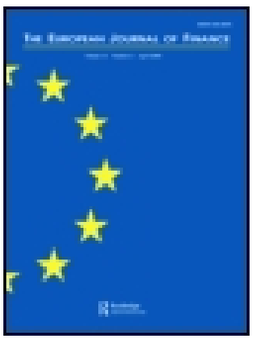

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Real estate investments and financial stability: evidence from regional commercial banks in China

Dayong Zhang[a*], Jing Cai[a], Jia Liu[b] and Ali M. Kutan[c,d,e]

[a]*Research Institute of Economics and Management, Southwestern University of Finance and Economics, Chengdu, People's Republic of China;* [b]*Salford Business School, University of Salford, Salford, UK;* [c]*Department of Economics and Finance, Southern Illinois University Edwardsville, Edwardsville, IL, USA;* [d]*Jiangxi School of Economics and Finance, Nanchang, People's Republic of China;* [e]*The William Davidson Institute, University of Michigan Business School, Ann Arbor, MI, USA*

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The 2008 US subprime mortgage crisis demonstrated how developments in real estate markets can cause instability in the banking sector and raised concerns in many emerging economies with significant real estate development and a rapidly growing commercial banking sector, particularly in China. There is clear evidence that commercial banks in China, especially regional commercial banks, have lent significantly to the real estate sector. The recent slowdown in the housing market in China and the increase in nonperforming loans (NPLs) in China's commercial banking sector motivated us to investigate the connection between real estate markets and banking stability. This paper proposes three testable hypotheses linking the growth of investment in real estate and the stability of regional commercial banks in China, measured by NPLs. Our empirical results reveal a close connection between the growth of investment in real estate and the NPLs among regional commercial banks, and its sensitivity to real estate market cycles. When real estate market activity declines, our results suggest, regional commercial banks can find themselves in trouble if they have significant exposure to one type of (real estate) asset. In addition, we find that regional bank competition plays a critical role in defining the relationship between bank stability and real estate investment activity.

Keywords: financial stability; nonperforming loans; real estate investment; regional commercial banks

JEL Classification: G21; G28

1. Introduction

The bursting of the US housing bubble and declining home prices combined with troubled subprime loans have been widely considered the direct causes of the 2008 US financial crisis. Diamond and Rajan (2009) argue that one of the main reasons for the US credit crisis was the misallocation of investment in real estate by the domestic financial sector. The crisis has had a profound impact on global financial stability and consequentially caused a global economic recession. The US housing crisis has also raised concerns for policy-makers in many emerging economies with significant real estate market activity and expectations of a future housing bubble. Whether and how real estate market activities affect commercial banking systems is therefore of great interest to both policy-makers and academic researchers in these economies.

This paper focuses on China, not only because of the size and significance of its economy in the world but also the special characteristics of both its real estate market and commercial

*Corresponding author. Email: dzhang@swufe.edu.cn

banking system compared to those in the United States. Banks in China lend significantly to real estate developers as well as providing mortgage loans. The bursting of the housing bubble in the United States caused subprime mortgage loans to default, which was then magnified through the derivatives market. In China, by contrast, the linkage between real estate loans and banks arises not only through mortgages but also via loans to real estate developers. When the real estate market is expanding, it is extremely profitable and generates significant wealth effects for borrowers in a relatively short time. During periods of market expansion, borrowers can easily repay loans to banks, which improves the banks' loan quality. However, when the housing market slows, real estate developers' profits fall, and they often find that it difficult to recover their initial investment; consequently, the loan quality at banks declines. An extreme example of this is China's famous ghost towns,[1] where developers have defaulted, leaving many unfinished projects.

China's rapidly growing real estate market and potential profit opportunities have caused the sector to attract significant investment. A high average growth rate for real estate investments, around 28% in our sample, is an important driving factor for the rapid growth in China's housing prices (Huang, Leung, and Qu 2015). Since China's commercial housing market reforms began in 1998, the real estate market has expanded quickly across the country, and housing prices have soared over time (Wu, Gyourko, and Deng 2012). This trend was even more apparent after the 2008 financial crisis, when the Chinese authorities implemented a RMB 4 trillion stimulus package. Housing prices have risen so quickly since 2009 that the government has had to introduce a series of strong policy interventions in order to moderate the rapid rise of housing prices. A sudden decline in housing prices could cause serious financial instability.

Another special feature of China's economy is a rapidly expanding regional commercial banking system. There is a clear evidence that these banks tend to lend significantly to the real estate market. Table 1 lists the top five regional commercial banks in China, in terms of size and the percentage of real estate-related loans relative to total loans and shows that real estate-related loans account for a significant share of those banks' total loans. When the construction sector

Table 1. Top five commercial banks and their respective shares of real estate-related loans.

Bank name	Year	Real estate share	Including construction
Bank of Beijing	2010	13.67 (3)	18.11 (1)
	2011	11.28 (2)	16.67 (1)
	2012	11.8 (2)	17.29 (2)
Bank of Shanghai	2010	15.6 (2)	20.45 (1)
	2011	14.06 (4)	19.12 (1)
	2012	12.81 (2)	18.11 (1)
Bank of Jiangsu	2010	9.03 (4)	–
	2011	9.29 (3)	15.09 (3)
	2012	8.8 (3)	15.97 (3)
Beijing Rural Commercial Bank	2010	18.87 (1)	21.82 (1)
	2011	25.57 (1)	28.06 (1)
	2012	15.44 (1)	21.78 (1)
Shanghai Rural Commercial Bank	2010	21.08 (1)	25.7 (1)
	2011	19.36 (2)	23.17 (1)
	2012	19.16 (2)	23.76 (1)

Note: Data (in percentage points) are collected from the annual report of each bank. The numbers in brackets are rankings of real estate-related loan share of each respective bank. The last column reports the share of loans including real estate and construction.

is included, the share of real estate-related loans becomes even higher and comprises the largest proportion of loans in four of the five banks. This situation is quite common at most regional commercial banks. Such a high level of exposure to one particular asset class can pose a significant threat to the stability of the banking system, especially when this type of asset is likely to be subject to price bubbles. China's regional commercial banking sector began to emerge in the early 1990s and has grown at an astonishing speed over the past 10 years. This sector consists of two main parts: city commercial banks and rural commercial banks. At the end of 2012, there were 144 city commercial banks and 337 rural commercial banks with a combined total of more than 10,000 local branches operating in almost every province in China.

However, the Chinese economy, including the housing market, has recently started to slow down. Nonperforming loans (NPLs) in commercial banking sector have also increased to the highest level since 2010,[2] which calls for the attention of policy-makers. The level of NPLs is often considered when identifying banks with potential financial troubles. Evidence also indicates that banks often experience a high level of NPLs prior to insolvency (see, e.g. Barr, Seiford, and Siems 1994; Dermirgüc-Kunt 1989). China's banking industry has faced a long-standing problem with NPLs, and the government has had to inject a significant amount of capital in order to reduce NPL levels (Jiang, Yao, and Feng 2013). According to the China Banking Regulatory Commission (CBRC), the NPL ratio in the banking industry has recently been an average of less than 2%. Regulating NPLs and avoiding financial instability have been among the most important policy concerns of Chinese regulators.

China has carried out reforms in its banking system. For example, on 1 May 2015, the State Council enacted the Deposit Insurance Act, which requires financial institutions to participate in a deposit insurance system by paying a premium to a fund managed by an agency appointed by the State Council. The aim of this reform is to further move toward a market mechanism for the banking industry, and it sends signals to markets that the government may not necessarily provide full support to all commercial banks in the event of default. In the event of bank insolvency or bankruptcy, deposit insurance will cover all individual deposits up to RMB 500,000, or USD 81,433.

Banks in China are owned mainly by the government, including the big four state-owned banks. Over 70% of the shares of the big banks are owned directly by the state, even after they go public, which means the government would likely step in if these banks encounter trouble. The ownership structures of joint-stock banks, especially newly established regional commercial banks, however, are more diversified (see the next section for further discussion). Regional commercial banks do not necessarily get a full government guarantee and are often subject to a higher level of competition. Given that the regional commercial banks are heavily exposed to real estate markets, and that this exposure might increase due to a recent change in policy that allows troubled banks to fail, it is therefore timely to investigate how real estate market developments affect the stability of the Chinese regional commercial banking system. The literature investigating efficiency, moral hazard, and behavior of the Chinese commercial banks has increased (e.g. Fang and Jiang 2014; Ferri 2009; Luo and Ying 2014; Shih, Zhang, and Liu 2007; Sun, Harimaya, and Yamoci 2013; Yano and Shiraishi 2014; Zhang, Wang, and Qu 2012; Zhang et al. 2015, 2016). To the best of our knowledge, however, this paper is the first to explicitly examine the relationship between the real estate market and the stability of China's regional commercial banks using a bank-level micro dataset.

This paper is built around three-related hypotheses, which are established based on analytical studies in the literature. The first hypothesis is that higher regional real estate investment growth reduces NPL ratios for regional commercial banks. The second hypothesis states that the impact

of the real estate market on the NPL ratios of regional commercial banks is sensitive to property cycles, which is tested using a threshold model. The third hypothesis is that regional bank competition affects the relationship between real estate market developments and the stability of the banking sector.

Our empirical results provide support for Hypothesis 1, suggesting that regional banks benefit from the rapid growth of real estate investments. Hypothesis 2 explores what happens to banking sector stability when the real estate market slows or even shrinks significantly. We find that a decline in real estate market activity increases NPLs and hence increases banking instability. Tests of Hypothesis 3 indicate that bank competition plays a critical role in defining the relationship between bank stability and real estate investments. These results have implications for many emerging markets that have seen significant growth in real estate markets and potential price bubbles in recent years.[3]

The rest of the paper is organized as follows. Section 2 reviews the history and major developments of regional commercial banks in China, and Section 3 summarizes related studies in the literature and develops an analytical framework to derive our hypotheses. Section 4 discusses the empirical methodology. Section 5 reports the empirical results and discusses our findings. Section 6 concludes the paper, offering some policy recommendations.

2. History of regional commercial banks in China

Although the modern Chinese regional commercial bank is less than 20 years old, its original form, namely, the credit union, can be traced much farther back, to the earliest period of the People's Republic of China. In the early 1950s, the People's Bank of China (PBoC) developed widespread rural credit unions. By the end of 1957, China had 88,368 rural credit unions. In the early 1980s, city credit unions were established and developed very quickly. Over the next 10 years, more than 5000 city credit unions were established, and they have played an important role in China's economy, complementing the big state-owned commercial banks. As economic activity and financial markets have expanded, credit unions started to encounter problems due to ambiguously defined ownership structures and inefficient risk management. Therefore, the PBoC imposed structural banking reforms in order to reorganize the credit unions.

Prior to 2003, rural credit unions experienced several stages of administrative transition; they were first supervised by local work units (1959–1979), next by the Agricultural Bank of China (1979–1996), and eventually by the PBoC (1996–2003). During this transition period, the rural credit unions started to function more effectively as their role became increasingly clear. In June 2003, the State Council initiated a new round of reforms and structural renovations with three main objectives: reorganizing traditional credit unions and creating provincial-level collaborative unions; setting up joint-equity commercial banks; and reorganizing rural cooperative banks. In 2010, the CBRC decided to stop establishing new rural cooperative banks and gradually transform the existing ones by directly converting qualified collaborative unions and cooperative banks into rural commercial banks. This policy fundamentally changed the rural banking system, and, by the end of 2012 there were a total of 337 rural commercial banks. Although 147 rural cooperative banks and 1927 credit unions are still in operation, rural commercial banks have started to play a dominant role in the industry.

Another main part of the Chinese regional commercial banking system includes city commercial banks, which have their origins in city credit unions. Since 1995, under the general guidance of the State Council, commercial banks have been established in 30 large to medium-size cities across China to serve both the local economy and small and medium-size enterprises.

Table 2. The regional banks in China.

	Rural commercial banks	City commercial banks
Number of banks	337	144
Assets	RMB6275.1 billion	RMB12,346.9 billion
Number of employees	220,042	259,261
Share	4.70%	9.24%

Source: China Banking Regulatory Committee (CBRC). Data are from the end of 2012.
Note: 'Share' describes each respective bank type's share in all financial institutions in terms of asset value.

City commercial banks are now an important part of China's financial market, holding about 9.24% of the total asset value of all financial institutions (see Table 2). Their role in local financial markets has grown significantly. As their business volume has grown quickly, restrictions circumscribing their operations within specific regions have gradually hampered their further development and effectiveness. This, in turn, has prompted many city commercial banks to expand their businesses beyond traditional geographic boundaries. A typical indicator of this change is that most city commercial banks have removed the word 'city' from their names in recent years. For example, 'Shanghai City Cooperative Bank' renamed itself 'Bank of Shanghai' and became the first city commercial bank to be allowed to operate across regions in November 2005. Other city banks, such as Bank of Beijing and Bank of Ningbo, quickly followed.

To encourage the further development of regional commercial banks, the CBRC eased restrictions on cross-regional operations and other relevant regulations in April 2009. As a result, a wave of cross-regional expansion of city commercial banks has taken place. Some big regional banks, including the Banks of Beijing, Ningbo, and Nanjing, listed shares on stock markets. Their successful stories have been well regarded as role models for a typical regional bank's expansion.[4]

The regional commercial banks' ownership structure is different from that of the main state-owned banks or joint-stock banks. In the early years of city commercial banks, their ownership structure was designed by the PBoC and included local enterprises, private businesses, urban residences, and local government as key shareholders, with the local government owning around 30% of total shares as the largest shareholder. The share held by local governments has declined over time and reached an average of 24.2% in 2004 (see the Development Research Center of the State Council 2005). There are now more banks controlled by private capital, and government control has started to decline. Overall, there is a clear trend of change in the ownership structure of the regional commercial banks. Since China's entry to World Trade Organization, foreign investment inflows to China have increased, including into the commercial banking sector. The CBRC allows a maximum of 25% foreign ownership, or 20% if there is a single owner. For example, in 2012 ING Bank held 13.64% of the Bank of Beijing and Commonwealth Bank of Australia held 20% of the Bank of Hangzhou. Other major city commercial banks have sold shares to foreign interests. Meanwhile, the CBRC also set up similar rules for rural commercial banks in 2003. Based on the initial ownership of rural credit unions, the ownership structure of rural commercial banks has expanded to rural residences, rural private businesses, enterprises, and other economic entities. Given this sector's developments trend, including the change in ownership structures and government policy encouraging the further development of these banks, it is of great interest to the central government and other-related stakeholders to ensure regional commercial banks' operations are sound and healthy.

3. Literature review and hypothesis development

In this section, using earlier analytical studies, we first build a framework to establish the causal link between real estate investments and banking sector stability and then derive three hypotheses.

Compared to other types of assets, secured real estate loans tend to have higher recovery rates in the event of default. Banks are therefore willing to lend more in real estate-related loans. When real estate values change, the collateral values of loans are affected, which in turn affects both borrowing and bank lending behavior. Herring and Wachter (1999) argue that banks benefit from real estate lending when real estate values rise, increasing the collateral value of real estate loans and therefore reducing existing loans' risk of default. Well-performing property-related loans and higher returns on real estate investments can encourage banks to further increase their real estate market loans. In a growing real estate market, banks make more loans and have higher returns on assets and fewer loan provisions. Niinimaki (2009) argues that rising real estate values increase bank profitability and reduce the likelihood of financial distress in the banking system. These theoretical arguments have empirical support. Related empirical studies, however, focus mainly on advanced economies. Goodhart (1995), for example, reports that property prices affect credit growth in the UK, but not in the United States. Hofmann (2003) confirms this finding for 16 countries. Employing a time-series approach to examine the causality between property prices and bank lending in Hong Kong, Gerlach and Peng (2005) find that the causality runs only from the former to the latter. In their cross-country analysis of member countries of the Organization for Economic Cooperation and Development (OECD), Davis and Zhu (2009, 2011) also report a significant impact of property prices on credit expansion. In addition to the macro-level studies, some recent studies have employed micro-level bank data. For example, Arpa et al. (2001), who studied Austrian banks in the 1990s, find a positive relationship between real estate prices and bank profitability. Blasko and Sinkey (2006) investigate the link between asset structure, real estate lending, and US banks' risk-taking behavior and conclude that specialized banks (commercial banks holding more than 40% of their total assets in secured real estate loans) are more likely to encounter insolvency. Barrell et al. (2010) estimate equations for early warning systems for banking crises in OECD countries and highlight the usefulness of real estate prices as an early warning sign for predicting banking crises. Using data from German banks, Koetter and Poghosyan (2010) find that real estate price developments can cause bank instability due to excessively risky lending.

Regional commercial banks in China play a crucial role in supporting the development of the real estate market in many respects, such as loans to purchase land, financing for real estate construction projects, and other activities. China's real estate market has experienced an upward trend, characterized by rising property prices and high investment growth. Chinese regional commercial banks hold significant real estate-related loans. Based on the theoretical arguments discussed by Herring and Wachter (1999) and others, real estate market activity is expected to affect the performance of Chinese regional commercial banks, including their loan quality. In particular, increased investments in the real estate sector, either by increasing collateral value or increasing profitability, should reduce troubled loans for banks. Hence, our first hypothesis (H1) is as follows:

> Hypothesis 1: Improved regional real estate market activity improves the loan quality of the regional commercial banks.

Although banks may benefit from real estate expansion, a key question is what happens when the property market goes through cycles. Hott (2011) suggests that the impact of the real estate

market on bank lending behavior may be sensitive to property market cycles. When the real estate cycle is in an expansion phase, banks may benefit from rising earnings or lower default rates; but when the market moves into a downward phase, they may suffer great losses. Indeed, bursting housing bubbles in the 1980s and early 1990s caused higher default rates and bank losses in Japan, the UK, and the United States.

As Figure 1 shows, in recent years the Chinese housing market has undergone a clear upward and persistent trend of real estate investment at the aggregate level. Despite an upward trend at the aggregate level, significant fluctuations take place in the short term. When micro data at the city-level is considered, we observe that the growth rate of real investments in our sample is quite diverse, however, ranging from −70.5% to 217.05% with a standard deviation of 30.45% (see Figure 2), displaying both high- and low-speed growth (even shrinking investments) over the full sample period. Hence, examining data on city-level investment growth rates provides additional information on whether the linkage between real estate investment and NPL ratios is sensitive to property cycles.

Figure 3 plots the correlation between NPLs and the growth rate of investment in real estate (DINV), which demonstrates that the relationship tends to be negative when the housing market expands quickly and positive when it slows down. This information suggests that we should employ a threshold model to capture the impact of property cycles.[5] Hence, our second hypothesis (H2) is as follows:

Hypothesis 2: Real estate development and loan quality relationship is subject to a threshold effect.

Recent studies (see, e.g. Davis and Zhu 2011; Pugh and Dehesh 2001) of regional commercial banks in China also emphasize the role of regional macroeconomic conditions and development on the performance of these banks. Pugh and Dehesh (2001) argue that deregulation of the financial sector has increased bank lending to the property market and consequently caused financial instability in some developed countries since 1980s. The level of bank competition can also affect banks' lending behavior. Keeley (1990) suggests that bank profits decline with higher levels of competition and banks tend to take higher risks when facing competition. Keeley's analytical model also suggests that the recent deposit insurance system introduced by Chinese regulators

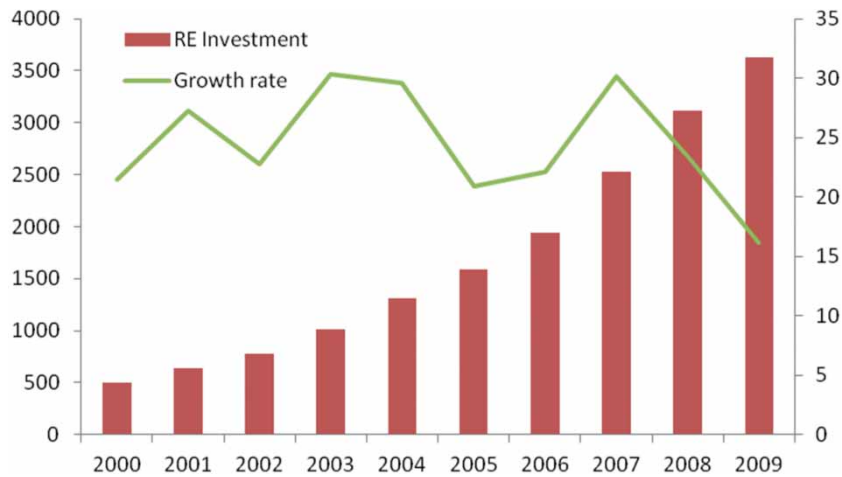

Figure 1. Real estate investment and growth rate in China. Source: National Bureau of Statistics. The unit for Investment level (left axis) is billions of RMB, and its growth rate (right axis) is in percentage.

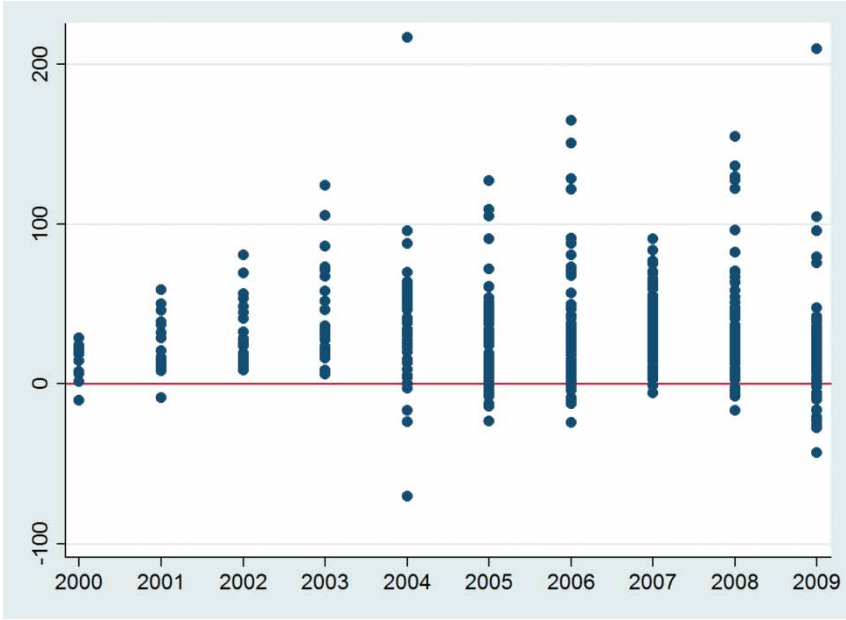

Figure 2. Distribution of real estate investment growth in our sample cities (in percentages).

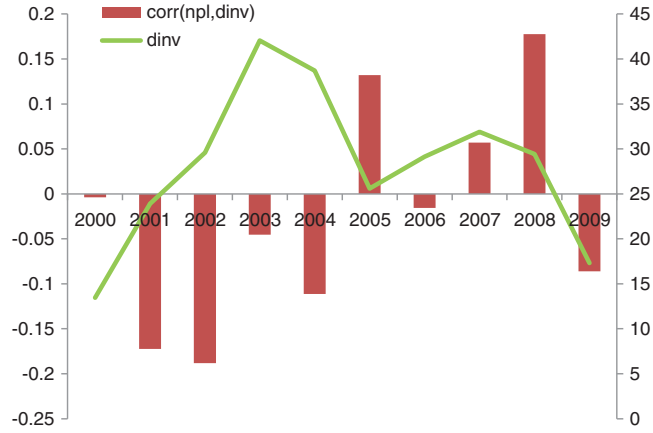

Figure 3. Correlations between real estate loan growth and NPLs.

in May 2015 may hurt bank stability through moral hazard problems by causing excessive risk-taking. Similar arguments are put forward by Allen and Gale (2000a) and Hellman, Murdock, and Stiglitz (2000). Using 406 banks in sample countries, Kim, Kim, and Han (2014) find that deposit insurance increases banks' risk-taking in the Association of Southeast Asian Nations (ASEAN) countries and Korea. These studies provide a clear motivation for including a measurement of the level of regional bank competition in our estimations to further understand the connection between real estate market growth and the stability of the banking sector.

Still, the existing literature has not yet reached a consensus on the role played by bank competition in banking sector stability. Boyd and Runkle (1993) and Mishkin (1999) argue that higher levels of bank concentration can cause instability due to banks' belief that they are 'too big to

fail'. Caminal and Matutes (2002) also suggest that banks are more vulnerable when the level of competition decreases. However, Broeker (1990) argues that competition may reduce banks' loan selection efforts, causing a higher likelihood of low-quality loans. Based on the theory of the 'winner's curse', Cao and Shi (2001) and Riordan (1993) find that higher levels of competition may cause more instability in the banking system. One explanation for this negative link between competition and banking stability is increased bank regulation. Recent studies find that banking regulation improves bank performance and stability, including a decline in NPLs in many emerging economies (see, e.g. Fu, Lin, and Molyneux 2014; Klomp and de Haan 2014; Neyapti and Dincer 2014; Ozkan, Balsari, and Varan 2014). Higher levels of bank regulation may decrease bank competition, thereby improving the stability of the banking system, which supports the evidence reported by Cao and Shi (2001) and Riordan (1993).

Based on these arguments, this paper considers the role that regional bank competition plays in the relationship between the real estate market and the Chinese banking sector's stability. Compared to larger state-owned banks and joint-stock banks, which operate across the country and have longer histories, Chinese regional commercial banks have a clear disadvantage in joining the competition. However, they also have several advantages. For example, a commercial bank operating in a particular city is more likely to have an information advantage and local government support. Hence, our third hypothesis (H3) is as follows:

> Hypothesis 3: Real estate development and loan quality link are affected by regional bank competition.

4. Empirical methodology

In order to test our three hypotheses, we construct the following empirical models:

$$\mathrm{NPL}_{i,t} = \alpha + \beta \mathrm{DINV}_{i,t} + f(\mathbf{X_{i,t}}) + \varepsilon_{i,t} \tag{1}$$

$$\mathrm{NPL}_{i,t} = \alpha + \beta_1 \mathrm{DINV}_{i,t} \cdot I(\mathrm{DINV}_{i,t} > \gamma) + \beta_2 \mathrm{DINV}_{i,t} \cdot I(\mathrm{DINV}_{i,t} \leq \gamma) + f(\mathbf{X_{i,t}}) + \varepsilon_{i,t} \tag{2}$$

$$\mathrm{NPL}_{i,t} = \alpha + \beta \mathrm{DINV}_{i,t} + \theta \mathrm{DINV}_{i,t} \cdot \mathrm{HHI}_{i,t} + \phi \mathrm{HHI}_{i,t} + f(\mathbf{X_{i,t}}) + \varepsilon_{i,t} \tag{3}$$

where DINV refers to real estate market growth[6], $\mathbf{X_{i,t}}$ is a vector of control variables, including bank-specific characteristics (i.e. bank size and deposit ratio) and also includes a proxy for macroeconomic conditions (i.e. the growth rate of local gross domestic product [GDP]). Year dummies are also included in all regressions.

Equation (1) is used to test H1. Given control variables, we expect a negative relationship between the NPL ratio and DINV. Equation (2) is used to test H2. $I(\cdot)$ is the indicator function (which has a value of 1 if the statement in parentheses is true and 0 otherwise) and γ is the threshold value estimated endogenously. We follow Hansen's (1999) basic principle and use a grid search to find the threshold value. To do so, all possible value of DINVs are used as potential threshold values in order to define two regimes, and regression residuals are saved. The threshold value is chosen based on the regression with the minimum sum of squared residuals.

In Equation (3), a measure of the level of bank competition is included to test H3. We use a dataset available from the CBRC website[7] and follow Chong, Lu, and Ongena (2013) in

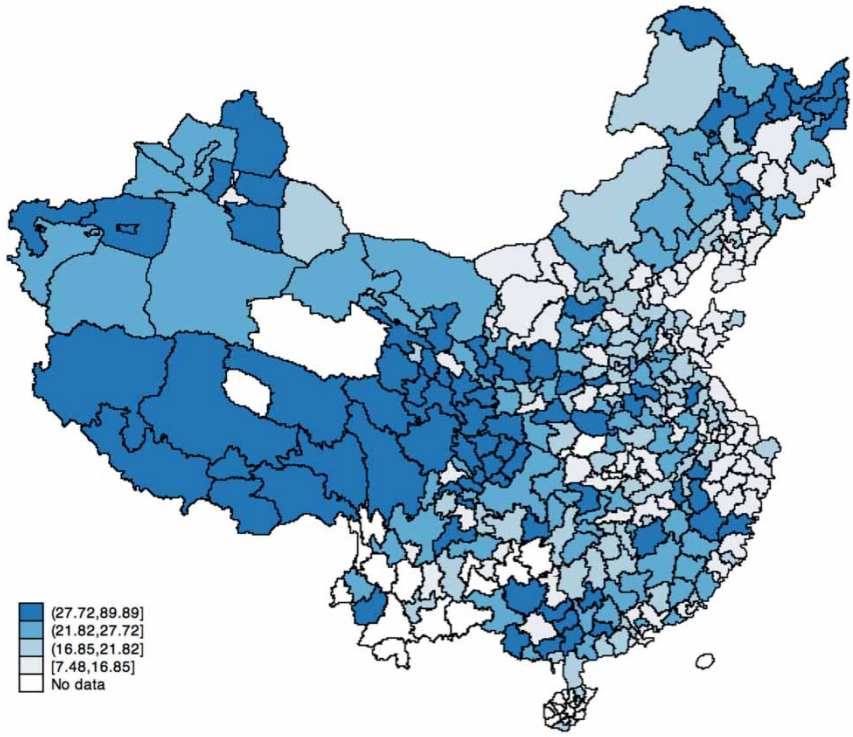

Figure 4. Map of regional bank competition map in China (HHI measured in 2009).
Source: CBRC (China Banking Regulatory Commission) and the authors' calculation.

constructing two measures of regional bank competition: the Herfindahl–Hirschman Index (HHI) and the concentration ratio (CR, the concentration ratio for the largest three banks in a city). Assuming that there are K banks in a city and each bank has a number of branches, denoted $\#\text{branch}_k$, the two measures can be calculated as:

$$\text{HHI} = \sum_{k=1}^{K} \left(\#\text{branch}_k / \sum_{k=1}^{K} \#\text{branch}_k \right)^2 \tag{4}$$

$$\text{CR} = \sum_{n=1}^{3} (\#\text{branch}_n) / \sum_{k=1}^{K} \#\text{branch}_k \tag{5}$$

The HHI measure using 2009 as an example across all Chinese cities is plotted in Figure 4.

5. Data and empirical results

5.1 *Data description*

One of the biggest limitations of micro-level studies of Chinese commercial banks is the scarcity or unavailability of high-quality data. In order to expand the available sample and incorporate as much reliable information as possible, we use a variety of sources and collect bank financial

Table 3. Variable descriptions.

Variables	Abbreviations	Description
Loan ratio	LR	End of period loan over total assets
Loan growth	LG	Loan growth rate
Nonperforming loans ratio	NPLs ratio	Nonperforming loan over total loans
Deposit growth	DG	Deposit growth rate
Deposit ratio	DR	End of period deposit over total assets
Equity ratio	ER	End of period equity over total assets
Capital ratio	CAR	Capital adequacy ratio
Return on assets	RoA	Return on assets
Size	LA	End of period total asset (in natural logarithm)
Loan share	LS	Loans of a bank over total city loans of all financial institutions: $LS_i = \frac{L_i}{\sum_{j=1}^{N} L_j}$
GDP growth	DGDP	GDP growth rate in cities
Real estate investment growth	DINV	Real estate investment growth rate in cities
Average wage of employee	WAGE	Average wage of employee in cities(in natural logarithm)
Competition index	HHI	Herfindahl–Hirschman Index
Concentration ratio	CR	Concentration ratio for the largest three banks

data from different sources. The majority of data is taken from the BANKSCOPE database, especially data before 2007. In July 2007, the CBRC officially released the Measures for Information Disclosure of Commercial Banks, requiring all commercial banks to disclose information to both investors and the general public in their annual reports. This financial information must be audited by certified public accountants and is also under CBRC supervision. This enables us to find additional reliable information about bank operations, especially that of regional commercial banks. In addition to city-level real estate data, local GDP, and other macro-level data are taken from the China Economic and Social Development Database. A description of the variables is in Table 3.

We use annual data from 2000 to 2009 and winsorize the key variables at the 1% level to avoid outliers. The full sample consists of 138 regional commercial banks (100 city commercial banks and 38 rural commercial banks). These banks are located in a total of 118 cities. In the following analysis, the banks are paired with their respective home cities. Since cross-regional operation was formally authorized only in 2009, our sample period ends in this year. Regional (city-level) GDP growth is used to represent the local economic environment of each specific bank. Generally, the word 'local' refers to a particular bank's main operating city.

The descriptive statistics of our samples are shown in Table 4. Notably, the loans of the regional commercial bank in a particular city can in some cases account for more than 37.78% of the city's total commercial loans. This indicates that some regional banks have a dominant role in their own regional economy.

5.2 *Empirical findings*

5.2.1 Real estate investment and NPL ratio

The baseline regression results based on Equation (1) between real estate investment growth and the banks' NPL ratios are reported in Table 5. The coefficients on DINV (annual growth of

Table 4. Descriptive statistics.

Variables	Number of observations	Mean	Median	Min	Max	Std. Dev.
LR	604	53.78	54.35	30.86	72.44	9.00
LG	604	25.88	23.19	− 8.02	91.85	17.39
NPL ratio	604	5.58	3.29	0.31	27.66	6.06
DG	604	27.07	23.21	− 4.57	83.98	16.3
DR	604	84.12	85.83	61.08	95.22	7.47
ER	604	5.38	5.16	1.26	12.28	2.19
CAR	604	9.59	9.72	− 4.16	25.46	4.60
RoA	604	0.76	0.61	0.01	2.58	0.55
DGDP	604	17.35	17.18	− 32.16	98.69	8.38
DINV	604	28.60	23.17	− 70.51	217.05	30.45
LS	604	9.00	7.14	0.22	37.78	6.38
LA	604	16.67	16.68	13.9	20.09	1.13
WAGE	593	3.16	3.17	2.43	4.04	0.35
HHI	604	17.17	16.33	7.49	48.64	5.26
CR	604	60.00	59.71	34.57	93.18	10.14

Sources: Bank-level data are collected from the BANKSCOPE Database and annual reports of banks; City-level real estate and macro data are taken from the China Economic and Social Development Database.
Notes: See Table 3 for definitions of the variables.

city-level real estate investment) are all negative and significant across all eight specifications. This provides support for H1. Higher real estate market investment growth indicating housing market expansion reduces regional commercial banks' risk of overexposure. Increasing collateral value or higher profit from the borrowers essentially reduces the probability of default and thus lowers the NPL ratio.

The magnitude of the estimated DINV coefficient may look relatively small when referring to the coefficients around -0.01 across all models. We have to recognize that the NPL ratios of Chinese banks have been generally low after many years of reform. Although the average NPL ratio is 5.58% in our sample period, according to the CBRC average NPL ratios have managed to remain relatively low and generally have been lower than 2% in recent years. Given that real estate investments have an average growth rate of about 28% with a standard deviation of 30%, the impact of bank risk levels on the current results cannot be ignored. Nonetheless, our results are consistent with the literature (i.e. Davis and Zhu 2009), which often reports small coefficients on real estate-related variables.

Regarding results for the control variables, we observe that the signs of the estimated coefficients in Table 5 are consistent with our prior beliefs. Capital adequacy ratios (CAR) or equity ratios (ER) both negatively affect NPL ratios. Banks with higher levels of CAR/ER are safer and should have correspondingly lower NPL ratios. Larger regional commercial banks (as measured by size) have lower NPL ratios, suggesting that smaller banks are riskier. Deposits and loan measures are all negatively related to NPL ratios (although most are not significant). Return on assets has a positive relationship with NPL ratios but, again, is not statistically significant.

The loan shares of these regional banks in their respective regions (cities) have a positive impact, suggesting that a bank with a higher share in its operating region has more risk. This finding has important implications for regulators and bank managers. As city and rural commercial banks in China expand rapidly in the twenty-first century, they need to diversify their businesses

Table 5. Real estate investment and NPL ratio.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DINV	− 0.0111**	− 0.0109**	− 0.0110**	− 0.0106**	− 0.0102**	− 0.0099**	− 0.0095**	− 0.0090**
	(0.0052)	(0.0052)	(0.0048)	(0.0049)	(0.0049)	(0.0048)	(0.0043)	(0.0044)
ER	− 0.3710*	− 0.3864*			− 0.3537*	− 0.3697*		
	(0.1938)	(0.2049)			(0.1948)	(0.2041)		
CAR			− 0.3126***	− 0.3142***			− 0.3036***	− 0.3048***
			(0.0981)	(0.1011)			(0.0992)	(0.1018)
LR	− 0.0090	− 0.0177	− 0.0589	− 0.0648				
	(0.0614)	(0.0626)	(0.0519)	(0.0525)				
LG					− 0.0170*	− 0.0147	− 0.0230**	− 0.0203*
					(0.0098)	(0.0102)	(0.0109)	(0.0111)
DR	− 0.0037	− 0.0082	0.0122	0.0073				
	(0.0556)	(0.0560)	(0.0552)	(0.0553)				
DG					− 0.0032	− 0.0047	− 0.0021	− 0.0041
					(0.0167)	(0.0174)	(0.0169)	(0.0175)
RoA	0.0598	0.1016	0.2209	0.2460	0.0448	0.0775	0.1851	0.1993
	(0.4826)	(0.4584)	(0.4770)	(0.4452)	(0.4915)	(0.4654)	(0.4800)	(0.4479)
LA	− 3.2781*	− 3.8706**	− 3.3639*	− 3.7621*	− 2.6447	− 3.0386	− 1.9929	− 2.1802
	(1.8880)	(1.8905)	(1.9141)	(1.9161)	(2.0830)	(1.9427)	(1.9619)	(1.8376)
LS	0.3545***	0.3824***	0.3925***	0.4117***	0.3481**	0.3614**	0.3397**	0.3445**
	(0.1350)	(0.1356)	(0.1340)	(0.1332)	(0.1459)	(0.1453)	(0.1392)	(0.1375)
DGDP		0.0104		0.0162		0.0104		0.0155
		(0.0164)		(0.0164)		(0.0163)		(0.0164)
WAGE		− 6.9552**		− 6.3198**		− 7.0799**		− 6.1805**
		(2.8366)		(2.6906)		(2.8222)		(2.6031)
Constant	58.2971*	93.9781**	61.8938*	92.1495**	47.1222	79.0778**	37.5852	62.6964*
	(34.2982)	(36.3403)	(34.2807)	(36.4861)	(35.5140)	(36.5017)	(33.2423)	(33.6622)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	604	593	604	593	604	593	604	593
R^2	0.605	0.609	0.627	0.630	0.608	0.611	0.630	0.632

Notes: This table reports the results of the test of the relationship between real estate investment growth and NPLs ratio. NPLs ratio is the dependent variable for all regressions. The results are based on panel regressions with bank fixed-effects (Breusch and Pagan LM test for random effects vs. pooled OLS, Hausman test for random effects vs. fixed-effects all significant in favor of the fixed-effect model). The last four regressions differ from the first four regressions in that they use LG and DG to replace LR and DR. For robustness, we use ER in regressions (1), (2), (5), and (6) and CAR in regressions (3), (4), (7), and (8). See Table 3 for definitions of the variables. The robust standard errors are in parentheses.
*** Significance level at 1%.
** Significance level at 5%.
* Significance level at 10%.

not just in terms of loan types but also in terms of regions, which supports the Chinese authorities' policy change allowing regional banks to operate across regions since 2009. Of course, one has to realize that moving out of one's home city can be risky due to losing the informational advantage and local government support, which may cause trouble for the expanding banks, as they are also more likely to suffer from an adverse selection bias (Stiglitz and Weiss 1981).

In addition to year dummies, two regional macroeconomic indicators are included in our regressions (see Models 2, 4, 6, and 8). Local GDP growth rates have no significant impact on NPL ratios, but average wage levels have a negative and statistically significant impact on NPL ratios. A higher average wage level represents the ability to repay bank loans and therefore reduces the NPL ratio.

5.2.2 Is there a threshold effect?

Recently, the threat of a potential housing market bubble has forced the Chinese government to introduce a series of intervention policies. While banks benefit from a real estate expansion, it may be more interesting to see the consequences of a shrinking housing market on the banking system. A decline in real estate investment activity may significantly hurt regional banks, as shrinking collateral value and insolvent borrowers can induce troubled loans. H2 suggests that the relationship between real estate market development and banks' NPL ratios is sensitive to property cycles. Our sample period includes clear cases of both high-speed and low-speed growth. This is more apparent in the city-level data (see the distribution of real estate investment growth across cities in Figure 2 as an example). Real estate expansion may benefit banks, but a decline in real estate market activity may equally harm the banks by increasing troubled loans. We capture this effect by using a threshold model. Banks may benefit from real estate market development only when their growth exceeds a critical level. If the growth of the real estate market drops below this critical threshold level, then banks may suffer more than they benefit.

Table 6 reports the results of allowing threshold effects. The threshold value is found through a grid search method proposed by Hansen (1999) that minimizes the sum of squared residuals. The estimated threshold value is 21.88%; this means that we can divide DINV into high-speed samples and low-speed samples using dummy variables. Hence we define dum_l and dum_u as $\text{dum}_l = I(\text{DINV} \leq \gamma)$ and $\text{dum}_u = I(\text{DINV} > \gamma)$, where $I(\cdot)$ is the indicator function (which has a value of 1 if the statement in parentheses is true and 0 otherwise), and γ denotes the threshold value.

In Table 6, while the impact of all other control variables remains the same as in Table 5, an interesting finding is the different coefficients for high-speed (dum_u) growth compared to low-speed (dum_l) growth (relative to the threshold value). The coefficients on the high-speed, DINV*dum_u, remain almost the same as the baseline regression results (Table 5), but those on the low-speed, DINV*dum_l, are generally positive and significant, and the values are clearly higher, suggesting that the impact of real estate expansion on banks' NPL ratios may not be linear but, rather, is governed by a threshold effect. Higher levels of growth in the real estate market (expansionary) can benefit bank operations by reducing troubled loans. Banks that are overexposed to real estate market development, however, may find themselves in trouble when the real estate market slows down. A down market (contractionary), which is more likely to occur as China's real estate market evolves, can potentially cause significant instability. Hence, both bank managers and policy-makers need to pay attention to banks' loan allocations to the real estate sector.

5.2.3 The role of regional competition

Following the literature (Chong, Lu, and Ongena 2013), we use a comprehensive database publicly available on the CBRC website to construct a measure of regional bank competition (namely, HHI and CR) and test whether the relationship between real estate market investment and bank NPL ratios is sensitive to regional bank competition. Table 7 reports the results.

Results for control variables remain similar to those reported in earlier tables. Hence the discussion here focuses primarily on regional bank competition and DINV variables. The results in Table 7 further confirm that a higher DINV reduces the level of NPL ratios. In addition, we observe that the magnitude of estimated coefficients increases significantly when HHI/CR measurements are included in the regressions. A higher level of competition increases the NPL ratios of the regional commercial banks (a higher HHI/CR means more concentration and, thus, lower

Table 6. Threshold regression models.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DINV*dum$_l$	0.0401**	0.0284*	0.0329**	0.0223*	0.0400**	0.0284*	0.0328**	0.0225
	(0.0155)	(0.0147)	(0.0140)	(0.0132)	(0.0159)	(0.0150)	(0.0144)	(0.0137)
DINV*dum$_u$	− 0.0135**	− 0.0126**	− 0.0128**	− 0.0119**	− 0.0125**	− 0.0116**	− 0.0112**	− 0.0102**
	(0.0055)	(0.0054)	(0.0050)	(0.0051)	(0.0051)	(0.0050)	(0.0046)	(0.0046)
ER	− 0.3935**	− 0.4041**			− 0.3763**	− 0.3869*		
	(0.1891)	(0.2007)			(0.1901)	(0.2000)		
CAR			− 0.3097***	− 0.3139***			− 0.2998***	− 0.3043***
			(0.0949)	(0.0987)			(0.0957)	(0.0992)
LR	− 0.0137	− 0.0186	− 0.0627	− 0.0657				
	(0.0589)	(0.0606)	(0.0505)	(0.0514)				
LG					− 0.0162*	− 0.0139	− 0.0224**	− 0.0198*
					(0.0094)	(0.0099)	(0.0104)	(0.0108)
DR	− 0.0044	− 0.0102	0.0124	0.0060				
	(0.0554)	(0.0558)	(0.0551)	(0.0550)				
DG					− 0.0033	− 0.0045	− 0.0022	− 0.0039
					(0.0170)	(0.0176)	(0.0171)	(0.0176)
RoA	− 0.0456	0.0173	0.1179	0.1688	− 0.0605	− 0.0052	0.0834	0.1247
	(0.4720)	(0.4598)	(0.4578)	(0.4383)	(0.4764)	(0.4632)	(0.4591)	(0.4395)
LA	− 3.5997*	− 4.0241**	− 3.6169*	− 3.8751**	− 2.8784	− 3.1537	− 2.1775	− 2.2627
	(1.8285)	(1.8949)	(1.8686)	(1.9233)	(2.0119)	(1.9533)	(1.9046)	(1.8434)
LS	0.3602***	0.3810***	0.3961***	0.4095***	0.3467**	0.3566**	0.3380**	0.3399**
	(0.1322)	(0.1338)	(0.1318)	(0.1321)	(0.1414)	(0.1429)	(0.1351)	(0.1352)
DGDP		0.0094		0.0154		0.0092		0.0146
		(0.0166)		(0.0166)		(0.0165)		(0.0166)
WAGE		− 5.6879**		− 5.1832**		− 5.7935**		− 5.0469**
		(2.7086)		(2.5996)		(2.6909)		(2.5274)
_cons	64.2252*	92.4506**	66.3285*	90.2117**	51.2692	76.5975**	40.7089	60.0903*
	(33.3825)	(36.6802)	(33.6312)	(36.9104)	(34.3296)	(36.5959)	(32.2887)	(33.9237)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	604	593	604	593	604	593	604	593
R^2	0.613	0.612	0.633	0.633	0.616	0.614	0.635	0.634

Notes: This table reports the threshold regression results of real estate investment growth and NPLs ratio. NPL ratio is the dependent variable for all regressions. The results are based on panel threshold regressions with bank fixed-effect. The threshold value is found through a grid search minimizing the sum of squared residuals and its value is 21.88%. $dum_l = \mathrm{I}(\mathrm{DINV} \leq \gamma)$ and $dum_u = \mathrm{I}(\mathrm{DINV} > \gamma)$ as $I(\cdot)$ is the indicator function that returns 1 if the statement in brackets is true and 0 otherwise. γ denotes the threshold value. The last four regressions differ from the first four regressions in that they use LG and DG to replace LR and DR. For robustness, we use ER in regressions (1), (2), (5), and (6) and CAR in regressions (3), (4), (7), and (8). See Table 3 for definitions of the variables. The robust standard errors are in parentheses.
*** Significance level at 1%.
** Significance level at 5%.
* Significance level at 10%.

levels of competition). The coefficients on HHI/CR are generally insignificant, however, especially when regional macroeconomic factors are included. Nevertheless, the interaction terms with DINV appear to be mostly significant at the 5% level, and they are all positive. The results provide support for H3. The positive coefficients of the interaction terms (HHI/CR) suggest that, in regions with higher levels of bank competition, banks benefit more from real estate expansion. These results suggest that when facing a high level of competition (often in more developed

Table 7. The role of bank competition.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DINV	− 0.0439**	− 0.0378**	− 0.0467***	− 0.0411**	− 0.0747**	− 0.0551**	− 0.0809***	− 0.0626**
	(0.0180)	(0.0172)	(0.0176)	(0.0170)	(0.0287)	(0.0275)	(0.0291)	(0.0275)
DINV*HHI	0.0017**	0.0014*	0.0019**	0.0016**				
	(0.0008)	(0.0008)	(0.0008)	(0.0008)				
DINV*CR					0.0010**	0.0007*	0.0011**	0.0008**
					(0.0004)	(0.0004)	(0.0004)	(0.0004)
HHI	− 0.1318	− 0.1054	− 0.0993	− 0.0755				
	(0.1306)	(0.1268)	(0.1243)	(0.1245)				
CR					− 0.1115**	− 0.0884	− 0.0992*	− 0.0788
					(0.0555)	(0.0555)	(0.0524)	(0.0538)
ER	− 0.3770*	− 0.3890*			− 0.3743*	− 0.3859*		
	(0.1939)	(0.2036)			(0.1927)	(0.2034)		
CAR			− 0.3137***	− 0.3155***			− 0.3101***	− 0.3124***
			(0.0962)	(0.0995)			(0.0958)	(0.0993)
LR	− 0.0151	− 0.0227	− 0.0640	− 0.0690	− 0.0222	− 0.0272	− 0.0708	− 0.0735
	(0.0614)	(0.0625)	(0.0527)	(0.0533)	(0.0618)	(0.0628)	(0.0531)	(0.0535)
DR	− 0.0002	− 0.0054	0.0153	0.0094	0.0022	− 0.0037	0.0182	0.0118
	(0.0568)	(0.0568)	(0.0560)	(0.0556)	(0.0573)	(0.0574)	(0.0566)	(0.0563)
RoA	0.1003	0.1394	0.2604	0.2867	0.1017	0.1315	0.2548	0.2728
	(0.4842)	(0.4638)	(0.4803)	(0.4518)	(0.4787)	(0.4583)	(0.4774)	(0.4496)
LA	− 3.4479*	− 4.0495**	− 3.5077*	− 3.9043**	− 3.6872**	− 4.2171**	− 3.7193**	− 4.0604**
	(1.9057)	(1.9341)	(1.9164)	(1.9460)	(1.8577)	(1.8975)	(1.8568)	(1.9010)
LS	0.3816***	0.4059***	0.4133***	0.4287***	0.4070***	0.4250***	0.4386***	0.4490***
	(0.1366)	(0.1401)	(0.1357)	(0.1379)	(0.1326)	(0.1374)	(0.1309)	(0.1345)
DGDP		0.0121		0.0185		0.0099		0.0161
		(0.0168)		(0.0169)		(0.0165)		(0.0166)
WAGE		− 6.6953**		− 6.1150**		− 6.2977**		− 5.7192**
		(2.8099)		(2.7047)		(2.8219)		(2.7147)
_cons	62.8520*	97.6506***	66.2108*	94.9760**	71.4562**	102.3688***	73.7533**	99.3554***
	(34.6047)	(37.1468)	(35.2518)	(37.0389)	(34.2146)	(36.3038)	(34.0388)	(36.0484)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	604	593	604	593	604	593	604	593
R^2	0.608	0.611	0.630	0.632	0.612	0.613	0.633	0.634

Notes: This table reports the regression results between real estate investment growth and NPLs ratio while considering regional banking competition. NPLs ratio is the dependent variable for all regressions. The results are based on panel threshold regressions with bank fixed-effect. The last four regressions differ from the first four regressions in that they use CR to replace HHI as the proxy for the level of competition. For robustness, we use ER in regressions (1), (2), (5), and (6) and CAR in regressions (3), (4), (7), and (8). See Table 3 for definitions of the variables. The robust standard errors are in parentheses.
*** Significance level at 1%.
** Significance level at 5%.
* Significance level at 10%.

coastal regions), regional commercial banks make riskier loans. This supports the arguments of Allen and Gale (2000b) and Hellman, Murdock, and Stiglitz (2000) that regional competition gives banks incentives to take higher risks.

We further investigate the results of our threshold model by including regional competition in this framework. Table 8 reports the results. The threshold effect remains valid, but DINV*dum$_l$ is no longer significant. The other results discussed above remain valid for cases above the threshold value.

Table 8. Controlling for bank competition in the threshold model.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DINV*dum$_l$	0.0533	0.0651	0.0366	0.0496	0.0731	0.1265	0.0547	0.1070
	(0.0559)	(0.0539)	(0.0508)	(0.0483)	(0.1014)	(0.0942)	(0.0952)	(0.0851)
DINV*dum$_u$	− 0.0517***	− 0.0453**	− 0.0531***	− 0.0475***	− 0.0880***	− 0.0711**	− 0.0928***	− 0.0772**
	(0.0193)	(0.0185)	(0.0185)	(0.0178)	(0.0328)	(0.0317)	(0.0316)	(0.0302)
HHI*DINV*dum$_l$	− 0.0010	− 0.0024	− 0.0005	− 0.0018				
	(0.0031)	(0.0030)	(0.0028)	(0.0026)				
HHI*DINV*dum$_u$	0.0020**	0.0017**	0.0021**	0.0019**				
	(0.0009)	(0.0008)	(0.0008)	(0.0008)				
CR*DINV*dum$_l$					− 0.0007	− 0.0017	− 0.0005	− 0.0015
					(0.0017)	(0.0015)	(0.0016)	(0.0014)
CR*DINV*dum$_u$					0.0012**	0.0009*	0.0013***	0.0010**
					(0.0005)	(0.0005)	(0.0005)	(0.0004)
HHI	− 0.1063	− 0.0878	− 0.0763	− 0.0600				
	(0.1273)	(0.1259)	(0.1221)	(0.1239)				
CR					− 0.0986*	− 0.0799	− 0.0877*	− 0.0712
					(0.0536)	(0.0546)	(0.0512)	(0.0532)
ER	− 0.3999**	− 0.4085**			− 0.3989**	− 0.4081**		
	(0.1869)	(0.1965)			(0.1844)	(0.1942)		
CAR			− 0.3113***	− 0.3155***			− 0.3088***	− 0.3134***
			(0.0927)	(0.0965)			(0.0923)	(0.0961)
LR	− 0.0189	− 0.0229	− 0.0672	− 0.0693	− 0.0264	− 0.0285	− 0.0746	− 0.0751
	(0.0587)	(0.0606)	(0.0511)	(0.0522)	(0.0593)	(0.0610)	(0.0516)	(0.0523)
DR	− 0.0014	− 0.0080	0.0150	0.0077	0.0015	− 0.0058	0.0184	0.0106
	(0.0561)	(0.0560)	(0.0555)	(0.0550)	(0.0567)	(0.0566)	(0.0562)	(0.0557)
RoA	− 0.0180	0.0372	0.1451	0.1909	− 0.0243	0.0148	0.1322	0.1628
	(0.4717)	(0.4641)	(0.4595)	(0.4439)	(0.4683)	(0.4603)	(0.4594)	(0.4436)
LA	− 3.7811**	− 4.1956**	− 3.7742**	− 4.0120**	− 3.9997**	− 4.3720**	− 3.9695**	− 4.1755**
	(1.8394)	(1.9408)	(1.8654)	(1.9543)	(1.8002)	(1.8991)	(1.8130)	(1.9046)
LS	0.3851***	0.4029***	0.4149***	0.4251***	0.4114***	0.4248***	0.4415***	0.4481***
	(0.1322)	(0.1364)	(0.1322)	(0.1348)	(0.1286)	(0.1336)	(0.1277)	(0.1311)
DGDP		0.0116		0.0182		0.0083		0.0148
		(0.0171)		(0.0171)		(0.0168)		(0.0170)
WAGE		− 5.4094**		− 4.9377*		− 5.0955*		− 4.6200*
		(2.6812)		(2.6049)		(2.6996)		(2.6198)
_cons	68.5031**	95.6406**	70.5546**	92.5415**	76.4806**	100.6431***	77.5246**	97.1684***
	(33.5947)	(37.7884)	(34.5109)	(37.7289)	(33.3090)	(36.9073)	(33.4091)	(36.7210)
N	604	593	604	593	604	593	604	593
R^2	0.616	0.615	0.636	0.635	0.620	0.618	0.639	0.637

Notes: This table reports the threshold regression results between real estate investment growth and NPLs ratio while considering regional banking competition. NPLs ratio is the dependent variable for all regressions. The results are based on panel threshold regressions with bank fixed-effect. The last four regressions differ from the first four regressions in that they use CR to replace HHI as the proxy for the level of competition. For robustness, we use ER in regressions (1), (2), (5), and (6) and CAR in regressions (3), (4), (7), and (8). See Table 3 for definitions of the variables. The robust standard errors are in parentheses.

*** Significance level at 1%.

** Significance level at 5%.

* Significance level at 10%.

5.2.4 Addressing the endogeneity problem

It is arguable that real estate market investment growth (DINV) can be endogenous. For example, Allen and Gale (2000b) suggest that a bank's credit expansion and risk-taking preferences can affect property cycles. Davis and Zhu (2011) show that expanding bank credit positively affects commercial property prices. Zhang et al. (2015a) argue that the financing behavior of the real estate sector is sensitive to the supply of funds in financial markets. It is therefore important to empirically address this potential reverse causality issue to ensure that our results are robust.[8] To

Table 9. Real estate investment and NPLs ratio with 2SLS and instrumental variable.

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
DINV	− 0.0307*	− 0.0290*	− 0.0287*	− 0.0268	− 0.0301*	− 0.0278	− 0.0255	− 0.0232
	(0.0175)	(0.0176)	(0.0164)	(0.0166)	(0.0178)	(0.0179)	(0.0165)	(0.0167)
ER	− 0.4319***	− 0.4406***			− 0.4183***	− 0.4257***		
	(0.1114)	(0.1100)			(0.1124)	(0.1110)		
CAR			− 0.3294***	− 0.3285***			− 0.3164***	− 0.3153***
			(0.0508)	(0.0500)			(0.0492)	(0.0487)
LR	− 0.0198	− 0.0276	− 0.0719*	− 0.0767*				
	(0.0406)	(0.0408)	(0.0407)	(0.0407)				
LG					− 0.0179	− 0.0153	− 0.0243**	− 0.0213*
					(0.0116)	(0.0115)	(0.0113)	(0.0112)
DR	− 0.0010	− 0.0054	0.0169	0.0117				
	(0.0301)	(0.0298)	(0.0292)	(0.0289)				
DG					0.0041	0.0015	0.0040	0.0010
					(0.0149)	(0.0146)	(0.0144)	(0.0141)
RoA	0.1368	0.1797	0.2820	0.3078	0.1260	0.1561	0.2384	0.2507
	(0.5340)	(0.5290)	(0.5179)	(0.5125)	(0.5327)	(0.5273)	(0.5142)	(0.5090)
LA	− 3.6655***	− 4.2698***	− 3.6915***	− 4.1003***	− 3.0560**	− 3.4278***	− 2.2736*	− 2.4454**
	(1.4185)	(1.4899)	(1.3694)	(1.4378)	(1.2268)	(1.2710)	(1.1702)	(1.2168)
LS	0.4176***	0.4403***	0.4511***	0.4650***	0.4063***	0.4121***	0.3863***	0.3844***
	(0.1281)	(0.1294)	(0.1245)	(0.1256)	(0.1165)	(0.1166)	(0.1119)	(0.1120)
DGDP		0.0100		0.0163		0.0095		0.0153
		(0.0212)		(0.0206)		(0.0211)		(0.0204)
WAGE		− 6.7959***		− 6.1347***		− 6.8231***		− 5.9263***
		(2.2332)		(2.1713)		(2.2187)		(2.1577)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	587	578	587	578	587	578	587	578
R^2	0.595	0.600	0.618	0.623	0.598	0.602	0.623	0.627
Anderson LM	49.386***	47.363***	51.342***	49.039***	48.005***	46.231***	50.841***	48.703***
C.D. Wald	53.343***	50.750***	55.717***	52.761***	51.680***	49.401***	55.108***	52.356***
Davidson-MacKinnon (*p*_value):	1.402 (0.237)	1.163 (0.281)	1.281 (0.258)	1.049 (0.306)	1.390 (0.239)	1.094 (0.296)	1.038 (0.309)	0.788 (0.375)

Notes: This table reports the 2SLS regression results testing the relationship between real estate investment growth and NPLs ratio. NPLs ratio is the dependent variable for all regressions. All results are based on panel 2SLS regressions with bank fixed-effect. Anderson LM is the Anderson canonical correlation LM statistics. The C.D. Wald (Cragg-Donald Wald *F* statistic) is significant across all models suggesting there is no weak identification problem. Davidson-MacKinnon is to test exogeneity and the *p*-value of these test statistics are reported in the parentheses. The last four regressions differ from the first four regressions in that they use LG and DG to replace LR and DR. For robustness, we use ER in regressions (1), (2), (5), and (6) and CAR in regressions (3), (4), (7), and (8). See Table 3 for definitions of the variables. The robust standard errors are in parentheses.

*** Significance level at 1%.

** Significance level at 5%.

* Significance level at 10%.

do so, we first adopt a 2SLS method and use an instrumental variable for DINV. Next, we use a dynamic general method of moments (GMM) model that not only corrects for the endogeneity bias but also allows a dynamic effect captured by lagged dependent variables.

Regarding the 2SLS approach, following Chong, Lu, and Ongena (2013), we first divide sample cities into three categories: municipalities, provincial capital cities, and other cities. The average DINV in each group excludes one city to be used as our instrumental variable. For other

Table 10. Threshold regression models with 2SLS and instrumental variable.

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
DINV*dum$_l$	− 0.0223	− 0.0261	− 0.0195	− 0.0220	− 0.0238	− 0.0256	− 0.0159	− 0.0163
	(0.0628)	(0.0639)	(0.0610)	(0.0619)	(0.0640)	(0.0646)	(0.0616)	(0.0622)
DINV*dum$_u$	− 0.0317**	− 0.0292**	− 0.0297**	− 0.0273**	− 0.0309**	− 0.0280**	− 0.0266**	− 0.0239**
	(0.0127)	(0.0125)	(0.0122)	(0.0120)	(0.0131)	(0.0127)	(0.0125)	(0.0121)
ER	− 0.4382***	− 0.4435***			− 0.4232***	− 0.4280***		
	(0.1017)	(0.1008)			(0.1016)	(0.1005)		
CAR			− 0.3291***	− 0.3292***			− 0.3158***	− 0.3161***
			(0.0511)	(0.0499)			(0.0499)	(0.0489)
LR	− 0.0208	− 0.0266	− 0.0731*	− 0.0761*				
	(0.0398)	(0.0402)	(0.0395)	(0.0397)				
LG					− 0.0177	− 0.0151	− 0.0241**	− 0.0211*
					(0.0117)	(0.0116)	(0.0114)	(0.0112)
DR	− 0.0010	− 0.0067	0.0172	0.0106				
	(0.0300)	(0.0298)	(0.0290)	(0.0288)				
DG					0.0043	0.0017	0.0041	0.0012
					(0.0145)	(0.0142)	(0.0141)	(0.0137)
RoA	0.1220	0.1836	0.2622	0.3055	0.1145	0.1617	0.2169	0.2432
	(0.5483)	(0.5517)	(0.5357)	(0.5382)	(0.5486)	(0.5512)	(0.5331)	(0.5353)
LA	− 3.7300***	− 4.2771***	− 3.7539***	− 4.1105***	− 3.0967***	− 3.4395***	− 2.3283**	− 2.4686**
	(1.3865)	(1.4575)	(1.3432)	(1.4117)	(1.1841)	(1.2331)	(1.1418)	(1.1910)
LS	0.4207***	0.4377***	0.4540***	0.4630***	0.4076***	0.4098***	0.3880***	0.3829***
	(0.1223)	(0.1245)	(0.1195)	(0.1213)	(0.1130)	(0.1133)	(0.1090)	(0.1093)
DGDP		0.0098		0.0160		0.0093		0.0148
		(0.0214)		(0.0207)		(0.0212)		(0.0205)
WAGE		− 6.1959***		− 5.5053**		− 6.2242***		− 5.2468**
		(2.3580)		(2.2809)		(2.3302)		(2.2472)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	587	578	587	578	587	578	587	578
R^2	0.597	0.599	0.620	0.623	0.599	0.602	0.624	0.627
Anderson LM	33.036***	32.987***	33.315***	33.260***	31.747***	32.122***	32.366***	32.663***
C.D. Wald	17.130***	17.036***	17.286***	17.189***	16.412***	16.556***	16.757***	16.856***

Notes: This table reports the threshold regression with IV (2SLS regressions) results between real estate investment growth and NPLs ratio. NPLs ratio is the dependent variable for all regressions. All results are based on panel 2SLS regressions with bank fixed-effect. Anderson LM is the Anderson canonical correlation LM statistics. The C.D. Wald (Cragg-Donald Wald *F* statistic) are significant across all models suggesting there is no weak identification problem. The threshold value is found through a grid search minimizing the sum of squared residuals and its value is 22.48%. dum$_l$ = $I(\text{DINV} \leq \gamma)$ and dum$_u$ = $I(\text{DINV} > \gamma)$ as $I(\cdot)$ is the indicator function returning 1 if the statement in parentheses is true and 0 otherwise. γ denotes the threshold value. The last four regressions differ from the first four regressions in that they use LG and DG to replace LR and DR. For robustness, we use ER in regressions (1), (2), (5), and (6) and CAR in regressions (3), (4), (7), and (8). See Table 3 for definitions of the variables. The robust standard errors are in parentheses.
*** Significance level at 1%.
** Significance level at 5%.
* Significance level at 10%.

cities, we use the average DINV of other cities within the same province as the instrumental variable.

Table 9 reports the 2SLS regression results for all models in Table 5. Tests for the validity of instrumental variables are all significant, suggesting the validity of the instruments. Both the Anderson canonical correlation LM statistics and the Cragg-Donald Wald F statistics are highly significant. The significance level of the DINV falls as only half our estimated models now give

Table 11. The role of bank competition with 2SLS and instrumental variable.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DINV	− 0.1868***	− 0.1624**	− 0.1609***	− 0.1399**	− 0.2670***	− 0.2217**	− 0.2275**	− 0.1871*
	(0.0657)	(0.0664)	(0.0620)	(0.0631)	(0.0997)	(0.1013)	(0.0946)	(0.0965)
DINV*HHI	0.0081***	0.0069**	0.0068**	0.0058**				
	(0.0030)	(0.0030)	(0.0028)	(0.0029)				
DINV*CR					0.0037***	0.0030**	0.0031**	0.0025*
					(0.0014)	(0.0014)	(0.0014)	(0.0014)
HHI	− 0.3245**	− 0.2768**	− 0.2426**	− 0.2028*				
	(0.1264)	(0.1294)	(0.1197)	(0.1231)				
CR					− 0.1914***	− 0.1595***	− 0.1570***	− 0.1293**
					(0.0579)	(0.0597)	(0.0550)	(0.0569)
ER	− 0.4449***	− 0.4481***			− 0.4342***	− 0.4396***		
	(0.1158)	(0.1135)			(0.1137)	(0.1120)		
CAR			− 0.3379***	− 0.3366***			− 0.3318***	− 0.3316***
			(0.0525)	(0.0515)			(0.0518)	(0.0511)
LR	− 0.0381	− 0.0438	− 0.0879**	− 0.0906**	− 0.0488	− 0.0502	− 0.0964**	− 0.0956**
	(0.0429)	(0.0429)	(0.0426)	(0.0425)	(0.0431)	(0.0431)	(0.0429)	(0.0428)
DR	0.0095	0.0030	0.0257	0.0184	0.0157	0.0085	0.0310	0.0232
	(0.0314)	(0.0309)	(0.0302)	(0.0298)	(0.0313)	(0.0310)	(0.0302)	(0.0300)
RoA	0.3070	0.3561	0.4290	0.4621	0.2206	0.2571	0.3532	0.3753
	(0.5574)	(0.5516)	(0.5343)	(0.5294)	(0.5450)	(0.5396)	(0.5239)	(0.5190)
LA	− 4.2356***	− 4.8579***	− 4.1573***	− 4.5637***	− 4.3751***	− 4.8545***	− 4.2772***	− 4.5764***
	(1.4923)	(1.5669)	(1.4223)	(1.4953)	(1.4732)	(1.5434)	(1.4077)	(1.4765)
LS	0.4921***	0.5082***	0.5104***	0.5178***	0.5135***	0.5201***	0.5306***	0.5305***
	(0.1377)	(0.1392)	(0.1321)	(0.1337)	(0.1372)	(0.1384)	(0.1319)	(0.1333)
DGDP		0.0205		0.0256		0.0125		0.0184
		(0.0223)		(0.0215)		(0.0217)		(0.0209)
WAGE		− 6.0079***		− 5.5151**		− 5.4294**		− 5.0152**
		(2.3236)		(2.2388)		(2.3363)		(2.2561)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	587	578	587	578	587	578	587	578
R^2	0.568	0.578	0.602	0.610	0.581	0.587	0.612	0.617
Anderson LM statistic	40.622***	38.361***	42.110***	39.471***	39.569***	37.330***	41.059***	38.479***
Cragg-Donald Wald	21.391***	20.020***	22.252***	20.654***	20.785***	19.434***	21.643***	20.087***

Notes: This table reports the 2SLS IV regression results between real estate investment growth and NPLs ratio while considering regional banking competition. The dependent variable is NPLs ratio for all regressions. All results are based on panel 2SLS regressions with bank fixed-effect. Anderson LM is the Anderson canonical correlation LM statistics. The C.D. Wald (Cragg-Donald Wald *F* statistic) are significant across all models suggesting there is no weak identification problem. The last four regressions differ from the first four regressions in that they use CR to replace HHI as the proxy for the level of competition. For robustness, we use ER in regressions (1), (2), (5), and (6) and CAR in regressions (3), (4), (7), and (8). See Table 3 for definitions of the variables. The robust standard errors are in parentheses.
*** Significance level at 1%.
** Significance level at 5%.
* Significance level at 10%.

significant results for it at the 10% level. For those significant cases, however, the economic significance of the estimated coefficients rises quite significantly. Combined, the results provide reasonably good support for H1.

For tests of H2 and H3, we report 2SLS regression results in Tables 10 and 11, respectively. In general, the Anderson canonical correlation LM statistics and the Cragg-Donald Wald F statistics are highly significant. The results of 2SLS regressions for both hypotheses are roughly consistent with the baseline regression results. The positive impact from DINV disappears when the

Table 12. Dynamic regression results.

Panel I: H1	(1)	(2)	(3)	(4)
L.NPLs ratio	0.4671***	0.4596***	0.4695***	0.4661***
	(0.0367)	(0.0376)	(0.0357)	(0.0365)
DINV	− 0.0125**	− 0.0136**	− 0.0066	− 0.0072
	(0.0058)	(0.0059)	(0.0056)	(0.0055)
Panel II: H2	(1)	(2)	(3)	(4)
L.NPLs ratio	0.4370***	0.4422***	0.4476***	0.4509***
	(0.0345)	(0.0357)	(0.0343)	(0.0354)
DINV*dum$_l$	0.0102	0.0186	0.0069	0.0141
	(0.0165)	(0.0172)	(0.0164)	(0.0171)
DINV*dum$_u$	− 0.0117**	− 0.0119**	− 0.0096*	− 0.0089*
	(0.0055)	(0.0055)	(0.0054)	(0.0054)
Panel III:H3.HHI	(1)	(2)	(3)	(4)
L.NPLs ratio	0.4620***	0.4540***	0.4621***	0.4599***
	(0.0369)	(0.0378)	(0.0359)	(0.0367)
DINV	− 0.0534**	− 0.0551**	− 0.0367	− 0.0374*
	(0.0229)	(0.0228)	(0.0226)	(0.0225)
DINV*HHI	0.0024**	0.0024**	0.0016	0.0016
	(0.0011)	(0.0011)	(0.0011)	(0.0011)
HHI	− 0.1594*	− 0.1986**	− 0.1385	− 0.1471
	(0.0910)	(0.0932)	(0.0891)	(0.0908)
Panel IV: H3.CR	(1)	(2)	(3)	(4)
L.NPLs ratio	0.4590***	0.4527***	0.4609***	0.4594***
	(0.0372)	(0.0378)	(0.0364)	(0.0369)
DINV	− 0.0519	− 0.0498	− 0.0231	− 0.0199
	(0.0393)	(0.0394)	(0.0387)	(0.0388)
DINV*CR	0.0007	0.0007	0.0003	0.0002
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
CR	− 0.0742*	− 0.0852**	− 0.0591	− 0.0628
	(0.0411)	(0.0421)	(0.0404)	(0.0412)

Notes: The dynamic panel regressions in this table are estimated using GMM based on the first difference. The independent variables include the lagged dependent variable and the same explanatory variables as described in previous non-dynamic regressions. The coefficients of other control variables are omitted to save space. Panels I and II refer to the regression specifications for testing the first two testable hypotheses; Panels III and IV are for the third testable hypothesis but differ by using HHI/CR as the measure of competition. See Table 3 for definitions of the variables. Models (1) and (2) use ER and Models (3) and (4) use CAR as the alternative. Models (2) and (4) include regional macroeconomic factors and Models (1) and (3) exclude them. All regressions pass the Sargan test for over-identifying restrictions and there is no evidence of second order autoregression. These results underline the validity of the instruments and the consistency of the estimators. The standard errors are in parentheses.*** Significance level at 1%.
** Significance level at 5%.
* Significance level at 10%.

growth rate is lower than the threshold value (insignificant). But there are still clear statistical differences for the impact below/above the threshold values. Both the DINV coefficients and the interaction terms with HHI/CR are still significant and have the same sign as in baseline regressions (Table 7). In general, these results (irrespective of model specification used) support all three hypotheses. Overall, 2SLS regression results show that our main results hold.

In order to control for the possibility that these regional commercial banks may have an auto-correlated NPL ratio, it might be useful to check the robustness of our results by including a dynamic effect along with dealing with the endogeneity bias. Table 12 reports the dynamic model estimated via system GMM, which we believe produces more reliable inferences than 2SLS due to the reported significant dynamic effect. In general, there is clear evidence that these regional commercial banks' NPL ratios are positively auto-correlated. Accounting for dynamic effects, however, does not affect our inferences for all three hypotheses. Overall, our three hypotheses hold when we correct for the endogeneity bias using both 2SLS and GMM approaches.

6. Conclusions and policy implications

A key lesson we have learned from the 2008 US subprime mortgage crisis is that overexposure to one type of asset, such as real estate, and the misallocation of investments by financial institutions toward assets can cause significant instability in the financial sector. Given China's booming real estate market and significant exposure of its regional banks to real estate loans, our research contributes to concerns of how the dynamics of China's real estate market can affect financial stability, using regional commercial banks as an example. We study a panel of Chinese regional commercial banks to show the impact of real estate market developments on banking sector stability, as measured by NPL ratios. Based on theoretical studies in the existing literature, we proposed three hypotheses.

Our empirical results can be summarized as follows. First, we find that an increase in the growth of investment in real estate reduces NPL ratios, supporting H1. Allowing for threshold effects, however, our data shows that the relationship between real estate market activity and banking sector stability is sensitive to real estate market cycles, H2. Compared to the benefits of real estate expansion, a declining real estate market seems to do more harm to banks. The implication of these findings for policy-makers and bank managers is that holding higher stakes in real estate is risky. When the real estate market is in trouble and starts shrinking, banks with high concentrations of loans in the real estate sector are more likely to become unstable. Additionally, systematic misallocation of investments toward the real estate sector can cause significant instability for the entire financial system.

The results of H3 indicate further challenges for regulators. The standard argument for introducing competition to the banking industry is that it improves bank efficiency and serves the real economy better. On the contrary, our results for China's regional commercial banks suggest that higher banking competition induces more risk-taking activities, supporting some of the arguments debated in the literature. While bank competition increases the benefits of real estate market expansion, banks may suffer even higher losses when the real estate market declines. Although support for bank competition is beneficial, our results suggest that regulators need to pay more attention to regional banks' risk of overexposure to the real estate market.

Our results also have broader implications. Many other emerging economies have experienced real estate booms, and their banking sectors are taking a larger role in real economic activity. For example, in addition to China, other Brazil, Russia, India, China, and South Africa (BRICS) economies have also had significant housing price increases and faced price bubbles in recent

years. A sudden drop in housing prices in any of the BRICS economies can easily destabilize the banking system, and this could easily spread to other countries. Given the growing significance of BRICS and other emerging economies in the global economy, including their increasing share of world GDP, banking and financial system instability within countries could lead to global financial instability.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. http://www.bbc.com/news/magazine-17390729/.
2. http://www.ft.com/fastft/372301/china-bad-loan-growth-accelerates/.
3. Other emerging markets that are experiencing property bubbles include Argentina, Brazil, Colombia, Israel, India, Indonesia, Malaysia, Philippines, South Africa, South Korea, Singapore, Serbia, Russia, Taiwan, Turkey, and Uruguay. The following website provides charts showing the dramatic increase in property prices in recent years in these markets. http://www.thebubblebubble.com/emerging-markets-bubble/.
4. For more information about the development and history of China's commercial banks, see Berger, Hasan, and Zhou (2009), Ferri (2009), Lin and Zhang (2009), and Matthews and Zhang (2010).
5. Other recent studies that also adopt a threshold approach include Gasha and Morales (2004), Law, Tan, and Azman-Saini (2014), Marcucci and Quagliariello (2009), Pan and Wang (2013), and Zhang et al. (2015b).
6. We have also tested the significance of additional lags of real estate loans, DINV, and the results are consistent (results are available upon request). We thank the anonymous referee for this suggestion.
7. The China Banking Regulatory Commission (CBRC) publishes financial authorization information for all branches (http://xukezheng.cbrc.gov.cn/ilicence/licence/licenceQuery.jsp), including location and authorization date.
8. Also see Gimeno and Martinez-Carrascal (2010), Liang and Cao (2007), Mora (2008), and Semlali and Collyns (2002).

ORCID

Dayong Zhang http://orcid.org/0000-0001-8722-176X

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