Interest Rate Liberalization and Bank Liquidity Creation：Evidence from China

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Abstract

Based on the panel data of 145 banks in China over 1997-2015, this paper empirically studies the relationship between interest rate liberalization and bank liquidity creation. The results show that there is a nonlinear relationship between interest rate liberalization and bank liquidity creation. With the improvement of interest rate liberalization, bank liquidity creation increases first and then decreases. This conclusion is robust after overcoming endogeneity problem, changing the proxy variable, and considering the influence of bank heterogeneity. Further, we investigate the influencing mechanism based on the mediating effect tests, and find that the interest rate liberalization affects bank liquidity creation through bank risk taking. This paper provides some enlightenment for China to further promote interest rate liberalization reforms.

Key words: Interest Rate Liberalization; Bank Liquidity Creation; Bank Risk Taking

JEL Codes: G18; G21

1. Introduction

Interest rate liberalization is one of the important contents of financial reform in China. China's interest rate liberalization began in 1996, and the regulation of deposit and loan rates were all cancelled in 2015, thus the reform of the interest rate liberalization had made substantial progress. The interest rate liberalization has a wide and far-reaching impact on the whole economic and financial system. Under the current financial structure in China, the banking system is no doubt the most affected by interest rate liberalization. Therefore, an immense number of literatures have discussed the effect of interest rate liberalization on banks, but most focus on bank loan pricing, bank spreads and risk. There is little literature to explore the influence of interest rate liberalization on bank liquidity creation. Liquidity creation is one of the two core functions of banks (Diamond, 1984; Berger and Bouwman, 2009), which means banks can provide liquidity to the economic system by playing the role of financial intermediaries. On the one hand, bank liquidity creation is closely related to the economic output. Bank liquidity creation on the asset side of bank balance sheet provides the credit for the real economy, thereby promoting economic growth. Bank liquidity creation on the liability side not only help consumers with the intertemporal consumption smoothing, but also makes the payment activities more convenient so as to reduce the friction in economic activities. Bank liquidity creation off the balance sheet also plays an important role in supporting economic growth, for instance, through loan commitments. The influence of bank liquidity creation off balance sheet is increasing in China. On the other hand, bank liquidity creation also has an impact on financial stability. From the perspective of micro prudential, excessive bank liquidity creation may lead to liquidity risk of individual institutions (Fungáčová et al., 2013). From the perspective of macro prudential, excessive bank liquidity creation may also result in asset price bubbles, or even financial crises (Acharya and Naqvi, 2012; Berger and Sedunov, 2015).

The effect of bank liquidity creation on economic growth and financial stability has been paid more and more attention. However, there is no literature exploring the impact of interest rate liberalization on bank liquidity creation, especially in China. This paper may be the first to study the relationship between interest rate liberalization and bank liquidity creation in China. Specifically, this paper attempts to answer the following questions: does the interest rate liberalization in China affect bank liquidity creation? If so, what is the possible mechanism of this

effect?

The remainder of the paper is organized as follows. Section 2 is the related theories and the literature review. Section 3 is econometric model specification. Section 4 is data and sample description, display and analysis of empirical results, as well as the robustness test. Section 5 analyzes the mechanism of the impact of interest rate liberalization on bank liquidity creation. Section 6 concludes and provides policy implications.

2. Literature Review

2.1 Research on bank liquidity creation

Bank is one of the most important financial intermediaries in modern financial system, whose function of liquidity creation has always been the concern. The early literature focuses on the theoretical research. Liquidity creation refers to the fact that banks provide illiquid loans to borrowers while giving depositors the ability to withdraw funds at par value at a moment's notice (Bryant, 1980; Diamond and Dybvig, 1983). In other words, the process of bank liquidity creation is one of converting illiquid assets into liquid liabilities. Other research shows that banks can increase or reduce liquidity creation only by changing the funding structure on liability side(Diamond and Rajan, 2001; Gorton and Winton, 2000). Bank capital will also affect the composition of its portfolio, so banks can also affect the liquidity creation by changing the structure of its assets(Thakor, 1996). The above research shows that banks can create liquidity on the balance sheet. At the same time, some literature suggests that banks can also create liquidity off the balance sheet. Banks not only face liquidity needs of depositors, it is also facing needs of customers who purchase a loan commitment. The role of a loan commitment in liquidity creation lies in that, when there is the presence of credit rationing on the spot credit market, a commitment can give a borrower access to future liquidity as if they have bought an insurance policy(Kashyap et al., 2002). Due to the lack of measurement of bank liquidity creation, the relevant empirical research has not been advancing until Berger and Bouwman (2009) presents a comprehensive method to measure bank liquidity creation. Based on this method, empirical literature on the topic of the bank liquidity creation begins to emerge.

The importance of bank liquidity creation is mainly reflected in two aspects. First, bank liquidity creation can promote economic growth. The positive impact of bank liquidity creation on

economic output has been supported by evidence from different countries. Berger and Sedunov (2015) studied the relationship between bank liquidity creation and the real economic output in the United States, finding that bank liquidity creation could significantly promote the growth of economic output, and this relationship is widely existed in various industries, especially in industries considered to be more bank-dependent. Fidrmuc et al. (2015) studied the impact of bank liquidity creation on economic growth in Russia over 2004-2012. The results showed that bank liquidity creation promoted Russian economic growth, and this effect remains during the financial crisis. Secondly, bank liquidity has an impact on financial stability. The empirical literature showed that, the impact of bank liquidity creation on financial stability is also significant. Fungáčová et al. (2013) showed that excessive bank liquidity creation significantly improved the possibility of bank's bankruptcy. Horváth et al. (2014) showed that there is a trade-off between financial stability and liquidity creation.

The importance of bank liquidity creation has reached a consensus. On this basis, the literature began to explore the factors that influence bank liquidity creation, especially factors on the macro level. Berger and Bouwman (2017) analyzed the impact of monetary policy on the total bank liquidity creation in the United States. Using the data from 1984 to 2008, they examined the effect of monetary policy on bank liquidity creation during normal times and financial crisis. The results showed that monetary policy affects liquidity creation only for small banks during normal times, and the effect of monetary policy during the financial crisis is weaker than that during normal times. Chatterjee's study (2015) showed that monetary policy has a stronger impact on the liquidity creation of small banks than that of big banks. Rauch et al. (2011) studied the factors influencing bank liquidity creation based on the sample of the German savings bank. They compared the impact of macro factors such as monetary policy, unemployment with bank level factors such as bank size, financial performance on bank liquidity creation, and found that the impact of monetary policy on bank liquidity creation is significant, while the bank level factors have little impact.

In China, the research on bank liquidity creation started late, and the results are still not abundant. The literature focused on the impact of monetary policy on bank liquidity creation (Li et al., 2014; Wang and Wang, 2016), the effect of the financial system on bank liquidity creation (Li and Chang, 2015), and the relationship between bank capital and bank liquidity creation (Xie,

2016).

2.2 Research on the impact of interest rate liberalization on banks

Generally, interest rate liberalization is regarded as a dimension of financial liberalization in developed countries, and the corresponding research is incorporated into the general framework of financial liberalization. In contrast, the discussion of the interest rate liberalization in China is more abundant and comprehensive.

The impact of interest rate liberalization on banks has been mainly studied in two aspects. One is to study the impact of interest rate liberalization on bank loan pricing and spreads. The other is to study the impact of interest rate liberalization on bank risk.

First, on the impact of interest rate liberalization on bank loan pricing and spreads, Feyzioglu et al. (2009) discussed the impact of interest rate liberalization on bank lending rates through building a banking monopoly competition model. In the model, interest rate on both deposits and loans exist are regulated. Interbank market lending rate is controlled by the central bank. Interest rate liberalization leads to the rise of interbank lending rate, which further results in the rise of loan interest rate. However, the above conclusions have not been agreed by others. Porter and Xu (2013) showed that the cancellation of deposit rate will lead to the decline of interbank lending rate. He and Wang (2014) pointed out that the effect of loosening deposit rate on loan rate is uncertain, depending on the competition between banks and the degree of capital account openness. Ji, et al. (2015) set up a two track interest rate model, and studied the equilibrium with the upper limit of the deposit interest rate by means of parameter calibration and nonlinear optimization. The study showed that the loosening of the upper limit significantly increased the deposit rate and significantly reduced the loan rate. Li (2015) analyzed the impact of interest rate liberalization on bank spreads based on data of more than 20 countries and regions and showed that after the interest rate liberalization had finished, deposit and loan rates and real interest rates of most countries rise but not necessarily narrow the nominal spread, net interest margin may even further expand. Peng (2016) studied the impact of interest rate liberalization on bank net interest margin based on panel data of 45 commercial banks in China from 2003 to 2014, and found that the interest rate liberalization has a nonlinear effect on bank net interest margin. With the promotion of interest rate liberalization, bank net interest margin first increased and then decreased.

Secondly, on the impact of interest rates liberalization on bank risk, Diaz-Alejandro (1984)

studied the process of financial liberalization in Latin American countries and the financial crisis along with it , and showed that financial liberalization might cause moral hazard of banks, and even lead to banking crisis. Based on panel data of cross countries, some literature found that there is a positive correlation between the financial liberalization and banking crisis (Demirguc-Kunt and Detragiache, 1998; Ranciere, 2006; Yin and Bian, 2016; Wang, 2016). While others showed that the correlation between financial liberalization and bank crisis was not significant (Daniel and Jones, 2007; Shehzad and Haan, 2008; Angkinand, et al., 2010). Zhang (2012) specify the year dummy variable of 2004 as the proxy variable of interest rate liberalization, and studied bank risk behavior under the background of interest rate liberalization based on data of 14 banks from 1998 to 2010. The empirical results showed that the influence of interest rate liberalization on bank credit risk is not significant, but might enhance the bank's business risk.

To sum up, the existing literature has reached a consensus on the role and impact of bank liquidity creation, and began to explore the factors that influence bank liquidity creation. However, there is no literature about the impact of interest rate liberalization on bank liquidity creation. China's interest rate liberalization has experienced a process of steady development and has almost finished by year of 2015. As an important step of financial reform, interest rate liberalization has an impact on the whole financial system that cannot be ignored, especially for the banking system. The current research on the interest rate liberalization, however, mainly focuses on bank loan pricing, bank spreads and bank risk. There is little literature discussing the relationship between interest rates liberalization and bank liquidity creation. In order to deepen the research on the basis of the existing literature, this paper empirically studies the relationship between interest rates liberalization and bank liquidity creation based on the panel data of 145 banks in China from 1997 to 2015, using the FGLS method, and analyzes the mechanism of interest rates liberalization affecting bank liquidity creation.

3. Research Design

3.1 Model Construction

The literature has indicated that China’s interest rate liberalization may have a nonlinear effect on the banks (Peng et al., 2016), so in order to capture the nonlinear impact of interest rate liberalization on bank liquidity creation, we introduce the square of interest rate liberalization, and

set up the regression model as follows:

$$LC_{it} = \alpha_0 + \alpha_1 IRL_{it}^2 + \alpha_2 IRL_{it} + X_{it}\delta + u_i + e_{it} \quad (1)$$

where LC is bank liquidity creation, and IRL is the index of China's interest rate liberalization. X is the vector of control variable, and u captures the individual effect that does not vary with time, and e represents the residual item. The sign of α_1, the parameter to be estimated can depict the nonlinear relationship between the interest rate liberalization and bank liquidity creation. Specifically, if α_1 is positive, there is a U shape relationship between interest rate liberalization and bank liquidity creation. Otherwise, if α_1 is negative, then there is an inverted U - shaped relationship between them.

3.2 Variables Description

3.2.1 The Dependent Variable: Bank Liquidity Creation

Berger and Bouwman (2009) proposed the first comprehensive measure of bank liquidity creation. The bank liquidity creation they measured is the weighted sum of all the items on and off bank's balance sheet, where the weights are based on category or maturity. When banks transform illiquid assets into liquid liabilities, the liquidity was created, so positive weights are given to both illiquid assets and liquid liabilities. Similarly, when banks transform liquid assets into illiquid liabilities or equity, negative weights are given to both liquid assets and illiquid liabilities or equity. Off-balance sheet items are assigned weights in a way consistent with that assigned to functionally similar on-balance sheet items.

Specifically, Berger and Bouwman (2009) use a three-step procedure to construct the measure of bank liquidity creation. First, they classify all the items on and off bank's balance sheet as liquid, semiliquid, or illiquid, based on the ease, cost, and time to liquidate. Secondly, they assign weights to the items classified in the first step: illiquid assets and liquid liabilities are weighted 0.5, liquid assets and illiquid liabilities plus equity are weighted -0.5, all the semiliquid items are weighted 0. Thirdly, they calculate the weighted sun according to the results of the first and the second steps, so as to construct the measure of bank liquidity creation.

Based on the above three steps, Berger and Bouwman (2009) calculate 4 measures of bank liquidity creation: CATFAT, CATNONFAT, MATFAT, MATNONFAT. Here we calculate China's bank liquidity creation based on the CATFAT measure. The specific formula is as follows:

Bank liquidity creation=0.5*Σ(illiquid assets+liquid liabilities+illiquid off-balance sheet

items) + 0*Σ(semiliquid assets+ semiliquid liabilities + semiliquid off-balance sheet items) - 0.5*Σ(liquid assets+illiquid liabilities+liquid off-balance sheet items)

Considering the particularity of China financial structure and financial system, we follow the practice of Zhou and Chen (2013) and Li (2014) when classifying the items on and off bank's balance sheet as liquid, semiliquid, and illiquid. The specific results of classification and weighting are shown in Table 1.

Table 1 –Liquidity classification of bank activities and construction of liquidity creation measure.

Assets					
Illiquid assets		Semiliquid assets		Liquid assets	
Net loans[1]	Loans and Advances to Banks			Cash and Due From Banks	Trading Securities and at FV through Income
At-equity Investments in Associates	Investments in Property			Derivatives	Available for Sale Securities
Foreclosed Real Estate	Deferred Tax Assets and Current Tax Assets			Held to Maturity Securities	Other Securities
Goodwill	Other Intangibles				
Fixed Assets	Other Assets				
Liabilities plus equity					
Illiquid liabilities plus equity		Semiliquid liabilities		Liquid liabilities	
Senior Debt Maturing after 1 Year	Subordinated Borrowing	Customer Deposits - Term	Other Deposits and Short-Term Borrowings	Customer Deposits - Current	Deposits from Banks
Deferred Tax Liabilities and Current Tax Liabilities	Other Liabilities	Customer Deposits - Savings	Other Funding	Derivatives	Trading Liabilities
Common Equity Revaluation Reserves	Non-controlling Interest				

[1] Net loans= Residential Mortgage Loans+ Other Mortgage Loans+ Other Consumer/Retail Loans+ Corporate & Commercial Loans+ Other Loans- Reserves for Impaired Loans.

Off-balance sheet activities		
Illiquid business	Semiliquid business	Liquid business
Acceptances and Documentary Credits Reported Off-Balance Sheet	Managed Securitized Assets Reported Off-Balance Sheet	
Committed Credit Lines	Other Off-Balance Sheet Exposure to Securitizations	
Other Contingent Liabilities	Guarantees	

Bank liquidity creation is measured with the above method, and then divided by the total assets as the dependent variable LC of the model (1).

3.2.2 The Key Independent Variable: Interest Rate Liberalization

Interest rate liberalization is the key independent variable of this paper. On the measurement of the interest rate liberalization, the literature has not yet reached the consensus. Zhang et al. (2012) used the time dummy variable, taking the year of 2004 as the critical year of China's interest rate liberalization. Zhang and Liang (2010) took the parameter multiplied by the benchmark rate of bank loan as the measure of interest rate liberalization. Considering that China's interest rate liberalization reform is a progressive process, the measurement indicators used in the literature cannot reflect the dynamic change characteristics of China's interest rate liberalization. In order to solve the problems and better reflect the process and extent of China's interest rate liberalization, Wang and Peng (2014) constructed an index of interest rate liberalization based on an index system. The index system consists of indicators on the four levels: deposit and loan interest rates, money market interest rates, the bond market interest rates and financial products yield rates. The indicators can be divided into 12 more detailed indicators, as shown in table 2.

First, they give scores that drop in [0,1] to each indicator based on the degree of the liberalization of each interest rate, then determine the weight using the Analytic Hierarchy Process methodology. At last, they take the weighted sum of the indicators as the index of China’s interest rate liberalization. The index comprehensively considers the degree of interest rate liberalization in different financial markets, and has been widely accepted and used by Chinese scholars. On the basis of Wang and Peng (2014), we extend the interest rate liberalization index to 2015 as our key independent variable IRL in model (1).

Table 2 –Measurement of interest rate liberalization

Index	Indicator of Level1	Indicator of Level 2
Interest Rate Liberalization	Deposit and loan interest rate	RMB loan interest rate
		RMB deposit interest rate
		Foreign currency loan interest rate
		Foreign currency deposit interest rate
	Money market interest rate	Interbank lending rate
		Discount rate of bill
	Bond market interest rate	Bond issue interest rate
		Bond repo interest rate
		Coupons trading interest rates
	Financial product yield rate	Bank financial products yield rate
		Monetary fund yield rate
		Trust product yield rate

The measurement of interest rate liberalization is also studied by Abiad et al. (2008). They constructed a new database of financial reforms for 91 economies including China over 1973-2005, which divides the level of an economy's interest rate liberalization into 4 kinds, namely the Fully Liberalized, Largely Liberalized, Partially Repressed, Fully Repressed, and with value of 3, 2, 1 and 0 respectively. According to Abiad et al. (2008), we update China's interest rate liberalization data to 2015, and use this index as an alternative measure for interest rate liberalization (IRL_ALTER), which is used for robustness test.

3.2.3 Control Variables

Referring to Berger and Bouwman (2009) and Li (2014), we introduce the following control variables:

ASSET: the natural logarithm of bank assets. The scale of bank assets can reflect the ability of bank liquidity creation to some extent.

ROA: return on assets .Higher return on assets can motivate banks to make more aggressive mismatches and create more liquidity.

EFFICIENCY: operation efficiency, the ratio of bank operation cost to total income. It is generally indicated in the literature that bank operation efficiency will also affect liquidity creation.

LEVERAGE: the ratio of equity to total assets. The higher is the ratio of equity to the total

assets, the lower the leverage ratio of the bank is.

GDP: the annual growth rate of GDP. It is used to control for the macro factors.

4. Empirical Results

4.1 Data And Sample

Our sample is from the Bankscope database, where we get the unbalanced panel data for 183 commercial banks in China over 1997-2015. After eliminating the banks whose observations are less than two years, we eventually have a sample of 145 banks, consisting of 970 observations, including 5 large state-owned commercial banks, 1 postal savings bank, 12 national joint-stock commercial banks, 92 city commercial banks, and 35 rural commercial banks.

4.2 Statistical Description

In order to reduce the influence of abnormal values, we winsorize all the variables at 1% and 99% quantile. Table 3 shows the Statistical Description results of the variables.

Table 3 –Statistical Description

Variable	Mean	Std.Err	Min	Max
LC	0.411	0.171	-0.012	0.820
IRL	0.749	0.167	0.209	1.000
IRL_ALTER	2.409	0.678	0.000	3.000
ASSET	18.545	1.814	14.430	23.402
ROA	0.014	0.006	-0.003	0.031
EFFICIENT	38.459	11.738	18.109	115.660
LEVERAGE	0.068	0.028	0.018	0.420
GDP	9.036	1.945	6.900	14.200

As can be seen from table 3, the average value of bank liquidity creation in the sample is 0.411, indicating that the bank's 1 yuan of assets can create 0.411 yuan of liquidity. The statistics of other variables reflect the banks' differences in scale, profitability, operating efficiency, leverage ratio and so on.

4.3 Regression Results

Considering that there may be correlations between banks, we carry out the cross-sectional heteroscedasticity test, autocorrelation and cross-sectional correlation test. Likelihood ratio (LR) test and Wooldridge test both reject the null hypothesis, and show that there exist cross-sectional heteroscedasticity and first order autocorrelation. Therefore, we regress the model with the comprehensive feasible generalized least squares (FGLS) estimates.

Table 4 –Benchmark regression results

	(1)	(2)	(3)	(4)
	LC	LC	LC	LC
IRL^2	-0.460***	-0.663***	-0.626***	-0.578***
	(0.072)	(0.067)	(0.081)	(0.080)
IRL	0.347***	0.952***	0.953***	0.929***
	(0.116)	(0.110)	(0.138)	(0.137)
ASSET		-0.073***	-0.090***	-0.088***
		(0.004)	(0.007)	(0.007)
ROA		2.699***	3.317***	4.274***
		(0.356)	(0.566)	(0.478)
EFICIENCY			-0.000	0.000
			(0.000)	(0.000)
LEVERAGE			-0.617***	-0.545***
			(0.122)	(0.126)
GDP				0.007***
				(0.001)
CONSTANT	0.401***	1.724***	2.125***	1.980***
	(0.060)	(0.106)	(0.157)	(0.148)
N	983	976	970	970

Standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Fixed effects are not listed for brevity.

Table 4 shows the estimation results. In column (1) of Table 4, the independent variables contain the square of IRL, IRL, and the fixed effect. In column (2) we add ASSET and ROA to the control variables, and add EFFICIENCY and LEVERAGE in column (3). In column (4), we retain all the independent variables.

Table 4 shows that, the coefficients for the square of IRL are all significance in different columns. This also indicates that the degree of collinearity is small, thus the model is robust to an extent. We can see that both the coefficient of IRL and that of the square of IRL are significant, and the latter is negative, indicating that, the relationship between bank liquidity creation and interest rate liberalization is inverted U shaped. That is to say, with the interest rate liberalization going forward, bank liquidity creation per asset increases at first, and then decreases.

As to the control variables, the coefficient of ASSET is significantly negative, indicating that bank liquidity creation and bank asset are negative correlation. So with the expansion of bank asset scale, the overall bank liquidity creation declines. The coefficient of ROA is significantly positive, that is, the impact of bank's profitability on bank liquidity creation is positive. It shows that the stronger the profitability of bank is, the stronger the liquidity creation ability is. The coefficient of LEVERAGE is significantly negative, indicating that the higher the leverage of the bank, the more liquidity is created. The coefficient of GDP is significantly positive, indicating that bank liquidity

creation is significantly pro-cyclical.

4.4 Robustness Tests

4.4.1 Endogeneity Problem

In order to overcome the potential endogeneity problem, the following three transformations are carried out in the model setting: first, the independent variables in the model contain only IRL and the square of IRL, and both of them are lagged; secondly, we retain all of the independent variables in the model, and IRL and the square of IRL are lagged; finally, we retain all the independent variables in the model, and all of them are lagged. The regression results are shown in Table 5.

Table 5 –Regression results after overcoming endogeneity problem

(1)		(2)		(3)	
	LC		LC		LC
L.IRL^2	-0.225***	L.IRL^2	-0.371***	L.IRL^2	-0.644***
	(0.036)		(0.090)		(0.124)
L.IRL	-0.077	L.IRL	0.540***	L.IRL	0.799***
	(0.048)		(0.153)		(0.211)
		ASSET	-0.083***	L.ASSET	-0.078***
			(0.007)		(0.010)
		ROA	4.784***	L.ROA	0.695
			(0.503)		(0.575)
		EFFICIENCY	-0.000	L.EFFICIENCY	0.000
			(0.000)		(0.000)
		LEVERAGE	-0.504***	L.LEVERAGE	-0.263**
			(0.134)		(0.129)
		GDP	0.006***	L.GDP	-0.005**
			(0.001)		(0.002)
CONSTANT	0.559***	CONSTANT	2.029***	CONSTANT	1.982***
	(0.042)		(0.142)		(0.203)
N	979		967		788

Standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Fixed effects are not listed for brevity.

As can be seen from table 5, regardless of how to set up the model, the coefficients of the square of IRL are all significantly negative, indicating that there is not serious endogeneity problem in the benchmark model, and after overcoming the endogeneity, we get results consistent with the benchmark regression.

4.4.2 Proxy Variable Selection

In order to further test the robustness of our model, we replace LC and IRL with alternative variables. Specifically, we substitute IRL_ALTER for IRL, and LC_ALTER for LC, where

LC_ALTER is measured according to Wang and Wang (2016). The corresponding regression results are shown in Table 6.

Table 6 –Regression results with alternative proxy variables

	(1)	(2)	(3)
	LC	LC_ALTER	LC_ALTER
IRL^2_ALTER	-0.017***		-0.036***
	(0.005)		(0.005)
IRL_ALTER	0.088***		0.164***
	(0.024)		(0.024)
IRL^2		-0.728***	
		(0.098)	
IRL		1.233***	
		(0.169)	
ASSET	-0.089***	-0.125***	-0.111***
	(0.005)	(0.008)	(0.006)
ROA	5.438***	3.571***	4.146***
	(0.513)	(0.656)	(0.512)
EFFICIENCY	-0.000	0.001	0.001*
	(0.000)	(0.000)	(0.000)
LEVERAGE	-0.721***	-0.801***	-0.811***
	(0.124)	(0.119)	(0.123)
GDP	0.007***	0.005**	-0.001
	(0.001)	(0.002)	(0.002)
CONSTANT	2.258***	2.642***	2.691***
	(0.130)	(0.167)	(0.147)
N	970	970	970

Standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Fixed effects are not listed for brevity.

The column (1) in Table 6 is the estimation result where we replace IRL with IRL_ALTER, and column (2) shows the result where we replace LC with LC_ALTER. In column (3) we replace both LC and IRL with alternative variables. It can be seen from table 6 that, the square IRL is significantly negative, and IRL is significantly positive, consistent with the benchmark regression results, showing that the benchmark regression is robust to the proxy variable selection.

4.4.3 Bank Heterogeneity

In order to investigate whether the heterogeneity of banks will affect the regression results, we divide the sample into two subsamples: large bank sample and small and medium-sized bank sample. Here, the five state-owned commercial banks and postal savings banks are classified as large banks, while the joint-stock commercial banks, city commercial banks and rural commercial banks are classified as small and medium-sized banks. The regression results are shown in Table

7.

Table 7 –Regression results for bank heterogeneity

	(1)	(2)
	LC	LC
IRL^2	-0.821*	-0.608***
	(0.434)	(0.082)
IRL	1.529**	0.983***
	(0.738)	(0.141)
ASSET	-0.118***	-0.085***
	(0.037)	(0.007)
ROA	-8.415**	4.149***
	(3.635)	(0.499)
EFFICIENCY	-0.009***	0.000
	(0.003)	(0.000)
LEVERAGE	-5.016***	-0.345***
	(0.726)	(0.129)
GDP	0.004	0.007***
	(0.005)	(0.001)
CONSTANT	3.142***	1.835***
	(0.861)	(0.138)
N	65	905

Standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Fixed effects are not listed for brevity.

It can be seen from table 7, both for large bank and small banks, the square of IRL is significantly negative, and IRL is significantly positive, indicating the inverted U shape relation exist for interest rate liberalization and liquidity creation of both large banks and small banks. This also suggests that our benchmark model is robust.

5. Further Discussion: The Mechanism of Interest Rate Liberalization Affecting Bank Liquidity Creation

One of the main findings of our empirical study is that the interest rate liberalization has a significant effect on bank liquidity creation. As the interest rate liberalization steps forward, bank liquidity creation per asset first increases and then decreases, and this conclusion remains robust after overcoming endogeneity problem, changing the proxy variable, and considering the influence of bank heterogeneity. Then follows a key question: why is the impact of interest rate liberalization on bank liquidity creation nonlinear? What is the mechanism behind it? Further research on this issue will help us deepen our understanding of the relationship between interest rate liberalization and bank liquidity creation, and also provide a reference for the design and practice of financial regulation and reform policies.

5.1 The Mechanism of Interest Rate Liberalization Affecting Bank Liquidity Creation: Theoretical Analysis

The latest research has provided an enlightening clue for us to explore the mechanism of the effect of interest rate liberalization on bank liquidity creation. On the one hand, it has been pointed out that banks have a positive incentive to bear risk due to interest rate liberalization. Lu et al.(2014) analyzed the impact of loan interest rate liberalization on bank risk by studying the consequences of loan interest rate liberalization—the change of bank profit and excessive credit growth. They showed that a relatively high ratio of non-interest income to total income and excessive loan growth would cause an increased risk of banks. Based on a DSGE model, Guo and Peng (2015) found that in the effective range of interest rate change, the liberalization of deposit interest rate will have a greater impact on systimatic risk. On the other hand, there is also literature supporting that bank liquidity creation is affected by bank risk taking. According to Angeloni (2015), the bank's risk-taking behavior may affect both the assets and the liabilities of bank's balance sheet. Based on the concept of bank liquidity creation, the adjustment of the items on and off balance sheet will directly affect bank liquidity creation. On asset side, if banks take more risk, the proportion net loans accounted for total assets will rise (Xu and Chen, 2012), or the growth rate of total loans and advances to customers will significantly increase (Zhang and Qiao, 2014). On liability side, bank risk taking will affect the choice of bank funding and leverage. When a bank takes more risk, the ratio of non-deposit liabilities to total assets will also increase (Angeloni et al., 2015, Li and Liang, 2015). In addition, in some special circumstances, bank risk taking may be reflected by off balance sheet activities (Hu et al., 2016) rather than information on balance sheet. That is to say, bank risk taking may also affect off balance sheet liquidity creation.

Based on the above research in the literature, we suggest that one of the possible way of interest rate liberalization affecting bank liquidity creation is through bank risk taking, in other words, interest rate liberalization leads to bank risk taking, and the latter results in changes in bank liquidity creation.

5.2 The Mechanism of Interest Rate Liberalization Affecting Bank Liquidity Creation: Empirical Tests

5.2.1 Empirical Design and Result Analysis

Based on the theoretical analysis, we introduce bank risk taking as a mediating variable, and construct a mediating effect model to examine whether interest rate liberalization affects bank liquidity creation through bank risk taking. The mediating effect test includes three steps. The first step is to regress the dependent variables on the key independent variables. The second step is to regress the mediating variables on the key independent variables. The third step is to regress the dependent variables on both the key independent variables and the mediating variables. Therefore, the mediating effect model of this paper consists of three regressions:

$$LC_{it} = \alpha_0 + \alpha_1 IRL_{it}^2 + \alpha_2 IRL_{it} + X_{it}\zeta + \lambda_{1i} + e_{it} \quad (1)$$

$$RISK_{it} = b_0 + b_1 IRL_{it}^2 + b_2 IRL_{it} + X_{it}\eta + \lambda_{2i} + \epsilon_{it} \quad (2)$$

$$LC_{it} = c_0 + c_1 RISK_{it} + c_2 IRL_{it}^2 + c_3 IRL_{it} + X_{it}\vartheta + \lambda_{3i} + \xi_{it} \quad (3)$$

where RISK is bank risk taking, and here we measure bank risk taking with the ratio of bank risk weighted assets to total assets, according to Fang(2012). X is the vector of control variable, and λ captures the individual effect that does not vary with time, and e, ϵ, ξ represent residual items. Equation (1) is also the benchmark regression model of this paper.

According to Baron and Kenny (1986), if α_1, b_1, c_1, c_2 are all statistically significant at the same time, the mediating variable plays the partial intermediary role. If α_1, b_1, c_1 are all statistically significant at the same time, but c_2 is not significant, the mediating variable plays the complete intermediary role; if α_1 is not significant, the mediating effect does not exist. Table 8 shows the regression results of models (1), (2), and (3).

Table 8 –Regression results for mediating effect tests

	(1)	(2)	(3)
	LC	RISK	LC
RISK			0.052***
			(0.019)
IRL^2	-0.578***	-0.194*	-0.457***
	(0.080)	(0.105)	(0.104)
IRL	0.929***	0.651***	0.658***
	(0.137)	(0.188)	(0.184)
ASSET	-0.088***	-0.041***	-0.088***
	(0.007)	(0.008)	(0.009)
ROA	4.274***	-0.639	3.204***
	(0.478)	(0.607)	(0.860)
EFFICIENCY	0.000	-0.001*	-0.000
	(0.000)	(0.000)	(0.000)
LEVERAGE	-0.545***	0.990***	-0.724***
	(0.126)	(0.114)	(0.153)
GDP	0.007***	0.008***	0.002
	(0.001)	(0.002)	(0.002)
CONSTANT	1.980***	0.743***	2.163***
	(0.148)	(0.270)	(0.200)
N	970	799	799

Standard errors are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Fixed effects are not listed for brevity.

In table 8, the estimation results in column (1) are the same as the benchmark regression. In column (2), the coefficients of the square of IRL is significantly negative, and the coefficients of IRL is significantly positive, indicating that there is also an inverted U relationship between interest rate liberalization and bank risk taking. In column (3), after controlling for bank risk

taking, the coefficient of the square of IRL is still significantly negative, and the coefficient of IRL is still significantly positive. This indicates that the inverted U relationship between interest rate liberalization and bank liquidity creation still remains. The regression results show that the bank risk taking plays a mediating effect in between the interest rate liberalization and bank liquidity creation. In other words, with the interest rate liberalization, bank risk taking first increases and then decreases, resulting in bank liquidity creation first increasing and then decreasing.

In China, that bank risk taking first increases and then decreases is easy to understand: in the early stage of interest rate liberalization reform, competition between banks is not very intense. Thus banks take more risks if driven by profit. This view has also been confirmed by the latest research. Guo and Zhao (2017) point out that when the banking competition is not fierce, the bank's profit is high and so is the risk tolerance. With the deepening of interest rate liberalization, competition between banks become more and more intense, and bank risk taking rises rapidly. Once bank risk taking goes beyond a threshold, the bank will face the constraints of financial supervision. More strict banking regulatory requirements thus constrain bank risk taking behavior (Guo and Zhao, 2017).

5.2.2 Robustness Test

In terms of determining the significance of mediating effect, Sobel Z test proposed by Sobel (1982) is also widely used in the literature. Therefore, we examine whether the bank risk taking has played a mediating effect between the interest rate liberalization and the bank liquidity creation with Sobel Z test. The null hypothesis is "mediating effect is not significant". In our regression model, the Z statistic of Sobel test is 2.147, the corresponding p value is 0.032, so the null hypothesis is rejected. This indicates that the mediating effect of the model is significant.

6.Conclusion

In this paper, we empirically test the effect of interest rate liberalization on bank liquidity creation, based on the unbalanced panel data of 145 banks in China over 1997-2015. The results show that, first, interest rate liberalization has a nonlinear impact on bank liquidity creation, and the relationship between them is inverted U shape. In other words, with the interest rate liberalization, bank liquidity creation increases first and then decreases. Secondly, through the mediating effect tests, we find that interest rate liberalization affects bank liquidity creation through bank risk taking. That is to say, interest rate liberalization leads to the changes of bank risk taking, thus resulting in the changes of bank liquidity creation.

The conclusion of this paper has the following policy implications. First, the interest rate liberalization has a significant impact on bank liquidity creation, therefore bank liquidity creation should be added into the objective function of the interest rate liberalization reform in China. Secondly, the effect of interest rate liberalization on bank liquidity creation is nonlinear, so promoting the interest rate liberalization faces a trade-off, because excessive bank liquidity creation may lead to asset price bubbles, while too little bank liquidity creation may inhibit the

economic growth. Finally, interest rate liberalization has a direct impact on bank risk taking, and it affects bank liquidity creation through bank risk taking. Therefore, interest rate liberalization must be included into the framework of macro-prudential supervision.

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