

A Study on the Triple Linkage Mechanism of the Short-Term Money Market Based on VAR Model

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Abstract: Against the backdrop of China's multi-tiered money market integration and more precise monetary policy regulation, understanding the short-term interest rate transmission mechanism is crucial for policy effectiveness and cross-market risk prevention. Using daily data from January 2018 to January 2026, this paper selects three core rates—the offshore RMB market, the exchange-traded pledged repo market, and the onshore interbank market—to construct a Vector Autoregression (VAR) model, systematically investigating their price transmission and linkage mechanisms. The findings reveal that: first, the exchange-traded repo rate occupies a central position in the transmission network, exhibiting significant unidirectional Granger causality with both offshore and onshore interbank rates. Second, shock transmission is markedly asymmetric; the spillover effect of the exchange-traded repo rate is significant, while shocks to interbank rates remain largely self-contained. Third, the three rates are coordinated in the long run but display differentiated responses during volatility, with the onshore interbank rate demonstrating greater stability. Fourth, the system possesses the capacity to absorb and converge from shocks, indicating good internal stability. This paper provides empirical evidence and policy insights for understanding China's short-term interest rate system, improving monetary policy transmission, and coordinating internal and external market linkages.

Keywords: Interest Rate Linkage; VAR Model; Overnight Interbank Rate; GC001; Offshore RMB Market; Monetary Policy Transmission

1. Introduction

Against the current macroeconomic backdrop of

deepening financial reform and accelerating RMB internationalization in China, the money market, as the core hub for monetary policy transmission, has seen the linkage mechanism among its various sub-markets become a critical factor influencing fund allocation efficiency and financial stability. With the continuous advancement of connectivity between the exchange-traded repo market, the interbank lending market, and the offshore RMB market, the funding rates of these three markets—GC001, SHIBOR, and CNH HIBOR—exhibit dynamic characteristics of being both independent and highly correlated. An in-depth understanding of the transmission paths, shock response patterns, and internal synergy mechanisms among these three rates not only helps clarify the operational logic of China's multi-tiered money market but also provides crucial theoretical support and a practical basis for improving monetary policy regulation and preventing cross-market risk contagion. Based on this, using daily data from January 1, 2018, to January 28, 2026, this paper constructs a Vector Autoregression model to systematically examine the dynamic transmission relationships among these three core short-term interest rates, aiming to provide empirical references for understanding the operational mechanism of China's short-term interest rate system and optimizing the monetary policy transmission path.

2. Literature Review

In recent years, the dynamic characteristics, influencing factors, and inter-market linkages of short-term money market rates have been a focal point of scholarly attention both domestically and internationally. Existing research primarily revolves around the benchmark nature, volatility, and interactions of interbank offered rates with domestic and foreign markets, extensively employing various time series models for empirical analysis.

Regarding the characteristics and modeling of interest rate volatility, the academic community has widely recognized that the SHIBOR series exhibits typical financial time series features. Tan Xiaoyu employed the CKLS-EGARCH model to model SHIBOR volatility and compared the fitting effects under different distribution assumptions, discovering that the model under the Generalized Error Distribution (GED) assumption achieved the best fit, thereby providing a methodological reference for characterizing the asymmetry of interest rate volatility [1]. Wang Dongyong's research further confirmed the existence of significant ARCH effects and leverage effects in the SHIBOR overnight rate, demonstrating that ARMA-GARCH family models can effectively capture the clustering and asymmetry of interest rate volatility, with negative news typically triggering greater volatility than positive news [2]. In characterizing the long-memory features of interest rates, Sun Xiaoxia and Wang Bing improved the classical CIR model based on fractional Brownian motion and constructed a fractional CIR model to more accurately describe the persistent dependence characteristics of interest rate series. To address the failure of traditional estimation methods caused by the non-Markovian nature of this model, they introduced and validated the feasibility of the indirect inference estimation method, empirically demonstrating that the fractional CIR model outperforms traditional models in fitting China's interbank offered rate data [3]. Cao and Liu, approaching from the perspective of monetary policy tools, empirically studied the regulatory effects of China's interest rate corridor system on short-term interest rate fluctuations based on the EGARCH-M model, offering a new perspective for understanding the impact of policy interventions on interest rate volatility [4].

In the realm of interest rate influencing factors and predictive modeling, scholars have explored the driving mechanisms of SHIBOR from multiple angles and attempted to construct forecasting models. Kong Mengqi and Xu Jingyi employed the entropy method to screen key influencing factors including money supply, exchange rates, the US Dollar Libor, and the statutory reserve requirement ratio, and constructed a BP neural network model optimized by particle swarm algorithm (PSO-BPNN) to forecast SHIBOR, finding that its

prediction accuracy significantly surpassed that of the traditional BPNN model [5]. Liu, Xie, and Wang, while investigating the volatility relationship between the Beijing Stock Exchange and the ChiNext Board, adopted the ARIMAX model and confirmed that introducing exogenous variables can effectively enhance model predictive capability, providing a methodological reference for studying multi-market volatility linkages [6]. In research on monetary policy transmission mechanisms, Lü et al. conducted an empirical analysis of China's monetary policy interest rate transmission mechanism and its transmission efficiency based on the TVP-SV-VAR model, revealing the time-varying characteristics of interest rate transmission [7]. Liu et al. further employed the TVP-FA-S-VAR model to conduct a time-varying comparative study on the effectiveness of price-based and quantity-based monetary policy tools, discovering significant differences in the relative efficacy of the two types of tools across different stages [8]. Zhang and Chen, focusing on the context of bond market opening, utilized the TVP-SV-VAR model to explore the dynamic relationships among bond market opening, monetary policy, and systemic financial risks, providing empirical evidence for understanding risk evolution during financial market opening [9].

Regarding SHIBOR quotation behavior and market microstructure, some studies have revealed potential imitation and manipulation behaviors within the quotation formation mechanism. Li Hong Kong, based on quotation data from 2017 to 2021, employed LASSO regression to analyze the imitation relationships among SHIBOR quoting banks, discovering significant leader-follower patterns in quotations among certain banks, and finding that banks' asset structures (such as the proportion of funds deposited with other banks) were significantly correlated with their roles in the imitation network [10]. Such studies deepen the understanding of SHIBOR quotation quality and the formation mechanism of benchmark interest rates from a micro-level perspective.

In terms of the linkage between domestic and foreign RMB interest rates, with the advancement of RMB internationalization, the interaction between offshore and onshore markets has become a research priority. Li Hui, Zhang Chi, and Liu Jing, based on Granger causality tests and the VAR-GARCH-BEKK

model, empirically analyzed the mean and volatility spillover effects between SHIBOR and the Hong Kong CNH HIBOR. The study found that with the opening of capital markets, the linear guiding role of the onshore market over the offshore market strengthened, and significant bidirectional volatility spillover effects existed between them, particularly more pronounced in medium- and long-term tenors [11]. This research provides important evidence for understanding cross-border capital flows and policy transmission. Furthermore, using RMB's inclusion in the SDR as a time demarcation, other studies have tested the linkage mechanism between SHIBOR and CNH HIBOR using nonlinear Granger causality tests and the MGARCH-BEKK model. The results indicated that mean spillover effects were insignificant in the short term, manifested as unidirectional spillover from onshore to offshore in the medium term, while the one-year tenor exhibited bidirectional mean spillover; in terms of volatility, significant volatility spillover effects existed across all tenors, with the intensity strengthening as the tenor lengthened [12]. Shao et al., based on the TVP-SV-VAR model, empirically tested the spillover effects of offshore financial market risks during RMB internationalization, discovering significant time-varying characteristics in the spillover from offshore market risks to the onshore market [13]. Zhang et al. studied the international transmission effects of China's monetary policy from a more macro perspective, revealing the spillover paths of monetary policy shocks to foreign markets through interest rate channels [14]. Zhong et al. systematically examined the spillover effects among the onshore and offshore RMB exchange rate markets and the RMB HIBOR market, finding complex interactive relationships among the three, with the offshore market exhibiting significant price discovery functions vis-à-vis the onshore market during specific periods [15]. Shieh, in their doctoral dissertation, systematically studied multi-dimensional issues of China's monetary policy, providing theoretical support for understanding the overall evolution of the monetary policy framework [16]. Wang Shiyu systematically assessed the efficiency of interest rate transmission among China's financial markets, discovering significant asymmetry and time-lag characteristics in transmission across different markets [17]. Mo Funing, against the backdrop

of deepening interest rate marketization reform, conducted in-depth research on the overall framework of China's interest rate transmission mechanism, revealing the dynamic evolution of transmission efficiency throughout the reform process [18].

In summary, existing literature has conducted relatively rich research on the volatility characteristics, influencing factors, forecasting methods, and domestic-foreign linkages of SHIBOR, achieving positive progress in areas such as GARCH family models, machine learning forecasting, micro-level quotation behavior, and cross-border spillover effects. However, current research predominantly focuses on SHIBOR itself or the binary relationship between SHIBOR and CNH HIBOR. Comprehensive investigations into the real-time linkages and dynamic transmission mechanisms among the three core rates—the onshore interbank market (SHIBOR), the exchange repo market (GC001), and the offshore RMB market (CNH HIBOR)—remain relatively scarce. This paper, based on the VAR model, simultaneously incorporates these three core short-term interest rates from the onshore interbank market, the exchange repo market, and the offshore RMB market to systematically explore their intrinsic interrelationships and price transmission paths, aiming to fill the gap in existing research concerning multi-market linkage analysis.

3. Characterization Analysis of Money Market Rates

3.1 Money Market Overview and Core Interest Rate Composition

The money market is a market for short-term fund financing with maturities within one year. It undertakes the core functions of meeting the liquidity needs of market entities and adjusting fund surpluses and shortages, while also serving as a crucial platform for the central bank to implement monetary policy. Its interest rate changes sensitively reflect fund supply and demand, liquidity expectations, and policy guidance, making it a key indicator for observing financial market operations and the efficiency of monetary policy transmission.

China's money market has formed a multi-tiered structure with the interbank market at its core, the exchange-traded market as a supplement, and the offshore market becoming increasingly

active. Different markets have derived differentiated representative interest rates. SHIBOR overnight (SHB) is the arithmetic average of RMB interbank offered rates voluntarily quoted by a panel of highly creditworthy banks. It reflects the unsecured borrowing costs of the banking system and serves as an intermediate target for monetary policy transmission. Its fluctuations are relatively gentle and stable, directly influenced by policy tools such as central bank open market operations and reserve requirement ratios. GC001 (GC) is the 1-day pledged treasury bond repo rate on the Shanghai Stock Exchange. Collateralized by highly liquid treasury bonds, its participants mainly include non-bank financial institutions such as securities companies and fund companies. It is highly sensitive to changes in fund supply and demand in the exchange market and can rapidly reflect the liquidity conditions of non-bank institutions, leverage trading sentiment, and periodic fund tightness around quarter- and year-ends. CNH HIBOR (CHB) is the offshore RMB Hong Kong interbank offered rate published by the Treasury Markets Association of Hong Kong. It reflects the cost of RMB fund borrowing in the offshore market. Its pricing is not only influenced by the supply and demand for offshore RMB but also deeply embedded with multiple external factors, including cross-border capital flows, RMB exchange rate expectations, international market risk appetite, and geopolitical events. As a key link connecting the onshore and offshore financial markets, its fluctuations often foreshadow changes in cross-arbitrage activities and capital flows during the process of RMB internationalization.

This paper selects the three rates—CHB, GC, and SHB—based on the following considerations: First, representativeness. They are anchored in the offshore, exchange, and interbank markets respectively, comprehensively covering the core levels of the short-term interest rate system. Second, linkage. With the deepening of financial market connectivity, cross-market fund flows make the correlation among these three increasingly close. Third, differentiated responses. Their reaction speeds and magnitudes to liquidity shocks, policy changes, and external environments differ significantly, providing ideal material for exploring the asymmetry of price transmission and market stratification characteristics.

Incorporating these three into a unified analytical framework helps systematically reveal the price transmission paths and internal linkage mechanisms within China's multi-tiered money market.

3.2 Formation Mechanism and Pricing Logic of Money Market Rates

From the perspective of fund pricing attributes, CHB primarily reflects offshore RMB liquidity conditions and is influenced by offshore RMB supply, cross-border capital flows, exchange rate expectations, and international financial market sentiment. GC, as a secured repo rate in the exchange market, directly represents the short-term funding costs for non-bank institutions and fund products, reacting sensitively to market liquidity tightness and institutional leverage behavior. SHB is the benchmark for unsecured interbank lending, mainly reflecting the liquidity situation within the banking system and is directly affected by the central bank's monetary policy operations.

Although the three belong to different markets, cross-market arbitrage, inter-market institutional financing, and the transmission of policy signals, against the backdrop of deepening financial openness and connectivity, cause these three rates to exhibit a dynamic relationship characterized by both synergy and divergence. Clarifying their respective formation logics and linkage mechanisms forms the basis for subsequent analysis of their price transmission and substitution relationships.

3.3 Trends in Money Market Rates

To further explore the periodic change characteristics of money market rates, this paper collects data on the CNH HIBOR closing price (CHB), the Shanghai Stock Exchange New Pledged Treasury Bond Repo Average: GC001 closing price (GC), and the SHIBOR overnight data (SHB) from January 2018 to January 2026 (see Figure 1). Overall, the trend of the three rates can be roughly divided into four stages.

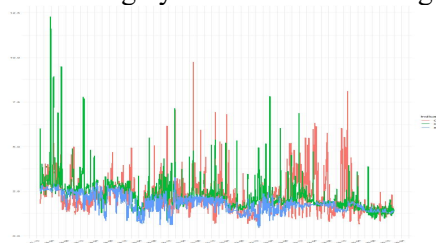


Figure 1. Trend Chart of CHB, GC, and SHB Rates

Stage 1: January 2018 to August 2019. During this period, CHB and GC fluctuated narrowly at relatively low levels, with stable and convergent trends, reflecting a macro environment of ample overall market liquidity and stable expectations. SHB maintained an even lower and more stable operational trend, demonstrating the strong anchoring characteristics of the onshore policy rate. Although moving in the same direction, CHB, as an offshore market rate, exhibited slight differences in fluctuation rhythm and magnitude compared to onshore GC and SHB, indicating price formation characteristics that are both linked and relatively independent across markets.

Stage 2: August 2019 to December 2020. Affected by changes in the internal and external environment, market rate volatility increased significantly. CHB and GC experienced two rapid surges during this period, with peaks reaching 9.8 and 9.5 at the end of 2019 and mid-2020 respectively, reflecting the sensitive reaction of offshore and exchange markets to liquidity shocks. SHB also rose but with a significantly moderated amplitude, highlighting its buffering role in the onshore market. The fluctuation amplitudes of the three diverged significantly during this stage, indicating differences in the shock absorption and response mechanisms of different markets.

Stage 3: January 2021 to August 2022. This stage was marked by CHB's rapid surge to 10.0 in April 2021, with GC also climbing to 9.5, setting the highest points in the observation period. Subsequently, both fell rapidly, forming secondary peaks in the first half of 2022. SHB continued to fluctuate within a relatively narrow range during this period, not following the dramatic upswings of the former two, further highlighting differences in pricing logic and reaction depth among markets. After mid-2022, all three entered a downward convergence channel.

Stage 4: September 2022 to December 2025. Entering this stage, all three exhibited distinct cyclical fluctuation characteristics, with narrowing fluctuation ranges and stabilizing centers. CHB and GC showed regular

bidirectional fluctuations within the 2.5-6.5 range, with highly synchronized trends. SHB continued to operate stably within a narrower range, maintaining its stability as a core policy rate. The degree of synergy among the three increased again, reflecting that after the macro environment and policy expectations stabilized, the interest rate system re-entered a new phase of orderly linkage and bidirectional adjustment.

Through the above stage analysis, it can be seen that CHB, GC, and SHB exhibit long-term synergistic trends but also show significant differences in fluctuation amplitude, reaction speed, and trend reversals under different market environments. To more precisely characterize their mutual guiding relationships and shock transmission mechanisms, a VAR model will be established for empirical testing in the following section.

4. Empirical Analysis of Short-Term Interest Rate Linkage Mechanism Based on a VAR Model

4.1 Data Sources and Acquisition

This paper selects daily data on the CNH HIBOR closing price, the Shanghai Stock Exchange New Pledged Treasury Bond Repo Average: GC001 closing price, and SHIBOR overnight from January 2018 to January 2026. To ensure data homogeneity and reliability, all data are daily frequencies. The CHB data originates from the Hong Kong interbank market, the GC data from the Shanghai Stock Exchange, and the SHB data from the Datayes website.

4.2 Descriptive Statistical Analysis

Table 1 shows that in the original series, the means of CHB and GC are close, but the kurtosis of GC is much higher than that of CHB and SHB, indicating more extreme fluctuations in GC. SHB has the smallest standard deviation, exhibiting the most stable trend. After first differencing, the means of all series revert to zero, and standard deviations decrease, satisfying the stationarity requirement.

Table 1. Descriptive Statistical Analysis Results

Variable	CHB	GC	SHB	CHB (1st Diff)	GC (1st Diff)	SHB (1st Diff)
Sample Size	1897	1897	1897	1896	1896	1896
Minimum	0.65	0.85	0.44	-6.51	-9.39	-0.97
Maximum	9.74	12.29	3.28	5.91	7.04	1.52
Mean	2.23	2.27	1.81	0.00	0.00	0.00

Median	2.06	2.08	1.77	0.01	0.00	0.00
Std. Error of Mean	0.02	0.02	0.01	0.02	0.01	0.00
Variance	0.91	0.76	0.24	0.45	0.36	0.04
Standard Deviation	0.95	0.87	0.49	0.67	0.60	0.20
Skewness	1.69	3.50	0.15	-0.62	-1.60	1.05
Kurtosis	5.40	22.68	-0.56	17.49	56.49	7.95

4.3 Stationarity Test

This paper employs the Augmented Dickey-Fuller (ADF) test for unit roots on the original series. See Table 2, the unit root test results for the three series CHB, GC, and SHB show: the ADF test statistic for CHB is -7.31, with a corresponding p-value of 0.01 (< 0.05), rejecting the null hypothesis of a unit root. The ADF statistic for GC is -8.60 ($p=0.01$), also rejecting the null. The ADF statistic for SHB is -6.40

($p=0.01$), likewise rejecting the null hypothesis of a unit root. These results indicate that the three price series, CHB, GC, and SHB, are stationary time series at their original levels, meeting the stationarity requirements for subsequent modeling without needing differencing. To ensure robustness, further tests like PP and KPSS could be considered, but based on the current ADF results, all three possess the data foundation for VAR model analysis.

Table 2. ADF Unit Root Test Results for CHB, GC, SHB

Series	Variable	ADF Statistic	Lag Order	p-value	Stationary
Original Series	CHB	-7.31	12	0.01	Yes
	GC	-8.60	12	0.01	Yes
	SHB	-6.40	12	0.01	Yes
First-Differenced Series	D(CHB)	-17.36	12	0.01	Yes
	D(GC)	-19.93	12	0.01	Yes
	D(SHB)	-17.36	12	0.01	Yes

The test results show that the original series of the three interest rate variables all reject the null hypothesis of a unit root at the 1% significance level, indicating that the original series already meet stationarity requirements. To ensure modeling robustness, the first-differenced series were further tested, and the results also significantly reject the null hypothesis, meaning all differenced series are stationary. Overall, the three series are suitable for subsequent VAR model construction and causal inference analysis.

comprehensive judgment using the AIC, SC, HQ, and FPE criteria, the SC criterion consistently suggested a lag order of 3 under different deterministic trend specifications.

See Figure 2, based on the chart data, combined with the ADF test results after first differencing, the series exhibit clear stationarity characteristics.

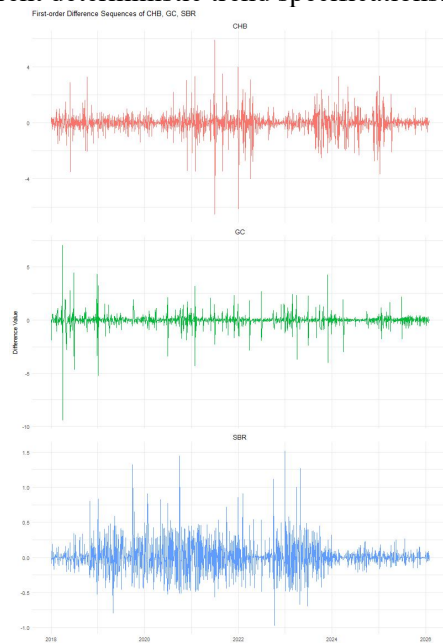


Figure 2. First-Difference Model Diagram for CHB, GC, SHB

All observed values fluctuate stably around zero, with no apparent trend or structural breaks. The graphical features are highly consistent with the statistical conclusion from the ADF tests that all three differenced series significantly reject the unit root hypothesis, jointly verifying that the data satisfy stationarity conditions and can serve as a reliable foundation for building the VAR model.

Table 3. Lag Order Selection Criteria Results

4.4 Parameter Estimation

Criterion	AIC	HQ	SC	FPE
Suggested Lag	10	6	3	10

A larger lag order in a VAR model reduces degrees of freedom. See Table 3, based on a

To ensure the model adequately reflects the

dynamic relationships among variables while avoiding excessive parameterization that could cost degrees of freedom, this study determines the optimal lag period as 3 and establishes a

VAR(3) model without an intercept term. Parameter estimation was performed using R language, with results shown in Table 4, Table 5 and Table 6.

Table 4. Parameter Estimation Results for the CHB Equation in the VAR (3) Model

Equation	Variable	Coefficient Estimate	Std. Error	t-value	p-value	Significance
CHB	CHB.11	-0.27	0.02	-11.54	< 0.001	***
	GC.11	0.11	0.03	4.17	< 0.001	***
	SHB.11	0.06	0.08	0.78	0.4379	
	CHB.12	-0.21	0.02	-8.88	< 0.001	***
	GC.12	0.06	0.03	2.18	0.0295	*
	SHB.12	0.03	0.08	0.39	0.6949	
	CHB.13	-0.13	0.02	-5.83	< 0.001	***
	GC.13	-0.04	0.03	-1.40	0.1632	
	SHB.13	0.10	0.08	1.24	0.2162	

Table 5. Parameter Estimation Results for the GC Equation in the VAR (3) Model

Equation	Variable	Coefficient Estimate	Std. Error	t-value	p-value	Significance
GC	CHB.11	0.04	0.02	1.98	0.0480	*
	GC.11	-0.21	0.02	-8.96	< 0.001	***
	SHB.11	-0.08	0.07	-1.07	0.2843	
	CHB.12	0.01	0.02	0.46	0.6496	
	GC.12	-0.10	0.02	-4.26	< 0.001	***
	SHB.12	-0.11	0.07	-1.60	0.1097	
	CHB.13	0.01	0.02	0.41	0.6842	
	GC.13	-0.13	0.02	-5.61	< 0.001	***
	SHB.13	-0.12	0.07	-1.73	0.0830	.

Table 6. Parameter Estimation Results for the SHB Equation in the VAR (3) Model

Equation	Variable	Coefficient Estimate	Std. Error	t-value	p-value	Significance
SHB	CHB.11	0.00	0.01	-0.61	0.5440	
	GC.11	0.05	0.01	6.57	< 0.001	***
	SHB.11	-0.07	0.02	-2.84	0.0045	**
	CHB.12	0.00	0.01	-0.30	0.7633	
	GC.12	0.03	0.01	3.69	0.0002	***
	SHB.12	-0.17	0.02	-7.65	< 0.001	***
	CHB.13	0.00	0.01	-0.70	0.4818	
	GC.13	0.00	0.01	0.11	0.9097	
	SHB.13	-0.13	0.02	-5.72	< 0.001	***

(*Note: Significance codes: *** p < 0.001, ** p < 0.01, * p < 0.05, p < 0.1. Model does not include a constant term (type = "none"). Overall p-value for each equation is < 0.001.*)

From the parameter estimation results, it can be seen that the lagged terms of each variable exhibit differentiated influence patterns and significance across different equations. In the CHB equation, its own lags 1 to 3 all have significant negative effects on the current value, while lags 1 and 2 of GC show significant positive effects. In the GC equation, its own lagged terms all show significant negative effects, and the lag 1 of CHB has a significant positive effect on GC. In the SHB equation, its own lagged terms all have significant negative effects, while lags 1 and 2 of GC have significant positive effects on SHB. The overall model fit is good, and all equations pass the significance test, laying a reliable foundation for subsequent causal inference and shock response analysis.

4.5 Granger Causality Test

To deeply explore the leading relationships among the three financial market interest rate variables CHB, GC, and SHB, this paper conducts a multivariate Granger causality test based on the VAR(3) model. The test employs a residual-based F-test and uses 500 bootstrap simulations to enhance result robustness. The test results are summarized in Table 7.

Table 7. Granger Causality Test Results (Based on VAR (3) Model)

Null Hypothesis	F-statistic	p-value	Conclusion(5% significance)
CHB does not Granger-cause GC & SHB	0.82	0.646	Do not reject
GC does not Granger-cause CHB & SHB	11.04	< 0.01	Reject
SHB does not Granger-cause CHB & GC	1.35	0.420	Do not reject

From Table 7, at the 5% significance level, GC

is a Granger cause of CHB and SHB, while the reverse causality (CHB or SHB as a cause of GC) does not hold. This indicates that within the selected sample period, there is a unidirectional Granger causality relationship from GC to CHB and SHB among the three short-term interest rate variables.

This result reveals potential transmission characteristics within China's financial market short-term interest rate system. GC, as a key barometer for short-term funding costs in the exchange market, has a significant leading role over the two major benchmark rates in the interbank market—CHB and SHB. This unidirectional leading relationship may stem from: First, GC, being a repo rate backed by highly liquid treasury bonds, reacts more sensitively and directly to market liquidity tightness and institutional short-term funding needs. Second, with the deepening of financial market connectivity, cross-market arbitrage activities enable price signals from the exchange market to transmit rapidly to the interbank market. Third, fluctuations in GC often reflect the funding conditions of non-bank financial institutions earlier, and the activities of these institutions are also important factors influencing the entire interbank market funding chain and pricing sentiment. Conversely, CHB and SHB do not exhibit significant predictive power over GC, suggesting that the short-term impact of interbank benchmark rates on exchange repo rates might be relatively lagged or dominated by other more complex factors.

Furthermore, the test also revealed significant instantaneous causality (indicated by the extremely low p-value in the "Instant" test part), suggesting that the three rates react almost synchronously to common market shocks, further confirming that they are within the same highly correlated financial system.

4.6 Impulse Response Analysis

To deeply characterize the dynamic transmission mechanism and shock persistence among the three interest rate variables CHB, GC, and SHB, this study conducts impulse response analysis based on the established VAR(3) model. By imposing a one-standard-deviation positive shock to each variable respectively, it simulates the path and intensity of how a disturbance in a single funding price diffuses through the entire short-term interest rate system. The systematic response functions are shown in Figure 3 and

Figure 4.

From the impulse response results, asymmetric transmission patterns and differentiated dynamic trajectories can be clearly identified:

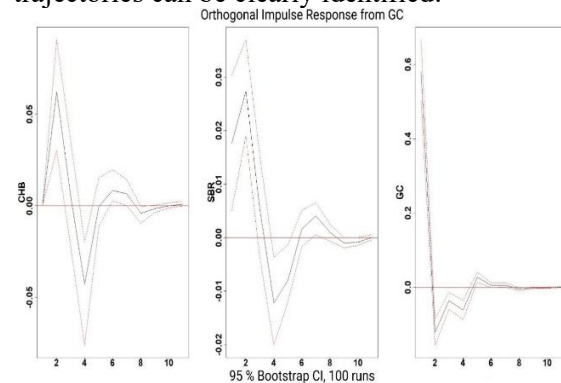


Figure 3. GC Impulse Response Analysis Chart

When GC is the source of the shock, its transmission effect is most significant. After a one-standard-deviation positive shock to GC, its own response shows a strong positive autocorrelation, jumping in the current period, peaking around period 2, then monotonically decaying and converging to zero after period 8. Simultaneously, this shock rapidly spills over to the interbank market: it generates a sustained positive impact on CHB, with the response value peaking in period 2 and then slowly decaying; it also positively impacts SHB, but with a smaller magnitude and faster convergence speed. No directional reversal occurs throughout the process, indicating that an increase in GC stably drives CHB and SHB in the same direction.

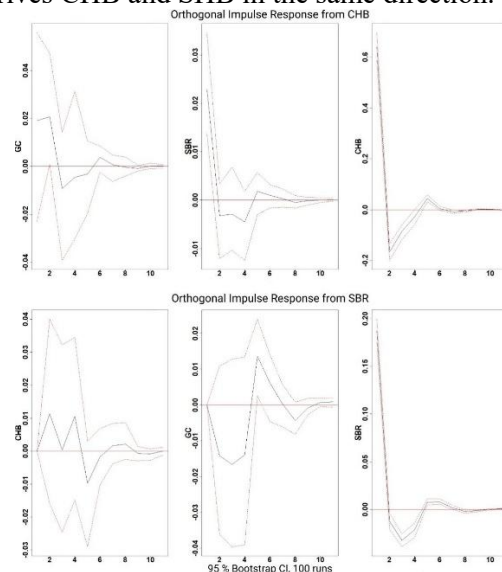


Figure 4. Combined CHB and SHB Impulse Response Analysis Chart

When CHB or SHB is the source of the shock, their spillover effects are very limited. When

CHB is shocked, its own response decays quickly after minor short-term fluctuations. The transmission paths of this shock to GC and SHB hover around zero, with negligible response magnitudes and no statistical significance. Similarly, SHB's own shock response also decays rapidly, but its impulse response curves for CHB and GC remain near zero throughout the forecast period, showing no economically meaningful cross-market transmission capacity. Regarding the overall characteristics of system dynamics, all impulse response functions converge to zero within a limited forecast period (about 8-10 periods), satisfying the condition for VAR system stability. The response paths generally exhibit a smooth unimodal "shock-peak-decay" shape, without long-term oscillation or divergence. This indicates that China's short-term interest rate system possesses a strong capacity to absorb and stabilize internal shocks. After a shock, the market primarily re-equilibrates through continuous, gradual adjustments, rather than through drastic overshooting and corrections, reflecting a certain market depth and inherent stability.

Synthesizing the impulse response analysis, it is evident that within the short-term interest rate network composed of CHB, GC, and SHB, there is a significant unidirectional and asymmetric transmission characteristic. GC is not only a Granger cause of the system but also dynamically plays the role of a "volatility radiation center," whose shocks generate sustained and significant spillover effects. In contrast, shocks to CHB and SHB are mainly confined to themselves, forming a "receiver-feedback" market position. This clear dynamic evidence fully aligns with the static conclusions from the Granger causality test, jointly revealing a short-term interest rate linkage paradigm led by the exchange-traded repo rate (GC), with interbank rates (CHB, SHB) adjusting accordingly.

4.7 Model Test

To test the parameter stability of the VAR (3) model, this paper employs the CUSUM test based on recursive least squares. This method repeatedly estimates the model using expanding data subsets and calculates the cumulative sum of standardized residuals to monitor whether the model parameters undergo structural changes during the sample period. The CUSUM test results are shown in the Figure 5.

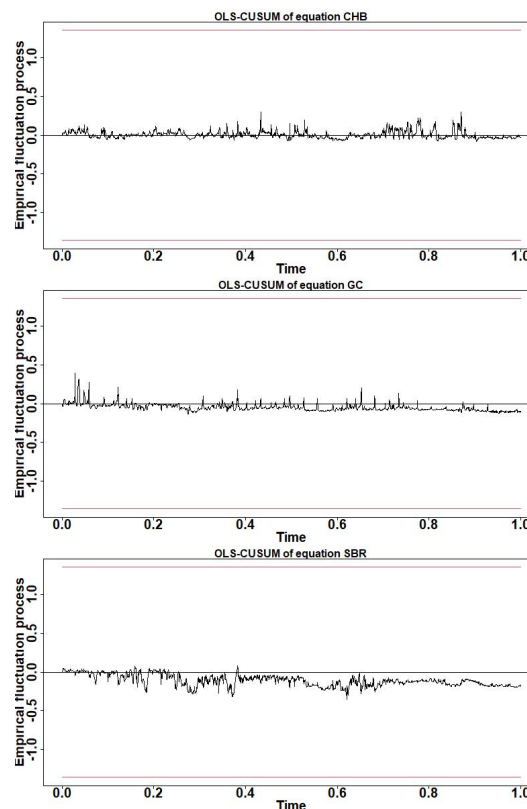


Figure 5. CUSUM Stability Test Chart for CHB, GC, SHB Coefficients

The test results show that the cumulative sum sequences of standardized residuals for the three equations (CHB, GC, SHB) fluctuate smoothly within the 5% significance level critical boundaries throughout the entire sample interval, never touching or crossing the boundaries.

This result econometrically indicates that the parameter structure of the model remained stable during the sample period, with no parameter drift caused by structural breaks or regime shifts. This stability characteristic provides an important empirical foundation for this study: on one hand, it supports the reliability of the previous Granger causality test and impulse response analysis conclusions; on the other hand, it implies that the estimated dynamic relationships among variables have good in-sample robustness, enhancing the reference value of the relevant conclusions under similar market environments.

5. Conclusions and Implications

5.1 Main Conclusions

Based on daily data from January 2018 to January 2026, this paper constructs a VAR model to systematically empirically analyze the linkage relationships and dynamic transmission

mechanisms among three core short-term interest rates: the offshore RMB market (represented by CHB), the exchange-traded repo market (represented by GC), and the onshore interbank market (represented by SHB). The study draws the following main conclusions:

GC (exchange-traded repo rate) holds a core position in the price transmission network of the short-term interest rate system, exerting a significant unidirectional leading effect on the other two market rates. Granger causality test results indicate that GC is a Granger cause of CHB and SHB, while the reverse causality does not hold. This suggests that in China's multi-tiered money market, the GC rate, backed by highly liquid treasury bonds and primarily reflecting the funding needs of non-bank institutions, plays the role of a "bellwether" and "leader" in price discovery and short-term volatility transmission.

The transmission of shocks among the three rates exhibits significant asymmetry and convergence. Impulse response analysis further validates and refines the above causality: when GC experiences a one-standard-deviation positive shock, it rapidly and continuously generates significant positive spillover effects on CHB and SHB, with the response path smoothly decaying and eventually converging to zero. Conversely, shocks to CHB or SHB are mainly confined to their own markets, with very weak cross-market transmission capacity to the other two markets. All response functions converge within a finite period, indicating that China's short-term interest rate system as a whole possesses inherent stability and effective shock absorption capacity.

Different market rates exhibit phased differences and co-evolutionary characteristics in their responses to the macro environment and liquidity shocks. Through the phased trend analysis of CHB, GC, and SHB, it is found that the three rates are coordinated in the long run. However, during periods of heightened market volatility (e.g., 2019-2020), the offshore market (CHB) and the exchange market (GC) react more sensitively and dramatically, while the onshore interbank benchmark rate (SHB) demonstrates stronger stability and a buffering effect. As the market environment stabilizes, the degree of synergy among the three increases again, reflecting the dynamic adjustment process of the interest rate system from differentiation to reintegration.

The linkage between offshore and onshore markets is primarily characterized by volatility spillovers and is influenced by the process of financial opening. Combining the literature review and empirical results, it is evident that there are significant bidirectional volatility spillover effects between CHB and SHB, especially more pronounced in longer tenors, reflecting the impact of cross-border capital flows and sentiment contagion. However, the empirical analysis focusing on overnight tenors in this paper shows that, in the short-term dimension, the transmission of price signals mainly manifests as a unidirectional mean guidance from the onshore exchange market (GC) to the offshore market (CHB) and the interbank market (SHB), revealing differences in linkage mechanisms across different maturities and channels.

5.2 Policy Implications

Based on the above conclusions, to better improve China's monetary policy transmission mechanism, promote the coordinated and healthy development of the multi-tiered money market, and maintain financial stability, the following policy implications are proposed:

Firstly, great importance should be attached to the monitoring and guidance of the exchange-traded repo rate (GC), using it as a key indicator for observing market liquidity sentiment. Given GC's significant role in price discovery and transmission leadership within the short-term interest rate system, monetary authorities and market regulators should strengthen real-time monitoring and analysis of GC rate fluctuations and their causes. In liquidity management operations, more attention should be paid to the non-bank institutional liquidity conditions reflected by GC, enabling more precise prediction and regulation of overall market funding liquidity fluctuations and enhancing the foresight of macro-prudential management. Simultaneously, efforts should be made to clear the transmission channels of price signals among various sub-markets of the money market, promoting the formation of a more unified and efficient benchmark yield curve. The asymmetric transmission revealed empirically (strong transmission from GC to CHB/SHB, weak in reverse) partly reflects the existence of certain segmentation or transmission frictions between markets. Continued deepening of financial infrastructure connectivity should be

pursued, encouraging cross-market compliant arbitrage activities to smooth price differentials. At the same time, optimizing the quotation formation mechanism of benchmarks like SHIBOR to enhance their market representativeness and transmission efficiency will promote smoother, bidirectional price linkages among onshore sub-markets and the offshore market.

Secondly, macro-prudential management tools addressing cross-border capital flows need to be improved to mitigate the spillover risk of offshore market volatility on the onshore market. Although short-term transmission is dominated by GC, fluctuations in the offshore market (CHB) can still affect onshore market expectations through medium-to-long-term channels or sentiment channels. Efforts should continue to improve the monitoring and early warning system for cross-border capital flows, enrich counter-cyclical adjustment tools, and strengthen policy coordination between onshore and offshore regulators. While promoting RMB internationalization and financial market opening, the stability of the onshore monetary and financial environment must be effectively maintained.

Finally, information disclosure and expectation management should be strengthened to enhance monetary policy transparency and stabilize market expectations. The high degree of correlation among the three rates and the leading role of GC imply that market expectations regarding policy intentions and future liquidity conditions are quickly reflected and transmitted in prices. The central bank should further enhance the regularity and transparency of its monetary policy operations, strengthen forward guidance, and effectively guide and stabilize market expectations. This will help reduce excessive short-term interest rate volatility and disorderly transmission caused by expectation confusion, fostering a stable financing rate environment for the real economy.

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