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The impact of off-balance-sheet regulations on bank risk-taking: Evidence from China

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ABSTRACT

The release of new asset management rules has played a positive role in regulating the asset management business of financial institutions, preventing and controlling financial risk. It has also had an important impact on the management of banks’ off-balance-sheet (OBS) innovation. This paper uses unbalanced panel data on 75 commercial banks in China from 2007 to 2017 and combines a theoretical and an empirical model to study the development of bank OBS innovation and bank risk taking from the perspective of new asset management regulations. The analysis finds (1) the rapid development of OBS innovation will increase bank risk taking and (2) the solution to the problem of rigid payment is conducive to reducing the risk taken by Chinese commercial banks when providing OBS innovation.

1. Introduction

A bank’s off-balance-sheet (OBS) activities refer to business that is not included in the bank’s balance sheet but which can directly change the bank’s profits and losses. The OBS business and on-balance-sheet business are related to each other, and some OBS business can be converted into on-balance-sheet business under certain circumstances. OBS business can be divided into four categories, namely, traditional intermediate business, commitments, guarantees, and transactions. Intermediate business refers to the business in which the bank promises to provide financial services to customers; commitments refer to the business in which the bank promises to provide loans to customers in the future; guarantees refer to the business in which the bank undertakes to repay the debt for guaranteed parties; transactions refer to agreements related to interest rates, exchange rates, and so forth, covering financial derivatives.

In China, OBS mainly includes traditional guarantee business and acceptance business, such as bank guarantee, acceptance business, and standby letters of credit. The bank guarantee means that when the creditor fails to pay the debt or fails to perform the contract, the bank assumes the debtor’s performance obligations to the creditor. Acceptance business is a payment commitment made by Chinese commercial banks to commercial papers issued by customers. Standby letters of credit refer to letters of credit opened for loan financing or guaranteed debt repayment. China’s OBS accounts for a relatively low proportion of total revenue. Compared with western countries, China’s OBS is still in its infancy, with a slower development rate and a single type of business.

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The report to the 19th National Congress\(^1\) pointed out that China's economy has shifted from rapid growth to high-quality development, and the emphasis of economic development should be on improving the efficiency of financial services for the real economy.\(^2\) In recent years, the rapid expansion of both traditional bank loan businesses and financial innovation has augmented the risk level of banks, especially in association with shadow banking, which increases the systemic risk in the Chinese financial market. Systemic risk arises from not only domestic economic impacts, but also foreign policy impacts on China. The current Sino-US trade war has had a negative impact on the development of China's real economy, increasing the level of domestic systemic risk. In 2020, the COVID-19 outbreak has had a serious impact on the global economy. In the first week of the outbreak (February 24–28, 2020), stocks and gold fell on the global financial markets, whereas the dollar and yen rose, creating a liquidity crisis in the markets. This phenomenon resembles the 2008 financial crisis. To prevent a financial crisis similar to that of 2008, regulators should focus on the risks in the banking sector. Therefore, China will implement the goal of preventing systemic risk set out in the report to the 19th National Congress of the Communist Party of China, strengthen supervision over financial risk, and stabilize economic development.

The banking industry is the core sector of China’s economy and acts as a main channel for social financing. Controlling individual bank risk taking is a crucial way to prevent systemic risk in the financial market as a whole. Bank OBS innovation is a vital part of asset management products; therefore, the provision of banks' OBS innovation is closely related to their risk fluctuations. Bank OBS innovation is designed and issued by Chinese commercial banks. Banks invest the raised funds into relevant financial markets and purchase related financial products according to the product contract. After obtaining the investment income, the bank will distribute the benefits to the investors according to the contract. In the process, banks take most of the risk of the investment. Asset management products in China are issued through fund management companies' or securities companies' public offerings to raise funds from specific clients. A custodian institution acts as a fund custodian and uses the entrusted property for investment.

Since 2005, the scale of bank OBS innovation has been expanding. According to the 2017 financial market report\(^3\) by the end of 2017, the total scale of asset management was CNY 2.54 billion, with non–capital-guaranteed OBS innovation\(^4\) reaching CNY 2.17 billion and accounting for a large proportion of China’s asset management business. At the same time, the number of types of bank OBS innovation has been increasing. The development of bank OBS innovation businesses has affected China's bond market and securities market direct and indirectly. Banks in China raise funds by issuing OBS innovation and then investing the funds in different fields that can be split among the four categories\(^5\) of current financing, fixed financing, structured financing, and capital preservation. The starting amounts, risk, investment targets, and pledge conditions of OBS innovation are shown in Table 1.

With the development of financial services in China, OBS innovation market risk has been gradually exposed, due to cognitive delay and asymmetric information. Therefore, the People's Bank of China, the China Banking and Insurance Regulatory Commission, the China Securities Regulatory Commission, and the State Administration of Foreign Exchange jointly promulgated “Guidance on Standardizing the Asset Management Business of Financial Institutions”\(^6\) on April 27, 2018. The new regulations make a series of important changes to the financial service standards of banks, aiming to solve the problem of the multilayer nesting of OBS innovation, rigid payments, and regulatory arbitrage, and provide a policy basis for the development and direction of bank financial services. To implement the new regulations on asset management, the China Banking and Insurance Regulatory Commission formulated “Measures on the Supervision and Management of Commercial Banks' Financial Services”\(^7\) and solicited public opinions from July 20 to August 19, 2018. The implementation of these regulations promoted the development of bank financial services.

"MEASURES" have defined bank OBS innovation in detail. It pointed out that bank OBS innovation refers to Chinese commercial banks accepting entrustment from investors. Banks provide financial services for investment and management of entrusted investor property in accordance with investment strategies, risk-taking and income distribution methods agreed with investors in advance. According to "MEASURES", bank OBS innovation is the non-guaranteed product and no longer has the nature of rigid payments."MEASURES" mainly contributed in the following aspects: First of all, it promotes the standardized transformation of bank OBS innovation and promotes the entry of funds into the real economy and financial markets in a legal and standardized manner. It has strengthened the management of bank OBS innovation by specifying the responsibilities and obligations of participating entities, shortening the financing chain, and prohibiting multiple nesting of bank OBS innovation. Secondly, it strengthens the management of investors and clearly distinguishes between public offering products and private offering products. Public offering wealth management products refer to the OBS innovation publicly issued by Chinese commercial banks to the unspecified social public. Private wealth management products refer to the wealth management products that Chinese commercial banks issue non-publicly to qualified investors. The distinction between public offerings and private offerings helps guide investors to purchase bank OBS innovation.

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\(^1\) This report was delivered by General Secretary Jinping Xi to the 19th National People’s Congress of the Communist Party of China in Beijing, on October 18, 2017.

\(^2\) The real economy is the physical side of the economy involving goods, services, and resources. It is concerned with using resources to produce the goods and services to potentially satisfy people’s wants and needs. This should be contrasted with the paper economy, or the financial side of the economy.

\(^3\) According to the division standard of OBS innovation of China’s five largest state-owned banks.

\(^4\) The bank does not promise to guarantee the capital and interest of the bank OBS innovation. The customer undertakes the risk of the bank OBS innovation.

\(^5\) According to the division standard of OBS innovation of China’s five largest state-owned banks.

\(^6\) “Guidance on Standardizing the Asset Management Business of Financial Institutions” is referred to as “New Regulations on Asset Management” in this paper.

\(^7\) “Measures on the Supervision and Management of Commercial Banks’ Financial Services” is referred to as “MEASURES”.

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| financial innovation | Minimum amount of investment (CNY) | type | Level of risk | Investment target | The pledge or not |
|----------------------|----------------------------------|------|--------------|------------------|-----------------|
| Current type         | 10000 – 50000                    | No guaranteed floating type return or Net type | low            | Money market: cash, money funds, interbank loans, bond repurchases. Fixed income: national bonds, local government bonds, all kinds of financial bonds, medium-term bills, short-term financing bonds, corporate bonds, non-financial corporate debt financing tools of non-public development banks, bond funds. Non-standardized creditor's rights assets: fund company asset management plan, securities company asset management plan, insurance company asset management plan, trust plan, entrusted creditor's rights. | no |
| Fixed type           | 10000 – 50000                    | No guaranteed floating return type | low            | Money market: money fund, inter-bank loan, bond repurchase. Fixed income: Treasury bonds, financial bonds, central bills, high-grade credit bonds, bond funds. Non-standardized creditor's rights assets: trust plan and entrusted creditor's rights. | no |
| Structural type      | 10000 – 50000                    | No guaranteed floating return type | low            | Money market: money fund, inter-bank loan, bond repurchase. Fixed income: Treasury bonds, financial bonds, central bills, high-grade credit bonds, bond funds. Non-standardized debt assets: trust plan. Financial derivatives: options, futures. | yes |
| Preservation type    | 10000                            | guaranteed floating return type | Very low       | Money market: money fund, inter-bank loan, bond repurchase. Fixed income: Treasury bonds, financial bonds, central bills, high-grade credit bonds, bond funds. | no |

Note: 1. The minimum investment amount of capital preservation type is low, indicating that this is a typical type of deposit business; 2. Risk level is for investors. For banks, the lower the assessment risk is, the higher the risk the bank bears; 3. Different investment objects indicate different uses of money and different risk. 4. For investors, they can make mortgage loans, while for banks to carry out both deposit and loan businesses, the risk may increase.
that match their risk tolerance and effectively protect the legitimate rights and interests of investors. Finally, "MEASURES" further break the rigid payments phenomenon that exists in bank wealth management products. It comprehensively covers the compliance management and operation standards of bank OBS innovation, standardize the operation of capital pools, and effectively prevent liquidity risk.

The "New Regulations on Asset Management" and "MEASURES" complement each other and are key to resolving the following two problems. First, since bank credits are associated with strict regulatory requirements, such as the capital ratio, leverage ratio, and loan limits, banks' issuance of OBS innovation avoids the supervision of credit funds. New regulations on asset management and "MEASURES" thus jointly restrict internal funding transfers among financial sectors through shadow banking or investments in the real estate sector. China's OBS innovation is closely related to shadow banking, and most of its financial funds are invested in shadow banking. Shadow banking in China differs from those in foreign countries, because foreign shadow banking development relies on the direct financing of the developed markets, whereas shadow banking in China depends on commercial banks. Second, under China's rigid exchange mechanism, to some extent, the OBS innovation of Chinese commercial banks resembles deposits, and banks must bear the default risk when repaying OBS innovation products.

This paper mainly studies the impact of OBS innovation issued by banks on bank risk against the background of new asset management regulations. Compared with previous studies, this paper's research contribution mainly includes the following three points. First, this paper studies the impact of bank OBS innovation on risk taking and compares the changes in risk between before and after the promulgation of the relevant restrictive policies on bank OBS innovation. The paper finds that the development of bank OBS innovation will increase the level of banks' risk taking. Because of the rigid payment phenomenon, where capital and the interest of the bank OBS innovation are guaranteed, banks bear the risk of OBS innovation. As the relevant policies of bank OBS innovation become more restrictive, the rigid payment ratio decreases, and the risk of bank OBS innovation is transferred from the bank to the customer. Therefore, as banks' implement further OBS innovation policy, the solution of rigid payments helps in reducing the risk induced by the development of bank OBS innovation. Second, there is a difference between Chinese bank OBS innovation and OBS business abroad. Bank OBS innovation in China is more similar to the deposit business of banks, and it generally suffers from the problem of rigid payment. Banks will take on most or all of the risk of bank OBS innovation. Third, this paper considers bank heterogeneity and provides policy support for the classified management of banks.

The remainder of this paper is organized as follows. Section 2 reviews the literature. Section 3 presents the institutional background and theoretical analysis and puts forth the research hypothesis. Section 4 describes the research design. Section 5 covers the empirical analysis and robustness tests and presents further discussion, using the mediation effect model to analyze the interaction terms. Finally, Section 6 presents the conclusion and suggestions.

2. Literature review

This paper mainly studies the impact of OBS innovation on bank risk taking against the background of new asset management regulations. China's OBS innovation is closely related to shadow banking, and most of China's OBS financial funds are invested in shadow banking. Shadow banks in China differ from those in foreign countries, with foreign shadow banking development relying on the direct financing of the developed markets and Chinese shadow banking depending on commercial banks. Since bank OBS innovation accounts for a large proportion of the shadow banking in China, the shadow of Chinese commercial banks can be referred to as shadow banking (Li, 2014). Intensifying competition has been the driving force for the rapid development of shadow banking (Ahn and Breton, 2014). Chinese commercial banks have evaded regulation by issuing OBS innovation to enhance profitability. The asset management funds of commercial banks are invested in different fields, and their operation mode covers interbank cooperation, bank–security cooperation, bank–fund company cooperation, bank–private equity cooperation, and bank–trust cooperation. These operation modes can evade supervision to a certain extent and expand the scale of shadow banking, which can raise financial risk. Lee (2015) find that the OBS innovation of Chinese banks is an important part of shadow banking. The highly leveraged operations mode of shadow banking can damage the normal function of the capital market and lead to systemic risk. Gao et al. (2016) find that the OBS innovation of commercial banks dominates the Chinese financial market. Shadow banks will thus have an impact on the stability of bank operations. Therefore, this paper studies the relation between bank OBS innovation and bank risk taking. The return from bank OBS innovation is regarded as non-interest income(NII). Previous literature has explored the impact of NII on bank risk taking. Since banks can prevent systemic risk by increasing NII through diversified means, they should emphasize the disclosure of the composition of NII (Williams and Prather, 2010).

After the global financial crisis, Basel III proposed strict regulations on the liquidity management of banks. In this context, banks tend to issue mortgage-backed securities to avoid liquidity constraints, which has an impact on banks' risk taking (Stanimiria et al., 2019). Matthias (2013) explores the relation between NII levels and the risk taking of retail banks and investment banks. The author finds that the level of NII is negatively correlated with risk taking among retail banks, but positively correlated with risk taking among investment banks. This conclusion shows that banks' heterogeneity in terms of NII influences their relation with risk. Lee et al. (2014) use the operations data of commercial banks in 22 countries in Asia and find that the NII of their sample banks plays a role in risk mitigation. Matthias (2014) uses 15 European Union countries from 2002 to 2011 to analyze the influence of NII on bank stability. The author finds that increasing the share of NII decreases banks' risk levels and increases their profitability, indicating that income diversification can lead to huge benefits.

The banking sector plays an important role in the global financial system and contributes significantly to systemic risk (Bostandzic and Wei, 2018). In recent years, the proportion of financial services in the overall business of banks has been increasing, and, due to an imperfect financial system, the risk of financial services has become gradually exposed. Since 2017, the regulatory authorities have implemented new regulations on the asset management market. The official start date of the new regulations on the asset...
management market was April 27, 2018. There are differences in the management mode between bank OBS innovation and other institutions’ asset management products. Currently, the OBS innovation of Chinese commercial banks has been facing problems such as rigid payments and the principal–agent problem, and scholars have provided guidance on the transformation of banks’ financial products from both macro and micro perspectives (Wang et al., 2016).

The OBS innovation of Chinese commercial banks differs from traditional OBS innovation. China’s OBS innovation is characterized by deposits and credits, and product risk is not really transferred to investors. The products’ risks and benefits do not match each other, increasing the severity of the principal–agent problem. Cheng (2017) finds that the bank OBS innovation mode and traditional credit business profit mode are essentially the same, because they both rely on interest margins for income. The banking sector is actually bearing the bank’s capital management risk. The release of new regulations on asset management can promote the operation mode of bank OBS innovation to that of real asset management, and it can solve the problem of rigid payments. Since 2012, when China’s asset management market sprang up, bank OBS innovation has become the main force leading the expansion of the asset management market. However, the prevailing driving force behind the rapid growth of bank OBS innovation is its unsustainable business model, including rigid payments and regulatory arbitrage, associated with huge risk. The emergence of new regulations on capital management has changed the rigid exchange situation in the financial market. Therefore, this paper introduces the proxy variable of rigid exchange to discuss the relation between bank OBS innovation and risk taking against the background of new regulations on capital management.

In sum, the literature focuses on the following four aspects: first, investigation of the relation between OBS innovation and shadow banking; second, analysis of the transformation of OBS innovation against the background of new asset management regulations; third, the impact of OBS innovation on bank financing structure under the consideration of NII, as reference citations show; and fourth, previous literature of OBS innovation focused on theoretical analysis.

This study embodies innovation in the following three ways. First, it combines theoretical with empirical analysis to analyze the relation between the new asset management regulations, bank OBS innovation, and bank risk taking. The paper’s conclusions thus have their own theoretical basis and data support, improving their robustness. Second, the study analyzes banks’ current rigid cashing and constructs a proxy variable for it to study the impact of the rigid cashing problem on the risk taking of OBS innovation. Finally, this paper considers the problem of bank heterogeneity and studies the differences in risk taken on by various types of banks in the development of OBS innovation, providing policy support for the differentiated management of banks.

3. Institutional background and theoretical analysis

3.1. Institutional background

With the growth of the asset management industry, the scale of bank OBS innovation has been constantly rising. Meanwhile, the competitive pressure of bank OBS innovation in the asset management industry has been increasing correspondingly. New OBS innovations have emerged in China’s asset management market, such as Yu’ebao8 and other Internet OBS innovations. Facing decreasing deposits and increasing competitive pressure, banks have been issuing capital and interest-guaranteed OBS innovation to attract funds. One of the purposes of banks’ mass issuance of OBS innovation is to absorb funds from the market and enhance their profitability. Banks attract residents into buying OBS innovation by increasing their expected rate of return, and the phenomenon of rigid payments generally affects banks, so banks issuing high-yield capital preservation asset management can increase the risk they bear.

Recent years have witnessed many problems in asset management, such as rigid payments, regulatory arbitrage, and multilayer nesting, all of which have a great impact on the risk of bank OBS innovation. To prevent and control the risk taken on by asset management departments, new regulations on asset management were officially released April 27, 2018, providing detailed rules on the issuance of China’s asset management products. These new rules focus on the following four aspects. First, they eliminate rigid payments. Rigid payments mean that the capital and interest of bank OBS innovation are guaranteed. When customers buy asset management products with a high return, they will be paid in full, so they tend to choose asset management products with high returns. Rigid payments disturb the level of the risk-free interest rate in the market and increase risk in the asset management market. Therefore, the new regulations on asset management clearly stipulate that financial institutions are prohibited from either issuing asset management products on a rolling basis or using their own funds to repay the proceeds of asset management products when due. The net value method must therefore be used to measure the real value of bank OBS innovation and reflect the risk of bank OBS innovation in income fluctuations.

Second, the new regulations provide detailed investment operations rules for both public and private offering products in the asset management industry. The new regulations clarify the legal status of private equity funds and relax restrictions on the classification of private equity products and financing channels to attract more capital. They note that public offering products are mainly invested in standardized creditor rights assets and stocks traded on the market, and they can not be invested in the equity of unlisted enterprises unless otherwise stipulated by laws and regulations and financial regulatory authorities. Third, the asset management new regulations are committed to eliminating and limiting the phenomenon of multilayer nesting in the current market. Multilayer nesting involves asset management products investing in themselves, nested layer by layer to avoid supervision. Multilayer nesting lengthens the capital chains in the market and increases the funding costs and risks of capital in the process. Finally, the new regulations limit the leverage ratio and hierarchical leverage.

After the release of the new regulations on asset management, the average income levels of bank OBS innovation and the risk index of the national financial market fluctuated significantly, as shown in Figs. 1 and 2. In Fig. 1, the average yield of bank OBS innovation displays a downward trend from January 2018 to April 2019. In particular, the average yield of bank OBS innovation

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8 Yu’ebao is a value-added fund management service of Ant Financial.
shows a more obvious downward trend after the official introduction of the new regulations on asset management. The analysis shows that the regulatory policy of the new asset management regulations has had a short-term inhibiting effect on the yield of OBS innovation. As shown in Fig. 2, the risk index of bank OBS innovation fluctuates greatly, but the overall level is decreasing. The data were obtained from PY Standard.

3.2. Theoretical analysis

This paper analyzes the impact of bank OBS innovation on risk taking based on Markowitz’s portfolio theory.

\[ \text{INCOME} = \text{NEI} + (\text{FPI} + \text{NOI}) \]  
\[ w + m + n = 1 \]  
\[ R_{\text{income}} = w \times R_{\text{nei}} + m \times R_{\text{fpi}} + n \times R_{\text{noi}} \]  
\[ \sigma^2(\text{RISK}) = w^2 \times \sigma^2(R_{\text{ei}}) + m^2 \times \sigma^2(R_{\text{fpi}}) + n^2 \times \sigma^2(R_{\text{noi}}) + 2 \times w \times m \times \sigma(R_{\text{ei}}) \times \sigma(R_{\text{fpi}}) + 2 \times w \times n \times \sigma(R_{\text{ei}}) \times \sigma(R_{\text{noi}}) + 2 \times m \times n \times \sigma(R_{\text{fpi}}) \times \sigma(R_{\text{noi}}) \]

Chinese commercial banks’ operating income is divided into net interest income and NII. This paper separates NII into bank financial product income and other NII, where bank operating income variable is INCOME, NEI represents net interest income, FPI financial product income, and NOI other NII. This paper models bank OBS innovation as display Eqs. (1) to (4), where \( R_{\text{income}} \) is the rate of return on operating income; \( R_{\text{nei}} \) is the rate of return on net interest income, \( R_{\text{fpi}} \) is the rate of return on bank financial product income; \( R_{\text{noi}} \) is the rate of return on other NII by; \( w \) is the proportion of return on net interest income; \( m \) is the weights of the return on bank OBS innovation to the total return; \( n \) is the proportion of other non-interest return to the total return.

Eqs. (2) and (3) show that bank OBS innovation will affect the overall earnings of banks through the return rate. In this paper, the total risk of the bank is expressed as \( \sigma^2(\text{RISK}) \), the risk of net interest income is expressed as \( \sigma^2(R_{\text{nei}}) \), the risk of OBS innovation is expressed as \( \sigma^2(R_{\text{fpi}}) \), and the risk of other NII is expressed as \( \sigma^2(R_{\text{noi}}) \). According to Markowitz’s portfolio theory combined with the analysis above, the risk of banks can be expressed as Eq. (4).

As Eq. (4) shows, the development of bank OBS innovation has an impact on bank risk taking and bank OBS innovation can affect bank risk through different asset portfolios. If the expected yield rate of OBS innovation is higher, the pressure on banks to repay the principal and interest on the OBS innovation will be greater and, due to adverse selection, the banks’ risk will increase.

This paper makes improvements on Su’s (2014)’s research. According to Su’s (2014)’s research, the capital pool–asset pool model shows that the return rate of bank OBS innovation is the difference between the return rate of the asset pool and that of the capital pool. The return rate of bank OBS innovation in this paper is split into three parts: the maturity spread, the rigid payment cost spread, and other credit spread.

\[ R_{\text{fpi}} = RAP - RCP = RAP - RDB - RNF + RDB - RCP + RNF = RO + RT + RNF \]
This paper models the rigid payment as display Eqs. (5) to (6). In this paper, the asset pool yield rate is represented by $R_{AP}$; the capital pool yield rate is $R_{CP}$; the treasury bond yield, of the same maturity as the asset pool, is $R_{DB}$; the other credit spread is $RO$; the interest rate of the rigid payment is $R_{NF}$ ($R_{NF} < 0$), and the term spread is $RT$. The total return rate is the sum of the above three. The calculation method of $RO$ is: the return of the asset pool minus the sum of the yield of the national debt with the same maturity of the asset pool and the rigid redemption rate. The calculation method of $RT$ is the yield of the treasury bond with the same maturity as the asset pool minus the yield of the capital pool.

According to Eqs. (5) and (6), only when the yield of OBS innovation is greater than or equal to zero will banks choose to issue OBS innovation, and the existence of rigid payments will affect the yield of OBS innovation. Banks issue OBS innovation on the premise of rigid payments. When the expected earnings of the projects invested in by banks are lower than expected, the rigid payment cost spread increases. The bank’s debt service pressure then increases, the bank’s earnings fluctuate, and the bank takes on more risk. Based on the above analysis, this paper thus proposes the two following hypotheses.

**H1.** The boom in OBS innovation of Chinese commercial banks will increase risk taking.

**H2.** The new asset management rules' solution to rigid payments are reducing the risk taking of Chinese commercial banks issuing OBS innovations.

### 4. Research design

#### 4.1. Sample selection and variable description

The scale of OBS innovation of Chinese commercial banks has been expanding rapidly since 2005. The bank OBS innovation data before 2006 is incomplete and information on bank OBS innovation after 2018 has not been updated. Therefore, the data on bank OBS innovation from 2007 to 2017 are used for the sample. This paper collected the information of 511,638 OBS innovation products of 75 banks from 2007 to 2017 and manually calculated the expected return rate of OBS innovation of sample banks. The data used in this paper are from the Wind and China Stock Market & Accounting Research databases and banks’ annual reports. This paper uses the non-equilibrium panel data of 75 commercial banks in China from 2007 to 2017. The sample covers the Big 5 banks, 47 urban commercial banks, 10 rural commercial banks, and 13 joint stock commercial banks. Table 2 shows the definitions and calculations of the specific variables.

#### 4.2. Description of variables

**4.2.1. Explained variable**

The risk bearing variable of commercial banks: Previous studies have concluded that the proxy variable of risk of commercial banks can be expressed by the Z-value, the default rate, the range of fluctuation for the return on assets, and the non-performing loan ratio. This paper refers to Nicolo (2001) and Laeven and Levine (2009) and uses the Z-value as the proxy variable for the risk taking of commercial banks. The default rate is the most accurate measure of the risk of banks. However, few data are available on the listings of Chinese commercial banks, and the Chinese banking database is not complete, so bank default rate data could not be obtained. China's banking business is single, mainly deposit and loan business. Bank risk in China is strongly affected by both national and local government policy. If the volatility of return on assets and the non-performing loan ratio are used to measure bank risk, the data can be distorted. Therefore, this paper selects the Z-value as an indicator of bank risk.

In robustness tests below, the volatility of the return on assets is used as the proxy variable for risk indicators. The Z-value is calculated as the ratio of the mean of the bank's return on assets to the sum of the capital asset ratio and the variance of the return on assets. The larger the Z-value, the lower the level of risk taking.

**4.2.2. Core explanatory variables**

Proxy variable for the expected effect of OBS innovation ($LCCP_{it}$). The calculation method of $LCCP_{it}$ variable is: the expected rate of return of the Chinese commercial bank OBS innovation minus the one-year deposit benchmark interest rate. This proxy variable is used to measure the degree of development of the OBS innovation of Chinese commercial banks. This paper collected the information of 511,638 OBS innovation products of 75 banks from 2007 to 2017 and manually calculated the expected return rate of OBS innovation of sample banks.

Dummy variable of rigid payment ($NF_{it}$). This paper uses the proportion of floating income to non–capital-guaranteed OBS innovation to measure the problem of rigid payment. A larger proportion means a lower degree of rigid payment, and vice versa. This dummy variable is set by taking the median of the proportion of floating income of non–capital-guaranteed OBS innovation, and a value equal to or above the median is set to zero, whereas a value below the median is set to one.

Interaction variables between the expected effect of OBS innovation and dummy variables measuring rigid payment ($LCCP_{it} \times NF_{it}$). This paper uses this interactive term to study the role of the development of bank OBS innovation on bank risk taking, given rigid payments.

**4.2.3. Control variables**

To accurately analyze the research on bank risk taking caused by increasing bank OBS innovation, a series of control variables are added into the model. The variable of OBS innovation is defined as the difference between the expected yield of OBS innovation and
Table 2
Describes design and descriptive statistics.
Sources: Wind database, bank annual reports.

| type                  | title                                      | symbol | Variable design                                      | mean  | variance | min  | max  |
|-----------------------|--------------------------------------------|--------|------------------------------------------------------|-------|----------|------|------|
| Explained variable    | bankruptcy risk                            | Z      | Z-score                                              | 21.995| 9.002    | 2.0432| 44.560|
| Core explanatory variable | proxy variable of expected effect of OBS innovation | LCCP   | The difference between the expected return rate of OBS innovation of Chinese commercial banks and the benchmark one-year deposit rate | 4.695 | 1.521    | 1.531 | 17.209|
| virtual variable of rigid payment | NF                                           |        | The proportion of capital balance of non-break-even floating income is the median | 0.455 | 0.498    | 0.000 | 1.000|
| Control variables     | Real GDP growth rate                        | GDP    | (current period real GDP-last period real GDP)/last period real GDP | 0.231 | 0.323    | 0.065 | 1.187|
|                       | Total assets                                | ASSET  | Take logarithm of the total assets                   | 0.781 | 0.173    | 0.427 | 1.239|
|                       | Capital adequacy ratio                      | CAR    | Capital adequacy ratio *100                          | 12.743| 6.227    | 3.400 | 150.330|
|                       | Return on assets                            | ROA    | (net profit/total assets) *100                       | 0.986 | 0.338    | 0.000 | 2.876|
|                       | Equity liability ratio                      | ED     | (The equity-liability ratio) * 10,000               | 7.137 | 2.042    | 1.890 | 19.090|
the one-year deposit benchmark interest rate. This paper introduces the real GDP growth rate as the control variable according to Zhang and He (2012).

The control variables include the following: the real GDP growth rate, \( GDP_{it} \), a macroeconomic indicator; total assets, \( ASSET_{it} \), the bank’s characteristic variable, representing bank asset size; the capital adequacy ratio, \( CAR_{it} \), a variable representing the bank’s capital level, where the higher the capital adequacy ratio, the greater the bank’s ability to bear losses; the return on assets, \( ROA_{it} \), representing the bank’s profitability, where a higher rate of return on assets indicates greater profitability; and, finally, the ratio of equity to debt, \( ED_{it} \), or the ratio of equity to liability.

4.3. Model setting

Given the new asset management regulations, this paper studies the development of OBS innovation and the problem of bank risk. The model setting is as follows.

\[
RISK_{it} = \omega_0 + \omega_1 \times LCCP_{it} + \omega_2 \times NF_{it} + \omega_3 \times GDP_{it} + \omega_4 \times ASSET_{it} + \omega_5 \times CAR_{it} + \omega_6 \times ROA_{it} + \omega_7 \times ED_{it} + \epsilon_{it}
\]

\[
RISK_{it} = \beta_0 + \beta_1 \times LCCP_{it} + \beta_2 \times NF_{it} + \beta_3 \times GDP_{it} + \beta_4 \times ASSET_{it} + \beta_5 \times CAR_{it} + \beta_6 \times ROA_{it} + \beta_7 \times ED_{it} + \mu_{it} + \epsilon_{it}
\]

5. Empirical analysis

5.1. Empirical methods

This paper uses unbalanced panel data, so the Fisher–augmented Dickey–Fuller test is first applied to detect the existence of a unit root. No unit root is found. A Hausman test is then carried out on the sample data, and the p-value of the result is found to be zero. The Hausman test results indicate that regression analysis should be used for the solid effect model, and that ordinary least squares (OLS), maximum likelihood estimation, the differential generalized method of moments (GMM), and systematic GMM should be used for the regression estimation.

5.2. Empirical analysis

5.2.1. Impact of bank OBS innovation on risk

For model (7), OLS, fixed effects, maximum likelihood estimation, differential GMM, and systematic GMM regression methods were used separately. The results are shown in Table 3.

The coefficients of the bank OBS innovation variable are negative and significant. The results indicate that the expected effect of bank OBS innovation is inversely related to bank risk taking. With the development of bank OBS innovation, the number of types of bank OBS innovation increases and the risk of bank OBS innovation is diversified. One of the characteristics of bank OBS innovation is that the bank guarantees capital and interest, and customers who buy bank OBS innovation do not take on any risk. Therefore, progress in bank OBS innovation will increase banks’ risk taking. Table 3 shows that the coefficients of the dummy variables of rigid payment are negative and significant. The results show that the solution of rigid payment helps decrease bank risk taking. A lower rigid payment level indicates a lower proportion of non–capital-guaranteed OBS innovation. Banks transfer the risk of bank OBS innovation to customers, reducing their own risk taking. This conclusion is consistent with the research results of Matthias (2014).

Table 3
Impact of Bank OBS Innovation on Risk.

|                  | OLS(7)     | fixed effect(7) | maximum likelihood estimation(7) | differential GMM(7) | systematic GMM(7) |
|------------------|------------|-----------------|----------------------------------|---------------------|-------------------|
| \( LCCP_{it} \)  | -0.3724*** (0.0551) | -0.2889*** (0.0496) | -0.3724*** (0.0547) | -0.7628*** (0.2416) | -0.7658*** (0.2382) |
| \( NF_{it} \)    | -0.4091*** (0.2093) | -1.2769*** (0.2586) | -4.0916*** (0.2077) | -0.9509*** (0.2608) | -2.3432*** (0.3473) |
| \( GDP_{it} \)   | -4.2635*** (0.3826) | -2.4424*** (0.3336) | -4.2635*** (0.3797) | -1.2806*** (0.4954) | -2.6758*** (1.6755) |
| \( ASSET_{it} \) | 0.8861 (0.5356) | 33.2524*** (2.3125) | 0.8861 (0.5313) | 41.1949*** (3.5694) | 11.9274*** (3.940) |
| \( CAR_{it} \)   | -0.1581*** (0.0401) | -0.1608*** (0.0559) | -0.1581*** (0.0398) | -0.0734 (0.0840) | -0.1112 (0.2415) |
| \( ROA_{it} \)   | -1.4142*** (0.2981) | -2.0104*** (0.3150) | -1.4142*** (0.2958) | -1.5349*** (0.4078) | -3.5038*** (0.9166) |
| \( ED_{it} \)    | 2.6922*** (0.0602) | 2.7193*** (0.0786) | 2.6922*** (0.0598) | 2.5131*** (0.1317) | 2.6670*** (0.1834) |
| _cons            | 11.3009*** (0.7516) | -16.3829*** (2.2276) | 11.3009*** (0.7457) | -22.0635*** (3.0050) | 0.0952 (6.1701) |
| N                | 825        | 825             | 825                              | 825                  | 825               |
| R²               | 0.9018     | 0.8998          |                                  |                     |                   |
| F test           | 4.9200*** (0.0000) |                  |                                  |                     |                   |

Note. The first behavioral estimation coefficient and the second behavioral robustness standard deviation of each explanatory variable, ***, ** and * mean significant at the significance level of 1%, 5% and 10% respectively, the numbers in brackets are std error. LCCP is the proxy variable of bank OBS innovation. The calculation method of LCCP is the expected yield of OBS innovation minus the one-year bank deposit benchmark interest rate. GDP represents real GDP growth rate, ASSET represents total assets, CAR represents capital adequacy ratio, ROA represents return on assets, ED represents ratio of equity to debt.
Therefore, the issuance of joint stock bank OBS innovations is most affected by the new regulations on capital management. The above banks were the earliest banks to launch OBS innovation. The OBS innovations of joint stock banks are numerous and in great demand. Payment; that is, joint stock commercial banks are greatly affected by the new regulations on capital management. Joint stock commercial problems brought induced by the development of the OBS innovation of joint stock commercial banks are most affected by the rigid payment level, the lower the risk the bank will take on in developing OBS innovation. The results show that the risk taking of joint stock commercial banks, urban commercial banks, and rural commercial banks are positive and significant. The results indicate that the lower the degree of rigid payment, the lower the risk the development of bank OBS innovation bear. This interaction term between the expected effect of OBS innovation and the dummy variable measuring rigid payment is positive and significant at the significance level of 1%, 5% and 10% respectively, the numbers in brackets are std error. LCCP is the proxy variable of bank OBS innovation. The calculation method of LCCP is the expected yield of OBS innovation minus the one-year bank deposit benchmark interest rate. NF is the proxy variable of rigid payment, which is the proportion of floating income of non-capital-guaranteed OBS innovation. GDP represents real GDP growth rate. ASSET represents total assets, CAR represents capital adequacy ratio, ROA represents return on assets, ED represents ratio of equity to debt.

5.2.2. Impact of the new asset management regulations on the risk taking effects of OBS innovation

5.2.2.1. Interaction terms. Model (8) describes the impact of the new asset management regulations on the risk taking effect of bank OBS innovation. A dummy variable for rigid payment is used to proxy for the new asset management regulations. The interaction term LCCPit × NFit between the expected effect of OBS innovation and the dummy variable measuring rigid payment is introduced in model (8). OLS, fixed effect, maximum likelihood estimation, differential GMM, and systematic GMM are successively used for the regression analysis of the whole sample. The results are shown in Table 4.

Table 4 shows that the coefficient of the development of bank OBS innovation are negative and significant. The results show that the expected effect of bank OBS innovation is inversely related to bank risk taking. The coefficient of the dummy variable of rigid payment is negative and significant, indicating that the solution of rigid payment helps to decrease bank risk taking. The coefficient of the interaction term between the expected effect of OBS innovation and the dummy variable measuring rigid payment is positive and significant, indicating that the lower the degree of rigid payment, the lower the risk the development of bank OBS innovation bear. This conclusion is consistent with Cheng’s (2017).

5.2.2.2. Time interval test. Since 2005, the scale of OBS innovation of Chinese commercial banks has grown rapidly, and the regulatory authorities have issued a series of relevant documents to regulate OBS innovation. This paper examines the regulatory policies related to Chinese bank OBS innovation and finds that the regulatory policies noted in the Appendix had a significant impact on bank OBS innovation. Since 2013, China’s regulatory policies have been comprehensively regulating the development of bank OBS innovation. Therefore, this paper splits the sample period into two, before and after 2013, and conducts regression analysis to analyze differences in the impact of the development of bank OBS innovation on bank risk taking. The regression results are shown in Table 5.

Table 5 shows that the development coefficients of bank OBS innovation are significantly negative and significant for both periods. The coefficient of OBS innovation before 2013 is smaller than that after 2013. The results show that the expected effect of OBS innovation is inversely related to bank risk taking. The coefficient of the dummy variable of rigid payment in both periods is significantly negative. The results show that the solution of rigid payment problem is conducive to decreasing bank risk taking. The coefficient of interaction in the two periods is significantly positive, and the coefficient of interaction before 2013 is smaller than that after 2013. The conclusion is that, as policy increases bank OBS innovation, the solution of rigid payment helps reduce the risk induced by the development of bank OBS innovation.

5.2.3. Regression analysis of the heterogeneity of banks

First, the total sample is divided into four categories, namely, large state-owned banks, joint stock commercial banks, urban commercial banks, and rural commercial banks. Regression analysis is conducted, using model (8), and the results are shown in Table 6.

The coefficients of the development of bank OBS innovation of the total sample, Big 5 banks, joint stock commercial banks, urban commercial banks, and rural commercial banks are negative and significant. The results show that the expected effect of bank OBS innovation is inversely related to bank risk taking. The dummy variable coefficients for rigid payment for the total sample, Big 5 banks, joint stock commercial banks, urban commercial banks, and rural commercial banks are negative and significant. The results show that the solution of rigid payment helps decrease bank risk taking. The interaction term coefficients of the total sample, Big 5 banks, joint stock commercial banks, urban commercial banks, and rural commercial banks are positive and significant. The results indicate that the lower the rigid payment level, the lower the risk the bank will take on in developing OBS innovation. The results show that the risk taking problems brought induced by the development of the OBS innovation of joint stock commercial banks are most affected by the rigid payment; that is, joint stock commercial banks are greatly affected by the new regulations on capital management. Joint stock commercial banks were the earliest banks to launch OBS innovation. The OBS innovations of joint stock banks are numerous and in great demand. Therefore, the issuance of joint stock bank OBS innovations is most affected by the new regulations on capital management. The above

| Table 4 Results of Interaction Terms model. |
|-------------------------------------------|
| OLS(8) | fixed effect(8) | maximum likelihood estimation(8) | differential GMM(8) | systematic GMM(8) |
| LCCPit | −0.9676*** (0.1214) | −1.4814*** (0.1240) | −1.0125*** (0.2129) | −1.2091*** (0.5672) | −1.7342*** (0.6118) |
| LCCPit × NFit | 0.7444*** (0.1362) | 1.3549*** (0.1315) | 0.7939*** (0.2232) | 0.8762*** (0.5914) | 1.7925** (0.7388) |
| NFit | −7.6356*** (0.6797) | −7.8504*** (0.6792) | −7.8803*** (0.9635) | −5.0503*** (2.9151) | −10.6321*** (3.5562) |
| GDPit | −4.7522*** (0.3743) | −2.7986*** (0.3016) | −4.4336*** (0.3939) | −2.3022*** (0.4033) | −4.2785*** (0.7503) |
| ASSETit | −0.3521 (0.5492) | 30.5674*** (2.0931) | 0.6527 (1.3554) | 35.5017*** (3.2882) | 11.0935** (3.8223) |
| CARit | −0.1618*** (0.0391) | −0.2113*** (0.0504) | −0.1735*** (0.0598) | −0.1458*** (0.784) | −0.1223*** (0.1035) |
| ROAit | −1.1359*** (0.2954) | −1.4584*** (0.2879) | −1.3187*** (0.6576) | −1.6292*** (0.4259) | −3.2615*** (0.7767) |
| EDit | 2.6711*** (0.0587) | 2.7165*** (0.0706) | 2.6764*** (0.0637) | 2.6119*** (0.1035) | 2.6943*** (0.1653) |
| cons | 14.5538*** (0.9428) | −8.2199*** (2.1518) | 14.8190*** (1.3190) | −14.7804*** (4.6617) | 7.3629*** (6.7522) |
| N | 825 | 825 | 825 | 825 | 825 |
| R² | 0.9072 | 0.9161 |
| F-test | 6.8100*** (0.0000) |

Note: The first behavioral estimation coefficient and the second behavioral robustness standard deviation of each explanatory variable, ***, ** and * mean significant at the significance level of 1%, 5% and 10% respectively, the numbers in brackets are std error. LCCP is the proxy variable of bank OBS innovation.
conclusions are consistent with those of Matthias (2013). Bank heterogeneity thus has an impact on the risk taking of OBS innovation.

5.3. Robustness test

Referring to the literature, this paper now uses the volatility of the return on assets to replace the Z-value. An increase in returns on assets indicates higher bank risk levels.

5.3.1. Robustness test

Using model (8), regression analysis is conducted on all the samples, using OLS, fixed utility, maximum likelihood, difference GMM, and system GMM methods, respectively. The regression results are shown in Table 7.

The coefficients of the development of bank OBS innovation are inversely related to bank risk taking. The dummy variable coefficients of rigid payment are positive and significant. The results show that the solution of rigid payment helps decrease bank risk taking. The coefficients of the dummy variables of rigid payment are negative and significant, indicating that the decrease in rigid payment is reducing the risk taking of Chinese commercial banks issuing OBS innovations.

Table 5
Results of time interval test model.

|                      | Before 2013(7) | Before 2013(8) | after 2013(7) | after 2013(8) |
|----------------------|----------------|----------------|---------------|---------------|
| LCCP_n               | −0.1454*** *(0.0294) | −0.2989*** *(0.0759) | −0.8108*** *(0.1821) | −0.7571*** *(0.2066) |
| LCCP_n×NFI           | 0.1706*(0.0779) | 0.1923**(0.2210) | 0.6242**(0.3734) | 0.7711**(0.4223) |
| NFI                  | −3.3430*** *(0.1948) | −3.3151*** *(0.1933) | 50.7465**(0.7770) | 20.0602** *(17.1855) |
| ASSET_n              | 2.1639*** *(0.1796) | 2.1649*** *(0.1778) | 7.9328** *(0.8929) | 2.2366** *(0.5759) |
| CAR_n                | −0.1973*** *(0.0474) | −0.1959*** *(0.0469) | −0.0815*(0.1118) | −0.0269*(0.0698) |
| ROA_n                | −0.2893*(0.2556) | −0.2879*(0.2531) | −3.1812** *(0.7451) | −1.0936** *(0.4719) |
| ED_n                 | 2.4367*** *(0.0718) | 2.4368*** *(0.0711) | 3.1703** *(0.1725) | 2.8413** *(0.1054) |
| conns                | −7.5456*** *(1.6446) | −6.8470*** *(1.6594) | −58.7921** *(8.7979) | −21.5149*** *(5.9022) |
| N                    | 525             | 525             | 375            | 375            |
| R^2                  | 0.9574         | 0.9384         | 0.8309         | 0.9378         |
| F-test               | 3.7600*** *(0.0000) | 3.8600*** *(0.0000) | 3.5500** *(0.0000) | 3.6900*** *(0.0000) |

Note. The first behavioral estimation coefficient and the second behavioral robustness standard deviation of each explanatory variable, ***, ** and * mean significant at the significance level of 1%, 5% and 10% respectively, the numbers in brackets are std error. LCCP_n is the proxy variable of bank OBS innovation. The calculation method of LCCP_n is the expected yield of OBS innovation minus the one-year bank deposit benchmark interest rate. NF is the proxy variable of rigid payment, which is the proportion of floating income of non-capital-guaranteed OBS innovation. GDP represents real GDP growth rate, ASSET represents total assets, CAR represents capital adequacy ratio, ROA represents return on assets, ED represents ratio of equity to debt.

Table 6
Results of Bank Heterogeneity.

|                      | the overall sample(8) | large state-owned banks(8) | joint-stock commercial banks(8) | urban commercial banks(8) | rural commercial banks(8) |
|----------------------|-----------------------|-----------------------------|---------------------------------|----------------------------|---------------------------|
| LCCP_n               | −1.4814*** *(0.1240) | −1.6687*** *(0.4861) | −2.3779*** *(0.2570) | −1.1740*** *(0.1250) | −2.2571*** *(0.6401) |
| LCCP_n×NFI           | 1.3549*** *(0.1315) | 1.8938*** *(0.5406) | 2.3146*** *(0.2619) | 0.9067** *(0.1514) | 1.8645*** *(0.6757) |
| NFI                  | −7.8504*** *(0.6792) | −9.6331*** *(2.6327) | −12.2651*** *(2.6711) | −6.3113** *(0.7809) | −9.3697*** *(3.3730) |
| GDP_p                | −2.7986*** *(0.3016) | −2.5522*** *(0.6693) | −2.4048*** *(0.3486) | −2.8187** *(0.4208) | −2.8869** *(0.9927) |
| ASSET_n              | 30.5674** *(2.0931) | 9.1284** *(1.8002) | 2.8461** *(0.2170) | 2.6253** *(0.2195) | 5.7809** *(1.0210) |
| CAR_n                | −0.2113** *(0.0504) | −0.1206*** *(0.4594) | −0.2988*** *(0.1127) | −0.2638** *(0.0503) | −0.0613**(0.1773) |
| ROA_n                | −1.4584*** *(0.2879) | −7.5836*** *(1.9159) | −0.1292*(0.5014) | −1.3374** *(0.3303) | −0.9957**(0.9881) |
| ED_n                 | 2.7165*** *(0.0706) | 2.1352*** *(0.4268) | 2.6074*** *(0.1358) | 2.7193** *(0.0737) | 2.4993** *(0.2944) |
| conns                | −8.2199*** *(2.1518) | −7.8552*** *(11.0012) | −6.4945** *(2.8213) | −2.7305*(2.0888) | −24.3284**(9.4470) |
| N                    | 825              | 55              | 132             | 506            | 132            |
| R^2                  | 0.9161         | 0.9724         | 0.9692         | 0.9274         | 0.9304         |
| F-test               | 6.8100*** *(0.0000) | 12.6400*** *(0.0000) | 13.1100** *(0.0000) | 7.1600** *(0.0000) | 5.1400** *(0.0000) |

Note. The first behavioral estimation coefficient and the second behavioral robustness standard deviation of each explanatory variable, ***, ** and * mean significant at the significance level of 1%, 5% and 10% respectively, the numbers in brackets are std error. LCCP_n is the proxy variable of bank OBS innovation. The calculation method of LCCP_n is the expected yield of OBS innovation minus the one-year bank deposit benchmark interest rate. NF is the proxy variable of rigid payment, which is the proportion of floating income of non-capital-guaranteed OBS innovation. GDP_p represents real GDP growth rate, ASSET represents total assets, CAR represents capital adequacy ratio, ROA represents return on assets, ED represents ratio of equity to debt.
5.3.2 Robustness test of bank heterogeneity

First, the overall sample is split into large state-owned banks, joint stock commercial banks, urban commercial banks, and rural commercial banks, and the volatility of the return on assets is then used to replace the Z-value for regression analysis. Model (8) is used for successive regression analyses. The results are shown in Table 8.

The coefficients of the development of bank OBS innovation of the total sample, Big 5 banks, joint stock commercial banks, urban commercial banks, and rural commercial banks are positive and significant. The results show an inverse relation between the expected effect of bank OBS innovation and bank risk taking. The coefficients of the rigid payment dummy variable for the total sample, Big 5 banks, joint stock commercial banks, urban commercial banks, and rural commercial banks are positive and significant. The results show that the solution of rigid payment helps decrease the bank’s risk taking. The interaction term coefficients of the total sample, Big 5 banks, joint stock commercial banks, urban commercial banks, and rural commercial banks are negative and significant. The results indicate that the decrease in rigid payment is associated with a lower bank OBS innovation risk level. The results show that the OBS innovation risk taking among joint stock commercial banks is most affected by the rigid payment. Joint stock commercial banks are thus greatly affected by the new regulations on asset management. The robustness test results are consistent with the conclusions of the main analysis.

5.4. Further discussion: the interaction term

The interaction term between bank OBS innovation and dummy variable measuring rigid payment is introduced into the model to study

Table 7

Results of Robustness test.

|          | OLS(8)  | fixed effect(8) | maximum likelihood estimation(8) | differential GMM(8) | systematic GMM(8) |
|----------|---------|-----------------|----------------------------------|---------------------|-------------------|
| LCCP     | 1.1102*** (0.1283) | 1.8324*** (0.10363) | 1.1102*** (0.1284) | 1.6865*** (0.7195) | 2.0462*** (0.7701) |
| LCCP × NF | -0.6437*** (0.1446) | -1.3645*** (0.1361) | -0.6437*** (0.1434) | -0.9456*** (0.7077) | -1.8515*** (0.7753) |
| NF       | 8.0748*** (0.7248) | 9.1315*** (0.6909) | 8.0748*** (0.7185) | 6.4654*** (3.4694) | 11.8451*** (3.7670) |
| GDP      | 12.3854*** (0.3778) | 9.7061*** (0.3110) | 12.3854*** (0.3745) | 8.5977*** (0.5293) | 11.3293*** (0.5707) |
| ASSET    | -0.0174 (0.0580) | -3.2586*** (0.1870) | -0.0174 (0.0574) | -4.5931*** (0.4790) | -1.2541*** (0.3417) |
| CAR      | 0.1239*** (0.0412) | 0.1338*** (0.0519) | 0.1239*** (0.0408) | 0.1376*** (0.0547) | 0.3518*** (0.0974) |
| ROA      | 1.4129*** (0.3142) | 1.4996*** (0.2945) | 1.4129*** (0.3114) | 2.1724*** (0.6364) | 4.4644*** (0.9110) |
| ED       | -0.1713*** (0.0622) | -0.3322** (0.0723) | -0.1713*** (0.0617) | -0.3041** (0.0898) | -0.5813*** (0.1548) |
| cons     | 21.6103*** (0.9999) | 46.7973 (1.9850) | 21.6103*** (0.9912) | 58.7981*** (6.209) | 20.0443*** (5.7220) |
| N        | 825     | 825             | 825                 | 825                 | 825               |
| R²       | 0.8542  | 0.2970          |                    |                     |                   |
| F-test   | 7.5900*** (0.0000) |                   |                     |                     |                   |

Note. The first behavioral estimation coefficient and the second behavioral robustness standard deviation of each explanatory variable, ***, ** and * mean significant at the significance level of 1%, 5% and 10% respectively, the numbers in brackets are std error. LCCP is the proxy variable of bank OBS innovation. The calculation method of LCCP is the expected yield of OBS innovation minus the one-year bank deposit benchmark interest rate. NF is the proxy variable of rigid payment, which is the proportion of floating income of non-capital-guaranteed OBS innovation. GDP represents real GDP growth rate. ASSET represents total assets, CAR represents capital adequacy ratio, ROA represents return on assets, ED represents ratio of equity to debt.

Table 8

Results of Robustness test of bank heterogeneity.

|          | overall samples(8) | large state-owned banks(8) | joint-stock commercial banks (8) | urban commercial banks (8) | rural commercial banks(8) |
|----------|---------------------|---------------------------|----------------------------------|----------------------------|----------------------------|
| LCCP     | 1.8324*** (0.1283) | 1.5201*** (0.5363) | 3.0299*** (0.3804) | 1.4271*** (0.1388) | 2.9338*** (0.7390) |
| LCCP × NF | -1.3645*** (0.1361) | -1.5774*** (0.5964) | -2.5467*** (0.3876) | -0.9327*** (0.1681) | -1.9203*** (0.4001) |
| NF       | 9.1315*** (0.6909) | 8.5729*** (2.9045) | 14.9916*** (1.8751) | 6.7660*** (0.8667) | 10.6959*** (1.9972) |
| GDP      | 9.7061*** (0.3110) | 8.5947*** (7.3834) | 10.1217*** (0.5159) | 8.6794*** (0.4670) | 10.1955*** (0.5878) |
| ASSET    | -3.2586*** (1.8070) | -10.9885*** (1.3021) | -2.2518*** (0.3212) | -3.6100*** (0.2436) | -6.0639*** (0.6045) |
| CAR      | 0.1338*** (0.0519) | 0.2614 (0.5068) | 0.1813 (0.1669) | 0.1617*** (0.0558) | 0.0847 (0.1050) |
| ROA      | 1.4996*** (0.2945) | 9.7556*** (2.1137) | 0.3832 (0.7420) | 1.8828*** (0.3665) | 0.5133 (0.5851) |
| ED       | -0.3322*** (0.0723) | 0.5278 (0.4709) | -0.3986*** (0.2099) | -0.2844*** (0.0818) | -0.1433 (0.1743) |
| cons     | 46.7973 (1.9850) | 135.6152*** (12.7992) | 37.0325*** (4.1751) | 47.3763*** (2.3183) | 62.1411*** (5.9393) |
| N        | 825     | 55             | 132                 | 506            | 132             |
| R²       | 0.8542  | 0.9270        |                    | 0.9259         | 0.9487          |
| F-test   | 7.5900*** (0.0000) | 15.8400*** (0.0000) | 13.1100*** (0.0000) | 8.2300*** (0.0000) | 5.1400*** (0.0000) |

Note. The first behavioral estimation coefficient and the second behavioral robustness standard deviation of each explanatory variable, ***, ** and * mean significant at the significance level of 1%, 5% and 10% respectively, the numbers in brackets are std error. LCCP is the proxy variable of bank OBS innovation. The calculation method of LCCP is the expected yield of OBS innovation minus the one-year bank deposit benchmark interest rate. NF is the proxy variable of rigid payment, which is the proportion of floating income of non-capital-guaranteed OBS innovation. GDP represents real GDP growth rate. ASSET represents total assets, CAR represents capital adequacy ratio, ROA represents return on assets, ED represents ratio of equity to debt.
the impact of rigid payment on the relation between financial product development and bank risk taking. Thus, this paper uses a mediation effect model for analysis. Referring to Baron and Kenny (1986) test method for mediation models, the following recursive model is constructed,

\[
\text{RISK}_it = \gamma_0 + \gamma_1 \text{NF}_it + \gamma_2 \text{GDP}_it + \gamma_3 \text{ASSET}_it + \gamma_4 \text{CAR}_it + \gamma_5 \text{ROA}_it + \gamma_6 \text{ED}_it + \epsilon_it
\]  
(9)

\[
\text{LCCP}_it = \eta_0 + \eta_1 \text{NF}_it + \eta_2 \text{GDP}_it + \eta_3 \text{ASSET}_it + \eta_4 \text{CAR}_it + \eta_5 \text{ROA}_it + \eta_6 \text{ED}_it + \epsilon_it
\]  
(10)

\[
\text{RISK}_it = \alpha_0 + \alpha_1 \text{LCCP}_it + \alpha_2 \text{GDP}_it + \alpha_3 \text{ASSET}_it + \alpha_4 \text{CAR}_it + \alpha_5 \text{ROA}_it + \alpha_6 \text{ED}_it + \epsilon_it
\]  
(11)

\[
\text{RISK}_it = \beta_0 + \beta_1 \text{NF}_it + \beta_2 \text{LCCP}_it + \beta_3 \text{GDP}_it + \beta_4 \text{ASSET}_it + \beta_5 \text{CAR}_it + \beta_6 \text{ROA}_it + \beta_6 \text{ED}_it + \epsilon_it
\]  
(12)

This paper builds a recursive model (9) and models (10) to (12). Model (9) is used to verify the impact of rigid payment on bank risk taking. Model (10) is used to verify the impact of rigid payment on the development of bank OBS innovation. Model (11) is used to verify the impact of financial product development on bank risk taking. Model (12) is established to verify the impact of financial product development and rigid payment on bank risk taking. In the analysis, if \( \beta_1 \) is not significant, the model is subject to complete mediation. If both \( \beta_1 \) and \( \beta_2 \) are significant and the absolute value of the coefficient of \( \beta_1 \) is less than that of \( \gamma_1 \), the model has a partially mediating effect in the model. If the model has a mediating effect, the rigid payment of banks will have an impact on the development of banks' OBS innovation, which will affect bank risk taking, and the degree of rigid payment of the banks will accordingly affect their risk. Regression analysis is performed on models (9) to (12), respectively, and the results are shown in Table 9.

The results of model (9) show that the rigid payment degree of bank OBS innovation is negatively correlated with bank risk taking. The results of model (10) show that the coefficient of \( \text{NF}_it \) is significantly negative, indicating that a higher degree of rigid payment in a bank's OBS innovation will hinder the development of bank OBS innovation. In the results of model (11), the coefficient of \( \text{LCCP}_it \) is positive, indicating that the development of bank OBS innovation is positively correlated with bank risk taking, without the restriction of rigid payment. The results of model (12) show that the coefficients of \( \text{NF}_it \) and \( \text{LCCP}_it \) are both significantly negative, and the absolute value of the coefficient of \( \beta_1 \) is less than \( \gamma_1 \), indicating that the model has a partially mediating effect. The results show that the degree of rigid payment of bank OBS innovation will affect the development of bank OBS innovation, and a bank's degree of rigid payment will thus have an impact on its risk taking. This conclusion is consistent with Cheng's (2017). The new regulations on asset management can alleviate the current rigid payment situation and reduce the problem of bank risk taking.

6. Conclusions

This paper uses unbalanced panel data on 75 Chinese commercial banks from 2007 to 2017 to study bank OBS innovation and bank risk taking in the context of new asset management regulations promulgated in 2018. Empirical analysis finds that the progress of bank OBS innovation, which is calculated by the difference between the expected return rate of Chinese commercial bank OBS innovation and the one-year deposit benchmark interest rate, is negatively correlated with bank risk taking. When the expected rate of return of bank OBS innovation increases, the greater the pressure for banks to take on new projects, and the higher the risks the

| Table 9 |
| --- |
| Results of Mediating Effects Model. |

| steps | Explained variable | model(9) | model(10) | model(11) | model(12) |
| --- | --- | --- | --- | --- | --- |
| The first step | RISK\(_it\) | The second step | LCCP\(_it\) | The third step | RISK\(_it\) | The fourth step | RISK\(_it\) |
| NF\(_it\) | -1.8705*** (0.1914) | LCCP\(_it\) | -0.5308*** (0.1996) | -0.2321*** (0.0495) | -1.7499*** (0.1934) |
| GDP\(_it\) | -3.3156*** (0.2893) | GDP\(_it\) | 0.6881*** (0.3263) | -2.4587*** (0.3424) | -2.6461*** (0.3153) |
| ASSET\(_it\) | 2.9964*** (0.1713) | ASSET\(_it\) | -0.3371* (0.0545) | 4.1732*** (0.1588) | 3.0958*** (0.1884) |
| CAR\(_it\) | -0.2098*** (0.0447) | CAR\(_it\) | 0.1182** (0.1953) | 0.17269 (0.0573) | 0.1801*** (0.0527) |
| ROA\(_it\) | -1.6128*** (0.0782) | ROA\(_it\) | 0.1929 (0.3070) | -1.8214*** (0.3209) | 1.6867** (0.2953) |
| ED\(_it\) | 2.6261*** (0.0686) | ED\(_it\) | 0.1946** (0.0762) | 2.7844*** (0.0795) | 2.6914*** (0.0738) |
| Cons | -13.3261*** (1.5728) | Cons | 7.5101*** (1.8697) | -24.5227*** (1.5372) | -13.9933*** (1.8304) |
| N | 825 | N | 825 | 825 | 825 |
| R\(^2\) | 0.9099 | R\(^2\) | 0.7940 | 0.8900 | 0.8900 |
| F-test | 5.8200*** (0.0000) | F-test | 4.3900*** (0.0000) | 12.1700*** (0.0000) | 5.6400*** (0.0000) |

Note. The first behavioral estimation coefficient and the second behavioral robustness standard deviation of each explanatory variable, ***, ** and * mean significant at the significance level of 1 %, 5 % and 10 % respectively, the numbers in brackets are std error. RISK is the proxy variable of bank’s risk taking. LCCP is the proxy variable of bank OBS innovation. The calculation method of LCCP is the expected yield of OBS innovation minus the one-year bank deposit benchmark interest rate. NF is the proxy variable of rigid payment, which is the proportion of floating income of non-capital-guaranteed OBS innovation. GDP represents real GDP growth rate, ASSET represents total assets, CAR represents capital adequacy ratio, ROA represents return on assets. ED represents ratio of equity to debt.
banks will take. Therefore, the development of bank OBS innovation is negatively correlated with bank risk taking, which is demonstrated by the robustness tests. The results suggest that a rigid payment level will impact the relation between the development of bank OBS innovation and risk taking, given the background of new regulations on asset management. The decrease in rigid payment shows that the pressure on banks to repay capital and interest is lower. Banks have less of an incentive to invest in high-risk projects; therefore, the risks they take are reduced.

This paper splits the total sample into Big 5 banks, urban commercial banks, rural commercial banks, and joint stock commercial banks. The analysis studies the relation between the development of bank OBS innovation and the risk taking of the different types of banks, referring to the new asset management rules. Regression results show that an increase in bank OBS innovation is negatively correlated with bank risk taking, and a lower rigid payment level can reduce the risk level of bank OBS innovation. The reduction of risk induced by the reduction of rigid payment levels is the most obvious effect, especially among joint stock commercial banks.

The scale of bank OBS innovation continues to grow, and bank OBS innovation is a significant financing channel in the market. Therefore, the development of bank OBS innovation is closely related to the stability of the financial system. This paper's analysis leads to the following suggestions. First, investors should be cautious about investing in bank OBS innovation and understand that bank OBS innovations are not capital guaranteed and no longer have an explicit return rate. Second, new rules for asset management have been introduced that provide policy support for eliminating rigid payments and the appropriate direction to advance bank OBS innovation. Regulators should monitor banks' behavior under the new rules. Due to the heterogeneity of banks, more targeted policies should be formulated to manage different types of banks differently.

Finally, the analysis suggests the need to greatly reduce bank OBS innovation with guaranteed capital and interest rates, implement a floating rate for bank OBS innovation.

CRediT authorship contribution statement

Qingjun Zhang: Conceptualization, Methodology, Data curation, Validation, Software, Writing - review & editing, Visualization, Resources. Si Chen: Conceptualization, Methodology, Data curation, Validation, Software, Writing - original draft, Visualization. Yi Jin: Conceptualization, Methodology.

Declaration of Competing Interest

None.

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Appendix A

Regulatory policies

| Before 2013 | after 2013 |
|-------------|-----------|
| 2009 ‘notice on regulating the transfer of credit assets and related matters of credit asset management services’ (no. 113 [2009] issued by bank supervision) | 2013 notice of the general office of the state council on strengthening the supervision of shadow banking (guo ban fa [2013] no. 107) |
| 2010 notice on standardizing bank-trust wealth management cooperation business (no. 72 [2010] of bank supervision) | Notice on issues related to standardizing the investment operation of commercial banks' financial services (no.8 [2013] issued by bank supervision) |
| Notice on matters related to the improvement of the organization and management system of bank financial services (no. 35 [2014] issued by bank supervision) | Notice on matters related to the improvement of the organization and management system of bank financial services (no. 35 [2014] issued by bank supervision) |
| 2015 revision of commercial banking law | 2016 measures for supervision and management of commercial banks' financial services (draft for comments) |
| 2017, the draft of the guidance on standardizing the asset management business of financial institutions was issued | In 2017, the draft of the guidance on standardizing the asset management business of financial institutions was issued |
| 2018 guidance on standardizing asset management business of financial institutions (‘new rules on asset management’) | |

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ribaf.2020.101297.
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