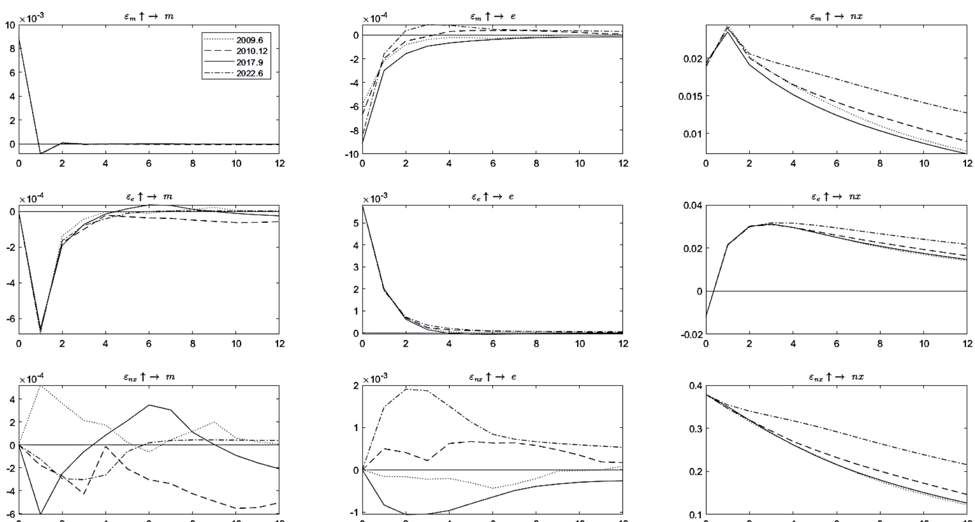
cooperation was endorsed by the five member countries, with Iran and Argentina applying for membership.

Figure 7. Time point impulse response of interest rate, RMB exchange rate, and trade balance under the interest rate effect model



Source: The authors

Figure 8. Time point impulse response of interest rate, RMB exchange rate, and trade balance under the monetary effect model



Source: The authors

From Figure 7, the interest rate effect model shows that after experiencing a positive interest rate shock, the impact of weighted interest rates on themselves ($\varepsilon_i \rightarrow i$) remains consistent across various time points, reverting to pre-shock levels approximately 12 months later. The RMB exchange rate ($\varepsilon_i \rightarrow e$) displayed a clear reverse spillover effect initially, which gradually diminished over about 8 months as the interest rate shock subsided. Notably, the impacts at different time points varied: the establishment of BRICS in June 2009 had a minimal effect on the RMB exchange rate with a slow recovery; the inclusion of South Africa in December 2010 intensified this impact; the events of September 2017 and the membership applications of Iran and Argentina in June 2022 significantly influenced the recovery speed of the RMB exchange rate. In contrast, China's trade balance ($\varepsilon_i \rightarrow nx$) exhibited a consistent pattern at these time points, initially showing a positive spillover effect, which transitioned to a reverse spillover after one month and then gradually diminished. In summary, while facing the positive influence of weighted interest rates, the RMB exchange rate endured negative spillover effects, with larger economies experiencing more pronounced impacts; China's trade balance initially showed positive effects that shifted to negative spillovers after one month.

As shown in Figure 8, in the monetary effect model, after experiencing a positive shock to the money supply, the impact of weighted money supply on itself ($\varepsilon_m \rightarrow m$) gradually diminishes over time, returning to pre-shock levels within 2 months. The RMB exchange rate ($\varepsilon_m \rightarrow e$) also exhibits a distinct reverse spillover effect initially, returning to its pre-shock state after 8 months. However, the rates of decrease vary significantly at different times: they were slower in June 2009 and December 2010, more pronounced following the shock in September 2017, and fastest in June 2022, evidently correlating with the size of the economy. Initially, China's trade balance ($\varepsilon_m \rightarrow nx$) displayed a positive spillover effect, which increased in the subsequent month and then gradually declined. The rate of decrease was quicker in June 2009 and December 2010, followed by the impact in September 2017, and was slowest in June 2022. In summary, under the influence of a positive weighted money supply, the RMB exchange rate experiences negative spillover effects, with larger economies showing faster recovery speeds; China's trade balance experiences initial positive effects that diminish over time.

5. CONCLUSION, IMPLICATION AND LIMITATION

5.1. Conclusion

This study constructs TVP-SV-VAR models to delineate the distinct impacts of interest rate and monetary supply resulting from monetary policy interventions. The estimation employs the MCMC simulation, while stochastic volatility (SV) and dynamic impulse response analyses facilitate an exploration of the dynamic, time-varying spillover effects that BRICS monetary policies exert on the RMB exchange rate and China's trade balance. Adjustments in macroeconomic policy through monetary levers affect both interest rates and the broad money supply. Key indicators for analyzing interest rate variations within the BRICS include the South African benchmark overnight interbank offered rate, SHIBOR, Brazilian Federal Funds Rate (SELIC), Russia Federal Interbank Offered Rate (MIACR), and Mumbai Interbank Offered Rate in India. Conversely, the aggregate money supply M2 from these nations serves as the principal metric for examining monetary supply variables. Within the TVP-SV-VAR model framework, separate models for the interest rate and monetary effects are developed to evaluate their influence on the RMB exchange rate and China's trade dynamics. The findings from the interest rate model indicate that monetary policy adjustments lead to shifts in capital flows, producing negative spillover effects on the RMB exchange rate and displaying mixed outcomes on China's trade balance—beneficial in the short term but detrimental over a longer horizon. In contrast, the monetary model reveals that BRICS monetary policies predominantly generate adverse impacts on the RMB exchange rate while yielding positive outcomes for China's trade balance. In the broader context of global economic digitization, the BRICS economies are pivotal in shaping international policy collaboration, markedly influencing the RMB exchange rate and China's trade balance, thereby fostering enhanced international cooperation. Drawing on these insights, this paper offers a series of policy recommendations:

5.2. Policy implication

Firstly, it is essential to establish and enhance the early warning mechanism for economic policy indicators in emerging economies, such as the BRICS countries. As the role of BRICS countries in global economic governance progressively strengthens, so too does their influence and discourse power within the global economic framework. The spillover effects of monetary policies enacted by BRICS countries are becoming increasingly consequential. Secondly, there is a need for BRICS countries to fortify policy cooperation, actively managing and balancing spillover effects. Empirical evidence indicates that the monetary policies of BRICS countries—both through monetary and interest rate effects—exert a significant short-term impact on China's exchange rate and trade balance, necessitating collaboration for mutually beneficial outcomes. Thirdly, the coordination and enhancement of international trade and cross-border capital flows among BRICS countries are imperative. Empirical evidence suggests that the spillover effects of BRICS monetary policies on China's trade balance are diverse, affecting both monetary and interest rate dimensions. Consequently, BRICS countries must implement tailored foreign trade and financial policies.

5.3. Research limitation

This study provides initial evidence of the significant spillover effects of BRICS monetary policies on the RMB exchange rate and China's trade balance. However, it should be noted that the divergent impacts observed under the interest rate and monetary effect models may relate to differences in the transmission channels of monetary policy. For example, the interest rate effect is more promptly reflected through interest rate differentials and capital flow channels, while the monetary effect is more evident in production and trade channels, necessitating further analysis. In addition, the extent of trade or financial linkages between BRICS countries and China may also influence the empirical outcomes. This study employs a three-variable TVP-SV-VAR model, and the number of variables could impact the robustness of the findings. Future research will expand the number of variables for more robust testing.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

FUNDING

The work was supported by Yunnan Provincial First-Class Discipline Construction Project "Cross-Border Digital Economy", the Yunnan Provincial Philosophy and Social Sciences Innovative Team Program (2024CX05), and the Yunnan Provincial Department of Education Key Laboratory Project "Industrial Digital Finance and Cross-Border Economic Cooperation" (ZX20240190).

REFERENCES

Borja, D. V. H., & Goyeau, D. (2011). International liquidity, monetary spillovers and asset prices. *Philippine Management Review*, *18*, 83-95.

Cao, W., Jin, Z. H., & Zhao, J. M. (2019). The study on spillover effect and reverse impact of China's economic growth shift and import and export fluctuation. *Journal of Quantitative & Technological Economics*, *36*(1), 3–21. https://doi.org/10.13653/j.cnki.jqte.2019.01.001

Cooper, R. N. (1968). Economic Interdependence and coordination of economic policies. In R. W. Jones & P. B. Kenen (Eds.), *Handbook of international economics* (pp. 1195–1234). Amsterdam: North Holland.

Deng, C., & Xi, X. W. (2013). A study on time-varying characteristics of Sino-US monetary policy spillover effects. *Studies of International Finance*, (9), 10–20.

Dizioil, A., Guajardo, J., Klyuev, V., Mano, R., Raissi, M., & Li, X. R. (2016). Spillovers from China's growth slowdown and rebalancing to the ASEAN-5 economies. *International Economic Review*, (6), 165–166.

Fu, G. M. (2017). America raising interest rate, RMB exchange rate and price fluctuation. *Journal of International Trade*, (3), 131–142. https://doi.org/10.13510/j.cnki.jit.2017.03.012

Hamada, K. (1974). Alternative exchange rate systems and the interdependence of monetary policies. In R. Z. Aliber (Ed.), *National monetary policies and the international financial system* (pp. 13–33). Chicago: University of Chicago Press.

Kazi, I. A., Wagan, H., & Akbar, F. (2013). The changing international transmission of US monetary policy shocks: Is there evidence of contagion effect on OECD countries. *Economic Modelling*, *30*, 90–116. https://doi.org/10.1016/j.econmod.2012.07.020

Kim, S., & Yang, D. Y. (2012). International monetary transmission in East Asia: Floaters, non-floaters, and capital controls. *Japan and the World Economy*, *24*(4), 305–316. https://doi.org/10.1016/j.japwor.2012.05.003

Li, J., Li, S. H., & Chen, B. (2024). The spillover effect of the Federal Reserve's monetary policy on the debt risk of China's non-financial enterprises. *Studies of International Finance*, (8), 85–96. https://doi.org/10.16475/j.cnki.1006-1029.2024.08.008

Liu, Y. C. (2016). International Monetary Policy Spillover Effects, Renmenbi Exchange Rate and China's Trade Balance: The Dynamic Relationship Analysis Based on TVP-VAR-SV Model. *World Economy Study*, (6), 69–81. *https://doi.org/10.13516/j.cnki.wes.2016.06.008*

Long, S. B, Zhang, R., & Hao, J. (2022). Asymmetric impact of Sino-US interest rate differentials and economic policy uncertainty ratio on RMB exchange rate. *Journal of International Financial Markets, Institutions & Money*, *78*, 101570. https://doi.org/10.1016/j.intfin.2022.101570

Nakajima, J. (2011). Time-varying parameter VAR model with stochastic volatility: An overview of methodology and empirical applications. *Monetary and Economic Studies*, *29*(11), 107–142.

Neri, S., & Nobili, A. (2010). The transmission of US monetary policy to the euro area. *International Finance*, *13*(1), 55–78. https://doi.org/10.1111/j.1468-2362.2010.01251.x

Ouyang, Z. G., & Zhang, S. (2016). The transmission effect of American monetary policy on the exchange rate of RMB in the era of the post financial crisis. *International Economics and Trade Research*, *32*(4), 63–76. https://doi.org/10.13687/j.cnki.gjjmts.2016.04.005

Primiceri, G. E. (2005). Time varying structural vector autoregressions and monetary policy. *The Review of Economic Studies*, *72*(3), 821-852. https://doi.org/10.1111/j.1467-937X.2005.00353.x

Rogoff, K. (1985). International macroeconomic policy coordination may be counterproductive. *Journal of International Economics*, *18*(3/4), 199–217. https://doi.org/10.1016/0022-1996(85)90052-2

Sun, G. F., & Sun, B. B. (2013). Calculation of RMB equilibrium exchange rate: An empirical study based on DSGE model. *Journal of Financial Research*, (8), 70–83.

Suo, Y. F., & Xu, X. W. (2007). Monetary policy coordination under asymmetric shocks: A stackeberg model. *Journal of Nanjing University of Finance and Economics*, (1), 61–64.

Wang, W. J., & Qiu, X. (2016). Untraditional monetary policy and its spillover effects at the zero Lower Bound. *Studies of International Finance*, (8), 24–37. https://doi.org/10.16475/j.cnki.1006-1029.2016.08.003

Wei, W., & Liu, X. S. (2024). Monetary policy coordination between China and USA can realize pare-to improvement: Based on analysis of game theory framework. *Finance Economy*, (1), 6–15. https://doi.org/10.3969/j.issn.1007-0753.2024.01.002

Xie, B. (2012). The spillover effect of US monetary policy on Chinese economy in post-crisis times: Evidence from VAR model. *Journal of Sichuan University (Social Science Edition)*, (4), 132–138.

Yang, Z. R., Xu, Q. Y., & Wang, S. M. (2018). A study on the bidirectional spillover effect of monetary policy between China and US - Based on two-country DSGE models. *Studies of International Finance*, (11), 14–24. https://doi.org/10.16475/j.cnki.1006-1029.2018.11.002

Yu, W. J., Gu, M. D., Liu, B., Fu, Y., Tong, S. Q., Wang, J. H., & Zhang, W. H. (2012). The spillover effect of monetary policy given the "Temperature Difference" in global economic recovery. *Shanghai Finance*, (4), 8–15.

Zhu, M. N., & Yan, S. (2015). Dynamic Spillovers of Economic Policy Uncertainty and RMB Exchange Rate. *Journal of International Trade*, (10), 111–119. *https://doi.org/10.13510/j.cnki.jit.2015.10.011*

Zhu, M. N., Zhou, Y., & Zheng, L. (2020). Research on the economic spillover effects of China's monetary policy on countries or regions along the Belt and Road. *World Economy Study*, (6), 89–105,137. https://doi.org/10.13516/j.cnki.wes.2020.06.008

Zhuang, J. (2009). *An empirical study on the spillover effect of US monetary policy on China's output* [Doctoral dissertation, Fudan University]. China National Knowledge Infrastructure (CNKI).