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Non-performing loans (NPLs), liquidity creation, and moral hazard: Case of Chinese banks

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Abstract

Background: This study analyzes the impact of non-performing loans (NPLs) on bank liquidity creation to investigate the existence of moral hazard problem in Chinese banks.

Methods: It uses data from 197 listed and unlisted Chinese banks, spanning the period 2005 to 2014. Generalized method of moments (GMM) estimation, fixed and random effect model, and pool data techniques have been used for analysis.

Results: Total liquidity creation by Chinese banks is declining, and NPLs ratio has started to increase following a continuous decline between 2005 and 2012. We find that liquidity creation by Chinese banks does not depend on NPLs ratio. We repeated the analysis for small and large banks and the results of these subsamples reinforced our findings for the aggregate sample.

Conclusions: We did not find the evidence of moral hazard problem in Chinese banks.

Keywords: Bank, Liquidity creation, Non-performing loans, Moral hazard, China

JEL classification: G21, G28

Background

Non-performing loans (NPLs) are unwanted byproduct of performing loans and are considered as "financial pollution" because of their adverse effect on economic growth (Gonzales-Hermosillo 1999; Barseghyan 2010; Espinoza and Prasad 2010; Nkusu 2011; Zeng 2012). International Monetary Fund's (IMF) compilation guide of March 2006 defines "loans (and other assets) should be classified as the NPL when (1) payments of principal and interest are past due by 3 months (90 days) or more, or (2) interest payments equal to 3 months (90 days) interest or more have been capitalized (re-invested into the principal amount, refinanced, or rolled over (i.e. payment has been delayed by arrangements)" IMF (2006). Similarly, Bank for International Settlements (BIS) defines "a default is considered to have occurred with regard to a particular obligor when the obligor is past due more than 90 days on any material credit obligation to the banking group" BIS (2006).

The recent incarnation of the idea that banks create liquidity traces back to the studies of Bryant (1980) and Diamond and Dybvig (1983). According to these studies, banks create liquidity on-balance sheet by financing relatively illiquid assets with relatively liquid liabilities. Another set of studies point to the liquidity creation by off-balance-sheet activities of the banks. Holmstrom and Tirole (1998)

and Kashyap et al. (2002) propose that banks also create liquidity off the balance sheet by commitments to provide liquidity to their clients, in case of need. Previous studies have also analyzed the role of banks as risk transformers. According to Diamond (1984) and Boyd and Prescott (1986), banks transform risk by issuing riskless deposits to lend risky loans. There are many similarities in the banks' role as liquidity creator and risk transformer.

Moral hazard occurs where one party takes higher risk because the consequences will be borne by another. Many studies have been conducted regarding a moral hazard problem after the seminal paper of Jensen and Meckling (1976) (Zhang et al. 2015; Foos et al. 2010; Shrieves and Dahl 2003; Gorton and Rosen 1995). It is a phenomenon which cannot be observed directly, but it is detected by other behaviors, and in case of banks, it is excessive risk taking in lending. Almost all of the existing studies use loan growth rate as a measure of bank risk taking (Zhang et al. 2015; Foos et al. 2010; Shrieves and Dahl 2003; Berger and Udell 1994). Some other studies investigate a moral hazard problem by a using shareholder structure, and it is believed that banks controlled by shareholders take greater risk than their counterparts controlled by managers (Saunders et al. 1990; Demsetz and Strahan 1997; Zhou 2014). However, to the best of our knowledge, none of the studies use the concept of bank liquidity creation (risk transformation) and NPLs to study the moral hazard problem.

There are numerous existing studies which explore macroeconomic and banking industry specific determinants of NPLs for different countries and regions, and most of them find an inverse relationship between macroeconomic environment and NPLs (Ghosh 2015; Zhu et al. 2014; Skarica 2014; Louzis et al. 2012; Zeng 2012; Espinoza and Prasad 2010). Similarly, there are many studies which provided different models and theories regarding bank liquidity creation. The number of studies which provide empirical evidence regarding bank liquidity creation and its relationship with bank capital has surged after the important paper of Berger and Bouwman (2009a) (Hackethal et al. 2010; Lei and Song 2013; Horvath et al. 2014; Chatterjee 2015). To the best of our knowledge, none of the existing studies investigates the a moral hazard problem by analyzing the relationship between bank liquidity creation and NPLs.

Therefore, this study investigates the moral hazard problem in the case of Chinese banks by using the concept of NPLs and liquidity creation. Our null hypothesis is that increase in NPLs leads to higher liquidity creation, i.e., a moral hazard problem exists in Chinese banks. Our hypothesis is based on the studies of Bernanke and Gertler (1989) and Jensen and Meckling (1976). According to Bernanke and Gertler (1989), increase in NPLs affects bank lending. Prudential banks reduce lending when they have higher NPLs, and the banks having a moral hazard problem tend to increase lending in the presence of higher NPLs. Jensen and Meckling (1976) argue that there are two types of moral hazard problems. According to managerial rent-seeking, managers lend to "pet projects" taking care of their personal benefits. Secondly, shareholders prefer risky portfolios by ultimately transferring risk to depositors. Therefore, we will conclude that a moral hazard problem exists for Chinese banks if liquidity creation increases in response to higher NPLs.

To test the abovementioned hypothesis, we used the data from 197 listed and unlisted Chinese banks spanning 2005 to 2014. First of all, we calculated the dollar amount of liquidity created by using three step mechanism established by Berger and Bouwman (2009a). We used "cat fat" measure to calculate the overall liquidity

created by on-balance-sheet as well as off-balance-sheet activities and "cat nonfat" measure to compute liquidity creation by on-balance-sheet activities only. To address the possible issue of endogeneity, we used system GMM technique to estimate the effect of NPLs on bank liquidity creation. We found that liquidity creation by Chinese banks does not depend on level of NPLs, i.e., we did not find the evidence of a moral hazard problem in Chinese banks. To be sure about our findings, we repeated the analysis by using random effect, fixed effect, and pool data techniques. The results obtained by different techniques confirmed our finding that there is no evidence of a moral hazard problem in Chinese banks.

We extend the existing literature on the moral hazard problem, bank liquidity creation, and non-performing loans in a new direction. To the best of our knowledge, this study is the first one to use the concept of liquidity creation and NPLs to study moral hazard problem. We believe that liquidity creation is a better measure of bank risk taking compared to loan growth because it not only includes on-balance-sheet activities but also risky off-balance-sheet activities in its formula. Liquidity creation is also a better measure because it provides us the absolute amount rather than a relative figure, which is offered by loan growth. Furthermore, loans may grow faster based on the policies adopted by government and not as a result of excessive risk taking but increase in liquidity creation shows the true risk taken by banks, regardless of the government policy. We also contribute to existing literature by providing the evidence regarding the moral hazard problem from an emerging market having a socialist system with Chinese characteristics.

The rest of the paper is as follows. The "Literature review" section provides a review of relevant existing studies. The "Methods" section describes the data and regression framework. The "Results and discussion" section presents the results obtained by analysis, and the "Conclusions" section mentions findings and implications of the study.

Literature review

This study relates three different strands of literature: the studies regarding bank liquidity creation, non-performing loans, and moral hazard problem. Some of the most relevant studies have been discussed below.

Studies regarding bank liquidity creation

There has been a surge in the studies concerning bank liquidity creation after the important paper of Berger and Bouwman (2009a). Most of these studies provide the empirical evidence regarding the relationship between bank capital and liquidity creation. The studies prior to the abovementioned study just established hypotheses regarding bank liquidity creation, without providing the empirical evidence, except that of Deep and Schaefer (2004). Former studies establishing the theories regarding the relationship between bank liquidity creation or risk transformation and capital have been mentioned in the "Background" section. Some of the most relevant empirical studies regarding liquidity creation have been discussed below.

Deep and Schaefer (2004) created a relative measure of liquidity creation, known as liquidity transformation gap (LT gap). It is calculated as the difference of liquid liabilities and liquid assets divided by total assets ((liquid liabilities – liquid assets)/

total assets). They applied this measure on the data of 200 largest US banks ranging from 1997 to 2001 and found that LT gap is about 20 % of the total assets on average. They argue that US banks do not create much liquidity.

Although the measure of liquidity creation established by Deep and Schaefer (2004) was not comprehensive, it was a step forward. Following their work, Berger and Bouwman (2009a) established four much better measures of liquidity creation. The measures created by them are known as "cat nonfat," "cat fat," "mat nonfat," and "mat fat". All the measures are similar in a way that they classify activities other than loans by using information regarding product category or maturity. They differ from each other on the basis of loan classification and on-balance-sheet and off-balance-sheet activities. "Cat" measures classify loans on the basis of category, and "mat" measures classify them on the basis of maturity. "Nonfat" measures exclude off-balance-sheet activities, but "fat" measures include them to calculate liquidity creation. Berger and Bouwman (2009a) prefer cat fat measure over other measures. According to all the "BB" (Berger & Bouwman) measures, a bank create $1 of liquidity when it converts $1 illiquid assets into $ 1 liquid liabilities. Similarly, a bank destroys $1 of liquidity by transforming $1 of liquid assets into $1 illiquid liabilities. A bank does not create or destroy liquidity when it converts $1 of liquid assets into $1 of liquid liabilities or $1 of illiquid assets into $1 of illiquid liabilities or equity.

Hackethal et al. (2010) used the measures of liquidity creation proposed by Deep and Schaefer (2004) and Berger and Bouwman (2009a) to compute the liquidity creation and explore its determinants for German saving banks using data ranging from 1997 to 2006. They found that liquidity creation by German saving banks increased by 51 % over the period. They used multivariate dynamic panel regression framework and found that macroeconomic variables particularly the monetary policy indicators had a strong negative effect on liquidity creation, and bank specific variables like bank financial performance and size did not affect liquidity creation.

Distinguin et al. (2013) investigated the relationship between bank regulatory capital and liquidity measured from on-balance-sheet activities. They used the data of US and European publically traded commercial banks spanning 2000 to 2006. The study found that banks decrease their regulatory capital when they face higher illiquidity or create more liquidity. They also observed that small US banks increased their capital when exposed to higher illiquidity. Lei and Song (2013) also used BB measures to explore the relationship between bank capital and liquidity creation by using the data of Chinese banks, ranging from 1998 to 2009. They found an inverse relationship between bank capital and liquidity creation and concluded that "financial fragility–crowding out" hypothesis holds for Chinese banks. They also discovered that "risk absorption" hypothesis holds for foreign banks working in China.

All the previous studies were focused on measuring the liquidity creation and the effect of changes in capital on liquidity creation. Horvath et al. (2014) extended the literature to a new direction. They show that the relationship between capital and liquidity creation is not unidirectional. They proposed that bank liquidity creation also affects the amount of the capital. They embedded Granger causality test in a dynamic GMM panel model and used the data of Czech banks spanning 2000 to 2010. Their study found that bank capital negatively Granger-causes liquidity creation and liquidity creation negatively affects the capital as well. They show

that bank management and authorities have to trade off between the stability induced by higher capital and benefits of liquidity creation.

Studies regarding non-performing loans

There are many studies which investigate NPLs of banks from different perspectives but most of them focus on exploring the determinants of NPLs. Studies related to the determinants of NPLs can be divided into three categories: the studies which investigate macroeconomic determinants (Nkusu 2011; Skarica 2014; Beck et al. 2015) only, the studies which explore bank-specific determinants only (Berger and DeYoung 1997; Boudriga et al. 2010; Dhar and Bakshi 2015), and the studies which analyze bank as well as macroeconomic determinants of NPLs (Espinoza and Prasad 2010; Louzis et al. 2012; Klein 2013; Tanaskovic and Jandric 2015; Ghosh 2015). The studies related to the determinants of NPLs trace back to the "financial accelerator theory" of Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and the "life cycle consumption model" of Lawrence (1995). Some of the studies which analyze NPLs of Chinese banks from different perspectives are given below.

Lu et al. (2007) explored the relationship between Chinese banks' lending behavior and level of NPLs. They used the data from a set of publically listed companies and concluded that state-owned enterprises (SOEs) got more loans compared with other firms. The most surprising finding of their study is that the SOEs which had high probability of default were able to get more loans compared with their less risky counterparts. They suggested that authorities should put hard budget constraints on SOBs and SOEs to control vicious cycle of NPLs' accumulation.

Suzuki et al. (2008) studied the role of economic rents in the compilation of NPLs in a Chinese banking system. They used financial constraints model as an analytical framework and concluded that the main reason for dismal performance of banks was failure to create sufficient economic rents. Their study pointed to the importance of an informal financial system by stating that they are critical for the economic growth of China because they lent to private firms, which are generally neglected by a formal banking system. They warned that if the authorities will not tackle the issue of NPLs in the formal banking system, it will lead to economic slowdown.

Zeng (2012) analyzed NPLs in a Chinese banking system by using utility function based on optimal control theory and concluded that the phenomenon of NPLs was mainly significant in state-owned banks. The study revealed that equilibrium of NPLs in China was dependent on microeconomic factors but was influenced by macroeconomic factors. The study suggested that internal management efforts must be enhanced, along with reforms in property rights, media policies, and hidden guarantees provided to SOEs by the government to bring the level of NPLs down.

Zhu et al. (2014) analyzed the relationship between productivity, efficiency, and non-performing loans in a Chinese banking system. They used directional distance function and Metafrontier-Luenberger productivity indicator to investigate the abovementioned relations by using data from 25 commercial banks, ranging from 2004 to 2010 period. Their study concluded that pure technical efficiency of state-owned commercial banks was better than joint stock commercial banks and city commercial banks. They also found that non-interest income was the main source of inefficiency for SOCBs.

Studies regarding moral hazard problem

Many studies regarding a moral hazard problem have been conducted after the seminal paper of Jensen and Meckling (1976). Some of the most relevant studies have been discussed below. Keeley (1990) found that a fixed rate deposit insurance system incites banks for excessive risk, i.e., promote a moral hazard problem. Keeley argue that a deposit insurance system worked well for over half a century but the problem started to pop up in the early 1980s when increase in the competition caused decline of bank charter values, which ultimately resulted in increased default risk via increase in assets risk and reduction in capital.

Hellmann et al. (2000) studied whether capital requirements are effective enough to combat a moral hazard problem or not. They found that the minimum capital requirements are inefficient in combating a moral hazard problem. They discovered that deposit insurance and freely determined deposit rates weaken prudent bank behavior and put forward that franchise value at risk provokes banks to prudent investment. They concluded that both deposit rate controls and capital requirements can collectively produce better results compared to capital requirements only.

Extending literature on bank capital and franchise value, Repullo (2004) presented a dynamic model of imperfect market competition in banking industry and show that reduction in intermediation margins results in lower franchise value, and in the absence of regulations, exists a gambling equilibrium. In this situation, flat rate equilibrium requirements or binding deposit rate ceiling can ensure the existence of prudent equilibrium. The study concluded that risk-based capital requirements are always effective for preventing banks from excessive risk taking.

By using the data of 729 banks ranging from 1993 to 2000, Nier and Bouwmann (2006) found that government safety nets result in lower capital buffer and stronger market discipline results in higher capital buffers, ceteris paribus. They also found the effect of uninsured funding and disclosure in the presence of higher government support. They concluded that higher risk taking as a result of increased competition could be curtailed by imposing intensive market discipline on banks in markets where the competition among banks is high.

Barseghyan (2010) studied the role of delayed bailout of banks by Japanese government on economic slowdown in the last decade of the twentieth century and first decade of the twenty-first century. They found that existence of NPLs along with delayed bailout led to consistent decline in economic activity via decline in investment, labor, and total factor productivity. Bruche and Llobet (2011) argue that banks have incentives to roll over bad loans to hide losses because of their limited liability. They suggested a voluntary scheme for banks to disclose bad loans, which can be foreclosed. They argue that this scheme will stop creating windfall gains for shareholders. They also suggested to pass on some losses to the depositors.

Koudstaal and Wijnbergen (2012) used the data of US banks spanning 1993 to 2010 and found that banks with troubled loan portfolios take more risk, and for the banks whose share price decreases sharply, try to resurrect it by increasing risk of their portfolios. However, they did not find any evidence that deposit insurance encourages risk-taking behavior. Luo and Ying (2014) studied whether political connections of listed companies help them to obtain bank lines of credit or not. They used the data of listed Chinese companies ranging from 2004 to 2009 and found that political connections

help firms to obtain bank lines of credit, particularly from state-owned banks. They also discovered that political connections have a stronger effect on obtaining lines of credit for companies which have financial constraints, not owned by government, or located in regions of intense government involvement.

Zhang et al. (2015) points to the existence of a moral hazard problem in lending by Chinese banks. In other words, they studied the impact of NPLs on Chinese banks' behavior. They used threshold panel regression and used data from 60 city commercial banks, 16 state-owned banks, and 11 rural commercial banks spanning 2006 to 2012. The findings of study supported moral hazard hypothesis which means that increase in NPLs ratio increases riskier lending, which may cause further deterioration in loan quality and stability of the financial system.

Methods

The sample of this study includes the data of 197 publically listed and unlisted Chinese banks ranging from 2005 to 2014. According to Bankscope database, there are 245 financial intermediaries currently operating in China but we eliminated all those firms for which we did not have the observations for total customer deposits. So, our sample includes only banks which are actively involved in the business of taking deposits and extending loans. Financial statements were extracted from Bankscope database of Bureau van Dijk. Data regarding macroeconomic variables was obtained from the Economist Intelligence Unit (EIU).

Regression framework

To test the null hypothesis of a moral hazard problem, we have used dynamic GMM estimation, panel data techniques of fixed effect and random effect, and pool data framework, following many existing studies (Espinoza and Prasad 2010; Louzis et al. 2012; Horvath et al. 2014; Imbierowicz and Rauch 2014; Ghosh 2015). First of all, we used system GMM estimation technique developed by Arellano and Bover (1995) and Blundell and Bond (1998). We performed the same analysis by using fixed effect, random effect, and pool data techniques as robustness test. To control for the suspected issue of endogeneity and to know the effect of lagged value of NPLs on liquidity creation, we also performed the analysis by replacing all the independent variables with their first lags (Lei and Song 2013). We estimated the following mathematical equations.

$$\mathrm{LC}_{it} = \alpha + \sum\nolimits_{j=1}^{j} \left(a_j X_{it}^{j}\right) + \sum\nolimits_{k=1}^{k} \left(a_k X_{it}^{k}\right) + \varepsilon_{it} \tag{1}$$

$$\mathrm{LC}_{it} = \alpha_0 + \alpha_{j_{it}} \left(X_{it}^{j}\right) + \alpha_{k_{it}} \left(X_{it}^{k}\right) + \mu_i + \lambda_t + \varepsilon_{it} \tag{2}$$

The first equation represents the dynamic regression model, and the Eq. 2 portrays the static one. LC_{it} stands for cat fat and cat nonfat measure of liquidity creation. α and a_0 are the intercept of the models, i.e., constant for dynamic and static framework, respectively. X_{it}^{j} represents the vector of bank-specific variables including NPLs ratio, and X_{it}^{k} denotes the vector of macroeconomic variables. In the dynamic model, the number of lags of the NPLs ratio varies from zero to four but all other control variables take their current values (Horvath et al. 2014). All the macroeconomic variables were treated as exogenous in one-step system GMM estimation. In the static models, no lags

have been used. ε_{it} indicates error term in both the equations. In the second equation, μ_i refer to bank fixed effect, and λ_t portrays time fixed effect. Detailed discussion of all the variables used in the analysis is given in the "Variables" section below.

Variables

The variables which have been used for the analysis include the following: bank liquidity creation cat fat measure standardized by total assets (LC_CF), cat nonfat measure standardized by total assets (LC_CNF), non-performing loans to total loans ratio (NPL_TL), natural log of total assets (LN_TA), average loans standardized by total assets (AVG_LNS), market share (MK_SHR), a measure of bank riskiness *Z* score (Z_SCR), return on average equity (ROAE), earning volatility (EAR_VOL), bank leverage (TE_TA), interbank offered rate (IBR), natural log of population (LN_POP), and percentage change in real gross domestic product (GDP). All these variables have been discussed below in detail.

Liquidity creation

We used the three-step approach adopted by Berger and Bouwman (2009a) and Lei and Song (2013) to estimate the absolute amount of liquidity created by Chinese banks. In the first step, we divided all the assets, liabilities, equity, and off-balance-sheet activities in liquid, semiliquid, and illiquid categories. This division was done on the basis of ease, cost, and time for customers to get funds from banks and for banks to dispose of their obligations. In the second step, we assigned weights of ½ to illiquid assets, liquid liabilities, and illiquid off-balance-sheet activities. Contrarily, liquid assets, illiquid liabilities, and liquid off-balance-sheet activities were given a weight of −½. Semiliquid assets, liabilities, and off-balance-sheet activities were allocated weight of zero. In step 3, we calculated the cat fat and the cat nonfat measures of liquidity creation by combining activities performed in step 1 and 2. The formulas to calculate cat fat and cat nonfat measures of liquidity creation are mentioned in Table 1, adopted from Lei and Song (2013).

By using the data of 197 banks, we estimated that in 2005, Chinese banks created liquidity of 16.20 billion USD. 6.92 billion dollars were created by on-balance-sheet activities, and 9.24 billion dollars were generated by off-balance-sheet activities. The overall liquidity creation decreased to 9.90 billion USD in 2007 before increasing to 12.20 billion USD in 2009. This increase in liquidity was the result of money injected to the banking system to stabilize it after the eruption of financial crisis in the USA in 2007. In 2009, on-balance-sheet liquidity creation stood at 6.01 billion USD, and off-balance-sheet liquidity creation amounted to 4.90 billion USD. So, the amount of liquidity created by on-balance-sheet activities exceeded the amount of liquidity generated by off-balance-sheet activities in 2009.

Liquidity creation by Chinese banks is on a decline since 2009. Chinese banks destroyed the liquidity of 3.40 billion USD in 2014, for the very first time over 2005–2014 period. The main culprit is the on-balance-sheet activities as a result of which liquidity of 9.62 billion USD was destroyed. Liquidity creation by off-balance-sheet activities has been quite stable after 2007. It stood at 6.30 billion USD in 2014. Liquidity creation by Chinese banks has a declining trend over the period with no hope of increase in the near future. Figure 1 shows the graph of liquidity created by Chinese banks by on-balance-sheet activities (cat nonfat), on-balance-sheet and off-balance-sheet activities (cat fat), and by off-balance-sheet activities only (LC_OBS).

Table 1 Liquidity classification of bank activities and formulas to calculate liquidity creation of a bank

Panel A: liquidity classification of bank activities			
Illiquid assets (weight = 1/2)		Semiliquid assets (weight = 0)	Liquid assets (weight = −1/2)
Assets			
Corporate commercial loans		Residential mortgage loans	Cash and due from banks
Investment in property		Other mortgage loans	Trading securities and at FV through income
Foreclosed real estate		Other consumer/retail loans	Tradable derivatives
Fixed assets		Loans and advances to banks	Available for sale securities
Goodwill		Reverse repos and cash collateral	Held to maturity securities
Other intangibles			At-equity investments in associates
Other assets			Other securities
Liabilities and equity			
Liquid liabilities (weight = 1/2)		Semiliquid liabilities (weight = 0)	Illiquid liabilities (−1/2)
Customer deposits-current		Customer deposits-term	Senior debt maturing after 1 year
Customer deposits-Savings		Deposits from banks	Subordinated borrowings
Tradable derivatives		Repos and cash collateral	Other funding
Trading liabilities		Other deposits and short term borrowings	Credit impairment reserves
			Reserves for pension and others
		Fair value portion of debt	Current tax liabilities
			Deferred tax liabilities
			Other deferred liabilities
			Other liabilities
			Total equity
Off-balance-sheet activities			
Illiquid activities (weight = 1/2)		Semiliquid activities (weight = 0)	Liquid activities (weight = −1/2)
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	
Panel B: "cat nonfat" and "cat fat" formulas			
Cat nonfat=	+1/2*illiquid assets	0*semiliquid assets	−1/2*liquid assets
	+1/2*liquid liabilities	0*semiliquid liabilities	−1/2*illiquid liabilities
			−1/2*equity
Cat fat=	+1/2*illiquid activities	0*semiliquid activities	−1/2*liquid activities
	+1/2*illiquid assets	0*semiliquid assets	−1/2*liquid assets
	+1/2*liquid liabilities	0*semiliquid liabilities	−1/2*illiquid liabilities
			−1/2*equity

Adopted from Lei and Song (2013). Panel A shows that the bank activities are classified as illiquid, semiliquid, and liquid. The weights used to calculate liquidity creation are given in parenthesis. Panel B represents two different formulas of liquidity creation and * represents multiplication

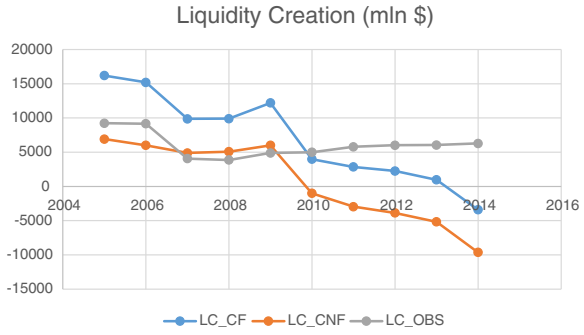

Fig. 1 The amount of liquidity created by Chinese banks over 2005–2014 period

Non-performing loans

Non-performing loans to total loans ratio (NPL_TL) is the variable of interest (Fig. 2), and the rest of the independent variables are the control variables. A higher value of the ratio means lower credit quality and vice versa. Historically, China had a very high level of NPL ratio. NPL ratio surged from 12.81 % in 2002 to 34.18 % in 2003 from where it plunged to 15.10 % in the very next year when 45 billion dollars were injected to the Bank of China and China Construction Bank by Central Huijin Investment (Mclever 2005). The same company injected 15 billion dollars to the Industrial and Commercial Bank of China in 2005 as a result of which NPL ratio declined further to 7.48 %. It continued to decline until 2012, reaching a level of 0.95 %, the lowest to date. It increased to 1.01 % in 2013 then to 1.28 % in 2014. NPL ratio is expected to grow at a faster rate because of economic slowdown.

Control variables

Many studies regarding bank liquidity conclude that banks of different sizes behave differently (Berger and Bouwman 2009a; Distinguin et al. 2013; Chatterjee 2015). So, we control for the bank size in our regression by including LN_TA. The natural log of total assets instead of total assets has been used to overcome the specification distortions because the value of the dependent variables ranges from −0.30 to 0.34. We have included average loan size to the total asset ratio (AVG_LNS) to control for the type of the business. A bank is considered to be predominantly involved in commercial (consumer) lending if it has higher (lower) value for this ratio. We divided the average loan size by total assets to overcome measurement distortions.

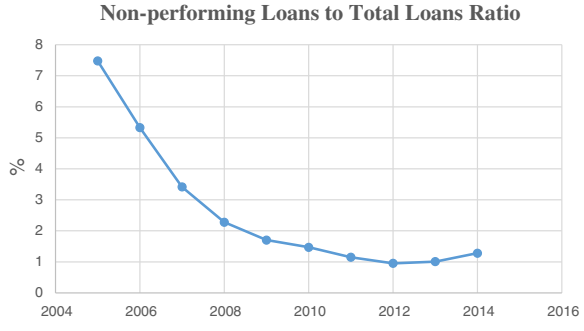

Fig. 2 NPLs ratio of Chinese bank over 2004 to 2014

Following Berger and Bouwman (2009a), Distinguin et al. (2013), and Horvath et al. (2014), we have included market power (MKT_POW) as a control variable because it can affect the availability of the funds to the banks which ultimately affect lending and hence liquidity creation. It has been calculated as the ratio of the total deposits of the bank to the total deposits of the whole banking system in a particular year. Following Berger and Bouwman (2009a) and Lei and Song (2013) *Z* score (Z_SCR), a measure of bank's distance from default has also been used as a control variable. It has been calculated as the sum of return on assets and equity/total assets ratio divided by standard deviation of return on average assets.

ROAE is the measure of return on shareholders' funds. It is measured as the ratio of net income to average stockholders' equity. ROAE represents the profitability of the bank. It is an important control variable because increase in profitability results in higher equity which ultimately affects bank liquidity creation. ROAE has also been used as a control variable by Hackethal et al. (2010) and Berger et al. (2014). EAR_VOL of the bank is another measure of bank riskiness. It has been included as the control variable following many existing studies (Berger and Bouwman 2009a; Lei and Song 2013; Horvath et al. 2014). We measured it as standard deviation of bank's return on average assets over the previous 3 years.

TE_TA or total equity to total assets ratio is one of the most important control variables. Many of the existing studies used it as the main independent variable to analyze the effect of capital on liquidity creation (Berger and Bouwman 2009a; Lei and Song 2013; Horvath et al. 2014). Some of the studies argue that the relationship between bank leverage and liquidity creation is negative (Diamond and Rajan 2000, 2001; Gorton and Winton 2000) but the others suggest that the relationship is positive (Repullo 2004; Von Thadden 2004).

IBR is one of the factors which are considered by central banks to formulate their monetary policy. Higher IBR indicates shortage of liquidity in interbank market and vice versa. So, in order to control for the effect of monetary policy on bank liquidity creation, we use a 90-day interbank market rate as a proxy for monetary policy. Following Berger and Bouwman (2009a) and Lei and Song (2013), we also use LN_POP as a control variable. Bank liquidity creation also depends on economic booms and busts. Generally, the banks create more liquidity during economic booms and reduce their lending during economic slowdown. So, following Berger and Bouwman (2009a) and Distinguin et al. (2013), we use GDP, over the previous year as a proxy for economic growth to control for the effect of changes in the business cycle on liquidity creation.

Results and discussion

Summary statistics

Table 2 displays the summary statics of the sample used for the analysis. The average amount of liquidity creation by the Chinese banks is 2.77 billion USD with a standard deviation of 15.7 billion USD. The highest amount of liquidity created by a Chinese bank in the given period is 75.70 billion USD, and the maximum amount of liquidity

Table 2 Descriptive statistics

	CF	CNF	NPL_TL	TA	LNS	MKT_POW	Z_SCR
Unit	Million USD	Million USD	%	Million USD	Million USD	%	–
Mean	2766	−2518	1.787	112,000	60,800	0.855	5.860
Median	368	−265	0.980	10,000	4786	0.069	3.809
Minimum	−53,900	−84,500	0.010	30	15	0.000	−0.433
Maximum	75,700	41,600	41.300	3,370,000	1,120,000	18.618	34.917
SD	15,700	14,000	3.495	360,000	182,000	2.978	6.587
25th PCT	−476	−1928	0.600	3626	1852	0.033	2.175
75th PCT	1781	556	1.750	30,800	13,900	0.186	6.798
N	644	772	845	1096	947	1107	1084
	TE_TA	ROAE	ROAA	EAR_VOL	IBR	POP	GDP
Unit	%	%	%	%	%	Million USD	%
Mean	9.577	14.527	1.019	24.726	3.768	1328.6	9.98
Median	7.173	15.370	1.063	16.980	3.873	1329.5	9.55
Minimum	1.641	−5.897	−0.502	0.854	1.706	1300	7.3
Maximum	94.709	41.776	4.831	336.212	5.285	1356	14.2
SD	9.494	8.668	0.569	27.866	1.196	18.238	2.143
25th PCT	5.745	8.112	0.670	8.568	2.663	1312	7.7
75th PCT	9.328	19.692	1.337	30.771	5.008	1345	11.3
N	1096	1089	1089	674	1970	1970	1970

Table 2 reports the summary statistics of "cat fat" (CF) and "cat nonfat" (CNF) measure of liquidity creation-measured in million USD; non-performing loans to total loans ratio (NPL_TL); total assets (TA), average loans (LNS); market power (MKT_POW); measure of bank stability risk *Z* score (Z_SCR); bank leverage (TE_TA); return on average equity (ROAE); return on average assets (ROAA); earnings volatility (EAR_VOL); interbank offer rate (IBR); population (POP); and percentage change in real gross domestic product (GDP)

destroyed by a bank is 53.90 billion USD. The average amount of liquidity destroyed by the on-balance-sheet activities of Chinese banks amounts to 2.52 billion USD with a standard deviation of 14.00 billion USD. The average of non-performing loans to total loans ratio is 1.79 % with a standard deviation of 3.50 %. The highest value of NPL ratio attained by a bank is 41.3 % in a year, and the lowest value of NPLs ratio is recorded at 0.01 %.

Chinese banking system is dominated by the large banks. Five Chinese banks are part of the Global Systematically Important Financial Institutions (GSIFI) (Moenninghoff et al. 2015). An average amount of 112 billion USD of total assets owned by 197 banks indicates this fact. The minimum amount of assets held by a bank over the period is 30 million USD, and the highest amount is 3.37 trillion USD. This huge difference in assets owned by the banks show that our analysis is unbiased as our sample includes very small as well as very large banks. The average loans lent by Chinese banks over the period amount to 60.80 billion USD with a standard deviation of 182 billion USD. The average market power over the period is 0.86 %. The largest bank had market power of 18.62 % in a particular year.

The average value of *Z* score is 5.86 with a standard deviation of 6.59. The average capital ratio of Chinese banks over the period is 9.58 %. It implies that most of the Chinese banks fulfill the requirement of the minimum capital, required by the Basel III. Return on average equity is much higher compared to the return on average assets. The average value of ROAE is 14.53 %, and the mean value of ROAA is 1.02 %. The

average of earning volatility is 24.73 % with a standard deviation of 27.87 %. The average value of interbank offered rate is 3.77 % with a standard deviation of 1.20 %. The average population over the period is 1.33 billion individuals. Chinese economy grew at a rate of 10 % on average, over the period with the highest growth rate of 14.2 % recorded in 2007.

Table 3 presents the pair-wise correlation matrix between all the variables used in the analysis. The correlation between NPL ratio and both measures of liquidity creation is very low but positive. The correlation coefficient between NPL ratio and cat fat and cat nonfat ratio is 13.4 and 15.4 %, respectively. Correlation among other variables is given in Table 3.

Regression analysis

We performed the dynamic panel regression to find the impact of NPLs ratio on bank liquidity creation (Table 4). We used one-step system GMM to control for the issue of endogeneity. We separately performed the regressions for narrow and broad measure of liquidity creation and run different models having current value of NPLs to four lagged vales. We also controlled for the variables mentioned in the "Variables" section. The regression approach adopted for this study is similar to Imbierowicz and Rauch (2014) and Horvath et al. (2014).

We found that bank liquidity creation by the Chinese banks does not depend on the level of NPLs. The relationship between the current period's NPL ratio and both measures of liquidity creation is negative and insignificant at 5 % level of significance. This negative relationship between NPLs and liquidity creation is opposite to our null hypothesis that increase in NPLs results in higher liquidity creation. Increase in previous year's NPLs is associated with higher liquidity creation in the current year, but lagged value of NPLs is also not a significant determinant of liquidity creation. Furthermore, the 3rd and 4th lags of NPLs ratio do not explain variation in liquidity creation. So, from the above results, we conclude that variation in NPLs ratio does not affect liquidity creation, i.e., we did not find the evidence of a moral hazard problem in Chinese banks.

Our results contradict the finding of Zhang et al. (2015) that a moral hazard problem exists in lending by Chinese banks. It may be because they used loan growth as a measure of bank risk taking instead of liquidity creation. Loan growth does not necessarily represent risk taking by banks, but liquidity creation does. We believe that the loans grew at a relatively faster rate as a result of the policies adopted by the government in response to global financial crisis, and not because of excessive risk taking, which lead that study to conclude that a moral hazard problem exists for Chinese banks.

Liquidity creation is a better measure of risk compared to loan growth because it includes both on-balance-sheet as well as off-balance-sheet activities in the formula, but loan growth is based on on-balance-sheet activities only. Furthermore, bank liquidity creation is a more objective measure of risk taking compared with credit growth because liquidity creation gives us an absolute amount of risk transformation. According to liquidity creation, the overall risk taken by Chinese banks shows a declining trend over the period. Moreover, our results are more reliable because we have used data of

Table 3 Pair-wise correlation matrix

	LC_CF	LC_CNF	NPL_TL	LN_TA	AVG_LNS	MKT_POW	Z_SCR	TE_TA	ROAE	SD3_ROAA	IBR	LN_POP	GDP
LC_CF	1												
LC_CNF	0.884***	1											
	(0.000)												
NPL_TL	0.134***	0.154***	1										
	(0.002)	(0.000)											
LN_TA	−0.104***	−0.101***	−0.139***	1									
	(0.009)	(0.005)	(0.000)										
AVG_LNS	0.311***	0.389***	0.179***	0.046	1								
	(0.000)	(0.000)	(0.000)	(0.157)									
MKT_POW	−0.005	0.045	0.051	0.584***	0.067**	1							
	(0.895)	(0.214)	(0.142)	(0.000)	(0.041)								
Z_SCR	−0.041	−0.027	−0.069**	0.236***	−0.099***	0.019	1						
	(0.304)	(0.464)	(0.047)	(0.000)	(0.003)	(0.525)							
TE_TA	−0.264***	−0.259***	0.077**	−0.434***	−0.162***	−0.106***	−0.147***	1					
	(0.000)	(0.000)	(0.025)	(0.000)	(0.000)	(0.001)	(0.000)						
ROAE	0.292***	0.226***	−0.153***	0.267***	−0.010	0.087***	0.300***	−0.451***	1				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.755)	(0.004)	(0.000)	(0.000)					
SD3_ROAA	−0.001	−0.040	0.038	−0.427***	−0.091**	−0.156***	−0.302***	0.436***	−0.208***	1			
	(0.989)	(0.368)	(0.374)	(0.000)	(0.018)	(0.000)	(0.000)	(0.000)	(0.000)				

Table 3 Pair-wise correlation matrix *(Continued)*

IBR	−0.267***	−0.269***	−0.185***	0.171***	−0.272***	−0.071**	0.217***	−0.010	0.092***	−0.175***	1		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.018)	(0.000)	(0.738)	(0.002)	(0.000)			
LN_POP	−0.311***	−0.305***	−0.309***	0.239***	−0.352***	−0.106***	0.256***	0.047	0.075**	−0.215***	0.668***	1	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.124)	(0.014)	(0.000)	(0.000)		
GDP	0.303***	0.294***	0.271***	−0.220***	0.292***	0.083***	−0.227***	−0.053*	−0.048	0.166***	−0.545***	−0.829***	1
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.077)	(0.115)	(0.000)	(0.000)	(0.000)	

Table 3 reports the pair-wise correlation matrix of the variables used in this study's analysis; parentheses denote *p* values, and *, **, and *** represent levels of statistical significance at 10, 5, and 1 % levels, respectively

Table 4 The effect of NPLs on liquidity creation

	Broad measure of liquidity creation					Narrow measure of liquidity creation				
	LC_CF	LC_CF	LC_CF	LC_CF	LC__CF	LC_CNF	LC_CNF	LC_CNF	LC_CNF	LC_CNF
NPL_TL	−0.006	−0.017	−0.005	0.015	−0.03	−0.011*	−0.014**	−0.012	−0.006	−0.038*
	(−0.50)	(−1.17)	(−0.26)	(0.62)	(−1.43)	(−1.72)	(−2.11)	(−0.79)	(−0.36)	(−1.72)
L.NPL_TL		0.007	0.006	−0.002	0.031		0.004	0.005	0.011	0.044**
		(0.44)	(0.32)	(−0.11)	(1.53)		(0.72)	−0.38	(0.66)	(2.14)
L2.NPL_TL			−0.007	−0.006	−0.004			−0.004	−0.007	−0.004
			(−1.01)	(−0.86)	(−0.23)			(−0.65)	(−1.30)	(−0.26)
L3.NPL_TL				0.003	−0.0005				−0.0003	−0.005
				(0.58)	(−0.07)				(−0.06)	(−0.75)
L4.NPL_TL					0.003					0.001
					(0.53)					(0.17)
LN_TA	−0.014	−0.019*	−0.027***	−0.017**	0.003	−0.016*	−0.023***	−0.028***	−0.020**	−0.007
	(−1.24)	(−1.92)	(−3.05)	(−2.02)	(0.53)	(−1.85)	(−2.87)	(−3.32)	(−2.40)	(−0.70)
AVG_LNS	0.429***	0.289***	0.435***	0.470***	0.324***	0.280***	0.347***	0.501***	0.576***	0.495***
	(4.06)	(2.93)	(4.20)	(4.50)	(2.78)	(3.48)	(3.86)	(5.00)	(5.56)	(4.05)
MKT_POW	−0.657	−0.536	−0.357	−0.586*	−0.908**	0.138	0.400	0.168	0.065	−0.462
	(−1.35)	(−1.31)	(−0.99)	(−1.66)	(−2.41)	(0.34)	(1.03)	(0.44)	(0.17)	(−1.08)
Z_SCR	−0.001	−0.008***	−0.006**	−0.007***	−0.003	0.002	0.002	0.0003	0.0004	0.001
	(−0.33)	(−3.14)	(−2.52)	(−2.66)	(−0.98)	(0.72)	(0.81)	(0.12)	(0.14)	(0.27)
ROAE	0.006***	0.008***	0.007***	0.007***	0.008***	0.003**	0.003**	0.005***	0.004**	0.002
	(2.64)	(4.63)	(4.60)	(4.48)	(3.97)	(2.34)	(2.22)	(2.97)	(2.57)	(0.72)
EAR_VOL	0.101	−0.078	−0.106**	−0.084	−0.078	−0.004	−0.021	−0.046	−0.051	−0.011
	(0.94)	(−1.42)	(−2.19)	(−1.57)	(−0.81)	(−0.13)	(−0.71)	(−1.03)	(−1.06)	(−0.11)
TE_TA	−1.049**	−0.702	−0.961**	−0.758	0.361	−1.096***	−1.056***	−0.931**	−0.829*	−0.537

Table 4 The effect of NPLs on liquidity creation *(Continued)*

	(−2.20)	(−1.40)	(−1.98)	(−1.55)	(0.71)	(−3.05)	(−2.68)	(−2.03)	(−1.75)	(−1.01)
IBR	−0.01*	−0.008	−0.004	−0.0001	−0.001	−0.015***	−0.012***	−0.011**	−0.01*	−0.004
	(−1.93)	(−1.46)	(−0.87)	(−0.02)	(−0.16)	(−3.65)	(−2.83)	(−2.49)	(−1.93)	(−0.48)
LN_POP	−1.039	−1.087	−1.797	−2.657**	−3.713**	−2.038**	−1.608	−1.69	−1.425	−2.773
	(−0.89)	(−0.72)	(−1.35)	(−2.28)	(−1.98)	(−2.33)	(−1.64)	(−1.49)	(−1.39)	(−1.45)
GDP	0.005	0.007	0.004	0.003	−0.007	0.004	0.003	0.001	0.005	−0.004
	(0.93)	(1.39)	(0.96)	(0.56)	(−0.90)	(1.03)	(0.78)	(0.3)	(0.78)	(−0.49)
CONS.	7.545	8.05	13.251	19.225**	26.575*	14.860**	11.86*	12.462	10.346	19.915
	(0.90)	(0.74)	(1.39)	(2.29)	(1.96)	(2.37)	(1.69)	(1.53)	(1.40)	(1.45)
Sargan (*p* value)	0.710	0.760	0.990	0.002	0.451	0.282	0.358	0.05	0.241	0.762
AR (1) (*p* value)	0.198	0.547	0.707	0.183	0.062	0.106	0.143	0.083	0.287	0.457
AR (2) (*p* value)	0.819	0.843	0.974	0.972	0.585	0.613	0.798	0.649	0.839	0.952
N	420	396	367	282	216	445	418	384	291	221

Table 4 reports the results regarding the impact of non-performing loans on bank liquidity creation, obtained by one-step system GMM estimation. The dependent variables are either broad or narrow measure of liquidity creation standardized by total assets. *L* with a number before an independent variable represents lag. Parentheses denote *t* values, and *, **, and *** represent statistical significance at 10, 5 and 1 % level, respectively

197 banks spanning 10 years, but the abovementioned study used the data of just 87 banks covering 8 years only.

AVG_LNS and ROAE are the control variables which are significant determinants of variation in broad as well as narrow measure of liquidity creation. The significant relationship between AVG_LNS and liquidity creation implies that liquidity creation depends on the type of business a bank is involved in. The positive relationship between AVG_LNS and liquidity creation means more liquidity is created when a bank lends larger loans. This result supports the findings of Hackethal et al. (2010). The positive relationship between bank profitability and liquidity creation suggests that banks which have high profitability create more liquidity and vice versa. Increase in profitability result in higher amount of available funds and hence higher amount of liquidity creation.

The variation in broad measure of liquidity creation is also explained by the riskiness of the bank (Z_SCR) and the bank capital. The inverse relationship between Z_SCR and cat fat measure of liquidity creation means that risky banks create more liquidity and vice versa. Increase in risk taking results in higher liquidity creation. The negative relationship between Z_SCR and LC_CF is according to the findings of Lei and Song (2013). According to these findings, the banks having higher equity capital compared with their assets create less liquidity compared to their highly leveraged counterparts. The negative relationship between capital and broad measure of liquidity creation suggest that "financial fragility–crowding out" hypothesis holds in the case of Chinese banks. This result supports the findings of Lei and Song (2013).

The other control variables which explain variation in narrow measure of liquidity creation include the following: bank size, capital ratio, and interbank offered rate. The negative relationship between bank size and liquidity creation suggests that larger banks create relatively less liquidity compared with their smaller counterparts. This negative sign of relationship between bank size and liquidity creation support the findings of Hackethal et al. (2010), Lei and Song (2013), and Horvath et al. (2014). The relationship between bank capital and narrow measure of liquidity creation is also negative, providing support to the findings of Lei and Song (2013). Unlike broad measure of liquidity creation, narrow measure depends on the availability of the funds in the interbank market. A higher interest rate in the interbank market results in lower liquidity creation by on-balance-sheet activities. It means that when the liquidity in the interbank market shrinks, the banks reduce lending and vice versa. Using IBR as a proxy for monetary policy, the results imply that tight monetary policy result in lower on-balance-sheet liquidity creation by the Chinese banks.

In order to make it sure that liquidity creation by Chinese banks does not depend on NPL ratio, we repeated the analysis by using fixed and random effect techniques of panel data. Time and bank variant unobserved factors were controlled by bank and time dummies. All the regression estimates are robust because we controlled for heteroskedasticity and possible correlation between observations of the same bank in a different year by clustering banks. We repeated the same analysis by replacing all the independent variables with their first lags to control for the issue of endogeneity (Lei and Song 2013). We also repeated the analysis by considering the data as pool rather than panel. The results obtained by all these methods reinforced our initial finding that there is no relationship between NPL and bank liquidity creation in the case of China,

i.e., we did not find the evidence of a moral hazard problem in Chinese banks. The results are given in Table 5.

Regression analysis on the basis of bank size

The existing studies in the field of liquidity creation argue that liquidity creation by the banks depend on their size. Berger and Bouwman (2009a) found that large US banks created 81 % of total liquidity while medium sized banks generated 5 %, and small banks produced 14 % of the overall liquidity. Similarly, many studies have found that the relationship of bank liquidity creation with other variables also differ for the banks of different sizes (Berger and Bouwman 2009a; Distinguin et al. 2013; Imbierowicz and Rauch 2014; Chatterjee 2015). So, following the norm in the existing literature and our findings for the overall sample, we have conducted the analysis on the basis of bank size to determine whether there exists a relationship between NPLs and liquidity creation for small and large banks.

Different studies divide banks in different categories on the basis of different criteria. Imbierowicz and Rauch (2014) divided the banks in small, medium, and large categories by dividing the total assets of the banks in three quantiles. The first, second, and third quantiles represented small, medium, and large banks, respectively. Chatterjee (2015) also divided the banks in three categories. A bank was considered small if the total assets of the bank were less than $1 billion; medium, if the total assets were more than $1 billion but less than $3 billion; and large, if the total assets were greater than $3 billion. Distinguin et al. (2013) also divided banks in small and large categories. They considered a bank small, if the total assets of the bank were less than $1 billion, and large otherwise. Following the methodology adopted by Imbierowicz and Rauch (2014), we divided banks in small and large categories by dividing the total assets of the banks in two quantiles. The first quantile represents small banks, and the second quantile represents the large banks. The analysis which we performed for the overall sample was repeated for sub-samples of small as well as large banks.[1] We found that liquidity creation by small or large banks also does not depend on the level of non-performing loans, i.e., we did not find the evidence of a moral hazard problem in small as well as large banks.

Conclusions

This study explores the impact of NPLs on bank liquidity creation to know whether a moral hazard problem exists in Chinese banks or not. There are many studies which analyze bank liquidity creation and NPLs from different perspectives but to the best of our knowledge, none of the studies use these concepts to investigate a moral hazard problem. Existing literature regarding a moral hazard problem use credit growth as a measure of bank risk taking, which is subjective in nature. Bank liquidity creation is a better measure of risk taking because its objective and include both on-balance-sheet and off-balance-sheet activities. It calculates the amount of liquidity creation or risk transformation, which gives us absolute amount of risk taken by banks. Our null hypothesis is that Chinese banks create more liquidity when NPLs increase, i.e., a moral hazard problem exists in Chinese banks.

Table 5 The effect of non-performing loans (NPLs) on bank liquidity creation

	Pool data analysis		Panel data analysis (static)				Panel data analysis (dynamic - lagged independent variables)			
	Broad	Narrow	Broad measure		Narrow measure		Broad measure		Narrow measure	
	LC_CF	LC_CNF	LC_CF	LC_CF	LC_CNF	LC_CNF	LC_CF	LC_CF	LC_CNF	LC_CNF
NPL_TL	−0.002	−0.002	0.0001	−0.0002	0.0002	0.0001	0.0003	0.001	0.001	0.001
	(−1.05)	(−1.59)	(0.05)	(−0.19)	(0.13)	(0.06)	(0.40)	(0.78)	(1.28)	(1.30)
LN_TA	−0.017***	−0.016***	−0.020***	−0.105***	−0.019***	−0.117***	−0.021***	−0.120***	−0.024***	−0.102***
	(−4.02)	(−4.62)	(−2.78)	(−2.76)	(−3.31)	(−2.97)	(−2.57)	(−3.56)	(−3.58)	(−3.13)
AVG_LNS	0.249***	0.295***	0.271***	0.087	0.282***	0.063	0.243***	0.051	0.318***	0.143
	(4.95)	(6.9)	(4.52)	(0.80)	(5.38)	(0.56)	(3.33)	(0.35)	(4.78)	(1.03)
MKT_POW	0.09	0.401***	0.244	0.824	0.549**	1.022	0.25	0.782	0.596***	0.324
	(0.66)	(3.47)	(0.89)	(1.10)	(2.42)	(1.13)	(0.93)	(1.05)	(2.66)	(0.48)
Z_SCR	−0.002***	−0.001**	−0.001	0.015**	−0.001	0.013**	−0.0003	0.023**	−0.0001	0.013
	(−2.85)	(−2.48)	(−1.12)	(2.14)	(−0.95)	(2.12)	(−0.23)	(2.20)	(−0.06)	(1.26)
ROAE	0.005***	0.005***	0.003***	−0.0001	0.003***	0.0003	0.002	−0.002	0.002	−0.001
	(5.21)	(5.85)	(3.73)	(−0.06)	(3.45)	(−0.29)	(1.57)	(−0.73)	(1.49)	(−0.42)
EAR_VOL	−0.021	−0.02	−0.009	0.003	−0.002	0.023	−0.015	0.007	−0.007	0.017
	(−1.05)	(−0.96)	(−0.58)	(0.16)	(−0.09)	(1.05)	(−0.99)	(0.39)	(−0.31)	(0.73)
TE_TA	(0.26)	0.01	−0.597*	−1.148**	−0.244	−0.993**	−0.465	−1.032**	−0.317	−0.765
	(−0.92)	(0.04)	(−1.95)	(−2.41)	(−0.96)	(−2.45)	(−1.55)	(−2.35)	(−1.16)	(−1.56)
IBR	−0.008	−0.013**	−0.048*	−0.004	0.005	−0.007	0.01	−0.003	0.004	−0.009
	(−1.35)	(−2.49)	(−2.04)	(−0.50)	(0.14)	(−0.81)	(0.80)	(−0.37)	(0.27)	(−1.03)
LN_POP	−1.931*	−1.541	0.065*		−2.949		−9.233***		−6.978**	
	(−1.85)	(−1.60)	(2.53)		(−1.09)		(−3.32)		(−2.38)	
GDP	0.004	0.004	0.001	−0.005	−0.005	−0.013	−0.026***	−0.008	−0.019*	−0.006
	(0.74)	(0.70)	(0.24)	(−0.63)	(−0.66)	(−1.32)	(−2.76)	(−1.14)	(−1.83)	(−0.97)

Table 5 The effect of non-performing loans (NPLs) on bank liquidity creation *(Continued)*

CONS.	14.075*	11.177		1.864**	21.397	2.098***	66.944***	2.109***	50.630**	1.730***
	(1.87)	(1.61)		(2.58)	(1.11)	(2.83)	(3.34)	−3.34	(2.39)	(2.82)
Framework	OLS	OLS	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect
Bank dummy			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummy			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.342	0.391	0.373	0.399	0.378	0.412	0.370	0.415	0.403	0.431
N	420	445	420	420	445	445	336	336	358	358

Table 5 represents the results regarding the impact of non-performing loans on bank liquidity creation, obtained by pool data analysis (left most), static (middle), and dynamic (right most) panel data analysis. The dependent variables are either broad or narrow measure of liquidity creation standardized by total assets. All the independent variables in the dynamic panel model assume one period lagged value. Parentheses denote *t* values, and *, **, and *** represent statistical significance at 10, 5 and 1 % level, respectively

In order to analyze the impact of NPLs on bank liquidity creation, we measured it by using a three-step procedure proposed by Berger and Bouwman (2009a). We calculated liquidity creation by using cat fat and cat nonfat measure of liquidity creation. Total liquidity creation by 197 Chinese banks shows a declining trend over 2005 to 2014. To analyze the impact of changes in NPLs on bank liquidity creation, we used one-step system GMM estimation, fixed and random effect techniques, and pool data analysis. We found that liquidity creation by the banks is independent of changes in NPLs, i.e., we did not find the evidence of a moral hazard problem in Chinese banks. We repeated the analysis for small and large banks and found that level of NPLs does not affect liquidity creation in any of these sub-samples, which support our finding of none existence of a moral hazard problem in Chinese banks.

Our findings suggest that bank regulators should be vigilant to the increase in the NPLs ratio which is expected to grow as a result of slow economic growth. They should also be careful about the decline in liquidity creation because increase in NPLs and reduction in liquidity creation may collectively suppress already slowing economic growth leading to a downward spiral. The regulators should continue reforms in the financial sector to make it resilient, competitive, and efficient. Regarding future research, the concepts of liquidity creation and NPLs should be used to study the moral hazard problem in developed and least developed countries to determine whether it exists there or not.

Endnotes

[1]The Results have not been presented here for brevity but can be provided on demand.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
U and S carried out research to investigate the existance of moral hazard problem in Chinese banks by using an innovative methodology. They equally participated in the research and wrote the manuscript. They both read and approve the final manuscript for publication.

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