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journal homepage: www.elsevier.com/locate/irefNeglected part of shadow banking in China[☆]Ping An^{a,b,*}, Mengxuan Yu^c^aPBC School of Finance, Tsinghua University, China^bPeople's Bank of China, China^cNorth China Sea Data & Information Service, SOA, China

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ABSTRACT

Guaranteed off-balance sheet (consists of banker's acceptance, letter of credit and letter of guarantee), is an essential part of China's shadow banking, but neglected by current research because no data available. This paper fills the research gap, by investigate the mechanism behinds its cyclical behavior through a novel dataset. Different from developed economies, guaranteed OBS in China has long-run substitute relation with commercial loan. Therefore, any policy impacts on commercial loan growth will has a converse effect on guaranteed OBS growth indirectly. Furthermore, contrary to existing research about China's shadow banking, we find the Desirability lending policy conducted by People's Bank of China during 2011–2014 is the unique fundamental driving force, rather than traditional regulatory constraints, such as reserve requirement ratio and loan-to-deposit ratio. It's an example of macroprudential policy induces shadow banking activity. Moreover, guaranteed OBS growth is also influenced by macroeconomy, risk and return factors of itself, operation efficiency and creditworthiness of the bank. Hence empirical results of this paper could also be viewed as the first time to test OBS development theories with China's data.

1. Introduction

Considering the rapid development of China's shadow banking since 2010 and haunted by the severe crisis in the US financial system in 2008, more and more research concerning on China's shadow banking system. But the definition of shadow banking still debating, especially for China. Two most popular definitions are proposed by [Financial Stability Board \(2011\)](#) and [Pozsar, Adrian, Ashcraft, and Boesky \(2012\)](#) separately. Due to China's shadow banking is not quite the same as developed economies,¹ the definition used in this paper follows the People's Bank of China ([PBC, 2013](#)), which defines it as “credit intermediation involving entities and activities outside the regular banking system, with the functions of liquidity and credit transformation, which could potentially cause systemic risks or regulatory arbitrage.”

Existing research about China's shadow banking, such as the literature discussed in next section, mainly focus on wealth management products (WMPs), trust loan and entrusted loan. While the “undiscounted bankers' acceptance” (BA), an important component of China's shadow banking was neglected due to data unavailable. It deserves seriously research for two main reasons:

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¹ There are many documentations about the differences, please refer to [Li \(2014\)](#), [Elliott et al. \(2015\)](#), [Dang et al. \(2015\)](#) and [Jiang \(2016\)](#).

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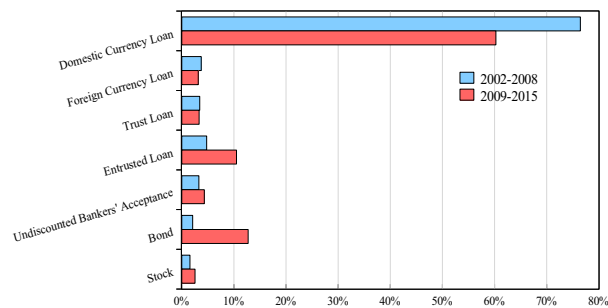


Fig. 1. Monthly average share of main components of AFRE.
Source: Wind Database.

On one hand, it accounts for a large share in China's shadow banking system. Fig. 1 displays monthly average share of main components of Aggregate Financing to the Real Economy² in pre-crisis (2002-2008) and post-crisis (2009-2015) periods. Focus on shadow banking part, we find the share of entrusted loan increased from 4.78% to 10.50%, the share of undiscounted bankers' acceptance increased from 3.30% to 4.34%, but the share of trust loan moderately decreased from 3.45% to 3.34%. Furthermore, besides BA, letter of credit (L/C) and letter of guarantee (L/G) are both have similar properties and should be viewed as shadow banking follows PBC's definition. Actually, China Banking Regulatory Commission (CBRC) defines BA, L/C and L/G as "guaranteed off-balance sheet" (guaranteed OBS) follows international standard. If we count in all these activities, China's shadow banking scale will get even larger.

On the other hand, these businesses may bring pressure on financial sector directly. The fundamental feature of guaranteed OBS is substitute corporation credit with bank credit, thus it links corporation risk with bank risk tighter. IMF (2016) figured out that Chinese corporation's bad financial performance originates from growth rate and investment efficiency slowing down, will bring a great pressure to financial institution's asset quality. It implies if guaranteed OBS scale grows too fast, then risk originates from real economy sector will transfer to financial sector more rapidly.

This paper attempts to fill the research gap. First of all, we present a remarkable cyclical behavior of guaranteed OBS: it grew stably from 2008 to 2010, but experienced supernormal fast growth during 2011–2014, then dropped sharply since 2015. After that, we investigate the mechanism behinds this cyclical behavior through a dataset we constructed, and get three main empirical conclusions.

The first one is Chinese commercial bank's guaranteed OBS business has a stable long-run substitute relation with commercial loan business. Any policy impacts on commercial loan growth will generates a converse effect on guaranteed OBS growth indirectly. This is the core mechanism behinds the supernormal growth of guaranteed OBS during 2011–2014. There is debating for a long time on whether the relation between guaranteed OBS and commercial loan is substitution or complementation. As we discuss in Section 2, substitute relation more likely exists in emerging market economies while complement relation is more likely exists in developed economies. But there is no such research about China before this paper.

The second one is, contrary to existing research about China's shadow banking, Desirability Lending Policy (DLP), introduced by PBC to control commercial loan growth during 2011–2014 is the unique fundamental driving force; rather than traditional constraints, such as "capital adequacy ratio", "reserve requirement ratio" or "loan-to-deposit ratio", which were blamed for main reasons of shadow banking growth in China (Elliott, Kroeber, & Qiao, 2015; Jiang, 2016; Lu, Guo, Kao, & Fung, 2015). Actually, this is the first time to investigate DLP's effect on shadow banking. We illustrate the mechanism as follows: because DLP imposes an *implicit* lending quota on commercial banks, both "reserve requirement ratio" and "loan-to-deposit ratio" will lose effect after DLP introduced. In addition, "capital adequacy ratio" will not change largely and frequently, therefore DLP would be the unique constraint that commercial banks faced, as Proposition 1 documents in section 4. Hence commercial banks had great incentive to avoid it, through guaranteed OBS, commercial banks can finance their customers and don't violate supervision. Therefore, when DLP is binding, it stimulates supernormal growth of guaranteed OBS indirectly; while has no effect in the period before policy introduced and the period of policy ameliorated.

The third one is guaranteed OBS growth is also influenced by macroeconomy, risk and return factors of itself, operation efficiency and creditworthiness of the bank. We can use these conclusions to judge which OBS development theory holds in China, since there's no research on this topic yet. According to these conclusions, "regulation avoidance theory" and "market power theory" are supported by China's data, while "moral hazard theory" and "scale economy theory" are not.

Policy implication is, though DLP controlled commercial loan growth effectively during the economy overheat period, the supernormal growth of guaranteed OBS partly offset its effect, if not totally cancelled it. There have already been many discussions on macroprudential tools may induce shadow banking activity, in this paper we give another example. Therefore, it's the right time to review this kind of macroprudential tool and to substitute another more market oriented tool for it, such as Macroprudential Assessment (MPA) introduced by PBC at the beginning of 2016.

The reminder of the paper is structured as follows: Section 2 reviews related literature. Section 3 presents cyclical behavior of

² "Aggregate Financing to the Real Economy" is the authority name of a core monetary policy indicator published by People's Bank of China since 2011. It was also called other name in the literature, such as "Total Social Financing Statistics" or "Aggregate Financing of the Economy".

guaranteed OBS and discusses why traditional regulatory policies can't explain it. At last, it also gives a brief introduction about DLP. In Section 4, we construct a simple model to formally elaborate our explanation about guaranteed OBS cyclical behavior and propose hypotheses can be tested by econometric model. Section 5 presents empirical results and Section 6 summarizes.

2. Related literature

2.1. Literature of shadow banking

Adrian and Ashcraft (2012) gave an excellent review about the paper before 2012. Hence, we focus on research after 2012 at here and we adopt their framework to organize new literature.

The first strand research is “why does shadow banking exist”. Similar to our paper's econometric method, Duca (2016) uses a long historical dataset to investigate driving forces behind the shadow banking in U.S., and finds capital regulation has long-run effect. Acharya, Hemal, and Öncü (2013) investigate non-bank financial corporations in India, and find these institutions rising as substitution of commercial banks in rural areas. This conclusion similar to ours that shadow banking emerges as substitution of traditional banking system in emerging market economy.

The second strand research is “how does shadow credit intermediation work”. Moreira and Savov (2014) construct a macroeconomic model which emphasizes liquidity transformation in financial sector. Luck and Schempp (2015) construct a banking model which emphasizes maturity transformation function.

The third strand research is “why does shadow credit intermediation need to be regulated”. For monetary policy view, Verona, Martins, and Drumond (2013) use a DSGE model to study the effect of shadow banking on monetary policy transmission. While Pozsar (2014) presents an accounting framework to study the effect of shadow banking on money supply. For financial stability view, Chernenko and Sunderam (2014) document frictions in money market fund (MMF) lending that lead to the transmission of distress across borrowers. Furthermore, Bengtsson (2013) uses European MMF industry experience to show financial instability may spread from the MMF sector to the wider financial system. He also notices that “political initiatives to maintain financial stability may undermine stability in other parts of the financial system”, and we get the same policy implication too.

The fourth strand research is “how should shadow credit intermediation be regulated”. Coincides with Bengtsson (2013), Plantin (2014) argues if banks can bypass capital regulation in an opaque shadow banking sector, it may be optimal to relax capital requirements. While Ordonez (2013) proposes there is a chance to combine traditional regulation and cross reputation subsidization to make shadow banking more sustainable, since banks are concerned for their reputation.

Papers focus on China's shadow banking can be categorized into three groups. The first group gives an overview about China's shadow banking, such as Li (2014), Barth, Wen, and Xu (2015); Elliott et al. (2015); Lu et al. (2015) and Jiang (2016). The second group focuses on macroeconomic implications of China's shadow banking. Funke, Mihaylovski, and Zhu (2015) study the effect of shadow banking on monetary policy transmission. Li, Hsu, and Qin (2014) focus on risk problem of China's shadow banking while Wang, Wang, Wang, and Zhou (2016) focus on welfare problem. The third group, each paper concentrates on one type shadow banking activity. Acharya, Qian, and Yang (2016); Hachem and Song (2016) are focus on WMPs; Allen et al. (2015); Chen, Ren, and Zha (2016); Li and Lin (2016) are focus on entrusted loan; Dang, Wang, and Yao (2015) focus on trust loan.

2.2. Literature of OBS development

OBS development theory first proposed in U.S. in the late 1980s. The first theory is “regulation avoidance theory” (Baer & Pavel, 1988; Pavel & Phillis, 1987; Pennacchi, 1988). It argues commercial banks have incentive to develop OBS bypass reserve requirement ratio, capital adequacy ratio and so on. But the empirical research of U.S. data didn't support it (Benveniste & Berger, 1987; Jagtiani, Saunders, & Udell, 1995a; Koppenhaver, 1989). Then the “moral hazard theory” was proposed. For example, Avery and Berger (1988) argued considering the bank can exploit a higher leverage to get more profits, the bank with worse assets quality usually has more incentive to develop OBS. Because they can use profit comes from OBS business to compensate its loss in commercial loan or some other in-balance businesses. Dionne and Harchaoui (2003) used Canada's data to test this theory, and the result supports it.

After year 1990, scholars started to propose OBS development theories from active perspective. The first one is “risk diversification theory”, presented by Boot and Thakor (1991). They constructed a model and proved loan commitment business can reduce the whole asset risk of a bank, hence the bank has incentive to develop OBS. This theory was supported by U.S. (Angbazo, 1997) and Canada's data (Calmès & Théoret, 2010). The second one is “market power theory” (Jagtiani, 1996b), it argues that banks with a better performance and creditworthiness can develop more OBS activities. The third one is “scale economy theory” (Jagtiani, Nathan & Sick, 1995b, Jagtiani and Khanthavit, 1996a), which believes that the cost complementation can benefit both in- and off-balance sheet activities, the growth of one business will stimulate the other. Fung and Cheng (2004) used Hong Kong's data to test this theory and their result supports it. But they also emphasized, it is information complementation rather than cost complementation generates the scale economy.

After year 2000, bank OBS activities in developing countries grow fast. Therefore the research of OBS development transferred to these regions. All these research are focus on empirical test. For example, Nachane and Ghosh (2002, 2007) investigates determinants of Indian bank's OBS activities. They found that “regulation avoidance theory”, “market power theory” and “moral hazard theory” were supported. At the same time they also find the macroeconomy has impact on OBS development. Khasawneh and Hassan (2010) explored determinants of OBS activities with MENA countries' data. They found that “scale economy theory”, “market power theory” and “risk diversification theory” were supported, but “regulation avoidance theory” was rejected. And they also found macroeconomy has impact

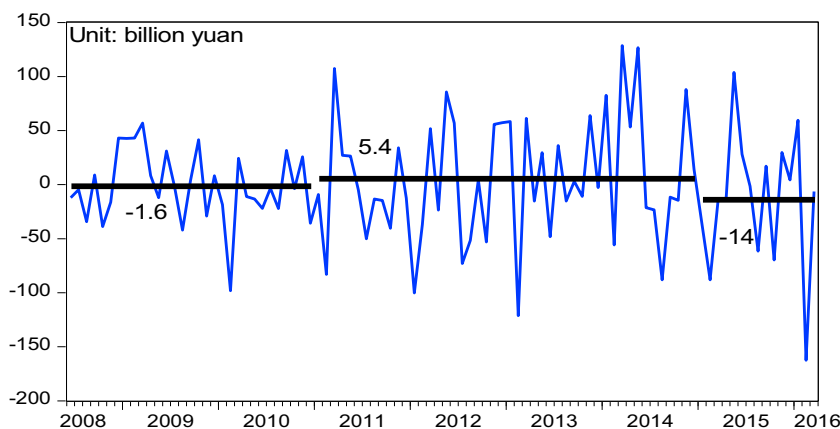


Fig. 2. Cyclical behavior of bankers' acceptance in Qingdao.
Source: Author collects.

on OBS development. [Elian \(2012\)](#) used GCC countries' data to investigate the same question, he found that “market power theory” holds in these countries, but “regulation avoidance theory” doesn't. And he didn't find the macroeconomy environment influences OBS development. [Perera, Ralston, and Wickramanayake \(2014\)](#) explored four south Asia countries' data and found “regulation avoidance theory” was supported. Limited by data, there is no such empirical study on this topic in China so far. Therefore this paper could be viewed as the first one.

3. Stylized facts and institutional background

Because there's no authoritative and complete guaranteed OBS statistics on country level, we exploit a representative city-level dataset in this paper. The data is about Qingdao, a second-tier city lies in Shandong province. In order to maintain regional financial stability, since Jun. 2008, Qingdao Branch of PBC collects guaranteed OBS data from commercial banks in Qingdao by the month. We construct two types dataset using these data. The first type is monthly aggregate time series data which views the city as a whole, range from Jun. 2008 to Mar. 2016. The second type is micro-level panel data, contains 21 Chinese commercial banks lying in Qingdao and the largest individual time span identical with time series dataset.

Considering potential argument about conclusion robustness when we extend them to the country level, we compare the city's core macroeconomy and finance indicators with the country in [Appendix A](#), and find they have quite similar trend and cycles. Therefore it seems that the city is a good representative, conclusions get from the research can be extended to the whole country in some extent. Actually, there's a blessing in disguise that we use a city-level dataset to investigate country-level policy effect: DLP is strictly exogenous for commercial banks in Qingdao, hence we can ignore the identification problem, which is the biggest trouble in empirical research.

We find a remarkable cyclical behavior of new grant BA, L/C and L/G monthly data in Qingdao, as [Figs. 2–4](#) show.³ All these activities grew stably from 2008 to 2010, but experienced supernormal fast growth during 2011–2014, then dropped sharply since 2015. Monthly average amount in three periods are labeled by horizontal solid line.

How can we interpret the cyclical behavior of guaranteed OBS mentioned above? Following existing explanations, it should be “capital adequacy ratio”, “loan-to-deposit ratio” or “reserve requirement ratio” changed dramatically. But these traditional constraints can't explain the phenomenon. Firstly, during 2015–2016, “capital adequacy ratio” is higher than before, but guaranteed OBS amount dropped in this period. Secondly, during 2008–2010, “loan-to-deposit ratio” is stricter than 2011–2014, but guaranteed OBS amount in this period lower than 2011–2014. Thirdly, “reserve requirement ratio” in 2008–2010 is lower than 2015–2016, but guaranteed OBS amount in 2008–2010 is higher than 2015–2016. These figures are displayed in [Appendix B](#). 合意贷款 2014Q3

The answer to the phenomenon is the “differentiated reserve requirement dynamic adjustment mechanism”, a new macroprudential policy tool introduced by PBC at the beginning of 2011⁴ and fade away around the end of 2014. It has a vivid and more famous name called “Desirability Lending Policy” (DLP) among market. For simplicity, we will use DLP instead of the “differentiated reserve requirement dynamic adjustment mechanism” in the rest paper. Base on authoritative statement of *China Monetary Policy Report (PBC, 2014)* about the policy, “The so-called ‘desirability lending’ ... is in fact the differentiated reserve requirement dynamic adjustment mechanism. The purpose of this mechanism is to help financial institutions to match their credit extensions with their capital levels and the reasonable demands for economic growth ... (in order to) prevent the build-up of systemic risks, and make sure that the financial system will support the real sector in a sustainable way.” As China's economy growth steps into the “New Normal”, the government proposes the “reform of the supply front”,

³ Data is the cycle part obtained after HP filter, so there are some negative values.

⁴ About the introduce time, please refer to the article wrote by Xiaochuan Zhou, the governor of People's Bank of China, *Establish Macro-finance Intervention System Suited to China*, published on *China Finance*, Jan. 2011.

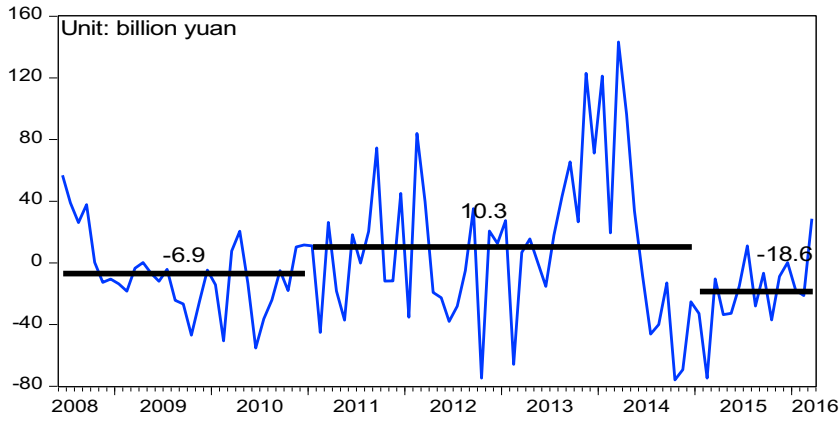


Fig. 3. Cyclical behavior of letter of credit in Qingdao.
Source: Author collects.

The executive meeting of the state council convened on 19th Nov. 2014 decided to ameliorate DLP.

4. Model and propositions

To demonstrate mechanism behinds the cyclical behavior formally and propose hypotheses can be tested by econometric model rigorously, we construct a simple model with DLP constraint. By comparing optimal solutions in different policy environments, we can testify the decisive effect of DLP on guaranteed OBS supernormal growth and get the premises on which the DLP stimulates guaranteed OBS growth hypothesis depends.

Existing empirical research already figured out, when we analyze the “output” of commercial bank, we must include the OBS activities or we will get a misspecified model (Jagtiani et al., 1995b; Casu & Girardone, 2005). As we discussed in section 2, guaranteed OBS and commercial loan have substitution relation in some economies, such as India; while have complementation relation in others, such as HongKong SAR. Because there's no prior knowledge about the relation in China mainland, without loss generality, we consider a CES output function:

$$f(x, y) = [a_1 x^\rho + a_2 y^\rho]^{\frac{1}{1-\rho}}$$

where x is the guaranteed OBS scale, y is the commercial loan scale, both of them are stock variables; $a_1, a_2 > 0$ are parameters, and $\frac{1}{1-\rho}$ is the elasticity of substitution of these two businesses. CES output function contains two types production function as the parameter ρ changes value on $(-\infty, 0)$. When $\rho \rightarrow 0$, $f(x, y)$ converges to Cobb-Douglas function in which the two businesses have substitute relation; when $\rho \rightarrow -\infty$, $f(x, y)$ converges to Leontief function in which the two businesses have complement relation.

Suppose the average liability cost of commercial bank is r , and the average business return is $(r + \tau)$. It means the commercial bank set the price with a markup τ . It makes sense base on two facts about China's commercial bank industry: the first one is, 70% of Chinese commercial bank's income still comes from interest spread (BCMFRC, 2016); the second one is China's commercial bank market is far from perfect competition. Therefore, bank's total income is $(r + \tau)f(x, y)$.

Deposit can be divided into two parts in our research background. The first part is common deposit, denotes as d ; the second part is the margin gets from guaranteed OBS activities. Suppose the margin ratio is $0 < \mu < 1$, then the total margin is μx . Furthermore, suppose reserve requirement ratio is $1 - \theta$, which means the proportion of total deposit a bank can keep by itself is $0 < \theta < 1$. Put all these together, we know the deposit cost is $r\theta(d + \mu x)$. Besides deposit cost, suppose costs of other businesses are fixed (Jagtiani et al., 1995b), denoted by FC . Therefore, the profit function needs to be optimized by commercial bank is:

$$\pi(x, y, d) = (r + \tau)f(x, y) - r\theta(d + \mu x) - FC = (r + \tau)[a_1 x^\rho + a_2 y^\rho]^{\frac{1}{1-\rho}} - r\theta(d + \mu x) - FC$$

Next, consider constraints faced by Chinese commercial bank. First of all, the capital adequacy ratio:

$$\frac{K}{m(1 - \mu)x + ny} \geq \delta$$

where K is commercial bank's capital, m, n are risky assets weight for guaranteed OBS and commercial loan separately, δ is the minimum

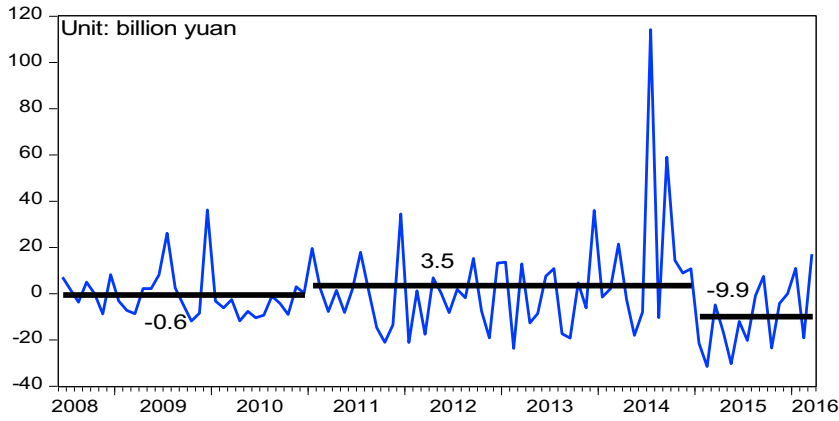


Fig. 4. Cyclical behavior of letter of guarantee in Qingdao.
Source: Author collects.

capital adequacy ratio.

Secondly, the loan-to-deposit ratio⁵:

$$\frac{y}{d + \mu x} \leq R$$

To sum up, commercial bank's optimization problem without DLP is:

$$\max \pi(x, y, d)$$

$$s.t. \frac{K}{m(1 - \mu)x + ny} \geq \delta \quad (1)$$

$$\frac{y}{d + \mu x} \leq R \quad (2)$$

Base on the assumption behind maximize behavior of commercial bank, constraints (1) and (2) are both hold with equality. Then use constraint (2) to replace $d + \mu x$ in the profit function, and construct the Lagrangian function:

$$L(x, y, \lambda) = (r + \tau)[a_1 x^\rho + a_2 y^\rho]^{\frac{1}{\rho}} - r\theta \frac{y}{R} - FC - \lambda \left[\frac{K}{\delta} - m(1 - \mu)x - ny \right]$$

Following the Kuhn-Tucker theorem, there's a positive multiplier λ makes first order necessary conditions below hold simultaneously:

$$\frac{\partial L}{\partial x} = \frac{r + \tau}{\rho} [a_1 x + a_2 y]^{\frac{1}{\rho}-1} a_1 \rho x^{\rho-1} - \lambda m(1 - \mu) = 0 \quad (3)$$

$$\frac{\partial L}{\partial y} = \frac{r + \tau}{\rho} [a_1 x + a_2 y]^{\frac{1}{\rho}-1} a_2 \rho y^{\rho-1} - \frac{r\theta}{R} - \lambda n = 0 \quad (4)$$

$$\frac{\partial L}{\partial \lambda} = \frac{K}{\delta} - m(1 - \mu)x - ny = 0 \quad (5)$$

Combine conditions (3) and (4), we get:

$$\left(\frac{x}{y} \right)^{\rho-1} = \frac{a_2 \lambda m(1 - \mu)}{a_1 (r\theta/R + \lambda n)} a \quad (6)$$

To simplify the calculation, define $\frac{a_2 \lambda m(1 - \mu)}{a_1 (r\theta/R + \lambda n)} \equiv \Phi$. Because RHS of equation (6) constituted by positive numbers, so we have $\Phi \in (0, +$

⁵ CBRC cancelled the "loan-to-deposit ratio" since Oct. 2015. But considering this requirement exists during most of the period on which the paper focuses (June 2008-March 2016), so we keep it in the model.

∞). Then equations (5) and (6) determine the optimal commercial loan and guaranteed OBS scale together. Now we discuss two cases base on different ρ values. Start from here, we use superscript “*” to indicate the optimal solution, and use subscript “r” to indicate the policy environment with DLP constraint.

Case (i), when $\rho \rightarrow 0$, commercial loan and guaranteed OBS has substitute relation. From equation (6) we know below equation holds:

$$y^* = \Phi x^* \quad (6.1)$$

Combine equations (6.1) and (5), we can solve out the optimal scale of commercial loan and guaranteed OBS as below:

$$x^* = \frac{K/\delta}{m(1-\mu) + n\Phi} \quad (7)$$

$$y^* = \frac{\Phi(K/\delta)}{m(1-\mu) + n\Phi} \quad (8)$$

Case (ii), when $\rho \rightarrow -\infty$, commercial loan and guaranteed OBS has complement relation. From equation (6) we know below equation holds:

$$\lim_{\rho \rightarrow -\infty} \left(\frac{y}{x}\right)^{1-\rho} = \Phi$$

If $y > x$, then we have $\Phi \rightarrow +\infty$; if $y < x$, then we have $\Phi \rightarrow 0$. Obviously, both cases are inconsistent with $\Phi \in (0, +\infty)$. Hence it means we must have:

$$y^* = x^* \quad (6.2)$$

Combine equations (6.2) and (5), we can solve out the optimal scale of commercial loan and guaranteed OBS as below:

$$x^* = y^* = \frac{K/\delta}{m(1-\mu) + n} \quad (9)$$

Now we add DLP constraint in the model, then consider the difference of the optimal solutions under two environments. In spite of DLP imposes restriction on new granted loan, which is a flow variable; it can be easily transfer into restriction on commercial loan scale y , which is a stock variable. Base on *China Monetary Policy Report (PBC, 2014)*, “desirability lending is a transparent, rule-based macro-prudential policy tool based on capital requirements.” But no one outside the Monetary Policy Department of PBC knows exactly the formula used to calculate the “desirability lending”. Headquarter of PBC imposes a desirability lending amount every month for each national bank, while branches of PBC impose it to local banks every month. Hence, we have to view DLP as an implicit “lending quota” policy.

Following this argument, DLP constraint can be written as $y \leq \bar{C}$. The new problem that a commercial bank faces is:

$$y \leq \bar{C} \quad (10)$$

As before, consider all constraints hold with equality. It means we can get the optimal solutions from these constraints directly:

$$x_r^* = \frac{K/\delta - n\bar{C}}{m(1-\mu)} \quad (11)$$

$$y_r^* = \bar{C} \quad (12)$$

$$d_r^* = \frac{\bar{C}}{R} - \mu x_r^* \quad (13)$$

Of course, it also deserves to figure out that equations (11) and (12) not necessary equals under the case (i), but must equals with each other under case (ii), thus $x_r^* = y_r^* = \bar{C}$ holds.

The first and most interesting finding from optimal solutions is the “reserve requirement ratio” and “loan-to-deposit ratio” have no effect on guaranteed OBS and commercial loan scale after we add DLP constraint in the model, no matter which case is true. Because expression Φ does not show in equations (11) and (12) anymore, which contains parameter θ and R . Furthermore, though “capital adequacy ratio” δ still exists, considering it's the “minimum”, which does not change after global financial crisis, hence we can ignore it. It implies DLP \bar{C} will be the only driving force behinds the optimal guaranteed OBS and commercial loan scale in reality. Therefore, we get the first Proposition.

Proposition 1. No matter what the value of ρ is, only if the minimum capital adequacy ratio δ does not change, then DLP will be the unique constraint has effect on optimal guaranteed OBS and commercial loan scale.

Proposition 1 implies that if the mechanism is true, we should expect DLP's quantitative effect explains major part of the supernormal growth of guaranteed OBS during 2011–2014. Intuitively, this effect should be observed more easily when we use high frequency data,

Table 1

Banks included in data.

Abbreviation of Bank Name	Bank Type	Numbers
ICBC, ABC, BOC, CCB, BCM	National big bank	5
China CITIC Bank, CEB, HXB, CMB, PAB, SPDB, HFB, CMBC, CIB	National medium bank	9
BQD, QLB, WFB, WHCCB, BRZ, BHB, QRCB	City bank	7

such as monthly data. Because capital adequacy ratio will not changes every month, while DLP does; hence the growth of guaranteed OBS calculates from data should nearly all attributed to DLP.

In addition, compare optimal solutions under two different policy environments, we can formally illustrate microeconomic mechanism behinds the cyclical behavior of guaranteed OBS as [Proposition 2](#). Simple proofs were relegated in [Appendix C](#):

Proposition 2-A. When $\rho \rightarrow 0$, commercial loan and guaranteed OBS exhibits substitute relation, if central bank wants to cool the economy and inflation rate by desirability lending restriction $y_r^* = \bar{C} < y^*$, then $x_r^* > x^*$ holds, thus the guaranteed OBS increase.

Proposition 2-B. When $\rho \rightarrow -\infty$, commercial loan and guaranteed OBS exhibits complement relation, if central bank wants to cool the economy and inflation rate by desirability lending restriction $y_r^* = \bar{C} < y^*$, then $x_r^* < x^*$ holds, thus the guaranteed OBS decrease.

From above propositions, we know if the mechanism of “DLP stimulates guaranteed OBS growth” is true, two preconditions must hold: the first one is commercial loan and guaranteed OBS have stable substitute relation; the second one is DLP is binding compares with the optimal commercial loan scale under the environment without it. If and only if these preconditions hold at the same time, then we can say in a causation sense that DLP stimulates guaranteed OBS growth.

In Section 5, we use guaranteed OBS as explained variable, use commercial loan and DLP as regressors in an ADL model to test these preconditions. If [Proposition 2-A](#) holds in reality, thus “regulation avoidance theory” holds in China, we should expect the coefficient of commercial loan significant negative and the coefficient before DLP and commercial loan interaction term significant positive. If [Proposition 2-B](#) holds in reality, thus “scale economy theory” holds in China, we should expect both coefficients are significant positive.

5. Empirical results

5.1. Data and method

5.1.1. Data description

Firstly, determine commercial banks and the time span included in the research. This paper chooses Chinese commercial banks since they are impacted by DLP much more than foreign commercial banks and China's policy banks. Banks included in the data were listed in [Table 1](#). It deserves to note that, headquarters of BQD and QRCB are established in Qingdao, while the other 19 banks are bank branches. Time span of the data ranges from Jun. 2008 to Mar. 2016. This is the largest span that we can collect the data. Views from worldwide, this period contains the Global financial crisis of 2008, European debt crisis, and the international finance market turbulence period marked by oil price went down. Views from China domestic economy, this interval contains “4 trillion fiscal stimulus packages” period, introduce and fade away of DLP, China's economy growth rate drops down from a high speed to a relatively low level. Anyway, this interval contains nearly all major shocks come from international and domestic economy, reflects almost all major business cycle behaviors of China's finance sectors. Of course, it needs to mention that some city banks open their branches in Qingdao after Jun. 2008,⁶ so the panel dataset used by this paper is unbalanced.

Secondly, determine variables included in the econometric model. Variables in time series dataset can be divided into three groups are listed in [Table 2](#). The third group is about country-level policy, which can be viewed as strictly exogenous intervention to Qingdao's macroeconomy and finance system. Since these policy variables are hard to measure, therefore we adopt dummy variable method to represent DLP and fiscal policy (4 trillion fiscal stimulus packages).

Variables in panel dataset can be divided into five groups are listed in [Table 3](#). We'd like to detail the reason that choose these variables. Because commercial bank develops guaranteed OBS must balance its return and risk, so we should control them first. There're two main benefits for develop guaranteed OBS. The first one is the charge get from these businesses, the second one is bank can get margin as deposit to slack loan-to-deposit ratio constraint. It deserves to emphasize that, we use “risk exposure” to measure the guaranteed OBS risk. In reality, if the bank trusts a customer, it will ask for a low margin ratio, which means a high risk exposure. Thus expect coefficients sign of these variables should be all significant positive. Moreover, according to OBS development theories in Section 2, return and risk factors relate to commercial loan should also be controlled. For example, if “moral hazard theory” holds in China, then expect coefficients sign of “non-performance loan ratio” and “loan loss reserves” should be significant positive. At last, because “return of assets” measures the operation efficiency; “ownership type” and “operation region” measure creditworthiness of the bank, these variables relate to the “market power theory”. If this theory is hold in China, then expect coefficient sign of “return of assets” should be

⁶ Specifically, BRZ's data starts from April 2009; WFB's data starts from May 2010; WHCCB's data starts from August 2010; QLB's data starts from September 2010; BHB's data starts from May 2011.

⁷ In order to get enough time dimension observations, we use Litterman data frequency convert method in EViews9 software to change the quarterly data into monthly data, such as “GDP” and “total retail sales of consumer goods”.

Table 2
Main statistics of time series variables.

Group	Variable (Abbr., Unit)	Main Statistics				
		Max.	Min.	Mean	Median	Std. Dev
Commercial Loan and Guaranteed OBS	Commercial loan increment per month (loan, billion yuan)	28	−6	9	8	6
	Guaranteed OBS granted per month (offb, billion yuan)	104	20	54	55	19
Macroeconomy and Financial Environment	GDP (gdp, billion yuan) ⁷	562	265	411	418	95
	Total retail sales of consumer goods (cons, billion yuan)	230	77	149	151	48
	Investment in fixed assets(inv, billion yuan)	371	106	221	212	78
	Total value of imports & exports (trade, billion dollars)	99	8	36	38	14
	CPI mom (cpi, %)	6.70	−0.60	2.49	2.30	1.58
	PPI mom (ppi, %)	9.24	−6.60	0.00	−0.74	3.60
	RMB effective exchange rate index (fxdex, 2010 = 100)	131	94	111	108	11
	Mid-price of RMB against Dollar (fx,¥/\$)	6.85	6.10	6.45	6.35	0.28
Country-level Policy	Dummy Variables (Abbr.)	Definition				
	Desirability lending policy (DLP)	DLP = 1, Jan. 2011-Dec.2014 DLP = 0, Others				
	4 trillion fiscal stimulus packages (fiscal)	fiscal = 1, Nov.2008-Dec.2010 fiscal = 0, Others				

significant positive, while expect coefficient sign of “ownership type” and “operation region” should be significant negative.

5.1.2. Econometric method

In that paper, we didn't model OBS development as a Logistic learning process as Jagtiani et al. (1995a). Because the OBS activities investigated in this paper all belongs to traditional type not innovative type, so there doesn't exit a learning process.

Because aggregate variables can't reflect commercial bank's individual optimization behavior, thus it cannot be used to test the mechanism proposed by the paper. Therefore, for time series data, we adopt VAR model to estimate the effect of DLP on guaranteed OBS growth. At the same time, we can also display the dynamic transmission of an exogenous policy shock between commercial loan and guaranteed OBS through impulse response graph. To sum up, this part used to test Proposition 1.

For panel data which originated from commercial bank's optimal behavior, can be used to investigate the mechanism demonstrated in Proposition 2. There're T = 94 observations on time dimension. Even the shortest time span (BHB) has 59 observations which is far more than the number of individuals, N = 21. So this data set is a typical time-series-cross-section (TSCS) data. We obey suggestions of Beck (2008) to analyze the data from time dimension and cross-section dimension.

Considering time dimension, we establish ADL model to capture the dynamic relationship between main variables. Since an ADL model can be changed into an ECM model easily, it means the ECM model estimation can be viewed as a robust test to our ADL model. Considering cross-section dimension, there're two problems in practice: individual heterogenous problem and contemporaneous interdependence errors. In general, for the first problem we use FE estimation and for the second problem we use SUR estimation. Though Nickell (1981) proved that FE method always get a bias estimation in dynamic panel model, some researchers already proved by Monte Carlo simulation that we can apply FE estimation directly if T ≥ 30, which is better than any dynamic panel GMM estimators (Beck & Katz, 2004; Judson & Owen, 1999). So we use LSDV estimation as a benchmark. But it's very awkward that we can't use LSDV and SUR at the same time in practice. Under this condition, we following the suggestion of Beck and Katz (2011), always use PCSE accompanies with LSDV and SUR to alleviate problems in statistical inference.

5.2. DLP's quantitative effect

For the time series data set, consider a VAR model as follows:

$$\begin{bmatrix} \text{off}b_t \\ \text{loan}_t \\ \text{GDP}_t \\ \text{CPI}_t \end{bmatrix} = \begin{bmatrix} a_{1,0} \\ a_{2,0} \\ a_{3,0} \\ a_{4,0} \end{bmatrix} + \sum_{l=1}^p \begin{bmatrix} a_{1,l} & \cdots & a_{1,4p} \\ \vdots & \ddots & \vdots \\ a_{4,l} & \cdots & a_{4,4p} \end{bmatrix} \begin{bmatrix} \text{off}b_{t-l} \\ \text{loan}_{t-l} \\ \text{GDP}_{t-l} \\ \text{CPI}_{t-l} \end{bmatrix} + \beta_1 \text{DLP}_t + \beta_2 \text{fiscal}_t + \beta_3 \text{fxdex}_t + \varepsilon_t$$

In this system, guaranteed OBS, commercial loan, GDP and inflation rate are endogenous variables, while DLP, fiscal policy and exchange rate of RMB are exogenous variables, because they are all determined on the country level. Since it's still unclear which inflation index was targeted by PBC, for robust test consideration, we use both CPI and PPI as inflation index to estimate the model separately, and then compare them.

First of all, test stationary of these variables. Test and treatment results listed in Table D.1 of Appendix D. Put all variables as their stationary forms into the model and then choose the best lag terms. For CPI model, SBC chooses 2 lag terms, AIC chooses 6 lag terms; for PPI model, SBC chooses 2 lag terms, AIC chooses 5 lag terms. According to lag terms determine principle proposed by Enders (2015), on one hand we should capture comprehensive dynamic relation as much as we can; on the other hand, we should avoid over parameterize problem. Balance the cost and benefit, we choose 3 lag terms for both models. In addition, there is economic reason supports 3 lag terms: the major part of guaranteed OBS are BA and L/C, both of them are mature in 3 or 6 months, so 3 months is the lifecycle or half-lifecycle of these businesses.

Table 3

Main statistics of panel data variables.

Group	Variable (Abbr., unit)	All Sample		National Big Commercial Bank		National Medium Commercial Bank		City Commercial Bank	
		Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Scale of Guaranteed OBS	Guaranteed OBS granted per month (offb, million yuan)	2486	1803	3721	1977	2639	1516	1171	1041
Risk & Return Factors of Guaranteed OBS	Margin deposit of guaranteed OBS per month (guardep, million yuan)	51	539	62	552	57	651	32	266
	Charge of guaranteed OBS per month (cha, million yuan)	5	7	7	5	6	8	2	3
	Risk exposure of guaranteed OBS per month (risk, million yuan)	50	997	50	1532	60	881	34	392
Scale of Commercial Loan	Commercial loan increment per month (loan, million yuan)	313	851	644	1114	186	802	225	523
Risk & Return Factors of Commercial Loan	Retrun of assets (roa,%)	0.89	0.70	1.04	0.75	0.86	0.69	0.79	0.65
	Non-performance loan ratio (nplr,%)	1.54	1.76	1.91	1.47	1.11	1.22	1.90	2.44
	Loan loss reserves increment per month (llr, 10 thousands yuan)	995	10871	2063	19889	459	4427	906	5507
Bank Type	Dummy Variable (Abbr.)	Definitions							
	Ownership type (owner)	owner = 0, National big commercial bank owner = 1, Others							
	Operation region (region)	region = 0, National banks region = 1, City banks							

Table 4

VAR model estimation results.

Explained Variable: Guaranteed OBS (unit: billion yuan)				
Exogenous Variables		CPI Model		PPI Model
DLP		6.600** (2.739)		6.562** (2.786)
fiscal		1.575 (2.684)		1.310 (2.785)
fxdex		−1.199* (0.659)		−1.311* (0.683)
constant		1.609 (4.287)		2.378 (4.496)
Main Statistics	Periods	90	Periods	90
	R-squared	0.258	R-squared	0.261
	AIC	30.25	AIC	30.25
	SBC	30.69	SBC	30.69

Note: Standard errors in parentheses; *** denotes significance on 1% level; ** denotes significance on 5% level; * denotes significance on 10% level.

Estimation results are displayed in Table 4. For space saving, we only list the exogenous variable estimation of guaranteed OBS equation, and omit coefficients of lag terms that we don't care.⁸ From Table 4, we can tell that the VAR model is robust to the central bank's inflation target, because coefficients' estimation and significance are not largely changed between CPI and PPI model.⁹ Both models show that DLP stimulated guaranteed OBS growth. Specifically, due to DLP, during the policy period (2011–2014), new granted guaranteed OBS per month in Qingdao is 6.6 billion yuan more than other periods. Considering we use dummy variable to measure DLP, there exists bias about its effect estimation. Therefore, in order to get a conservative conclusion, we use the lowest bound of DLP's coefficient confidence interval to do the calculation. Base on Table 4, for CPI model, this bound value is 3.9 billion (6.6–2.7 = 3.9) yuan per month; for PPI model, the number is 3.8 (6.6–2.8 = 3.8) million yuan per month. On the other hand, if we calculate the difference of new granted guaranteed OBS mean between policy period and the other period with actual data, it's easy to get the number is 3.8 billion yuan per month. The estimation of DLP's effect almost equals the data, which means DLP is the only fundamental reason of guaranteed OBS rapid growth during 2011–2014 on a large extent. What about the robustness test result in Table D.2? Base on that result, for CPI model, the lowest bound value is 2.8 billion (5.7–2.9 = 2.8) yuan per month, which accounts for 74% (2.8/3.8 ≈ 0.74) of monthly growth of guaranteed OBS on average; for PPI model, the lowest bound value is 3 billion (5.9–2.9 = 3) yuan per month, which accounts for 79% (3/3.8 ≈ 0.79) of monthly growth of guaranteed OBS on average. From above discussions, it's easy to learn that, DLP is indeed the only fundamental reason which stimulates the supernormal growth of guaranteed OBS during 2011–2014, thus Proposition 1 holds in reality.

In addition, coefficient of fiscal policy variable is insignificant, which consistent with the mechanism proposed by this paper. Because during the period of “4 trillion fiscal stimulus packages” (2008–2010), commercial loan increased dramatically, which means

⁸ For all empirical results, readers could email the author to get the full results.⁹ We also use “mid-price of RMB against dollar” as exchange rate measurement to check the robustness. Estimation results and impulse response graphs are displayed in Table D.2 and Fig D.1 of Appendix D separately.

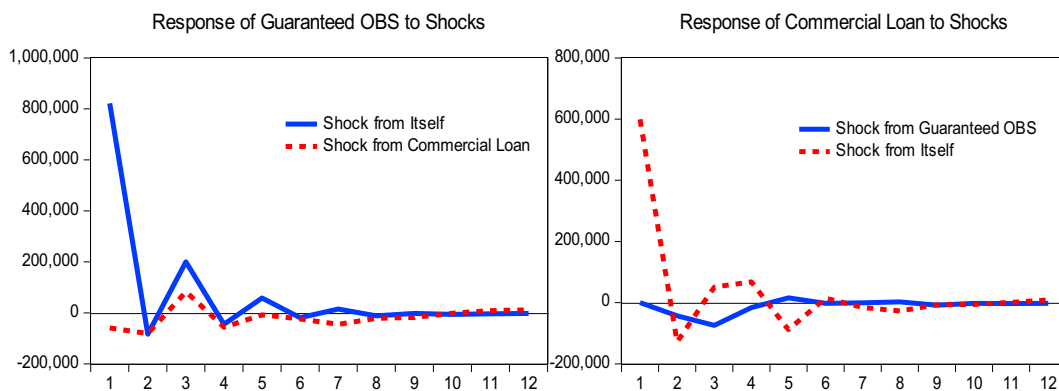


Fig. 5. Impulse response graphs of CPI model.

commercial banks have sufficient loan to satisfy the finance demand came from real economy sector. So the growth of guaranteed OBS wasn't fast. At last, exchange rate of RMB also has some influence on guaranteed OBS: When RMB appreciation (thus "fxdex" increases), China's export decreases, international trade finance demand decreases correspondingly, which decreases the amount of new granted guaranteed OBS. All these two results will be discussed in detail in [subsection 5.3](#).

Impulse response graphs of the VAR model are showed in [Fig. 5](#) and [Fig. 6](#). These figures display the dynamic interaction of commercial loan and guaranteed OBS¹⁰. On one hand, in both CPI and PPI models, the impulse responses of guaranteed OBS to a positive shock from commercial loan are drop down instantaneously, and achieve the lowest level in the second term. Then they bounce back temporarily in the third term, but go down again from then on, till they return to the equilibrium gradually around the tenth term. On the other hand, in both CPI and PPI models, the impulse responses of commercial loan to a positive shock from guaranteed OBS are drop down with a term lag, and achieve the lowest level in the third term. Then they start to return to the equilibrium gradually around the seventh term. To sum up, commercial loan and guaranteed OBS exhibit a substitute relation.

5.3. Mechanism behinds the cyclical behavior

For the micro-level panel data set, consider an ADL model as follows:

$$offb_{it} = \alpha_0 + A(L) \cdot offb_{it-1} + B(L) \cdot loan_{it-1} + \beta_0 \cdot loan_{it} \cdot DLP_t + \beta^T X_{it} + \varepsilon_{it}$$

where $A(L)$ and $B(L)$ are lag polynomial; β_0 is the interact term coefficient of commercial loan and DLP; X_{it} is the control variable vector.

Before the regression, we need to test the stationary of variables too. Here we adopt panel unit root test, test results and variable treatments are listed in [Table D.3 of Appendix D](#). Put all variables into the model with their stationary forms, then we need to determine the best lag term of commercial loan and guaranteed OBS. The autocorrelation shows the best lag term for guaranteed OBS itself is 4, and the cross-correlation shows the best lag term for commercial loan is 5.¹¹ The economic reason to choose these lag terms are the same as we mentioned before. After we have done all these work, we get the estimation results in [Table 5](#).¹²

From these results, four models estimated under two methods are all have a high fitting degree. Adjusted R-square values of LSDV and SUR are around 0.84 and 0.79 separately. It means that the model has a good explanation power, nearly contains all factors that have an influence on the guaranteed OBS growth. At the same time, D.W. values show that the model is specified dynamic completely, thus it also captures nearly all dynamic relation between main variables. It not only benefits the statistical inference, but also establishes a solid ground for ECM estimation. In addition, test the residuals get from LSDV estimation, it shows that contemporaneous interdependence error problem exists indeed. While we test the residuals get from SUR estimation, there's no such problem, which means using SUR method is appropriate.¹³ At last, no matter which inflation index we add in the model, estimation results and significance of main variables are not vary obviously, which means our estimation is robust to the central bank's inflation target.

Let's first analyze the coefficient estimates of commercial loan and DLP. Both LSDV and SUR estimates show that coefficients before commercial loan are jointly significant negative.¹⁴ It means guaranteed OBS and commercial loan has a stable long-run substitute relation. At the same time, coefficient estimates of DLP is positive significant. Bases on these two results, the mechanism proposed by this paper, thus [Proposition 2-A](#) is supported by micro-level data.

¹⁰ Cholesky identification method is used to generate the impulse response here, the variables order from the most exogenous to the least is: GDP, commercial loan, guaranteed OBS and price level.

¹¹ Both autocorrelation coefficients and cross-correlation coefficients are listed in [Table D.4 of Appendix D](#).

¹² For space saving, [Table 5](#) omits the coefficients output of guaranteed OBS lag terms.

¹³ Tests of contemporaneous interdependence error problem are listed in [Table D.5 of Appendix D](#).

¹⁴ Jointly coefficient significant tests are listed in [Table D.6 of Appendix D](#).

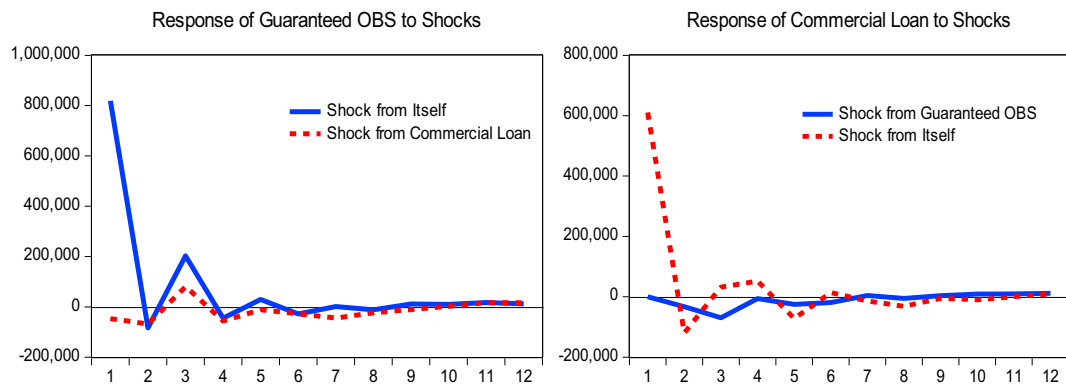


Fig. 6. Impulse response graphs of PPI model.

Table 5
ADL model estimation results.

Group	Variable	LSDV		SUR	
		CPI Model	PPI Model	CPI Model	PPI Model
Scale of Commercial Loan	loan	−0.037 (0.025)	−0.040 (0.025)	−0.024 (0.020)	−0.027 (0.019)
	loan(−1)	−0.013 (0.019)	−0.011 (0.019)	−0.019 (0.014)	−0.016 (0.014)
	loan(−2)	0.015 (0.019)	0.014 (0.019)	0.008 (0.014)	0.008 (0.014)
	loan(−3)	−0.031 (0.019)	−0.029 (0.019)	−0.001 (0.014)	0.001 (0.014)
	loan(−4)	−0.049** (0.019)	−0.049** (0.020)	−0.042*** (0.015)	−0.042*** (0.014)
	loan(−5)	−0.044** (0.020)	−0.048** (0.020)	−0.034** (0.015)	−0.034** (0.015)
	loan × DLP	0.076** (0.034)	0.080** (0.035)	0.061** (0.028)	0.063** (0.027)
Country-level Policy	fiscal	−9672.5* (5464.7)	−10930.3* (5624.4)	2746.1 (5588.0)	3027.3 (5689.8)
Risk & Return Factors of Commercial Loan	nplr	−2171.7 (2296.5)	−2361.4 (2318.9)	−682.5 (1787.1)	−825.0 (1781.5)
	llr	0.067 (0.142)	0.066 (0.143)	0.110 (0.111)	0.115 (0.110)
	roa	11427.7*** (3810.4)	11564.1*** (3848.2)	7200.9*** (2417.1)	7263.2*** (2410.3)
Risk & Return Factors of Guaranteed OBS	risk	0.351*** (0.025)	0.350*** (0.025)	0.340*** (0.020)	0.339*** (0.020)
	cha	34.363*** (4.648)	34.690*** (4.700)	21.862*** (3.257)	21.644*** (3.250)
	guardep	0.394*** (0.034)	0.395*** (0.034)	0.359*** (0.028)	0.359*** (0.028)
Macroeconomy Environment	GDP	−59.335 (73.688)	−75.3 (77.4)	−178.7** (80.5)	−226.9*** (83.9)
	CPI/PPI	−5173.5*** (1617.0)	−78.4 (499.3)	−3781.7** (1757.1)	390.0 (538.8)
	fxdex	−2081.4** (934.0)	−1745.7* (961.8)	−2181.9** (1004.7)	−2320.0** (1025.0)
Bank Type	owner			−24292.6*** (5616.0)	−24131.3*** (5616.5)
	region			−16192.1*** (3701.0)	−16234.2*** (3701.1)
Others	constant	57707.6*** (8713.8)	59735.3*** (8858.8)	44580.1*** (9422.8)	46055.4*** (9544.6)
Main Statistics	trend	yes	yes	yes	yes
	Obs = 1747	Adj-R ² = 0.839	Adj-R ² = 0.837	Adj-R ² = 0.794	Adj-R ² = 0.793
		F-Stat = 216.99	F-Stat = 214.43	F-Stat = 280.75	F-Stat = 279.40
		D.W. = 2.02	D.W. = 2.01	D.W. = 2.00	D.W. = 2.01

Note: Standard errors in parentheses; *** denotes significance on 1% level; ** denotes significance on 5% level; * denotes significance on 10% level.

Table 6
ECM estimation results.

Variables	CPI Model	PPI Model
Long-run Equilibrium Relation		
loan	−0.184** (0.077)	−0.171** (0.076)
Short-run Dynamic Relation		
Error-Correction term	−0.691*** (0.072)	−0.719*** (0.070)
loan × DLP	0.203*** (0.041)	0.203*** (0.040)
nplr	−6076.9 (8429.8)	−3405.7 (8246.6)
roa	24917.9** (10138.1)	32626.9*** (8642.4)
risk	0.356*** (0.047)	0.346*** (0.046)
cha	224.9** (89.8)	227.0** (90.8)
guardep	0.445*** (0.072)	0.441*** (0.069)
GDP	23.9 (115.7)	24.1 (125.0)
CPI/PPI	−4955.4* (2762.9)	−41.2 (825.4)
fxdex	−56.5 (1695.3)	221.5 (2091.2)
constant	32176.4** (13675.9)	31564.9** (14906.7)
trend	yes	yes

Note: Standard errors in parentheses; *** denotes significance on 1% level; ** denotes significance on 5% level; * denotes significance on 10% level.

Next, analyze the fiscal policy variable which represents the “4 trillion fiscal stimulus packages”. The sign of LSDV results are significant negative, while the sign of SUR results are insignificant. It means “4 trillion stimulus packages” has negative effect on guaranteed OBS growth, or it has no effect on it at most. Both estimation results consistent with the mechanism: during 2008–2010, commercial banks had enough loans to satisfy real economic sectors, and they had no strong incentive to develop the guaranteed OBS. Therefore, we observe no growth or even decrease of new granted guaranteed OBS. All above results give a support to “regulatory avoidance theory” and reject the “scale economy theory”.

For commercial loan risk factors coefficients, no matter which method we used, both “nonperformance loan ratio” and “loan loss reserves” are insignificant. So “moral hazard theory” is not supported by China's data. While “return of asset”, the variable used to measure operation efficiency of the bank is significant positive. At the same time, we also notice that coefficients of bank's ownership and operation region which measure creditworthiness of the bank are both significant negative. All these results indicate that “market power theory” is also supported by China's data.

At last, coefficient signs of return and risk factors of guaranteed OBS are all consistent with our expectation.

I will keep the analysis of macroeconomy variables estimation results to the next subsection. Because interpretation of these results link to a series robustness tests of the mechanism proposed by the paper. The most important mechanism we want to emphasize is, except affects guaranteed OBS growth directly, any macroeconomy variable can also affects it through commercial loan substitution channel indirectly.

5.4. Robustness tests

On the surface, ECM is changed from ADL model directly, but it adopts a different estimation method, so its results can be viewed as a robust test to ADL model.

Besides focus on the coefficient of error correction term, we should also expect the coefficient before commercial loan in long-run relationship estimation is significant negative, then we can say commercial loan and guaranteed OBS has a substitute relation. Furthermore, we should get a significant positive coefficient of interaction term of DLP and commercial loan. If these three preconditions are hold, then we will have more confidence about the mechanism.

In line with ADL model specification in [subsection 5.3](#), we choose 3 lag terms for guaranteed OBS and 4 lag terms for commercial

loan. Meanwhile, we drop the “loan loss reserves” from the model, which brings a serious multicollinearity problem in estimation process.¹⁵ ECM estimation results displayed in Table 6. For space saving, we didn't list lag term coefficients estimation of *offb* and *loan*. Obviously, no matter which inflation index we used, all three preconditions are hold: (1) coefficient before the error correction term is significant negative; (2) coefficient before the commercial loan is significant negative; (3) coefficient before interaction term is significant positive. Hence our mechanism gets support from ECM estimation.

Next, our analysis goes back to Table 5, to discuss the estimation results of macroeconomy variables. From Table 5, we can see estimation results of GDP and inflation index are depend on the estimation method and on which inflation index was included in model. For these results, we try to propose some interpretations which could also be viewed as robust tests for the main mechanism.

Firstly, consider the coefficient of GDP. If we use GDP to measure economy growth, then it may not impacts on guaranteed OBS growth (LSDV result), and to some extent, it may even has negative effect (SUR result). The potential reason is GDP can be divided into three parts: consumption, investment and international trade. BA and L/C are broadly used in international trade, but the finance method for consumption and investment are mainly depends on commercial loan in China. Following this stylized fact, if the economic growth is driven by consumption and investment, then we'll expect a fast growth of commercial loan. Furthermore, if our mechanism is true, then new granted guaranteed OBS growth will goes down. Therefore, if we put consumption, investment and international trade variables into the model to replace GDP, we should expect coefficients of consumption and investment are significant negative, and the coefficient of international trade is significant positive. The new regression results support this interpretation, estimation results are displayed in Table D.7 of Appendix D.

Secondly, consider the coefficient of inflation rate. No matter which method we applied, coefficients of PPI are always insignificant while CPI's are always significant. These results are so robust that we can even observe them after we divide GDP into three parts. So the first inference we can get from them is PBC's inflation target tends to be CPI rather than PPI. The second thing we want to indicate is why CPI has a negative effect on guaranteed OBS growth. Actually, there are two channels that CPI can affect guaranteed OBS growth. The first channel is a higher inflation will stimulates a higher debt finance demand, thus a higher growth of commercial loan, which implies the growth of guaranteed OBS will slow down if our mechanism is true. The second channel is a higher inflation rate will leads PBC to control commercial loan growth, which implies the growth of guaranteed OBS will increases if our mechanism is true. If the first effect dominants, then we'll get a negative sign of CPI's coefficient. Base on this effect decomposition, if we add interaction term of inflation rate and DLP into the model, we should expect the coefficient of inflation rate is significant negative while the coefficient of interaction term is significant positive. These regression results are displayed in Table D.8 of Appendix D, and empirical results support our view.

Thirdly, consider the coefficient of exchange rate. Though the sign of this coefficient consistents with the mechanism, we can still decompose the effect of RMB depreciation into two parts. The first part is “trade volume effect”, which means the depreciation will increases international trade volume then the demand for guaranteed OBS will increases correspondingly. By this effect, we should expect the coefficient of the exchange rate (use “*fxdex*” as measurement) is significant negative. The second part is “price transmission effect”, which means the depreciation will increases import goods price then transmits it to domestic inflation rate. Since the rise of CPI has a negative impact on guaranteed OBS, if PBC uses DLP to control it, according to above result, we should expect the coefficient of the interaction term of exchange rate and CPI is significant negative. These regression results are listed in Table D.9 of Appendix D, and empirical results support our interpretation.

6. Conclusions

More and more research about China's shadow banking emerging out. But none of them, at least in our reading scope, focuses on guaranteed OBS activity. Therefore, this paper fills the research gap through a novel city-level dataset. We find China's guaranteed OBS activity experienced a supernormal growth during 2011–2014 and then dropped sharply since 2015.

Different from existing research, which believe traditional regulatory constraints, such as “capital adequacy ratio”, “reserve requirement ratio” or “loan-to-deposit ratio”, are main forces deriving China's shadow banking. In this paper, we prove the DLP, a macroprudential policy tool introduced by PBC, is the unique fundamental reason. Furthermore, empirical estimation shows that DLP can explain almost all the supernormal growth of guaranteed OBS during 2011–2014. The mechanism is guaranteed OBS and commercial loan have a stable substitute relation, hence any policy impacts on commercial loan will has converse effect on guaranteed OBS indirectly.

Besides above findings, empirical results also show that guaranteed OBS development is influenced by macroeconomy condition, risk and return factors of itself, operation efficiency and creditworthiness of the bank. To sum up, these conclusions can be viewed as the first time to test OBS development theories with China's data. Specifically, “regulation avoidance theory” and “market power theory” are supported, while “moral hazard theory” and “scale economy theory” are not.

The policy implication of this paper is obvious. It proves that directly manage commercial loan growth to cool the overheat economy is ineffective. The conclusion consistent with historical supervision experience in advanced economies during 1970s (Shin, 2016). Therefore, at the beginning of 2016, PBC introduced Macro-prudential Assessment (MPA) as a refinement and substitution to DLP, which is a more market oriented policy. Thus this paper documents the central bank should depends on market oriented tools to conduct supervision in order to reduce the regulatory arbitrage.

¹⁵ There are two reasons that we needn't to concern too much about drop this variable: firstly, we still have “nonperformance loan ratio” in the model which measures the commercial loan risk; secondly, we have already known from ADL estimation that “loan loss reserves” is insignificant.

Appendix A. Comparison between China and Qingdao

Part one: macroeconomy environment

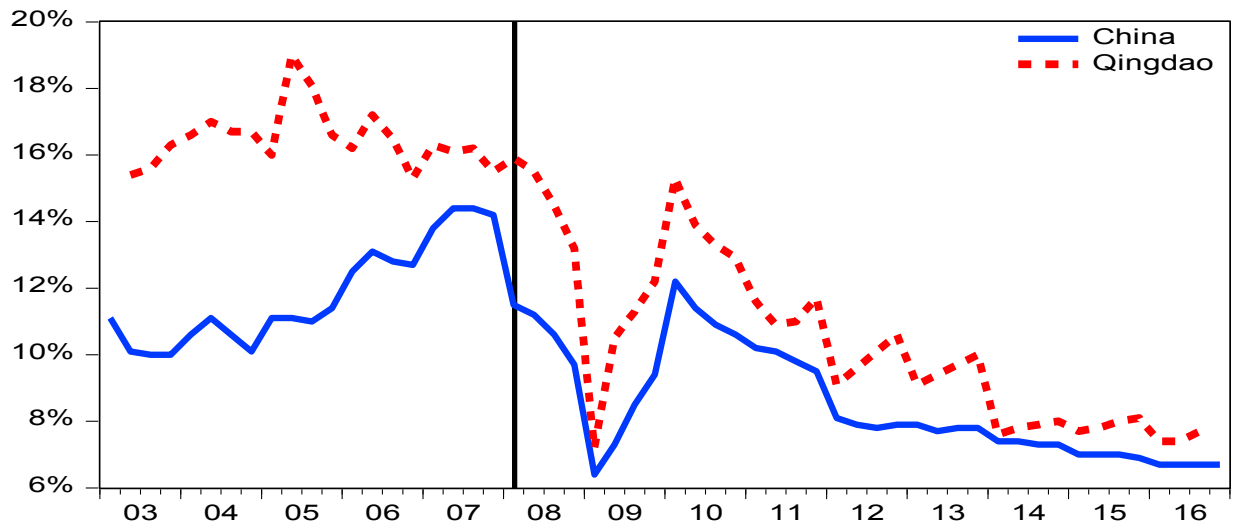


Fig. A.1. GDP growth rate. Source: Wind Database

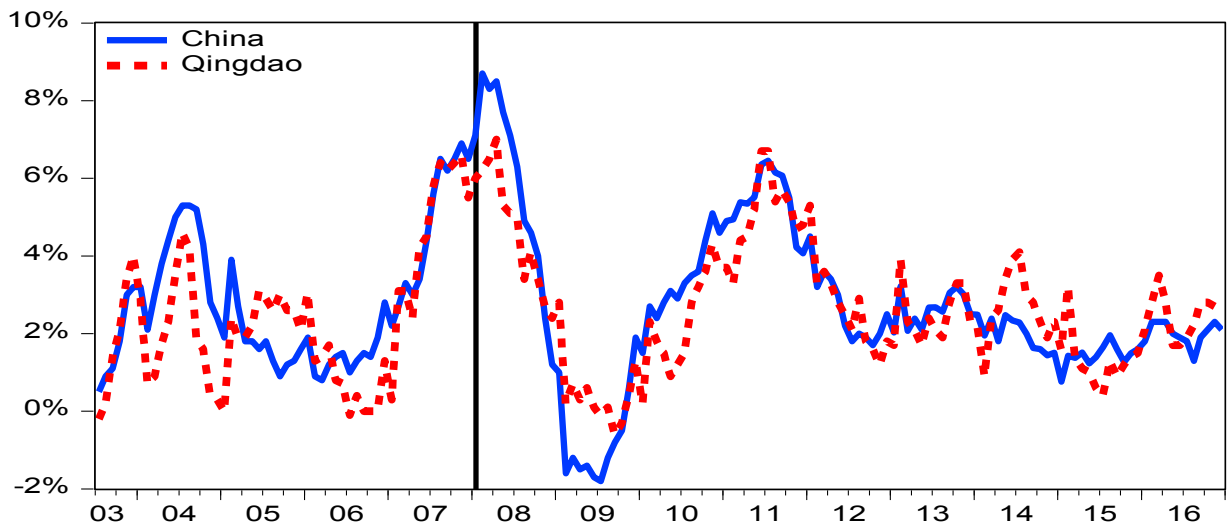


Fig. A.2. Price level (CPI). Source: Wind Database

Part two: industry production & international trade

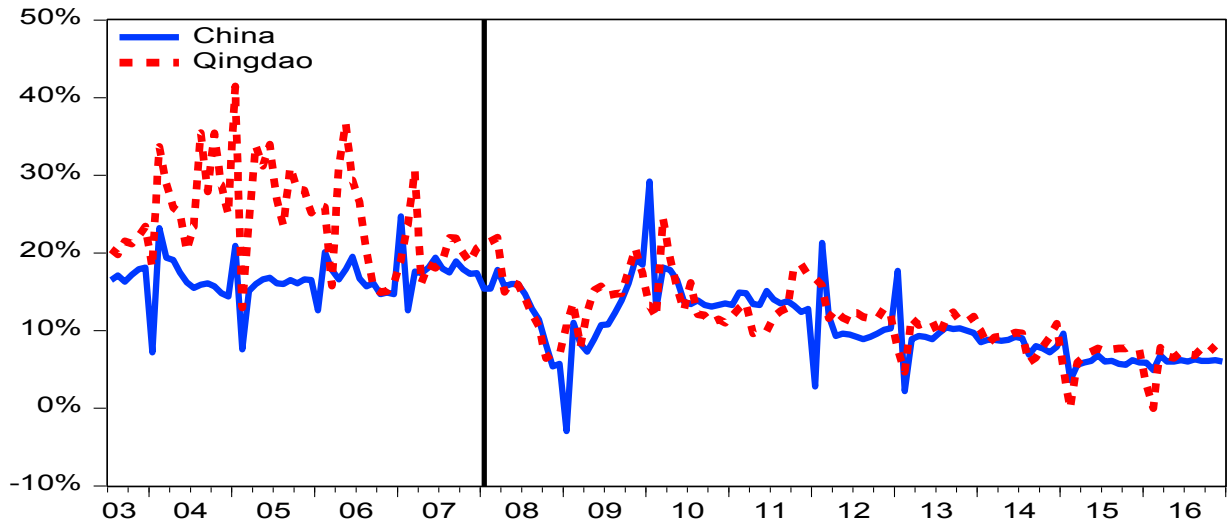


Fig. A.3. IP growth rate.Source: Wind Database

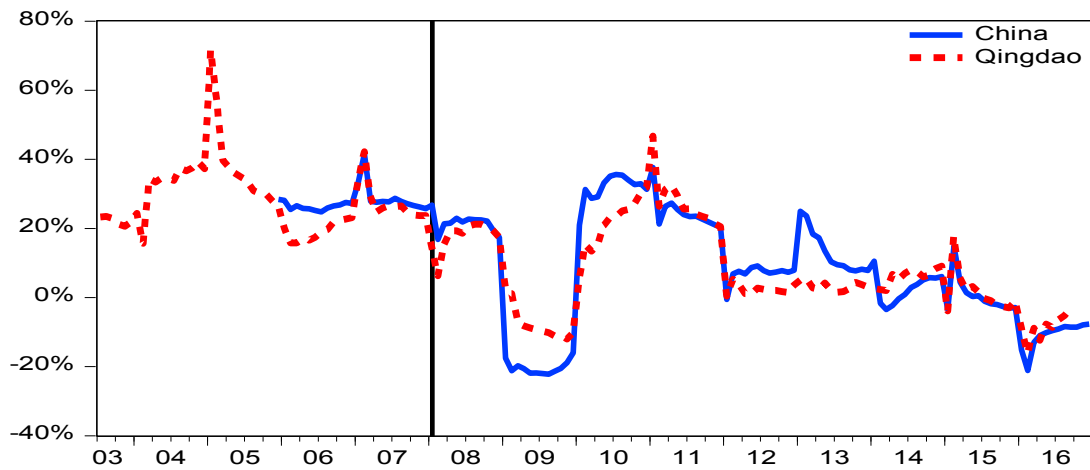


Fig. A.4. Export growth rate.Source: Wind Database

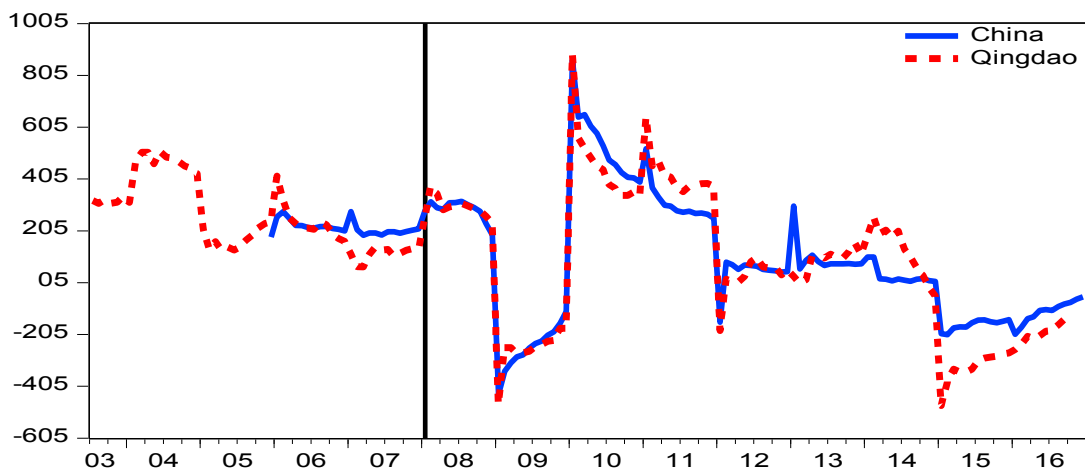


Fig. A.5. Import growth rate.Source: Wind Database

Part three: finance development

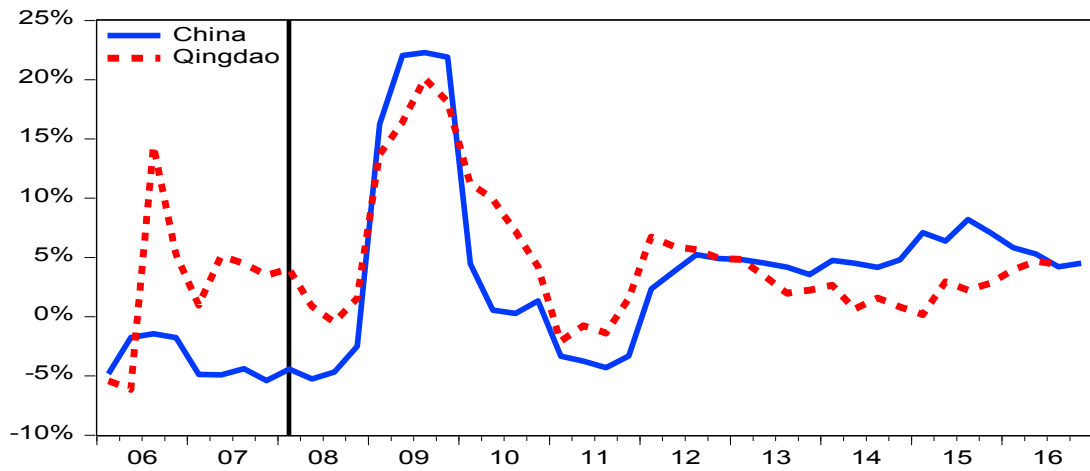


Fig. A.6. Growth rate of Loan-to-GDP ratio.Source: Wind Database

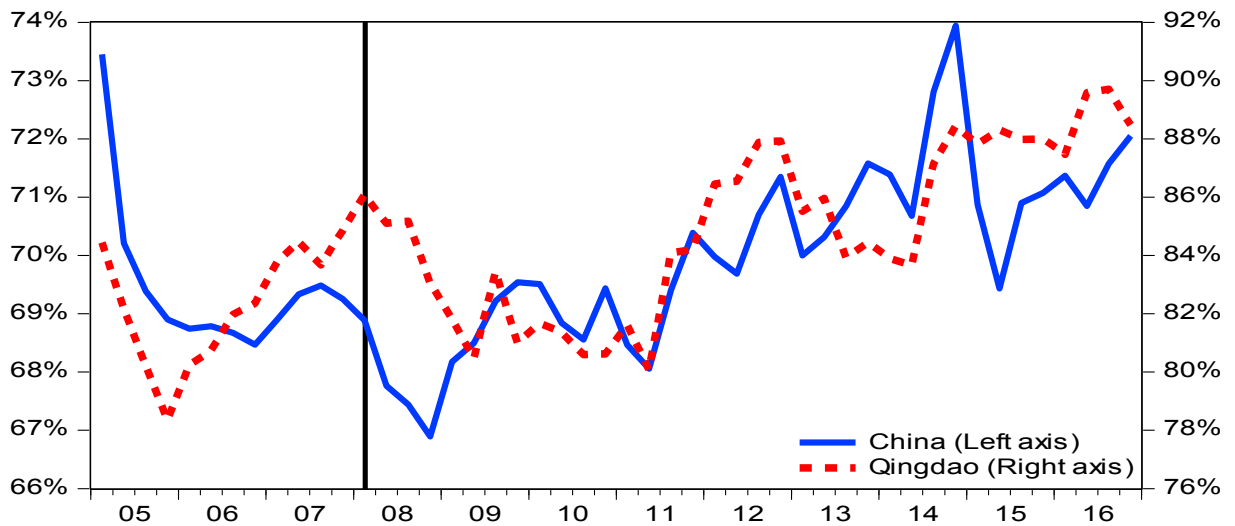


Fig. A.7. Loan-to-Deposit ratio.Source: Wind Database

Appendix B. Traditional regulatory constraints

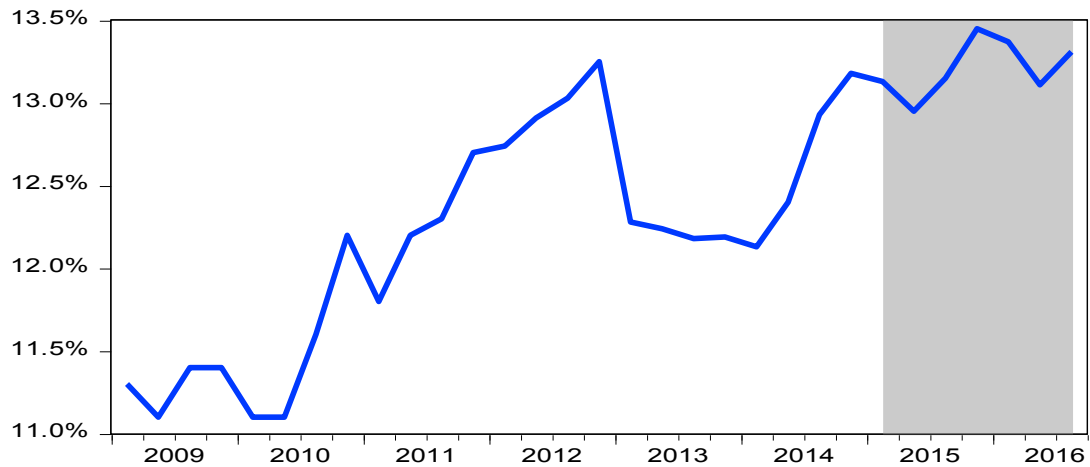


Fig. B.1. Capital adequacy ratio in China (Shade area: 2015Q1-2016Q3)¹⁶.Source: Wind Database.

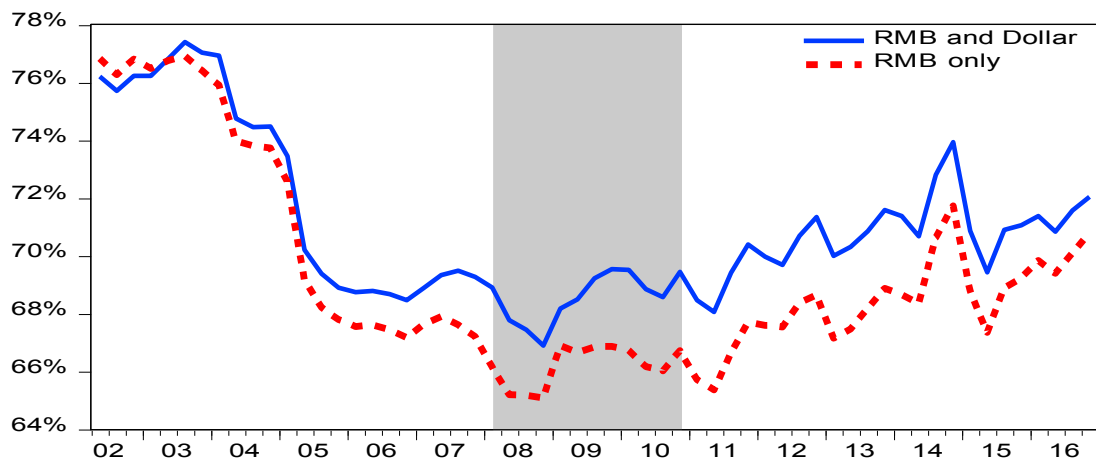


Fig. B.2. Loan-to-deposit ratio in China (Shade area: 2008Q1-2010Q4).Source: Author calculates.

¹⁶ CBRC states on its website, since the first quarter of 2013, it adopts a new method to calculate the capital adequacy ratio. This new method is stricter than before, though the ratio decreased during 2013.

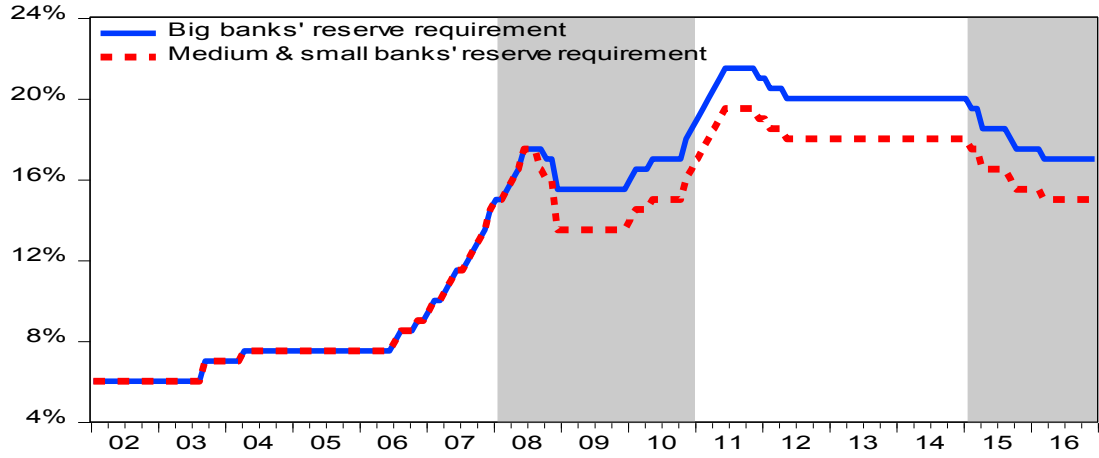


Fig. B.3. Reserve requirement ratio in China.
(Shade area: 2008M01-2010M12; 2015M01-2016M12).
Source: Wind Database.

Appendix C. Proof

Proposition 2-A. By equations (11) and (7), we have

$$x_r^* - x^* = \frac{K/\delta - n\bar{C}}{m(1-\mu)} - \frac{K/\delta}{m(1-\mu) + n\Phi} = \frac{n[\Phi(K/\delta) - \bar{C}(m(1-\mu) + n\Phi)]}{m(1-\mu)[m(1-\mu) + n\Phi]}$$

In addition, we have

$$\bar{C} < y^* = \frac{\Phi(K/\delta)}{m(1-\mu) + n\Phi} \Rightarrow \Phi(K/\delta) - \bar{C}[m(1-\mu) + n\Phi] > 0$$

Thus

$$x_r^* - x^* > 0$$

Proposition 2-B. By equations (11) and (9), we have

$$x_r^* - x^* = y_r^* - y^*$$

Since we already know

$$y_r^* < y^*$$

So we get the result

$$x_r^* - x^* < 0$$

Appendix D. Empirical results**Table D.1**

Time Series Variable Unit Root Test and Treatment.

Variables	Stationary Type	Treatment
offb	Trend stationary	Detrend
bankacep	Trend stationary	Detrend
lcredit	Trend stationary	Detrend
guarant	Trend stationary	Detrend
loan	Stationary	–
GDP	Difference stationary	Take difference
cons	Trend stationary	Detrend
inv	Trend stationary	Detrend
trade	Stationary	–
CPI	Difference stationary	Take difference
PPI	Stationary	–
fx	Trend stationary	Detrend
fxdex	Difference stationary	Take difference

Table D.2

VAR Model Robust Test Uses Mid-Price of RMB against Dollar (fx) as Exchange Rate Measurement.

Explained Variable: Guaranteed OBS (unit: billion yuan)				
Exogenous Variables	CPI Model		PPI Model	
DLP	5.711**		5.873**	
	(2.859)		(2.900)	
fiscal	2.402		2.585	
	(2.746)		(2.848)	
fx	–13.07		–12.10	
	(15.75)		(15.61)	
constant	–0.892		–0.819	
	(4.405)		(4.543)	
Main Statistics	Periods	90	Periods	90
	R-squared	0.232	R-squared	0.230
	AIC	30.28	AIC	30.29
	SBC	30.73	SBC	30.73

Note: Standard errors in parentheses; *** denotes significance on 1% level; ** denotes significance on 5% level; * denotes significance on 10% level.

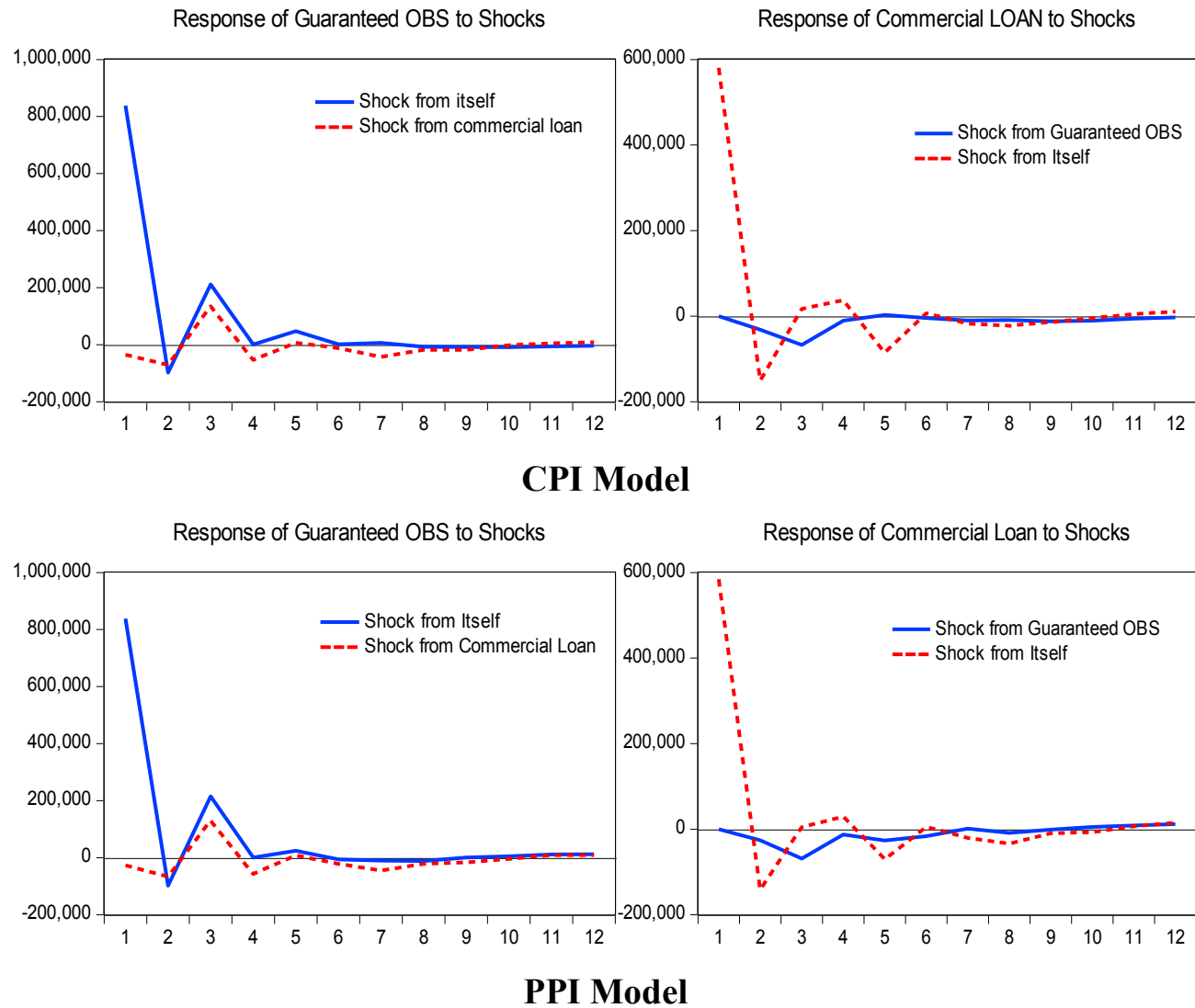


Fig. D.1. VAR Model Robust Test Uses Mid-Price of RMB against Dollar (fx) as Exchange Rate Measurement.

Table D.3
Panel Unit Root Test and Treatment.

Variables	Stationary Type	Treatment
offb	Stationary	–
guarddep	Stationary	–
cha	Stationary	–
risk	Difference stationary	Take difference
loan	Stationary	–
nplr	Difference stationary	Take difference
llr	Stationary	–
roa	Stationary	–

Table D.4.1
AC & PAC Coefficients of Guaranteed OBS.

Lag term	AC	PAC
1	0.771	0.771
2	0.760	0.408
3	0.731	0.205
4	0.720	0.154
5	0.692	0.065
6	0.731	0.229
7	0.669	–0.043
8	0.663	0.007
9	0.632	–0.030
10	0.619	–0.009
11	0.607	0.029
12	0.636	0.116

Table D.4.2
Cross-correlation Coefficients of Guaranteed OBS (Contemporary term) and Commercial Loan (Lag term).

Lag term	Corr.
0	0.1206
1	0.0927
2	0.0807
3	0.0794
4	0.0765
5	0.0575
6	0.0361
7	0.0353
8	0.0208
9	0.0273
10	0.0215
11	0.0226
12	0.0222

Table D.5
Contemporaneous Interdependence Errors Test.

H ₀ : No Contemporaneous Interdependence Errors		
Regression Equation	Pesaran CD Statistics	p-Value
LSDV(CPI)	18.433	0.000
SUR(CPI)	0.566	0.571
LSDV(PPI)	19.043	0.000
SUR(PPI)	0.475	0.635

Table D.6
Coefficients Jointly Significance Test of Commercial Loan.

H ₀ : Coefficients of Commercial Loan All Equal 0		
Regression Equation	Wald Statistics	p-Value
LSDV(CPI)	15.824	0.015
LSDV(PPI)	15.933	0.014
SUR(CPI)	18.973	0.004
SUR(PPI)	18.953	0.004

Table D.7

ADL Model Robust Test: Divide GDP into Consumption, Investment and International Trade.

Group	Variable	LSDV		SUR	
		CPI Model	PPI Model	CPI Model	PPI Model
Scale of Commercial Loan	loan	−0.031 (0.026)	−0.036 (0.026)	−0.014 (0.020)	−0.018 (0.020)
	loan(-1)	−0.020 (0.020)	−0.019 (0.020)	−0.022 (0.015)	−0.018 (0.014)
	loan(-2)	0.009 (0.020)	0.008 (0.020)	0.002 (0.014)	0.001 (0.014)
	loan(-3)	−0.025 (0.020)	−0.024 (0.020)	−0.001 (0.015)	0.001 (0.015)
	loan(-4)	−0.045** (0.020)	−0.047** (0.020)	−0.042*** (0.015)	−0.044*** (0.015)
	loan(-5)	−0.040** (0.020)	−0.045** (0.020)	−0.033** (0.015)	−0.037** (0.015)
Country-level Policy	loan × DLP	0.064* (0.036)	0.068* (0.036)	0.048* (0.029)	0.050* (0.029)
	fiscal	−11385.4 (7366.1)	−17283.0** (8013.0)	7143.1 (7463.7)	2916.2 (8111.4)
Risk & Return Factors of Commercial Loan	nplr	−2001.1 (2271.8)	−2293.9 (2299.6)	−699.0 (1786.3)	−1071.3 (1780.9)
	llr	0.092 (0.149)	0.095 (0.149)	0.100 (0.115)	0.100 (0.115)
	roa	10363.0*** (3771.4)	10621.5*** (3816.5)	6893.6*** (2434.8)	7114.4*** (2425.0)
Risk & Return Factors of Guaranteed OBS	risk	0.351*** (0.025)	0.350*** (0.025)	0.345*** (0.020)	0.347*** (0.020)
	cha	31.082*** (4.655)	31.767*** (4.720)	20.919*** (3.274)	20.948*** (3.271)
	guardep	0.388*** (0.034)	0.395*** (0.034)	0.353*** (0.028)	0.357*** (0.028)
Macroeconomy Environment	cons	−118.2** (47.4)	−131.1*** (49.9)	−62.2 (51.2)	−68.0 (54.2)
	inv	−124.3*** (47.8)	−101.5** (47.6)	−92.2* (51.8)	−71.6 (51.8)
	trade	32.5*** (10.8)	30.629*** (10.879)	48.4*** (11.7)	47.3*** (11.8)
	CPI/PPI	−6503.3*** (1655.2)	−701.1 (515.2)	−5918.4*** (1804.0)	−698.7 (569.5)
	fxdex	−2493.0*** (967.8)	−1860.6* (971.3)	−1987.8* (1042.4)	−1350.6 (1052.4)
Bank Type	owner			−24175.0*** (5655.0)	−24520.3*** (5655.9)
	region			−16127.0*** (3726.8)	−16224.4*** (3734.8)
Others	constant	50908.8*** (10151.0)	58978.9*** (10919.1)	23815.1** (10423.0)	30286.1*** (11114.9)
	trend	yes	yes	yes	yes
Main Statistics	Obs = 1726	Adj-R ² = 0.838	Adj-R ² = 0.836	Adj-R ² = 0.795	Adj-R ² = 0.794
		F-Stat = 203.56	F-Stat = 200.98	F-Stat = 258.27	F-Stat = 256.30
		D.W. = 2.01	D.W. = 2.00	D.W. = 2.01	D.W. = 2.01

Note: Standard errors in parentheses; *** denotes significance on 1% level; ** denotes significance on 5% level; * denotes significance on 10% level.

Table D.8

ADL Model Robust Test: Effects of Inflation Rate on Guaranteed OBS.

Group	Variable	LSDV		SUR	
		CPI Model	PPI Model	CPI Model	PPI Model
Scale of Commercial Loan	loan	−0.027 (0.026)	−0.031 (0.026)	−0.009 (0.020)	−0.017 (0.020)
	loan(-1)	−0.022 (0.019)	−0.020 (0.020)	−0.021 (0.014)	−0.018 (0.015)
	loan(-2)	0.008 (0.020)	0.008 (0.020)	0.002 (0.014)	0.001 (0.014)
	loan(-3)	−0.024 (0.020)	−0.026 (0.020)	−0.001 (0.015)	0.001 (0.015)
	loan(-4)	−0.045** (0.020)	−0.049** (0.021)	−0.042*** (0.015)	−0.044*** (0.015)
	loan(-5)	−0.045** (0.020)	−0.044** (0.021)	−0.036** (0.015)	−0.037** (0.015)
Country-level Policy	loan × DLP	0.061* (0.036)	0.066* (0.037)	0.045 (0.029)	0.050* (0.029)
	fiscal	−12496.3* (7323.2)	−15169.2* (8155.8)	5320.5 (7081.1)	2729.5 (8304.3)
Risk & Return Factors of Commercial Loan	nplr	−1606.3 (2263.9)	−2405.1 (2296.8)	−558.5 (1776.4)	−1077.7 (1787.0)
	llr	0.080 (0.148)	0.089 (0.152)	0.095 (0.113)	0.099 (0.115)
	roa	9779.7*** (3770.2)	10382.2*** (3810.1)	6607.2*** (2424.9)	7047.6*** (2429.4)
Risk & Return Factors of Guaranteed OBS	risk	0.353*** (0.025)	0.349*** (0.025)	0.347*** (0.020)	0.347*** (0.020)
	cha	30.266*** (4.650)	31.300*** (4.707)	20.902*** (3.273)	20.833*** (3.272)
	guardep	0.385*** (0.034)	0.392*** (0.034)	0.351*** (0.028)	0.356*** (0.028)
Macroeconomy Environment	cons	−135.1*** (47.3)	−43.2 (64.4)	−86.7* (48.6)	−65.4 (70.7)
	inv	−119.8** (47.4)	−84.5* (48.7)	−88.5* (48.5)	−72.4 (52.8)
	trade	36.2*** (10.8)	28.6*** (11.0)	51.2*** (10.9)	46.9*** (11.9)
	CPI/PPI ×	12612.8*** (3324.7)	−2736.9** (1201.5)	11436.5*** (3425.9)	−207.0 (1316.1)
	DLP	−14027.6*** (2571.3)	867.2 (856.4)	−12385.0*** (2681.8)	−634.6 (940.7)
	CPI/PPI	−2489.0*** (960.5)	−2115.3** (984.9)	−2033.1** (979.4)	−1367.1 (1061.3)
	fxdex				
Bank Type	owner			−24383.2*** (5652.7)	−24529.2*** (5658.9)
	region			−16277.2*** (3734.9)	−16445.7*** (3741.0)
Others	constant	51980.8*** (10089.1)	60155.0*** (11000.7)	24950.9** (10032.9)	30927.6*** (11166.0)
	trend	yes	yes	yes	yes
Main Statistics	Obs = 1726	Adj-R ² = 0.839	Adj-R ² = 0.835	Adj-R ² = 0.797	Adj-R ² = 0.793
		F-Stat = 200.61	F-Stat = 194.94	F-Stat = 251.32	F-Stat = 245.80
		D.W. = 2.00	D.W. = 2.00	D.W. = 2.00	D.W. = 2.01

Note: Standard errors in parentheses; *** denotes significance on 1% level; ** denotes significance on 5% level; * denotes significance on 10% level.

Table D.9

ADL Model Robust Test: Effects of Exchange Rate on Guaranteed OBS.

Group	Variable	LSDV		SUR	
		CPI Model	PPI Model	CPI Model	PPI Model
Scale of Commercial Loan	loan	−0.027 (0.026)	−0.037 (0.026)	−0.012 (0.020)	−0.018 (0.020)
	loan(-1)	−0.023 (0.020)	−0.020 (0.020)	−0.022 (0.015)	−0.019 (0.015)
	loan(-2)	0.001 (0.020)	0.007 (0.020)	−0.003 (0.015)	0.001 (0.014)
	loan(-3)	−0.021 (0.020)	−0.024 (0.020)	0.001 (0.015)	0.002 (0.015)
	loan(-4)	−0.043** (0.020)	−0.045** (0.020)	−0.042*** (0.015)	−0.044*** (0.015)
	loan(-5)	−0.038* (0.020)	−0.045** (0.020)	−0.033** (0.015)	−0.037** (0.015)
Country-level Policy	loan × DLP	0.059 (0.037)	0.068* (0.036)	0.048* (0.029)	0.052* (0.029)
	fiscal	−14076.4* (7393.2)	−17231.5* (8021.0)	5382.7 (7383.3)	3070.3 (8176.8)
Risk & Return Factors of Commercial Loan	nplr	−1864.6 (2277.6)	−2287.1 (2302.3)	−705.3 (1797.0)	−1052.4 (1785.1)
	llr	0.086 (0.151)	0.097 (0.150)	0.087 (0.115)	0.099 (0.115)
	roa	9432.6** (3790.2)	10573.8*** (3819.2)	6405.9*** (2451.1)	7015.2*** (2433.2)
Risk & Return Factors of Guaranteed OBS	risk	0.352*** (0.025)	0.350*** (0.025)	0.346*** (0.020)	0.347*** (0.020)
	cha	30.454*** (4.662)	31.709*** (4.719)	20.967*** (3.276)	20.806*** (3.270)
	guardep	0.374*** (0.034)	0.391*** (0.034)	0.346*** (0.028)	0.355*** (0.028)
Macroeconomy Environment	cons	−120.2** (47.5)	−130.5*** (50.0)	−71.1 (50.6)	−66.2 (54.7)
	inv	−123.3*** (47.8)	−97.1** (48.0)	−104.2** (51.2)	−71.6 (52.6)
	trade	31.4*** (10.8)	31.3*** (10.9)	46.9*** (11.6)	47.6*** (11.9)
	CPI/PPI × fxdex	−4309.0*** (1046.1)	−281.1 (318.0)	−3138.3*** (1121.7)	−127.3 (355.0)
	CPI/PPI	−3860.3** (1773.3)	−674.8 (516.7)	−3266.5* (1913.9)	−714.3 (574.9)
	fxdex	−1942.5** (980.5)	−1997.1** (984.7)	−1671.0 (1048.3)	−1339.4 (1073.7)
Bank Type	owner			−24377.6*** (5636.2)	−24375.4*** (5653.3)
	region			−16238.1*** (3725.6)	−16177.2*** (3729.8)
Others	constant	55572.9*** (10225.0)	59870.6*** (10975.3)	121.0*** (112.3)	44.7*** (134.5)
	trend	yes	yes	yes	yes
Main Statistics	Obs = 1726	Adj-R ² = 0.838 F-Stat = 198.60 D.W. = 2.02	Adj-R ² = 0.836 F-Stat = 196.27 D.W. = 2.00	Adj-R ² = 0.794 F-Stat = 247.99 D.W. = 2.01	Adj-R ² = 0.794 F-Stat = 246.81 D.W. = 2.01

Note: Standard errors in parentheses; *** denotes significance on 1% level; ** denotes significance on 5% level; * denotes significance on 10% level.

Appendix E. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.iref.2018.01.005>.

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