Journal of Asian Economics 86 (2023) 101595

Contents lists available at ScienceDirect

Journal of Asian Economics

journal homepage: www.elsevier.com/locate/asieco

Does bank competition affect the transmission mechanism of monetary policy through bank lending channel? Evidence from India

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ARTICLE INFO

JEL Classifications:
D41
E5
G2
L12

Keywords:
Bank competition
Monetary policy transmission, Bank lending channel, India

ABSTRACT

This paper empirically investigates how intensified competition in the Indian banking affects the transmission of monetary policy through bank lending channel over the period 1997–2017. Additionally, this study examines the impact of deposit and loan market channels on bank's credit growth. Results obtained through two-step system-GMM reveal that a higher degree of market power weakens the monetary policy transmission mechanism for the entire banking industry and across ownerships. Results show that higher market power in the deposit and loan markets weakens the impact of monetary policy on bank loan supply. The findings of this study extend important policy measures that can strengthen the transmission mechanism of monetary policy by reducing the adverse effects of changes in bank competition.

1. Introduction

While traditional interest rates channel predominantly occupies the discourse of monetary policy, little attention has been paid to the bank lending channel of monetary policy transmission. Beck et al. (2014) highlight that financial intermediaries play a crucial role in influencing the transmission of monetary policy through bank lending channel. Unlike interest rates channel, the bank lending and risk-taking channels of monetary policy identify the conduct of individual banks in the transmission mechanism of monetary policy (Kashyap & Stein, 2000; Gambacorta & Marques-Ibanez, 2011; Borio & Zhu, 2012). However, the effectiveness of these channels largely depends on certain bank-specific characteristics such as size, liquidity, and capitalization (Brissmis et al., 2014; Khan et al., 2016). In light of the previous studies, this paper examines whether bank competition affects the transmission mechanism of monetary policy in one of the fastest-growing economies, such as India.

Existing literature typically maps the link between bank competition and monetary policy through bank lending channel (Brissimis et al., 2014; Borio & Zhu, 2012; Segev & Schaffer, 2020; Wang et al., 2022). The theoretical foundation of the bank lending channel is built on the ground that changes in monetary policy can influence the lending capacity of banks by impacting their balance sheet positions and cost of credit. Bernanke and Blinder (1988, 1992) suggest that banks with limited access to alternative funding sources other than customer deposits are more sensitive to changes in monetary policy. For example, thriving bank competition intensified by fewer barriers to expansion may push the relatively weaker banks (reliant on deposit finance) out of the market, making bank lending channel more sensitive to the changes in monetary policy. On the other hand, banks with increased market power are likely to have

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https://doi.org/10.1016/j.asieco.2023.101595
Received 19 February 2022; Received in revised form 22 December 2022; Accepted 2 March 2023
Available online 5 March 2023

easier, superior, and alternative access to uninsured finance, which makes their lending decision less reliant on central bank funding during monetary tightening. A higher degree of market power influences the transmission mechanism of monetary policy through two other channels, deposit and loan market channels (Scharfstein & Sunderam, 2016; Drechsler et al., 2017; Repullo, 2021). Drechsler et al. (2017) test that banks tend to widen deposit spreads with an increase in the policy rate, resulting in deposits flowing out of the banking system. Since a substantial part of the loan is financed through bank deposits, the outflow of deposits leads to a contraction in bank lending. The study ascertains that the contraction in lending happens due to bank's market power over deposits. Scharfstein and Sunderam (2016) view that a concentrated banking sector impedes the transmission mechanism of monetary policy as the pass-through of policy changes is lower in a concentrated banking system than in competitive markets.

In emerging economies such as India, where the financial sector is predominantly bank-based with limited access to the capital market, the bank lending channel appears to be crucial. Since the financial liberalization of 1991, there have been considerable variations in the degree of bank competition in India. During first-generation economic reforms (1991–1997), a slew of deregulation measures such as the provision of more open and liberal entry of private banks, abolition of administered interest rates, larger presence of foreign banks, aggressive bank-branch expansion, and fewer activity restrictions promoted competition in Indian banking (Mohan, 2005; Rakshit & Bardhan, 2019; Rakshit & Bardhan, 2022). During the second phase of financial reform (post-1998), the banking industry underwent the process of bank consolidation following the wave of mergers and acquisitions to ensure stability, which was evident from the decline in total competitors (Jayadev & Sensarma, 2007). The mixed events of bank competition and bank consolidation extend an interesting set-up to understand the dynamics among bank competition, market structure, and the bank lending channel of monetary policy.

Unlike developed economies, the banking sector in India is dominated by state-owned banks (SOBs). SOBs have greater autonomy and can exercise market power while making lending decisions. These banks meet the maximum loan demand of firms and households, thereby opening themselves up to greater scrutiny.[1] Banks with different ownerships have differences in terms of their customer base and differ in terms of factors that influence their lending decisions (Bahumik & Piesse, 2008). While deposit growth outpaced loan growth at the aggregate level, the public sector banks (PSBs) loan-to-deposit ratio declined steadily to 64.12 per cent in 2021 from 75.14 per cent in 2012 (RBI, IBA, 2021). The declining trend in loan-to-deposit rates intrigues us to explore whether concentration in deposit markets contracts bank lending for PSBs. Regarding competition conditions, PSBs are characterized by higher competition conditions than private sector banks (see Table 3).[2]

In response to financial development and changing macroeconomic environment, the operational framework of monetary policy has undergone significant changes over the past few decades. The policy framework has evolved with respect to monetary instruments and targeting mechanisms. In the Indian context, several studies attempted to identify the interest rate channel of monetary policy with little attention being paid to other channels of monetary policy, particularly the bank lending channel (Prasad & Ghosh, 2005; Sengupta, 2014; Bhoi et al., 2017). However, the literature is almost negligible when it comes to scrutinizing the role of bank competition in bank lending. In India, where the demand for a large amount of loan is met through bank deposits, market power in deposit and loan markets is expected to influence the bank lending channel of monetary policy.

Against the background, this paper investigates how bank competition in deposit and loan markets affects monetary policy transmission through the bank lending channel. We calculate market concentration in deposit and loan markets using HHI and investigate the effect of market power in deposit and loan markets on loan growth. We employ three non-structural (Lerner index, adjusted Lerner index and Boone indicator) and two structural (HHI and CR3) measures of bank competition and test the differential effects of concentration and competition measures on bank lending using a two-step system GMM estimation. We use weighted average of call money market rate (CMR), bank rate (BR) and Taylor rule residuals to proxy monetary policy conditions. This study shows how balance sheet information such as size, liquidity, and capitalization affect bank competition and monetary policy transmission across ownerships.

The paper reports three important findings. First, higher market power/lower competition weakens the impact of monetary policy transmission on bank lending activities. Second, the weakening and strengthening effect of monetary policy largely depends upon the selection of competition measures and bank-specific variables. Third, the results suggest that increased market power in deposit and loan markets affects the transmission mechanism of monetary policy in India.

This study highlights several contributions to the existing branch of banking literature. **First**, while existing studies explored whether bank competition weakens/ strengthens monetary policy transmission from developed economies' standpoint (Brissmis et al., 2014; Segev & Schaffer, 2020; Wang et al., 2022), our study addresses it from an emerging economy's context. Yang and Shao (2016) used a single measure of bank competition in the Chinese context; this paper employs a wide range of competition measures. Carbó et al. (2009)) argue that the level of competition differs widely with different measures of bank competition and, therefore, implications of bank competition on monetary policy transmission depend on the selection of competition indicators. Using just one indicator of bank competition can provide misleading interpretations. Using a wide range of competition measures and comparing the results is imperative. **Second,** this study suggests the macroeconomic reverse causation problem. We argue that the development of the banking sector responds to the changes in monetary policy transmission mechanism and vice versa. The dynamic panel data model application addresses the problem of reverse causality. **Third,** unlike existing studies, we employ a semi-parametric partial linear coefficient technique while estimating marginal cost (MC). The application of a semi-parametric approach reduces the potential gap

[1] RBI report reveals that the share of PSBs in total banking assets account 69.92% in 2016–17(Annual Publication Report, RBI, 2016–17).

[2] Andries and Billion (2010) theoretically demonstrate that the state-owned banks (SOBs) are well-positioned to weaken the effectiveness of a contractionary monetary policy as SOBs are well-equipped to raise additional deposits.

between the actual and estimated value of MC. **Fourth**, we use both the structural and non-structural measures of bank competition to avoid misleading interpretations of the implications of competition on monetary policy.[3] **Fifth,** while choosing an appropriate monetary policy indicator has been challenging, this study chooses the instrument that has a quick pass-through to the bank lending rates, namely, the call money rate (CMR). **Finally**, we examine the responsiveness of bank ownership groups to the changes in monetary policy and the implication of bank competition on bank lending across all the ownership groups. Although Bhaumik et al. (2011) investigated the implications of bank ownership on monetary policy transmission, their study did not consider how bank competition affects bank's lending decisions across ownerships.

The rest of the paper is structured as follows. Section 2 discusses the related literature. Section 3 gives a brief overview of the Indian banking industry and the evolution of India's monetary policy. Section 4 presents the data sources, measures of variables, and methodology used. Section 5 analyses the estimated results and discusses the findings. Section 6 concludes the paper with policy implications, limitations and future scope of direction.

2. Literature review and hypotheses development

A promising strand of literature examines the response of banking sector development to the changes in monetary policy transmission mechanism in terms of bank ownership, efficiency, profitability, financial stability, and macroprudential policies (Scharler, 2008; Jeon & Wu, 2014; Allen et al., 2017; Brei & Schclarek, 2015; Borio et al., 2017; Bussière et al., 2021; Sui et al., 2022). Recently, there has been a renewed interest in examining the role of bank competition in monetary policy transmission via the bank lending channel (Aghion et al., 2019; Morlacco & Zeke, 2021; Duval et al., 2021; Wang et al., 2022). Kashyap and Stein (2000) emphasize that competitive conditions in banking markets should be considered while scrutinizing policy effectiveness. Adams and Amel (2005), Gunji et al. (2009), and Amidu and Wolfe (2013) find that increased market power weakens the response of lending to changes in monetary policy. Khan et al. (2016) and Yang and Shao (2016) investigate the connection between bank competition and monetary transmission and find mixed results for Asian and Latin American countries. Segev and Schaffer (2020) investigate how bank competition affects the transmission mechanism of monetary policy and explains the variation in the expansion of credit across regions in the US. By applying an integrated panel VAR model for 23 advanced economies, Kim et al. (2020) examine the association between bank competition and monetary policy and find that the transmission mechanism gets stronger in a competitive banking system.

A large volume of literature targets developed economies to explore the bank lending channel of monetary policy. However, limited literature focuses on the transmission mechanism of monetary policy through bank lending channel in India. Applying VAR, Pandit et al. (2006) investigate the existence of the bank lending channel in India and find that small banks are more prone to changes in loan supply during monetary shock. Using aggregate data at the bank level, Aleem (2010) examines the effectiveness of several channels of monetary policy and finds that total output is negatively related to the contraction in the bank lending channel. Using panel data for a series of Indian states, (Bhatt, Kishor, & Ma, 2017) address whether monetary policy shocks affect the size of bank loans and whether bank loans affect real economic activities. Findings show that money demand shocks have a large and statistically significant impact on bank loans. Mishra and Burns (2017) explore the dynamic interactions among monetary policy, bank lending, and bank liquidity in India. Results show that monetary policy shocks exert strong initial and persistent impacts on bank lending. However, our study on bank lending significantly differs from the previous studies on two grounds. While the existing studies mostly use aggregate data, we use bank-level disaggregate data to capture better insights into credit supply. Second, in this study, we introduce the role of bank competition while examining the bank lending channel of monetary policy.

As far as bank competition condition is concerned, there have been considerable variations in the Indian banking market. Misra and Coccorese (2022) and Khan and Ahmad (2022) find that multiple episodes of financial reform measures contributed to the increasing bank competition in India. On the contrary, Jayadev & Sensarma (2007) and Rakshit and Bardhan (2021) report that the bank consolidation post-1998 had given rise to bank concentration, which was evident from the decline in the number of total competitors. Although few recent studies explored bank competitiveness and inferred that the banking industry in India is characterized by competition conditions (Prasad & Ghosh, 2007; Rakshit & Bardhan, 2019, 2020), no attempt has been made to investigate the implications of bank competition on monetary policy transmission mechanism. In light of limited evidence on bank lending channel and mixed events of bank competition and market power, we develop our first hypothesis as follows.

Hypothesis 1. Increased bank competition strengthens the bank lending channel of monetary policy.

This study is also closely related to the work of Drechsler et al. (2017), who proposed the deposit channel as a new channel for the monetary policy transmission mechanism. The theoretical model proposed by Drechsler et al. (2017) posits that higher market power over deposits helps banks widen the interest spreads they charge on deposits. As a result, banks with greater deposit pricing power experience an outflow of bank deposits during the phase of monetary tightening, resulting in a contraction in lending. In other words, an increase in bank competition that reduces the extent of market power over deposits strengthens the impact of monetary policy on bank lending. Kashyap and Stein (2000) and Gambacorta (2005) suggest that loan supply is less sensitive to monetary policy changes if big-sized banks with higher market power rely less on deposit financing. Li et al. (2019) show that banks with higher market power in the deposit market extend longer-maturity loans with lower maturity premiums. Berger and Hanan (1989) and Rice and Strahan

[3] Though there is a general disagreement among researchers regarding the best measure of bank competition, it is difficult to favor a particular measure over another. Since the implication of bank competition depends on the choice of indicators, and each indicator has its own advantage and disadvantage, it is imperative to use a wide array of measures and compare the findings (Leon, 2014).

(2010) theoretically demonstrate that bank services such as deposit rate prices are lower in a less competitive banking market. However, the empirical exploration of the deposit channel in the discourse of monetary policy transmission is limited. Due to competitive pressures, a large bank loan volume is advanced through deposit financing in India (Mishra et al., 2012). Recently, Repullo (2021) presented a critical review of the deposit channel of monetary policy and showed that an increase in policy rate has ambiguous effects on the equilibrium amount of deposits and the relationship is U-shaped. Based on the literature mentioned above, we formulate our second hypothesis, which states that higher market power over the deposit market could impact monetary policy transmission.

Hypothesis 2. Higher market power in deposit market weakens the monetary policy transmission mechanism.

Another crucial channel through which the transmission mechanism of monetary policy can be viewed is the loan market channel. The loan market channel suggests that increased market power in loan market contracts the credit supply even during monetary tightening (Scharfstein & Sunderam, 2016). Large and well-capitalized banks that exercise a higher degree of market power can by-pass the effect of any policy changes to retain their profit margins. Scharfstein and Sunderam (2016) present evidence that a higher market in mortgage lending reduces the sensitivity of mortgage rates, leading to a decrease in mortgage-backed security yields. Ansari (2013) measures bank competition in the Indian loan market using a new competitiveness index, Augmented Relative Profit Difference (ARPD). The author finds that the implementation of financial sector reforms has led to significant improvements in bank competition in loan markets more competitive. Rakshit and Bardhan (2022) calculated the loan market concentration using HHI and investigated the impact of loan market concentration on bank's risk-taking. Findings reveal that a concentrated loan market is positively associated with financial stability. However, previous literature on bank market power did not explore the loan market power channel and its connection to monetary policy. Against this background, we develop our third hypothesis as follows.

Hypothesis 3. Higher market power in loan market weakens the monetary policy transmission mechanism.

3. Monetary policy framework in India

The balance of payments crisis in 1991 necessitated the implementation of economic reforms, which subsequently led to significant changes in the operational pattern of monetary policy. In response to financial development, the operational framework of monetary policy has undergone significant changes over the past few decades. Post financial liberalization, since the financial system was increasingly connected globally, RBI emphasized the implementation of Multiple Indicator Approach (MIA) in 1998, which comprises all financial variables that aimed at fulfilling all the major objectives laid down in the preamble of RBI act.

Although the fundamental aim of monetary policy of ensuring price stability and maintaining growth remained the same, the policy focus of the RBI got shifted. RBI's emphasis was shifted from direct monetary policy instruments (interest rates regulations, selective credit controls and CRR) to indirect instruments such as repo operations under liquidity adjustment facility (LAF). These changes paved the way for a wide array of policy measures that could fulfill the price stability objective. The introduction of LAF in 2000 enabled the RBI to manage the daily liquidity base by absorbing and injecting liquidity through short-term interest rates such as repo rate and reverse repo and transmitting the interest rate signals to the market (Mishra & Burns, 2017).

Post LAF period, the repo rate continued to be used as the crucial monetary policy instrument along with the lending rates of RBI, thus replacing the bank rate (Aleem, 2010). Bhaumik et al. (2011) use the prime lending rate (PLR) to study the impact of bank ownership on the reaction of banks to monetary policy. However, Acharya (2017) pointed out that the interest rate pass-through from the central bank's policy rates to PLR is slow. To further revise and strengthen the policy framework, a formal transition was made in 2016 towards flexible inflation targeting under the chairmanship of Dr Urijit Patel. The government of India (GOI) and RBI formally signed the monetary policy framework agreement to announce the flexible inflation targeting framework (FIT). The central government notified in the official Gazette that the CPI inflation target would be 4% with $\pm$ 2% tolerance band from August 5, 2016 to March 31, 2021.

The above discussion puts forward a policy debate over the selection of a single appropriate instrument as representative of policy stance in India. Singh and Kalirajan (2007) argue that interest rates should be considered the main policy instrument indicating the monetary policy stance. Although several other policy rates, such as bank and repo rates, have been considered appropriate instruments, monetary policy expectations are built through overnight call money rate (CMR). CMR has emerged as the most closely scrutinized monetary policy instrument and has a robust operating target (Aleem, 2010). Several studies on monetary policy applied CMR as an important monetary policy indicator in India (Virmani, 2004; Kannan et al., 2007; Mishra & Mishra, 2012, Mishra & Burns, 2017). Rajan et al., (2015) and Acharya (2017) suggest that any changes in the policy rates have an immediate pass-through to the call money market rate (CMR). Moreover, this rate is internally decided and uniform across banks. Since this present study deals with the transmission mechanism of monetary policy via bank lending and considers the competition conditions of each bank, CMR appears as a suitable indicator of the monetary policy stance.

4. Data and methodology

4.1. Data

We use annual bank-level data on the balance sheet and income statement from 1997–2017. Since the PSBs underwent the process of mergers in two major phases after 2016–17, we restrict the sample period to 2017 to avoid a significant loss in the total number of banks.[4] Our final dataset comprises 70 commercial banks and gives 1470 bank-level observations. Of these banks, there are 26 public sector banks, 19 private domestic, and 25 foreign banks. We restrict our samples to banks with at least ten years of data. Information on bank-specific variables has been obtained from Statistical Tables Relating to Bank in India, published by RBI. Statistical data on the number of employees is collected from *Performance Highlights of Banks*, an annual publication of the Indian Bank's Association (IBA). Data on macroeconomic variables have been collected from the Central Statistical Office (CSO). All data are presented in Indian currency and adjusted for inflation.

4.2. Measures of bank competition

4.2.1. Lerner index (LI)

Lerner index can be defined as the relative difference between price and marginal cost divided by the price and represents banks' ability about the extent to which they can exercise their market power by charging price over the marginal cost. Lerner index will take the following form

$$Lerner_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \tag{1}$$

where $P_{i,t}$ denotes the price of bank i at time t. MC denotes the marginal cost of banks. The value of the Lerner index lies from a maximum value of one to a minimum value of zero.

4.2.2. Adjusted Lerner index (ALI)

Koetter et al. (2012) view the conventional Lerner index as a measure of competition that fails to reflect the true extent of market power. According to them, the application of the Lerner index might provide a biased estimation of competition if the price or marginal cost is not correctly specified. Moreover, the conventional Lerner index assumes that all banks are fully efficient. Turk Ariss (2010) argues that unless the assumption of full efficiency holds, this assumption biases the Lerner index because some banks can exploit pricing opportunities arising from market power. To control the assumption that banks are fully efficient, following and Clerides et al. (2015), we express the following form for adjusted Lerner index:

$$AdjustedLernerIndex = \frac{\pi_i + tc_i - mc_i * q_i}{\pi_i + tc_i} \tag{2}$$

In Eq. (2), i and t represent a bank operating in a particular year. π_i presents the profit of the bank. tc, mc, and q denotes total cost, marginal cost and total output of firm *i*, respectively. The interpretation of the efficiency adjusted Lerner index is similar to the conventional Lerner index.[5]

4.2.3. Boone indicator (BI)

Boone (2008) defines market power as an estimation of the percentage loss in profits resulting from a per cent increase in marginal cost. Boone indicator for bank i at time t can be defined as follows:

$$\text{Profit elasticity} = \frac{\partial \ln \pi_i}{\partial \ln mc_i} \tag{3}$$

The inverse relationship between profit and marginal cost suggests the profit elasticity to be negative. The stronger the effect of competition, the larger the Boone indicator is. This measure of profit elasticity can also be derived from the adjusted Lerner index, solving for π in Eq. (2) and differentiating it w.r.t marginal cost, as follows:

$$Profitelasticity = \frac{q_i * mc_i}{q_i * mc_i - tc_i(1 - adjustedlerner_i)} \tag{4}$$

Hence, the adjusted Lerner index is closely associated with the profit elasticity concept. The estimation of the adjusted Lerner and Boone indicator requires information on price and marginal costs.[6] Following the conventional approach in the previous literature

[4] In 2017, the five associates of the State Bank of India and Bharatiya Mahila Bank were merged into the state bank of India. Government's plan to merge 10 public sector banks into four with the aim of reducing the total number of banks to 11 from 21 has been effective from April 1, 2020 (https://www.bloombergquint.com/business/cabinet-approves-merger-of-10-public-sector-banks-into-four)

[5] To deal with the shortcomings associated with conventional Lerner index, Koetter et al. (2012) developed the indicator of efficiency adjusted Lerner index that considers the possibility that banks may forgo profits- in terms of inefficient output pricing –in exchange for a quiet life.

[6] For a theoretical and empirical exposure of Boone indicator, see Schaeck and Cihak (2014)

(Fernandez de Guevara et al., 2005; Leroy, 2014), we compute price by using the ratio of total revenue (interest and non-interest revenue) over total assets. The estimation of MC has been presented in the Appendix (***see appendix A for details***).

4.2.4. *Measures of bank concentration*

We estimate the HHI by summing the squares of market shares of all banks in our sample, which can be expressed as follows

$$HHI = \sum_{i=1}^{N} S_i^2 \forall_i = 1, \ldots..N \tag{5}$$

In equation (31), N represents the total number of banks in the industry. The value of HHI lies between 1/N (for equalized firms) and 1 for monopolies. We calculate a country-level indicator of deposit and loan market concentration using HHI (deposit) and HHI (loan) indexes.

The specification of three bank concentration ratio that measures the market share of the top three largest banks in the industry takes the following form

$$CR_3 = \sum_{i=1}^{N} s_i \forall N \geq K \tag{6}$$

S_i denotes the market share of i_{th} firms, when firms are ranked in descending order of market share. N is the total number of firms. The ranges from 0 to 1, where 0 implies an infinite number of equally sized firms and 1 implies that firms included in the calculations constitute the entire industry.

4.3. *Empirical framework*

Following Amidu and Wolfe (2013) and Khan et al. (2016), we present the empirical specification that maps bank lending with bank competition, monetary policy and their interactions. The following equation represents the extent to which the loan supply of banks responds to the change in monetary policy and to which bank-specific characteristics affect the transmission mechanism

$$\begin{aligned}\Delta\ln(loans)_{i,t} = {} & \alpha_i + \beta\Delta\ln(loans)_{i,t-1} + \delta\Delta MP_{t-1} + \theta BC_{i,t-1} + \gamma_1 Size_{i,t-1} + \gamma_2 LIQ_{i,t-1} + \gamma_3 CAP_{i,t-1} + i\Delta MP_{t-1} * Size_{i,t-1} + k\Delta MP_{t-1} \\ & * LIQ_{i,t-1} + \rho\Delta MP_{t-1} * CAP_{i,t-1} + \upsilon\Delta MP_{t-1} * BC_{i,t-1} + \varphi\Delta\ln(M)_{t-1} + \varepsilon_{i,t}\end{aligned} \tag{7}$$

where $i = 1, \ldots., N$ represents the number of banks; $t = 1, \ldots.., T$ represents the year of observation during the period 1997–2017. The variation in loan growth ($\Delta\ln(loans)_{i,t}$)can be determined by its lagged value ($\Delta\ln(loans)_{i,t-1}$), changes in monetary policy (ΔMP_{t-1}), lagged bank competition and bank-specific characteristics ($BC_{i,t-1}$, $Size_{i,t-1}$, $LIQ_{i,t-1}$, $CAP_{i,t-1}$), and lagged macroeconomic factors such as inflation and GDP growth. In order to capture the monetary policy transmission via bank lending channel, we consider the annual percentage change in bank's loan volume as our main dependent variable. We calculate the logarithm growth rate of loans between t and t + 1. For monetary policy instruments, we consider three policy indicators: *call money rate, bank rate and Taylor rule residuals.*[7] We define the size variable by taking the natural logarithm of total bank assets. Liquidity and capitalization have been defined considering the ratio of total equity to total assets and the ratio of liquid assets to total assets, respectively. Two macroeconomic variables are the annual growth rate of the real GDP with base (2004–2005), and inflation is measured by the annual Consumer Price Index (CPI).

The application of the Generalized Method of Moments (GMM) method controls for the possibility of reverse causality that may be running from the dependent variable to the explanatory variables. In our case, it is reasonable to consider some of the bank-specific to be endogenous or predetermined. For example, bank size may increase by the higher growth of loans advanced to its customers. Jimenez et al. (2013) emphasized that the inclusion of a lagged dependent variable as one of the regressors in the dynamic model gives rise to the problem of endogeneity, and estimating the model with OLS would provide biased and inconsistent results. We use the two-step system GMM estimator as suggested by Arellano and Bover (1995) and Blundell and Bond (1998). Hansen (1982) test on over-identifying restrictions has been used to check the reliability of the GMM procedure and the validity of the instruments. To ensure that there is no possible second-order autocorrelation, we use the Arellano-Bond (AR) test.

5. Results and discussion

5.1. *Descriptive statistics and correlations*

Table 1 presents the descriptive statistics of the variables used in the regression models. The table shows that the average estimated values of the Lerner index, efficiency-adjusted Lerner index, and Boone indicator for the sample period are 0.31, 0.19, – 0.14, respectively. Compared with other emerging economies like China and Indonesia, India's banking industry is found to be more competitive.[8] The mean capitalization value for the entire banking sector stands at 12.37, with the maximum and minimum values of

[7] The empirical specification of Taylor Rule residuals has been provided in Appendix A.

[8] According to data sourced from World Bank, Global financial Development (2014), the estimated value of Lerner index for China and Indonesia is 0.34 and 0.35 respectively.

Table 1
Descriptive statistics.

		LI	ALI	BI	CAP	SIZE	LIQ	Loan	CMR	BR	HHI	CR3	CPI	GDP
All Banks	**Obs**	1433	1434	1435	1435	1434	1425	1391	20	20	1470	1470	1469	1470
	Mean	0.324	0.198	-0.144	12.362	9.254	47.923	0.163	0.002	0.009	0.068	0.287	0.070	0.070
	Min	0.006	-0.976	-0.495	-14.18	3.404	21.12	-1.00	-0.54	-0.36	0.052	0.25	3.77	0.038
	Max	0.943	0.775	-0.013	98.316	14.63	83.42	4.527	0.790	0.28	0.095	0.328	13.17	0.095
	SD	0.132	0.143	0.037	12.381	2.334	5.0817	0.366	0.301	0.156	0.013	0.022	0.028	0.018
Public	**Obs**	**538**	**538**	**538**	**537**	**538**	**537**	**537**						
	Mean	0.246	0.161	-0.133	4.9016	11.05	41.23	0.157						
	Min	0.025	-0.065	-0.157	-6.1315	8.463	0.8825	-0.160						
	Max	0.930	0.284	-0.036	9.495	14.65	68.357	0.900						
	SD	0.084	0.052	0.011	1.5127	1.187	11.889	0.153						
Private	**Obs**	388	388	388	**396**	**396**	**395**	**371**						
	Mean	0.283	0.184	-0.136	7.534	9.3014	48.91	0.189						
	Min	0.012	-0.125	-0.171	1.6632	5.348	0.4481	-0.893						
	Max	0.928	0.533	-0.073	90.331	13.72	70.951	2.158						
	SD	0.107	0.062	0.012	5.3563	1.673	14.53	0.255						
Foreign	**Obs**	502	503	503	**526**	**526**	**525**	**495**						
	Mean	0.402	0.251	-0.161	24.01	7.325	54.006	0.150						
	Min	0.008	-0.985	-0.495	-14.18	3.424	0.0211	-1						
	Max	0.9442	0.7745	-0.013	98.318	11.93	83.428	4.527						
	SD	0.1716	0.2174	0.056	18.595	2.167	15.209	0.552						

Note: LI = Lerner Index, ALI= Adjusted Lerner Index, BI= Boone Indicator, CAP = capitalization, LIQ= Liquidity, CMR= Call money rate, BR= bank rate, HHI = Herfindahl- Hirschman Index, CR3 = Three bank concentration ratio, CPI= Consumer Price Index, GDP= Gross domestic product.

Table 2
Correlation matrix.

	Loan Growth	CMR	Lerner Index	Adjusted Lerner Index	Boone Indicator	CR3	HHI	Liquidity	Capitalization	Size	GDP	CPI
Loan Growth	1.00											
CMR	-0.014 *	1.00										
Lerner Index	0.138 *	-0.117 *	1.00									
Adjusted Lerner Index	0.174 *	-0.100 *	0.674 *	1.00								
Boone Indicator	0.147 *	0.081 *	-704 *	-820 *	1.00							
CR3	-0.842 *	-0.447 *	0.065 *	0.037	-0.021	1.00						
HHI	-0.133 *	0.460 *	-0.149 *	-0.152 *	0.152 *	-0.113 *	1.00					
Liquidity	0.036	-0.045	0.175 *	0.092 *	-0.015	-0.015	-0.001	1.00				
Capitalization	0.085 *	-0.079 *	0.548 *	0.425 *	0.012	0.012	-0.156 *	0.239 *	1.00			
Size	0.035	-0.112 *	-0.265 *	-0.160 *	0.020	0.020	-0.352 *	-0.227 *	-0.563 *	1.00		
GDP	0.023	-0.261 *	0.061 *	0.083 *	0.074 *	0.074 *	-0.327 *	0.024	0.031	0.050	1.00	
CPI	0.139 *	0.113 *	0.046	0.117 *	-0.537 *	-0.537 *	-0.290	0.023	0.064 *	0.079 *	-0018	1.00

Source: Author(s) Calculation

98.31 and − 14.19. Oilvero et al. (2010), in their study of a sample of Asian and Latin American countries, found mean capitalization value 13.42 with a maximum capitalization value of 99.08. The mean value of capitalization across ownership further indicates that foreign banks in India are well-capitalized compared to public and private banks. Considering the liquidity variable, foreign banks turned out to be more liquid, with an average value of 54.00, than public (41.23) and private banks (48.91). Another variable of interest in this study includes loan growth. The average loan growth for the banking industry over the examined period is 16 per cent, while private sector bank has the highest loan growth (19%) among the ownership group. We consider GDP growth rate and CPI index as control variables in our empirical models which are used as indicators of economic growth and inflation in the Indian economy.

Table 2 reports the correlation matrix of the variables and shows that explanatory variables are not strongly correlated with the dependent variable, as confirmed by the first column of the correlation matrix. The weak correlations rule out the possible presence of multicollinearity among the variables. The correlation between loan growth and the main variable of interest (monetary policy indicator) is − 0.014 and significant at a 5% level. The three non-structural bank competition indicators (Lerner index, adjusted Lerner index, and Boone indicator) are positively and significantly correlated with loan growth. The positive correlation values of these variables imply that a higher degree of market power positively contributes to loan growth. The correlation coefficient between the Lerner index and the adjusted Lerner index is 0.67 and significant at a 5% level. The table further shows the negative and significant correlation between the Lerner index and two bank concentration measures (HHI and CR3). Lerner index, being an inverse measure of bank competition, this correlation value discerns the validity of the structure-conduct-performance (SCP) hypothesis, according to which there exists an inverse relationship between competition and concentration. Considering the bank-specific and macroeconomic factors, we find these variables positively correlate with loan growth.

5.2. Bank competition results

Table 3 presents the estimations of competition conditions for the overall Indian banking and different ownership groups over the period. The average estimates of various indicators of bank competition reflect the degree of market power, an inverse measure of bank competition. Average estimates of market power measured by the Lerner index vary from 0.22 to 0.36 for the entire banking industry. Lerner index for the public, private and foreign banks ranges between 0.18 and 0.33; 0.20–0.30; and 0.26–0.46, respectively. It reveals that private and foreign banks have lower competition (higher market power) than public sector banks. It can be attributed to the fact that many of these banks are listed on the stock market and have alternative sources of funding, and therefore they have relatively less incentive to compete with each other to generate funds from the public. In contrast, public sector banks are state-owned; thus, capital infusion by the government and deposits constitute the major source of funding. The estimated value of the Boone indicator suggests that foreign banks are also more competitive, similar to public and private banks. In fact, financial globalization across emerging and developed economies, coupled with the gradual entry of foreign banks into the local markets, becomes instrumental in enhancing the competitiveness of the foreign banks in the host country (Claessens et al., 2001). These findings on competition conditions are in conformity with Khan and Ahmad (2022) and Coccorese and Misra (2022), who also found considerable variations in competition conditions in Indian banking post-financial liberalization.

The bank competition estimations also reflect the implications of the financial sector reforms in India initiated in two major phases. It can be noticed that during the first phase of financial reforms (1992 −1998), the Indian banking industry experienced a lower degree of market power. This has been confirmed by the lower estimated values of the Lerner index and adjusted Lerner index. The second-generation reforms post-1998 induced bank consolidation in India through mergers and acquisitions and the implementation of several structural measures (Prasad & Ghosh, 2007). Our estimations on bank competition conform to post-1999 that marked the restructuring of weak banks through mergers. Findings show that from 1999 to 2011, there was a slight decrease in the estimated values of the Lerner index and adjusted Lerner index, implying the case of bank consolidation in India.

5.3. Main results

Table 4 presents the results from the two-step GMM dynamic estimator for the full sample period. The dependent variable in all specifications is the annual percentage change in bank loans. We use two structural (HHI and CR3) and two non-structural (Lerner index and Boone indicator) measures of bank competition to capture its heterogeneous effect on monetary policy transmission. Results from the structural and non-structural measures are reported in panels A and B, respectively. The coefficients of the lagged dependent variable are positive and statistically significant in all specifications, justifying the dynamic specification of the models. Results indicate that coefficients of market structure measures are positive and statistically significant in panels A and B, implying that bank concentration and higher market power enable banks to expand their loans. We notice that a one-unit change in HHI, CR3, Lerner index and Boone indicator increases bank's loan growth by 0.14, 0.17, 0.04 and 0.11 units. The negative and consistently significant coefficients of CMR across all specifications justify the existence of bank lending channel of monetary policy. The negative coefficients suggest that a contractionary monetary policy reduces bank's lending capacity during monetary tightening.

The coefficients of interaction terms of CMR and competition measures appeared positive and statistically significant in all models except for the Boone indicator. The coefficients of the interaction terms indicate that the bank lending channel of monetary policy is less effective for banks exercising higher market power, and an increase in policy rate does not necessarily hamper their credit supply. The two structural indicators, such as HHI and CR3, extend complementary evidence that bank concentration in Indian banking has undermined the effectiveness of monetary policy through the lending channel. Regarding the effect of the Lerner index on loan growth, findings confirm that Lerner index positively impacts loan growth. This is because, post-1999, the Indian banking system had undergone the process of consolidation through mergers and acquisitions and the implementation of several structural reforms leading to

Table 3
Estimates of bank competition indicators.

Years	Public Banks			Private Banks			Foreign Banks			All Banks		
	Lerner Index	Adjusted Lerner	Boone Indicator	Lerner Index	Adjusted Lerner	Boone Indicator	Lerner Index	Adjusted Lerner	Boone Indicator	Lerner Index	Adjusted Lerner	Boone Indicator
1997	0.183	0.066	-0.117	0.286	0.192	-0.138	0.364	0.243	-0.012	0.255	0.154	-0.135
1998	0.225	0.115	-0.126	0.271	0.185	-0.137	0.365	0.245	-0.168	0.276	0.164	-0.132
1999	0.207	0.147	-0.135	0.282	0.122	-0.088	0.343	0.197	-0.134	0.285	0.176	-0.125
2000	0.188	0.112	-0.126	0.245	0.153	-0.131	0.291	0.166	-0.148	0.243	0.141	-0.131
2001	0.205	0.128	-0.128	0.276	0.114	-0.086	0.266	0.138	-0.139	0.246	0.143	-0.136
2002	0.202	0.117	-0.126	0.221	0.156	-0.133	0.281	0.122	-0.144	0.231	0.137	-0.133
2003	0.231	0.151	-0.131	0.321	0.186	-0.134	0.326	0.223	-0.145	0.217	0.183	-0.138
2004	0.296	0.184	-0.136	0.282	0.202	-0.141	0.322	0.235	-0.156	0.303	0.212	-0.144
2005	0.338	0.221	-0.143	0.311	0.223	-0.143	0.418	0.241	-0.167	0.362	0.229	-0.148
2006	0.324	0.201	-0.146	0.277	0.117	-0.131	0.364	0.256	-0.148	0.325	0.187	-0.141
2007	0.295	0.184	-0.136	0.287	0.168	-0.135	0.364	0.172	-0.145	0.318	0.174	-0.142
2008	0.288	0.195	-0.138	0.301	0.186	-0.137	0.391	0.301	-0.166	0.327	0.232	-0.148
2009	0.256	0.196	-0.142	0.286	0.193	-0.138	0.408	0.346	-0.182	0.321	0.246	-0.154
2010	0.289	0.182	-0.136	0.232	0.185	-0.137	0.473	0.358	-0.195	0.338	0.246	-0.152
2011	0.272	0.191	-0.137	0.291	0.184	-0.136	0.452	0.282	-0.167	0.342	0.223	-0.141
2012	0.286	0.193	-0.138	0.281	0.201	-0.142	0.461	0.236	-0.185	0.351	0.217	-0.154
2013	0.264	0.172	-0.134	0.212	0.184	-0.136	0.445	0.345	-0.194	0.317	0.236	-0.153
2014	0.247	0.156	-0.131	0.202	0.183	-0.134	0.442	0.365	-0.161	0.305	0.237	-0.144
2015	0.236	0.123	-0.127	0.243	0.172	-0.135	0.405	0.197	-0.159	0.274	0.163	-0.138
2016	0.236	0.124	-0.129	0.244	0.167	-0.134	0.407	0.238	-0.157	0.295	0.175	-0.138
2017	0.251	0.144	-0.117	0.261	0.153	-0.123	0.414	0.237	-0.154	0.293	0.143	-0.134

Source: Author’s calculations

Table 4
Estimation results on the impact of bank competition on bank lending.

	Dependent variable = annual percentage change in bank loans			
	Panel A: Structural measures		Panel B: Non-structural measures	
	CR3	HHI	Lerner index	Boone Indicator
Lagged loan growth	0.485 ***	0.497 ***	0.375 ***	0.394 ***
	(0.1426)	(0.1473)	(0.1234)	(0.1302)
CMR	-0.687 ***	-0.742 ***	-0.469 ***	-0.712 ***
	(0.1782)	(0.2157)	(0.1478)	(0.2354)
Size	-0.002 **	-0.018 *	-0.013 **	-0.008
	(0.0011)	(0.0111)	(0.007)	(0.0092)
Liquidity	0.413 **	0.392 *	0.521 **	0.373 *
	(0.1945)	(0.2654)	(0.2687)	(0.2341)
Capitalization	0.074 *	0.040	0.014	0.032 ***
	(0.0456)	(0.0519)	(0.0436)	(0.0084)
CMR* Size	0.028 **	0.014 ***	0.039 *	0.064 *
	(0.0154))	(0.0057)	(0.0242)	(0.0514)
CMR*liquidity	0.312	0.294	0.748 **	0.674 **
	(0.4512)	(0.3854)	(0.3171)	(0.3354)
CMR*capitalization	0.0002 **	0.0151 *	0.014 ***	0.011 *
	(0.0001)	(0.0100)	(0.0022)	(0.0078)
Bank competition	0.145 **	0.172 ***	0.045 ***	0.114 **
	(0.6412)	(0.0452)	(0.0027)	(0.0451)
CMR* competition	0.354 ***	0.325 **	0.369 ***	-0.29 ***
	(0.1132)	(0.1293)	(0.1218)	(0.0924)
GDP Growth	2.36 ***	1.483 ***	1.30 ***	1.745 ***
	(0.3932)	(0.3577)	(0.4264)	(0.3987)
Inflation	0.128 ***	0.127 ***	0.196 ***	0.214 ***
	(0.0464)	(0.0393)	(0.0797)	(0.0654)
Number of Banks	70	70	70	70
No of instruments	38	39	38	41
Observations	1433	1431	1433	1433
AR (2) P- value	0.36	0.39	0.43	0.54
Hansen P- value	0.79	0.78	0.84	0.74

Note: Table reports the estimated results of the two-step system GMM dynamic panel model. The dependent variable is loan growth. CMR is the monetary policy instrument. Lerner index and Boone indicator are used as inverse measures of bank competition. The explanatory variables are included in lagged one period. Robust (Windmeijer) standard errors are presented in parentheses. * , **, *** indicate statistical significance at the 10% level, 5% level and 1% level, respectively.

an increase in market power (Prasad & Ghosh, 2007; Jasrotia & Agarwal, 2021). Therefore, we argue that the market power that increases the scope for alternative funding sources hinders the transmission mechanism of monetary policy. This finding supports Hypothesis 1, which states that increased competition strengthens monetary policy transmission through the bank lending channel. However, the negative coefficient value of the Boone indicator confirms that increased market power/ lower level of bank competition strengthens the transmission mechanism of monetary policy. The economic implication of this finding relates to the efficient structure (ES) hypothesis upon which the Boone indicator is based. ES hypothesis (Demsetz, 1973) suggests that efficient firms in concentrated markets reduce their lending in the event of monetary tightening because of efficiency concerns. We argue that different findings from structural and non-structural measures of bank competition extend different implications on monetary policy transmission. The implications largely depend on the choice of indicators. While the evidence obtained from Lerner index contrast the earlier studies by Olivero et al. (2011a, 2011b) and Amidu and Wolfe (2013), nonetheless, the evidence from Boone is in agreement with Leroy (2014) and Yang and Shao (2016).

Regarding the effects of bank-specific characteristics on loan growth, we find that liquidity and capitalization have positive and significant coefficients on bank lending, implying that highly liquid and well-capitalized banks have a higher capacity to expand their supply of loans. The coefficient of size turns out to be negative and statistically significant, indicating that the scope of asymmetric information is lesser as large banks invest in monitoring and screening and make prudent decisions before lending to opaque borrowers (Altunbas et al., 2009). The positive association between capitalization and credit supply implies that banks that maintain a higher capital-to-risk-weighted assets ratio (CRAR) mandated by the Basel Committee can expand their loan supply. This finding corroborates Mohanty and Mahakund (2018), who find that banks with higher CRAR ratios lend more and can avoid risks. Similarly, the positive and significant coefficient of liquidity indicates that more liquid banks can arrange for more loan supply even during monetary tightening by drawing down cash and selling securities.

The coefficients of monetary policy interaction terms for size, capitalization, and liquidity are positive and significant. These findings support the argument that highly liquid and well-capitalized banks that are financially less constrained can buffer their lending activities against any monetary shock by raising their liquid assets and mobilizing uninsured deposits by issuing commercial papers. Large banks in India extend credit to the priority sector under a directed credit program at concessional rates. Given this, contractionary monetary policy may not squeeze the credit demand of the priority sectors and thus contradicts the basic objective of monetary policy (Rastogi & Rao, 2014). Likewise, the weakening effect of monetary policy transmission in the case of well-capitalized banks in India is probably due to the fact that over the years, the banking regulatory bodies and policymakers emphasized maintaining a higher capital ratio to minimize the solvency and liquidity risks. A higher CRAR ratio allows well-capitalized banks to meet lending opportunities without experiencing statutory constraints during monetary policy shock.

Regarding the macroeconomic variables, GDP growth and inflation rate coefficients are found to be positive and significant on credit growth in all the models, indicating the demand-side effect of the bank lending channel. Economic growth increases the demand for credit from firms and households. These results contradict the findings of Fungáčová et al. (2014), who obtain insignificant coefficients of the monetary policy interaction terms for liquidity and capitalization, implying that bank-specific indicators do not affect the manner in which bank lending reacts to monetary policy changes. We conjecture that the differences in estimation methodology, the time period selected, and the number of countries considered for the study might derive from the differences. With regards to the interaction terms for monetary policy with bank-specific characteristics, our findings are, however, not at odds with previous findings. Brissimis et al., (2014) found strong evidence of liquid and well-capitalized banks reacting more to the changes in monetary policy stance.

5.4. Results on deposit and loan market channels

In addition to exploring the bank lending channel of monetary policy, we also examine the impact of market power in deposit and loan markets on bank's lending activities. We calculate the CR3 and HHI of loans and deposits markets to capture the market power in loan and deposit markets. Additionally, we consider bank rate as an indicator of monetary policy as Ghosh (2010) found that post-liberalization period, bank rate has been positively and closely correlated with loan and deposit rates and the pass-through of bank rate to loan and deposit rates is fairly quick. The results are presented in Table 5. We find consistent evidence about the existence of bank lending channel, which has been confirmed by the inverse relationship between bank rate and loan growth across all specifications. We find positive and statistically significant effects of CR3 (deposit) and HHI (deposit) on loan growth, implying that banks that usually exercise a higher degree of market power can continue to lend to their customers from alternative funding sources other

Table 5
Results on deposit and loan market channels.

	CR3 (deposits)	HHI (deposits)	CR3 (loans)	HHI (loans)
Lagged loan growth	0.331 ***	0.374 ***	0.345 **	0.392 ***
	(0.1028)	(0.1146)	(0.1256)	(0.1261)
BR	-0.082 ***	-0.072 **	-0.095 ***	-0.077 ***
	(0.0287)	(0.0480)	(0.0327)	(0.0280)
Size	-0.003 ***	-0.070 **	-0.0522	-0.014
	(0.0009)	(0.0320)	(0.1891)	(0.0480)
Liquidity	0.042	0.136	0.093	0.142
	(0.0909)	(0.4776)	(0.1741)	(0.0969)
Capitalization	0.021 **	0.013 **	0.011 *	0.019
	(0.0180)	(0.0043)	(0.009)	(0.0292)
BR* Size	0.040 ***	0.087 ***	0.052 **	0.010 **
	(0.0187)	(0.0328)	(0.0312)	(0.0649)
BR*liquidity	0.174	0.241	0.298	0.178
	(0.2541)	(0.2620)	(0.5744)	(0.2057)
BR*capitalization	0.005	0.006	0.015	0.018
	(0.2155)	(0.1149)	(0.3254)	(0.1198)
CR3(deposits)/ CR3(loans)	0.108 ***	0.146 ***	0.121 ***	0.085 ***
	(0.0323)	(0.054)	(0.0477)	(0.0328)
HHI (deposits)/ HHI (loans)	0.052 ***	0.037 ***	0.021 ***	0.047 ***
	(0.0021)	(0.017)	(0.0003)	(0.0101)
CR3 (deposits)*BR/ CR3 (loans)*BR	0.001		-0.546	
	(0.0874)		(1.254)	
HHI (deposits) * BR/ HHI (loans)*BR		0.032 **		0.049 ***
		(0.0108)		(0.0201)
GDP Growth	1.124 ***	0.845 ***	1.415 ****	1.637 ***
	(0.3618)	(0.2466)	(0.2673)	(0.3588)
Inflation	0.125 ***	0.092 **	0.129 **	0.142 **
	(0.0221)	(0.039)	(0.0211)	(0.0317)
Number of Banks	70	70	70	70
Instruments	43	42	41	41
Observations	1432	1435	1431	1432
AR.(2)	0.35	0.43	0.35	0.38
Hansen	0.87	0.88	0.81	0.76

Note: Table reports the estimated results of the two-step system GMM dynamic panel model. The dependent variable is loan growth. We calculate CR3 and HHI of loans and deposits to indirectly proxy the market power in the loan and deposit markets. BR is the annual percentage change in the bank rate and is used as an alternative indicator of monetary policy. The explanatory variables are included in lagged one period. Robust (Windmeijer) standard errors are presented in parentheses. * , **, *** indicate statistical significance at the 10% level, 5% level and 1% level, respectively.

than customer deposits. Due to concentration in the deposit markets, banks get easy access to sources of loanable funds and thus it is possible for banks to continue their loan supply despite the negative shocks of monetary policy to loanable funds. The positive impact of loan market concentration on loan growth suggests that banks typically establish lending relationships with their clients in a concentrated loan market. Banks with market power in loan markets are equipped with screening and monitoring facilities to distinguish good borrowers from bad or informationally opaque borrowers. By building lending relationships with their clients, banks with market power in the loan market meet the credit needs of the borrowers.

One unit change in the interaction term between HHI (deposit) and bank rate leads to an increase in loan growth by 0.03 units. It is possible that when a deposit market becomes concentrated, an increase in policy rate may fail to restrict the deposit mobilization of banks. In general, when RBI announces a contractionary monetary policy by increasing policy rates, banks with higher market power widen the interest spreads they charge on deposits, and as a result, deposits flow out of the market. However, since banks do not heavily rely on customer deposits in a concentrated banking market, the outflow of the deposit does not induce a contraction in bank lending. This finding is in line with Drechsler et al. (2017) and lends support to the existence of deposit channel of monetary policy. The coefficient of the interaction term between HHI (loans) and bank rate on bank lending is positive and statistically significant at 1 per cent level, implying that a concentrated loan market can continue its lending activities even during monetary tightening. Contrary, increased bank competition in the loan market strengthens the transmission of monetary policy. In India, competition among banks reduce the interest rates margins, and commercial banks are likely to meet the credit need of small borrowers. Additionally, PSBs are subject to priority sector lending; therefore, an increase in any policy rates directly impacts banks' lending decisions. This particular finding provides evidence in favor of the loan channel of monetary policy.

The sign and significance level of the bank-specific characteristics are mixed. While highly capitalized and large banks seemed to impact bank lending positively, we did not find any significant effect of liquidity on loan growth. The coefficient on the interaction between monetary policy and bank size is negative and statistically significant across all models. The negative coefficient indicates that large-sized banks display an expansion in bank credit during the contractionary monetary policy. The coefficient on GDP growth is positive and statistically significant, indicating that credit expansion takes place in an economy when GDP grows and demand for bank credit increases.

5.5. *Ownership results*

In this section, we present the estimation results that account for variations in bank's lending activities across ownerships in light of

Table 6
Ownership results.

	Public sector banks			Private sector banks			Foreign sector banks		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Lagged loan growth	0.27 ***	0.252 **	0.285 ***	0.300 **	0.255 ***	0.419 **	0.082	0.080	0.087
	(0.0800)	(0.0681)	(0.0870)	(0.0953)	(0.0673)	(0.2158)	(0.4755)	(0.5706)	(0.5787)
CMR	-0.320 ***	-0.876 ***	-0.353 ***	-1.60 ***	-1.704 *	-3.202 **	-0.936 ***	-2.139 ***	-1.63 **
	(0.1175)	(0.1565)	(0.1341)	(0.3369)	(0.6383)	(1.713)	(0.2527)	(0.5235)	(0.4514)
Size	-0.022	-0.489	0.408	0.725 ***	0.875 **	1.072 **	0.063	0.112	0.253
	(1.5160)	(1.1305)	(1.241)	(0.2331)	(0.2883)	(0.3447)	(0.2344)	(0.2141)	(0.8806)
Liquidity	-4.375	0.101	-8.952 ***	4.838 **	5.757 *	6.040	-0.770 ***	-0.409	-0.367
	(10.404)	(1.7299)	(2.1311)	(1.7327)	(4.3994)	(7.461)	(0.3269)	(1.313)	(2.905)
Capitalization	0.421 ***	0.372 *	1.117 ***	-1.55 ***	1.956	1.817	0.208	0.0008	0.020
	(0.1433)	(0.2461)	(0.3262)	(0.5777)	(3.806)	(3.0907)	(0.8151)	(1.618)	(0.1547)
CMR* Size		0.156 ***	0.175 ***		0.057	0.016		0.110	0.087
		(0.0500)	(0.0628)		(0.2582)	(0.1172)		(0.2141)	(0.4263)
CMR*liquidity		-0.897	0.160		0.347	0.448		-0.110	-0.048
		(1.7446)	(1.0245)		(1.129)	(0.5498)		(1.285)	(1.7613)
CMR*capitalization		0.092 **	0.144 ***		-0.209 **	-0.280 **		0.0008	0.0008
		(0.0069)	(0.0348)		(0.1058)	(0.1484)		(0.0193)	(0.0437)
Lerner Index			1.592 **			1.128			4.439
			(0.3871)			(1.447)			(1.134)
Lerner Index*CMR			0.896 **			2.302			-0.358
			(0.2929)			(2.427)			(1.8148)
GDP Growth	1.078 *	2.27 **	5.302 ***	2.635	3.708	4.885	2.738 ***	3.552 ***	4.164 ***
	(0.4077)	(0.9098)	(2.570)	(3.175)	(3.739)	(3.243)	(1.106)	(1.7217)	(1.5110)
Inflation	0.956 **	1.006 **	1.010	2.338 ***	-0.851	-1.495	0.363	0.084	0.047
	(0.3885)	(0.3356)	(1.687)	(0.3908)	(2.143)	(1.062)	(1.239)	(2.390)	(2.5786)
Number of banks	26	26	26	19	19	19	25	25	25
Number of instruments	24	24	23	18	18	18	24	24	24
Observations	546	546	546	399	399	399	525	525	525
AR (2)- P value	0.34	0.35	0.34	0.56	0.67	0.47	0.321	0.150	0.32
Hansen P-value	0.41	0.37	0.98	0.71	0.84	1.00	0.912	0.962	0.933

Note: The dependent variable is loan growth. CMR is the monetary policy instrument. The Lerner index is used as an inverse measure of bank competition. *, **, *** indicate statistical significance at the 10% level, 5% level and 1% level, respectively.

policy changes. The ownership structures of Indian banking largely differ in terms of its customer base and operational pattern, and therefore, bank-specific characteristics and monetary policy variables are expected to have a heterogeneous effect on bank's lending activities. Table 6 presents the estimation results. We find a negative and statistically significant CMR coefficient on bank loan supply across all specifications. The regression results suggest that monetary policy shocks adversely affect the supply of bank credit across the ownership. The negative response to the credit supply by private and foreign banks can be closely linked to the reason that these two ownership groups, especially foreign banks, have a less diversified customer base. Therefore, this ownership group is vulnerable to shocks. Foreign banks in India are largely risk-averse when it comes to credit disbursement as this bank group has certain disadvantages in obtaining information about some borrowers in the host market. However, the public sector banks that operate on the basis of market incentives, though respond negatively to the loan supply; the effect is much lesser than their private and foreign counterparts. The lending pattern of private banks in India is mostly community-based and concentrated geographically (Berger et al., 2008), and therefore, the response of these banks to adverse shocks is stronger.

Regarding the joint effect of the Lerner index and CMR, we find that public sector banks have positive and statistically significant effects on loan supply at a 5 per cent level. One unit change in the joint effect of Lerner index and CMR results in 0.86 unit change in credit supply. However, private and foreign banks fail to show any impact of monetary policy changes on loan supply. The positive coefficient of the interaction term implies that banks operating under the public sector can buffer the effect of a tighter monetary policy on their credit supply, thus weakening the transmission mechanism of the bank lending channel of monetary policy. The PSBs mostly meet the credit needs of local borrowers and small and microenterprises by establishing a historically long-standing relationship with their clients. This provides PSBs greater incentive to protect the credit demand of the customers during the monetary shock. This explanation closely resembles the arguments of Bhaumik et al. (2011) that if banks are closely tied to their borrowers, monetary policy might have limited effects. Of all the control variables, large-size and well-capitalized PSBs are in a better position to continue their loan supply even during the phase of monetary contraction.

5.6. Robustness test

Our previous empirical analysis considered the weighted average call money market rate as an indicator of monetary policy. However, it has been argued that a set of macroeconomic factors determines the interest rate of an economy and, therefore, using short-term interest rates as a monetary policy instrument may overestimate its effect (Khan et al., 2016). Thus, for the robustness of our results, we use two years lagged *bank rate* (BR) as an alternative indicator of monetary policy.[9] We select BR, given the arguments that the pass-through from the bank rate to CMR is quick, and while ensuring credit to the targeted sector, the bank rate is preferred as a monetary policy instrument (Swamy, 2016). The bank rate is considered for assessing the effectiveness of monetary policy as its medium-term impact on bank lending can be expected to be direct and relatively quick. Regarding competition measures, in our robustness analysis, we also consider an alternative measure of bank competition, i.e., Boone indicator, to examine its impact on bank lending. We estimate Eq. (7) by panel-fixed effect and two-step system GMM estimation to report the consistency in our main findings.

Table 7 presents the findings of the robustness analysis. Coefficients of two years lagged BR are negative and statistically significant at 1 per cent in both static and dynamic panel estimations, implying that a contractionary monetary policy reduces bank's lending activities. However, when we interact the monetary policy indicator with the alternative non-structural measure of bank competition, we find contradictory findings. The positive and significant coefficients of interaction between lagged BR and Boone indicator imply that an increase in market power, as indicated by the Boone indicator (low competition), hampers the transmission mechanism of monetary policy via bank lending channel. Results obtained through static and dynamic panel models extend similar results and are highly consistent with our main results. Regarding the coefficients on the interaction between monetary policy variable and bank-specific factors, we obtain similar findings as earlier. Our finding with Boone indicator as an indicator of bank competition is in agreement with Gunji et al. (2009), Amidu and Wolfe (2013) and Khan et al. (2016).

5.7. Sensitivity analysis

We run a sensitivity check on our main findings. In doing so, we employ an alternative indicator of bank competition measure, i.e., efficiency adjusted Lerner index, which controls for the assumption that all banks are fully efficient. Following Delis et al. (2017) and Segev and Schaffer (2020), we measure and test the monetary conditions using Taylor rule residuals as an alternative indicator of monetary policy. Higher Taylor rule residuals indicate a tighter monetary policy. Additionally, we use deposit growth as an explanatory variable to capture the supply side of the lending channel. The results of the sensitivity analysis are reported in Table 8. We note that, like Lerner index and Boone indicator, the adjusted Lerner index has a significant and positive coefficient, indicating that more market power enables banks to increase their credit supply. The sign and significance levels of Taylor residuals are consistent and in line with two other measures of monetary policy indicators. The negative coefficients of Taylor residuals suggest that tighter monetary conditions reduce bank's loan growth; however, higher market power can weaken the negative effect of monetary tightening. The positive and significant coefficient of deposit growth suggests that an increase in the volume of deposits also increases bank lending activities. The coefficients of other bank-specific characteristics and their interactions with Taylor residuals are highly consistent with our previous results.

[9] Our concern with the selection of one year lagged bank rate is to account for the possible endogeneity issue that could be present in the regression analysis.

Table 7
Robustness Test.

	Dependent variable: annual percentage change in loan growth	
	Panel fixed effect	Two-step system GMM
Lagged loan growth		0.66 ***
		(0.0483)
ΔBR_{t-2}	-1.024 ***	-2.99 ***
	(0.2674)	(1.006)
Size	-0.064 ***	-0.054 ***
	(0.0264)	(0.027)
Liquidity	0.834	0.475
	(0.17844)	(0.3578)
Capitalization	0.058 ***	0.039 ***
	(0.0085)	(0.0011)
ΔBR_{t-2}* Size	0.055 ***	-0.073 ***
	(0.0227)	(0.0269)
ΔBR_{t-2}*Liquidity	0.216 ***	0.27 ***
	(0.0539)	(0.0854)
ΔBR_{t-2}*Capitalization	0.654	0.51 **
	(0.8306)	(0.0810)
Boone Indicator	1.39 ***	1.679 ***
	(0.4215)	(0.4615)
Boone Indicator *ΔBR_{t-1}	0.124 ***	0.07 ***
	(0.0351)	(0.0130)
GDP Growth	0.502 ***	0.757 ***
	(0.1872)	(0.2415)
Inflation	0.095 ***	0.051 ***
	(0.0381)	(0.0043)
Constant	7.180	-9.33 ***
	(10.257)	(1.231)
Number of Banks	70	70
Instruments	69	
Observations	1431	1437
AR. (2) P value	0.35	
Hansen P-value	0.78	
Fixed Effect	0.78	yes

Note: The dependent variable used in the model is loan growth. BR is the annual percentage change in the bank rate and is used as an alternative indicator of monetary policy. *, **, *** indicate statistical significance at the 10% level, 5% level and 1% level, respectively.

6. Conclusion and policy implications

This study empirically investigates the role of bank competition in monetary policy transmission via bank lending channel in India. It further examines how market power in deposit and loan markets affects the transmission mechanism of monetary policy. The implications of bank competition across ownerships and their impact on bank lending have been investigated using bank-level balance sheet information. Findings show that higher market power/lower competition weakens the effect of monetary policy transmission on bank lending. However, such weakening and strengthening effects of monetary policy depend on the selection of appropriate competition measures. There have been considerable variations in the response of ownership groups to changes in monetary policy depending on their levels of competition.

From policy perspectives, the findings suggest careful scrutiny of the financial system, such as financial deregulations, privatizations, and bank consolidation, affecting bank competition. The monetary authority should direct policies that can offset the adverse effects of the changes in competition conditions on the effectiveness of monetary policy transmission. Pro-competitive policies should be adopted for private and foreign banks to enhance the effective implementation of monetary policy. These policy suggestions could be useful for other emerging economies that witnessed a similar experience of bank deregulation and increased competition conditions.

Finally, we conclude the paper by highlighting the limitations of this study, which leaves the scope for future research direction. First, we note that previous studies emphasized the risk-taking channel of monetary policy while analyzing the response of bank competition to monetary policy stance. Since this study is based on a specific theme, i.e. bank lending channel, we did not discuss the risk-taking channel of monetary policy. Second, we acknowledge the possibility that banks' lending responses can differ during the phase of easy and tight monetary policy regimes.

Data availability

Data will be made available on request.

Table 8
Sensitivity analysis.

	ALI	ALI with interactions
Lagged Loan growth	0.4120 ***	0.398 ***
	(0.1327)	(0.1357)
Taylor	-0.006 ***	-0.017 ***
	(0.0026)	(0.0082)
Size	-0.039 *	-0.089
	(0.0031)	(0.2397)
Liquidity	0.3838	0.414 *
	(0.7222)	(0.5773)
Capitalization	0.0841 **	0.077
	(0.0528)	(0.0974)
Taylor* Size		0.034 **
		(0.0215)
Taylor *liquidity		0.0538
		(0.9597)
Taylor*capitalization		0.065
		(0.0117)
ALI	0.384 ***	0.551 **
	(0.1301)	(0.1648)
Taylor* Adjusted Lerner		0.403 **
		(0.1361)
Deposit growth	0.072 ***	0.097 ***
	(0.025)	(0.0374)
GDP Growth	0.695 ***	0.584 ***
	(0.2387)	(0.1790)
Inflation	0.233 ***	0.283 ***
	(0.0829)	(0.0676)
Number of Banks	70	70
Instruments	49	48
Observations	1434	1431
AR(2)	0.38	0.34
Hansen	0.82	0.79

Note: Table reports the estimated results of the two-step system GMM dynamic panel model. The dependent variable is loan growth. The adjusted Lerner index is used as an inverse measure of bank competition. Taylor residuals are used as an alternative indicator of monetary policy. The explanatory variables are included in lagged one period. Robust (Windmeijer) standard errors are presented in parentheses. * , **, *** indicate statistical significance at the 10% level, 5% level and 1% level, respectively.

Appendix A

Estimation of marginal cost

The estimation of Lerner index, adjusted Lerner index, and Boone indicator requires information on banks' price and marginal costs. However, information on P and MC can be difficult to obtain as they are not directly observable. Following the conventional approach in the previous literature (Fernandez de Guevara et al., 2005; Leroy, 2014), we compute price by using the ratio of total revenue (interest and non-interest revenue) over total assets. To estimate the MC required for all three indices, we specify the following cost function advanced by Delis (2012) and Delis et al. (2014).

$$tc_{i,t} = f\left(q_{i,t}, W_{l,it,} W_{k,it,} W_{d,it}\right) \tag{A.1}$$

In equation (A.1) tc denotes total cost comprising of total operating expenses and total financial expenses (interest cost), and q presents the total assets of banks. We use three input prices in this study. , W_l denotes the prices of labor which is measured by the ratio of personnel expenses over total assets. W_k stands for the price of capital calculated as non-interest expenses to fixed assets. W_d indicates price for funds and we calculate it as a ratio of total interest expenses over total funding. We covert the above specified simple cost function into a standard log-linear form and impose the usual assumption of linear homogeneity upon the input prices (we normalize the total costs and other input prices by the deposit price prior to taking logarithm).

$$\ln tc_{it} = b_1 + b_2 \ln W_{l,it} + b_2 \ln W_{k,it} + a_1 \ln q_{it} \tag{A.2}$$

In order to estimate equation (A.2), we apply a semiparametric partial -linear smooth coefficient (PLSC) model (see Fan & Zhang 1999; Mamuneas et al., 2006 for a theoretical discussion on PLSC). The PLSC model uses local polynomial fitting regression and Gaussian kernel function to obtain the estimate of a_1 for each bank i at time t. The merit of applying PLSC technique lies in the fact that it permits the model to be linear in regressions and allows the coefficients to change "smoothly" with the help of the value of another variable say, z with the linear combination of two more input prices. When we apply the PLSC technique in equation (A.2), we get the following econometric specification

$$\ln tc_{it} = b_1 + a_1(z_{it}) lnq_{it} + b_2 \ln w_{l,it} + b_3 \ln w_{k,it} + \varepsilon_{it} \tag{A.3}$$

In equation (A.3), z is a smoothing variable required by the PLSC technique. We consider the model semiparametric in the sense that it accounts the coefficient a_1 as a function of z. From equation (A.2), we derive the marginal cost for each bank i at time t.

$$MC = \frac{\partial tc_{it}}{\partial q_{it}} = a_1(z_{it})(tc_{it}/q_{it}) \tag{A.4}$$

An appropriate selection of input variables is a prerequisite to estimate the empirical model. The input variables should be highly correlated with z so that it allows the variation of $a_1$across banks over time. Following Delis et al. (2014), we choose the linear combination of two input prices and define the smoothing variable as $z_{it} = \ln w_{l,it} + \ln w_{k,it}$ which has been used in the equation (A.4) to the final estimation of marginal cost.

Taylor rule residuals calculation

We present the estimation technique for constructing Taylor rule residuals for India. Taylor rule residuals are measured as the difference between RBI's interest rate (repo rate) and Taylor rule rate, which is usually calculated as a function of output gap and inflation. The empirical specification of Taylor rule residuals is expressed in the following way

$$IR_t = r + \pi_t + \alpha(\pi_t - \pi_t^*) + \beta(Y_t - Y_t^*) \tag{A.5}$$

Where IR denotes RBI's representative interest rates (repo rate). π_t denotes inflation rate and π_t^* is the targeted inflation rate, assumed to be 2%. The steady state real interest rate has been denoted by *r*. The output gap has been shown by $Y_t - Y_t^*$, and it is measured as the difference between potential output and real GDP. Finally, we regress the interest rate on inflation rate (measured by annual CPI rate) and estimated output gap. The residuals from the regression equation are then used as a proxy for the monetary policy indicator, with higher residual values implying tighter monetary conditions.

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