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Monetary Policy and Deleveraging of Microfinance Institutions in China: A Dynamic Threshold Approach

Yue Li[1,2], Zariyawati Mohd Ashhari[1], Nazrul Hisyam Ab Razak[1] and Wei Ni Soh[1]

[1]School of Business and Economics, Universiti Putra Malaysia, Selangor, 43400, Malaysia,

[2]Guangxi Financial Vocational College, 530007, Nanning, China

Email: nolee36@gmail.com, nazrul@upm.edu.my, sohweini@upm.edu.my

Corresponding Author Email: zariyawati@upm.edu.my

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Abstract

By constructing the dynamic panel model and dynamic threshold model, this paper empirically analyzes the direct impact of monetary policy transmission on deleveraging initiatives of 204 microfinance institutions (MFIs) in China from 2012 to 2021, and the interactive effects of different monetary policy tools. The empirical investigations find that: the quantitative monetary policy transmission directs a negative impact on MFIs' deleveraging, while the direct macro-control of price-based monetary policy tool is not significant. When two monetary policy tools interact, the inhibitory effect of quantitative monetary policy on MFIs' deleveraging weakens once the price-based monetary policy tightening exceeds the threshold. Additionally, as the endogenous money multiplier amplifies the actual money quantity, price-based monetary policy starts to play its role in stable controllability, and MFIs gradually accept market-oriented interest rate mechanisms to adjust their deleveraging initiatives. The findings herein contribute to the significant implications of the study. The central bank should characterize the quantity control of quantitative monetary policy and the structural control of price-based monetary policy to formulate a scientific monetary policy. By improving the market-oriented interest rate mechanism of microfinance and coordinating with macroprudential regulations, it could achieve micro-prudential guidance on MFIs' deleveraging progress, as well accelerate economic transition and structural leverage adjustment.

Keywords: Microfinance Institutions, Deleveraging, Monetary Policy

Introduction

Monetary policy is a crucial tool for macroeconomic control as it significantly impacts economic growth, financial stability, and full employment. The global financial crisis of 2008

prompted a thorough examination of its root causes. Some scholars argue that the crisis was primarily caused by the Federal Reserve's long-term low interest rate monetary policy and loose liquidity (Acharya & Naqvi, 2012; Prokopowicz, 2020). As financial institutions play the pivot in implementing monetary policy and controlling the financial market, their operational behaviors are inevitably influenced by changes in monetary policy, leading to alterations in their operating risks (Rostagno et al., 2021). Therefore, implementing appropriate monetary policies can effectively manage systemic risks in banks, known as 'leverage'. In general, Dang & Nguyen (2021) suggest that monetary policy affects financial institutions' operations by adjusting their leverage and the allocation of credit resources. Empirical research conducted by Fraisse et al (2020) reveal that a lower level of bank liabilities corresponds to a smaller level of risk for the bank. By regulating bank leverage ratios, the impact of monetary policy on banks can be weakened or mitigated. In the risk propagation theory of monetary policy, scholars argue that monetary policy goes beyond the constraints of banks' passive risk-neutral role and magnifies systemic risks through leveraged operations, thereby leading to the fragility of the financial system (Greenbaum et al., 2019; Wang et al., 2022). Consequently, they emphasize the importance of incorporating the risk perceptions and responses of financial institutions in the monetary policy-making process. This contributes to mitigating certain constraints within the theoretical framework of monetary policy.

Following the financial crisis, major developed countries have frequently implemented loose monetary policies to adjust interest rates, aiming to manage the expectations of financial institutions. In recent years, the central banks across the globe have launched or intensified quantitative easing measures to address the financial challenges arising from the COVID-19 pandemic (Botiș, 2020; Shkodina et al., 2020). Consequently, there has been a significant increase in interest rate cuts and the macro leverage level, resulting in the accumulation of certain financial risks. In light of this, Cuadro-Sáez et al (2020) argue that monetary policy should actively take measures to reduce the occurrence of financial crises. In China, deleveraging has been proposed as a key strategy to address the high debt burden on the economy resulting from excessive misallocated investments. The primary focus of deleveraging is to promote structural transformation. This involves redirecting credit allocation away from sectors with high debt levels, particularly the numerous unproductive state-owned enterprises that heavily rely on loans for survival. Furthermore, it emphasizes the need for credit allocation to be more considerate of credit-starved fields, such as small businesses[1] and emerging enterprises (Gott, 2023). This reallocation is expected to expedite economic transition while mitigating systemic risks associated with high debt level.

Financial institutions are affected by macro strategies and are currently in the process of deleveraging. As Fig. 1 shows, the leverage (liability ratio) of financial institutions has consistently decreased in recent years. Microfinance institutions (MFIs), which play a crucial role in serving local small businesses, are also experiencing this decline. In the wake of a tightening macroprudential regulation, particularly the macroprudential assessment system initiated in 2017, the scope for financial institutions to exploit regulatory loopholes through off-balance sheet financial innovations has been significantly diminished. However, MFIs have simpler business models compared to traditional banks, and the macroprudential regulation may not reach the micro prudence on including heterogeneous regulation for different

[1] Small businesses include vulnerable groups of individual businesses, household businesses, small rural-related businesses and other small-medium enterprises, which are excluded by major banking.

institutions. This strict regulation could be too harsh for MFIs. According to Beker (2019), at a certain critical point, the deleveraging efforts of financial institutions reach a level that renders the financial system extremely fragile, exponentially increasing the likelihood of a financial crisis. This highlights the dual nature of deleveraging. Excessive deleveraging raises concerns among MFIs regarding their financial stability and regulatory compliance, which may drift their mission from promoting financial inclusion. To facilitate the capital allocation through credit by financial institutions to support the entity economy, scholars have highlighted the importance of improving the transmission mechanism of monetary policy to enhance the service capabilities of the financial system and achieve economic goals (Anarfo et al., 2019; Buch et al., 2019; Ca'Zorzi et al., 2020). In 2018, China's financial work shifted its focus from strong supervision to unblocking and improving the transmission mechanism of prudent monetary policy to address the negative impacts of slowing economic growth, weak credit growth, and depletion of credit funds. Financial institutions were encouraged to adopt prudent and gradual measures to deleverage. In the second half of 2019 and the first half of 2020, China's central bank attempted to stimulate financial institutions to increase support for small businesses through targeted reductions in reserve requirements for financial inclusion loans and targeted loose monetary policies. In the meantime, the leverage ratio of MFIs rebounded significantly (see Figure 1).

In the short term, loose monetary policy may increase the profits of financial institutions (White, 2012). According to the analysis of trade-off theory, financial institutions benefit from tax shield advantages in a way of faster decline in debt financing costs compared to their interest income, thereby increasing the net interest rate (Ricca et al., 2021). The increase in debt financing also leads to higher leverage. In the long term, loose monetary policy affects financial institution's risks by smoothing the yield curve and reducing term premiums. During this period, the pecking order theory gives preference to internal financing deleveraging over external financing, with the aim of reducing risk-taking (Beck et al., 2014). The impact of monetary policy on the deleveraging initiatives of financial institutions appears to be undergoing a period of inflection. In the case of MFIs, this interest arouses the first research objective of the study to investigate the influencing mechanisms of quantitative and price-based monetary tools in MFIs' deleveraging initiatives. Is there a specific point at which nonlinear effects occur? To address these questions, the second research objective of this study engages in developing a nonlinear structural model to analyze the transmission mechanism of monetary policy on MFIs' deleveraging. This analysis will provide valuable insights into the formulation and implementation of central bank's monetary policy, as well as the policy transmission mechanism. Furthermore, it will have significant implications for improving the leverage management of MFIs.

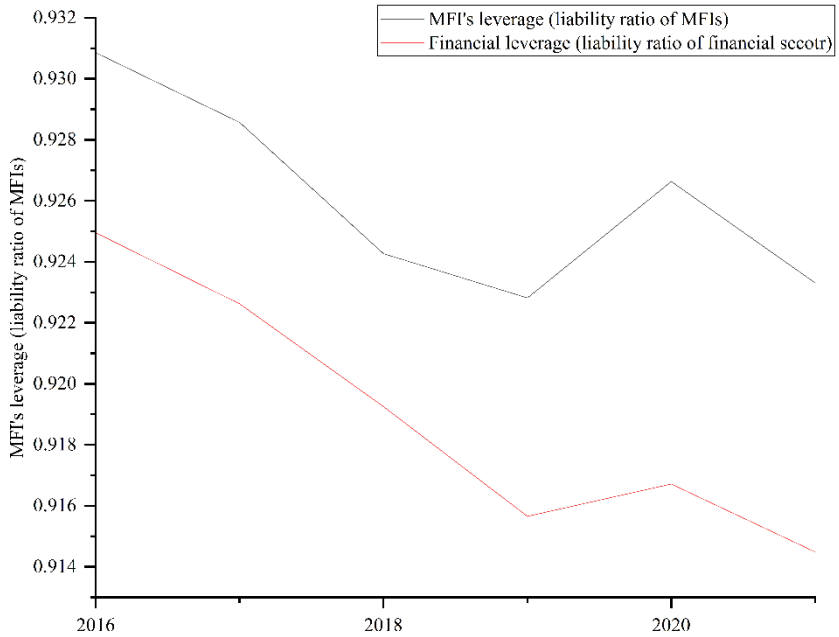

Fig. 1: Trends of MFIs' leverage and financial leverage

Literature Review

Monetary policy and financial institution's leverage

The painful lesson from financial crisis in 2008 has raised the attention on the financial risk mitigation by deleveraging. Scholars have reached a fundamental consensus that deleveraging focuses on the role of financial institutions as credit intermediation, addressing misallocated investments through credit reallocation and achieving economic debt reduction (Chi, 2021; Duqi, 2023; Woodford, 2010). Deleveraging is a top-down process, with financial institutions being the first to be affected. To ensure the stability of the financial system, Basel III introduced the leverage ratio as a supplement of macroprudential requirements for capital regulation. Accordingly, financial institutions are compelled to reduce their risk exposures and strengthen their capital positions, resulting in a substantial deleveraging (Masera, 2019). Overall, the adjustments observed at the global level can be attributed to regulatory and financial factors, as well as the unsustainable business models of pre-crisis banking activities need to be modified (Borio et al., 2020). At the same time, the sharp deleveraging has exacerbated the tightening of debts and interbank markets, increasing the fragility of the financial system (Patalano & Roulet, 2020). According to the prevailing view among scholars, under the low-risk exposure maintained by the deleveraging process, it is believed that liquidity provision to financial institutions through the momentum towards loose monetary policy is facilitating credit allocation rather than credit expansion (Ba, 2022; Chan, 2019; Ryan-Collins et al., 2023). Borio & Zhu (2008) revealed the mechanism of monetary policy transmission through the risk-taking channel of financial institutions and directed the cause of leverage. Building on this understanding, theories such as the financial accelerator effect Benedictow & Hammersland (2020); Giri et al (2019); Hirakata et al (2018), interest pursuit effect Bartscher et al (2022); Bernanke (2020), herd effect Apergis et al (2020); Aydin et al (2021); Krokida et al (2020), and habit formation effect Amato & Laubach (2004); Bartolomeo et al (2011); Monnet & Puy (2020), have been derived to expound the transmission of monetary policy. The causes of leverage are typically explained by capital structure theories, such as the trade-off theory and pecking order theory (Adair & Adaskou, 2015; Jarallah et al., 2019; Myers, 1984), which examine how financial institutions adjust their capital structure.

In the empirical testing of theoretical models, Jiménez et al (2012) discover that implementing loose monetary policy increases loan default rates and leveraging risk in the Spanish capital market. This finding aligns with study of Lenarčič (2019) conducted in the Haiti countries and Slovenia. Dell'Ariccia et al (2017) employ a two-period theoretical model to investigate the impact of a low interest rate environment on bank risk-taking and found that loose monetary policy encourages banks to increase leverage and take on higher risks, especially when banks are allowed to adjust their capital structure. When banks' fixed capital structure is fixed, well-capitalized banks tend to increase risk-taking, while highly leveraged banks decrease risk-taking.

The aforementioned though, only highlights the probably direct influence of monetary policy on leveraging or deleveraging of major financial institutions, it is short in evidence to show whether the monetary policy transmission significantly influences MFIs' deleveraging. To this end, this study aims to provide an empirical test following the hypothesis as:

H1: Loose monetary policy directs a negative impact on MFIs' deleverage.

Nonlinearity of Various Monetary Policy Transmission

The effectiveness of monetary policy implementation in different economic periods depends on the choice and application of monetary policy tools. Various monetary policy tools also differ in macro-control effects on macroeconomic variables. Among others, quantitative monetary policy tools are more stable and have better predictive capability in the short term Bernanke (2020), making it easier to achieve short-term policy control goals. However, over period prolonging, as financial innovation activities increase, the endogeneity of the money multiplier gradually rises (Fontana et al., 2020). This hinders precise measurement of monetary quantity and leads to reduced effectiveness of quantitative monetary policy tools. In contrast, interest rates can overcome these shortcomings and provide better controllability over targets compared to quantitative tools (Zhou et al., 2022). Therefore, price-based monetary policy tools are more effective in the long term. Bernanke (2020) observes a significant variation in the response levels of different regulatory targets to various monetary policies. Quantitative monetary policy has immediate effects and can counter short-term economic growth slowdowns. Price-based monetary policy, conversely, demonstrates medium and long-term impacts and is proficient in addressing structural inflation (Hohberger et al., 2020). Chen et al (2021) utilize endogenous network models to simulate the progression of systemic financial risks under various monetary policy tools. Their findings indicate that, when the magnitude of short-term liquidity fluctuations is identical, price-based monetary tools are more efficient than quantity monetary tools. These price-based monetary tools play a role in maintaining stability in the financial system and influencing the leverage ratio of financial institutions. The application of different types of monetary policy tools has interrelated effects, giving rise to a nonlinear relationship between monetary policy and deleveraging of financial institutions. This study aims to analyze the cross effects of different monetary policy tools on MFIs' deleveraging using a threshold panel model. Accordingly, a hypothesis can be proposed as

H2: Quantitative monetary policy and price-based monetary policy have threshold effects on each other, making nonlinear impacts on MFIs' deleveraging.

Measurement of Key Variables

MFIs' deleveraging (DEL)

MFIs are the specific financial institutions that offer services to local communities and are influenced by local economic positions. In China, there is uneven development across various regions. In the context of macro deleveraging, developed provinces experience more deleveraging pressure compared to underdeveloped provinces. Withal, the financial sector's deleveraging is aimed at economic fundamentals deleveraging through credit reallocation. In this regard, the leveraging or deleveraging of MFIs transmits the credit allocation for local economic entities. It is more accurate to account for MFIs' leverage through considering the provincial leverage level as a benchmark and the heterogeneity across provinces. Therefore, a Z-score referenced to MacKie-Mason (1990) can be constructed to measure the spillover of MFIs' micro leverage in accordance with provincial leverage.

$$LEV = \frac{\mu_{proleverage} - micleverage}{\sigma_{proleverage}} \quad (1)$$

Where, LEV indicates the Z-score of leverage level of MFIs and $micleverage$ is measured by liability-to-equity ratio. Given the uneven development among different province and the short period during 2012-2021 this study focuses on, the rolling 3-year provincial leverage, which is a ratio of provincial debts of non-financial sectors to provincial GDP, is employed to calculate its mean ($\mu_{proleverage}$) and standard deviation ($\sigma_{proleverage}$). Due to the potential distortion of cyclic fluctuation terms on macroeconomic indicators, the provincial leverage analyzed in this study represents a smooth trend after the removal of cyclic fluctuation terms using the Hodrick–Prescott filter (Drehmann & Yetman, 2018).

The subsequent step is to reverse leverage level (LEV) for obtaining deleveraging indicator (DEL) on premise of adhering to original distribution. A approach of min-max reversed standardization conducted by Fostel & Geanakoplos (2015) is applied for transformation of DEL as :

$$DEL_{i,t} = \frac{\max(LEV_{i,t}) - LEV_{i,t}}{\max(LEV_{i,t}) - \min(LEV_{i,t})} \quad (2)$$

Where $\max(LEV)$ and $\min(LEV)$ denote the maximum and minimum values of leverage respectively. Through reversely standardized processing, $DEL_{i,t}$ indicates the deleveraging level of particular MFI i at period t. The higher its magnitude, the greater its downward deviation from the regional leverage of economic fundamentals and the deeper the MFI's deleveraging transmission to regional entity economy

Monetary policy ($MONEY$)

Monetary policy consists of quantitative monetary policy ($M2$) and price-based monetary policy ($R7$). Quantitative monetary policy involves direct control of the money supply to influence economic operations, typically proxied by the amount of broad money (Chadha et al., 2020; Corrado et al., 2020). Increased money supply provides more liquidity in the market, resulting in a looser monetary policy. Price-based monetary policy affects the financial costs and income expectations of micro entities by adjusting interest rates (asset prices). This policy transmits macroeconomic control signals for micro entities to adapt their behaviors (Wang, 2020). The central bank's announcement of the 7-days repo rate is utilized to gauge the price-based monetary policy. This rate acts as a benchmark for the benchmark interest rate and indicates the supply and demand of funds, as well as the tightness of liquidity in the financial market (Chen et al., 2023; Cho & Kim, 2021). The 7-days repo rate decline indicates a shift towards a looser monetary policy.

Methodology and Data

Sample and Data Source

The sample construction consists of 204 MFIs, including categories of deposit-taking and profit-making, which engage in granting small loans for financial inclusion and specialize in regional financial services. Specifically, sample size is composed by 159 deposit-taking MFIs which are screened from those small banks classified by People's Bank of China, as well as 45 profit-making MFIs originating from microloan companies and microfinance guarantee companies. Considering the developmental history of sampled MFIs, among them, numerous deposit-taking MFIs institutions gradually disassociated from the cooperative alliance or established with independent financial system after 2010, while profit-making MFIs piloted after 2008. To ensure data consistency and completeness, this study focused on their annual data from 2012 to 2021, a period when they had reached a relatively mature stage. The data used in evaluating for specific characteristics of 204 MFIs is mainly sourced from annual reports released on China's National Interbank Funding Center[2] and Nation Equities Exchange and Quotations[3]. Meanwhile, the missing data is supplemented by Wind database which is widely recognized as the largest economic database in China. Besides, the external and macroeconomic indicators are obtained from provincial and national Statistical Yearbooks respectively. To visually inspect the potential co-movement between monetary policy and MFIs' deleveraging, Fig. 2 and Fig. 3 plot MFIs' deleveraging against quantitative monetary policy and price-based monetary policy respectively. The evidence of possible transmission mechanism of monetary policy seems obvious across two categories, but it appears to be more pronounced for the suppressing effect of broad money growth on MFIs' deleveraging.

[2] The official website of National Interbank Funding Center links to https://www.chinamoney.com.cn/

[3] NEEQ access to https://www.neeq.com.cn/.

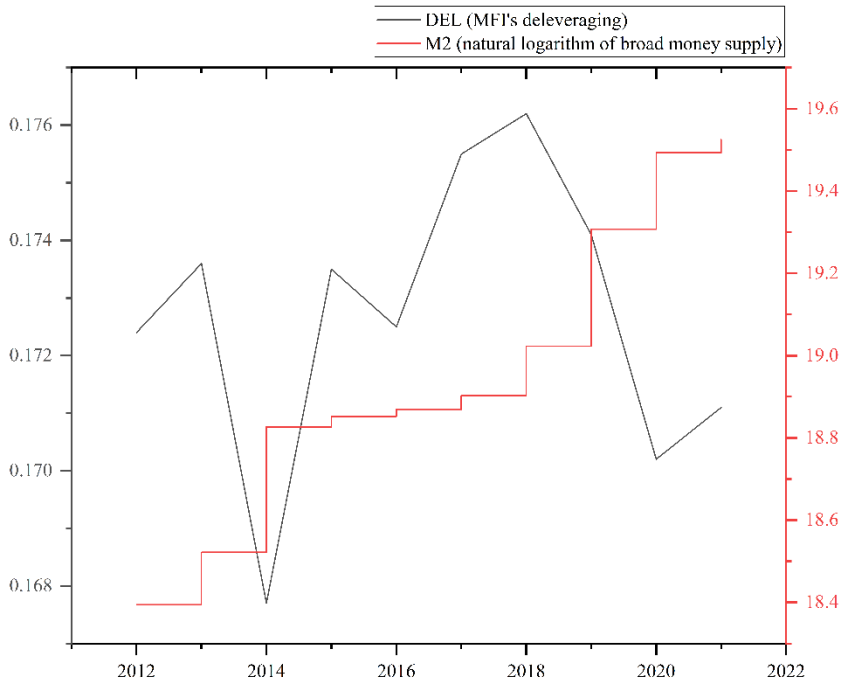

Fig. 2: MFIs' deleveraging and quantitative monetary policy

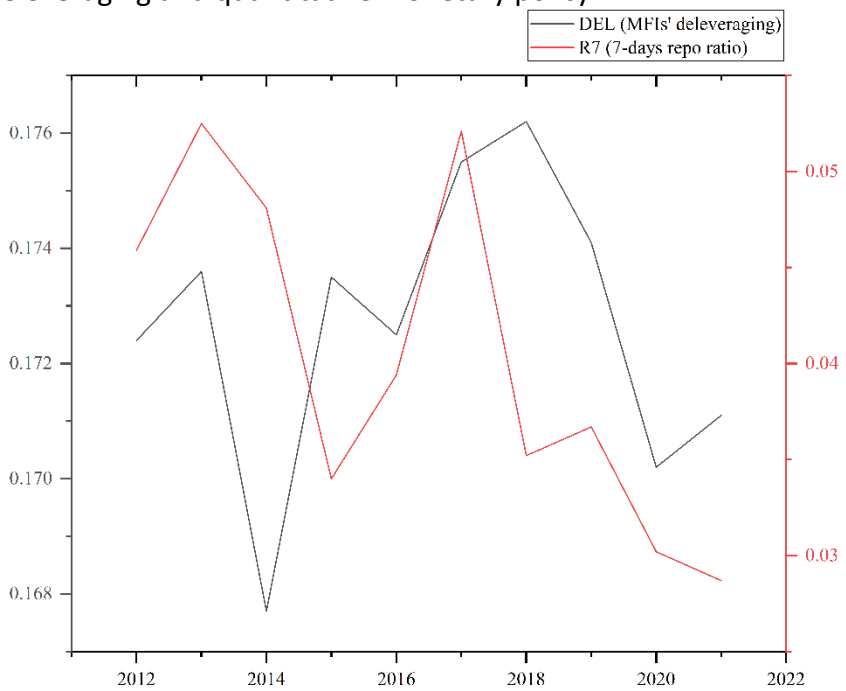

Fig. 3: MFIs' deleveraging and price-based monetary policy

Econometric Methods

To capture a consistent and unbiased estimation, this paper constructs a dynamic panel model using Generalized Method of Moments (GMM) estimators to investigate the linear relationship between monetary policy and MFIs' deleveraging. In comparison to other estimators for dynamic models, system GMM has the advantage of addressing endogeneity using more information in a finite sample (Blundell & Bond, 1998). Thereupon, the dynamic panel model is written as:

$$DEL_{i,t} = c + \beta_0 DEL_{i,t-1} + \beta_1 MONEY_{i,t} + \varphi_\tau X_{control\ i,t} + u_i + \lambda_t + \varepsilon_{i,t} \quad (3)$$

Where, i and t represent MFI and year period respectively. The DEL and $MONEY$ are explained variable and explanatory variable respectively. To reduce the potential heteroscedasticity of random error terms and ensure the goodness of fit of the sample dataset and the model, the variables, which have been empirically demonstrated to significantly affect the leverage in previous research, are incorporated into regression as control variables. The vector $X_{control}$ collectively denotes three level of control variables, including macroeconomic level: economic growth (EG) and inflation (INF) Muriu (2022); Ottonello & Perez (2019); External level: financial competition (FC) and financial saturation (FS) Girdzijauskas et al (2022); Osifo & Omoregbe (2020); and internal level: operating sustainability (OSS), profitability ($PROFIT$), net loan scale ($LOAN$), credit risk (CR), asset size ($SIZE$), size growth ($GROW$), non-earning asset ratio ($NEAR$) and a dummy differentiating MFI's type ($TYPE$) in deposit-taking or profit-making (Akuetteh, 2019; Ayayi & Sene, 2010; Bolognesi et al., 2020; Tarek Al-Kayed et al., 2014). The specific interpretation of all variables used refers to Table A1 in Appendices. Moreover, α is the intercept term of regression. β and ∂ mean respective coefficients of variables and control vector to be estimated. u_i controls the individual effects. Given an unusual change in financial leverage observed in Fig. 1, λ_t captures the potential idiosyncratic shock of Covid-19 to differentiate its time effects of pre- and pro-2020. The last term $\varepsilon_{i,t}$ determines the residual error.

Quantitative monetary policy tools and price-based monetary policy tools utilize distinct mechanisms to collectively transmit macro-control to the market through financial institutions. Consequently, when these two types of tools collaborate, the potential cross-effect between them may nonlinearly influence the MFIs' deleveraging. This study proceeds to explore the impacts of the intersection of two distinct monetary policy on the MFIs' deleveraging using the threshold panel model originally proposed by (Hansen, 1999). The threshold panel model is a piecewise function model by incorporating an unknown threshold variable into the model. The general equation is formulated as

$$Y_{i,t} = \begin{cases} \delta_i + \gamma_1' X_{i,t} + \varepsilon_{i,t}, & k_{i,t} \le \gamma \\ \delta_i + \gamma_2' X_{i,t} + \varepsilon_{i,t}, & k_{i,t} > \gamma \end{cases} \quad (4)$$

Where, k represents threshold variable, and γ is the threshold value. To counter the endogeneity and maintain consistent analysis, this study applies a more advanced dynamic threshold panel model developed by Seo & Shin (2016). Following the estimating procedures by Vinayagathasan, (2013), the system GMM estimators are allowed to introduce for addressing potential endogeneity problems within a kink restriction. In this regard, this paper insists in system GMM procedures to improve the dynamic threshold panel model for grasping the threshold effects between monetary policy. Firstly, the price-based monetary policy tools are employed as threshold variables to examine the impact mechanism of changes in the quantity of broad money on the MFIs' deleveraging under different interest rate policy environments. Based on this, the following test model using the interaction of quantity monetary policy tools and the corresponding threshold values as explanatory variables is constructed as

$$DEL_{i,t} = \alpha + \delta_0 DEL_{i,t-1} + \delta_1 M2_{i,t} \cdot I(R7_{i,t} \le \gamma_1) + \delta_2 M2_{i,t} \cdot I(R7_{i,t} > \gamma_1) + \partial_\tau X_{control\ i,t} + u_i + \lambda_t + \varepsilon_{i,t} \quad (5)$$

Where, $M2_{i,t} \cdot I(R7_{i,t} > \gamma_1)$ indicates that when threshold variable $R7$ is greater than γ_1, $I(R7_{i,t} > \gamma_1)$ is 1, otherwise 0. $M2_{i,t} \cdot I(R7_{i,t} \le \gamma_1)$ is defined similarly. The same control variables as in Eq. (3), individual effect (u_i) and Covid-19 time effect (λ_t) are introduced as well for consistent analysis.

In the wake of the reform of interest rate liberalization in China, the transition of monetary policy gradually shifts towards price-based guidance from quantity stimulus, while the transition progress increases macro-control complexity. However, existing research does not offer specific conclusion regarding the dominance of particular macro-control tools. To ensure the integrity of the analysis results, this paper subsequently employs quantitative monetary policy tools as threshold variables. It analyzes the impact of interest rate changes on MFIs' deleveraging under different levels of broad money supply growth by using the interaction of price-based monetary policy tools and threshold values as explanatory variables. the following model is constructed as:

$$DEL_{i,t} = \alpha + \eta_0 DEL_{i,t-1} + \eta_1 R7_{i,t} \cdot I(M2_{i,t} \le \gamma_2) + \eta_2 R7_{i,t} \cdot I(M2_{i,t} > \gamma_2) + \vartheta_\tau X_{control\ i,t} + u_i + \lambda_t + \varepsilon_{i,t} \quad (6)$$

Where, the interaction of $R7_{i,t} \cdot I(M2_{i,t} > \gamma_2)$ represents that when threshold variable $M2$ is greater than γ_2, $I(M2_{i,t} > \gamma_2)$ is 1, otherwise 0. It is an identical manner to define $R7_{i,t} \cdot I(M2_{i,t} \le \gamma_2)$.

Empirical Results and Discussion

Data Description

The sample's statistics are depicted in Table 1, with a focus on the constructed variables of interest. No variable with a high standard deviation is reported, indicating that the values for all indicators are close to the means. It is more probable that the dataset follows a normal distribution overall.

Table 1
Descriptive statistics for variables

Variables	No. of obs.	Mean	Standard deviation	Min	Max
Explained variable					
Deleveraging (DEL)	2040	0.171	0.118	0.000	1.000
Explanatory variables					
Quantitative monetary policy ($M2$)	2040	18.83	0.258	18.39	19.20
Price-based monetary policy ($R7$)	2040	0.039	0.012	0.024	0.060
Control variables					
Economic growth (EG)	2040	8.071	0.165	7.801	8.289
Inflation (INF)	2040	6.444	0.052	6.363	6.532
Financial competition (FC)	2040	-0.97	1.008	-5.260	2.054
Financial saturation (FS)	2040	1.423	0.347	0.740	2.360
Operating Sustainability (OSS)	2040	1.945	2.435	0.017	37.09
Profitability ($PROFIT$)	2040	0.070	0.084	-0.708	0.221

Net loan scale ($LOAN$)	2040	0.701	0.289	0.0135	0.982
Credit risk (CR)	2040	0.067	0.096	0.003	0.811
Non-earning assets ratio ($NEAR$)	2040	0.176	0.165	0.002	0.557
Size of assets ($SIZE$)	2040	9.351	1.606	4.330	15.32
Size growth ($GROW$)	2040	0.065	0.169	-0.474	1.072

Subsequently, a correlation test is needed to verify if multicollinearity exists among independent variables. According to Gujarati & Porter (2009), Table 2 demonstrates that no correlation coefficient exceeds the magnitude of 0.8 at statistically significant and eliminates the possibility of collinearity.

Table 2
Correlation Matrix

	EG	***INF***	***M2***	***R7***	***FC***	***FS***	***OSS***	***PROFIT***	***LOAN***	***CR***	***NEAR***	***lnSIZE***	***GROW***
EG	1.000												
INF	0.486***	1.000											
M2	0.497***	0.489***	1.000										
R7	-0.501***	-0.532***	-0.524***	1.000									
FC	0.180***	0.166***	0.182***	-0.075	1.000								
FS	0.356***	0.375***	0.362***	-0.222***	0.224***	1.000							
OSS	-0.210***	-0.201***	-0.212***	0.059	-0.031	-0.143***	1.000						
PROFIT	-0.352***	-0.360***	-0.347***	0.188***	-0.061	-0.125**	0.128***	1.000					
LOAN	-0.127**	-0.129***	-0.130***	0.066	-0.065	-0.131***	-0.090*	0.148***	1.000				
CR	0.276***	0.275***	0.271***	-0.143***	0.040	0.122**	-0.153***	-0.60*****	0.073	1.000			
NEAR	-0.028	-0.025	-0.028	0.020	0.005	0.033	-0.003	-0.027	-0.562***	-0.084*	1.000		
SIZE	0.083*	0.077	0.083*	-0.042	0.188***	0.189***	0.088*	-0.074	-0.531***	-0.161***	0.521***	1.000	
GROW	-0.271***	-0.280***	-0.288***	0.160***	-0.006	-0.078	0.208***	0.327***	-0.161***	-0.345***	0.132***	0.279***	1.000

Notes: ***, **, * indicates significance at 1%, 5% and 10% levels respectively.

Direct effects within linear dynamic panel regressions

This study applies the dynamic panel regression with system GMM estimators to capture dynamic effects among variables and address endogeneity for obtaining a consistent

estimate. As Table 3 shows, according to Blundell & Bond (1998), the aforehand inspection by Arellano-Bond tests for AR (1) less than 1% and AR (2) greater than 10%, that excludes presence of second-order autocorrelation. Withal, all regressions success in Hansen's test of overidentification restrictions on instrumental variables as their p-value exceeds 10%, indicating the instrumental variables used are valid and completely replace with potential endogenous variables.

According to the estimated results obtained through system GMM in column (1) of Table 3, quantitative monetary policy ($M2$) directs a negative effect on MFIs' deleveraging at 1% significance. This portends that MFIs are sensitive to the changes in quantity of money supply, as well their deleveraging initiatives are impeded in an easing quantitative monetary environment, that echo the phenomenon observed in Fig. 2. However, the estimated results shown in column (2) indicates an insignificant effect of price-based monetary policy ($R7$) on MFIs' deleveraging. Hohberger et al (2020) elucidate that price-based monetary policy integrates the anticipated trajectory of inflation. In instances where the effective policy interest rate falls short of the projected critical value, the efficacy of price-based monetary policy is constrained. As a result, the influence of price-based monetary policy on deleveraging is inconsequential, contrary to anticipation. In reality, the macro-control effect of these two types of monetary policies often coexists. Column (3) shows the effects of dual monetary policy. Among others, the influencing magnitude of quantitative monetary policy has been amplified, as compared to when it operates alone, while the impact of price-based monetary policy remains insignificant. This further illustrates the sensitivity of MFIs' deleveraging in response to quantitative monetary policy, and the relatively low degree of interest rate liberalization in MFIs.

Table 3
Results for Dynamic Panel Regressions

Variable	(1) Under quantitative policy	(2) Under price-based policy	(3) Under dual policy
$L.DEL$	0.308***	0.314***	0.299***
	(7.21)	(6.75)	(6.61)
$M2$	-0.243***		-0.309**
	(-2.77)		(-2.64)
$R7$		0.110	-0.093
		(1.52)	(-0.82)
EG	0.232	-0.236	0.313*
	(1.56)	(-3.39)	(1.78)
INF	-0.410*	0.037	-0.375
	(-1.70)	(0.16)	(-1.59)
FC	0.036***	0.034***	0.039***
	(4.92)	(4.41)	(4.44)
FS	0.206***	0.195***	0.202***
	(9.37)	(8.64)	(8.77)
OSS	0.004***	0.004***	0.004***
	(6.84)	(6.30)	(6.23)
$PROFIT$	0.196**	0.227**	0.190**
	(2.31)	(2.48)	(2.45)

$LOAN$	-0.197***	-0.184***	-0.217***
	(-4.78)	(-4.71)	(-4.48)
CR	0.173**	0.182**	0.186***
	(2.63)	(2.54)	(2.74)
$NEAR$	0.012	0.064	-0.007
	(0.19)	(0.85)	(-0.10)
$SIZE$	0.001	0.007	-0.003
	(0.07)	(0.61)	(-0.25)
$GROW$	-0.152***	-0.151***	-0.150***
	(-6.36)	(-6.12)	(-6.01)
$TYPE$	-0.098***	-0.118***	-0.100***
	(-3.98)	(-4.69)	(-3.99)
Covid-year effect	Yes	Yes	Yes
AR (1)	0.067	0.052	0.083
AR (2)	0.278	0.422	0.246
Hansen test	0.314	0.346	0.326
Obs.	1836	1836	1836

Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively. Figure in () are t-values of coefficients. All tests report p-value. The GMM estimators are obtained using Stata module xtabond2.

Robustness tests

Although the categories of MFIs have been distinguished using a dummy variable ($TYPE$), there is a question about whether the regression model for synthetic MFI categories is still applicable to the original data. As a result, separate regression analyses were carried out for the subsets of deposit-taking and profit-making MFIs. As Table 4 exhibits, the findings from both distinct sets of deposit-taking MFIs and profit-making MFIs reveal no significant disparity when compared to the whole sample. However, the findings do point to the fact that the transmission of price-based monetary policy ($R7$) in deposit-taking MFIs has a noteworthy positive impact. This implies that deposit-taking MFIs are responsive to adjustments in interest rate guidance compared to profit-making MFIs.

Table 4
Robustness check within separate types of MFIs

Variable	**(1)** **Deposit-taking MFIs**	**(2)** **Profit-making MFIs**
$L.DEL$	0.285***	0.608**
	(15.94)	(2.29)
$M2$	-0.030	-0.233*
	(-0.82)	(-1.76)
$R7$	0.148***	0.017
	(3.59)	(0.49)
EG	-0.045	0.393***
	(-1.15)	(4.05)
INF	-0.148**	0.418
	(-2.11)	(0.23)
FC	0.015***	-0.308

	(2.86)	(0.74)
FS	0.045***	0.576***
	(3.12)	(3.34)
OSS	0.003***	0.017***
	(4.78)	(2.70)
$PROFIT$	0.025*	0.273***
	(1.72)	(3.87)
$LOAN$	0.038***	-0.337**
	(3.81)	(2.07)
CR	0.017	0.466***
	(0.80)	(3.34)
$NEAR$	0.127***	0.124
	(5.46)	(0.76)
$lnSIZE$	-0.012***	-0.063***
	(-2.74)	(-3.68)
$GROW$	-0.093***	-0.377*
	(-7.50)	(-1.77)
Covid-year effect	Yes	YES
AR (1)	0.004	0.003
AR (2)	0.647	0.114
Hansen test	0.287	0.437
Obs.	1431	405

Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively. Figure in () are t-values of coefficients. All tests report p-value. The GMM estimators are obtained using Stata module xtabond2.

Indirect impacts within nonlinear dynamic threshold regressions

A bootstrap with 1000 times is used to capture the gradual distribution of statistics for threshold effect in 95% confidence intervals. Table 5 reports the cross thresholds of quantitative monetary policy ($M2$) and price-based monetary policy ($R7$) for regressions with MFIs' deleveraging (DEL). The specific point that needs to be illustrated is that the detailed analysis of this study relies on all regressions conducted after incorporating all control variables. This is because in aforehand tests, the threshold values of quantitative monetary policy and price-based monetary policy exhibit no significant variances with the changes in the combinations of control variables added to the models. According to the results of p-values and confidence intervals, their threshold effects in all dynamic threshold models are significant. The null hypothesis of no threshold effect can be rejected within the confidence intervals that do not cross zero. Therefore, the effects of monetary policy on MFIs' deleveraging might be nonlinear and the introduction of dynamic threshold panel models is necessary. In an identical manner to examine applicability of system GMM estimation, the results of AR tests and Hansen's tests, showed in Table 6, prompt the inexistence of second-order autocorrelation and effectiveness of instrumental variables respectively. Additionally, the results of Wald test provide further evidence of the threshold effects of monetary policy with statistically significant levels of at least 5%.

Table 5
Threshold effects of monetary policy

Threshold variables	Threshold value	P-value	Bootstrap	95% confidence interval	
				Lower	Upper
$R7$	0.026	0.013	1000	0.018	0.033
$M2$	19.023	0.067	1000	12.013	28.329

Table 6 illustrates the threshold effects of monetary policy on MFIs' deleveraging initiatives. Therein, column (1) lists the results for the threshold effect of price-based monetary policy on quantitative monetary policy. The results demonstrate that when the price-based monetary policy tools exceed 0.026, the inhibitory effect of quantitative monetary policy on MFIs' deleveraging weakens. This indicates that a relatively high interest rate can mitigate the deleveraging pressure on MFIs caused by quantitative easing monetary policy, if the interest rate level surpasses 0.026. Column (2) examines the impact of price-based monetary policy on MFIs' deleveraging when quantitative monetary policy acts as the threshold variable. The results report that when quantitative monetary policy tools exceed the threshold of 19.023, the price-based monetary policy tools exert a significantly positive effect on MFIs' deleveraging. As the amount of money supply increases, the endogeneity of money multiplier strengthens (Wang, 2020). When the natural logarithm of broad money steps over 19.023, the calculation of the money supply becomes complex, and the price-based monetary policy, which is relatively moderate, starts to reflect its stable controllability. In this stage, price-based monetary policy influences the MFIs' deleveraging by adjusting interest rates in the same direction.

Table 6
Results for Dynamic Threshold Regressions

Variable	**Threshold of price-based monetary policy (1)**	**Threshold of quantitative monetary policy (2)**
$L.DEL$	0.331***	0.361***
	(18.26)	(23.45)
$M2 \cdot I(R7 \leq 0.026)$	-0.351**	
	(-2.23)	
$M2 \cdot I(R7 > 0.026)$	-0.295***	
	(-4.47)	
$R7 \cdot I(M2 \leq 19.023)$		0.186
		(0.87)
$R7 \cdot I(M2 > 19.023)$		0.102*
		(1.70)
EG	0.271**	-0.185
	(2.16)	(-1.61)
INF	-0.086	0.094
	(-0.43)	(0.21)
FC	0.038***	0.033***
	(7.89)	(7.26)

FS	0.132***	0.113***
	(12.31)	(9.95)
OSS	0.004***	0.004***
	(8.55)	(8.72)
$PROFIT$	0.113**	0.129***
	(2.31)	(3.44)
$LOAN$	-0.210***	0.150***
	(-6.14)	(-6.00)
CR	0.098**	0.103***
	(2.03)	(3.64)
$NEAR$	0.023	0.108***
	(0.50)	(3.10)
$SIZE$	-0.006	0.006
	(-0.84)	(0.91)
$GROW$	-0.134***	-0.121***
	(-7.36)	(-7.46)
$TYPE$	-0.098***	-0.115***
	(-4.42)	(-6.41)
Covid-year effect	Yes	Yes
AR (1)	0.017	0.033
AR (2)	0.196	0.468
Hansen test	0.401	0.481
Wald test	73.22***	88.01***
Obs.	1836	1836

Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively. Figure in () are t-values of coefficients. All tests report p-value. The GMM estimators are obtained using Stata module xtabond2.

Conclusion

Based on annual data from MFIs in China from 2012 to 2021, this paper utilizes dynamic panel regression and dynamic threshold regression with system GMM estimators, to investigate the impact of monetary policy on the MFIs' deleveraging. It also focuses on examining the cross effects of different monetary policy tools on the influencing mechanism. The findings are concluded as follows: First, quantitative monetary policy restrain MFIs' deleveraging progress and indices them to take more leveraging risks. It verifies the transmission of quantitative monetary policy in MFIs' risk-taking channel. Second, the results of dynamic threshold regression uncovers that the inhibitory effect of quantitative monetary policy on MFIs' deleveraging weakens once the price-based monetary policy tightening exceeds the threshold. Third, as the endogenous money multiplier amplifies the actual money supply quantity, price-based monetary policy starts to play its role in stable controllability, and MFIs gradually accept market-oriented interest rate mechanisms to adjust their deleveraging initiatives.

According to the findings above, this paper proposes several implications to optimize the macro-control mechanisms of monetary policy and the deleveraging initiatives of MFIs. Firstly, it suggests combining the characteristics of quantitative and price-based monetary policy tools and utilizing them in a coordinated manner. Quantitative tools have a more significant direct effect, stimulating consumption and investment for immediate economic

growth. On the other hand, price-based tools have a more stable controllability and are better suited for addressing deleveraging and risk prevention (Galati & Moessner, 2018; Wang et al., 2023). Accordingly, the paper recommends that the central bank flexibly employ reverse repurchase operations in the open market to stimulate the short-term recovery of a weak economy. Simultaneously, it proposes gradually improving the interest rate transmission mechanism to enhance the effectiveness of price-based monetary policy tools. Additionally, the paper suggests implementing quantitative policies such as targeted reserve requirement ratio cuts to incentivize MFIs to increase financial inclusion for small businesses. Secondly, it is essential for MFIs to overcome conceptual constraints and recognize the optimization of resource allocation through the price mechanism. This can be achieved by establishing and enhancing the market benchmark interest rate system, the central bank policy interest rate system, and the risk-free yield curve. Moreover, it is crucial to improve the transmission effect of interest rates on asset prices and the guiding role of funds. Additionally, a clear understanding of the transmission mechanisms of quantitative and price-based monetary policy tools is necessary. Considering the unique characteristics of economic development in different periods, it is important to construct a well-aligned combination of monetary policy operations that consider both overall economic growth goals and structural issues. Lastly, this study suggests improving the deleveraging mechanism of MFIs and strengthening the effective coordination of monetary policy tools and macro-prudential supervision. The findings indicate that loose monetary policy may encourage MFIs to take on more leveraging risks. Therefore, when formulating policies, it is crucial to consider the response paths and capabilities of MFIs regarding the implementation of the targeted monetary policy, while also maintaining a forward-looking and systematic understanding of potential risks. It is important to establish a robust macroprudential regulation system, along with countercyclical credit control methods and capital buffer mechanisms. Additionally, establishing the interest rate liberalization for MFIs and coordinating macroprudential regulation can gradually achieve a micro-prudential approach to regulate on MFIs' leverage.

Although this study for the first time investigates the cross-effects of various monetary policy on MFIs' deleveraging using nonlinear model, as scholars have pointed out, the mechanisms of monetary policy may vary over time (Boivin et al., 2010; Takáts & Vela, 2014; Wang, 2020), and there is not inadequate evidence to confirm their effects on MFIs' deleveraging evolving over time. Given this conjecture, the future research is encouraged to explore the asymmetric impacts of monetary policies in short- and long-term.

Significance

This study contributes to a significant insight in the form of theoretical contributions and practical significance regarding the monetary policy effects on MFIs' deleveraging initiatives. In theoretical contributions, this study provides a method approaching to MFIs' deleveraging through incorporating the external and heterogenous leverage level across regions. Additionally, an improved method of dynamic threshold model using system GMM estimators is constructed based on the research by Seo & Shin (2016). In practical views, this study offers evidence around the effects of monetary policy transmission mechanisms on MFIs' deleveraging in China. Withal, the relevant capital structure theories are employed to interpret the empirical findings.

Appendices

Table A1: Summary of control variables

Variables	Symbol	Description
Macroeconomic factors		
Economic growth	EG	natural logarithm of Annual growth based on GDP level of 100 in 1978
Inflation	INF	natural logarithm of Annual growth based on price index of 100 in 1978
External factors		
Financial competition	FC	$\ln(provincial\ amount\ of\ \ MFIs\ branches\ per\ 10\ km^2)$
Financial saturation	FS	$\frac{provincial\ amount\ of\ Credit\ granted\ by\ Financial\ Sector}{provincial\ GDP}$
Internal factors		
Operating sustainability	OSS	$\frac{Net\ Income}{Operating\ Expenses\ +\ Capital\ Costs\ +\ Loss\ Reserves}$
Profitability	$PROFIT$	Integrating ROA and ROE by using PCA method
Net loan ratio	$LOAN$	$\frac{Total\ Loans - Provisions}{Total\ Assets}$
Credit risk	CR	$\frac{\text{Nonperforming Loans}}{Total\ \text{Loans}}$
Type	$TYPE$	A dummy variable takes value of 1 if the particular MFI deposit-taking and 0 otherwise
Non-earning assets ratio	$NEAR$	$\frac{Cash\ and\ Cash\ Equivalents + Tangible\ Assets}{Total\ Assets}$
Assets size	$SIZE$	$\ln(\text{Total Assets})$
Size growth	$GROW$	$\frac{Current\ Assets - Previous\ Assets}{Previous\ Assets}$

Declarations

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Conflict of interest disclosure

The authors declare that the research was conducted in the absence of any competing interest.

Data Availability Statement

Not available.

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