Bond Financing Channel of Monetary Policy: Evidence from Chinese Policy Bank Lending*

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ABSTRACT

Using granular loan-level data from a policy bank in China, we examine the lending response to bond financing costs fluctuation incurred by monetary policy shocks. Tighter monetary policy increases loan rate and loan spread, at the same time reduces loan volume and improves loan quality. The pass-through of monetary policy is genuinely heterogeneous—stronger during monetary contractions and market-oriented reform period, among manufacturing firms, in firms with more default risks, and in areas with lower income, weaker fiscal capacity, and smaller banking penetration.

Key Words: Monetary policy transmission, Bond financing channel, Chinese policy bank, Loan rate and spread

JEL classification: E44, E52, G21

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I. Introduction

In this paper, we examine the bond financing channel of monetary policy transmission via policy bank's funding costs. For commercial banks, their liabilities mainly come from deposits, which are characterized with stable costs in response to monetary policy shocks (Drechsler et al., 2017, 2021). Previous research studies the bright side (effective transmission) and dark side (liquidity panics) of bank wholesale funding (Calomiris, 1999; Huang and Ratnovski, 2011; Chen et al., 2021). However, the deposits channel still counts the absolute majority of the transmission of monetary policy through bank balance sheet, while the wholesale channel is more relevant for small- and medium-size banks (Drechsler et al., 2017; Chen et al., 2021). Contrary to bank lending channels, *corporate bond financing* channel does not reduce monetary transmission—in Eurozone, e.g., firms with more bonds are more affected by unexpected monetary tightening relative to other firms (Darmouni et al., 2020). However, for policy banks, the main funding channel is issuing sub-national bonds (Ru, 2018; Gao et al., 2021), and we provide novel empirical evidence that the channel of *policy bank bond financing* is highly effective in monetary policy transmission. In particular, the policy bank's funding costs are directly affected by monetary policy shocks and yet remains as the bank's stable funding source.

Based on the loan-level data from a large Chinese bank, we propose that the bond financing channel of monetary policy transmission is related to a change of the funding costs of policy banks. The dataset contains detailed loan-level information, including loan prices. To measure the Chinese monetary policy stance, we make use of the monetary policy indicator constructed in Xu and Jia (2019). This index could summarize the policy stance of PBOC and can be regarded as the analog of the Federal Funds Rate (Miranda-Agrippino et al., 2020). The sample bank is huge by assets. Yet we still know very little about its lending behavior, especially its response to monetary policy shocks. The key difference between the sample bank from other banks is the liability: it mainly issues bonds instead of deposits. The bond costs are directly affected by MP shocks.

We find that tighter monetary policy would increase loan rate and loan spread through bond financing channels. In addition, it would also reduce loan volume and increase loan quality. We also explore the heterogeneous effect of monetary policy. The pass-through of monetary policy is stronger in the tight monetary policy period, as well as during the market-oriented reform period.

The effect is strongest in the manufacturing sector, and then the service sector. In the end, we also find stronger transmission in loans with higher default risks. For firm heterogeneity, we find smaller pass-through for strong bargaining power firms, large firms and LGFVs. For regional heterogeneity, we find stronger pass-through in areas with weaker fiscal capacity, more default cases, lower level of economic development, and less bank penetration.

Overall, as a policy bank, although the sample bank may be subject to policy constraints in the selection of regions and industries, the findings in our paper indicate that its loan pricing exhibits strong marketization. The pricing will fully consider the default risk factors of the loan. This is mainly due to the special financing method of the policy bank, which is through the market-oriented bond financing. Therefore, changes in monetary policy can affect the bank's loan pricing by affecting the cost of the bond financing.

Our research may have the following contribution. For the data , we use highly detailed loan-level data directly from the sample bank to provide micro evidence for the transmission of monetary policy. The data contains detailed loan-level information, especially loan rates. Besides, the borrower information, such as industry, location information, and LGFV information enables us to explore the monetary policy heterogeneity. For monetary policy measurement, we make use of the monetary policy indicator constructed in Xu and Jia (2019), which could summarize the policy stance of PBOC, and can be regarded as the analog of the Federal Funds Rate (Miranda-Agrippino et al., 2020). For robustness, we also measure monetary policy shocks by the exogenous component of the M_2 growth rate estimated from the regime-switching model of Chen et al. (2018). For identification, we use the monetary policy movement as a measure of borrowing cost shock and identify its effect on the bond financing of the bank and therefore its lending behavior. This is a new channel of monetary policy transmission. Finally, we demonstrate strong heterogeneity of monetary policy transmission, both cross-time, cross-firm and cross-region with the redistribution effects.

Related Literature. The research contributes to the literature on monetary policy transmission (Bernanke, 1991; Bernanke and Blinder, 1988, 1992; Kashyap and Stein, 1994, 2000; Bernanke and Gertler, 1995; Drechsler et al., 2017; Chen et al., 2018; Auclert, 2019; Beraja et al., 2019; Amir-Ahmadi et al., 2020; Fang et al., 2020; Miranda-Agrippino et al., 2020; Li et al., 2020; Chen et al., 2021). Different from the lending channel, the balance sheet channel, and the deposit channel

of monetary policy transmission which are well-identified in previous studies, our paper uses loan-level data with price information and a novel Chinese monetary policy stance measure to identify a unique channel of monetary policy transmission, the bond financing channel.

The paper further contributes to a recent body of research on government credit, or the government bank loan (Bertay et al., 2012; Carvalho, 2014; Brei and Schclarek, 2013, 2015; Coleman and Feler, 2015; Cortes et al., 2019; Ru, 2018; Cai et al., 2020; Huang et al., 2020; Gao et al., 2021). Government banks play a positive role in mitigating economic fluctuations, especially during the financial crisis period (Bertay et al., 2012; De Haas et al., 2012; Allen et al., 2013; Brei and Schclarek, 2013; Coleman and Feler, 2015; Brei and Schclarek, 2015; Lin et al., 2017). However, some research points out that government credit usually prefers the state-owned sector, which may crowd out the investment of private firms and reduce the efficiency of resource allocation (King and Levine, 1993a,b; Ru, 2018). In addition, government credit is usually accompanied by interest rate subsidies (Carvalho, 2014; Lazzarini et al., 2015; Cai et al., 2020). Finally, some research highlights that government credit is characterized by political color, and is used by politicians as an election tool (Carvalho, 2014; Coleman and Feler, 2015). Our paper identifies the redistributive effect of government credit.

II. Data, Variable and Specification

A. Data

We mainly rely on the loan-level data from a large Chinese bank from the year 2006 to 2018. This is a large, comprehensive, and unique loan dataset directly from the sample bank, including approximately 60,000 loan projects and 15,000 firms. In the year 2018, the aggregate loan outstanding accounts for about 10 percent of China's GDP. The dataset contains detailed contract level information about the approval date, loan volume, loan maturity, loan rate, collateral, internal rating (loan quality), and borrower information (such as the industry, location, and ownership). Meanwhile, it not only includes the new-issued loans, but also records the disbursement history for each loan project. We only keep the newly-issued loans for empirical analysis.

Figure 1 shows the regional distribution of the sample bank loan in the year 2010 and 2018. We divide the sample loan outstanding at the end of the year by local GDP. A darker color demonstrates

a larger relative loan outstanding. The figure suggests that western areas, generally speaking, have a large loan outstanding relative to local GDP. This pattern is correspondent with the fact that the sample bank mainly supports the infrastructure projects in under-developed western areas.

We further explore the loan spread distribution in Figure 2. Loan spread is defined as loan rate minus policy rate (the benchmark loan rate decided by the PBOC). We calculate the province-level average loan spread as the simple average of each loan in the area. The figure demonstrates the central area has the largest loan spread. Surprisingly, borrowers in western areas enjoy a relatively lower loan cost. One possible reason is that the sample bank mainly supports the infrastructure projects in those areas and will subsidized the loan interest, leading to the relatively low spread of the loans to western areas.

B. Variable

(1) Loan outcomes

We mainly focus on the loan price in our regressions. We use two indicators to measure loan price, loan rate and, loan spread. Loan spread is defined as the loan rate minus policy rate (the benchmark loan rate set by the PBOC). The policy rate only varies with time and loan maturity.

Besides loan price, we also explore the impact of monetary policy on other loan outcomes, such as loan volume (in logs), loan maturity (in logs), and loan quality. We use the internal loan rating to measure loan quality, ranging from 1 to 8. Larger value of internal rating indicates lower loan quality.

(2) Monetary policy

To measure the Chinese monetary policy stance, we make use of the monetary policy indicator constructed in Xu and Jia (2019). This index could summarize the policy stance of PBOC and can be regarded as the analog of the Federal Funds Rate (Miranda-Agrippino et al., 2020). Figure 3 shows the revolution of monetary policy index and the benchmark one-year deposit rate.

For robustness, following Chen et al. (2021), we also employ three alternative measures, 7-day reverse repo rate, 30-day shibor rate and the exogenous component of the M_2 growth rate estimated from the regime-switching model of Chen et al. (2018).

(3) Bond financing costs

To testify the bond financing channel, we also need the information of the bond financing costs

of the sample bank. we use both the yield of bond issuance (10-year) and yields of bond Yield to maturity (YTM, 10-year) as the proxies of funding costs. The bond issuance yield shows the funding costs in the first bond market, while the YTM of the bond represents the funding costs in the secondary bond market.

In addition to directly using the bond issuance cost of the sample bank, we further investigate the impact of the issuance interest rates of other bonds and the various deposit rate changes on loan pricing. Specifically, in terms of bond costs, we also examine the issuance rate of 10-year treasury bond and 10-year corporate bonds (AAA rated). In terms of deposit rates, we examine the one-year benchmark deposit rate of the People's Bank of China, the average deposit rate of the four major banks, the average deposit rate of 12 joint-stock banks, and the average deposit rate of several major city commercial banks. Both bond interest rate data and deposit interest rate data are sourced from the Wind database.

Figure 4 shows the evolution of the one-year deposit rates and the changes in the sample bank's one-year bond issuance rates. Among them, the one-year deposit rates include the average deposit rate of the big-four banks, the average deposit rate of the 12 national joint-stock banks, and the average deposit rate of several major city commercial banks.[1] The figure demonstrates that the bank deposit interest rates are relatively stable, while the bond issuance rates of the sample bank are much more volatile.

(4) Heterogeneity measure

We conduct a series of heterogeneity analyses in our empirical part, including the cross-time, cross-firm and cross-region heterogeneity.

For cross-time heterogeneity, we mainly focus on the contractive monetary policy period. Specifically, we set the contractive dummy to capture the contractive monetary policy period. We choose three periods of sharp monetary policy tightening and define those periods as contractive monetary policy periods. The dummy Contractive is set to be 1 during these periods: Jan. 2006 - Feb. 2008; Feb. 2010 - Mar. 2012; Sep. 2013 - Mar. 2014.

[1]The big-four banks include Industrial and Commercial Bank of China (ICBC), Bank of China (BOC), Agricultural Bank of China (ABC) and China Construction Bank (CCB). The 12 national joint banks include China Merchants Bank, Shanghai Pudong Development Bank, China Citic Bank, China Everbright Bank, China Minsheng Bank, Huaxia Bank, China Industrial Bank, China Guangfa Bank, Ping'an Bank , China Zheshang Bank, China Bohai Bank and Evergrowing Bank. The major city commercial banks include Bank of Beijing, Bank of Hangzhou, Bank of Nanjing, Bank of Jiangsu, Bank of Ningbo and Bank of Shanghai.

For firm heterogeneity, we focus on three firm-level variables, the firm bargaining power, local government financing vehicles (LGFV) and the small and medium sized firms (SME). The bargaining power variable, which ranges from 1 to 5, is obtained directly from the bank loan dataset. The variable is evaluated by the sample bank based on firm characteristics such as firm size, probability, industry and location. A larger value indicates stronger borrower bargaining power with the bank. The small and medium sized firm variable, or "SME" dummy could also be directly obtained from the dataset. If the loan type is the "small and medium sized loan", we then define the borrower to the be "SME" firm and the dummy to be 1. For LGFV, we merge the loan dataset with the LGFV list collected by the CBRC using the unified code for a legal person. If the firm could be found at the LGFV list, we then define the firm to be LGFV.

For cross-region heterogeneity, we mainly focus on four dimensions, fiscal capacity, default cases, economic development and financial development. We use the local fiscal deficit rate to measure fiscal capacity, which is defined as the difference between fiscal expenditure and fiscal revenue, divided by fiscal expenditure. A larger fiscal deficit rate means a more financially constrained local government. We then use the local default cases variable to measure the local default probability. The default cases is defined as the number of default persons divided by the local GDP. For economic development, we use the GDP per capita to measure the local economic development level. We finally employ the bank penetration indicator to measure the financial development level, which is defined as the total number of bank branches divided by the population. A larger bank penetration indicates more credit supplies and a more financially developed city.

(5) Control variables

We control a series of loan-level, firm-level and city-level control variables. For loan-level variables, we control the loan volume, loan maturity, guarantee, and loan spread. For firm-level controls, we mainly control for firm revenue and firm profit rate. For city-level variables, we control the local GDP, local population, and local fiscal revenue divided by local GDP.

C. Summary statistics

Table I shows the summary statistics of key variables.

D. *Research design*

In order to explore the impact of monetary policy shocks on the sample bank loan outcomes, we conduct the following regression:

$$y_{ijct} = \alpha + \beta * MP_{t-1} + \varphi * X_{ict} + \mu_{cj} + \theta_{year} + \epsilon_{ijct} \quad (1)$$

Where i, j, c and t stand for loan, industry, city and year-month. We only consider the newly-issued loans in the regressions. The y_{ijct} stands for a series of loan outcome variables, such as loan rate, volume, maturity, and quality. The MP_{t-1} is the monetary policy index indicator in the last period. A larger value indicates a tighter monetary policy. The X_{ict} are a series of loan-level and city-level time-varying control variables. The μ_{cj} is city-industry fixed effects, θ_{year} is the year dummy. We also employ stronger city×industry×year fixed effects and firm×year fixed effects in robustness checks. Standard errors are clustered at year-month level.

In equation (2), we further explore the heterogeneous monetary policy transmission:

$$y_{ijct} = \alpha + \beta_1 * MP_{t-1} + \beta_2 * MP_{t-1} * Z_{ct} + \beta_3 * Z_{ct} + \varphi * X_{ict} + \mu_{cj} + \theta_{year} + \epsilon_{ijct} \quad (2)$$

Where Z_{ct} stands for a series of cross-city or cross-time variables. Cross-time variable is the contractive monetary policy dummy. Cross-region variables include economic development, fiscal capacity, and bank penetration, all in initial year value. Besides, we further explore the firm-level heterogeneity, such as firm ownership and the LGFV.

III. Empirical Results

A. *Baseline result*

Table II reports the baseline result. In column (1), the coefficient of lagged monetary policy index is significantly positive, indicating that tighter monetary policy would increase the loan rate of the sample bank. Results of control variables demonstrate that loans with smaller volume, longer maturity, and guaranteed loans are characterized by larger loan rates. The coefficients of city-level control variables, however, are not significant. In column (2), we further explore the impact of

monetary policy on loan spread. Loan spread is defined as the difference between loan rate and the benchmark loan rate, which is decided by the PBOC. The coefficient of MP index is still significantly positive, indicating that tighter monetary policy would also increase loan spread. The coefficient of loan volume is still significant, yet the coefficient of loan maturity turns significantly negative. Loans with longer maturity tend to have a larger loan rate, yet smaller loan spread. This is due to the fact that the benchmark loan rate is also larger for loans with longer maturity, leading to a smaller loan spread. Besides, the increase of GDP and fiscal revenue would also increase loan spread. Loans to larger cities or cities with more fiscal revenue are associated with lower default risk, as well as smaller loan spread. Results in Table II illustrate that there is a significant pass-through from monetary policy to loan pricing. Tighter monetary policy would increase loan rate and spread of the bank lending.

In baseline regression, we control the city×industry fixed effects to absorb any time-invariant variables for each city-industry pair. By doing so, we actually compare the loan price of different loans within each city-industry pair. Besides, we also control the year fixed effects to absorb the common macro shocks faced by all loans. However, some time-variant city or industry level variables may still be correlated to monetary policy shock and loan price, thus causing an omitted variable problem in baseline specification. In Table III, we further conduct several tests with stricter fixed effects to mitigate the endogeneity problem. In panel a, we directly control the city×industry×year fixed effects. This stronger fixed effects could absorb any possible time-variant shocks at the city×industry level. The coefficients of the MP index are still significantly positive in both columns. The magnitude is also similar to the coefficient in baseline regression.

Considering the fact that we do not control the firm-level variables in our baseline regression, the firm-level time-variant factors could also significantly affect the loan pricing, such as the change of a firm's size or its financial condition such as revenue and profit, etc. Omitting those variables may flaw our results. In panel b, we directly control the firm-year fixed effects to absorb the impact of any firm-level variables. Results indicate that the lagged MP index still has a significant and positive effect on loan rate and loan spread. Results in In Table III indicate that the above-mentioned possible omitted variable problem would not flaw our baseline result.

For robustness, we further use alternative monetary policy stance measures. Following Chen et al. (2021), we use 7-day reverse repo rate and 30-day shibor as the price-based monetary policy

measure, and the the M_2 growth rate as the quantitative monetary policy measure. Results are reported in In Table IV. In column (1) - (4), the coefficients of the 7-day reverse repo rate,and the coefficients of the 30-day shibor are all significantly positve, indicating that contractive monetary policy would increase the loan rate and loan spread. In column (5) and (6), we find significantly negative coefficients of M_2 growth rate, suggesting that when the money supply increases, the loan rate and loan rate would decrease. We find robust results using all three alternative monetary policy measures.

In Table V, in order to further alleviate the endogeneity of the monetary policy measure, we employ the monetary policy shock measures, instead of the monetary policy stance measures. Firstly, in columns (1) and (2), following Li et al.(2020), we use the exogenous component of the M_2 growth rate measure estimated from the regime-switching model of Chen et al. (2018). We still find that the coefficients of the M_2 growth shock are significant and negative. In columns (3) and (4), following Miranda-Agrippino et al.(2020), we identify Chinese monetary policy shocks by postulating a Taylor-type rule for the monetary authority, as an innovation of the monetary policy index. Results indicate that the coefficients of the monetary policy index shock are both significantly positive, consistent with the baseline results. Results in Table V indicate that our main results still hold after considering the possible endogeneity problem of the monetary policy measures.

In order to explore the dynamic effect of monetary policy on loan rate, we separately run six regressions using the monetary policy index with different lag periods (from 1 to 6 months) to explain the changes of loan rate, based on the specification of Table II. We then demonstrate the coefficient estimates of the monetary policy index with the 95% confidence intervals. Figure 5(a) shows the impact of the monetary policy index of different lag periods on loan rate. It can be seen that the impact of monetary policy on loan rate reaches a peak after two months, after which the coefficient gradually decreases. Monetary policy indexes with a lag of 1 period to a lag of 6 periods all have a significant positive effect on loan interest rates. Figure 5(b) further shows the impact of monetary policy index of different lag periods on loan spread. Results show that the effect of monetary policy on loan spread is the strongest after 3 months, after which the coefficient also gradually decreases. Figure 5 demonstrates that the effect of monetary policy on loan price is significant and relatively persistent. The strongest impact appears approximately one quarter

after.

We further explore the asymmetric effect of monetary policy shock on loan price. Figure 6 shows the evolution of the monetary policy index during the sample period. We circle three periods of sharp monetary policy tightening and define those periods as contractive monetary policy periods. In order to study the asymmetric impact of monetary policy shock, we construct the dummy Contractive, which is set to be 1 during tight monetary policy periods: Jan.2006-Feb.2008; Feb.2010-Mar.2012; Sep.2013-Mar.2014. We then put the dummy and its interaction with lagged monetary policy index into the estimation. Results in Table VI show that coefficients of the interaction terms are both significant and positive, illustrating a stronger pass-through of monetary policy shock during the contractive monetary policy period.

Finally, we utilize the market-oriented reform of the bank to examine the changes in monetary policy transmission before and after the reform.

In February 2008, the State Council abruptly announced the sample bank's "commercialization plan". According to the commercialization plan, the bank would eventually become a market-oriented commercial bank, just like the big-4 commercial banks in China. In April 2015, the State Council required that the sample bank adhered to the position of development-oriented financial institution. The "commercialization plan" thus came to an end. The marketization of the bank provides a unique set up to show the heterogeneous response of policy banks funding cost to monetary policy shock under different institution.

In order to explore the impact of marketization reform on the pass-through of monetary policy shock, we separate the whole sample period into pre-reform period, during-reform period and after-reform period. We then separately run sub-sample regressions , based on the specification of Table II . The coefficient estimates of the 1-month lagged monetary policy index are shown in Figure 7,with the confidence intervals at 95% level. .

Figure 7(a) shows the results when the dependent variable is the loan rate. The results show that before the market-oriented reform, the coefficient is the smallest and the monetary policy transmission is also the weakest; During the market-oriented reform, the coefficient has significantly increased, and the transmission is strongest; After the end of the market-oriented reform, the coefficient slightly decreases, but is still larger than that of the "before-reform" period. This indicates that during the market-oriented reform period, the transmission of monetary policy in

the sample bank is indeed significantly stronger than during the non market-oriented reform period. Figure 7(b) shows the result of the dependent variable being the loan spread. We have reached a similar conclusion. Figure 7 shows that the market-oriented reform has significantly promoted the transmission of monetary policy. After the end of market-oriented reform, the transmission has decreased, but it is still significantly stronger than before the reform.

B. Transmission channel—bond financing costs

We find a significant pass-through of monetary policy shock on loan price. One of the key differences between the sample bank and other commercial banks is that the bank mainly relies on bond financing, while other banks mainly finance through deposits. The mechanism of the pass-through of monetary policy is thus the bond financing channel for our sample bank. Contractive monetary policy would directly affect the bond market and increase the funding costs of the bank. Afterward, the bank also increases the interest rate of bank lending on the asset side.

In order to testify this bond financing channel, we firstly directly explore the relationship between the costs of bonds issued by the bank and the loan rate of the bank. We use two indicators to measure the bond costs of the bank. In the first market, we use the issuing rate of the 10-year bonds issued by the bank to represent the bond costs. In the second market, we employ the YTM (yield to maturity) of the 10-year bonds issued by the bank. Column (1) - (4) of Table VII show that the coefficients of both bond costs measures are significantly positive. The increase of bond costs, or the funding costs of the bank, would significantly increase the loan rate and loan spread on the asset side. In columns (5) - (8) of Table VII , we also explore the impact of alternative bond cost measures, including both the bond issuing rate of the 10-year treasury bonds, as well as the issuing rate of the 10-year AAA corporate bonds. We find that the coefficients remain significantly positive.

Then, We testify the hypothesis that the contractive monetary policy would directly increase the funding costs of the sample bank. Figure 8 shows the time series of the monetary policy index and the YTM of 10-year bonds issued by the sample bank. From the figure, the bond costs and the monetary policy index are positively correlated. The correlation coefficient of the two variables is 0.72 during the sample period. Figure 8 provides suggestive evidence that the contractive monetary policy would directly increase the bond costs of the sample bank.

We finally use the VAR method to show the relationship between the issuing rate of the bank bonds and the monetary policy shock. Results are reported in Figure 9. Figure 9 illustrates the response of the bond issuance rate to monetary policy shock. We firstly look at the full sample of bonds issued by the bank. Results show that the increase of the MP index would also cause the issuance rate to rise. The effect is strongest in the first month and then gradually declines. We then separately explore the response of the issuance rate of bonds with different maturities. Results indicate that the 7-year bond cost is the most sensitive to the monetary policy shock, while the 5-year bond rate is relatively less responsive. Overall, the results in Figure 9 directly demonstrate that the contractive monetary policy would directly cause the funding costs of the sample bank to rise.

Combining the analysis together, we now provide evidence of the bond financing channel. The mechanism behind the pass-through of monetary policy shock on loan rate is that firstly the tighter monetary policy would increase the funding costs of the bank. Afterwards, the bank would charge a higher price on the asset side, and raise the loan rate and spread. This is a new channel of monetary policy transmission, different from the lending channel and deposit channel extensively discussed in the previous literature (Bernanke, 1991; Drechsler et al., 2017, 2021).

C. Other loan outcomes

In baseline regression, we mainly focus on the impact of monetary policy shock on loan price. However, the effect may extend to other loan outcomes, such as loan maturity, loan volume, and loan quality. Results in Table VIII show that tighter monetary policy would increase loan quality (a smaller loan quality indicator implies a higher quality loan) and loan maturity, as well as reduce loan volume. When faced with a tighter monetary policy, the sample bank not only charges higher loan price but also reduces loan volume. Besides, it would also be more risk-averse, and allocate more resources to high-quality borrowers and loans. This is consistent with the findings in **?**. Finally, the average loan maturity also increases in response to tighter monetary policy shock. One possible reason is that the sample bank would lend more to relatively safer infrastructure projects (which are usually implicitly guaranteed by local governments) in such cases, which are characterized with longer maturity.

D. Sub-sample tests

(1) Sub-sample tests: by industry

The total loans mainly consist of three type of loans, infrastructure loans, manufacturing loans, and service loans, accounting for 44%, 27%, and 17% of the total sample, respectively. The response of different types of loans may be highly heterogeneous. Loans to infrastructure projects may be more policy-oriented and are considered to be implicitly guaranteed by local governments. While loans to the manufacturing sector tend to be more market-oriented. We thus expect the pass-through of monetary policy to be strongest in the manufacturing sector, and to be weakest in the infrastructure sector. Following the literature (**?**), the infrastructure sector includes (1) transportation, warehousing, and postal services; (2) production and supply of electricity, heat, gas, and water; and (3) water conservancy, environment, and public facilities management. The service sector includes 7 industries, including wholesale and retail industry, accommodation and catering industry, leasing and business service industry, information transmission computer services and software, education, health, culture.

The sub-sample test results are reported in Table IX. Results show that there is a significant pass-through of monetary policy shock in all three sectors. However, the magnitude is largest for manufacturing sector, and smallest for infrastructure sector, just as expected. Results in Table IX indicate that pass-through of monetary policy to loan rate is strongest in the manufacturing sector, and weakest in the infrastructure sector.

(2) Sub-sample tests: by area

We also conduct subsample tests by areas. We divide all provinces into three areas: the eastern area, the central area, and the western area[2]. We separately run regressions using three sub-samples by area. Results are reported in Table X. Results demonstrate that the pass-through of monetary policy shock to loan spread is strongest for eastern area, and smallest in the western area. One possible explanation is that loans to western areas are mostly policy-oriented infrastructure loans, leading to the weak pass-through of monetary policy shock to loan spread.

[2]We use the geographical definition. The western area includes 12 provinces, including Inner Mongolia, Gansu, Shanxi, Qinghai, Guizhou, Guangxi, Sichuan, Ningxia, Yunnan, Xinjiang, Chongqing and Tibet. The central area includes 6 provinces, including Shanxi, Henan, Anhui, Jiangxi and Hunan. Other provinces belong to the eastern area.

E. Economic mechanism—firm and regional heterogeneity

In this section, we explore the heterogeneity of the the monetary policy pass-through among different firms and cities. As a policy bank, the sample bank may not be able to freely choose loan distribution among different regions or industries, but it can price loan risks, especially default risks, in a more market-oriented manner. This is partly due to the market-oriented financing channel of the sample bank on the liability side, namely the bond financing channel. Therefore, when monetary policy changes cause fluctuations in bank financing costs, the bank will transfer the cost of liabilities to the asset side, especially for high-risk loans. Therefore, we expect the transmission of monetary policy to be stronger for loans with higher default risk. In this section, we measure the loan default risk both from the firm level as well as the city level.

(1) Firm heterogeneity

We firstly explore the firm heterogeneity in the transmission of monetary policy. We expect stronger monetary policy transmission in loans to higher risk firms. We employ three firm-level variables to measure firm-level default risk.

Firstly, we use the firm-level bargaining power variable to measure the firm-level default risk. The bargaining power variable ranges from 1 to 5, and it is comprehensively evaluated by the sample bank based on the firm size, profitability, industry, and location. The higher the indicator, the stronger the bargaining power of the firm when negotiating with the bank. Generally speaking, if a firm has good qualifications or is located in a region with dense banking institutions, it would have a stronger bargaining power with the bank. We hold the view that firms with stronger bargaining power would have lower default risk and the transmission would be smaller for those firms. In columns (1) and (2) of Table XI, we add the interaction term of monetary policy index and the firm bargaining power variable. We find significant and negative coefficients of the interaction variable, indicating smaller monetary policy transmission for firms with larger bargaining power.

Secondly, We directly examine the impact of firm size. According to the loan type, there is a type of loan called "small and medium-sized enterprise loan", or "SME" loan. Generally speaking, compared to large-scaled firm, small and medium-sized firms have a higher degree of information asymmetry, so from the perspective of the bank, their default risk is larger. Therefore, we expect the monetary policy transmission to be more pronounced for loans to small and medium-sized

enterprises. To testify this hypothesis, we construct the "SME" dummy for the loans to small and medium-sized firms, and interact it with the monetary policy indicator. Results are reported in columns (3) and (4) of Table XI. We find that the coefficients of the interaction terms of the monetary policy index and the SME dummy are both significantly positive, indicating stronger transmission for loans to small and medium-sized firms.

In the end, we look at the role of local government financing vehicle. Local government financing vehicle (LGFV) is a kind of special SOE established by local governments to solve financing problems. The main responsibility of LGFV is to finance local infrastructure projects. In our sample, about half of all loans are lent to LGFVs. Compared with the general SOE, LGFV has the following differences. Firstly, LGFVs have stronger political connection, and they are directly supported by local governments. The debt of LGFVs could be partly considered as the local government debt. Secondly, a large proportion of LGFV loans flow to the infrastructure sector. Therefore, it is possible that the policy factors could play a more important role in the pricing of LGFV loans. Thus, it is very likely that the defaul risk of the LGFV loans are relatively smaller. In order to explore the heterogeneous response of the LGFV loans, we merge the loan dataset with the LGFV list collected by the China Banking Regulation Commission (CBRC) using the unified code for a legal person. We construct the dummy LGFV, which is set to be 1 if the borrower of the loan is LGFV. We interact the LGFV dummy with the lagged monetary policy index. Results columns (5)-(6) of Table XI show that the interactions are significantly negative, implying that the impact of monetary policy shock on loan price is less pronounced for LGFVs. Two reasons might rationalize the phenomenon. Firstly, LGFV debt is considered to be implicitly guaranteed by local government, thus the default risk is relatively lower. Secondly, most LGFV loans are used to finance infrastructure projects and are more policy-oriented. In such case, the sensitivity of LGFV loan price to monetary policy shock tends to be smaller.

The results of Table XI combine to indicate that for firms with higher default risks, the monetary policy transmission will be stronger.

(2) Regional heterogeneity In this part, we would explore the city-level risk characteristics, and its impact on monetary policy transmission. Consistent with the firm-level risk characteristics, we also expect that the transmission would be more evident in cities with more default risk. For robustness, we measure the city heterogeneity from four dimensions: fiscal capacity, default cases,

economic development, and financial development.

Firstly, we use the fiscal deficit rate to measure the fiscal capacity for each city. Deficit rate is defined as the difference between fiscal expenditure and fiscal revenue, divided by fiscal expenditure. It measures the fiscal pressure of the local government. A larger deficit rate indicates a more financially distressed local government, and thus higher default risk. We interact the fiscal deficit rate of each city in the year 2006 with the lagged MP index, and put them into the estimation.

Results are reported in column (1) of Table XII, showing that the coefficients of the interaction are significantly positive. The results indicate that the pass-through of monetary policy is stronger in areas with a larger deficit rate. When faced with tighter monetary policy, the bank would charge a higher loan price for areas with larger deficit rate. This is consistent with the hypothesis that the bank would charge higher prices for cities with larger default risk.

To directly measure the city-level default risk, we also employ the default cases variable, which is defined as the number of default persons divided by the city total GDP in year 2018. We then add the interaction term of the default case variable with the monetary policy index. Result in column (2) of Table XIIshows that the coefficient of the interaction term is significantly positive, indicating that the transmission is more pronounced in cities with more default cases.

We then explore the role of economic development. Generally speaking, loans to more developed areas are considered safer and less risky. We use the GDP per capita to measure the economic development level for each city. We interact the GDP per capita of each city (in the year 2006) with the lagged MP index and put them into the estimation. Result in column (3) of Table XII shows that the coefficients of the interactions are significantly negative, indicating that the impact of monetary policy on loan price is stronger in less developed areas.

Lastly, we also explore the heterogeneity of local financial development. For more financially developed areas, firms have more financing channels and rely less on the policy bank loan. In such a case, even the funding costs increase, the bank would only increase limited loan prices as the bargaining power of the sample bank is weaker in those areas. We thus expect that the pass-through of monetary policy to the bank's loan price is weaker in financially developed areas. We use the bank penetration indicator to represent the financial development level. It is defined as the number of commercial banks divided by the total population (in thousands) of the city at the end of the year. A larger value of bank penetration indicator means more credit supply, and implies a

higher level of financial development. We interact the bank penetration indicator of each city in the year 2006 (Bank) with lagged MP index. Results in Table XII show that the coefficients of the interaction terms are both significantly negative, indicating that the pass-through of monetary policy shock is more pronounced in areas with lower level of bank penetration. This is in line with the hypothesis that in financially developed areas, the bargaining power of the sample bank is lower, thus it would increase less loan price when faced with contractive monetary policy shock.

Overall, we find strong heterogeneity of monetary policy transmission among different areas in Table XII. The pass-through of monetary policy shock is stronger in less developed areas, especially those with higher default risks.

IV. Conclusion

In this paper, we propose the bond financing channel of monetary policy transmission is related to a change in the funding costs of policy banks. We find that the bond financing channel matters: tighter monetary policy would increase loan rate and spread of the policy bank lending. Besides, it would also reduce loan volume and increase loan quality. We also find vast heterogeneity of the monetary policy transmission. We find stronger transmission in the tight monetary policy period and market-oriented reform period, and also in loans with higher default risks. For example, we find smaller transmission in firms with strong bargaining power, large firms and LGFVs, and stronger transmission in areas with lower level of economic development, weaker fiscal capacity ,and less bank penetration.

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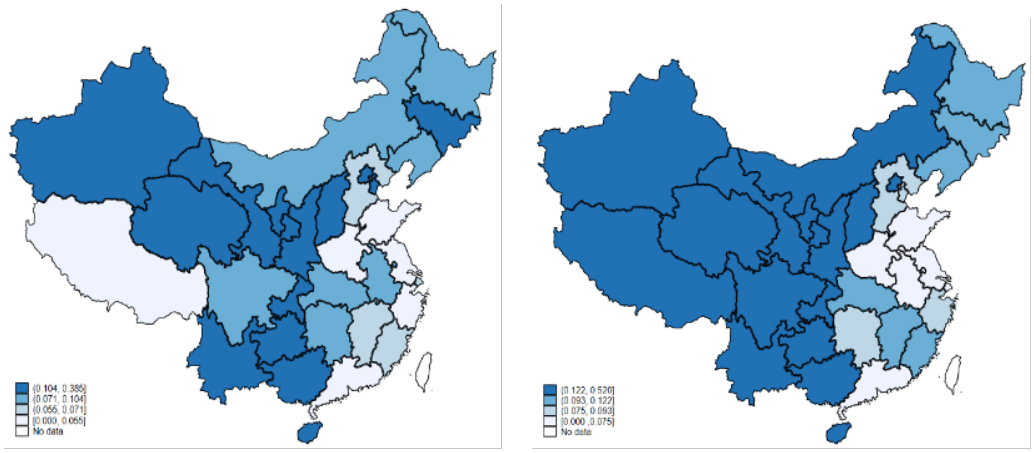
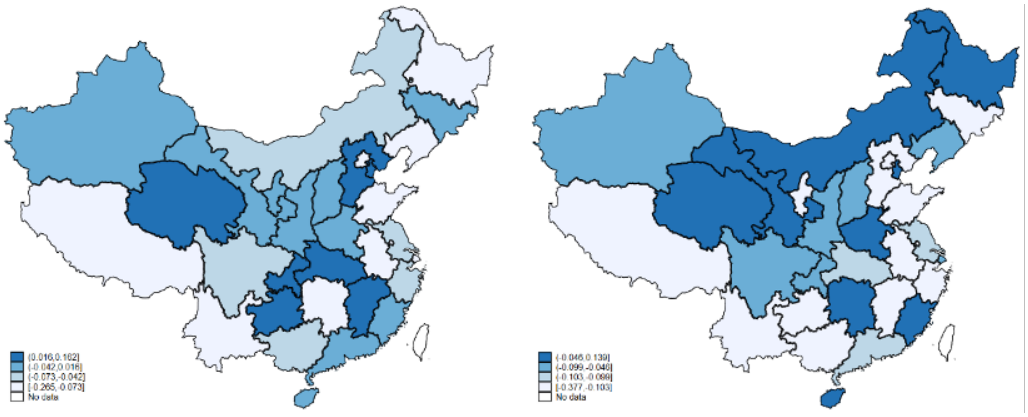


(a) Year 2010 (b) Year 2018

Figure 1. Loan outstanding/ GDP, by province

Notes: This figure reports the regional distribution of the sample bank loan in the year 2010 and 2018.



(a) Year 2010 (b) Year 2018

Figure 2. Average loan spread, by province

Notes: This figure reports the average loan spread distribution of the sample bank loan in the year 2010 and 2018.

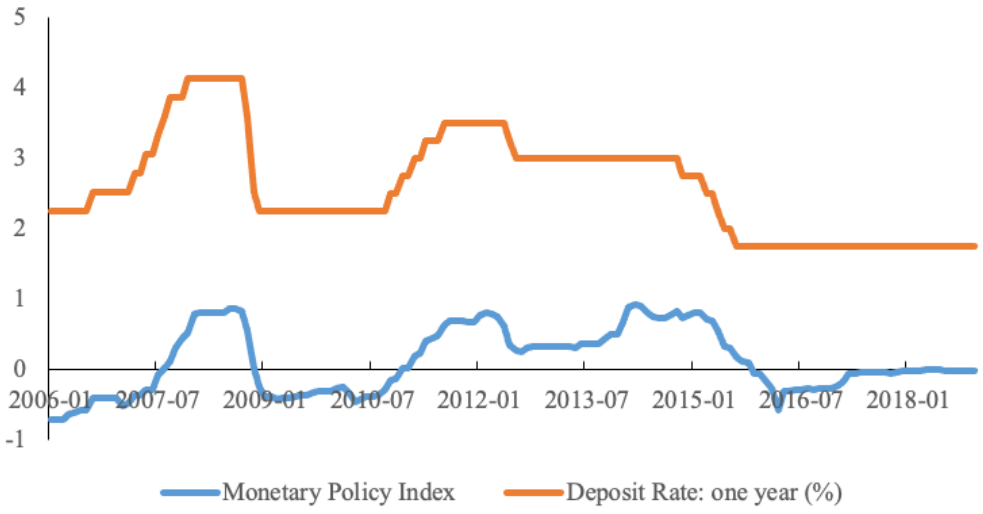


Figure 3. Monetary policy indicators

Notes: This figure shows the evolution of two monetary policy indicators, the monetary policy index used in the paper, and the one-year deposit rate during the sample period.

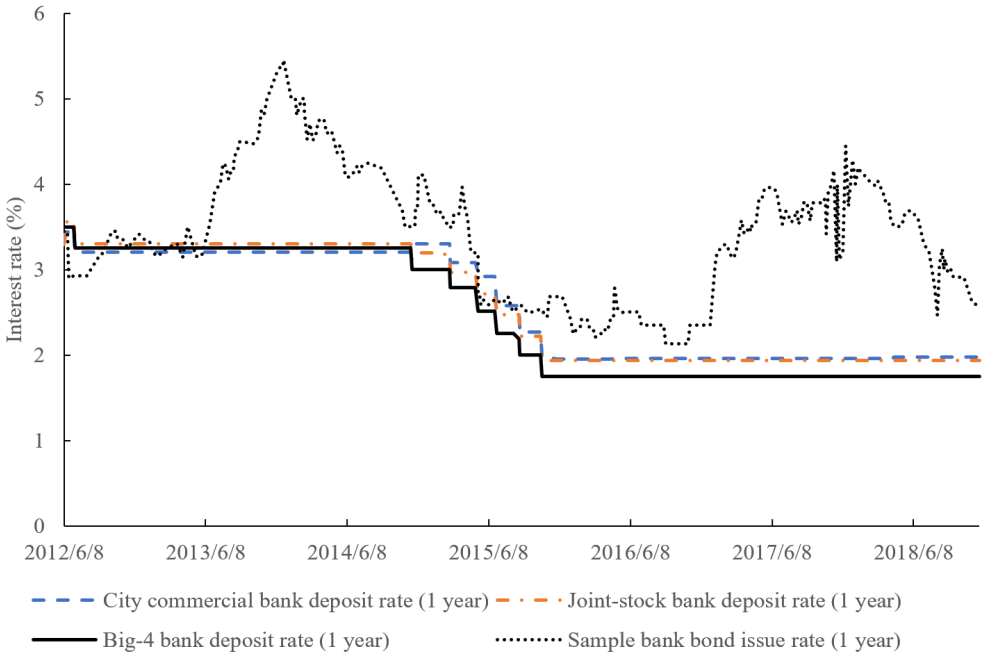
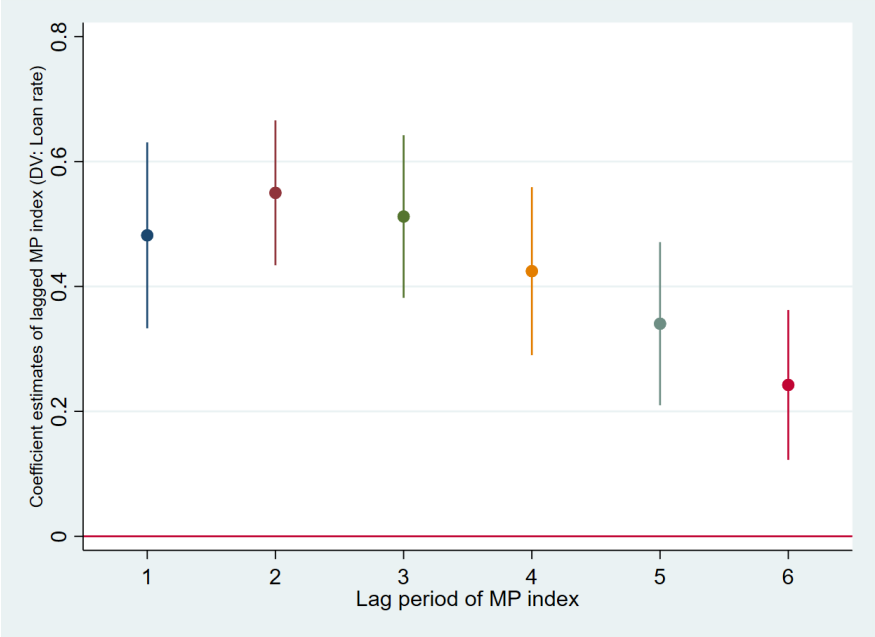
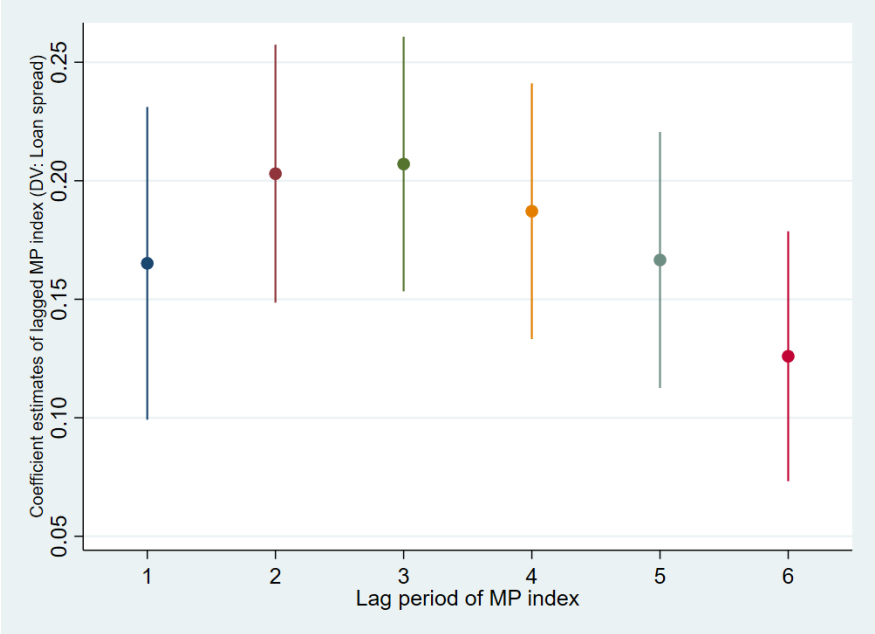


Figure 4. Deposit rates and the bond issuance rate (one-year)

Notes: This figure shows the evolution of one-year deposit rate of Chinese main commercial banks, and the one-year bond issuance rate of the sample bank.



(a) The dynamic effect of monetary policy shock on loan rate



(b) The dynamic effect of monetary policy shock on loan spread

Figure 5. The dynamic effect of monetary policy shock on loan price

Notes: This figure shows the dynamic effect of monetary policy on loan rate and loan spread. We separately run regressions using monetary policy index with different lag periods, based on the specification of Table II. The coefficient estimates of lagged MP index are reported with a 95% confidence interval.

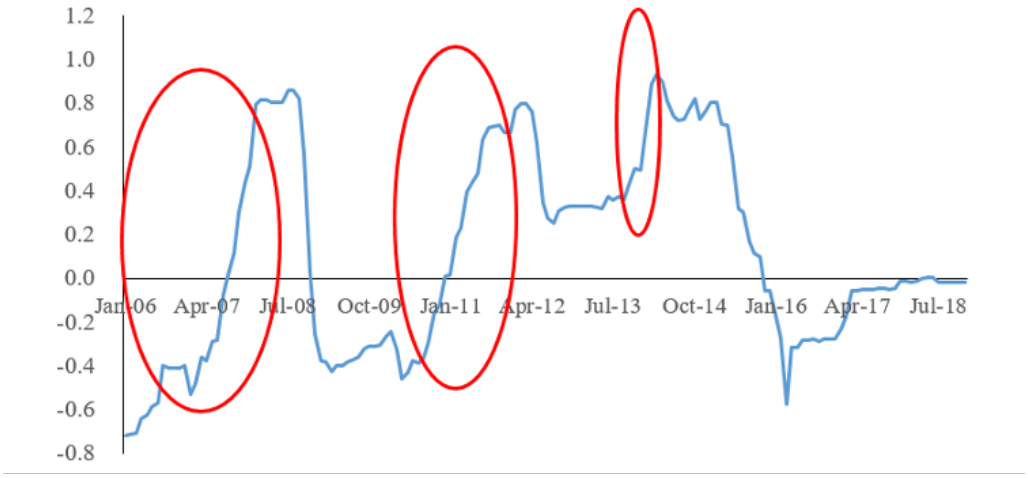
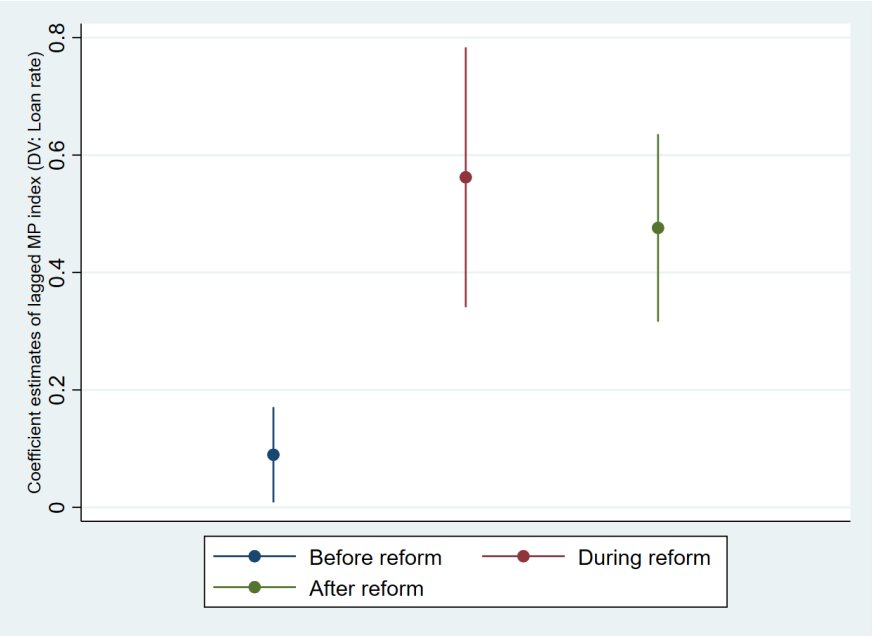
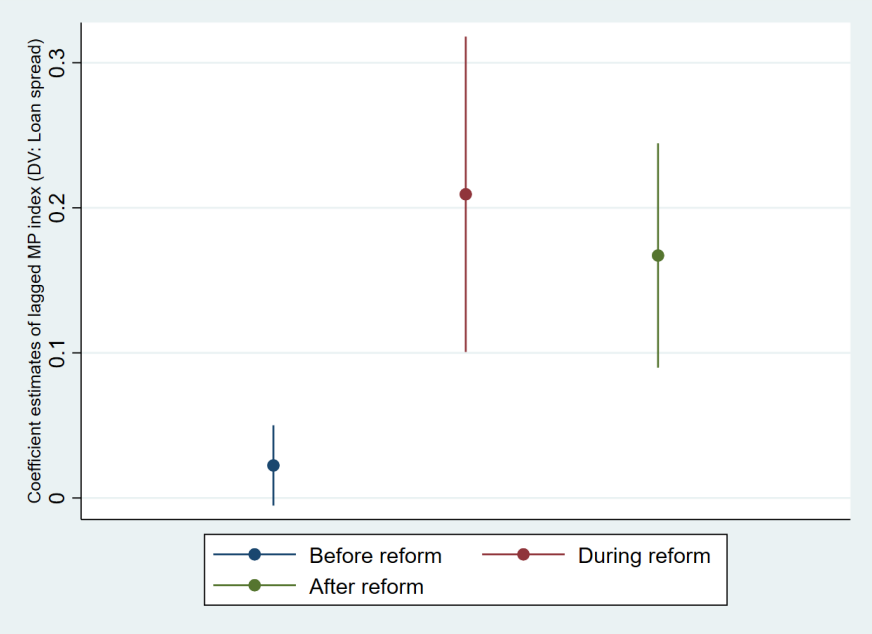


Figure 6. Contractive monetary policy period

Notes: The circle indicates the periods of sharp monetary policy tightening.



(a) Loan rate



(b) Loan spread

Figure 7. The impact of the market-oriented reform on monetary policy transmission

Notes: This figure shows the effect of the market-oriented reform on monetary policy transmission. Based on the specification of II, we separately run regressions in three sub-samples, the before reform period, the during reform period, and the after reform period. The coefficient estimations of lagged MP index are reported with 95% confidence intervals.

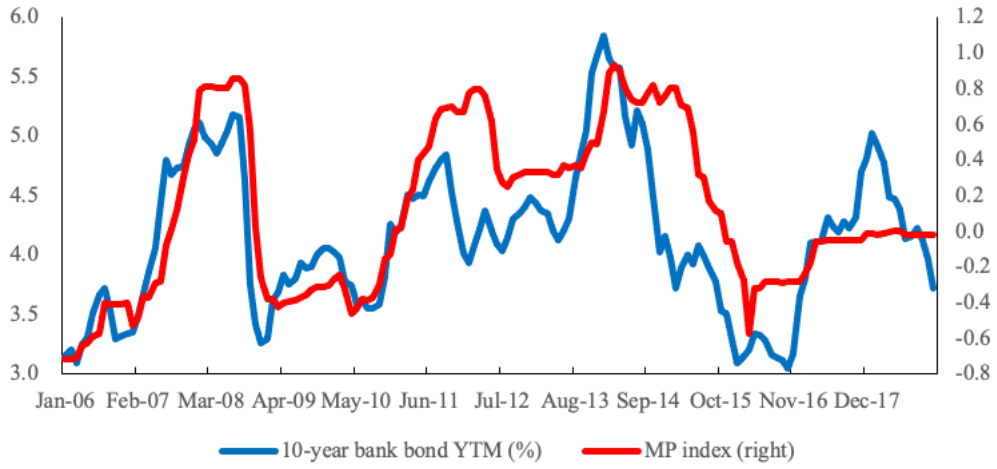
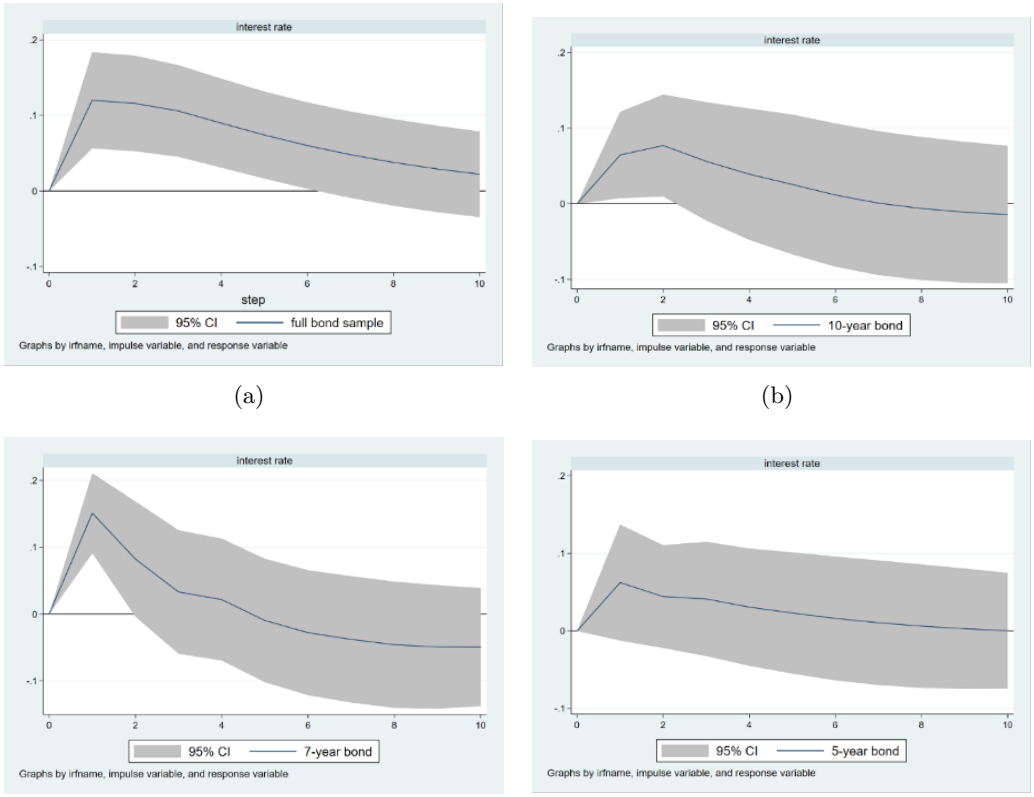


Figure 8. MP index and 10-year bond YTM

Notes: This figure shows the time series of the MP index and the YTM of 10-year bonds issued by the sample bank.



(a) (b)

(c) (d)

Figure 9. Response of bond issuance rate to MP shocks

Notes: This figure shows the response of bond (10-year, 7-year, 5-year, and full sample) issuance rate to MP shocks.

Table I:Summary statistics of key variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Loan level					
Loan rate(%)	48,518	5.997	0.930	4.133	7.800
Loan spread(%)	48,518	0.154	0.449	-1.155	1.800
MP index	48,754	0.137	0.433	-0.720	0.930
Deposit rate	48,754	2.641	0.672	1.750	4.140
Non-performance Loan	48,754	0.004	0.065	0.000	1.000
Loan volume (billion RMB)	48,754	0.392	1.979	0.000	260.7
Loan maturity (in years)	48,754	7.197	7.116	0.833	40.00
Loan quality	48,185	3.895	0.884	1.000	8.000
City level					
Ln GDP	47,404	7.808	1.275	2.303	13.731
Ln Population	47,131	8.607	0.924	5.048	14.147
Rev/GDP	44,851	0.090	0.039	0.011	0.238

Notes: The table shows the summary statistics of key variables.

Table II:MP index and loan rate

	(1)	(2)
	Loan rate	Loan spread
L. MP index	0.482***	0.165***
	(0.075)	(0.033)
Loan volume	-0.055***	-0.035***
	(0.004)	(0.002)
Loan maturity	0.182***	-0.017***
	(0.010)	(0.005)
GDP	-0.039	-0.125***
	(0.040)	(0.039)
Population	0.114*	-0.087*
	(0.069)	(0.051)
Rev/GDP	-0.670*	-1.755***
	(0.359)	(0.339)
City×Industry FE	Yes	Yes
Year FE	Yes	Yes
Observations	42,399	42,399
R-squared	0.856	0.579

Notes: This table shows the relationship between monetary policy index (MP index) and loan rate (spread). City×industry fixed effects and year fixed effects are controlled in all columns. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table III:MP index and loan rate: stricter fixed effects

Panel a		
	(1)	(2)
	Loan rate	Loan spread
L.MP index	0.485***	0.155***
	(0.074)	(0.034)
Controls	Yes	Yes
City∗Ind∗Year FE	Yes	Yes
Observations	34,333	34,333
R-squared	0.927	0.792
Panel b		
	(1)	(2)
	Loan rate	Loan spread
L.MP index	0.556***	0.178***
	(0.076)	(0.039)
Controls	Yes	Yes
Firm∗Year FE	Yes	Yes
Observations	28,841	28,841
R-squared	0.960	0.891

Notes: This table shows the relationship between monetary policy index (MP index) and loan rate (spread) using stricter fixed effects. All regressions include controls used in Table II. In panel a, we control city×industry×year fixed effects. In panel b, we control firm×year fixed effects. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table IV:Alternative monetary policy measures

	(1)	(2)	(3)	(4)	(5)	(6)
	Loan rate	Loan spread	Loan rate	Loan spread	Loan rate	Loan spread
L.Repo7	0.283***	0.040**				
	(0.047)	(0.017)				
L.Shibor30			0.047***	0.007**		
			(0.014)	(0.003)		
L.M_2g					-1.480**	-0.439***
					(0.742)	(0.160)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
City*Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,028	15,028	41,417	41,417	42,399	42,399
R-squared	0.916	0.623	0.853	0.575	0.850	0.576

Notes: This table shows the robustness results using alternative monetary policy measures. All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table V:Using the monetary policy shock measures

	(1) Loan rate	(2) Loan spread	(3) Loan rate	(4) Loan spread
L.M_2g shock	-4.773***	-1.403**		
	(1.824)	(0.774)		
L.MP index shock			0.302***	0.072***
			(0.065)	(0.025)
Controls	Yes	Yes	Yes	Yes
City×Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	35,264	35,264	42,399	42,399
R-squared	0.786	0.602	0.851	0.576

Notes: This table shows the robustness results using the monetary policy shock measures. All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table VI:The asymmetric effect of monetary policy transmission

	(1) Loan rate	(2) Loan spread
L. MP index	0.456***	0.128***
	(0.032)	(0.034)
L. MP×Contractive	0.060*	0.094**
	(0.033)	(0.042)
Contractive	-0.028*	-0.062***
	(0.016)	(0.021)
Controls	Yes	Yes
City×Industry FE	Yes	Yes
Year FE	Yes	Yes
Observations	42,399	42,399
R-squared	0.856	0.580

Notes: This table shows the asymmetric impact of monetary policy shock on loan price. The dummy Contractive is set to be 1 during the contractive monetary policy period. All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table VII:Mechanism: Bond financing channel

	(1) Loan rate	(2) Loan spread	(3) Loan rate	(4) Loan spread	(5) Loan rate	(6) Loan spread	(7) Loan rate	(8) Loan spread
L. Bond issue rate	0.147***	0.045***						
	(0.030)	(0.013)						
L. Bond YTM			0.089***	0.015*				
			(0.030)	(0.008)				
L. Treasury issue rate					0.151**	0.026*		
					(0.061)	(0.015)		
L. Corp. bond issue rate							0.086***	0.021*
							(0.031)	(0.012)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City×Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,168	31,168	42,399	42,399	23,429	23,429	15,553	15,553
R-squared	0.877	0.594	0.850	0.576	0.883	0.624	0.902	0.603

Notes: This table shows the impact of the bond financing costs on loan price. Bond issue rate is the issuing rate of the 10-year bonds issued by the sample bank in the first market. Bond YTM is the yield to maturity of the 10-year bonds issued by the sample bank in the second market. Treasury issue rate is the issuing rate of the 10-year treasury bonds. Corp. bond issue rate is the issuing rate of the 10-year corporate bonds (AAA rating). All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table VIII:The impact of monetary policy on other loan outcomes

	(1) Loan quality	(2) Loan volume	(3) Loan maturity
L. MP index	-0.115***	-0.106**	0.058**
	(0.038)	(0.053)	(0.028)
Controls	Yes	Yes	Yes
City×Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	42,075	42,399	42,399
R-squared	0.516	0.702	0.732

Notes: This table shows the impact of monetary policy shock on other loan outcomes. All regressions include year dummies and city×industry fixed effects. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table IX:Subsample test: by industry

	(1) Loan rate	(2) Loan spread
Manufacturing		
L. MP index	0.774***	0.309***
	(0.072)	(0.046)
Observations	10,920	10,920
R-squared	0.867	0.574
Infrastructure		
L. MP index	0.274***	0.073**
	(0.067)	(0.029)
Observations	19,038	19,038
R-squared	0.835	0.441
Service		
L. MP index	0.471***	0.197***
	(0.095)	(0.052)
Observations	7,431	7,431
R-squared	0.859	0.551
Controls	Yes	Yes
City×Industry FE	Yes	Yes
Year FE	Yes	Yes

Notes: This table shows the subsample test results. We separately run regressions for infrastructure loans, manufacturing loans and service loans. All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table X:Subsample test: by area

	(1) Loan rate	(2) Loan spread
Eastern area		
L.MP index	0.447***	0.170***
	(0.070)	(0.032)
Observations	16,282	16,282
R-squared	0.87	0.597
Central area		
L.MP index	0.402***	0.164***
	(0.063)	(0.043)
Observations	11,541	11,541
R-squared	0.851	0.592
Western area		
L.MP index	0.585***	0.156***
	(0.101)	(0.039)
Observations	14,229	14,229
R-squared	0.853	0.571
Controls	Yes	Yes
City×Industry FE	Yes	Yes
Year FE	Yes	Yes

Notes: This table shows the subsample test results. We separately run regressions for loans to eastern area, central area and western area. All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table XI:Firm heterogeneity in monetary policy transmission

	(1)	(2)	(3)	(4)	(5)	(6)
	Loan rate	Loan spread	Loan rate	Loan spread	Loan rate	Loan spread
L.MP index	0.625***	0.267***	0.421***	0.130***	0.527***	0.186***
	(0.077)	(0.043)	(0.081)	(0.034)	(0.069)	(0.031)
L.MP index×Power	-0.062***	-0.040***				
	(0.012)	(0.010)				
Power	-0.110***	-0.085***				
	(0.007)	(0.005)				
L.MP index×SME			0.327***	0.181***		
			(0.053)	(0.036)		
SME			0.134***	0.154***		
			(0.032)	(0.018)		
L.MP index×LGFV					-0.118***	-0.045***
					(0.029)	(0.015)
LGFV					0.099***	0.033***
					(0.014)	(0.009)
Contros	Yes	Yes	Yes	Yes	Yes	Yes
City×Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	41,037	41,037	41,141	41,141	42,399	42,399
R-squared	0.861	0.599	0.826	0.593	0.857	0.568

Notes: This table shows the results of firm heterogeneity tests. All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.

Table XII:Regional heterogeneity in monetary policy transmission

	(1)	(2)	(3)	(4)
	Loan spread			
L.MP index	0.134***	0.153***	0.867***	0.281***
	(0.036)	(0.034)	(0.156)	(0.039)
L.MP index×Deficit rate	0.098**			
	(0.042)			
L.MP index×Default		0.017*		
		(0.009)		
L.MP index×GDP per			-0.070***	
			(0.015)	
L.MP index×Bank				-0.965***
				(0.151)
Controls	Yes	Yes	Yes	Yes
City×Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	40,392	41,797	40,408	40,237
R-squared	0.574	0.580	0.574	0.575

Notes: This table shows the results of regional heterogeneity tests. All regressions include year dummies, city×industry fixed effects, and the controls used in Table II. Standard errors are clustered at year-month level. *, **, *** denote significance level at 10%, 5% and 1%.