Effectiveness and Functional Orientation of Monetary Policy Intermediate Targets: Evidence from China

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Abstract

China has gradually relinquished the special status of Aggregating Financing to the Real Economy (AFRE) launched in 2011 and changed functional orientation of monetary policy intermediate targets to matching nominal output growth since 2019. Using macro data in recent two decades, this paper constructs a SVAR model identified by imposing sign and zero restrictions based on directed acyclic graph and examines the effectiveness of three targets. Empirical results prove that M2 invariably maintains the advantages, while AFRE and interest rate are prominent in function. Interestingly, we find distinct impulse responses of AFRE and M2, mainly explained by shadow banking activities to a monetary policy shock. Furthermore, we also confirm that a short-run expansionary shock strengthens the matching effect of the two indicators, whilst a certain weakening effect in the long run. Considering China's interest rate liberalization process, the effectiveness of arranging the matching effect at real and nominal output has improved. Our paper documents comparative merits of three indicators, also providing powerful support for intermediate target transformation and orientation adjustment for China.

JEL Classification: E51, E52, E58, E61

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1 Introduction

In the wake of the international financial crisis, China launched the 4-trillion policy to stimulate the economy, and at the same time, the shadow banking business of commercial banks expanded rapidly, which greatly enriched financing channels of enterprises while evading financial regulations. In order to learn from lessons of the crisis — backwardness that financial statistics is insufficient to reflect financial changes, to comprehensively account for the growing financial innovations (including financial products and institutions, etc.), and to strengthen macro-prudential management, the People's Bank of China (PBC, China's central bank) introduced the indicator of aggregate financing to the real economy (AFRE, hereafter) for the first time in 2011.

The aggregate financing to the real economy, also known as "total social financing", is officially defined as the total amount of funds received by real sector in the economy (i.e., nonfinancial corporations and households) from the financial system (i.e., financial institutions and markets) over a certain period.[1] Since the creation of the indicator, the Chinese government has always emphasized to "maintain a reasonable growth in the scale of AFRE" and even set targets for its growth rate in relation to M2 in 2016 (both around 13%) and 2017 (both around 12%). As a result, AFRE has risen from a monitoring indicator of monetary policy to an intermediate target with a status comparable to M2. However, starting in 2019, the Chinese government has scrapped its original growth plans for both M2 and AFRE and adjusted them to "keep the growth rates of M2 and AFRE basically in line with the nominal economic growth." The PBC emphasized that this target transformation and repositioning is "a scientific and prudent acting point of the counter-cyclical adjustment of monetary policy, which not only takes into account economic growth, but helps to maintain price stability."[2] In this regard, at least during the economic downturn, China's monetary policy intermediate target function will not rely on the expected growth target, but on growth matching target.[3]

It can be seen that Chinese government is gradually casting away the special status of AFRE as an intermediate target and blurring the target's functional orientation. Is this blurring in the targeting scheme a deliberate avoidance because AFRE is no longer effective, or an intention for other reasons? If deliberate, is it reasonable and effective to adjust the expected growth target to a growth matching target? Could it fulfil the function of an intermediate target? Or just a lip service from the top policymakers in

[1] We recommend readers to Sheng & Xie (2016), Sheng et al. (2016) and Z. He & Wei (2023) for a comprehensive understanding of AFRE. Sheng & Xie (2016) marked the first academic paper on AFRE in Chinese top journal, successfully endorsing the practical effectiveness of the indicator. It should be recalled that Songcheng Sheng, the former director of Statistics and Analysis Department of the PBC, took the lead in launching and developing AFRE during his tenure, to the extent that this has become a globally unique macro-financial indicator with very Chinese characteristics.

[2] Source: *China's Monetary Policy Implementation Report (2019Q4)*

[3] In particular, this matching target was explicitly reaffirmed in the Outline of the 14th Five-Year Plan for Economic and Social Development and Long-Range Objectives through the Year 2035 of the People's Republic of China, adopted by the fourth session of the 13th National People's Congress, which serves as a policy guideline for a longer run. In the recent 2023 Central Economic Working Conference, the price level expected target was incorporated into the original matching effect. Source: https://www.gov.cn/yaowen/liebiao/202312/content_6919834.htm

Beijing? To our best knowledge, no studies have yet been conducted to discuss these problems, which concern evaluation of the effectiveness of China's existing intermediate targets of monetary policy and particularly the functional orientation transformation, but precisely the focus of this paper.

In general, the effectiveness of monetary policy and the realization of its final targets depend on the effectiveness of monetary policy transmission. The transmission mechanism of monetary policy, also named *black box*, refers to the dynamic transmission process of monetary policy to the real economy. The monetary authority, through the direct operation of monetary policy instruments, causes the response of the operational and intermediate targets accordingly, so as to realize the final targets (the real economy targets) through various channels, in which an intermediate target is a bridge linking the monetary policy and the real economy.

Literature Review The assessment of intermediate targets is based on three criteria: measurability, controllability, and relevance (Belongia & Batten, 1992; Sheng et al., 2016). The latter two depend on the transmission of monetary policy, i.e., controllability concerns whether monetary policy can be effectively transmitted to the financial system, and relevance concerns whether the real economy could provide effective feedback to the financial variables.[4] Since the PBC performed the functions of central banking in 1984, the intermediate target of monetary policy has been adjusted twice, with the original loan size and cash issuance abandoned in 1998, and the intermediate target status of money supply (M1 and M2) established. However, due to the influence of multiple factors at home and abroad, there is no uniform conclusion on the assessment of intermediate targets in the academic for the time being. Before the international financial crisis, academics generally supported the status of M1. Y. Jiang et al. (2005) based on the stability of impact on final targets including prices and output, argued that M1 is more suitable as an intermediate target than M2, with RMB lending the worst. Geng & Hui (2009) found that since the 1980s the controllability and relevance of M1 in China was superior to that of M2, suggesting that the former should be an intermediate target, while the latter being a monitoring target. With the advancement of interest rate liberalization, China has constructed a relatively complete market-based interest rate system (Yi, 2021), and the transmission of monetary policy to market interest rates has become increasingly effective (D. He & Wang, 2012; Fu & Ho, 2022), with studies supporting the rule of interest rates and the status of interest rates as an operational or intermediate target (Laurens & Maino, 2007; X. Li & Wang, 2020),[5] and declaring limitations of M1 as an intermediate target (Liu & Zhang, 2010). Typically, the measurability and controllability of M1 and M2 have been ineffective due to financial innovation and others (Estrella & Mishkin, 1997), so the Federal Reserve has shifted its intermediate target to the federal funds rate. Compared to nominal interest rates, however, some studies still support the output effects of quantitative indicators or rules represented by M2 in China (K. Chen et al., 2016; B. Li & Liu, 2017).

[4] Measurability refers to the structure and amount of the target variable measurable and counted with precision, which is not our concern in the paper.

[5] Svensson (1997) points out that as long as the intermediate target of monetary policy satisfies the criteria and is rationally formulated by the monetary authority, then the monetary policy rule and the intermediate target are consistent.

According to the substitutability between money and financial assets, monetary policy transmission can be broadly classified into money channel and credit channel. Sheng (2013) and Sheng & Xie (2016) pointed out that due to the shortcomings of the Money View and its incompatibility with China's current situation, the Credit View would be a good supplement to it, and at the same time, the expansion of credit indicators from the asset side of the financial system was the theoretical basis for the birth of AFRE, which is influenced by the New View. As China maintains a special financial system dominated by commercial banks, the credit channel has been important (Pan & Tao, 2006; H. Li et al., 2021) and its effectiveness has been investigated in different perspectives, such as role of state-owned enterprises (H. Chen et al., 2019) and bank heterogeneity (Bashir et al., 2020), BigTech banking (Huang et al., 2022), interbank wholesale funding markets (K. Chen et al., 2022), interbank behaviors (H. Jiang et al., 2023). Recently, Breitenlechner & Nuutilainen (2023) investigated the credit supply and demand two major dynamics of monetary policy transmission in loan markets based on a factor-augmented VAR model (FAVAR) with zero and sign restriction identification using Chinese macro data from 2004M10 to 2016M6. Their results confirmed that the credit channel was an important channel for market-based policy instruments. In fact, before the international financial crisis, the PBC paid much attention to the use of RMB loans and M2, forming a binary transmission mechanism of "two intermediate and two detective targets", with the former targeting the real economy and the latter the financial markets (Sheng & Wu, 2008). Sheng & Xie (2016) referred to the New Keynesian paradigm and constructed a structural vector autoregressive model (SVAR) using macro monthly data from 2002 to 2014, which was identified by the short-run zero restrictions under the economic assumptions. It was found that the effectiveness of AFRE was better than that of RMB loans, highly consistent with broad money supply, and could be used as a new intermediate or detective target. Therefore, the innovation and improvement of AFRE, together with M2, would constitute a "new partner" of the binary transmission mechanism (Sheng & Xie, 2016), which has been supported in many studies (Yuan & Liu, 2013; Zhou et al., 2013).

Despite considerable international research on the credit channel and domestic academics on AFRE as an intermediate target, global understanding of AFRE is still limited, especially lack of understanding of the PBC and its policy adjustments. With the deepening of interest rate liberalization, effectiveness of the intermediate target of monetary policy in China deserves further exploration, especially the adjustment of the status of AFRE and transformation of the intermediate target. Although Sheng & Xie (2016) considered the impact of interest rate liberalization, the interest rate as an intermediate target neglected, and deficiencies in the model identification methodology led to the construction of multiple models to analyze the controllability and relevance of intermediate targets, and more importantly, the potential *price puzzle* would be overlooked.[6]

In view of this, our paper contributes to providing a novel identification method to overcome the *price puzzle* under a unified modelling framework by simply replacing different financial variables in the benchmark model to assess effectiveness of different intermediate targets. Furthermore, based on the results of the impulse responses, we

[6]We validate this point using an identification method of DAG-based short-run zero restrictions and the *price puzzle* holds in the results, see A.3.

formulate and confirm the conjecture and uncover more findings on the policy adjustments of the PBC. Our goal is to shed some light on China's *black box* and share our understanding of PBC's monetary policy.[7] This paper serves a new introduction and reasonable interpretation to the issue mentioned at the very beginning. Our results provide robust empirical evidence for target transformation and orientation adjustment of PBC's monetary policy.

This paper constructs a SVAR model identified by imposing sign and zero restriction based on directed acyclic graphs (DAGs) and using China's macro data from 2003M1 to 2022M12. In our DAG-VAR-SR model, there are four endogenous variables, i.e., (1) monetary policy, (2) monetary policy intermediate targets including interest rate, M2 and AFRE respectively, (3) output, (4) price level. Then, we examine our conjecture using spread scissors between AFRE and M2 in time-varying parameter VAR (TVP-VAR) model incorporating interest rate as well as in time-varying Granger causality (TVGC) test.

The main findings are as follows. Traditional quantitative target M2 still maintains the advantages, while AFRE and interest rate are prominent in function. Interestingly, we find that a distinct impulse response of AFRE and M2 to a contractionary monetary policy shock (we call it as an *opposite mirroring effect*) that is contrary to results by Sheng & Xie (2016), leaving the other findings consistent with previous studies. Furthermore, we also confirm that a short-run expansionary monetary policy would strengthen the matching effect between AFRE and M2, whilst to some extent, weakening in the long run, namely, asymmetry of the *opposite mirroring effect*. Considering China's interest rate liberalization process, the effectiveness of arranging the matching effect at real output target has improved, even more significant at nominal output.

The remainder of the paper is organized as follows. Section 2 describes empirical methodologies. Section 3 provides data, by which we introduce identifying restriction in Section 4. Empirical results from DAG-VAR-SR are reported in Section 5, as well as comparison to those by DAG-SVAR and VAR-SR and further discussion. We examine robustness in Section 6. Section 7 concludes. Additional exhibitions and introduction of TVGC are described in the final appendix.

2 Empirical Methodology

In this section, we describe empirical methodology measuring effectiveness of monetary policy intermediate targets and time-variated scissors. The first subsection introduces principles of SVAR modelling and sign restriction, along with zero restriction from DAG method. The advantage of DAG-VAR-SR is to combine theoretical assumptions and data-determined method. In the second subsection, a time-varying parameter VAR model is used to testify important findings including an *opposite mirroring effect* between AFRE and M2.

[7] "As China has the features of both a large transition economy and an emerging market economy, China's central bank and its monetary policy are yet to be well understood by the outside world." Spoke by Xiaochuan Zhou, former governor of the PBC, at IMF Central Banking Lecture, Washington D.C., June 24, 2016.

2.1 DAG-VAR-SR

Due to the traditional VAR model's failure to consider contemporaneous relationships between variables, a structural vector autoregressive model (SVAR) is used to enhance it by incorporating the contemporaneous relationship matrix (structural matrix) (Sims, 1986; Blanchard & Watson, 1986; Blanchard & Quah, 1989).

Generally, a SVAR model lagged p incorporating k internal variables could be written as,

$$\Gamma_0 y_t = \delta + \sum_{i=1}^{p} B_i y_{t-i} + e_t \tag{1}$$

where Γ_0 denotes contemporaneous relation matrix, $\{y_t\}_{t=1}^{T}$ is a column vector of k dimensions, δ is an intercept vector, $B_i\,(i = 1, \cdots, p)$ are coefficient matrices needed estimation, and $\{e_t\}$ is a random disturbance sequence (also called as structural shock vector, or innovations) following white noise: $e_t \sim \left(0, \Sigma_k \Sigma_k^{'}\right)$.

To transform SVAR into reduced-form, it is simplified by multiplying an invertible matrix Γ_0^{-1} in the left hand,

$$y_t = c + \sum_{i=1}^{p} \phi_i y_{t-i} + u_t \tag{2}$$

where $c = \Gamma_0^{-1}\delta$, $u_t = \Gamma_0^{-1} e_t$, $\phi_i = \Gamma_0^{-1} B_i\,(i = 1, \cdots, p)$. Since $\{e_t\}$ follows a white noise, $\{u_t\}$ as a name of reduced shock vector, has zero means, constant variances/covariances, and little autocorrelation: $u_t \sim (0, \Omega)$. It is easy to estimate all the parameters by OLS through the reduced-form, imposing extra $k\,(k-1)\,/2$ restrictions to contemporaneous coefficient matrix at least. As a rule, an AB-form is restricted to innovations once $Ae_t = Bu_t$ is satisfied, where A corresponds to Γ_0^{-1} above and B denotes by identity matrix, from which restrictions are imposed to these invertible matrices.

To compute accurate impulse response functions (IRFs) and forecast error variance decomposition (FEVD), it is vital to estimate parameters precisely. Traditionally, identification involves using Cholesky factorization, assuming the structural matrix A as a lower triangular matrix with main diagonal elements equal to 1. That is, for any real symmetric matrix Ω, there exists such a matrix Γ_0^{-1} and the diagonal matrix G whose unique main diagonal is positive, that holds $\Omega = \Gamma_0^{-1} G \left(\Gamma_0^{-1}\right)'$. Simultaneously construct $e_t = \Gamma_0 u_t$, which satisfies $\Omega = \Gamma_0^{-1}\Sigma_k\Sigma_k^{'}\left(\Gamma_0^{-1}\right)' = PP'$, the lower triangular matrix $P = \Gamma_0^{-1}\Sigma_k$ as a Cholesky factor.

Nevertheless, this assumption can significantly deviate from the characterization of contemporaneous relationships. One commonly used and modified approach is to manually impose short-run zero restrictions on structural matrices according to economic theory (Blanchard & Watson, 1986). These restrictions imply that some certain variables do not respond to contemporaneous shocks from others. For example, current disturbances in financial variables typically do not cause changes in real economic variables directly and instantaneously (i.e., policy hysteresis), while contemporaneous impacts between financial variables are more common. Hence, prior subjectivity

stemming from it is inevitable. Increasingly, an innovative method of directed acyclic graph (DAG) is proposed to overcome drawbacks mentioned (Swanson & Granger, 1997; Spirtes et al., 2000; Bessler & Lee, 2002).

To ensure "data talks" as much as possible, by calculating (conditional) correlation coefficients between the residuals of variables, DAG can identify their contemporaneous causal relationships. There are four circumstances to reflect causal links between every two variables: (1)"X→Y" represents unilateral causality of X to Y; (2) "X↔Y" represents bilateral causality between X and Y; (3) "X—Y" represents ambiguous causality between X and Y; (4) X and Y is not cause and effect if no links display. As a data-determined approach, it offers reference to identify the structural relationships of SVAR disturbances in a relatively objective way. However, it leads to over-identification easily when zero restrictions are far beyond $k\left(k-1\right)/2$. To examine reliability and validity of identifying, Sims's likelihood ratio (Sims, 1986) is used to test restrictive connection between disturbance and its orthogonalization. It is introduced to test whether elements estimated of matrix A are all zero significantly, whose statistics follows Chi-square distribution as follows,

$$2\left[\log\left(\det\left(\Sigma_k\Sigma_k'\right)\right)-\log\left(\det\left(I_k\right)\right)\right]\times T\sim\chi^2\left(k\left(k-1\right)/2-l\right)$$

where l is number of over-restrictions.

It is noteworthy that relying solely on data-determined constraints may not always align with economic theory and empirical knowledge. It may not accurately reflect the actual functioning of the economy and can even overlook or confuse contemporaneous causal relationships between variables. In addition to imposing zero constraints on the contemporaneous coefficient matrix, another accessible approach is to impose constraints on the parameters of IRFs, e.g., long-run zero restriction (Blanchard & Quah, 1989). Apart from that, the introduction of sign restrictions methods (SR), particularly, allows for a reasonable integration of constraints driven by economic theory or reliable empirical evidence with data-determined constraints.[8]

Specifically, pre-setting signs of confirmed impulse responses (IRs) can effectively avoid puzzles, e.g., *price puzzle* (Sims, 1992), while leaving rest shocks of interest with signs of unknown IRs unrestricted to let "data talks" as much as possible. Moreover, based on sign restrictions, the order of variables in SVAR does not affect the estimation results, making the empirical findings more robust. Therefore, we adopt a combination of sign restriction and zero restriction method by DAG, aiming to overcome the loss of economic interpretability caused by sole reliance on data-determined method. In the meanwhile, we attempt to compare IRs and FEVD results from these two methods solely (see A.3 and A.4).

Briefly, write Equation 2 in a compact form:

$$\begin{aligned} y_t &= c+\sum_{i=1}^{p}\phi_i y_{t-i}+e_t \\ &= \Pi x_t+e_t \end{aligned} \tag{3}$$

[8]For a critical view of sign restrictions, see Fry & Pagan (2011).

where $\Pi = (c, \phi_1, \cdots, \phi_k)_{k\times(kp+1)}$, $x_t = \left(1, y_{t-1}^{'}, \cdots, y_{t-p}^{'}\right)_{(kp+1)\times 1}^{'}$. Following Rubio-Ramirez et al. (2010) and Fry & Pagan (2011), implementing hybrid restriction identification method is to find the set of orthogonal matrices G, that the corresponding IRFs of $\left(\Pi, G' \times \Gamma_0^{-1}\right)$ satisfying the restrictions we set. To implement identification strategy, we apply algorithms of penalty-function approach by Uhlig (2005).

2.2 TVP-VAR-SV

Without loss of generality, Ω can be reduced by a lower triangular matrix Γ_0^{-1} as $\Gamma_0^{'}\Omega\Gamma_0^{'} = \Sigma_k\Sigma_k^{'}$, so Equation 2 can be rewritten as through factorization,

$$y_t = c + \sum_{i=1}^{p} \phi_i y_{t-i} + \Gamma_0^{-1}\Sigma_k\varepsilon_t,\ \varepsilon_t\ (0, I_k) \tag{4}$$

Stack the elements in the rows of the intercept and coefficient matrices, and denote X_t by $I_k \otimes \left(1, y_{t-1}^{'}, ..., y_{t-p}^{'}\right)$, where $\otimes$ is Kronecker product. Following Primiceri (2005), a vector autoregression model can be extended to one with time varying parameters and stochastic volatility (TVP-VAR-SV).

$$y_t = X_t\beta_t + \Gamma_t^{-1}\Sigma_t\varepsilon_t,\ \varepsilon_t\ (0, I_k) \tag{5}$$

Let κ_t be a stacked vector of elements in Γ_0^{-1} and denote h_{jt} by $\log\sigma_{jt}^2$, σ_{jt} as the elements in Σ_t. Parameters above are set by random-walk series as follows,

$$\begin{aligned} \beta_{t+1} &= \beta_t + \nu_t \\ \kappa_{t+1} &= \kappa_t + \zeta_t \\ h_{t+1} &= h_t + \eta_t \end{aligned} \qquad \begin{pmatrix} \varepsilon_t \\ \nu_t \\ \zeta_t \\ \eta_t \end{pmatrix} \sim N\left(0, \begin{pmatrix} I_k & 0 & 0 & 0 \\ 0 & V & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{pmatrix}\right)$$

As to estimation of parameters in TVP-VAR-SV, we use Markov Chain Monte Carlo (MCMC) method in the Bayesian inference framework and follow settings from Nakajima (2011): $(\Sigma_\beta)_i^{-2} \sim Gamma\,(40, 0.02)$, $(\Sigma_\kappa)_i^{-2}$, $(\Sigma_h)_i^{-2} \sim Gamma\,(4, 0.02)$.

Additionally, different from the identification in DAG-VAR-SR, traditional Cholesky factorization is applied in the model, rather than hybrid restriction. Recently, Cross & Nguyen (2017, 2018) provided a method that combines hybrid restrictions into TVP-VAR-SV and sign restrictions into VAR-SV to study time varying effects of international oil price shocks to China's macroeconomics. Whilst hybrid restrictions can be integrated into time-varying parameter VAR, but in our paper, we need to testify reliability of findings from DAG-VAR-SR without preliminary restrictions, along with showing the dynamics of IRs throughout the sample period. To this end, TVP-VAR-SV identified by Cholesky factorization is more befitting for choice.

Two points need to be reminded before next section. In the first place, we establish three different models to capture the process of monetary policy transmission under various channels where the same operational and final target variables are included, for sake of stripping interacted effects from other channels following Sheng & Xie (2016). That is to say, through three independent models with one different target variable

contained in each by the same method, either DAG-VAR-SR or TVP-VAR-SV, IRs to intermediate target shocks can be quantified and comparable with each other. Secondly, in addition to inference between intermediate targets, heterogeneity of one standard deviation shock from each series for time-varying setting should be taken into consideration. To acquire comparable IRFs at each time, we adopt a method from Nakajima (2011), by which the size of shocks is set equal to time-series average of stochastic volatility throughout the sample period.

3 Empirical Data

The key of SVAR model building is to portray the monetary policy transmission mechanism. To attain requirements of the mechanism, all relevant variables should be included, namely, operational tools, intermediate and final targets, which feature the two stages of transmission. At the first stage, monetary policy can be transmitted to financial system through operational tools. For the second one, the effect of monetary policy can be transmitted to the real economy essential to determining whether the channels are smooth or not.

For sake of brevity, we choose repo rate (r) as representative of the only operational target variable following Fu & Ho (2022) and K. Chen et al. (2022), regardless of quantitative methods like required reserve ratio or monetary base, etc. Meanwhile, according to the *Law of the People's Republic of China on the People's Bank of China*, China's final targets of monetary policy conclude currency stabilization and economic growth.[9] That is to say, besides repo rate (r), inflation rate (p) and economic growth rate (q) are required in the SVAR model. Alternative variables define to monetary policy intermediate targets (MPI), including monetary market rate, broad money supply, and AFRE, as a reflection of economic and financial environment through indicators from financial system. The benchmark model could be set as followed,

$$y_i = f\left[r,\ MPI_i,\ q,\ p\right]'$$

To reflect the economic and financial development of China in the past two decades, monthly frequency data is priorly selected from 2003M1 to 2022M12, with 240 observations overall. For the other, accessible data in the sample depends on AFRE, which only draws back to 2002M1.[10] Considering that GDP growth rate announced is limited to quarterly frequency, and potential information loss caused by interpolation method, so that industrial added value is used as a proxy variable of economic growth. Specifically, we select 7-day weighted average interest rate on interbank pledged bond repurchase (R007),[11] 7-day interbank offered rate (IBOR, i), and year-on-year growth rate[12]

[9] Currency stability encompasses domestic price stability as well as exchange rate stability of the domestic currency to foreign currencies. Our paper focuses on established or potential intermediate targets of China's monetary policy and neglects the exchange rate indicator or channel. See the statement by Gang Yi, former governor of the PBC at the State Council Information Office on 3 March 2023, available at https://www.gov.cn/xinwen/2023-03/03/content_5744366.htm

[10] We calculate monthly AFRE stock value from 2002M1 onwards according to official data, see Figure 12.

[11] Although DR007 (especially for depository financial institutions) is better suited as a variable for operational targets, its sample size is insufficient for modeling needs.

[12] To meet requirements of policy statements and practical analysis as far as possible, we quit using the first difference of logarithmic stock value to be a growth rate.

of CPI, industrial added valve, AFRE ($afre$) and M2 ($m2$).

Data Processing: (1) real year-on-year growth rate of industrial added value is obtained by eliminating price effects from producer price index (PPI) in which we choose 2002 as the basis year; (2) seasonal effects were eliminated for all variables by X-12 method; (3) all variables except $m2$ are stationary over the significance level of 5%; (4) there is a cointegration among variables by Johansen test, and the three VAR models are stable with lags of 3, 5 and 3 orders, respectively.

[Herein Insert Table 1]

4 Identification Strategy

In order to efficiently estimate SVAR model parameters, constraints need to be imposed on the structural shocks. Our idea is as follows: firstly, we impose hybrid constrictions for the IRFs of the SVAR models based on the contemporaneous causality identified by the DAGs, together with the economic theories and the sign directions identified in practice. In addition, to compare the differences of results under the hybrid restriction identification, we also estimate the DAG-SVAR models with only short-run zero restrictions, and the VAR-SR models with only sign restrictions, respectively (see A.3 and A.4).

4.1 Zero Restriction

In this paper the DAG method is used to determine whether there is a contemporaneous causal relationship between the variables and thus the directions of causal transmission by testing whether the conditional correlation coefficients are non-significantly zero by the Fisher's z statistic (Awokuse & Bessler, 2003). Based on the results determined by the DAGs, zero restrictions can be set in the IRFs.

Given that all variables meet the basic requirements for VAR modeling, we can directly utilize a five-variable VAR to generate the residuals each series, thereby generating the correlation matrix of them. Through PC-algorithm TETRAD II, we can compute (conditional) correlation coefficients between variables to determine the existence and directionality of their contemporaneous causal relationships. From Table 2, it is obvious that the two highest correlations exist between r and i, as well as between $m2$ and $afre$. The former is because these are both marketized interest rates in the monetary market as a benchmark to reflect the tightness of macro funding. Besides, interest rate transmission between them is quite smooth, resulting in a strong interconnection. The latter is because both $m2$ and $afre$ belong to the assets and liabilities sides of financial companies' survey,[13] exhibiting "two sides of one coin" (Sheng & Xie, 2016).

[Herein Insert Table 2]

[13]To be precise, M2 derives from the liability side of the consolidated statement of the monetary authority and depository financial institutions (i.e., monetary survey), and AFRE from the asset side of the financial survey, the consolidation of other financial institutions on the basis of the monetary survey.

In reference to Spirtes et al. (2000), we adjust the significance level to 20% establishing contemporaneously causal directions. However, it is noteworthy that even at a 20% significance level, no exact contemporaneous causal relationships exist in Model (c) among variables. Therefore, we set at a 30% significance level that is also considered by Awokuse & Bessler (2003), while Model (a) and (b) still maintain at 20%.

[Herein Insert Figure 1]

Spirtes et al. (2000) focused on small sample studies to raise significance level with fewer than 200 observations, while our study is based on a large sample. In this study, despite conducting a large sample research, the significance level condition is relaxed as well.[14] In constructing the DAG-SVAR model, we impose short-run zero restrictions on the structural matrix A according to Figure 1 rather than on the IRFs and examine the feasibility of the fitting by Sims's likelihood ratio (see Table 8). In here, we mainly find that no contemporaneous correlation exists between either the repo rate or MPI and the actual output, which provides the guidance for imposition of the zero restrictions, and the rest of analysis are described in detail in the next subsection.

4.2 Hybrid Restriction

On the basis of contemporaneously non-causal relationships from DAGs, zero restrictions are described as no causality between two variables and sign restrictions are introduced with support from widely accepted empirical evidence (Uhlig, 2005). We impose restrictions based on the principle of ignoring the directionality of causality and using contemporaneous correlation (where contemporaneous causality exists) as a reference for sign restrictions between variables. For two variables that are not causally related, we impose zero restrictions, but for the price level and variables of interest, we impose sign restrictions uniformly and empirically to ensure the results comparable with each other.

In the first place, from evidence in Figure 1, there is no direct and contemporaneous impact of financial variables on the output, neither it is operational nor intermediate targets. However, as to the inflation, some of results showing no impact from repo rate or $afre$, so we loosen assumptions that financial variables have temporary impact on the price directly, which is the point to solve *price puzzle*. That is to say, a contractionary monetary policy could calm the price, including a rising from base rate and monetary market benchmark rate, whilst an expansionary monetary policy would cause positive responses of the price, such as an increase of demand and supply in funding markets.

Considering a relatively sound interest rate system having been established in China and the transmission among interest rates is smooth from monetary policy to the markets (Yi, 2021), an/a increase (decrease) of base rate has a positive (negative) impact on rates of the monetary markets, and vice versa. Additionally, the positive shocks from

[14]Since the traditional PC algorithm is order dependent by default, we reconsider order-independent one (Colombo & Maathuis, 2014) and use the PC-stable algorithm TETRAD II to test the new sample model with the last 40 sample sizes excluded (the significance level setting keeps the same, see Section 6). It is found that the original results remained robust, except for some arrow directions and causality of Model (b), which differ from the original ones (see Figure 16). Furthermore, we reset the identifying specification in Table 15 according to Figure 16b, and the IRs remain robust (Figure 17).

base rate could cause money supply decline but money demand unaffected, which is an important result of our interest from Figure 1b and 1c. On the other, Figure 1c illustrates that $afre$ is uncorrelated with r, but we choose to set no restrictions on positive shocks from funding demand. Similarly, even though $m2$ is correlated with r (Figure 1b), no restrictions are set on positive shocks from funding supply to ensure the results compared. Therefore, we assume a positive shock from funding markets to be one that cause a positive impact on itself, no matter from which side, but remain influence on base rate unknown of interest. Patterns of hybrid restrictions are shown in Table 3.

[Herein Insert Table 3]

Following Mumtaz & Surico (2009), we apply AB-form mentioned above to illustrate specific condition of hybrid restrictions in each model. Model (a) contains 4 endogenous variables as the base rate (r), MPI of interest rate (i), real output (q) and inflation rate (p), which corresponds to innovations as $u_t = (u_{r,t}, u_{i,t}, u_{q,t}, u_{p,t})'$ in the reduced form, respectively. As to the structural form, structural shocks (innovations) can be written as $e_t = (e_{mp,t}, e_{mm,t}, e_{AS,t}, e_{AD,t})'$, where $e_{mp,t}$ denotes monetary policy shock, $e_{mm,t}$ denotes monetary market shock, $e_{AS,t}$ denotes aggregate supply shock and $e_{AD,t}$ denotes aggregate demand shock. Therefore, a contemporaneous matrix A (4×4) identified structural shocks can be set as follows,

$$\begin{bmatrix} u_{r,t} \\ u_{shi,t} \\ u_{q,t} \\ u_{p,t} \end{bmatrix} = \begin{bmatrix} + & + & \times & \times \\ + & + & \times & \times \\ 0 & 0 & + & + \\ - & - & - & + \end{bmatrix} \begin{bmatrix} e_{mp,t} \\ e_{mm,t} \\ e_{AS,t} \\ e_{AD,t} \end{bmatrix}$$

In Model (b), MPI is denoted by $m2$, which represents social liquidity and overall purchasing power in the view of financial markets, with $e_{fs,t}$ to be aggregate funding supply shock as for a structural form.

$$\begin{bmatrix} u_{r,t} \\ u_{m2,t} \\ u_{q,t} \\ u_{p,t} \end{bmatrix} = \begin{bmatrix} + & \times & \times & \times \\ - & + & \times & \times \\ 0 & 0 & + & + \\ - & + & - & + \end{bmatrix} \begin{bmatrix} e_{mp,t} \\ e_{fs,t} \\ e_{AS,t} \\ e_{AD,t} \end{bmatrix}$$

In Model (c), MPI is denoted by $afre$, which represents financial support from financial system to the real economy, also funding demand from non-financial companies and individuals. Thus, $e_{fd,t}$ is defined as aggregate funding demand shock.

$$\begin{bmatrix} u_{r,t} \\ u_{afre,t} \\ u_{q,t} \\ u_{p,t} \end{bmatrix} = \begin{bmatrix} + & \times & \times & \times \\ 0 & + & \times & \times \\ 0 & 0 & + & + \\ - & + & - & + \end{bmatrix} \begin{bmatrix} e_{mp,t} \\ e_{fd,t} \\ e_{AS,t} \\ e_{AD,t} \end{bmatrix}$$

It is noteworthy that elements from last two columns in the contemporaneous matrix A above are in the same setting, as a reflection of responses to shocks from goods markets. We assume that both shocks could have impacts on financial variables with

sign unrestricted, and under Keynesian supply curve, those from aggregate demand side always generate positive influence on output and overall price. That is to say, shocks from aggregate supply side cause an increase of output and a decrease of overall price. Despite capture of influence by AD or AS (e.g., Fry & Pagan (2011)), responses to shocks from goods markets are beyond our concern, and that is why we neglect these in Table 3 but complete in matrices to exhibit directly.

5 Empirical Results

In this section we first measure and compare the controllability and relevance of the three intermediate targets based on the DAG-VAR-SR model using the IRFs and FEVD, and in particular we find an opposite mirroring relationship between AFRE and M2, which leads to the formulation of our hypothesis. Second, we deliberately compare the results with those of the DAG-SVAR and VAR-SR models to illustrate the validity and robustness of the sign and hybrid restrictions. Finally, in further analysis, we confirm the hypothesis by using TVP-VAR-SVAR and find that the asymmetry of the *opposite mirroring effect* in the short- and long-run, and results support the transformation of the intermediate target of monetary policy in China. In addition, we test the TVGC of the monetary policy (targets) and scissors and uncover a significant unidirectional Granger causality from scissors to real (nominal) output.

5.1 Evaluation of Controllability for Intermediate Targets

Figure 2 portrays the IRs of three MPIs to monetary policy shocks. It can be found in Figure 2a that given the current monetary policy one-standard-deviation shock, the market interest rate will immediately response positively and reach a peak of 0.37, following a rapid decline rebound to a great value of 0.17 in the 4th period, and then the response magnitude deceases slowly and converges to zero in the 39th period remaining stable. It shows that the market interest rate can make timely positive feedback to the price-based monetary policy and the transmission is relatively smooth, which supports the previous literature. Therefore, the monetary authority can effectively guide market interest rate changes through the policy rate, but this regulation is only valid in the short run, with its magnitude decaying to 38% of its peak only in the 3rd period and 24% after one year.

Figure 2b portrays the feedback of M2 on the monetary policy shock. Shocked by the monetary policy, the response magnitude of M2 reaches -0.60 immediately and falls to the minimum (-0.86) in the 4th period, then rises to -0.40 quickly before period 30 following a slow increase. The magnitude does not converge to zero until period 60, showing a long memory of the feedback. This suggests that the broad money supply can provide effective feedback to price-based monetary policy, achieving different response effects at different lags: peak response, rapid convergence, and slow convergence in short-, medium-, and long-run respectively. Therefore, the implementation of expansionary monetary policy could release liquidity from the supply side of funding in the long run. In addition, the controllability of M2 is better than that of the market interest rate, both in terms of the immediate magnitude and the speed of short-run response. However, as the response duration of M2 is much longer than that of market

interest rates, the implementation and adjustment of monetary policy need to be taken into account policy hysteresis on the broad liquidity.

Figure 2c portrays the feedback of AFRE on the monetary policy shock. Completely different from M2, also a quantitative indicator, the same positive monetary policy shock promotes the growth of AFRE in the full lag, rather than a decline, exhibiting an *opposite mirroring effect* completely to the IRs of M2. Specifically, when shocked immediately, the response magnitude climbs rapidly from zero to a peak of 0.30 in period 8, then declining slowing at a constant speed and converging to zero around period 60. This is contrary to the empirical results of Sheng & Xie (2016), where we not only consider the robustness of the hybrid restriction identification (see Figure 10 and 18) but provide the following four plausible explanations.[15]

(1) *The two indicators reflect different characteristics and their influence by monetary policy.* The overall financing demand reflected by AFRE is more influenced by the behaviors of economic agents themselves, and the demand-side regulation of monetary policy affects financing supply directly and the financing behaviors indirectly. Even after the LPR reform, the transmission between lending rates and bond rates has been increasing (Yi, 2021), but the indirect transmission effect on AFRE is limited.[16] However, M2 reflects the overall liquidity and the level of social purchasing power. Both quantity-based monetary policy tools, such as adjusting base money and the required reserve ratio, and price-based tools will directly affect the size of the broad money supply through both deposit-creation channel and the money multiplier, where transmission of the policy is more direct and smoother, as can be seen from the correlation coefficient matrix and the DAGs.

(2) *The tight monetary policy means the current overheated economic environment and the optimistic expectations for the future, and the resulting gradual increase of financing cost creates a herd effect among economic agents.* In the event of a to-be tightening supply of funding, economic agents will increase credit at a low-interest rate currently, so as to satisfy and smoothen the future demand for investment or consumption. As the cost of financing rising continuously, economic agents will strengthen their expectations and follow suit, thus increasing the overall demand for financing in a short period. In addition, with the improvement of China's direct financing markets and the influence of risk appetite, non-financial enterprises and households are willing to transfer their deposits to investment in non-standard financial assets, and this behavior will be further potentized by the herding effect until the financial products incur losses or a black

[15] In addition, we also re-estimate Model (c) using the full sample data, at which we quit any restrictions, and the results are the same as those from Sheng & Xie (2016), i.e., the feedback of AFRE to monetary policy shocks is negative while generating some degree of *output puzzle* and *price puzzle* (see Figure 18). The comparison reveals that imposing sign restrictions on the price level is key to understanding the impulse response of AFRE. In other words, the hybrid (sign) restrictions effectively solves the *price puzzle*, and at the same time draws unusual conclusions (see A.4 for the results by sign restrictions).

[16] As of 2022M12, the outstanding bank loans in RMB accounted for 61.7%, while at the same time the proportion of bonds financing (corporate and government bonds) accounted for 26.5% in stock AFRE. Under the implicit dual-track interest rate regime, the transmission of monetary policy interest rates to the deposit side of commercial banks is relatively efficient, especially to loan supply by non-state banks via interbank certificates of deposit (K. Chen et al., 2022), whilst the transmission chain for off-balance-sheet business and direct financing is longer or somehow obstructed.

swan.

(3) *With the development of financial innovation and the diversification of financing channels, the off-balance-sheet and direct financing components of AFRE have accounted for an increasing proportion.* In particular, a large part of growth in AFRE has come from the financing of non-banking institutions under shallow financial regulation and the expansion of off-balance-sheet business, such as entrusted loans, trust loans and undiscounted bankers' acceptances. The rise in financing costs due to the tight monetary policy will directly inhibit the scale of on-balance-sheet business, together with the inevitable regulatory arbitrage, which has squeezed out some of the loans to off-balance-sheet forcibly. As pointed out by Funke et al. (2015) and Yang et al. (2019), in other words, lending by commercial (traditional) and shadow banks to a contractionary monetary policy reacts oppositely,[17] as a result of expansionary shadow banking activities lowering social liquidity while increasing AFRE (P. He et al., 2017). In this regard, as a smaller component of AFRE,[18] off-sheet-balance activities in all likelihood play a more influential role in the responses to monetary policy than on-sheet-balance ones. Apart from this, *moral hazard* would be triggered easily when economic agents obtaining the indirect financing, so transferring funds through various channels, which are distracted from intended purpose, for example, transferring the funds obtained from bond issuance by local governments to real estate investment (managed by municipal investment corporations under the leading of local governments), etc., and even accelerating the idle of funds in the financial market. Therefore, instead of suppressing the demand for financing, the tightening of monetary policy will stimulate the demand due to an increase in asset yields, which will in turn increase the investment in the non-real economy.

(4) *AFRE flaws inherently in statistics, making it difficult to achieve its defined purpose, which in turn may generate abnormal IRs to monetary policy shocks.* First, whether off-balance-sheet or direct financing, there always exists the possibility of mutual financing in the real economy, and this duplication of statistics may lead to an amplification of the impulse response effect, but the proportion of duplication of statistics and the degree of contribution need to be assessed. Secondly, undiscounted bankers' acceptances as a component in off-balance-sheet financing belongs to the credit granted by banks, and although it will offset the discounted and maturity scale in the stock statistics at the end of the period, it is not suitable to be included along with on-balance-sheet business. Finally, AFRE is essentially a sum of funds from the asset side through consolidation of the balance sheets of depository institutions and other financial companies, including both debt and equity financial instruments, as well as on- and off-balance-sheet accounts, of which it is not possible to fully supervise the use of funds, making it difficult to regard it as real investment by the financial system to the real economy.

In a nutshell, comparing the IR effects of the three MPIs, for controllability charac-

[17] In robustness, we substitute AFRE with loans growth under the same specification in Table 3 (see Figure 10d).

[18] According to our extrapolation from the AFRE subitems, the stock of off-balance-sheet business peaked in 2018M1 (CNY 27.02 Trillion), at which it was preceded by a period of expansion and followed by contraction. The ratio of the stock of off-balance-sheet business to the stock AFRE was greater than 15% between 2012M12 and 2016M12, and peaked in 2014M6 (18.29%); the ratio of the stock of on-balance-sheet business to AFRE has remained above 60%.

teristics of the intermediate target of monetary policy, the traditional M2 is the most controllable, following the market interest rate second, and AFRE relatively least controllable. In terms of statistical significance, the IRs of the first two remain significant in all lags, while the IR of AFRE is no longer significant only from the 10th period onwards. It is noteworthy that facing the same tight monetary policy shock, the feedback curves of M2 and AFRE show a completely *opposite mirroring effect*. The IR of M2 has a long memory, while the IRs of market interest rate and AFRE converge well to zero with the former faster. Whether regulating the macroeconomy through monetary policy or observing the effects of its implementation, the lagged impact of policy on the money supply in the long run cannot be ignored.

[Herein Insert Figure 2]

One of the manifestations of China's obstructed monetary policy transmission channels is that the abundant supply of macro funds corresponds to the weak demand for financing on the credit side, which reflects the phenomenon of "loose money and tight credit" in the New Normal, i.e., the occurrence of liquidity hoarding (Xiang & Zhou, 2022).[19] The PBC has been implementing a prudent monetary policy with the economy slowing down, but the adequate liquidity has created a low interest rate environment. Empirical evidence from developed countries suggests that a prolonged low interest rate environment can create a liquidity trap and reduce the effectiveness of conventional monetary policy or even make it ineffective (Bodenstein et al., 2012), which is the reason why unconventional policies have been put in place. As to China, it has been using a complex monetary policy framework containing multiple targets and instruments, coupled with the requirements of economic and financial system reforms, and some administrative measurements. According to Zhou (2013), China has always been implementing unconventional monetary policy. This implies that effectiveness of traditional policy tools limit, and financial deepening and financial markets develop quite slowly. Consequently, it is vital to smoothen the monetary policy transmission mechanism in the circumstance of underdevelopment of Chinese bond markets and institutional rigidities (K. Chen et al., 2016).

To reflect and ensure the effectiveness of monetary policy transmission from both the supply and demand sides of macro funding, Chinese government proposed for the first time in 2019 that "the growth rate of broad money M2 and AFRE should match the nominal growth rate of GDP" and quitted setting the expected growth target of M2 or AFRE.[20] Relevant expressions can also be found in the *China's Financial Stability Report*

[19] As stated by Yi (2023), "Since 2018 we have cut rates 14 times, and these 14 cuts have probably lowered the average required reserve ratio from nearly 15% to less than 8%, a reduction of more than 7% in the required reserve ratio. Over the past five years, through the 14 cuts, less than 8% of the required reserve ratio, not as high as that in the past, but the use of cuts to provide long-run liquidity to support the real economy, all things considered, is still a more effective way to keep the overall liquidity at a reasonably abundant level." In fact, the economic data in 2018 and post-pandemic confirmed the phenomenon of liquidity hoarding, mainly due to the sharp decline in off-balance-sheet financing. In 2018, the four RRR cuts released 3.65 trillion yuan of funds, and the annually cumulative AFRE flow was 19.26 trn, 3.14 trn less than that in 2017, mainly due to a significant drop in off-balance-sheet financing. In 2021, the two RRR cuts released 2.2 trillion yuan of funds, and the annually cumulative AFRE flow was 31.35 trn, 3.44 trn less than that in 2020. See Table 6.

[20] Report on the Work of the Government by Premier Keqiang Li at the second Session of the 13th National People's Congress, 5 March 2019, available at https://www.gov.cn/premier/2019-03/16/content_5374314.htm

and Monetary Policy Implementation Report in previous years, showing that the growth matching target has become a functional orientation and standard of China's monetary policy intermediate target for the present and even a longer period in the future.

Based on the results above, we have found that for monetary policy shocks, the feedback curves of M2 and AFRE show a completely opposite mirror effect. This implies that a long-run expansionary monetary policy during the sample period causes a positive IR to M2 as well as a negative IR to AFRE. In addition, the IR of M2 to monetary policy is stronger and lasts longer than AFRE, and the same expansionary monetary policy causes a rapid and sustained tightening of the difference between the two IRs.

Considering the difference between year-on-year growth rates of AFRE and M2, i.e., the scissors spread, then the poor transmission of monetary policy can be reflected in the tightening of the scissors. Figure 3 portrays the historical trend of growth of AFRE and M2 and their scissors. Since the outbreak of the international financial crisis, China has adopted a 4-trillion-yuan stimulus policy, and the rate of these three has achieved a significant increase. Then, with the arrival of the New Normal and the tightening of financial regulation, the scissors gradually contracted and showed a divergence during the stock market crash in mid-2015 and the post epidemic period. For most of the period, the tightening and divergence of the scissors was accompanied by an expansion of monetary policy. Given this high degree of coincidence, we then conjectured:

An expansionary monetary policy leads to a narrowing of the scissors, and even a divergence.

[Herein Insert Figure 3]

In light of the conjecture, this leads us to wonder whether the Chinese government's blurring of the intermediate target is reasonably effective. If an accommodative interest rate environment (or expansionary monetary policy) does lead to a reduction of the scissors, with a significant promotion in the time-varying characteristics, then we can argue that this shift helps to fulfil functions of the intermediate target. Officially, the matching target involves the adaptation of three indicators in terms of growth rates, one between AFRE and M2, and both to the nominal output. In this regard, we use the scissors to model the effects of arranging the matching effect at nominal economic growth and argue that a tightening of scissors (sci) indicates a better match between AFRE and M2, while a loosening indicates a worse match.[21]

[21] In here, three factors are taken into consideration. One is that the IR of the scissor to monetary policy can be used to directly corroborate our conjecture. Secondly, the use of scissors can avoid the difficulty of analyzing the effect of the overlapped part if modelling separately, i.e. the common part of AFRE and M2 accounts for a big share of RMB loans, etc. Lastly, the scissors itself is rich in connotations, reflecting the expansion of financing demand, mainly containing non-bank financial institutions and off-balance-sheet business. The main cause of scissors rising could be a rise in AFRE and fall in M2, or both, as well as the difference in the growth rate. Typically, the main cause is split into an expansion of excess financing demand in a booming economy and a contraction of M2 due to financial tightening and deleveraging. However, the scissors' radical decline and divergence is representative of the obstructed transmission mentioned in our text. Ideally, a certain degree of positive scissors (meaning that AFRE and M2 maintain a reasonable growth range) and a slow contraction of the scissors indicate smooth transmission. For sure, scissors rising also counts as the other obstruction, e.g., over-regulation, but not as harmful as divergence.

In 5.5, we will use the TVP-VAR model to further explore the dynamics between monetary policy targets and the scissors and test its time-varying Granger causality providing empirical evidence for evaluating the functional orientation of the intermediate targets of China's monetary policy, from the perspectives of both impulse responses and statistical causality. In the next subsection, evaluation of the relevance characteristic of these intermediate targets continues to be completed.

5.2 Evaluation of Relevance for Intermediate Targets

Figure 4 portrays the feedback of real output to shocks from the financial system. It can be found in Figure 4a that given the current money market price (interest rate) one-standard-deviation shock, real output is not affected immediately (zero restriction), but the magnitude of the response quickly reaches a minimum of -0.12 in period 2, followed by a certain rebound to -0.04, after which a slow concave decline and rise happens and then reaches a minimum again in period 26, until the impulse response in period 60 nor does it converge to zero. Tight money market prices can slow real output growth in the long run by compressing the consumption demand of economic agents and stimulating their incentives of saving, while the resulting increase in the cost of financing reduces their future investment. This suppressive effect on real output is increasing in short- and medium-run (the first 26 periods) and then decaying, with no significance in the long run.

Figure 4b portrays the feedback of real output on the financing supply shock. Hit by one-standard-deviation shock to financing supply immediately, real output does not respond in time (zero restriction), and the impulse magnitude quickly reaches a maximum of 0.33 in the 3rd period, and then undergoes a relatively rapid decay, reaching a very small value of 0.23 in the 12th period and then climbing to a very large value of 0.31 (25th period). It slowly declines and does not converge to zero in the 60th period, which also exhibits the feedback's long memory. This suggests that an expanding funding supply can ease monetary environment in the markets, effectively lower the cost of using funds, thus driving investment and consumption demand, and promoting real economic growth. Real output can effectively respond to the loosening or tightening of the financing supply and maintain a high and stable level of impulse response in short- and medium-run and a stimulus effect sustain in the long run. Compared with the feedback from the monetary market shock, the output effect induced by financing supply is better, both in terms of the magnitude and speed of response in short-run and the duration in long-run. For sure, the lagged effect of this feedback needs to be taken into account if the monetary authority make frequent adjustments to monetary policy in the short run.

Figure 4c portrays the feedback of real output on the financing demand shock. When subjected to a shock from the demand side of financing, real output will climb rapidly and immediately from zero (zero restriction) to the maximum of 0.17 in the 10th period, followed by a slow decline at a constant speed, showing a low-level long memory. With the diversification of financing channels in China, the expanded financing needs will be fulfilled, thus accelerating the flow and utilization efficiency of social capital, which is conducive to financial services for promoting the growth of the real economy. Compared with the financing supply shock, the output feedback curve

induced by the demand-side shock is relatively flat (less responsive), but these two shapes and trends are relatively close to each other, which implies that the intermediate targeting function of AFRE has been formed, but the output effect is not as effective as that of the traditional M2.

In a nutshell, comparing the IR effects of the three MPIs, for the relevance characteristics of the intermediate target of monetary policy to real output, the traditional M2 has the best relevance, followed by AFRE, and the market interest rate relatively least relevant. In terms of statistical significance, the IR of output to the shock from funding supply remains significant in all lags, with the one from funding demand significant only in short- and medium-run and one from monetary markets insignificant in all lags. In addition, the output feedback of AFRE becomes prominent and closer to M2, and the function of intermediate targeting comes to the force. The monetary authority can rationally choose a combination of different instruments to achieve varying levels of economic growth relying on various final targets.

[Herein Insert Figure 4]

Figure 5 portrays the feedback of inflation to shocks from the financial system. It can be found in Figure 5a that given the current money market price (interest rate) one-standard-deviation shock, inflation will be immediate feedback and at the minimum of -0.32, then the impulse magnitude rises rapidly and breaks through the val-ue of zero in the 15th period, maintaining a low level of positive response before the 26th period, and then again breaking through zero with a negative response. It can be seen that, through the sign restrictions, the short-run increase in the money market price will significantly suppress the inflation, effectively solving the *price puzzle*. However, a gradual increase in the cost of financing changes the inflationary expectations of economic agents, ensuring the real level of purchasing power of money holdings stable by increasing current consumption and investment, which causes the low inflation to some extent. The curve depicts the balanced effect among multiple forces, with the rising cost of financing ultimately bringing about continuous deflation. Due to the asymmetry of price feedback from the money market shock in short- and medium-run, when guiding market expectations, the monetary authority needs to prevent reinforcement of expectations or a potential herd effect against inflation.

Figure 5b portrays the feedback of inflation on the financing supply shock. After being subjected to the shock, inflation will reflect and fluctuate immediately, reaching the maximum of 0.36 in the 4th period, followed by a rapid decline to 0.05 (19th period), after which a convexity of slow rise and fall occurs, with a certain long memory. This suggests that an easy monetary environment will stimulate residents' enthusiasm for investment and consumption so as to promote price increases effectively. However, this inflation-boosting effect is not strong, and it remains low and persistent after one year and a half, reflecting that the excess money supply is absorbed by overall prices, i.e., monetary neutrality in medium- to long-run. In conjunction with Figure 4b, an increase in M2 alone would have been able to achieve an increase of real output and the price level in the short run, while maintaining the output-boosting effect at a low cost of inflation in the medium to long run.

Figure 5c portrays the feedback of inflation on the financing demand shock. In the

case of one-standard-deviation shock to financing demand, the level of overall prices provides timely feedback (0.26) and reaches a maximum of 0.31 in period 3, before dropping to 0.10 (period 15) and then converging slowly. Like the financing supply, an expansion in demand leads directly to higher investment and consumption, which in turn boosts output while incurring an increase of the price level. Compared with the financing supply shock, the response magnitude to demand side is slightly weaker and closer to convergence of zero. This confirms to some extent the long-run neutrality of AFRE. In fact, as expanding domestic demand has become a powerful tool to stimulate China's economic recovery in recent years, personal consumer credit has achieved steady growth.[22] The proxy variable for inflation selected in this paper is the consumer price index, reflecting the stronger correlation between consumer credit and AFRE. In addition, unlike the feedback on the financing supply, the output effect from demand side is weaker than the price effect, but the duration of the former lasts longer.

In a nutshell, comparing the IR effects of the three MPIs, for the relevance characteristics of the intermediate target of monetary policy to inflation, the traditional M2 is optimally relevant, followed by AFRE and the market interest rate. In terms of statistical significance, the IR of inflation to the shock from financing supply remains significant in most lags, with AFRE and the money market interest rate in fewer lags. The inflation feedback from AFRE becomes closer to M2, with the intermediate target function coming to the fore and more convergent in the long run. In addition, there exists a degree of long- and short-run asymmetry in the regulation of inflation by money market interest rates, which converge better than M2 in the long run.

[Herein Insert Figure 5]

Combining the IR effects of the three MPIs on real output and inflation, it can be found that: when in a period of economic overheating, the monetary authority can inhibit economic bubbles by appropriately raising the market interest rate to smoothen economic growth, but it is necessary to guide market expectations to prevent the short-run push of prices again; while in a period of economic downturn, the monetary authority can expand the money supply or AFRE to stimulate the economy and overall price increases, which incur responsive feedback on real output and inflation in the short run. The very distinction is that output-boosting effect of M2 is stronger and has a long memory, while the price-boosting effect of AFRE is quite closer to M2 without long-run constraint on the real economy. Thus, depending on the economic environment and policy targets, the monetary authority can use M2 to achieve rapid and long-run output growth, or AFRE for short- to medium-run stimulus or to suppress economic fluctuations.

With respect to effectiveness of the intermediate target of monetary policy, as a conclusion, the traditional broad money supply remains optimal similar to results found by K. Chen et al. (2016), with the money market interest rate and AFRE prominent in function, especially the price feedback of AFRE.[23] Next, we will analyze the degree

[22] As of 2021, the balance of personal consumption loans stood at CNY 54.89 trillion yuan, accounting for 17.5% of AFRE and 28.7% of RMB loans at the same time. Source: *China's Inclusive Financial Indicator Analysis Report* (2021).

[23] The PBC has used M2 as an intermediate target for nearly three decades. When AFRE was first es-

of contribution of the source among shocks in each model through FEVD to further confirm the intermediate targeting effect of the three indicators.

5.3 Variance Decomposition

Furthermore, we decomposed the forecast error variance of each model over the sample range, choosing different periods after the shock for the analysis. Not surprisingly, all FEVD results are consistent with the impulse response results above.

Table 4 summarizes the results of FEVD for each MPI after a monetary policy shock, reflecting the extent to which monetary policy contributes to the variance of the three MPIs. As the pledged bond repo rate selected in this paper has the strongest correlation with the money market interest rate (see Table 2 and Figure 11), monetary policy contributes to the market interest rate to the greatest extent, but the explanatory effect is gradually diminishing, accounting for more than 50% overall. Similar to the characteristics of market interest rates, the degree of contribution to M2 decreases from year to year, with the peak of the explanatory share immediately, but the decaying explanatory effect is worse than that of the market interest rate.

The only difference is that the share of monetary policy shocks explaining the variance in the forecast of AFRE increases from near zero immediately and then increases gradually, but the overall explanatory strength is the worst. Consistent with the impulse response results, the response is zero in the month following the monetary policy shock (in which explanation yet unfolds), and it peaks within six months, with the largest increased contribution (26 times the current month's share). The incremental increase in the explanatory share then slows down and peaks in period 60 (16.7%). However, the share of FEVD to AFRE accounts for less than half of which to M2 in all lags. This reconfirms that AFRE is the least controllable relative to other intermediate targets.

[Herein Insert Table 4]

Table 5 summarizes the results of FEVD of the two real economy targets shocked and contributed by each intermediate target. In the case of output, contribution of all intermediate targets exhibits gradual increases across all lags. The broad money supply has the largest explanatory share in all lags, at least twice as large as which of the other two targets. The AFRE has the second largest explanatory share, and the market interest rate has the worst. This suggests that quantitative intermediate target shocks have greater explanatory strength in terms of long-run forecast variance, and that an expansionary quantity-based monetary policy can cause a more persistent impact on real output. Thus, consistent with the impulse response results, the output effect of the

tablished, it mainly drew lessons from the financial indicator statistics of developed countries as well as preparing for future rapidly expanding financial innovations. Many studies in Chinese academia support the exit of M2 from the historical stage, which, while favorable to advancing the price-based regulatory transition of monetary policy, ignores factors such as the dampening effect of financial regulation on the money multiplier (Dabrowski, 2016), and the efficiency improvement of credit allocation by the anti-corruption campaign (B. Li et al., 2022), etc. We utilize nearly two decades of monthly macro data, which still effectively supports the intermediate targeting function of M2.

quantity-based intermediate target remains superior to that of the price-based target, and the traditional broad money supply stays the most effective.

As to inflation, the contribution of all intermediate targets shows a decreasing trend from year to year and eventually stabilizes as a whole. Specifically, the share of market interest rate shocks in explaining the variance of price forecasts increases and then decreases, peaking half a year after the shock. Shocks from M2 and AFRE explain the variance of price forecasts in a decreasing and then increasing manner, and both reach their minimum values one year after the shocks. The short-run contribution of market interest rate shocks is the largest, while broad money supply shocks have a relatively larger long-run explanation, and thus an expansionary monetary policy by expanding M2 has a longer-lasting effect on prices. In contrast, an expansionary monetary policy through expanding AFRE has a less-lasting effect on prices, reflecting the greater neutrality than M2. Therefore, consistent with the impulse response results, the price effect of market interest rates is best in the short run, the feedback of AFRE is worse in the long run, and the overall feedback effect of M2 keeps the best.

[Herein Insert Table 5]

5.4 Identification Method Comparison

In order to corroborate the identification effects of hybrid restriction, we also compare the IRs of results under two identification methods including the short-run zero restriction based on DAG and the sign restrictions. Based on the same ordering and lag order of the VAR variables, the comparative analysis reveals that the overall impulse response results (trend and sign) are consistent with the previous results except for the response magnitude and some details, but there does exist some apparent distinct.[24]

For the IRs of AFRE to a monetary policy shock, the short-run zero restrictions present a significant negative impulse relationship (see Figure 6a), which is consistent with Sheng & Xie (2016) and the re-simulation results in this paper (Figure 18b), i.e., a tight monetary policy brings about a decline in the scale of quantitative indicators of AFRE, rather than a rise. However, the results for both sign and hybrid restrictions suggest that monetary policy shocks to AFRE cause a rise in the short run (see Figure 2c and 6b). Different from hybrid ones, the IRs identified by the sign restrictions also exhibit a weak asymmetric effect in medium- to long-run, i.e., negative feedback during the periods. To some extent, this reaffirms the correctness and robustness of the results from short-run zero restrictions and hybrid restrictions.

As to inflation, a clear difference in the identification of the short-run zero restrictions represents, with both market interest rates and broad money supply exhibiting a degree of *price puzzle* (Figure 6c and 6d). In the case of market interest rate shocks, the magnitude of the spot price response turns positive and rises in the short run in a small shape of "V", before falling below zero again after one year and a half. For M2 shocks, the price feedback fluctuates anomalously up and down in the short run, with a normal response in medium- to long-run. This again suggests that the hybrid

[24] All IRs and FEVD results are detailed in A.3 and A.4.

and sign restrictions are effective in solving the *price puzzle* and facilitate comparative analysis of the variables.

[Herein Insert Figure 6]

5.5 Further Analysis

In 5.1, a completely opposite mirroring relationship between AFRE and M2 was discovered. To further verify our conjecture about the relationship between monetary policy targets and scissors, this section assesses the effect of matching the quantitative intermediate targets with the output growth from the perspectives of both impulse response effect and statistical causality. The first subsection will introduce the TVP-VAR model used to analyze the time-varying mechanism of monetary policy targets and scissors. In the second subsection, the TVGC is employed to test whether the two are time-varying statistical causality. Further findings not only confirm our conjecture, but also effectively support the transformation and functional orientation of China's monetary policy intermediate targets.

5.5.1 Analysis of Time-varying Impulse Response

We first use the TVP-VAR model to analyze the dynamics of the monetary policy, scissors, and final targets, while portraying the time-varying impulse response effects over the sample period.

Considering that China has constructed a more complete marketized interest rate system (Yi, 2021), the model incorporates interbank lending rates and becomes a five-variable TVP-VAR model. First, according to Akaike information criterion (AIC) and Schwarz criterion (SC), the lag order of the model is set to 3 periods, and the parameter estimation is carried out by Monte Carlo Markov Chain (MCMC), and the sampling number is set to 10,000 times. Second, the IRF was calculated and generated for each period, and the impulse response curves at all time points were plotted as a three-dimensional surface (see Figure 14 for details).[25]

Based on China's interest rate liberalization process and the New Normal, we select three representative time points to focus on the time-varying effects of scissors, specifically the liberalization of the lending rate floor (2013M7), the deposit rate cap (2015M10), and the LPR reform (2019M8). In addition, three different lags (one quarter, a half year, and one year)[26] are chosen to portray the overall impulse responses after the shocks.

Figure 7 portrays the periodic feedback at three points in all lags. It can be found in Figure 7a that the impulse response of a monetary policy shock to the scissors spread shows a positive effect for about a half year and then turns negative. This implies that

[25]To avoid the bias of the selected time point or the lack of generality, the use of three-dimensional surfaces can better observe the IRs at each time point and lag period, so as to have an overall intuitive and comprehensive grasp of the dynamics of the impact effects.

[26]The three lags here correspond to the short, medium and long run of IRs, different from the analysis in DAG-VAR-SR.

an expansionary monetary policy shock causes a short-run contraction of the scissors (which, according to the previous analysis, mainly stems from the influence of off-balance-sheet activities), and then incurs a widening of the scissors in the long run mainly contributes to the feedback of M2 unfolding on the monetary policy shock, which outweighs the impact of AFRE (see Figure 2b and 2c). This finding not only confirms our conjecture, but also reveals the asymmetry of the long- and short-run matching effect. Thus, after being shocked, the matching effect of the two intermediate targets varies across the periods, with the matching effect on being strengthened in the first half year, and then weakened or even widened in the second half year. From another view, the expansion of the scissors gap is not definitely caused by the immediate or short-run tightening of monetary policy, but may be owing to the lagged effects of earlier expansionary policies.

Considering the process of interest rate liberalization in China and the three different periodic IRs, we can see that both magnitude of the positive response in the short run (peaks from around 0.20 to 0.275) and the duration (from 4.5 to 7 periods) have been improved, suggesting that the abundant liquidity environment has led to a growing contraction of scissor spreads, that is, an expansionary monetary policy in the short run has strengthened the matching effect. Especially with the deepening of interest rate liberalization, this reinforcing effect has also been enhanced in terms of response magnitude and duration. In fact, with the liberalization of China's deposit and lending interest rate limits and the LPR reform, the cost of real financing will be further reduced, and the problems of difficult and expensive financing in the real economy will be somehow solved, so that the efficiency of monetary policy transmission will be further improved, whether through on- or off-balance-sheet channels. The feedback effect of excess financing demand (i.e., financial support for the real economy from non-banking institutions and off-balance-sheet businesses) becomes more pronounced, in addition to the weakening of the long-run negative impact. Combined with Figure 3, the matching effect of intermediate targeting will continue to unfold in a prolonged low-interest-rate environment. Findings above confirm that orientating the intermediate targeting function at the degree of matching effect between AFRE and M2 can effectively monitor and adjust monetary policy in different periods, which in turn validates the reliability of the targeting transformation and orientation adjustment.

Figure 7b portrays the periodic feedback of real output to a scissors shock. The impulse response of real output to the scissors shock is negative immediately, then rises rapidly and peaks around period 2, before leveling off at a high value, with some long memory. This suggests that scissor shocks have some lagged effects on real output, and that expanding financing demand brings about and peaks output growth in the short run, driving prosperity in the medium to long run. That is to say, the degree of matching effect between the intermediate targets is strongly correlated with real output. Moving on to the feedback at three different points, with the interest rate liberalization advancing, the short-run peak of the output effect declines slightly, shocked from the quantity-based monetary policy, and the magnitude of long memory decreases, with a tendency for the correlation with real output to weaken. This may stem from the deepening of financial regulation,[27] and the off-balance-sheet business being squeezed into on-balance-sheet ones, which provides poor support to the real

[27]The three points chosen also reflect the process of financial strengthening regulation, see Xiang &

economy. This implies during the process of interest rate liberalization and financial regulation strengthening, that a decline effect in the quantity-based regulation will inevitably be accompanied. To achieve the smooth transition from quantitative-based to price-based regulation and strengthen the price-based monetary policy will become the future direction of development. On the other, a negative output caused by a negative or inversed scissors shock (indicating the deviation of AFRE and M2) weakens subsequently. It is further illustrated after considering the reality of the current obstructed transmission and the process of interest rate liberalization, that the effectiveness of arranging the matching effect at the actual output has improved, which reconfirms the intermediate target transformation and functional orientation.[28]

To compare the matching effect to inflation, we also examined the periodic feedback of inflation on the scissors shock (see Figure 7c).[29] The impulse response of inflation is positive immediately, then falls rapidly to a minimum of about -0.03, before a peak after the second period and leveling off at a low value. For the impulse response at the LPR reform period, it steadily increases after an extremely large value. This suggests that the feedback shows asymmetrically in the short and long run, with the negative short-run impact probably stemming from the fear of tighter market expectations, which reduces real demand for consumption and investment, while expanding demand for financing keeps (and pulls) the price level stable (up) in the long run. However, in terms of the magnitude, the degree of target matching effect is poorly correlated with inflation, not as strongly as with real output. In addition, considering the feedback at three different points, the magnitude of impulse response increases slightly as interest rate liberalization advances, especially long-run memory enhanced indicating the correlation with inflation becomes strengthened. Due partly to the cost of financing for non-financial firms and residents gradually declining, as the LPR releases its guiding potential, effective demand on the credit side has been boosted, and off-balance-sheet expansion of financing demand has stimulated the recovery of consumption over the long run, pulling up the CPI. This assertion can be discovered in the macro policy adjustments during the pandemics.[30] It is also noteworthy that the deflationary effect by

Zhou (2022).

[28] One of drawbacks of the TVP-VAR-SV model lies in its inability to perfectly reflect the asymmetry of monetary policy, and further research can consider nonlinear endogenous-switching SVAR (K. Chen et al., 2016), state-dependent local projections (H. Chen et al., 2019), etc. However, according to the symmetric impact caused by the reverse shock, compared with the positive scissors shock, the negative scissors shock mainly reflects the obstructed transmission of monetary policy, that is, the abundant macro liquidity cannot be effectively transmitted to the weak micro financing demand, forming a liquidity hoarding. For periods of relatively smooth transmission, the output effect of positive scissor shocks is decreasing. For periods of relatively poor transmission, the negative output effect of the obstructed transmission is diminishing, implying the feasibility of arranging the matching effect of the intermediate targets on output.

[29] As mentioned by Yi (2023), "The focus of our policy is to emphasize maintaining price stability. This requires that the growth rates of our M2 and AFRE broadly match the growth rate of nominal GDP, so that we can maintain an appropriate supply of money and make overall prices stable for China."

[30] Shortly after the LPR reforms, China experienced a three-year pandemic challenge. China's economy faced serious confrontation during the omicron period. To ensure the safety and health of the Chinese people while maintaining the economy, Premier Keqiang Li chaired a State Council executive meeting on 18 August 2022, stressing the needs to "improve the market-based interest rate formation and transmission mechanism, play a guiding role in loan prime rate (LPR), support the rebound of the effective demand for credit, and promote the reduction of the costs of enterprises' comprehensive financing and the personal consuming credit." Source: http://www.news.cn/politics/leaders/2022-08/19/c_

the negative scissors shock (denoting the divergence between AFRE and M2) strengthens subsequently, suggesting inappropriateness of arranging the matching effect at inflation, considering the current obstructed transmission and the process of interest rate liberalization.

[Herein Insert Figure 7]

Figure 8 portrays the feedback for three isochronous intervals. It can be found in Figure 8a, over the sample period, that the three curves move similarly but not intersect, and the short-, medium- and long-run impulse responses decrease in magnitude sequentially, showing a clear duration effect. In particular, the response curve with a lag of 6 months (medium-run) breaks through zero, and the short- and long-run curves exhibit a kind of asymmetry (consistent with the results in Figure 7a). Overall, the feedback of the scissors to the monetary policy shock has been weakening gradually until around 2011, and then strengthening after 2015, with small fluctuations and stabilization over the period.

In terms of China's practice of monetary policy regulation, from 2003 to 2012, foreign exchange accounts became the main means of passive liquidity injection due to the "double surpluses". To regulate the excess liquidity, the PBC started issuing central bank bills in 2003M4 to supplement liquidity with open market operations for a rise in the reserve requirement ratio (RRR). In 2013, the PBC created open market short-run liquidity adjustment tools (SLO) and standing lending facilities (SLF) to inject short-run liquidity and allowed the SLF to play the role of a market interest rate corridor ceiling, thus transitioning to the price-based regulation.

Since the scissors excludes the impact of foreign exchange account and others, mainly reflecting the financing of non-banking institutions and off-balance-sheet financing demand, the feedback of the scissors is more affected by the monetary policy itself. As R007 is the proxy of the monetary policy, the trend of the scissors response is closely related to the price-based regulatory transition. With the liberalization of the upper and lower limits of deposit and lending rates, the effect of price-based regulation has been further enhanced, and the response magnitude has remained stable at a high level since then.

Figure 8b portrays the isochronous feedback of real output to the scissors shock. During the sample period, the response magnitude and curve fluctuations in short-run are relatively small, and the responses in medium- and long-run stay similar trends with larger curve fluctuations. As all three curves converges, it shows a clear duration effect. Comparing the magnitude and speed of responses in different lags, the feedback in the short run is significantly the worst, with the long run being the best, reflecting the time lagged effect of transmission.

Take long-run feedback for example, the impulse magnitude fluctuated modestly and increased significantly from 2003 to 2012, then declined rapidly by about 75% by 2017, and then increased by double. The output effect of the scissors is closely related to the development of the Chinese economy. Before 2012, except for the period after

the international financial crisis, China has maintained at a high growth rate, and the output effect has remained high. Especially after 2008, with the 4-trillion-yuan policy stimulus and the rapid development of shadow banking, the output effect has further increased and reached its peak. Between 2012 and 2017, China's economy achieved a soft landing while financial regulation was reinforced, compressing the off-balance-sheet business, so the output effect weakened rapidly.[31] After 2017, the output effect increased rapidly, mainly due to the expansion of the statistical scope of AFRE, items of "government bonds" "asset-backed securities of depository financial institutions" and "loan write-offs" were gradually incorporated, thus improving the correlation with real output.[32] Since 2020, the response has declined slightly during the pandemics, while the output effect is still obviously superior to that around 2017, thus reconfirming the validity of targeting at the output level.

Similarly, we also examine the effect of isochronous feedback of inflation on scissor shocks (see Figure 8c). Over the sample period, the short-run response magnitude is less strong, and the curve volatility is less volatile than the medium- and long-run responses, showing clear duration and lagged effects. Combining Figure 11, it can be found that the inflation curve shapes closely to the price feedback curve, especially to the long-run impulse response. In addition, the price feedback curve steps ahead of the inflation curve, indicating a smooth price transmission of the scissors spread to the consumer side and its somewhat predictivity.

Take long-run feedback for example, the magnitude of price feedback declined until around 2006, corresponding to a contraction of the scissors. China has faced inflationary pressures since entering the WTO, and even the sudden onset of SARS in 2003 could not dampen the demand-driven inflation. The excess financing demand caused price increases continuously, but the effect decreased until 2006. From 2006 to 2007, the price feedback increased, reaching maximum around in 2007. During this period, excess financing demand continued to push the expansion of investment and consumption, especially real estate investment and the food basket centered on pork and vegetables. From 2007 to 2008, with the implementation of tightening, the expansion of financing demand was curbed, and the price feedback rapidly declined and even fell below zero, thus calming the inflation. From 2009 and 2011, due to the 4-trillion-yuan stimulus and international oil prices, the price feedback climbed rapidly and further boosted demand-driven inflation. From 2011 to 2014, with the economy landing softly, the fluctuations of the economic growth and prices decreased, and the price feedback weakened. From 2015 to 2019, entering the New Normal, with the tightening of regulation

[31] In 2013, the former China Banking Regulatory Commission published the Notice on Issues Related to the *Standardization of Investment Operations of Wealth Management Businesses of Commercial Banks* (*CBRC No. 8*), which comprehensively restricted the investment of wealth management funds raised by channel businesses in non-standard assets, and then interbank businesses became mainstream (Xiang & Zhou, 2022).

[32] Regarding the inclusion of government bonds, the PBC has expanded the financial principles, arguing that the fiscal expenditure of government bond funds holds a considerable support for the real economy, and can indirectly flow into the real sector. In September 2018 and December 2019, the caliber of AFRE was adjusted twice, and "local government special bonds" "treasury bonds" and "local government general bonds" were successively included in the statistical scope, and the amount of the indicator is custodial nominal value. For more details in statistical principles of AFRE, see Sheng et al. (2016).

and the improvement of the consumer credit market, as well as the supply-side structural reforms, price pressure on industrial commodities has been transmitted to the consumer side, and price feedback has steadily enhanced. From the end of 2019 to the end of 2020, the lagged impact of the U.S.-China trade war and the pandemics incurred deflation, China's economy has been facing the triple pressure of "demand contraction, supply shocks and weakening expectations", and the price feedback weakened at this time. During the post-pandemic era after 2020, with multiple RRR cuts and macroeconomic recovery, the overall price rose to a reasonable range owing partly to the excess financing demand.

[Herein Insert Figure 8]

To sum up, this section confirms our conjecture in 5.1 with a time-varying impulse response and analysis the effectiveness of adjusting functional orientation of intermediate targets to match the growth rate. Our research mainly finds that the expansionary policy strengthens the matching effect in the short run but weakens in the long run. In addition, considering the process of interest rate liberalization and transmission obstruction, the effectiveness of the matching effect on real output is enhanced, but inappropriate to arrange the matching effect at inflation.

In addition to testing the matching effect using impulse responses, we next apply the bidirectional relationship using time-varying Granger causality to observe the regulating and forecasting ability between the scissors and targets, so as to assess the matching effect of the intermediate target together.

5.5.2 Analysis of Time-varying Granger Causality

Referring to Shi et al. (2018, 2020), the time-varying Granger causality between scissors and monetary policy (targets) is tested by establishing a lag augmented vector autoregression model (LA-VAR) and constructing the Wald statistic (see A.6 for details). As with setup in the TVP-VAR, except for the explanatory variables of interest, market interest rates are also incorporated. One is to consider that the market interest rate is highly correlated with monetary policy (the benchmark interest rate) and thus has some impact on the scissors.[33] For the other, the market interest rate functions relatively well as an intermediate target (see Figure 4a and 5a), inevitably affecting real output and inflation. In this regard, we include the market interest rate in the model and construct a time-varying Granger causality test model by selecting monetary policy, scissors, real output and inflation, to observe the regulation and forecasting ability of the scissors and its relationship with monetary policy targets.

To avoid the spurious regression, all variables pass stationarity test, while the model lag is determined as order 3 according to SC and AIC, etc.[34] According to Shi et al. (2018), we set the minimum rolling window in TVGC to 36 periods and select the recursive rolling method that makes full use of historical information for the test. Figure

[33]Our conjecture has been verified, and it is conceivable that lower market interest rates will also narrow the scissors to some extent.

[34]For the LA-VAR, which takes nominal output into account, it is similarly lagged 3.

9 portrays the time-varying Granger bi-directional causality between monetary policy (targets) and scissors, and the corresponding Wald decomposition results are presented in Table 13.

Time-varying Granger causality analysis between monetary policy and the scissors. Figure 9a reveals that monetary policy is the Granger cause of the scissors over the sample interval, a result that holds at the 5% significance level (unless otherwise stated, all references hereafters are to 5%). Considering the 1% significance level, Granger causes exhibit in fewer time periods before 2016, and after 2016, the test statistic is serially significant, suggesting that the ability to regulate the scissors has enhanced since then. Back to Figure 8a, the feedback magnitude of scissors to the monetary policy shock is always gradually decreasing before 2016 and continuously increasing afterwards, which to a certain extent laterally reconfirms the conclusions. According to Figure 9d, except for the pandemics and some periods, the scissors is the Granger cause of monetary policy in most of the sample intervals, suggesting that the scissors can reflect and monitor the loosening and tightening of monetary policy to a certain extent. In majority time, the two are Granger causes of each other.

Time-varying Granger causality analysis between the scissors and real output. Figure 9b shows that the scissors is the Granger cause of real output over the sample intervals and significant in most of the time, suggesting that the scissors can better influence and predict the real output, which confirms that it is more effective to locate the matching effect of the intermediate targets of China's monetary policy on real output. According to Figure 9e, however, with multiple periods of unhooking, the Granger-causal relationship between real output and the scissors is not stable, which has become more obvious since the New Normal, especially prominent hit by external shocks, such as the stock market crisis in 2015, the stringent and comprehensive regulation from 2018, and the pandemics from 2020, etc. This implies that the scissors is susceptible to many factors, with an obvious time-varying characteristics of the Granger cause and exhibition of some unidirectionality of the matching effect. This result supportively holds even at the 1% significance level.

Time-varying Granger causality analysis between the scissors and inflation. It can be found in Figure 9c that the scissors is the Granger cause of inflation over the sample intervals and highly significant in most of the time, showing a good prediction to the inflation. In Figure 9f, the Granger-causal relationship of inflation to the scissors is not significant in most intervals before 2013, but after which the Granger-causal relationship turns significant and stable. Compared to the time-varying Granger causality of the scissors with real output, the relationship with inflation is more significant and stable, showing bidirectional Granger causality in the main period. This finding supportively holds at the 1% significance level. However, the Granger causality does not imply that the intermediate targeting function is better arranged at the price level, only indicating these two are more predictive. In fact, according to the TVP-VAR impulse response, the feedback of real output on the scissors is superior to that of inflation.

[Herein Insert Figure 9]

To sum up, from the view of the monetary policy regulation, in most sample intervals, monetary policy can regulate the scissors well (especially after 2016, the effective

of regulation strengthened), and at the same time, the scissors can reflect the tightness of monetary policy. From the view of the monetary policy effectiveness, in most sample intervals, the scissors can affect and predict the real economy, but its Granger causality with real output shows a certain unidirectionality, and that with inflation shows a longer period of bidirectionality.[35] However, in relation to the impulse responses of monetary policy targets on scissors shocks, the feedback magnitude of real output is larger than that of inflation, suggesting preference to arranging the matching effect at output than inflation.[36] It can be concluded that the Chinese government's matching effect of the intermediate targets at the level of output is more of a policy arrangement during the economic downturn, which is conducive to achieving a smooth transition in the process of transition from quantity to price.

6 Robustness

This paper conducts an empirical study using DAG-VAR-SR, TVP-VAR-SV, and TVGC, and the results are examined for robustness one by one in the following.

Firstly, for the DAG-VAR-SR model, we utilized four methods to perform robustness separately. (1) The DAGs of a new model with a sample size of 200 are re-examined using the PC-stable algorithm (Figure 16). After re-imposing restrictions, the IRs (Figure 17) exhibit the same in terms of direction and trend as the original results but differ to magnitude (Figure 2b, 4b and 5b).

(2) While keeping the same setting of the hybrid restrictions, the intercept term in the VAR is removed and the lag order of three models changes to 6. Figure 19 shows that the trend of the curves is kept the same as the original results except for the strength and speed of the IRs, which are slightly different, indicating that the original results are robust.

(3) The controllability characteristics of MPIs is re-examined by changing the restrictions. Since Figure 2 illustrates the exact *opposite mirroring effect* caused by one-standard-deviation monetary policy shock to AFRE and M2, to confirm the robustness, we relax the restrictions on it in Table 3, from which it is assumed that the monetary policy shock causes negative feedback on M2 immediately, and that the first six periods of feedback from AFRE are set to zero. To this end, we re-examine the IRs under new short-run zero restrictions imposed on M2 (which happens to a new DAG under the PC-stable algorithm, see Figure 16 and Table 15) as well as under no restrictions on both M2 and AFRE. According to Figure 10a and 10b, the feedback of M2, unlike Figure 2b, shows some positive responses in the short run after the relaxation of the

[35] Since the official statement is to match the nominal economic growth rate, we also re-examined nominal output, and results above remain robust and the Granger causality of nominal output on the scissors is even more significant, further confirming that the target matching effect arranged at the nominal economic growth rate is better than at the real rate, as detailed in Figure 15 and Table 13.

[36] As a matter of fact, after 2012, China's real output growth rate has been declining gradually, while the level of inflation has remained volatile around 2%. For the CPI, it is influenced to a greater extent by the food and non-food items, with significant seasonal fluctuations. The scissors spread, as observation of the macro-financing situation, is not only related to the goods markets, but more importantly reflects the financing supply and demand in the financial markets.

restrictions (due in all likelihood to the influence by the RMB loans and other components, see Figure 10d) and the minimum value lags to one year and a half later, but the overall responses remain negative unchanged. For the feedback of AFRE, unlike Figure 2c, positive feedback generates immediately after the relaxation and the peak is slightly higher, but overall remains consistent with the original results.

(4) Under the original setting in Table 3, AFRE is replaced by RMB loans.[37] Figure 10d illustrates that faced with one-standard-deviation monetary policy shock, the IR of RMB loans, despite positive feedback in the short run, exhibits pronounced negative feedback in the medium and long run, and the total feedback is much weaker than that of AFRE. This not only confirms the robustness, which to a certain extent corroborates views from Funke et al. (2015) and Yang et al. (2019), but demonstrates the evidence sideways that off-balance-sheet business intensifies the positive feedback effect in all lags, thus ultimately presenting the fully positive response curve in Figure 2c.

[Herein Insert Figure 10]

Secondly, for the TVP-VAR-SV model, we adjust the sampling number to 15,000 times and the lag order of the model to 2. Figure 20 demonstrates the results of the robustness, except for the response magnitude and some details, the trend and primary details of the curve are consistent with the original results, indicating that the original results are robust.

Finally, for the TVGC results, we assume that the residual series disobey the homoskedasticity hypothesis and perform a test using the heteroskedasticity-robust Wald statistic (see Figure 21 and Table 16). Again, the original results are proven to be robust.

7 Conclusion

In this paper we construct a SVAR model to test and compare the characteristics and effectiveness of the intermediate targets based on recent two decades of macro data in China, which depicts the monetary policy transmission process through various channels. In order to avoid the *price puzzle*, we introduce hybrid restrictions to identify the structural shocks, thus unveiling the *opposing mirroring effect* of AFRE and M2, and further examining our conjecture by TVP-VAR and TVGC, respectively.

As to the effectiveness of the intermediate targets of monetary policy, our study finds that, overall, the traditional M2 maintains dominant advantages, and the intermediate target functions of AFRE and market interest rates are highlighted. Specifically, (1) for the controllability characteristics, traditional M2 is optimal, followed by market interest rate second, and AFRE relatively the worst. (2) For the relevance characteristics to the real output, the traditional M2 is optimal, followed by AFRE second, and market interest rate relatively worst. (3) For the relevance characteristics to overall prices, the traditional M2 is still optimal, followed by the AFRE and market interest rate. In particular, AFRE is apparently more long-run neutral than M2.

[37] As the year-on-year growth rate data of RMB loans is not stationary, the first-order difference of the logarithmic monthly stock data (imputed data before 2015) is used here, with the same data processing and model lags of 3. Data source: The People's Bank of China.

In order to further confirm the conjecture of the *opposite mirroring effect*, we investigate the time-varying influence mechanism of scissors spread and monetary policy (targets), and find that: (1) the abundant liquidity environment will cause scissors contraction, or a short-run expansionary monetary policy strengthens the matching effect of AFRE and M2, while in the long run there exists a certain degree of weakening effect, showing asymmetry. With the deepening of interest rate liberalization, this strengthening effect will be further enhanced. (2) Although the scissors spread has a smooth transmission to consumer prices, the degree of target matching effect has a stronger correlation with real output than with inflation. Considering the process of interest rate liberalization and obstructed transmission at present, the effectiveness of arranging the matching effect at real output gets enhanced (more significant at nominal output) and it is not appropriate to locate it on inflation. (3) Especially for the level of real output, with the interest rate liberalization and the improvement of financial regulation, the output effect of quantity-based tools or targets is gradually declining, and to realize the smooth transition of quantity- to price-based ones and strengthen the effect of price-based functioning should be the direction to the future.

Using the TVGC, we find that the scissors spread has a bi-directional Granger causality with monetary policy and inflation in most of the sample intervals, which reaffirms the conclusions above. In addition, although the scissors spread is the Granger cause of real output, the time-varying Granger relationship between the two behaves unstably, with multiple periods of unhooking, and the matching effect between the two appears a certain degree of unidirectionality.

In conclusion, arranging the functions of the intermediate targets at a growth matching target, and particularly at the level of output, allows for effective detection and adjustment of monetary policy at different times, with a view to achieving different growth targets. Therefore, the Chinese government has intentionally blurred the orientation of the intermediate targets, which is more like a policy arrangement during economic downturns and conducive to achieving a smooth transition of quantity- and price-based regulation. However, the matching effect of AFRE and M2 is affected by numerous factors, which means that future research will work at how to strengthen the forecasting ability of output and the bi-directional matching effect with the expected price level. Our findings not only support the reliability of choosing AFRE as the intermediate target in the process of quantity- and price-mixed transition in China, but provide empirical evidence for reliability and effectiveness of the intermediate target transformation and its functional orientation adjustment for China.

Appendix

A.1 Exhibitions in the Main Text

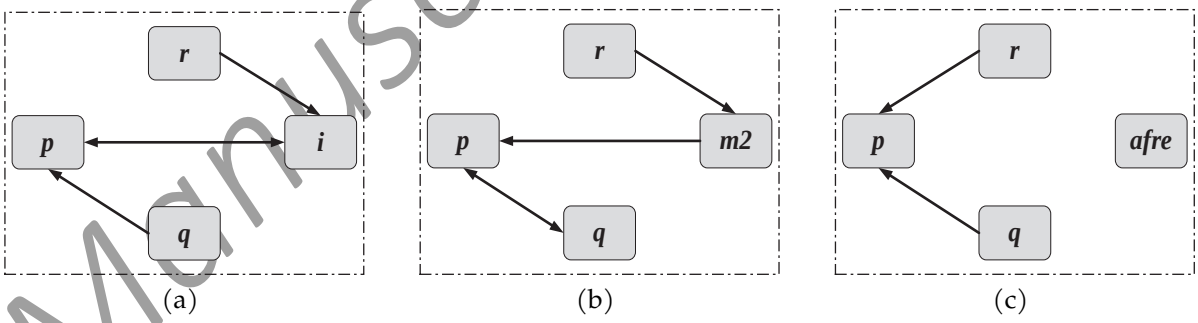
Table 1: Data Description

	r	*i*	*m2*	*afre*	*q*	*p*
Mean	2.697	2.791	14.421	23.086	10.309	2.488
Median	2.555	2.599	13.621	20.983	9.683	2.131
Maximum	6.951	6.945	29.622	63.325	2.966	8.894
Minimum	0.832	0.833	7.85	9.644	-2.795	-1.879
S.D.	0.924	0.882	4.827	12.588	4.819	1.842
ADF (20)	-2.935**	-2.932**	-3.355*	-4.417***	-6.217***	-3.578**
KPSS	0.336***	0.360**	0.143**	0.108***	0.076***	0.054***

*Note: ***, ** and * indicate that statistics are significant at the level of 1%, 5% and 10% respectively. In KPSS test, *** indicates null hypothesis that series is stationary cannot be rejected under 10%, and so forth. Data Source: The People's Bank of China; National Bureau of Statistics of China.*

Table 2: Correlation Coefficients of Residuals

	r	*i*	*m2*	*afre*	*q*	*p*
r	1					
i	0.964	1				
m2	-0.093	-0.105	1			
afre	-0.03	-0.046	0.563	1		
q	-0.045	-0.027	0.102	0.046	1	
p	0.077	0.099	-0.125	-0.047	-0.178	1



(a) (b) (c)

Figure 1: DAGs of Three Models

Table 3: Identifying Specification Combined Sign with Zero Restrictions

	shock source	*r*	*i*	*m2*	*afre*	*q*	*p*
Model (a)	*base rate*	>0	>0			$\begin{cases}0, k\epsilon\,[0,K]\\ ?, k>K\end{cases}$	<0
	monetary market	>0	>0			$\begin{cases}0, k\epsilon\,[0,K]\\ ?, k>K\end{cases}$	<0
Model (b)	*base rate*	>0		<0		$\begin{cases}0, k\epsilon\,[0,K]\\ ?, k>K\end{cases}$	<0
	funding supply	?		>0		$\begin{cases}0, k\epsilon\,[0,K]\\ ?, k>K\end{cases}$	>0
Model (c)	*base rate*	>0			$\begin{cases}0, k\epsilon\,[0,K]\\ ?, k>K\end{cases}$	$\begin{cases}0, k\epsilon\,[0,K]\\ ?, k>K\end{cases}$	<0
	funding demand	?			>0	$\begin{cases}0, k\epsilon\,[0,K]\\ ?, k>K\end{cases}$	>0

Note: Maximum lagged period for imposing constraints is assumed to be half a year $(K=6)$*, and within a given impulse response period* k $(k=0,1,...,6)$ *directions or levels of shocks to the three endogenous variables are set as positive* $(>)$*, negative* $(<)$*, zero* (0) *and unrestricted* $(?)$*. Shocks from monetary and funding market denote financial system impacts and those from the base rate denote monetary policy impacts.*

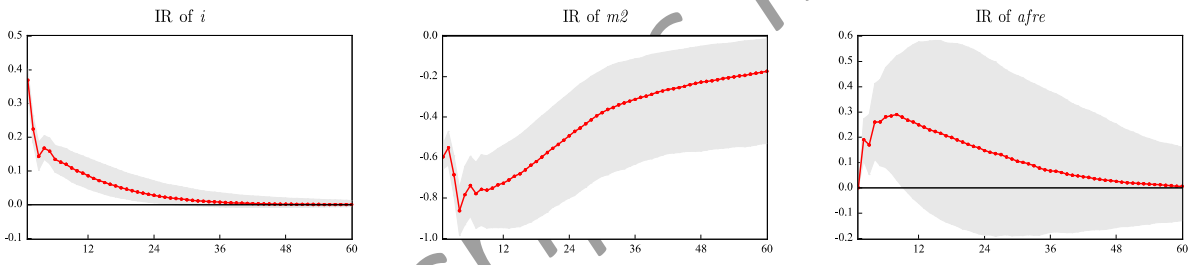


Figure 2: Impulse Responses of MPI to Shocks from the Base Rate

Note: Red solid lines represent means of IRFs regarding MPI to one-standard-deviation of one positive shock from the base rate during 5 years and dash areas represent 68% credible interval of the IRFs.

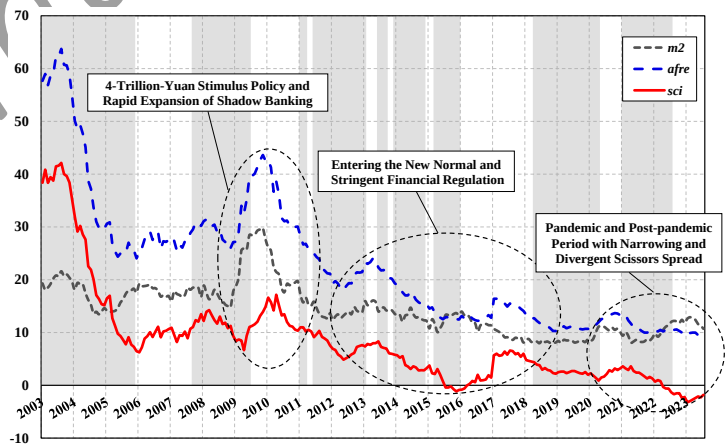
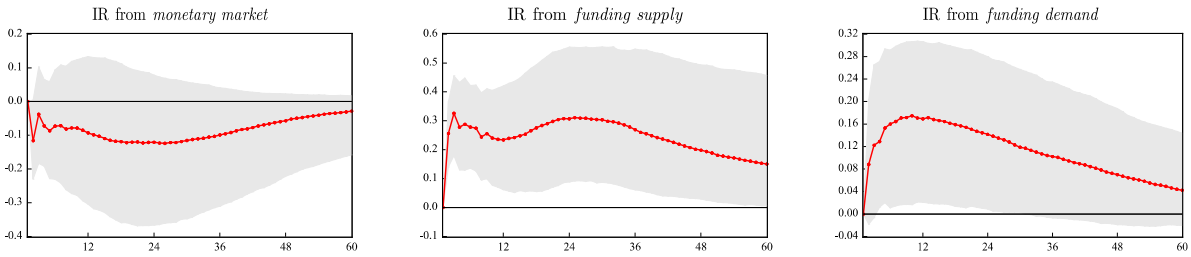


Figure 3: Scissors Spread between Social Financing Demand and Monetary Supply

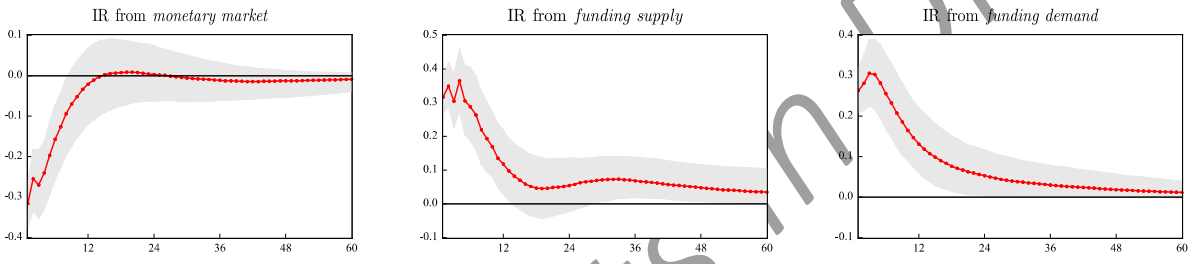
Note: Dash area represents a period of extended or rapid expansion in price-based monetary policy implementation (r) *that can be found in Figure 11.*



(a) (b) (c)

Figure 4: Impulse Responses of Output to Shocks from the Financial System

Note: Red solid lines represent means of IRFs regarding real output to one-standard-deviation of three positive shocks from the financial system during 5 years and dash areas represent 68% credible interval of the IRFs.



(a) (b) (c)

Figure 5: Impulse Responses of Inflation to Shocks from the Financial System

Note: Red solid lines represent means of IRFs regarding inflation rate to one-standard-deviation of positive shocks from the financial system during 5 years and dash areas represent 68% credible interval of the IRFs.

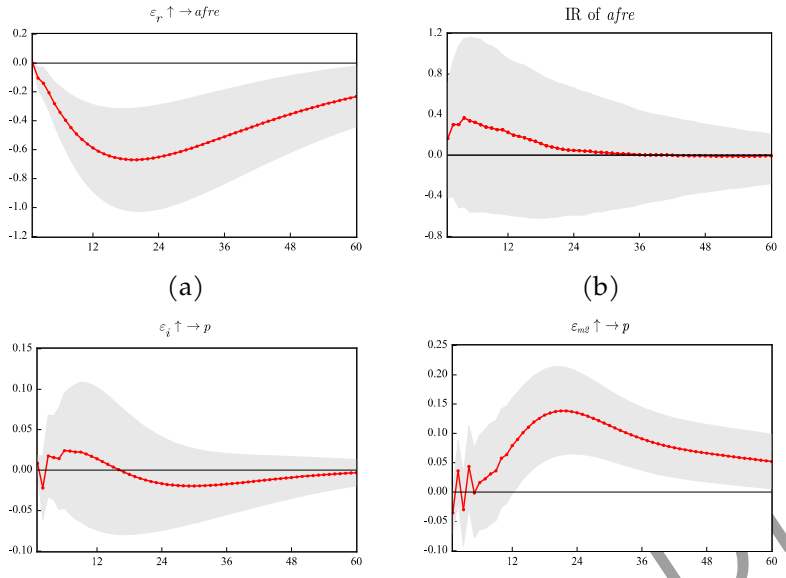
Table 4: FEVD I

lags	*i*	*m2*	*afre*
1	0.579 (0.488, 0.662) [59.08%]	0.399 (0.323, 0.483) [40.71%]	0.002 (0.000, 0.009) [0.20%]
6	0.562 (0.479, 0.643) [56.26%]	0.383 (0.347, 0.429) [38.34%]	0.054 (0.029, 0.093) [5.41%]
12	0.551 (0.471, 0.631) [53.97%]	0.371 (0.336, 0.409) [36.34%]	0.099 (0.049, 0.164) [9.70%]
36	0.501 (0.411, 0.591) [49.95%]	0.353 (0.313, 0.400) [35.19%]	0.149 (0.071, 0.256) [14.86%]
60	0.502 (0.404, 0.592) [48.93%]	0.357 (0.305, 0.403) [34.80%]	0.167 (0.080, 0.274) [16.28%]

Note: Five lag periods are selected to represent the immediate-, short-, medium-, and long-run. The upper and lower limits of 68% confidence interval and relative FEVD are shown in parentheses and brackets.

Table 5: FEVD II

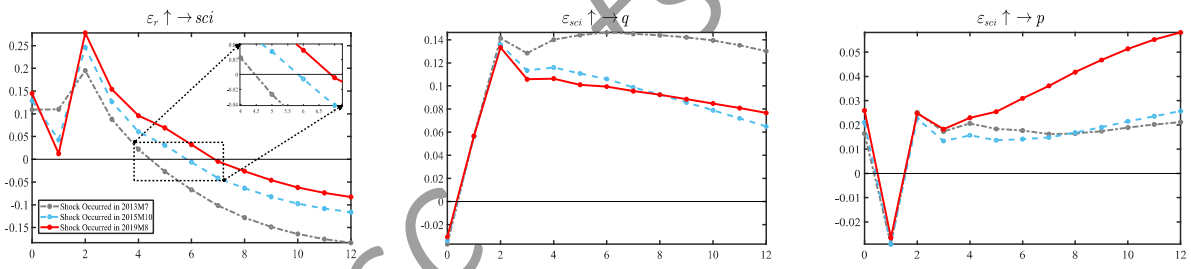
	monetary market	*funding supply*	*funding demand*
output			
1	0.004 (0.001, 0.017) [16.00%]	0.014 (0.003, 0.036) [56.00%]	0.007 (0.001, 0.023) [28.00%]
6	0.018 (0.009, 0.035) [13.43%]	0.084 (0.051, 0.132) [62.69%]	0.032 (0.014, 0.067) [23.88%]
12	0.039 (0.017, 0.082) [13.59%]	0.171 (0.112, 0.236) [59.58%]	0.077 (0.039, 0.137) [26.83%]
36	0.114 (0.048, 0.209) [21.23%]	0.264 (0.175, 0.359) [49.16%]	0.159 (0.087, 0.251) [29.61%]
60	0.122 (0.050, 0.236) [21.29%]	0.273 (0.169, 0.383) [47.64%]	0.178 (0.100, 0.273) [31.06%]
inflation			
1	0.341 (0.262, 0.434) [36.51%]	0.347 (0.269, 0.430) [37.15%]	0.246 (0.175, 0.323) [26.34%]
6	0.361 (0.277, 0.436) [38.78%]	0.332 (0.260, 0.416) [35.66%]	0.238 (0.169, 0.313) [25.56%]
12	0.338 (0.259, 0.411) [39.44%]	0.306 (0.238, 0.389) [35.71%]	0.213 (0.151, 0.289) [24.85%]
36	0.285 (0.212, 0.365) [34.30%]	0.329 (0.264, 0.396) [39.59%]	0.217 (0.155, 0.285) [26.11%]
60	0.286 (0.218, 0.367)] [34.33%]	0.327 (0.261, 0.393) [39.26%]	0.22 (0.157, 0.285) [26.41%]



(a) (b) (c) (d)

Figure 6: Impulse Responses by the Other Two Identification Methods

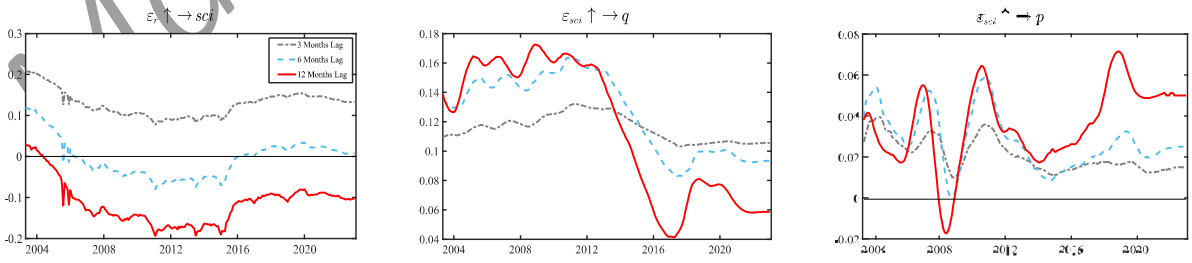
Note: Figures 6a, 6c & 6d represent results from DAG-SVAR and Figure 6b is one of the results from VAR-SR.



(a) (b) (c)

Figure 7: Periodic Impulse Responses from TVP-VAR

Note: The gray, blue, and red solid lines indicate that the shocks occurred at the liberalization of lending rates (2013M7), deposit rates (2015M10), and LPR reforms (2019M8) respectively.



(a) (b) (c)

Figure 8: Isochronous Impulse Responses from TVP-VAR

Note: The gray, blue, and red solid lines indicate three months, six months, and one year after the shocks occurred respectively.

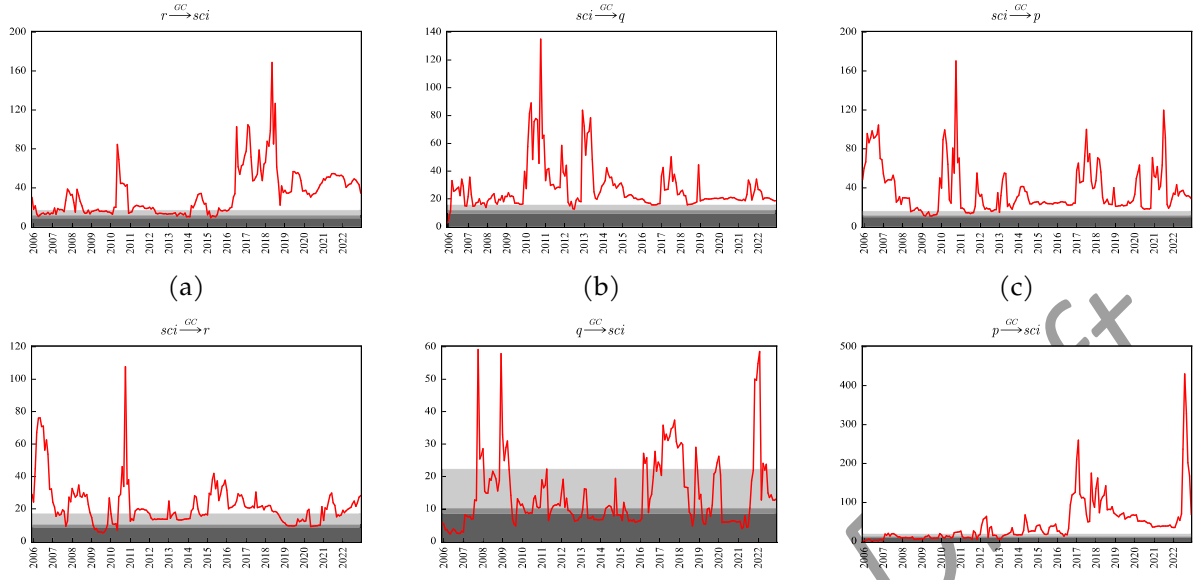
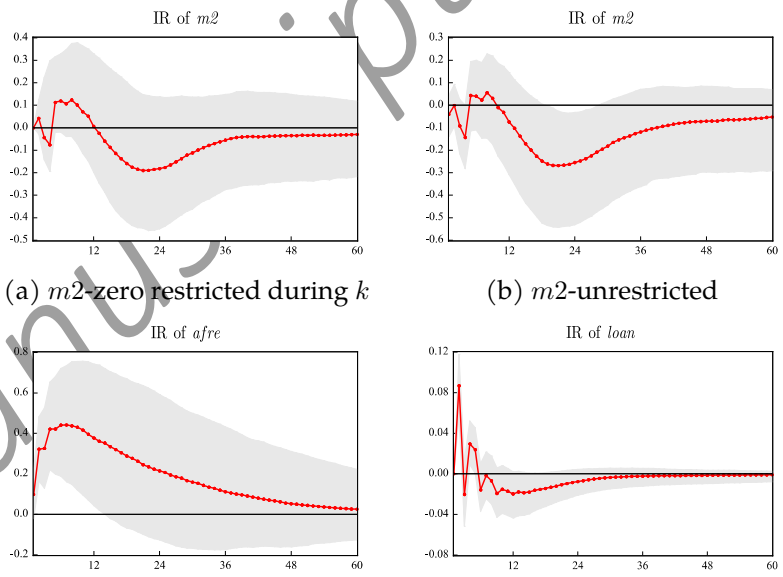


Figure 9: Bidirectional Time-varying Granger Causality

Note: The red solid lines indicate the sequences of Wald test statistics and the boundaries of dash areas from shallow to deep indicate the critical value of 1%, 5% and 10% significance level. Unidirectional Granger causality between two variables exists when the sequence of test statistics is above the critical value.



(a) $m2$-zero restricted during k (b) $m2$-unrestricted

(c) $afre$-unrestricted (d) substitute $loan$ for $afre$

Figure 10: Impulse Responses under Restrictions Relaxed

A.2 Data and RRR Cuts

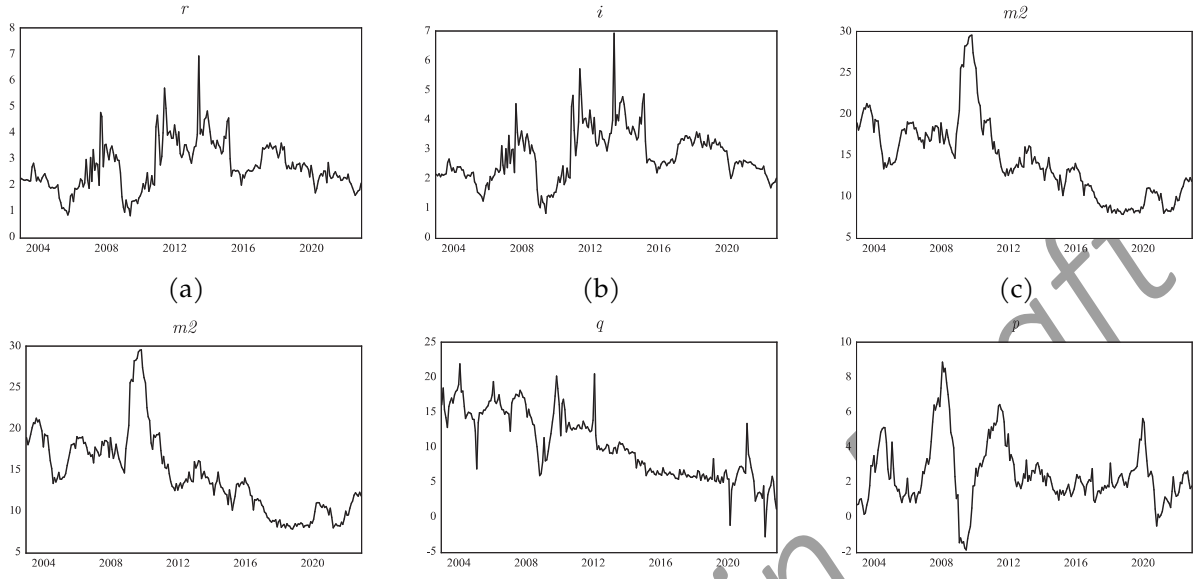


Figure 11: Time Series (%)

Note: The PBC has published stock value of AFRE since the end of 2015, with the increment value since the beginning of 2002 (the subitem "Other Items" has been published since January 2017). To calculate the year-on-year growth rate from January 2003 onwards, stock data from the end of 2015 is applied to retrospect to which from January 2002 onwards.

Table 6: Liquidity Released and AFRE (Trillion in RMB)

year	*liquidity released*	*cumulative AFRE flow*	*dominant contributions of changes*
2022	>1	32.01 (+0.67)	An increase of 2.1 trn in off-balance sheet financing more and a decline of 1.2 trn in government bonds less than which in 2021
2021	2.2	31.35 (-3.44)	A decline of 1.35 trn in off-balance sheet financing and 1.09 trn in corporate bonds less than which in 2020
2020	1.75	34.86 (+9.19)	An increase of 3.6 trn in government bonds, 3.1 trn in RMB loans and 1.1 trn in corporate bonds more than which in 2019
2019	2.7	25.58 (+3.08)	An increase of 1.2 trn in RMB loans more than which in 2018
2018	3.65	19.26 (-3.14)	A decline of 6.5 trn in off-balance sheet financing less as well as an increase of 2 trn in corporate bonds and 1.8 trn in RMB loans more than which in 2017

Note: The increments of cumulative AFRE flow in parentheses differentiate from calculation due to statistical caliber adjustments. Data Source: China's Monetary Policy Implementation Report.

A.3 Results from DAG-SVAR

According to results from DAGs in Figure 1, three contemporaneous coefficient matrixes can be successively set as follows, in which in (matrix A in the AB-form) as an element to be estimated, represents variable j makes a contemporaneous cause to variable i.

$$A_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & a_{24} \\ 0 & 0 & 1 & 0 \\ 0 & a_{42} & a_{43} & 1 \end{bmatrix}; \; A_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ 0 & 0 & 1 & a_{34} \\ 0 & a_{42} & a_{43} & 1 \end{bmatrix}; \; A_3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ a_{41} & 0 & a_{43} & 1 \end{bmatrix}$$

In the AB-form, matrix B is left to be estimated without any restriction. Additionally, to ensure the reliability of the DAG, we employ the Sims's likelihood ratio test (Sims, 1986) to statistically examine the "over-identification as true" hypothesis individually. All the p-values corresponding to the test statistic exceeds 10% (or 5%), so the null hypothesis cannot be rejected, confirming the effectiveness of the contemporaneous causal relationships identified by the DAGs in three models.

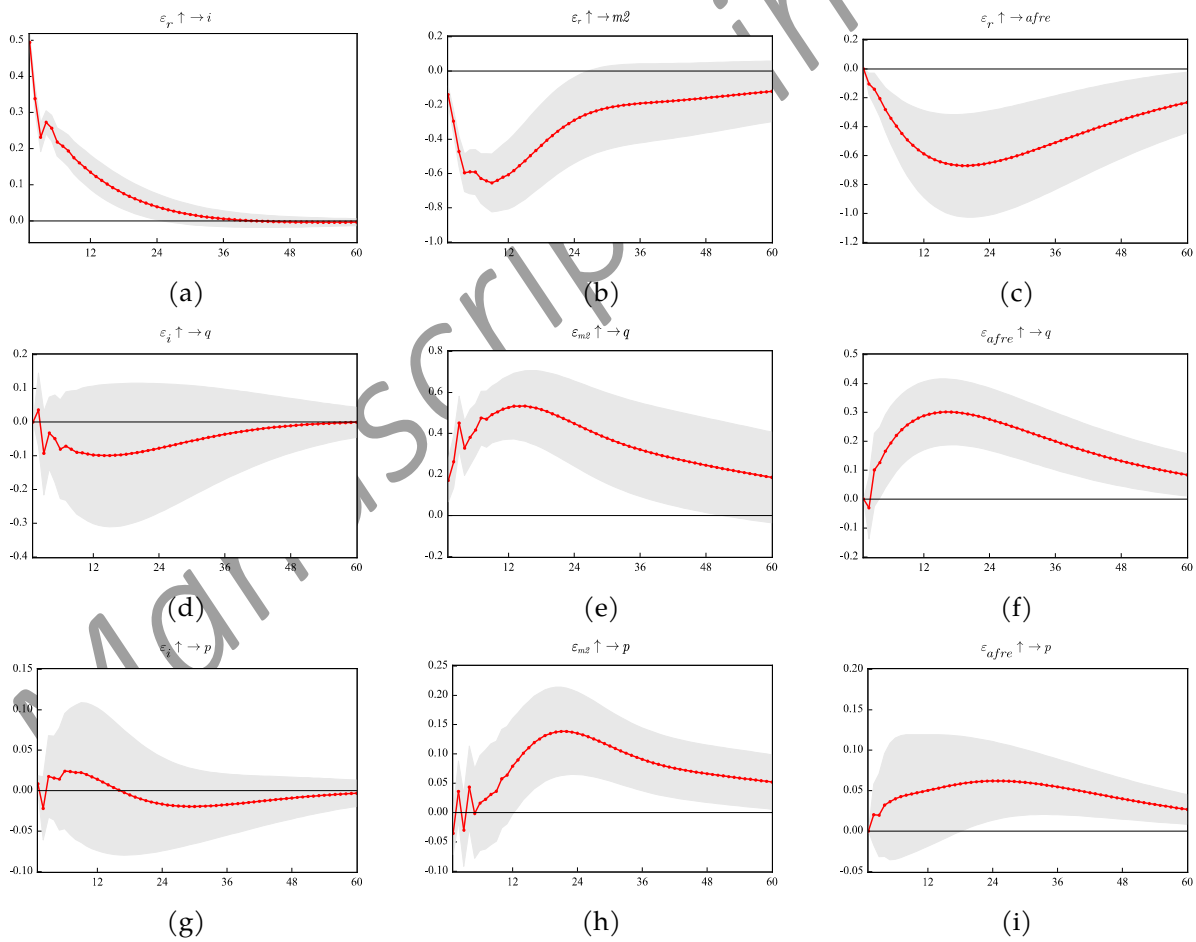


Figure 12: Impulse Responses from DAG-SVAR

Note: Red solid lines represent means of IRFs regarding dependent variables to one-standard-deviation of positive shocks from independent variables during 5 years and dash areas represent 68% credible interval of the IRFs.

Table 7: FEVD I from DAG-SVAR

	i	*m2*	*afre*
1	92.811	2.897	0
6	89.987	24.509	1.991
12	89.729	29.691	6.486
36	88.897	32.095	18.658
60	88.705	31.867	21.24

Note: It records the results of forecast error variance decomposition of MPI by unit monetary policy shock.

Table 8: Sim's Likelihood Ratio

	Log likelihood	*p-value*
Model (a)	-677.534	0.602
Model (b)	-1195.784	0.648
Model (c)	-1096.233	0.798

Table 9: FEVD II from DAG-SVAR

	i	*m2*	*afre*
output			
1	0	1.082	0
6	0.218	11.19	1.276
12	0.459	20.96	5.202
36	0.905	33.853	15.682
60	0.898	36.279	17.226
inflation			
1	0.021	0.388	0
6	0.094	0.276	0.236
12	0.152	0.755	0.619
36	0.271	10.324	2.996
60	0.328	12.926	4.054

Note: It records the results of forecast error variance decomposition of real output and inflation rate by shocks from the financial system.

A.4 Results from VAR-SR

Table 10: Identifying Specification Only for Sign Restrictions

	shock source	*r*	*i*	*m2*	*afre*	*q*	*p*
Model (*a*)	*base rate*	>0	>0			?	<0
	monetary market	>0	>0			?	<0
Model (*b*)	*base rate*	>0		<0		?	<0
	funding supply	?		>0		?	>0
Model (*c*)	*base rate*	>0			?	?	<0
	funding demand	?			>0	?	>0

Note: We assume the directions or levels of shocks to the other three endogenous variables are set as positive (>)*, negative* (<)*, zero* (0) *and unrestricted* (?)*.*

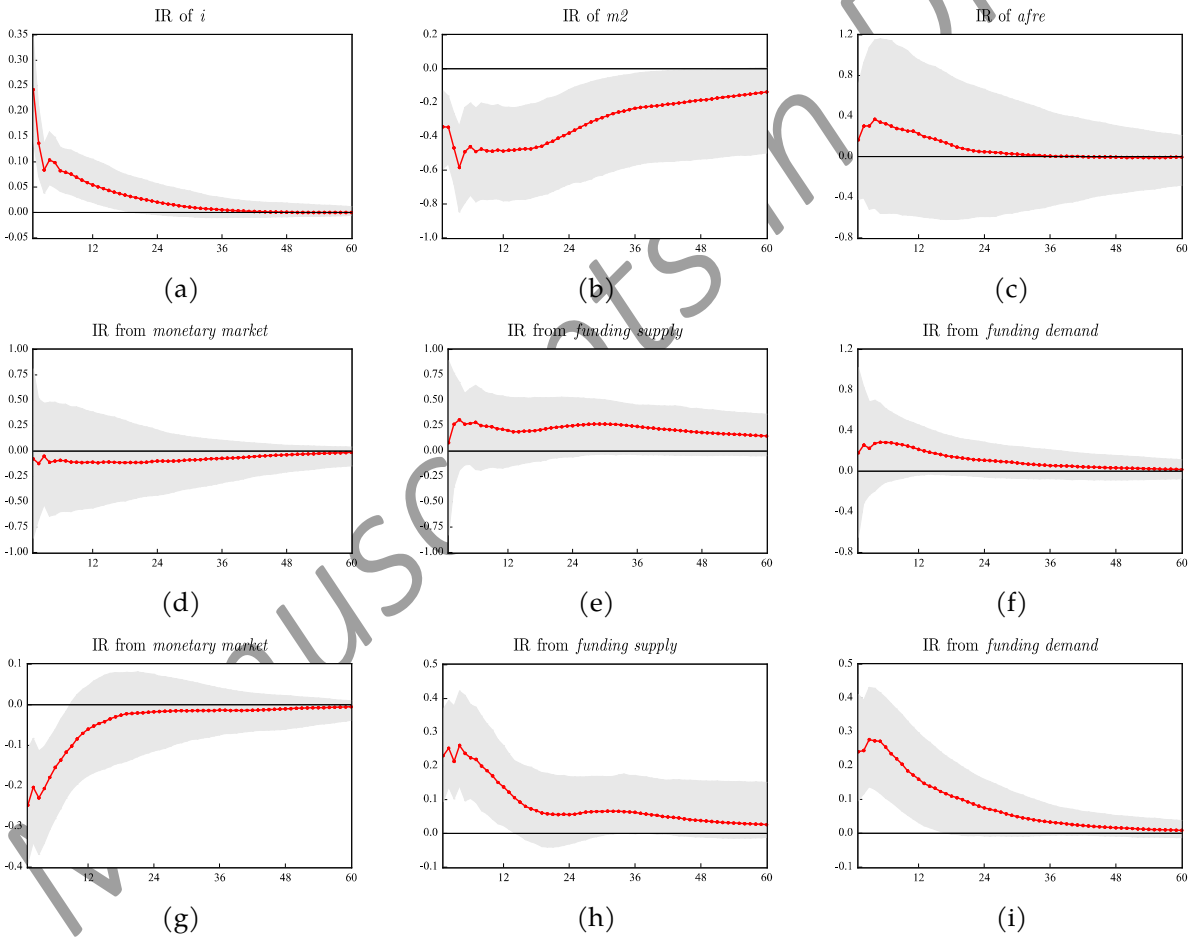


Figure 13: Impulse Responses from VAR-SR

Note: Red solid lines represent means of IRFs regarding dependent variables to one-standard-deviation of positive shocks from independent variables during 5 years and dash areas represent 68% credible interval of the IRFs. Specifically, Figure 13a, 13b and 13c represent the impulse responses of MPI to shock from a base rate; Figure 13d, 13e and 13f represent the impulse responses of real output to the shocks from the financial system; Figure 13g, 13h and 13i represent the impulse responses of inflation rate to the shocks from the financial system. Note: Algorithms of pure-sign-restriction approach by Uhlig (2005) are implemented in here.

Table 11: FEVD I from VAR-SR

	i	*m2*	*afre*
1	0.291	0.116	0.143
6	0.29	0.207	0.177
12	0.257	0.24	0.189
36	0.25	0.234	0.224
60	0.272	0.232	0.24

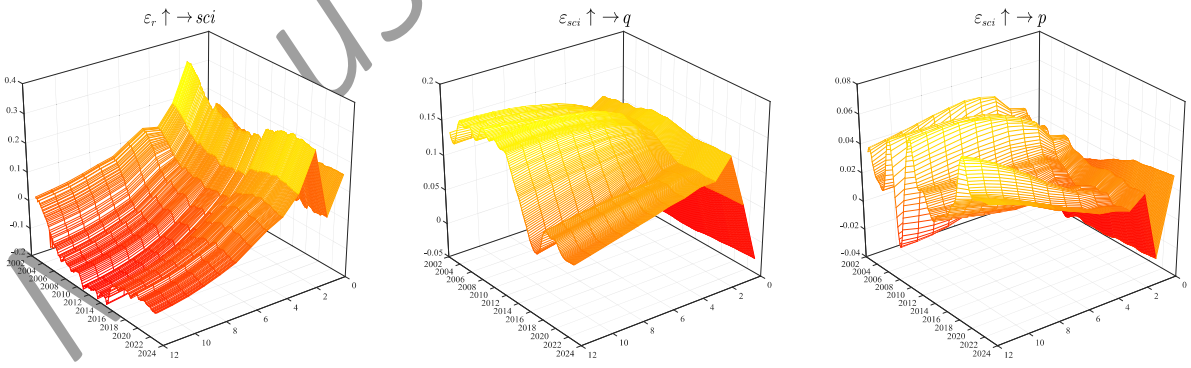
Note: It records the results of forecast error variance decomposition of MPI by unit monetary policy shock.

Table 12: FEVD II from VAR-SR

	monetary market	*funding supply*	*funding demand*
output			
1	0.13	0.122	0.12
6	0.119	0.184	0.15
12	0.153	0.223	0.169
36	0.195	0.257	0.224
60	0.201	0.26	0.229
inflation			
1	0.228	0.218	0.193
6	0.255	0.202	0.201
12	0.232	0.211	0.201
36	0.25	0.24	0.215
60	0.228	0.236	0.21

Note: It records the results of forecast error variance decomposition of real output and inflation rate by shocks from the financial system.

A.5 Results from TVP-VAR-SV



(a) (b) (c)

Figure 14: Impulse Responses from TVP-VAR

A.6 Time Varying Granger Causality

Following Shi et al. (2020), Equation 1 can be written to LA-VAR (p):

$$\begin{aligned} y_t &= \delta_0 + \delta_1 t + \sum_{i=1}^{p} B_i y_{t-i} + \sum_{j=p+1}^{p+d} B_j y_{t-j} + u_t \\ &= \Lambda \tau_t + \Phi x_t + \Psi z_t + u_t \end{aligned} \tag{6}$$

where $\Lambda = (\delta_0, \delta_1)_{k\times(q+1)}$, $\tau_t = (1,t)'_{2\times 1}$, $\Phi = (B_1, \cdots, B_p)_{k\times kp}$, $x_t = \left(y'_{t-1}, \cdots, y'_{t-p}\right)'_{kp\times 1}$, $\Psi = (B_{p+1}, \cdots, B_{p+d})_{k\times kd}$, $z_t = \left(y'_{t-p-1}, \cdots, y'_{t-p-d}\right)'_{kd\times 1}$, $B_{p+1} = \cdots = B_{p+d} = 0$ with d as maximum order of integration in endogenous variables.

In a more compact form, Equation 5 can be further transformed to,

$$Y = \tau\Lambda' + X\Phi' + Z\Psi' + u$$

where $Y = (y_1, \cdots, y_T)'_{T\times k}$, $\tau = (\tau_1, \cdots, \tau_T)'_{T\times 2}$, $X = (x_1, \cdots, x_T)'_{T\times kp}$, $Z = (z_1, \cdots, z_T)'_{T\times kd}$ and $u = (u_1, \cdots, u_T)'_{T\times k}$.

The null hypothesis of Granger non-causality is given as follows:

$$H_0 : R\varphi = 0$$

Parameter φ can be obtained by row vectorization of Φ , and R is a $m \times k^2 p$ matrix□Since the coefficients are set to 0, the last d-order vector of coefficient matrices can be ignored, so the OLS estimator can be written as

$$\Phi = Y'QX\left(X'QX\right)^{-1}$$

where $Q = Q_\tau - Q_\tau Z\left(Z'Q_\tau Z\right)^{-1} Z'Q_\tau$, $Q_\tau = I_T - \tau\left(\tau'\tau\right)'\tau'$, and let $\hat{\varphi} = vec\left(\Phi\right)$, $\Sigma_u = \dfrac{1}{T}\left(\hat{u}'\hat{u}\right)$, then the Wald test statistic for the null hypothesis criterion can be expressed as:

$$W = \left(R\hat{\varphi}\right)'\left[R\left\{\Sigma_u \otimes \left(X'QX\right)^{-1}\right\}R'\right]^{-1} R\hat{\varphi}$$

The statistic asymptotically follows χ^2_m distribution with a constrained number of m.

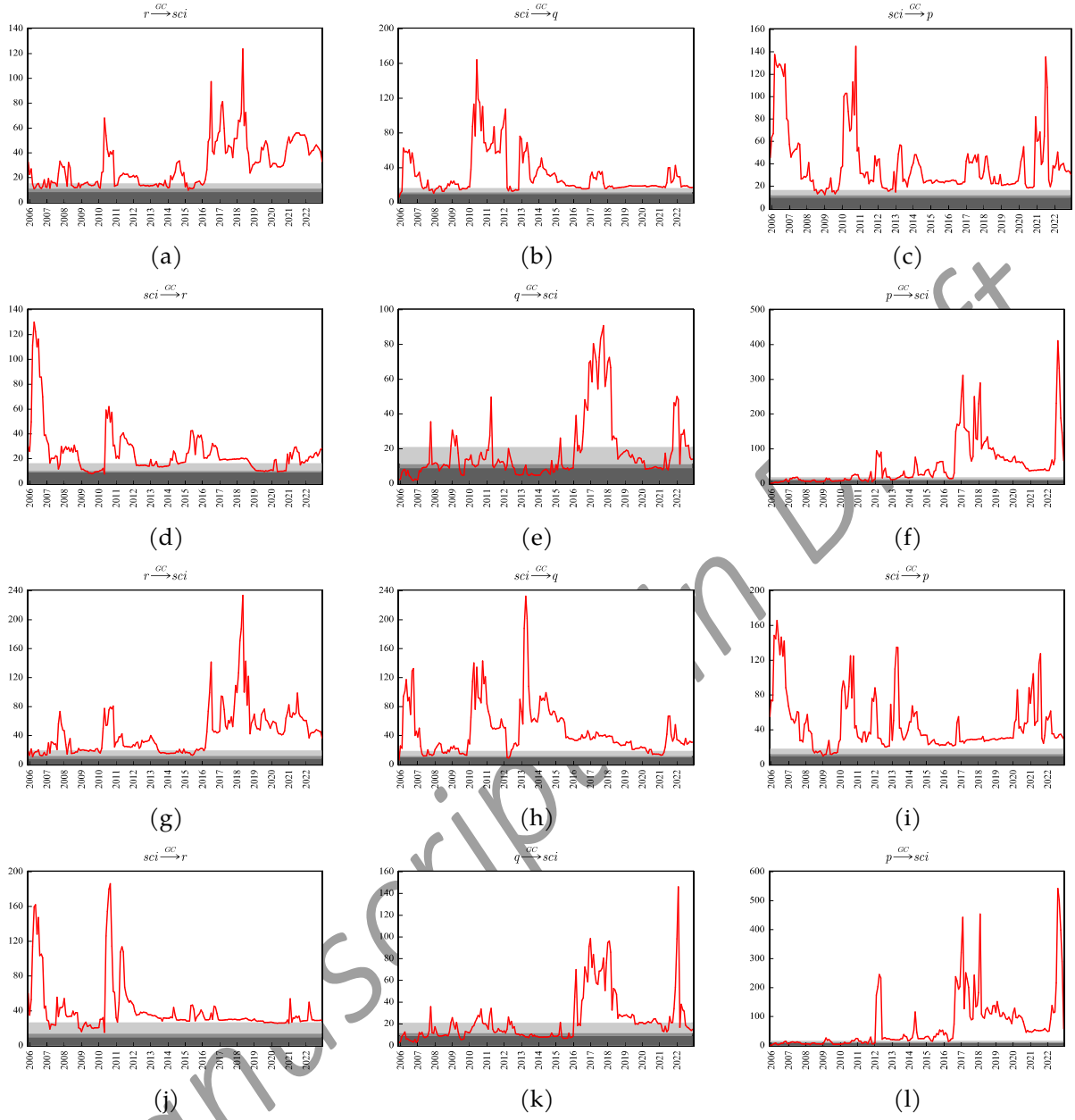


Figure 15: Bidirectional Time-varying Granger Causality Considering Nominal Output

Note: Figure 15a to 15f follow the assumption of homoskedasticity to the residual sequences, and Figure 15g to 15l follow the assumption of heteroscedasticity to the residual sequences, that is, from which the red solid lines indicate sequences of robust Wald test statistics.

Table 13: Wald Tests of Granger Causality Considering Real Output

Direction of Granger Causality	*Max Wald*	*Direction of Granger Causality*	*Max Wald*
	168.955		107.788
$r \xrightarrow{GC} sci$	(11.657)	$sci \xrightarrow{GC} r$	(10.301)
	[17.085]		[17.044]
	135.001		59.177
$sci \xrightarrow{GC} q$	(11.866)	$q \xrightarrow{GC} sci$	(10.233)
	[15.624]		[22.304]
	170.252		430.44
$sci \xrightarrow{GC} p$	(11.542)	$p \xrightarrow{GC} sci$	(12.328)
	[15.975]		[18.969]

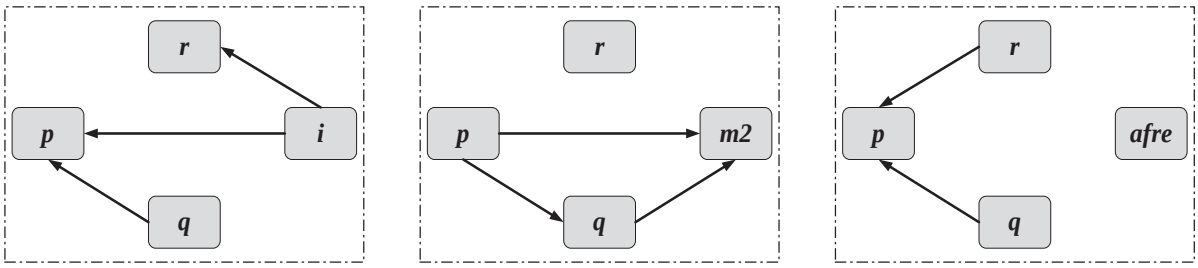
Note: It records the maximum value of Wald statistic series under the homoskedasticity hypothesis, and the 95% and 99% quantiles of the bootstrap test statistic distribution are marked in parentheses and brackets, respectively.

Table 14: Wald Tests of Granger Causality Considering Nominal Output

Direction of Granger Causality	*Max Wald*	*Max Wald Robust*	*Direction of Granger Causality*	*Max Wald*	*Max Wald Robust*
	123.764	233.805		130.077	186.312
$r \xrightarrow{GC} sci$	(11.217)	(11.932)	$sci \xrightarrow{GC} r$	(10.191)	(13.642)
	[15.356]	[19.404]		[16.345]	[26.477]
	164.388	232.624		90.958	146.181
$sci \xrightarrow{GC} q$	(11.760)	(11.812)	$q \xrightarrow{GC} sci$	(11.128)	(11.325)
	[16.452]	[18.746]		[20.973]	[21.046]
	145.115	165.913		411.722	542.458
$sci \xrightarrow{GC} p$	(11.836)	(12.021)	$p \xrightarrow{GC} sci$	(12.296)	(11.521)
	[16.456]	[18.163]		[18.078]	[16.087]

Note: It records the maximum value of Wald (Robust) statistic series under the homoskedasticity and heteroskedasticity hypothesis.

A.7 Robustness

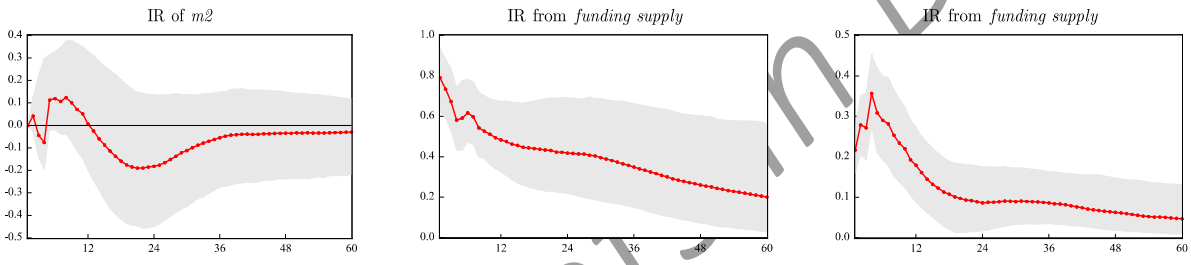


(a) (b) (c)

Figure 16: DAGs Considering Order-independence

Table 15: Identifying Specification Based on Figure 16b

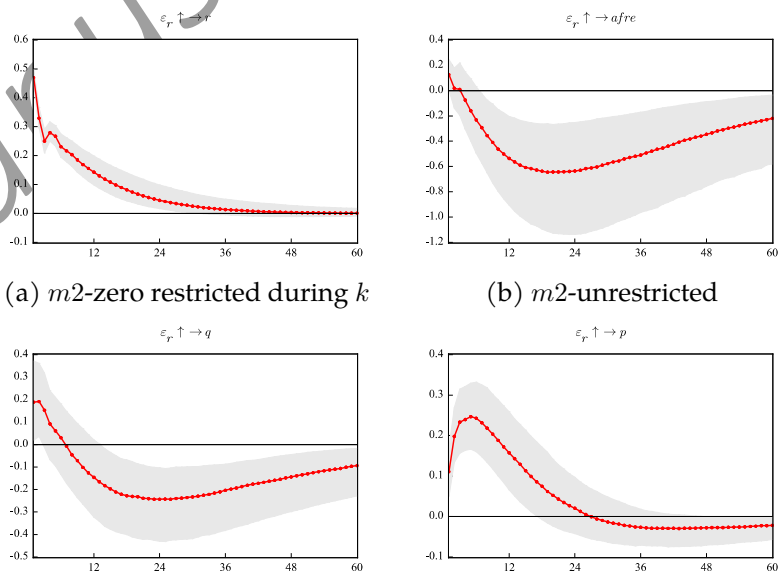
	shock source	*r*	*m2*	*q*	*p*
Model (b)	*base rate*	>0	$\begin{cases} 0, k\epsilon\,[0,K] \\ ?, k>K \end{cases}$	$\begin{cases} 0, k\epsilon\,[0,K] \\ ?, k>K \end{cases}$	<0
	funding supply	?	>0	>0	>0



(a) (b) (c)

Figure 17: Impulse Responses Based on Table 15

Note: Red solid lines represent means of IRFs regarding dependent variables to one-standard-deviation of positive shocks from independent variables during 5 years and dash areas represent 68% credible interval of the IRFs. Specifically, Figure 17a (also Figure 10a) represents the impulse response of m2 to shock from base rate; Figure 17b and 17c represent the impulse response of real output and inflation rate to shock from the monetary markets respectively.



(a) $m2$-zero restricted during k (b) $m2$-unrestricted

(c) $afre$-unrestricted (d) substitute $loan$ for $afre$

Figure 18: Results under No Restrictions as Compared to Sheng & Xie (2016)

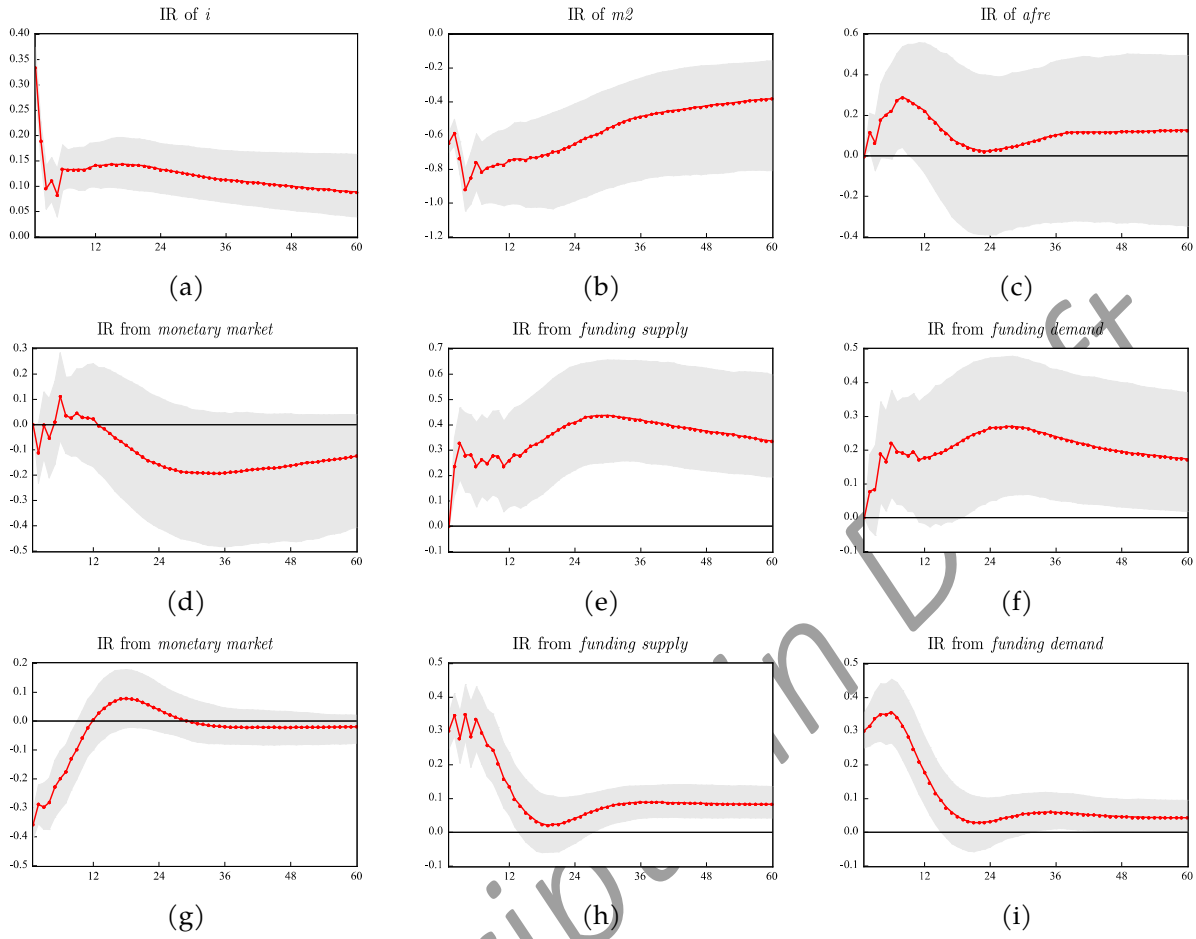


Figure 19: Impulse Responses from DAG-VAR-SR

Note: Red solid lines represent means of IRFs regarding dependent variables to one-standard-deviation of positive shocks from independent variables during 5 years and dash areas represent 68% credible interval of the IRFs. Specifically, Figure 19a, 19b and 19c represent the impulse responses of MPIs to shock from the ,base rate; Figure 19d, 19e and 19f represent the impulse responses of real output to the shocks from the financial system; Figure 19g, 19h and 19i represent the impulse responses of inflation rate to the shocks from the financial system.

Table 16: Roubust Wald Tests of Granger Causality Considering Real Output

Direction of Granger Causality	*Max Wald Roubust*	*Direction of Granger Causality*	*Max Wald Roubust*
$r \xrightarrow{GC} sci$	173.089 (11.629) [19.348]	$sci \xrightarrow{GC} r$	145.538 (13.372) [25.051]
$sci \xrightarrow{GC} q$	158.018 (12.252) [18.591]	$q \xrightarrow{GC} sci$	59.177 (12.017) [20.240]
$sci \xrightarrow{GC} p$	167.982 (11.966) [18.170]	$p \xrightarrow{GC} sci$	638.703 (11.823) [16.317]

Note: It records the maximum value of Wald Robust statistic series under the heteroskedasticity hypothesis.

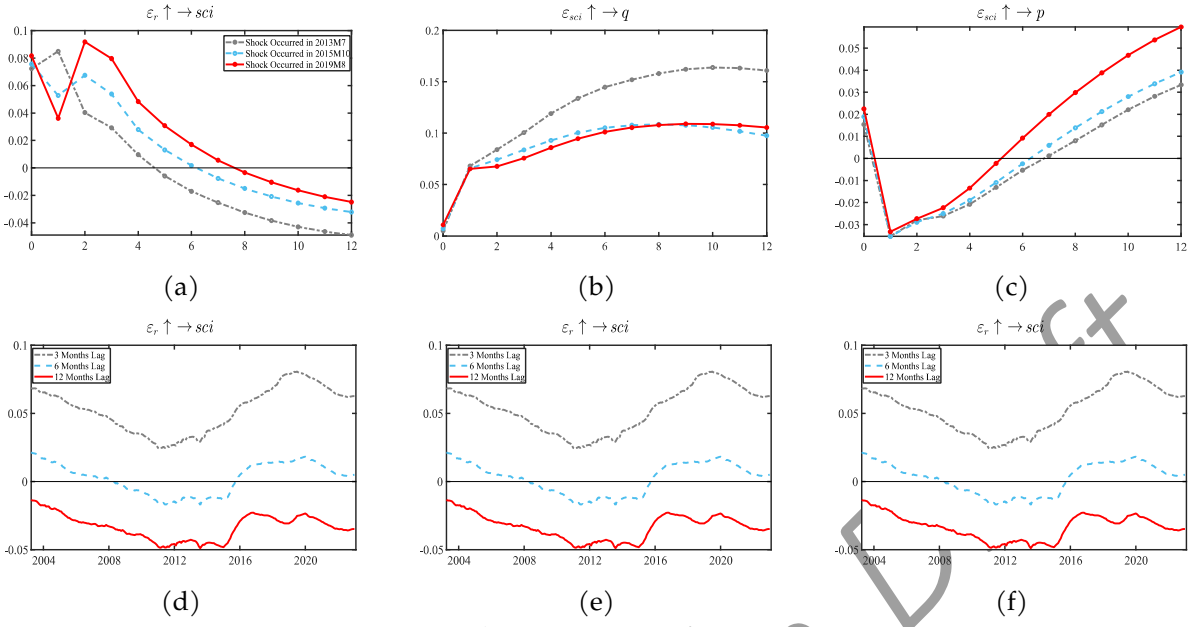


Figure 20: Impulse Responses from TVP-VAR-SV

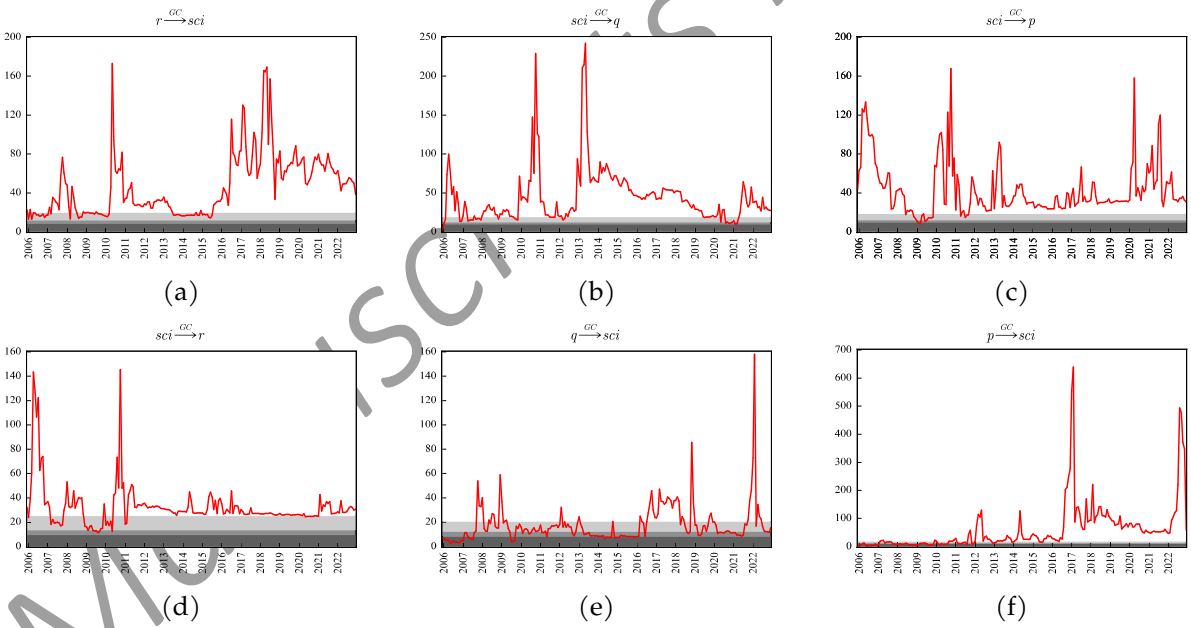


Figure 21: Bidirectional Time-varying Granger Causality Considering Real Output

Note: The red solid lines indicate the sequences of robust Wald test statistics.

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