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# Liquidity creation cyclicality, capital regulation and interbank credit: Evidence from Chinese commercial banks

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ABSTRACT

The cyclicality of the banking industry is closely related to financial crisis. Based on the methodology of Berger and Bouwman (2009) to measure bank liquidity creation, this paper investigates whether liquidity creation is cyclical for Chinese banks during 2012–2018. Our results indicate that liquidity creation by Chinese banks is procyclical and this procyclicality is more pronounced among regional banks. And we further explore the influence of capital regulatory pressure and interbank credit on the procyclicality of Chinese bank liquidity creation. We find that capital regulatory pressure and interbank credit are helpful in mitigating the procyclicality of bank liquidity creation, especially among regional banks. As the Chinese banking industry takes a great proportion of the global banking industry, our findings provide various implications on capital regulation and interbank business supervision for national and international bank regulators and policymakers.

## 1. Introduction

As the most important financial intermediary, banks create liquidity by financing relatively illiquid assets with relatively liquid liabilities, which facilitates the capital flow from the financial system to the real economy. Liquidity creation is closely linked to financial stability (Berger et al., 2019). We have learnt lessons from the global financial crisis in 2008 that market participants tend to behave in a procyclical manner and financial shocks could be amplified throughout the banking system and the broader economy. In order to offset the procyclical effect of financial shocks, the Basel Committee has put forward the policy framework of countercyclical capital buffers in December 2010 in Basel III (BCBS, 2010), which helps banks to become more resilient to procyclical dynamics. Afterwards, the macro-prudential regulatory framework has been established globally.

Since then, the cyclicality in banking industry, which is considered to be an important driver of the crisis, has received widespread attention. Bank liquidity creation plays a crucial role in providing funds to the market and boosting the development of the real economy. Even though there is former evidence for the cyclicality of bank lending (eg. Micco and Panizza, 2006; Bertay et al., 2015), we are concerned about the cyclicality of bank liquidity creation, which is a much broader concept. The main reason lies in that bank lending is not the optimal measure of bank output (Berger and Bouwman, 2015). To our knowledge, the cyclicality of bank liquidity creation has received far less attention and only a very few studies are focused on this topic. For example, Davydov et al. (2018) investigate the cyclicality of liquidity creation among Russian banks. They consider the influence of bank ownership on cyclicality of

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liquidity creation and find that Russian banks are procyclical as well. As they suggested, liquidity creation is expected to be cyclical due to the fact that greater lending and depository activities of banks would result in more liquidity creation alongside economic growth. Berger and Sedunov (2017) also provide evidence that bank liquidity creation is statistically and economically significantly positively related to real economic output in terms of GDP.

China plays an increasingly important role in global economy while it is facing a critical period of optimization and upgrading its economic structure. In terms of the total assets, the 'Big Four' Chinese banks take the top four places in the world's largest banks table and so that the Chinese banking industry contributes to a large portion of the global banking sector. A sound financial environment can not only help realize the transformation of the development mode, but also help financial institutions to bolster the real economy. In 2011, the China Banking Regulatory Commission (CBRC) issued the *Guiding Opinions on the Implementation of New Regulatory Standards for the Chinese Banking Industry*, which officially proposed the countercyclical capital buffer as one of the tools for macro-prudential supervision. Subsequently in 2012, the CBRC promulgated the *Measures for Capital Management of Commercial Banks (Trial)*, which stipulated that new capital regulations for Chinese commercial banks would be implemented since 2013. This implies that commercial banks in China are subject to higher capital regulatory requirements since then, which may have crucial influence on their business activities. Meanwhile, it is worth noting that interbank credit expands significantly within the Chinese banking system in recent years mainly as a result of supervision evasion. Traditionally, the lending business in Chinese commercial banks has to meet rigorous requirements such as the limit of total credit and the loan-to-deposit ratio, which may restrict banks' ability to grant loans. To reverse this situation, Chinese commercial banks tend to allocate a large quantity of interbank liabilities with lower costs in non-standard low-risk assets in order to avoid the occupation of capitals. As a consequence, the interbank credit soared.

As stated above, we are concerned about the following questions: does Chinese banks' liquidity creation exhibit a cyclicality? Is the macro-prudential policy helpful in alleviating the cyclicality of bank liquidity creation? Moreover, does the expanding interbank credit have a significant impact on the cyclicality of bank liquidity creation? The answers to these questions are of great significance to the Chinese financial system and other emerging markets as well. This current research aims to examine the cyclicality of bank liquidity creation in China, and then explore the influence of capital regulation and interbank credit on the cyclicality of liquidity creation. As a matter of fact, bank loan is the dominant financing source for the real economy in China, a bank-dependent and transition economy. Based on the open statistics, Chinese bank loans account for 64.95% in Aggregate Financing to the Real Economy (Flow)[1] in 2019.

This paper extends the work of Davydov et al. (2018) by further considering the mitigating effect of capital regulatory pressure and interbank credit on the cyclicality of bank liquidity creation in the Chinese context. In comparison with previous studies, we contribute to the literature in the following aspects. Firstly, we add Chinese evidence to the international studies in the relevant areas concerning the cyclicality of bank lending or bank leverage, including the works of Bertay et al. (2015) and Micco and Panizza (2006) both on international samples, Adrian and Shin (2010) on U.S. commercial banks and Baglioni et al. (2013) on European banks, and Davydov et al. (2018) on Russian banks. Given the fact that the Chinese banking industry takes a large share of the global banking sector, there is no research to analyze the liquidity creation cyclicality in China. Specifically, we conduct empirical analysis to test whether the liquidity creation of Chinese commercial banks exhibits procyclicality and whether significant differences exist among different types of banks, namely regional and cross-regional ones. This is a beneficial expansion of the liquidity creation research. Secondly, we also provide evidence for the practical effectiveness of macro-prudential policy implementation in China by investigating the association between capital regulatory pressure and cyclicality of bank liquidity creation. Thirdly, this study further examines the possible effect of expanding interbank credit on the cyclicality of liquidity creation in Chinese banks. The results indicate that liquidity creation by Chinese banks is procyclical as a whole, and this procyclicality is more pronounced among regional banks instead of cross-regional banks. Additionally, we find that capital regulatory pressure and interbank credit are helpful in mitigating the procyclicality of bank liquidity creation for Chinese banks as a whole as well as the regional banks. These findings may have implications for the implementation of differentiated capital regulation policies in China.

The rest of this paper is structured as follows: Section 2 discusses the related literature and hypothesis. Section 3 presents the variables, data and regression models. Section 4 is empirical results and analysis. Section 5 concludes the whole paper.

## 2. Literature review and hypotheses

### 2.1. Cyclicality of bank liquidity creation

Market participants including banks tend to behave in a procyclical manner. There has already been evidence that bank lending is positively associated with the business cycle (e.g., Fidrmuc et al., 2015; Berger and Sedunov, 2017). Lending is the core business of commercial banks, and loans account for the largest proportion of bank assets, but loans simply cannot fully reflect the important role played by banks as financial intermediaries in the financial market. In fact, liquidity creation is another function of banks and it is a sound measure by taking both bank assets and liabilities into account. Undoubtedly, there is a significant correlation between the two. Bank liquidity creation will rise along with the increase of credit supply during the economic upturn and decline during the downturn. As such, we can reasonably expect that bank liquidity creation is likely to be cyclical, as argued by Davydov et al. (2018).

Based on the operational approach in measuring bank liquidity creation proposed by Berger and Bouwman (2009), extensive studies on bank liquidity creation have emerged and some are focused on bank-level determinants of liquidity creation. For example,

[1] AFRE (flow) refers to the total volume of financing provided by the financial system to the real economy during a certain period of time.

Horváth et al. (2016) found that bank competition exacerbated the vulnerability of banks, which directly led to the reduction of bank deposit and loan activities, and then had a negative impact on liquidity creation. Jiang et al. (2019) further provided evidence that regulatory-induced competition reduces bank liquidity creation, especially among less profitable banks. Díaz and Huang (2017) found that large banks with better internal controls were more capable of creating liquidity during the 2008 financial crisis. Huang et al. (2018) pointed out that optimism about bank management has a significant negative impact on liquidity creation.

There are also studies paying attention to the impact of macroeconomic environment on bank liquidity creation while some are focused on the monetary policy perspective. For example, Acharya and Naqvi (2012) suggested that a loose monetary policy will stimulate a liquidity creation increase, but also accumulate risks within the banking system. Chatterjee (2015) argued that the monetary policy changes bank liquidity creation through its impact on the asset market liquidity. However, Berger and Bouwman (2017) found that monetary policy does not significantly affect the liquidity creation of large and medium-sized banks whereas significantly affects the level of liquidity creation of small banks during non-crisis periods. Casu et al. (2019) use the unemployment rate as an indicator of macro conditions and find that it has a significant negative impact on bank liquidity creation.

Meanwhile, some studies concerning the relationship between bank liquidity creation and economic output suggest a positive and significant association between them, such as Berger and Sedunov (2017) and Fidrmuc et al. (2015). Additionally, several studies focus on the cyclicality of bank leverage and extend empirical study based on US and Europe samples. Their conclusion suggest that bank leverage is procyclical. The above studies provide indirect evidence and strong support for the cyclicality of bank liquidity creation (eg. Adrian and Shin, 2010; Baglioni et al., 2013).

We can also find several studies devoted to the determinants of liquidity creation for Chinese banks. For example, Lei and Song (2013) provided evidence that bank capital is negatively related to liquidity creation and this effect is weaker in foreign banks in China. Chen et al. (2015) found that excess lending has a significant impact on bank liquidity creation in China and ownership structure significantly affect banks' liquidity preferences. Hou et al. (2018) argue that bank diversification has both positive and negative impact on bank liquidity creation in the context of China, depending on the bank heterogeneity. Zhang and Deng (2020) explored the impact of interest rate liberalization on bank liquidity creation and found an inverted U-shaped relationship between them by using a panel dataset of 145 Chinese banks in the period of 1997–2015.

However, extant literature pays limited attention to the cyclicality of liquidity creation among Chinese commercial banks. In order to fill this gap, we propose the first hypothesis:

**H1**. : There is cyclicality of liquidity creation among Chinese commercial banks.

### *2.2. Capital regulation and cyclicality of liquidity creation*

Banks providing larger volume of credit funds are subject to more capital demand in order to meet the capital regulation requirements. This is to say that, capital regulation may effectively affect bank credit activities. Tabak et al. (2011) found that capital buffer has the effect of mitigating the fluctuation of credit cycle. Specifically, during an economic upturn, increasing capital buffer can suppress bank loan growth, and during an economic downturn, releasing capital buffer can encourage banks to supply more loans. Harimohan and Nelson (2012) argued that the impact of counter-cyclical capital regulation on bank credit through two channels, affecting bank cost from the supply side and credit need from the demand side. Aiyar et al. (2012) pointed out that banks would initiate alternative business when facing capital regulatory pressure, but there is an incomplete substitution relationship between the alternative business and bank's traditional credit.

Capital regulation may also impact a bank's asset structure. Generally speaking, when banks face capital constraints, they tend to increase low risk assets and reduce high-risk assets. For example, Haubrich and Wachtel (1993) found that capital regulatory pressure is an important reason for changes in bank's asset portfolio. In face of greater capital pressure, banks are likely to shrink loans and allocate more funds to safer assets such as government bonds and mortgage loans. Fu et al. (2016) argued that there exists a trade-off between regulatory capital and liquidity creation based on the sample of commercial banks in 14 Asia-Pacific economies. Banerjee and Mio (2018) found that liquidity regulation would force banks to adjust their balance sheet structure, specifically by increasing the proportion of liquid assets and non-financial deposits, while reducing the share of financial loans and short-term wholesale funds. Tran et al. (2016) suggested that there is a positive association between regulatory capital and liquidity creation after controlling bank profitability based on the sample of US banks.

As stated above, capital regulation may produce significant influence on liquidity creation of banks. As such, we are further concerned about whether capital regulatory pressure faced by banks would impact bank liquidity creation. More specifically, will capital regulatory pressure mitigate or strengthen the cyclicality of bank liquidity creation? In order to answer this question, we put forward the second hypothesis:

**H2**. : Capital regulatory pressure has a significant impact on the cyclicality of liquidity creation for Chinese commercial banks.

### *2.3. Interbank credit and cyclicality of liquidity creation*

The interbank market is crucial for banks facing uncertainty regarding their liquidity needs (Freixas et al., 2011), as a consequence of bank liquidity management. As Castiglionesi and Eboli (2018) discussed, the interbank market is a flow network that is able to channel liquidity flows among banks. In recent years, avoiding financial regulation and increasing operating profits are important driving forces of interbank credit for Chinese banks. In fact, the expansion of interbank credit will not only affect the effect of monetary policy, but also indirectly affect the liquidity creation of the whole banking system. Relevant research generally believes that

tightening monetary policy has restricted the scale of traditional bank credit, but at the same time encouraged the expansion of interbank credit, which pushes up the level of interbank liquidity creation and then weakens the effectiveness of monetary policy (Nelson et al., 2018; Chen et al., 2018). Beladi et al. (2020) examined the impact of interbank lending collapse during the financial crisis on bank liquidity creation and point out that liquidity creation of borrowing banks in the interbank market is negatively affected, namely having lower loan growth. They argued that borrowing banks have to reduce their risky assets holdings due to reduced access to interbank funds. These studies suggested that interbank business would affect bank liquidity creation to a large extent, and we wonder if this association holds when it comes to cyclicality of bank liquidity creation. As such, we propose the third hypothesis:

**H3**. : Interbank credit has a significant impact on the cyclicality of liquidity creation for Chinese commercial banks.

## 3. Methodology

### 3.1. Variables

#### 3.1.1. Liquidity creation

Based on the approach proposed by Berger and Bouwman (2009), we use the following three steps to construct our liquidity creation measure.

First, we classify bank assets, liabilities and capital into three categories, namely liquidity, semi-liquidity and illiquidity, according to their degree of liquidity. In fact, Berger and Bouwman (2009) propose two approaches to calculate liquidity creation, namely category-based and maturity-based approaches. Considering the China-specific factors and data availability, the category-based approach is more appropriate, which is also preferred by Berger and Bouwman (2009), though the differences between this study and B—B measure (2009) include: 1) personal housing mortgage loans are classified as illiquid assets; 2) other personal loans with shorter maturities such as consumer loans are classified as semi-liquid assets; 3) fixed assets, intangible assets and corporate loans with low liquidity are classified as illiquid assets; 4) correspondent accounts are classified as liquid assets and liquid liabilities respectively.

Second, each category of assets and liabilities is assigned a weight, as Berger and Bouwman (2009). Specifically, the weight of illiquid assets and liquid liabilities is 0.5, the weight of semi-liquid assets and semi-liquid liabilities is 0, and the weight of liquid assets and illiquid liabilities is −0.5. Details of various types of assets and liabilities are presented in Table 1.

Third, we compute an integrated liquidity creation index for each bank in the above way. The specific formula is as follows:

$$\begin{aligned} Liquidity\ Creation = {} & 0.5 \times Illiquid\ Assets + 0 \times Semi - liquid\ Assets - 0.5 \times Liquid\ Assets \\ & +0.5 \times Liquid\ Liabilities + 0 \times Semi - liquid\ Liabilities - \\ & 0.5 \times Illiquid\ Liabilities - 0.5 \times Capital \end{aligned} \tag{1}$$

After calculating the liquidity creation for each bank in each year, we use the change of liquidity creation by each bank at the end of each year as the dependent variable (ΔLC) following Davydov et al. (2018), in order to reflect the dynamic change of bank liquidity creation. To ensure the reliability of results, we use the ratio of liquidity creation to bank assets for robustness check.

#### 3.1.2. Business cycle

The Hodrick-Prescott filtering (Hodrick and Prescott, 1997) is applied to measure the economic cycle in this study, which is common in macroeconomics that is used to capture the trend in a time series (De Jong and Sakarya, 2016). Following Lin and Zhang (2020), we conduct the HP filtering on annual GDP growth rates from 1987 to 2018 in order to extract reliable and stable components of the economic cycle. Due to the data quality, we focus on the period from 2012 to 2018 in regression.

#### 3.1.3. Capital regulatory pressure

Following Jacques and Nigro (1997) and Mora and Logan (2012), we proxy capital regulatory pressure by the difference between the minimum capital adequacy ratio required by the regulatory authority and the actual capital buffer held by the bank at the end of each year. The specification is as follows:

$$CAPITAL_{i,t} = CAP_{i,t}^{*} - CAP_{i,t} \tag{2}$$

where $CAPITAL_{i,\ t}$ is the capital regulatory pressure faced by bank $i$ in year $t$. $CAP_{i,t}^{*}$ is the minimum capital requirement stipulated by the regulatory authority for bank $i$ in year $t$. $CAP_{i,\ t}$ is the capital adequacy ratio actually held by bank $i$ in year $t$.

By 2013, the minimum capital requirement for commercial banks in China was 8%, which is in line with Basel III. In June 2012, the China Banking Regulatory Commission (CBRC) issued the *Rules for Regulating the Capital Adequacy Requirement of Commercial Banks* (the *Rules 2012* thereafter), which stated that commercial banks have to satisfy the relevant regulatory requirements for capital adequacy from 2013 onwards. Generally, this new capital regulation framework in China complies with the Basel III Accord that was

**Table 1**
Liquidity creation measures for Chinese commercial banks.

| Illiquid assets (0.5) | Semi-liquid assets (0) | Liquid assets (−0.5) |
|---|---|---|
| Fixed assets | Loans to customers | Cash |
| Intangible assets | Loans to depository institutions | Due from banks |
| Corporate loans | Other due from banks | Financial instruments |
| Mortgage loans | | Financial assets held to maturity |
| Loans loss reserves | | Financial assets available for sale |
| Other long-term assets | | Derivative financial assets |
| **Illiquid liabilities (−0.5)** | **Semi-liquid liabilities (0)** | **Liquid liabilities (0.5)** |
| Subordinated liabilities | Borrowings form banks | Due to banks |
| Other illiquid liabilities | Certificates of deposit | Due to central banks |
| Capital | Time deposits | Demand deposits |
| | Other borrowed money | Other liquid liabilities |

Notes: This table classifies all balance sheet items in terms of their liquidity for Chinese commercial banks. The weight of each category is given in parentheses, which is used to calculate the category-based liquidity creation measure as in Eq. (1).

issued in 2010. The Tier 1 Capital and Total Capital (Tier 1 Capital plus Tier 2 Capital) of Chinese banks should be at least 6% and 8% of the Risk Weighted Assets (RWA) respectively, and the capital conservation buffer should be held above the regulatory minimum capital requirements, which is 2.5% of the RWA. Meanwhile, Chinese banks need to meet the requirements of countercyclical capital buffers (0–2.5% of the RWA) as well. If a domestic bank is recognized as global systemically important banks (G-SIBs), the applicable additional capital requirements shall not be lower than the uniform provisions of the Basel Committee. All these requirements are consistent with Basel III. However, the Core Tier 1 Capital of Chinese banks should be at least 5% of the RWA, which is higher than the requirement of Common Equity Tier 1 Capital in Basel III (4.5%).[2] Additionally, if a bank is recognized as domestical systemically important banks (D-SIBs), it should have an additional capital ratio of 1%. In addition to the common minimum capital adequacy ratio of 8%, the minimum capital adequacy ratio for D-SIBs and non D-SIBs in China are 11.5% and 10.5% respectively. In order to alleviate the pressure of commercial banks to meet the new capital adequacy requirements, the CBRC further announced a transition period from 2013 to 2018, during which the minimum capital adequacy ratios for D-SIBs are 9.5%, 9.9%, 10.3%, 10.7%, 11.1%, 11.5%, and those for non D-SIBs are 8.5%, 8.9%, 9.3%, 9.7%, 10.1%, 10.5%.[3]

#### *3.1.4. Interbank credit*

We measure the bank-level expansion of interbank credit by interbank leverage, which is calculated as the ratio of interbank liabilities to interbank assets for each bank. Interbank liabilities include financial assets sold for repurchase, borrowing funds and deposits from other banks. Interbank assets include financial assets held for trading, interbank offered credit and interbank deposits. When banks do not allocate the interbank liabilities to traditional interbank assets such as interbank deposits, shadow credit is created. The more interbank credit is extended, the greater the gap between interbank liabilities and interbank assets becomes, resulting in a higher level of interbank leverage.

### *3.2. Control variables*

Drawing on relevant studies (Berger and Bouwman, 2009; Horváth et al., 2014; Casu et al., 2019), we introduce several control variables. Bank size (SIZE), which is proxied by the natural logarithm of bank's total assets. Banks of different sizes may behave differently in their liquidity creation. Bank risk (NPL), which is measured by the ratio of non-performing loan to total loans. In China, each loan is classified into five categories depending on the severity of losses, namely normal, concerned, subprime, questionable and lost loans where the latter three types are defined as non-performing loans. The higher the ratio NPL is, the more risk the bank undertakes in their operation, which may affect the bank's liquidity creation as well. Return on assets (ROA) controls for the impact of profitability of banks on their liquidity creation. Monetary policy (MP), which is measured by annual growth rate of M2, controls for the impact of monetary policy on bank liquidity creation. All variables are summarized in Table 2.

[2] The basic structures and components of bank capitals in the *Rules 2012* and in Basel III are consistent. For example, Core Tier 1 Capital in the *Rules 2012* and Common Equity Tier 1 in Basel III both consist of common shares issued by the bank, stock surplus, retained earnings, etc. Additional Tier 1 Capital (both in the *Rules 2012* and in Basel III) consists of instruments issued by the bank that meet the criteria for inclusion in Additional Tier 1 capital, stock surplus, etc. Tier 2 capital consists of instruments issued by the bank that meet the criteria for inclusion in Tier 2 capital, stock surplus, certain loan loss provisions, etc.

[3] *Guidance on Improving the Supervision of Systemically Important Financial Institutions* issued by People's Bank of China, China Banking and Insurance Regulatory Commission and China Securities Regulatory Commission in November 2018 and *Evaluation Method for Systemically Important Banks (Draft)* issued by People's Bank of China, China Banking and Insurance Regulatory Commission in November 2019 provide the regulatory framework for systemically important financial institutions in China.

**Table 2**
Variable description.

| Variables | Description |
|---|---|
| LC | Liquidity creation measure, calculated based on category. |
| ΔLC | The change in liquidity creation measure. |
| CYCLE | Business cycle component extracted from Hodrick-Prescott filtering on GDP growth rates. |
| CAPITAL | Capital regulatory pressure, measured as the difference between the minimum capital adequacy ratio required by the regulatory authority and the actual capital buffer held by the bank. |
| LEV | Interbank leverage indicator, measured as the ratio of interbank liabilities to interbank assets for each bank. |
| SIZE | Bank size, measured as the natural logarithm of total assets. |
| ROA | Average return on net worth, measured as net profit/average net worth. |
| NPL | Non-performing loan ratio, measured as non-performing loans/total loans. |
| MP | Monetary policy indicator, measured as the annual growth rate of M2. |

### 3.3. Data

We use 192 Chinese commercial banks during the period 2012–2018 as our empirical sample due to data availability. After excluding banks with observations spanning less than three consecutive years, our final sample consists of 147 Chinese banks including 5 large state-owned commercial banks and 9 joint-stock commercial banks and 133 city commercial banks and rural commercial banks. Among them, state-owned banks and joint-stock commercial banks can conduct their business nationwide and have branches nearly in all provinces, whereas city commercial banks and rural commercial banks are based in local areas and restricted in setting up cross-provincial branches, which makes them mostly be regional banks. As such, we categorize state-owned banks and joint-stock commercial banks as cross-regional banks, and city commercial banks and rural commercial banks as regional banks in our sample. Meanwhile, these two groups are quite different in bank size. Based on the data from China Banking and Insurance Regulatory Commission (CBIRC, formerly the CBRC), at the end of 2020, state-owned banks and joint-equity commercial banks, namely the cross-regional group, take 57.4% market share in terms of total assets in the Chinese banking system, while city commercial banks and rural commercial banks take only 26.4%. More importantly, these two groups of banks differ from each other not only in their operating area and bank size, but also in the differentiated regulations in terms of the deposit reserve ratio, capital adequacy ratio etc. For example, the CBIRC implemented a three-level deposit-reserve ratio framework in May 2019. According to it, large banks (state-owned) face a higher requirement of deposit-reserve ratio, and medium-sized banks (joint-equity commercial banks and some city commercial banks) face a relatively lower level, and small banks (rural commercial banks and other rural financial houses) face a lowest level. In terms of capital adequacy regulation, cross-regional banks also have to meet higher requirements due to that most of them are categorized as D-SIBs. Since Tallman and Moen (2012) find that dominant national banks were crucial providers of temporary liquidity, we can reasonably infer that regional banks and cross-regional banks in China have different liquidity creation performance.

All the data regarding sample banks are retrieved from Orbis Bank Focus, a banking database that contains detailed, standardized reports and ratios for over 44,000 global banks. Macroeconomic data is obtained from the website of the National Bureau of Statistics of China. In order to avoid the influence of outliers, all the continuous variables are winsorized at 1% and 99%.

Descriptive statistics are reported in Table 3. In terms of liquidity creation measure (LC), cross-regional banks in larger size have a much higher level of liquidity creation than regional banks of smaller size, which in line with related studies (eg. Berger and Sedunov, 2017). The mean value of liquidity creation change among the full sample is 0.107. Similar to Davydov et al. (2018), we also find that the variation of liquidity creation (ΔLC) is higher in regional banks than that of cross-regional banks. This indicates that regional banks with lower level of liquidity creation suffers higher fluctuation than cross-regional banks, which also implies that the large banks play an important role in stabilizing the financial system. As far as the capital pressure is concerned, the mean value of the full sample is −2.849, indicating that the Chinese commercial banks can meet the regulatory requirements on capital adequacy. And cross-regional banks are faced with higher capital regulatory pressure than regional banks. The average interbank leverage of full sample is 2.634, and cross-regional banks are less leveraged in terms of interbank credit than regional banks. This indicates that regional banks are more aggressive in raising interbank liabilities to expand their business. Regarding the bank size, cross-regional banks are much larger than regional banks. The mean value of NPL is 1.498, indicating that China's banking industry overall has a relatively low level of bad loans. Specifically, regional banks undertake higher risk in their operation than cross-regional banks in terms of NPL. The mean value of profitability is 12.98%, and cross-regional banks have higher profitability than regional banks though they undertake lower risk.

### 3.4. Regression models

In order to test H1, we build the following dynamic unbalanced panel regression to examine whether there is cyclicality of liquidity creation among Chinese commercial banks.

$$\Delta LC_{i,t} = \alpha_0 + \alpha_1 CYCLE_{i,t} + \alpha_2 NPL_{i,t} + \alpha_3 ROA_{i,t} + \alpha_4 SIZE_{i,t} + \alpha_5 MP_{i,t} + \varepsilon_{i,t} \tag{3}$$

where $\Delta LC_{i,\,t}$ is the change in liquidity creation for bank $i$ in year $t$. One-year lagged change in liquidity creation is incorporated in the right-hand-side of the equation to control for the impact of change of liquidity creation in last year. Bank-level controls are assumed to be endogenous and instrumented with their lags, and monetary policy is considered as predetermined.

To explore the impact of capital regulatory pressure and interbank credit on the cyclicality of liquidity creation for Chinese banks,

**Table 3**
Descriptive statistics of variables.

| Variable | Full sample | | | | Regional banks | | | | Cross-regional banks | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Std.D | Min | Max | Mean | Std.D | Min | Max | Mean | Std.D | Min | Max |
| LC | 369,321 | 1,170,803 | 504 | 10,730,689 | 69,494 | 93,705 | 504 | 913,278 | 2,894,172 | 2,398,873 | 454,682 | 10,730,689 |
| ΔLC | 0.107 | 0.308 | −0.869 | 1.171 | 0.108 | 0.323 | −0.869 | 1.171 | 0.102 | 0.139 | −0.392 | 0.608 |
| CAPITAL | −2.849 | 2.081 | −10.750 | 0.620 | −2.943 | 2.112 | −10.750 | 0.620 | −2.058 | 1.612 | −6.490 | 0.620 |
| LEV | 2.634 | 3.403 | 0.0177 | 25.196 | 2.605 | 3.463 | 0.0177 | 25.196 | 2.873 | 2.854 | 0.645 | 21.946 |
| CYCLE | −0.0003 | 0.001 | −0.006 | 0.001 | | | | | | | | |
| SIZE | 5.355 | 0.621 | 4.430 | 7.323 | 5.186 | 0.387 | 4.430 | 6.410 | 6.773 | 0.355 | 6.167 | 7.323 |
| NPL | 1.498 | 0.725 | 0.130 | 4.950 | 1.516 | 0.758 | 0.130 | 4.950 | 1.368 | 0.385 | 0.430 | 2.390 |
| ROA | 12.979 | 5.351 | 0.810 | 26.370 | 12.634 | 5.402 | 0.810 | 26.370 | 15.887 | 3.845 | 7.860 | 25.310 |
| MP | 11.154 | 2.077 | 8.076 | 14.391 | | | | | | | | |

Notes: This table presents descriptive statistics of variables over the investigation period.

we include the interaction term of business cycle and capital regulatory pressure in Model (2) and the interaction term of business cycle and interbank credit in Model (3). All the two interactions are centered in the regressions.

$$\Delta LC_{i,t} = \beta_0 + \beta_1 CYCLE_{i,t} + \beta_2 CYCLE_{i,t} \times CAPITAL_{i,t} + \beta_3 CAPITAL_{i,t} + \beta_4 NPL_{i,t} + \beta_5 ROA_{i,t} + \beta_6 SIZE_{i,t} + \beta_7 MP_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$\Delta LC_{i,t} = \gamma_0 + \gamma_1 CYCLE_{i,t} + \gamma_2 CYCLE_{i,t} \times LEV_{i,t} + \gamma_3 LEV_{i,t} + \gamma_4 NPL_{i,t} + \gamma_5 ROA_{i,t} + \gamma_6 SIZE_{i,t} + \gamma_7 MP_{i,t} + \varepsilon_{i,t} \quad (5)$$

Following Davydov et al. (2018), we employ System GMM (Generalized Method of Moments) panel estimators (Arellano and Bond, 1991, 1998) as our econometric approach in the analysis. Compared to Difference GMM, System GMM provides robust results as well as efficient and consistent parameter estimates (Boubakri et al., 2013). Meanwhile, the endogeneity and heterogeneity problem could be alleviated by using System GMM. Macroeconomic variables are assumed to be predetermined and bank-level controls are considered as endogenous and instrumented with their lags. The Sargan and Arellano-Bond tests are conducted as diagnostic tests to check for the validity of the instrument and for the absence of second-order autocorrelation. We perform the empirical analysis in two steps. Firstly, we run an aggregated analysis using the whole sample. Secondly, we conduct a disaggregated analysis by splitting our sample into two sub-samples, namely regional and cross-regional banks, in order to explore whether there exist significant differences between them in terms of liquidity creation cyclicality. Specifically, we conduct two-step System GMM regression among the full group and regional group and reporting WC-Robust Standard Error (Windmeijer, 2005). While in the cross-regional group, one-step System GMM regression is employed in order to obtain more reliable results, considering the sample size is relatively small (Arellano and Bond, 1991).

## 4. Empirical results and analysis

### 4.1. Baseline results

The results of the Sargan test and Arellano-Bond test in the full sample and regional sample show that the instrument variables are valid, and there is no second-order autocorrelation, satisfying the premise of the system GMM model. However, the results of the Sargan test in the cross-regional sample is not sound, possibly due to the relatively small sample size. The *p*-value of the Wald test is 0.0000 in all regression, rejecting the null that all the coefficients are zero. The regression results of Model (1) are reported in Table 4, including regressions on the full sample, cross-regional banks and regional banks.

The results on the full sample in Column 1 imply an insignificant association between current and lagged liquidity creation change by showing negative and insignificant coefficients of $\Delta LC_{i,\ t\text{-}1}$ among the full sample. The coefficient of business cycle (CYCLE) is significantly positive, indicating that the liquidity creation of Chinese commercial banks is procyclical as a whole. The level of liquidity creation rises during an economic boom and declines during the depression, in line with the findings on Russian banks by Davydov et al. (2018). We suggest that the procyclicality of liquidity creation by Chinese commercial banks may occur due to the following: firstly, bank credit is the dominant financing sources for firms in China with a bank-dependent financial system. This indicates that bank credit supply would affect the financing and investment decision of firms and have a strong association with the business cycle. It means that, there is an interdependent and mutually reinforcing relationship between liquidity creation and economic growth. Secondly, interest rate liberalization may promote the procyclicality of Chinese bank liquidity creation. In 2013, the People's Bank of China announced that it would release the floor of loan interest rates. The cap of deposit interest rates in China has been lifted since

**Table 4**
Cyclicality of liquidity creation for Chinese banks.

| Variables | All | Regional | Cross-regional |
|---|---|---|---|
| $\Delta LC_{t-1}$ | −0.102 (0.0698) | −0.0651 (0.0748) | −0.281*** (0.0956) |
| CYCLE | 46.38** (22.70) | 68.55*** (24.37) | −25.16 (23.02) |
| MP | 0.0568*** (0.0136) | 0.0697*** (0.0160) | 0.00569 (0.0138) |
| NPL | −0.0748 (0.0788) | −0.0327 (0.0794) | −0.198 (0.135) |
| ROA | 0.00722 (0.0116) | 0.0139 (0.0128) | −0.00714 (0.0147) |
| SIZE | −0.141* (0.0799) | −0.142 (0.111) | 0.150*** (0.0577) |
| Constant | 0.296 (0.529) | −0.00434 (0.735) | −0.551 (0.486) |
| Wald | 56.56 (0.0000) | 43.80 (0.0000) | 90.39 (0.0000) |
| AR(2) (p-value) | 0.9277 | 0.8602 | 0.3844 |
| Sargan (p-value) | 0.4852 | 0.5336 | 0.0026 |
| Obs. | 540 | 473 | 67 |
| No. of banks | 146 | 132 | 14 |

Note: The dependent variable is the change in liquidity creation measure based on category. Two-step System GMM regression is employed among full sample and the regional group, and one-step System GMM regression is employed among the cross-regional group. Wald is the Wald test for the joint significance of all independent variables under the null that all parameters are not statistically different from zero. AR(2) is the Arellano-Bond test for second-order serial correlation under the null that there is no serial two-order correlation. Sargan is to test for the existence of over identification under the null that instruments are overidentified. Robust standard errors in parentheses. *, **, and *** denote statistical significance level at 10%, 5%, and 1% levels, respectively.

2015. As such, competition for deposits among commercial banks has been intensified, leading to the increase in the financing costs of banks. Along with the interest rate liberalization, Chinese banks are likely to be more aggressive in their asset allocation strategy. Especially during an economic boom, banks are motivated to undertake more risks due to fiercer competition in order to make more profits, in terms of granting more high-risk loans and creating more liquidity for the economy.

In Columns 2 and 3, we can observe that the coefficient of business cycle is positive among the regional group, indicates significant procyclicality of liquidity creation by regional banks. Interestingly, the coefficient of business cycle is negative but insignificant among the cross-regional banks. This implies that there is no significant procyclicality of liquidity creation by cross-regional banks with a much higher market share. This is supported by the findings of Bertay et al. (2015) that state banks are less procyclical than private banks in terms of bank lending and Micco and Panizza (2006) that state-owned banks are less responsive to macroeconomic shocks than private banks in terms of bank lending. As such, our results suggest that cross-regional banks play a crucial role in stabilizing overall credit over the business cycle. In fact, cross-regional banks are larger in size and faced with stricter financial regulatory requirements than regional banks. This leads cross-regional banks to be less aggressive in their operation and more stable in their liquidity creation. Meanwhile, cross-regional banks, especially state-owned banks, are more likely to have implicit enhancement from governments and may face more intervention from governments while weakening their procyclicality of liquidity creation. In contrast, regional banks are smaller in size and more flexible in their strategy. They may grant more loans during a boom and shrink their credit supply during a recession. As far as the underlying realistic factors are concerned, we suggest the following: firstly, interest rate marketization and the development of internet finance have increased market competition in financial markets and compressed both deposit market and loan market for smaller banks to some extent. Secondly, due to restrictions of operating area, regional banks tend to increase their allocation of long-term assets during a boom, thereby pushing up their level of liquidity creation. Thirdly, the implementation of China's deposit insurance in 2015 may exacerbate the problem of moral hazard of regional banks and thus intensify their procyclicality of liquidity creation.

The coefficient of $\Delta LC_{t-1}$ is negative and significant at the 1% level in cross-regional banks, indicating that liquidity creation change by cross-regional banks in the previous period is negatively related to that in the current period. We also find that the coefficient of bank size (SIZE) is negative in the full sample and regional group, but only significant at 10% level among the full sample, implying that smaller banks have higher growth rate of liquidity creation. They may allocate more funds to long-term loans confronted with fierce market competition and performance pressure, and thereby push up the level of liquidity creation. However, its coefficient is positive and significant among the cross-regional group. The coefficient of NPL is negative insignificantly in all the regressions, indicating that bank with higher risk have a lower growth in liquidity creation. The coefficient of bank profitability (ROA) is positive insignificantly among the full sample and regional group, but negative among the cross-regional group, which implies that regional banks in China with higher profits generally have higher growth rate of liquidity creation, while cross-regional banks are on the opposite side. As far as monetary policy (MP) is concerned, it has a positive and significant impact on liquidity creation among full sample and regional banks. This implies that Chinese commercial banks have higher level of liquidity creation during the period of expanding monetary policy, especially regional banks.

Overall, our results indicate that the liquidity creation of Chinese commercial banks exhibit significant procyclicality, and the procyclicality is more pronounced among regional banks than cross-regional banks. Thus, H1 is supported.

**Table 5**
Capital regulatory pressure and liquidity creation procyclicality.

| Variables | All | Regional | Cross-regional |
|---|---|---|---|
| $\Delta LC_{t-1}$ | −0.121* (0.0699) | −0.0886 (0.0741) | −0.297*** (0.103) |
| CYCLE | 59.60*** (20.28) | 79.08*** (19.77) | −20.45 (21.12) |
| CAPITAL | 0.0363** (0.0157) | 0.0326** (0.0157) | −0.0495 (0.0380) |
| CYCLE*CAPITAL | −17.16** (7.041) | −14.60* (8.208) | −7.848 (14.13) |
| MP | 0.0551*** (0.0132) | 0.0667*** (0.0120) | 0.00837 (0.0133) |
| NPL | −0.0630 (0.0558) | −0.0608 (0.0579) | −0.143 (0.104) |
| ROA | 0.0103 (0.00851) | 0.0124 (0.00922) | 0.000688 (0.0127) |
| SIZE | −0.158** (0.0727) | −0.171** (0.0836) | −0.0549 (0.0974) |
| Constant | 0.440 (0.471) | 0.325 (0.468) | 0.522 (0.597) |
| Wald | 76.97 (0.0000) | 58.55 (0.0000) | 51.40 (0.0000) |
| AR(2) (p-value) | 0.9764 | 0.8889 | 0.6045 |
| Sargan (p-value) | 0.5746 | 0.5569 | 0.0551 |
| Obs. | 540 | 473 | 67 |
| No. of banks | 146 | 132 | 14 |

Note: The dependent variable is the change in liquidity creation measure based on category. Two-step System GMM regression is employed among full sample and regional group, and one-step System GMM regression is employed among cross-regional group. Wald is the Wald test for the joint significance of all independent variables under the null that all parameters are not statistically different from zero. AR(2) is the Arellano-Bond test for second-order serial correlation under the null that there is no serial two-order correlation. Sargan is to test for the existence of over identification under the null that instruments are overidentified. Robust standard errors in parentheses. *, **, and *** denote statistical significance level at 10%, 5%, and 1% levels, respectively.

### 4.2. Capital regulatory pressure and liquidity creation procyclicality

To examine whether regulatory capital pressure has any impact on Chinese banks' liquidity creation procyclicality, we run regression on Model (2). The results of the Sargan and Arellano-Bond test in the full sample and regional sample show that the instrument variables are valid, and there is no second-order autocorrelation, satisfying the premise of the system GMM model. However, the results of the Sargan test in the cross-regional sample is not sound, possibly due to the relatively small sample size. The *p*-value of the Wald test is 0.0000 in all regressions, rejecting the null that all the coefficients are zero. The regression results of Model (2) are reported in Table 5, including regressions on the full sample, the cross-regional sample and the regional sample.

From the results in Column 1 of Table 5, we can see that the coefficient of interaction between business cycle and capital regulatory pressure is significantly negative among the full sample and the regional sample, but insignificant among the cross-regional group. It implies that capital regulatory pressure faced by Chinese banks from regulatory authorities helps mitigate their procyclicality of liquidity creation, and this effect is more significant for regional banks. During a boom, banks would face a higher level of capital pressure along with their expansion of credit assets and may strive to meet the capital adequacy requirements through shrinking their credit supply. Meanwhile, a low level of capital buffer, namely a higher level of capital pressure, implies that banks are more vulnerable to unexpected losses. And thus, banks may compress on-balance sheet credit and liquidity creation. During the recession time, capital pressure declines, and capital buffer is released. At this time, bank liquidity creation is promoted. From the results above, we find that the implementation of counter-cyclical capital regulation policies is helpful in mitigating the procyclicality of Chinese bank liquidity creation. As such, H2 is supported.

### 4.3. Interbank credit and liquidity creation procyclicality

In this section, we aim to investigate whether interbank credit has any impact on Chinese bank liquidity creation procyclicality by running regression on Model (3) among the full sample and two sub-samples. The results of Arellano-Bond test show that there is no second-order autocorrelation for all the regressions. The results of Sargan test indicate that the instrument variables are valid, except that for the cross-regional sample. The *p*-value of Wald test is 0.0000 in all regressions, rejecting the null that all the coefficients are zero. The regression results are reported in Table 6.

From the results on the full sample in Column 1, we can observe a significantly negative association between the interaction term (CYCLE*LEV) and bank liquidity creation. It indicates that due to interbank credit expansion, bank liquidity creation has decreased during a boom and increased during a recession. During a boom time, banks would engage more in traditional loans in order to earn higher spread yields and thus are less motivated to extend interbank credit business, resulting in a relative decline in overall liquidity creation. During a recession, credit demand from the real economy is likely to decline. At this time, banks tend to extend more interbank credit to strike a good balance between risk and revenue. As such, the decline in the overall liquidity creation by the banking industry would be alleviated due to the interbank credit.

The regression results on two sub-sample reveal that the mitigating effect of interbank credit on procyclicality of bank liquidity creation is significant among regional banks only, and insignificant among cross-regional banks. As far as the cross-regional banks are concerned, most of them are listed banks and have multiple access to external finance. This implies that cross-regional banks can supplement their capital reserve even in face of strict regulatory requirements, and thus capital regulatory pressure has less impact on their procyclicality of liquidity creation. While regional banks have relatively restricted access to new capital and are more aggressive

**Table 6**
Interbank credit and procyclicality of bank liquidity creation.

| Variables | All | Regional | Cross-regional |
|---|---|---|---|
| $\Delta LC_{t-1}$ | −0.111* (0.0616) | −0.0794 (0.0611) | −0.283*** (0.0864) |
| CYCLE | 56.52*** (21.90) | 85.29*** (25.15) | −23.81 (23.72) |
| LEV | 0.00801* (0.00427) | 0.00914* (0.00542) | −0.0107 (0.00687) |
| CYCLE*LEV | −6.003** (3.053) | −8.740** (3.742) | −2.104 (3.826) |
| MP | 0.0599*** (0.0123) | 0.0766*** (0.0144) | 0.00217 (0.0152) |
| NPL | −0.0706 (0.0627) | −0.0493 (0.0567) | −0.163 (0.152) |
| ROA | 0.0102 (0.0109) | 0.0121 (0.0103) | −0.00873 (0.0145) |
| SIZE | −0.127*** (0.0478) | −0.0805 (0.0503) | 0.112 (0.0897) |
| Constant | 0.126 (0.340) | −0.384 (0.395) | −0.246 (0.648) |
| Wald | 56.59 (0.0000) | 51.73 (0.0000) | 162.08 (0.0000) |
| AR(2) (p-value) | 0.8523 | 0.7971 | 0.2026 |
| Sargan (p-value) | 0.3911 | 0.4385 | 0.0061 |
| Observations | 540 | 473 | 67 |
| Number of id | 146 | 132 | 14 |

Note: The dependent variable is the change in liquidity creation measure based on category. Two-step System GMM regression is employed among full sample and regional group, and one-step System GMM regression is employed among cross-regional group. All variables follow Table 2 definitions. Wald is the Wald test for the joint significance of all independent variables under the null that all parameters are not statistically different from zero. AR(2) is the Arellano-Bond test for second-order serial correlation under the null that there is lack of serial two-order correlation. Sargan is to test for the existence of over identification under the null that instruments are overidentified. Robust standard errors in parentheses. *, **, and *** denote statistical significance level at 10%, 5%, and 1% levels, respectively.

**Table 7**
Robustness analysis: alternative measure of liquidity creation.

| Variables | Model (1) | | | Model (2) | | | Model (3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | Regional | Cross-regional | All | Regional | Cross-regional | All | Regional | Cross-regional |
| $LCTA_{t-1}$ | 0.707*** (0.0724) | 0.696*** (0.0690) | 0.437*** (0.115) | 0.723*** (0.0713) | 0.686*** (0.0893) | 0.303* (0.167) | 0.699*** (0.0728) | 0.671*** (0.0753) | 0.445*** (0.107) |
| $LCTA_{t-2}$ | 0.00625 (0.0856) | 0.0127 (0.0797) | 0.216 (0.147) | 0.0399 (0.0776) | 0.0272 (0.0818) | 0.294* (0.167) | 0.0185 (0.0962) | 0.0360 (0.0931) | 0.278 (0.175) |
| CYCLE | 13.95*** (5.040) | 20.49*** (5.647) | −1.391 (5.884) | 19.47*** (6.111) | 22.18*** (5.812) | −2.655 (5.837) | 15.12*** (5.414) | 20.10*** (5.846) | −2.358 (5.314) |
| CAPITAL | | | | 0.00556 (0.0041) | 0.00656* (0.0037) | −0.0272** (0.0111) | | | |
| CYCLE*CAPITAL | | | | −4.676** (2.152) | −3.804* (2.275) | −2.836 (3.185) | | | |
| LEV | | | | | | | 0.00139 (0.0014) | 0.00194 (0.0013) | −0.00301 (0.0021) |
| CYCLE*LEV | | | | | | | −0.782 (0.990) | −0.985 (0.955) | −0.249 (0.778) |
| MP | 0.0131*** (0.00314) | 0.0170*** (0.00396) | −0.000399 (0.00438) | 0.0151*** (0.00366) | 0.0161*** (0.00438) | −0.000202 (0.00407) | 0.0142*** (0.00362) | 0.0170*** (0.00395) | −0.00179 (0.00466) |
| NPL | −0.00325 (0.0105) | 0.00206 (0.00929) | −0.0416 (0.0337) | −0.00132 (0.0130) | 0.00188 (0.0113) | −0.00976 (0.0277) | −0.00714 (0.00915) | 8.54e-05 (0.00907) | −0.0363 (0.0414) |
| ROA | 0.000198 (0.00200) | 0.00122 (0.00216) | −0.000537 (0.00420) | 0.00117 (0.00240) | 0.00167 (0.00219) | 0.00387 (0.00372) | 0.000166 (0.00187) | 0.00129 (0.00214) | −0.00109 (0.00406) |
| SIZE | 0.0101 (0.0149) | −0.00614 (0.0356) | 0.0219 (0.0203) | −0.00034 (0.0144) | −0.0303 (0.0298) | −0.0738* (0.0379) | 0.00271 (0.0119) | −0.0171 (0.0190) | 0.0331 (0.0233) |
| Constant | −0.122 (0.0906) | −0.0997 (0.202) | 0.0475 (0.210) | −0.103 (0.0945) | 0.0470 (0.189) | 0.549** (0.278) | −0.0923 (0.0722) | −0.0445 (0.118) | −0.0296 (0.225) |
| Wald | 190.02 (0.0000) | 182.05 (0.0000) | 106.11 (0.0000) | 223.94 (0.0000) | 145.99 (0.0000) | 226.39 (0.0000) | 197.42 (0.0000) | 164.40 (0.0000) | 246.88 (0.0000) |
| AR(2) (p-value) | 0.9458 | 0.9686 | 0.3826 | 0.9503 | 0.9488 | 0.9351 | 0.9638 | 0.8991 | 0.1824 |
| Sargan (p-value) | 0.1622 | 0.3948 | 0.0169 | 0.3060 | 0.5376 | 0.1808 | 0.3238 | 0.5331 | 0.0252 |
| Obs. | 540 | 473 | 67 | 540 | 473 | 67 | 540 | 473 | 67 |
| No. of banks | 146 | 132 | 14 | 146 | 132 | 14 | 146 | 132 | 14 |

Note: The dependent variable is the ratio of liquidity creation to total bank assets. Two-step System GMM regression is employed among full sample and regional group, and one-step System GMM regression is employed among cross-regional group. All variables follow Table 2 definitions. Wald is the Wald test for the joint significance of all independent variables under the null that all parameters are not statistically different from zero. AR(2) is the Arellano-Bond test for second-order serial correlation under the null that there is lack of serial two-order correlation. Sargan is to test for the existence of over identification under the null that instruments are overidentified. Robust standard errors in parentheses. *, **, and *** denote statistical significance level at 10%, 5%, and 1% levels, respectively.

**Table 8**
Robustness analysis: fixed-effect regressions.

| Variables | Model (1) | | | Model (2) | | | Model (3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | Regional | Cross-regional | All | Regional | Cross-regional | All | Regional | Cross-regional |
| CYCLE | 79.33*** (26.80) | 91.17*** (30.02) | −8.030 (36.63) | 54.92* (28.46) | 63.91* (32.66) | −0.0737 (45.27) | 83.67*** (27.33) | 94.91*** (30.46) | −10.34 (31.82) |
| CAPITAL | | | | 0.00620 (0.0102) | 0.0103 (0.0106) | −0.0523 (0.0437) | | | |
| CYCLE*CAPITAL | | | | −14.03** (7.075) | −14.62* (7.866) | 2.267 (10.53) | | | |
| LEV | | | | | | | 0.00135 (0.00514) | 0.00169 (0.00559) | −0.0108 (0.00726) |
| CYCLE*LEV | | | | | | | −4.463** (2.146) | −4.663** (2.291) | −1.199 (4.511) |
| MP | 0.0608*** 0.0163) | 0.0707*** (0.0184) | 0.00454 (0.0177) | 0.0663*** (0.0170) | 0.0755*** (0.0191) | 0.0115 (0.0178) | 0.0624*** (0.0165) | 0.0721*** (0.0186) | 0.00566 (0.0172) |
| L.NPL | −0.0294 (0.0405) | −0.0306 (0.0412) | −0.215 (0.153) | −0.0244 (0.0418) | −0.0256 (0.0427) | −0.195 (0.145) | −0.0304 (0.0404) | −0.0317 (0.0411) | −0.199 (0.162) |
| L.ROA | −0.0131*** (0.00487) | −0.0126** (0.00505) | −0.0279 (0.0169) | −0.0129*** (0.00489) | −0.0120** (0.00510) | −0.0258 (0.0163) | −0.0133*** (0.00487) | −0.0128** (0.00498) | −0.0303* (0.0146) |
| L.SIZE | −0.794*** (0.144) | −0.784*** (0.153) | −0.289 (0.524) | −0.816*** (0.143) | −0.800*** (0.153) | −0.588 (0.511) | −0.792*** (0.146) | −0.781*** (0.156) | −0.197 (0.558) |
| Constant | 3.950*** (0.803) | 3.636*** (0.834) | 2.753 (3.566) | 4.017*** (0.805) | 3.679*** (0.840) | 4.541 (3.511) | 3.923*** (0.813) | 3.607*** (0.849) | 2.173 (3.726) |
| Obs. | 666 | 585 | 81 | 666 | 585 | 81 | 666 | 585 | 81 |
| R-squared | 0.135 | 0.141 | 0.146 | 0.144 | 0.151 | 0.191 | 0.139 | 0.145 | 0.171 |
| No. of banks | 147 | 133 | 14 | 147 | 133 | 14 | 147 | 133 | 14 |

Note: The dependent variable is the change in liquidity creation measure based on category. OLS with fixed effects regression is employed. All variables follow Table 2 definitions. L. means the one-year lagged value of bank-level characteristics. Robust standard errors in parentheses. *, **, and *** denote statistical significance level at 10%, 5%, and 1% levels, respectively.

**Table 9**
Robustness analysis: dropping the observations in 2012.

| Variables | Model (1) | | | Model (2) | | | Model (3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | Regional | Cross-regional | All | Regional | Cross-regional | All | Regional | Cross-regional |
| $\Delta LC_{t-1}$ | −0.104 (0.0657) | −0.0611 (0.0637) | −0.288*** (0.0958) | −0.121* (0.0699) | −0.0886 (0.0741) | −0.297*** (0.103) | −0.111* (0.0616) | −0.0794 (0.0611) | −0.283*** (0.0864) |
| CYCLE | 48.78** (20.75) | 74.71*** (18.35) | −25.86 (22.84) | 59.60*** (20.28) | 79.08*** (19.77) | −20.45 (21.12) | 56.52*** (21.90) | 85.29*** (25.15) | −23.81 (23.72) |
| CAPITAL | | | | 0.0363** (0.0157) | 0.0326** (0.0157) | −0.0495 (0.0380) | | | |
| CYCLE*CAPITAL | | | | −17.16** (7.041) | −14.60* (8.208) | −7.848 (14.13) | | | |
| LEV | | | | | | | 0.00801* (0.00427) | 0.00914* (0.00542) | −0.0107 (0.00687) |
| CYCLE*LEV | | | | | | | −6.003** (3.053) | −8.740** (3.742) | −2.104 (3.826) |
| MP | 0.0559*** (0.0118) | 0.0710*** (0.0116) | 0.00480 (0.0140) | 0.0551*** (0.0132) | 0.0667*** (0.0120) | 0.00837 (0.0133) | 0.0599*** (0.0123) | 0.0766*** (0.0144) | 0.00217 (0.0152) |
| NPL | −0.0631 (0.0750) | −0.0314 (0.0745) | −0.196 (0.135) | −0.0630 (0.0558) | −0.0608 (0.0579) | −0.143 (0.104) | −0.0706 (0.0627) | −0.0493 (0.0567) | −0.163 (0.152) |
| ROA | 0.00872 (0.0117) | 0.0135 (0.00993) | −0.00631 (0.0146) | 0.0103 (0.00851) | 0.0124 (0.00922) | 0.000688 (0.0127) | 0.0102 (0.0109) | 0.0121 (0.0103) | −0.00873 (0.0145) |
| SIZE | −0.146** (0.0722) | −0.114 (0.0964) | 0.147** (0.0574) | −0.158** (0.0727) | −0.171** (0.0836) | −0.0549 (0.0974) | −0.127*** (0.0478) | −0.0805 (0.0503) | 0.112 (0.0897) |
| Constant | 0.294 (0.488) | −0.179 (0.587) | −0.531 (0.488) | 0.440 (0.471) | 0.325 (0.468) | 0.522 (0.597) | 0.126 (0.340) | −0.384 (0.395) | −0.246 (0.648) |
| Wald | 56.56 (0.0000) | 43.80 (0.0000) | 90.39 (0.0000) | 76.97 (0.0000) | 58.55 (0.0000) | 51.40 (0.0000) | 56.59 (0.0000) | 51.73 (0.0000) | 162.08 (0.0000) |
| AR(2) (p-value) | 0.9277 | 0.8602 | 0.3844 | 0.9764 | 0.8889 | 0.6045 | 0.8523 | 0.7971 | 0.2026 |
| Sargan (p-value) | 0.4852 | 0.5336 | 0.0026 | 0.5746 | 0.5569 | 0.0551 | 0.3911 | 0.4385 | 0.0061 |
| Obs. | 540 | 473 | 67 | 540 | 473 | 67 | 540 | 473 | 67 |
| No. of banks | 146 | 132 | 14 | 146 | 132 | 14 | 146 | 132 | 14 |

Note: The dependent variable is the change in liquidity creation measure based on category. Two-step System GMM regression is employed among full sample and regional group, and one-step System GMM regression is employed among cross-regional group. All variables follow Table 2 definitions. Wald is the Wald test for the joint significance of all independent variables under the null that all parameters are not statistically different from zero. AR(2) is the Arellano-Bond test for second-order serial correlation under the null that there is lack of serial two-order correlation. Sargan is to test for the existence of over identification under the null that instruments are overidentified. Robust standard errors in parentheses. *, **, and *** denote statistical significance level at 10%, 5%, and 1% levels, respectively.

in their operating strategy. For regional banks that are confronted with relatively weaker ability in raising new capital and fierce market competition, they are more likely to engage more in interbank credit to alleviate capital regulatory pressure and improve their profitability. However, the motivation of profit-pursuing and alleviating capital regulatory pressure is much weaker among cross-regional banks, due to their large customer base, stable profitability and higher levels of capital adequacy even during a recession. As such, due to bank heterogeneity in terms of different abilities of raising new capital and risk preferences, the mitigating effect of interbank credit is more significant among regional banks. As such, H3 is supported.

### *4.4. Robustness tests*

Firstly, it can be argued that our results are affected by bank size when measuring liquidity creation. We proxy liquidity creation by the ratio of liquidity creation to total bank assets (LCTA) and also consider the two-year lagged liquidity creation indicator for robustness check. The results are reported in Table 7. As indicated, the coefficients of business cycle in the full sample as well as regional sample in Model (1) are positive and significant, indicating that the procyclicality of bank liquidity creation still exists among our sample. But this procyclicality is insignificant among cross-regional banks. The results of Model (2) show that the coefficients of the interaction between business cycle and regulatory capital pressure is significantly negative for the full sample and regional sample, implying that the mitigating effect of capital regulatory pressure is significant. The results of Model (3) show that the coefficient of interaction between business cycle and interbank credit is negative but not significant. This indicates that our main conclusions still hold.

Secondly, a static panel model is employed for robustness. Based on the results of the F statistics and Hausman (1978) specification test, we use a fixed-effect model to run regressions on all the models. Following Berger and Bouwman (2009) and Bertay et al. (2015), one-year lagged bank-level characteristics are incorporated to control for reverse causality. The results are reported in Table 8. As can be observed, the coefficient of business cycle is positive and significant among the full sample and regional sample, which is consistent with our previous conclusion. Furthermore, the interaction term of business cycle and capital pressure in Model (2) and that of business cycle and interbank credit are negative significantly among the full sample as well as the regional sample. All of these provide supportive evidence for our main conclusions.

Finally, the *Rules 2012* has been implemented since 2013. In order to avoid the influence of the sample period on our analysis, we re-run all the models by dropping the observations in 2012. The results are reported in Table 9. It can be observed that our main conclusions are still robust. Specifically, the procyclicality of liquidity creation is significant among the full sample and the regional sample. And the mitigating effect of capital regulatory pressure and interbank credit are both significant.

## 5. Conclusions

Based on the unbalanced panel data of Chinese commercial banks during the period of 2012–2018, we empirically explored whether bank liquidity creation is procyclical in China, as well as the mitigating effect of capital regulatory pressure and interbank credit. A series of robustness tests are conducted to ensure the reliability of our findings. We have the following conclusions.

First, the liquidity creation of Chinese commercial banks exhibits significant procyclicality. Further analysis on sub-sample indicates that the liquidity creation procyclicality of regional banks are more pronounced than that of cross-regional banks. This may be linked to the fact that regional banks of a smaller size face fiercer market competition and more pressure on profitability especially along with the implementation of interest rate liberalization reform and deposit insurance scheme in China.

Second, the implementation of countercyclical capital buffers helps mitigate the procyclicality of bank liquidity creation in China and thus reduces systemic risk in the financial system. This mitigating effect is significant among regional banks instead of cross-regional banks, given the difference in their capability of raising new capital, market position and risk preference. This provides empirical evidence for the implementation of countercyclical capital regulation.

Third, interbank credit also helps mitigate the procyclicality of bank liquidity creation in China. Motivated by profit-seeking incentives and circumventing regulation, Chinese banks engage more in interbank credit when traditional credit demand declines and engage less when the traditional credit demand increases. Specifically, interbank credit mitigates the decline of bank liquidity creation during periods of economic downturn, and banks will grant more loans to the real economy instead of interbank credit during an economic upturn.

The Basel Accord has been the global guidelines of bank supervision for decades and China joined the Basel Committee in 2009. As a committee member, China has soon adapted to the latest guidelines though obviously not all banks or all countries are capable of following all the requirements. Compared to developed countries, the indirect finance in China takes a great proportion of the financial market. This study provides insights for commercial banks, regulators and policymakers in other emerging markets where banking plays an important role in the country's economic development.

For banks, we suggest that they actively carry out light capital consumption business like intermediate business. This not only helps reduce the pressure of capital supervision, but also promote the formation of a diversified business structure. And more importantly, bank managers may pay attention to the countercyclical capital buffer as initiated by Basel III and the establishment of a scientific credit risk management system to enhance their operational stability. For regulatory authorities, we suggest that they improve the countercyclical capital supervision in China under the framework of Basel III and flexibly use various capital supervision tools, such as implementing differentiated capital supervision on different types of banks on the premise of not damaging the ability of regional banks to serve local economic development. For policymakers, we suggest that they scrutinize both sides of the interbank credit. On the one hand, the expansion of interbank credit may lead to the problem of shifting from real to virtual and increase the systemic risk of the

whole banking system. On the other hand, as our results indicated, interbank credit is helpful in mitigating the procyclicality of bank liquidity creation. As such, a sound trade-off between these two sides needs to be achieved.

Due to lack of data on off-balance sheet accounts in the database, we only consider on-balance sheet business and are unable to explore the procyclicality of off-balance sheet accounts among Chinese banks. In fact, this limitation opens a further area of investigation: to explore whether there exists a procyclicality of off-balance sheet liquidity creation, or the overall liquidity creation including both on-balance sheet accounts and off-balance sheet accounts. More specifically, how the cyclicality of on-balance sheet accounts and that of off-balance sheet accounts interact with each other also remains an interesting proposition for future research. An additional area of research is to explore whether market competition exerts an impact on the procyclicality of bank liquidity creation along with the implementation of financial liberalization policy in China.

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