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Does China's Foreign Exchange Market Volatility Affect Agricultural Loan Market Volatility?

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Abstract

Background and Aims: China's foreign exchange (Forex) market has become increasingly volatile due to global economic shocks and domestic financial reforms. This volatility poses potential systemic risks to interconnected markets, including the agricultural loan market. Given the centrality of agriculture in China's export profile and its dependence on specialized credit mechanisms, understanding how foreign exchange fluctuations impact agricultural finance is critical. This study investigates whether volatility in China's foreign exchange market generates spillover effects on the agricultural loan market. It specifically explores the direction and time-varying nature of these effects and examines the mediating role of agricultural exports in this transmission process.

Methodology: A Time-Varying Parameter Stochastic Volatility Vector Autoregression (TVP-SV-VAR) model is employed to analyze quarterly data from Q3 2011 to Q4 2023. The model integrates three variables: Forex volatility (measured via RMB/USD parity rate log returns), agricultural exports (from the Ministry of Commerce), and agricultural loan market volatility (based on adjusted loan balance data). Bayesian inference and MCMC methods are used for robust parameter estimation.

Results: The findings indicate that Forex market volatility exerts significant but predominantly negative effects on agricultural loan market volatility in the short- and medium-term, challenging conventional expectations of positive spillovers. Agricultural exports, however, respond negatively to foreign exchange shocks, while their recovery has a positive impact on agricultural loan volatility. These results confirm that exports serve as a critical transmission channel. Policy resilience—via credit guarantees and export subsidies—helps buffer short-term effects, although systemic risks accumulate over time.

Conclusion: Foreign exchange volatility influences agricultural loan markets in a dynamic, time-varying manner, with agricultural exports acting as a key conduit. While China's policy interventions have mitigated immediate impacts, long-term resilience demands adaptive strategies. These insights offer valuable guidance for policymakers seeking to enhance financial stability in sectors vulnerable to external financial shocks.

Keywords: Foreign Exchange Market Volatility; Agricultural Exports; Agricultural Loan Market Volatility; TVP-SV-VAR Model

Introduction

In the context of economic globalization and the gradual liberalization of China's financial markets, the efficiency of capital flows and information transmission across financial markets has seen significant improvement. However, the cross-market contagion of financial risks has emerged as a critical threat to systemic stability (Shan & Wang, 2024). The foreign exchange market, a pivotal component of the financial system, is particularly susceptible to major global events. For instance, the Federal Reserve's aggressive monetary tightening in 2022 and heightened risk-aversion sentiment due to the prolonged Russia-Ukraine conflict triggered pronounced fluctuations in the RMB exchange rate. Additionally, reforms in China's exchange rate regime and increased trade openness amplify spillover effects from the foreign exchange market to other financial submarkets (Wang & Xiao, 2023). The foreign exchange market is widely recognized as a core source of global financial risk (Louzis & Vouldis, 2012; Cyn-Young et al., 2014), alongside bond markets, establishing its central role in the global financial risk transmission network (Zheng et al., 2023).

Theoretically, foreign exchange market volatility impacts other markets through mechanisms outlined in the portfolio balance approach and exchange rate pass-through models. The portfolio balance approach posits that changes in exchange rates influence asset allocation decisions, which could extend to credit markets, including agricultural loans. Meanwhile, exchange rate pass-through models highlight how

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currency fluctuations affect domestic prices, trade balances, and corporate profitability, further rippling into financial markets. At the microeconomic level, exchange rate volatility disrupts corporate operations—including import/export activities, investment and financing decisions, mergers and acquisitions, and production efficiency—via mechanisms such as input cost fluctuations, resource reallocation, cross-border capital flows, and competitive pressures (Deng & Xie, 2020; Mao & Chen, 2021; Cao et al., 2022). These disruptions directly influence banks' creditworthiness assessments, which in turn shape agricultural loan market dynamics.

Existing studies have provided foundational insights into the effects of foreign exchange (Forex) market volatility on agricultural financing (Baghestany & Sherafatmand, 2019), yet significant research gaps remain in understanding its impact on agricultural loan markets. First, while prior research extensively addresses agricultural loan accessibility (Ameh & Lee, 2022; Gültekin, 2023) and market characteristics (Linh et al., 2019; Sonehekpon & Fiamohe, 2023), the volatility dynamics within agricultural loan markets have been largely overlooked. Second, although robust literature exists on the spillover effects between Forex and commodity markets, the intricate linkages between Forex volatility and agricultural loan market behavior remain underexplored. Third, while prior studies either focus on the direct effects of exchange rate volatility on agricultural exports (Lu & Dai, 2005; Li & Song, 2004; Sylvanus et al., 2023; Orman & Dellal, 2021; Tulasombat & Ratanakomut, 2015; Chen, 2010; Mesagan et al., 2021) or examine exports' impact on loan markets (Busari et al., 2022; Esbosynovna & Sarsenbaevich, 2022), the mediating role of agricultural exports as a transmission channel remains understudied. Fourth, methodological limitations persist: conventional VAR/SVAR models, with fixed coefficient matrices and disturbance variances, fail to capture time-varying dynamics (Zhang et al., 2022). In contrast, the Time-Varying Parameter Stochastic Volatility Vector Autoregression (TVP-SV-VAR) model, which accommodates time-varying coefficients and variance-covariance matrices (Primiceri, 2005), provides a more robust framework for analyzing dynamic financial market relationships. However, the application of this model to China's foreign exchange and agricultural loan markets remains limited. Collectively, these gaps underscore the need for a nuanced, time-sensitive approach to unravel the interplay between Forex volatility, agricultural exports, and loan market stability.

The sensitivity of China's agricultural loan market to foreign exchange volatility can be attributed to the country's agricultural trade profile and the financing structure of its agricultural sector. As a major global exporter of agricultural goods, fluctuations in foreign exchange rates directly affect the revenue and competitiveness of Chinese agricultural enterprises. These variations, in turn, influence the profitability and credit demand of such enterprises, shaping the dynamics of the agricultural loan market. Furthermore, the financing of the agricultural sector in China often relies on specialized credit products and government-backed guarantees, making it particularly susceptible to macroeconomic and financial shocks.

Fluctuations in foreign exchange markets exert a cascading impact on the stability of agricultural loan markets through intermediary channels (Baghestany & Sherafatmand, 2019), notably via shifts in the value and revenue of agricultural exports (Sylvanus et al., 2023; Orman & Dellal, 2021; Tulasombat & Ratanakomut, 2015). These export-driven variations directly influence the profitability and financing requirements of agricultural enterprises (Esbosynovna & Sarsenbaevich, 2022), with spillover effects transmitted to agricultural loan markets through financial intermediation mechanisms. The volatility of agricultural exports serves as a barometer of market perceptions regarding international trade conditions in the sector, which in turn shapes investment decisions and financing behaviors among market participants, thereby amplifying fluctuations in credit demand within agricultural loan markets.

This study aims to address the following pivotal questions:(1)Does foreign exchange market volatility generate spillover effects on agricultural loan markets? (2)What are the directional nature (positive or negative) and time-varying characteristics of such spillovers? (3)What is the mediating role of agricultural exports in transmitting foreign exchange market volatility to agricultural loan market instability?

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By integrating insights from foreign exchange theories and highlighting the unique sensitivities of the agricultural loan market, this study seeks to advance theoretical understanding and provide policy-relevant insights.

Objectives

By employing a TVP-SV-VAR model that integrates foreign exchange market volatility, agricultural exports, and agricultural loan market volatility, this study seeks to address a central research question: Does rising foreign exchange market volatility exacerbate agricultural loan market instability, and through what mechanisms does this occur? Specifically, the research aims to uncover how agricultural exports mediate this relationship and how the interconnected dynamics evolve. A key contribution of this research lies in demonstrating the role of agricultural exports as a critical intermediary in the transmission of foreign exchange market volatility to agricultural loan markets. By capturing time-varying dynamics, the study provides both theoretical advancements and actionable insights for policymakers, financial regulators, and banking institutions. These findings are pivotal for managing systemic risks, particularly given the significant interplay between financial markets and the agricultural sector. This investigation is highly relevant, as understanding the linkages between foreign exchange volatility, agricultural exports, and loan market stability is crucial for developing effective risk management strategies. By explicitly focusing on this relationship, the study aims to inform both theoretical frameworks and practical measures to enhance resilience in the financial and agricultural domains.

Literature review

Exchange rate volatility has been widely shown to significantly influence corporate behavior, investment, financing, and bank credit. Mechanisms such as transaction costs, market competition, and profit-shifting are central to understanding these impacts (Deng, 2020; Dao et al., 2021). For example, currency appreciation can enhance firm profitability by reducing the costs of imported inputs, resulting in lower leverage ratios, as observed in Chinese manufacturing firms (Ding et al., 2020). In the context of corporate financing, Yang (2020) demonstrates that foreign exchange market volatility suppresses investment demand among small businesses and individual entrepreneurs in China. During the global financial crisis, heightened exchange rate volatility led to reduced corporate financing demand, weakening the real economy. From a foreign currency loan perspective, exchange rate fluctuations affect access to USD financing and firm valuations in emerging markets. Bruno and Shin (2020) show that currency depreciation in a firm's home country increases the default probability of foreign currency loans, transforming exchange rate risks into bank credit risks. Similarly, Niepmann and Schmidt-Eisenloh (2022) find that such depreciation raises credit risk for U.S. banks lending to firms in 79 countries.

While these broader findings are important, their relevance to the agricultural sector and its loan markets needs clearer integration. The agricultural sector, particularly in China, faces unique challenges due to its dependence on international trade and the import of production inputs such as machinery, fertilizers, and seeds. Exchange rate volatility directly impacts these input costs, which can alter profit margins, the creditworthiness of agricultural enterprises, and their loan demand. For export-oriented agricultural producers, exchange rate fluctuations influence revenue streams, creating further uncertainty that banks must consider in their credit assessments. By explicitly linking these mechanisms to the agricultural loan market, the transmission of foreign exchange market volatility becomes more apparent.

The impact of foreign exchange market volatility is not uniform across periods and market conditions. For example, during periods of active international trade, fluctuations tend to be more frequent and severe, amplifying their effects on agricultural loan markets. Conversely, in economically closed periods, these impacts may diminish. Theoretical perspectives, such as market efficiency or the depth of financial markets, provide insight into these variations. Efficient markets with robust hedging mechanisms may absorb volatility impacts more effectively, while interventions such as exchange rate controls or

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subsidies can dampen spillover effects. This dynamic is particularly relevant in China, where active state intervention in financial and agricultural markets shapes the transmission of volatility.

Baghestany and Sherafatmand (2019) provide further insight by examining the asymmetric impact of exchange rate shocks on agricultural investment. Using a nonlinear autoregressive distributed lag (NARDL) model, they find that negative exchange rate shocks stimulate agricultural investment, while positive shocks suppress it. This asymmetry stems from resource allocation shifts during periods of turbulence, diverting resources from productive activities (e.g., agricultural production) to speculative ones (e.g., foreign exchange trading). These findings contribute to Hypothesis 1, which posits that the impact of foreign exchange market volatility on agricultural loan market volatility is time-varying and predominantly positive. However, the connection between directional shocks and loan market volatility could be further developed. For instance, heightened uncertainty, regardless of shock direction, increases the risk premium for agricultural loans, leading to greater volatility in both loan supply and demand.

As a major global agricultural exporter, China's foreign exchange market volatility inevitably affects its agricultural trade. Existing studies broadly confirm that exchange rate volatility significantly influences agricultural exports, with currency depreciation boosting exports (Lu & Dai, 2005; Li & Song, 2004; Chen, 2010). For instance, Mesagan et al. (2021) find that currency depreciation enhances agricultural exports in Nigeria, while manufacturing exports suffer. Conversely, studies in Nigeria and Turkey suggest that exchange rate volatility suppresses agricultural export volumes (Sylvanus et al., 2023; Orman & Dellal, 2021). Similarly, Tulasombat and Ratanakomut (2015) observe a negative relationship between exchange rates and Thailand's rice and rubber exports. These divergent findings highlight potential differences in country contexts, the specific commodities studied, and methodological approaches. For example, agricultural commodities with high price elasticity or those heavily reliant on imported inputs might be more sensitive to exchange rate fluctuations.

Agricultural exports are closely linked to agricultural loan markets. Scholars argue that export performance stimulates economic growth and increases credit demand, particularly in export-oriented agricultural economies. Xiong et al. (2011) identify a long-term bidirectional causal relationship between agricultural loan efficiency and trade dependency using data from 1982 to 2009. In the short term, positive correlations have been observed between agricultural credit, exchange rates, and export volumes, as shown in Nigeria (Busari et al., 2022). Esbosynovna and Sarsenbaevich (2022) emphasize the role of export financing and market development programs in enhancing agricultural credit demand by increasing the appeal of products to international buyers. For example, export revenues improve the repayment capacity of agricultural enterprises, reducing default risks and encouraging banks to extend more credit.

In summary, foreign exchange market volatility affects agricultural exports, which in turn influence trade balances, production investments, and credit demand, thereby transmitting volatility to agricultural loan markets. This leads to Hypothesis 2: Agricultural exports serve as a critical transmission channel for the impact of foreign exchange market volatility on agricultural loan market volatility. By situating these relationships within the context of China's institutional and economic framework, this study aims to illuminate how unique national characteristics—such as state influence in banking, capital controls, and agricultural policies—might amplify, dampen, or modify these linkages, providing a nuanced understanding of their dynamics.

Conceptual Framework

Fluctuations in China's foreign exchange market serve as a critical barometer of financial market conditions, significantly influencing agricultural loan markets. Foreign exchange market volatility reflects broader dynamics such as currency movements, international capital flows, trade patterns, and macroeconomic policies. These fluctuations disrupt the equilibrium of agricultural loan markets through three interconnected mechanisms. First, exchange rate volatility alters the financial outlook of agricultural businesses. Currency depreciation enhances export competitiveness, increasing revenues and stimulating loan demand, while appreciation suppresses exports and reduces credit needs. Pass-through effects on

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agricultural input and output prices further influence farm profitability and loan repayment capacity. Firms unable to hedge against exchange rate risks face heightened uncertainty, which increases their reliance on credit to manage financial pressures.

Second, capital flow dynamics driven by foreign exchange fluctuations directly affect credit availability and interest rates. Speculative "hot money" flows tied to exchange rate speculation often create unstable lending conditions, whereas stable foreign direct investment exerts less disruptive effects. China's gradual liberalization of its capital account amplifies these dynamics, as looser restrictions on cross-border flows increase the agricultural loan market's exposure to foreign exchange volatility. Finally, monetary policy adjustments by the People's Bank of China (PBOC), such as changes to reserve requirements or interest rates, influence the liquidity positions of financial institutions, particularly rural banks heavily engaged in agricultural financing. These actions affect lending behavior and borrowing costs, while macroprudential measures like targeted credit quotas interact with monetary policy to stabilize credit supply during periods of foreign exchange turbulence.

The conceptual framework could be strengthened by integrating established economic theories that explain these mechanisms. Exchange rate pass-through theories highlight how currency volatility affects agricultural input costs and output prices, directly impacting profitability and creditworthiness. Theories on international capital mobility provide insights into how speculative capital flows disrupt credit markets, while the credit channel of monetary policy transmission explains how central bank interventions influence agricultural lenders. Additionally, acknowledging the unique characteristics of China's financial and agricultural sectors, such as the role of policy banks, rural financial underdevelopment, and government-backed credit programs, would provide a more nuanced understanding of these dynamics. By situating this framework within relevant theories and contextualizing it within China's institutional environment, the study lays a solid foundation for analyzing the impact of foreign exchange market volatility on agricultural loan market stability.

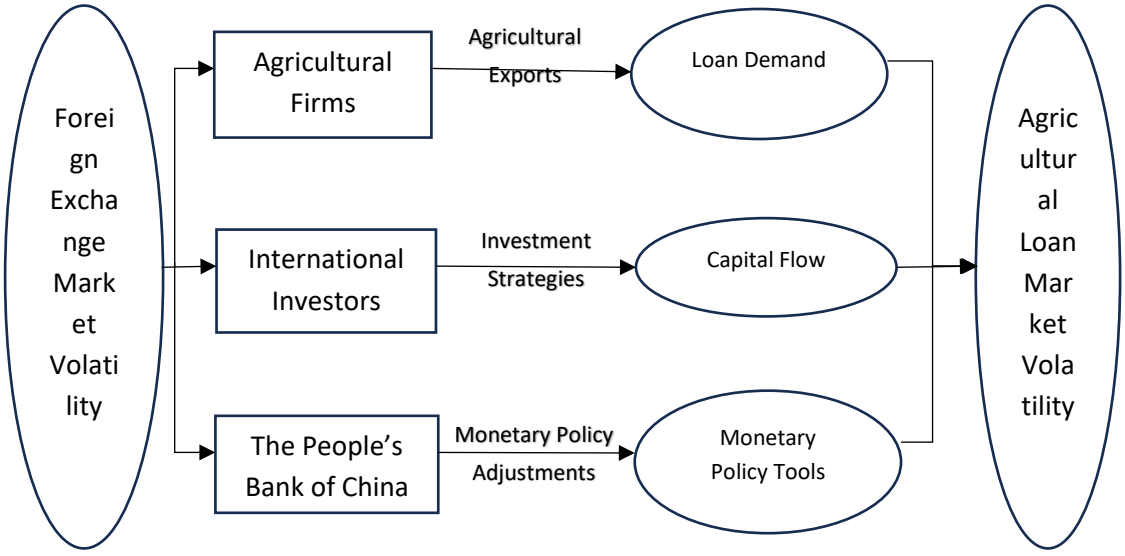

Figure 1 Flowchart of Foreign Exchange Market Volatility's Impact on Agricultural Loan Market Equilibrium
Source: Authors' compilation.

Methodology

1. Data

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This study integrates three key variables—foreign exchange market volatility, agricultural exports, and agricultural loan market volatility—into a unified TVP-SV-VAR model. The data frequency is quarterly, with foreign exchange and agricultural loan volatility sourced from the CSMAR Database, and agricultural export data obtained from the official website of China's Ministry of Commerce. The sample period spans from Q3 2011 to Q4 2023.

1.1 Foreign Exchange Market Volatility (Forex)

Following methodologies by Wu and Wang (2019), Wu and Huang (2016), and He and Zhang (2016), foreign exchange market volatility is measured using the daily RMB/USD central parity rate, which serves as an appropriate indicator due to its policy relevance and its dominant role in facilitating China's international trade. This rate is a key benchmark for China's foreign exchange market, reflecting both market-driven currency valuations and the influence of monetary policy interventions by the People's Bank of China (PBOC). Guo et al. (2021) measure foreign exchange market volatility as the standard deviation of daily log returns of the RMB/USD central parity rate—a widely adopted approach (Liu, 2022). This study follows this standard practice, calculating quarterly volatility by first deriving daily log returns and then computing the standard deviation over each quarter, adjusted by the square root of the number of trading days, where D denotes the number of trading days per quarter.

1.2 Agricultural Exports (Agrex)

Agricultural export data are sourced from the Monthly Statistical Report on China's Agricultural Imports and Exports, published by the Ministry of Commerce. Seasonal adjustments are applied using the Census X-12 method in EViews 13 to eliminate seasonal fluctuations in the data. The study computes logarithmic returns to measure export volatility, ensuring consistency with volatility analysis methods. However, for clarity, the "Agrex" variable entering the TVP-SV-VAR model represents the level of seasonally adjusted agricultural exports rather than a volatility measure. The computed export volatility metric serves as a preliminary analysis tool and is not directly used in the main model. If agricultural export volatility were to enter the model, a detailed explanation of its derivation, such as using the standard deviation of monthly log returns within each quarter, would be explicitly provided.

1.3 Agricultural Loan Market Volatility (Loan)

Drawing on the methodology of Luo and Hu (2023), this study proxies agricultural loan market volatility using quarterly agricultural loan balances. Loan balance data are seasonally adjusted using the Census X-12 method to account for recurring seasonal patterns. Following Jin et al. (2024), rolling-window volatility is estimated using a 3-quarter window width. Logarithmic returns of seasonally adjusted loan balances are first calculated, and volatility is derived using the rolling-window approach. The choice of a 3-quarter window width reflects the medium-term cyclical nature of agricultural financing and the typical reporting frequency of agricultural loan data. This choice balances the need to capture meaningful fluctuations while minimizing noise, ensuring the resulting volatility series accurately reflects underlying market dynamics.

2. Empirical method

Amid ongoing reforms and developments in China's foreign exchange market, agricultural loan markets exhibit dynamic changes over time. Traditional Vector Autoregression (VAR) models fail to capture such time-varying effects and volatility clustering phenomena. To address these limitations, this study adopts a Time-Varying Parameter Stochastic Volatility Vector Autoregression (TVP-SV-VAR) model, which integrates time-varying coefficients and stochastic volatility to dynamically analyze the relationship between foreign exchange market volatility and agricultural loan markets. The TVP-SV-VAR framework not only captures evolving interdependencies among variables but also resolves heteroscedasticity issues, offering superior flexibility in identifying dynamic spillover effects (Lü et al., 2023).

The traditional VAR model can be specified as follows:

$$\boldsymbol{A y_t} = F_1 \boldsymbol{y_{t-1}} + \cdots + F_s \boldsymbol{y_{t-s}} + \boldsymbol{u_t} \quad t = s+1, \ \cdots, \ n \tag{1}$$

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Inequation (1), $\boldsymbol{y_t}$ is a k*1 vector; $\boldsymbol{A}, \boldsymbol{F_1}, \cdots, F_s$ are k*k coefficient matrices; $\boldsymbol{u_t}$ is a k*1 structural shock vector, where $\boldsymbol{u_t} \sim N(0, \sum)$; $\boldsymbol{A}$ is a lower triangular matrix that describes the synchronous structure between the variables.

downright, $\sum = \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_k \end{bmatrix}$, $A = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ a_{21} & 1 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ a_{k1} & a_{k2} & \cdots & 1 \end{bmatrix}$

Assuming $\boldsymbol{B_i} = A^{-1}F_i$ ($\boldsymbol{i} = 1, \cdots, s$), multiplying both sides of equation (1) by A^{-1}on the left, we obtain:

$$\boldsymbol{y_t} = B_1\boldsymbol{y_{t-1}} + \cdots + B_s\boldsymbol{y_{t-s}} + A^{-1}\sum \varepsilon_t \quad \varepsilon_t \sim N(0, I_k) \qquad (2)$$

In equation (2), I_k is the $k \times k$ identity matrix. Further, following Primiceri (2005), let $\boldsymbol{X_i} = I_k \otimes (\boldsymbol{y}'_{t-1}, \cdots, \boldsymbol{y}'_{t-s})$, where $\otimes$ denotes the Kronecker product. By stacking the row vectors of matrix $\boldsymbol{B_i}$ to form vector β, equation (2) can be transformed into:

$$\boldsymbol{y_t} = X_t\beta + A^{-1}\sum \varepsilon_t \qquad (3)$$

Incorporating time-varying factors, the TVP-SV-VAR model is:

$$\boldsymbol{y_t} = X_t\beta_t + A_t^{-1}\sum_t \varepsilon_t \quad \varepsilon_t \sim N(0, I_k), \ t = s+1, \cdots, n \qquad (4)$$

In equation (4), the parameters β_t, A_t and $\sum_t$ vary over time. Based on this, let α_t be the stacked vector of the lower triangular elements of matrix A_t, and $h_t = (h_{1t}, \cdots, h_{kt})^T$ represents the log-volatility matrix (SV), and for all $j = 1, \cdots, k$ and $t = s+1, \cdots, n$, $h_{jt} = \ln \sigma_{jt}^2$. In equation (4), all parameters follow a first-order random walk process:

$$\begin{aligned} \beta_{t+1} &= \beta_t + \mu_{\beta_t} \\ a_{t+1} &= a_t + \mu_{a_t}, \\ h_{t+1} &= h_t + \mu_{h_t} \end{aligned} \begin{pmatrix} \varepsilon_t \\ \mu_{\beta_t} \\ \mu_{a_t} \\ \mu_{h_t} \end{pmatrix} \sim N\left(0, \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \sum_\beta & 0 & 0 \\ 0 & 0 & \sum_a & 0 \\ 0 & 0 & 0 & \sum_h \end{pmatrix}\right)$$

Where $\beta_{t+1} \sim N(\mu_{\beta 0}, \sum_{\beta 0})$, $a_{t+1} \sim N(\mu_{a0}, \sum_{a0})$, and $h_{t+1} \sim N(\mu_{h0}, \sum_{h0})$.

The assumption of stochastic volatility in structural shocks introduces parameter complexity, complicating maximum likelihood estimation. To overcome this, we follow Nakajima (2011) and employ Bayesian inference with Markov Chain Monte Carlo (MCMC) methods. This approach iteratively samples from the posterior distribution of parameters, ensuring robust estimation through systematic stochastic simulations.

The lag length s for the VAR model is determined through information criteria such as the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC) from a preliminary stable VAR estimation. This is a standard reporting practice in VAR-based studies.

This study constructs a three-variable TVP-SV-VAR model with variables ordered as Forex, Agrex, and Loan. This ordering aligns with the theoretical premise that foreign exchange shocks propagate through agricultural exports before affecting loan markets, ensuring coherent identification of transmission mechanisms. Given the ongoing reforms in China's exchange rate mechanism and changes in agricultural support policies, the strength and speed of transmission effects may vary over the sample period. These policy adjustments and market reforms are expected to introduce time-varying parameters, making the TVP-SV-VAR framework particularly pertinent for capturing the dynamic nature of these relationships.

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Results

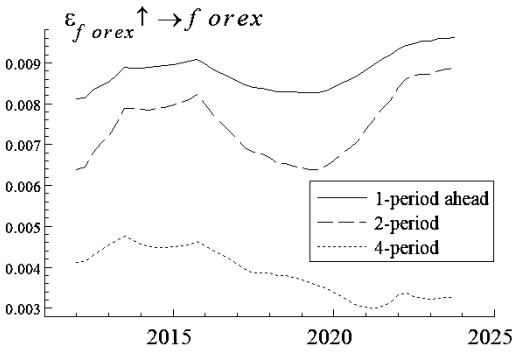

Figure 2 Impulse Response of Foreign Exchange Market Volatility to Its Own Shocks at Equal Intervals
Source: Authors' compilation.

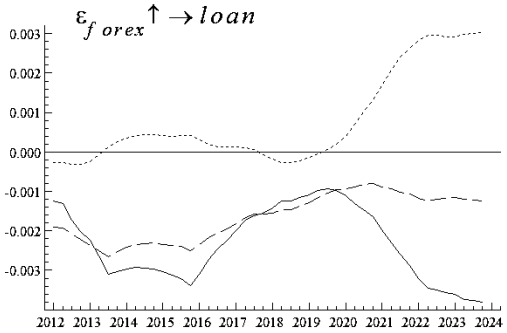

Figure 3 Impulse Response of Agricultural Loan Market Volatility to Foreign Exchange Market Volatility Shocks at Equal Intervals
Source: Authors' compilation.

Figure 2 reveals that the short-term (one quarter), medium-term (six months), and long-term responses exhibit broadly consistent yet time-varying trends. Notably, the self-shock effects of Forex remain pronounced at higher levels in the short and medium terms but diminish significantly over the long term. This attenuation aligns with economic principles, suggesting that the self-reinforcing impact of Forex volatility weakens progressively over time.

Figure 3 demonstrates that the impulse effects of Forex volatility on agricultural loan market volatility are negative and time-varying in the short and medium terms. A plausible explanation lies in China's ongoing reforms to marketize its exchange rate formation mechanism, which have gradually fostered adaptive expectations among market participants regarding exchange rate fluctuations. Increased Forex volatility does not induce synchronous fluctuations in the agricultural loan market; instead, China's resilient financial policies and export-oriented interventions enhance the stability of agricultural lending. The time-varying impulse response analysis from 2011 to 2023 confirms that Forex volatility exerts predominantly negative effects on agricultural loan market volatility, partially validating research hypothesis H1. These findings highlight the effectiveness of China's policy frameworks in buffering external shocks while underscoring the need for adaptive long-term strategies to address systemic risk accumulation.

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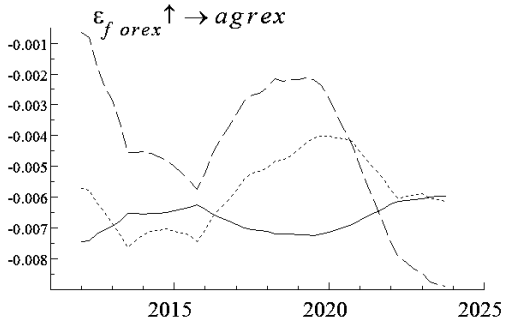

Figure 4 Impulse Response of Agricultural Exports to Foreign Exchange Market Volatility Shocks at Equal Intervals
Source: Authors' compilation.

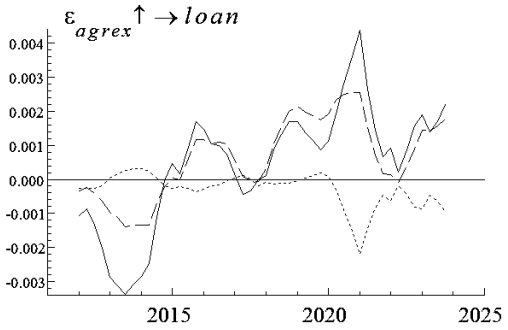

Figure 5 Impulse Response of Agricultural Loan Market Volatility to Agricultural Export Shocks at Equal Intervals
Source: Authors' compilation.

Figure 4 presents the impulse response functions of agricultural exports to foreign exchange market volatility shocks across different time horizons. All intervals exhibit negative responses, indicating that heightened Forex volatility suppresses agricultural exports. Integrated analysis of Figures 4 and 5 reveals that a one-standard-deviation shock in foreign exchange markets induces significant negative responses in agricultural exports across all lag intervals, with short-term effects being most pronounced. In contrast, agricultural exports exhibit primarily positive impulse effects on agricultural loan market volatility in the short- and medium-term, a phenomenon driven by policy initiatives such as the Belt and Road Initiative's emphasis on export-oriented agricultural trade. However, long-term effects reversed post-2020 due to structural adaptations in global supply chains and delayed impacts of pandemic-era stabilization policies. This duality—negative export responses to Forex shocks juxtaposed with positive loan market responses to export growth—confirms hypothesis H2, positioning agricultural exports as a critical transmission channel bridging Forex volatility and agricultural loan market dynamics. Notably, this mechanism intensified under post-pandemic disruptions, underscoring the interplay between external financial turbulence, policy-driven export strategies, and agrarian financial stability.

In VAR models, both variable selection and data handling procedures may significantly influence empirical outcomes (Qian et al., 2021). For the TVP-SV-VAR framework employed in this study, robustness was rigorously assessed through two methodological adjustments: (1) lag order adjustment (Zhang et al., 2022; Wang et al., 2023) and (2) variable reordering (Song & Zhang, 2023; Gu & Wang, 2023). To test robustness, we re-estimate the model using a lag order of 1 (optimal under SBIC). MCMC simulations show stable parameter estimates, with no significant changes in the impact of foreign exchange market volatility on agricultural loan market volatility, confirming result robustness. Reordering variables as $\boldsymbol{y_t} = (Loan_{\mathbf{t}},\ Agrex_{\mathbf{t}},\ Forex_{\mathbf{t}})$, the results demonstrate that notwithstanding divergent directional responses in the short-term impulse effects from foreign exchange markets to agricultural exports (Forex→Agrex) and the medium-term (6-month) effects from Forex to agricultural loan markets (Forex→Loan) post-2020, the time-varying impacts observed throughout the sample period and the mediating role of agricultural exports as a transmission channel align closely with the baseline model's predictions. Overall, the core findings demonstrate resilience to variable ordering changes, underscoring the robustness of the conclusions.

Discussion

The empirical findings provide nuanced insights into the hypothesized relationships. For Hypothesis H1, which posits a time-varying and predominantly positive impact of foreign exchange market volatility on agricultural loan market volatility, the results reveal a contrasting pattern: while the effects are indeed

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time-varying, they are negative in the short to medium term. This deviation from conventional theories, such as monetary transmission and financial fragility frameworks, highlights the need to contextualize these theories within China's unique economic and policy environment during the observed period. Conventional frameworks suggest that exchange rate volatility heightens financial instability by increasing uncertainty and risk perceptions. However, China's policy resilience appears to mitigate these impacts. Targeted interventions, such as agricultural credit guarantees, directly reduce the perceived risk in the agricultural loan sector by ensuring loan repayment even during periods of market turbulence. Similarly, export stabilization measures, such as subsidies or tax incentives, cushion the agricultural sector from exchange rate volatility by preserving export revenues, which indirectly stabilizes the loan market.

The findings also diverge from the study by Baghestany and Sherafatmand (2019), which identified positive spillovers from exchange rate shocks to agricultural investment. A more detailed comparison reveals that the divergent results may stem from differences in economic structures, policy environments, and periods studied. For instance, Baghestany and Sherafatmand's analysis focused on agricultural investment in a context with limited policy buffers, whereas China's highly interventionist approach, including extensive state support for rural credit, likely dampened the transmission of foreign exchange volatility to agricultural loan markets. Additionally, the long-term transition to positive spillovers post-2019 observed in this study aligns with theories of cumulative risk and the gradual erosion of policy effectiveness under prolonged stress. As systemic risks accumulate and external shocks persist, the capacity of policy interventions to fully shield the loan market diminishes, leading to eventual positive spillovers from foreign exchange volatility.

For Hypothesis H2, the findings robustly support the mediating role of agricultural exports (Agrex). The results demonstrate that foreign exchange market volatility suppresses agricultural exports through exchange rate uncertainty (negative Forex→Agrex effects), while recovery in exports stimulates credit demand, driving agricultural loan market volatility upward (positive Agrex→Loan effects). This dual transmission mechanism was particularly pronounced during the COVID-19 pandemic, when global trade disruptions amplified the role of exports as a mediator. The People's Bank of China (PBOC) played a crucial role in mitigating these shocks through rapid monetary responses, including liquidity injections and targeted lending programs. These actions align with broader theories of central bank intervention during crises, particularly the lender-of-last-resort function, which aims to stabilize liquidity and maintain credit flows in critical economic sectors.

The interplay between market dynamics and institutional adaptability underscores the importance of a flexible policy environment in managing economic shocks. Existing literature on institutional quality and policy flexibility in emerging markets supports this observation, highlighting how the agility of domestic institutions can mitigate the adverse effects of external financial turbulence. Furthermore, the specific nature of China's agricultural exports, such as their reliance on particular destination markets and product types (e.g., grain, fruits, and vegetables), likely influences the effectiveness of these transmission mechanisms. For example, export diversification strategies could further stabilize the agricultural sector by reducing dependency on volatile markets.

The theoretical implications of these findings are significant. They suggest that robust policy frameworks, such as credit guarantees and export subsidies, are critical for minimizing the destabilizing effects of foreign exchange volatility in emerging economies. Policymakers in China and other countries with similar economic structures can draw lessons from these results to design targeted interventions that enhance the resilience of their agricultural and financial sectors. However, these findings also highlight the limitations of policy buffers under sustained stress, emphasizing the need for adaptive long-term strategies to address systemic risks.

Finally, while the study provides valuable insights, limitations remain. The reliance on a specific model framework, such as the TVP-SV-VAR, inherently depends on the accuracy of data and assumptions regarding variable relationships. Future research could explore alternative modeling approaches, incorporate additional variables such as capital controls or global commodity prices, or examine cross-

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country comparisons to generalize these findings further. By addressing these limitations, subsequent studies could deepen the understanding of foreign exchange volatility's impact on credit markets, particularly in emerging economies.

Conclusion

This study employs the TVP-SV-VAR model to investigate the dynamic relationship between foreign exchange market volatility and agricultural loan market volatility, with agricultural exports as a mediating channel. The results reveal that Forex exerts significant time-varying effects on Loan, predominantly negative in the short term (3 months) and medium term (6 months). This counterintuitive finding aligns with theories on exchange rate pass-through and uncertainty, where short-term exchange rate volatility may suppress credit market fluctuations by reducing investment activity or stabilizing loan demand as firms delay credit-intensive decisions under uncertain conditions. The resilience of China's financial system further highlights the effectiveness of proactive policy interventions, such as export stabilization measures and targeted agricultural credit guarantees, in mitigating external shocks. These measures address information asymmetries in credit markets by reducing perceived risks, ensuring loan repayment, and maintaining credit flows. In the long term (1 year), however, the effects transition to positive spillovers post-2019, reflecting the erosion of policy effectiveness and the accumulation of systemic risks. This observation is consistent with theories on the diminishing returns of macroeconomic controls and the adaptive responses of markets to prolonged volatility.

Agricultural exports play a dual role as both a shock absorber and a transmitter. Forex volatility suppresses exports due to exchange rate uncertainty (negative Forex→Agrex responses), a finding consistent with broader literature on the vulnerability of export-oriented sectors to currency fluctuations. Export recovery, in turn, stimulates credit demand, driving Loan volatility upward (positive Agrex→Loan effects). This mediation intensified during the COVID-19 pandemic, when global trade disruptions amplified the role of agricultural exports in bridging foreign exchange and credit markets. The rapid policy responses by the Chinese government—including liquidity injections and export subsidies—stabilized agricultural finance during this period, aligning with theories of government intervention in markets. These interventions not only mitigated the immediate shocks but also addressed structural vulnerabilities by stabilizing export revenues and reducing uncertainty in credit markets.

Event-specific analyses further reveal distinct transmission mechanisms. For instance, geopolitical shocks such as the Russia-Ukraine conflict initially suppressed Loan volatility as heightened risk aversion reduced credit activity. However, as supply chain adjustments unfolded, these shocks later amplified fluctuations in the loan market. Similarly, exchange rate reforms exhibited phased adaptations, where market responses aligned with evolving expectations, consistent with theories of market adaptation and expectation formation in foreign exchange markets. These observations underscore the importance of understanding how systemic shocks interact with market dynamics to produce distinct temporal effects.

The findings also contribute to a deeper understanding of the interplay between foreign exchange market management and agricultural finance. Proactive interventions, such as credit guarantees and export subsidies, demonstrate how governments can address information asymmetry in credit markets and stabilize agricultural loan markets amidst external shocks. By ensuring liquidity and reducing perceived risks, these measures mitigate the adverse effects of foreign exchange volatility while supporting broader economic stability. The transition to long-term positive spillovers suggests that while policy interventions are effective in the short run, their efficacy may diminish over time as systemic risks accumulate, necessitating adaptive strategies for sustained resilience.

The study's findings have clear policy implications. For emerging economies with significant exposure to foreign exchange volatility, the Chinese example highlights the importance of targeted interventions to stabilize credit markets and support export-oriented sectors. Theoretical perspectives on government intervention provide a strong rationale for such actions, emphasizing the role of institutional quality and policy flexibility in managing economic shocks. Future research could explore similar mechanisms in other emerging markets or examine the role of specific export products and destination markets in shaping the observed dynamics. These insights not only extend the academic discourse but also offer practical guidance for policymakers seeking to balance financial stability with economic growth in volatile global markets.

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Recommendation

To address the time-varying and policy-sensitive nature of volatility transmission, a multi-pronged strategy is essential. First, dynamic risk management frameworks should be institutionalized to monitor foreign exchange fluctuations and deploy contingency measures during stress periods. These frameworks could leverage real-time monitoring of key indicators, such as exchange rate fluctuations, agricultural input costs, export revenues, and credit default rates, to identify vulnerabilities. Drawing on theories of information asymmetry in financial markets, these systems should aim to reduce uncertainty by improving the transparency of borrowers' financial health, particularly when foreign exchange fluctuations obscure the creditworthiness of agricultural borrowers. Adaptive monetary policies, such as targeted interest rate adjustments or sector-specific liquidity injections, could shield agricultural borrowers by ensuring credit accessibility during periods of heightened uncertainty. Literature on the sectoral effects of monetary policy suggests that these tools can be effective in stabilizing agricultural credit markets, which are often more sensitive to financial shocks due to their reliance on predictable trade and financing conditions.

Strengthening early warning systems and regulatory oversight is critical for preemptively addressing risks. By integrating theories of financial contagion and systemic risk, these systems could focus on preventing localized foreign exchange shocks from destabilizing the broader agricultural credit system. For example, regulatory tools such as stress testing, countercyclical capital buffers, and macroprudential supervision could be adapted to China's institutional environment to contain spillovers. Drawing on international best practices, such as Basel III guidelines, these measures could be tailored to account for the unique challenges of managing agricultural finance within an emerging market context.

Enhancing agricultural export resilience is another vital component. Export diversification should be prioritized as a risk mitigation strategy, aligning with portfolio theory, which posits that diversifying markets reduces overall risk exposure. Initiatives like the Belt and Road can be leveraged to reduce regional demand dependency and expand trade partnerships. Academic discussions on the Belt and Road Initiative highlight its potential to enhance trade connectivity while spreading exchange rate risks across a broader set of markets. Financial instruments such as export credit guarantees and tax rebates should be optimized to counteract volatility originating from foreign exchange markets. For instance, export credit guarantees could be designed with flexible payout structures tied to exchange rate thresholds, ensuring that exporters remain protected during periods of significant currency fluctuations. Studies on the effectiveness of such instruments suggest that targeted design improvements can significantly enhance their capacity to stabilize export revenues.

Finally, embedding crisis-response mechanisms within agricultural finance systems is essential for ensuring rapid adaptation during systemic shocks. Lessons from past episodes of financial stress in China and other emerging markets could inform the development of these mechanisms. For example, incorporating policy uncertainty indices into risk models could help financial institutions anticipate and mitigate the impact of sudden policy shifts on agricultural loans. These indices could be used to adjust lending criteria dynamically or to trigger preventive measures such as temporary loan guarantees or interest rate caps. Stress-testing methodologies tailored to the agricultural sector should include scenarios of foreign exchange volatility, geopolitical shocks, and trade disruptions, ensuring that financial institutions are prepared for a wide range of contingencies. By integrating these strategies, China can build a more resilient agricultural finance system capable of withstanding external shocks while maintaining credit stability.

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