Technology, Regulation, and the Transformation of Bank Deposit Business in China*

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Abstract

Bank deposit business in China used to be old-fashioned and tedious. Yet during the past decade, technology innovations and regulatory reforms have been swiftly transforming deposit business in China's banking sector. To understand this historical transformation, this paper first constructs a model incorporating both large and small banks, as well as a FinTech sector, to analyze how technological and regulatory shocks impact bank deposit business. Based on a newly available comprehensive dataset — China Banking Database — we empirically test the model's predictions. Specifically, we examine the evolution of business practices and the differential responses of banks with varying sizes to three major shocks: the launch of Yu'e Bao in 2013, the full marketization of deposit rates in 2015, and the massive shadow banking regulation in 2017. Consistent with the model's predictions, large banks accelerate digital transformation and expand wealth management products following FinTech competition, while small banks compete more aggressively on deposit rates. The effectiveness of these strategies varies with market structure: large banks' digital initiatives are more pronounced in regions with higher FinTech penetration, while small banks' deposit-taking advantage is stronger in more concentrated markets. Our findings contribute to understanding how technological innovation and regulatory changes reshape banking sector competition, and provide implications for policy design in an evolving financial landscape.

Keywords: Digital Finance; Marketization of Interest Rates; Shadow Banking; New Asset Management Regulations
JEL Classifications: G21; G28; E58

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1 Introduction

China's financial system, predominantly led by banks, has provided significant support for the stable and sustained development of the country's economy. Since the economic reform and opening up, China has pursued the reform of interest rate marketization, gradually relaxing interest rate controls and establishing a marketized interest rate system determined by supply and demand. The central bank uses monetary policy tools to guide market interest rates (Yi, 2021), progressively realizing the marketization of China's commercial banking system. These reforms have promoted the transformation and upgrading of commercial banking businesses. In recent years, shadow banking businesses that shift on-balance-sheet loan funds off-balance-sheet have developed rapidly, and the digitalization of banks has significantly improved. Mobile banking, digital branches, and e-commerce, along with other digital financial technologies, are now widely used in various financial services. According to Li (2019), the scale of China's shadow banking stock surged from RMB 6.6 trillion at the end of 2008 to RMB 51.1 trillion at the end of 2017, with an annual compound growth rate of 25.5%. The monthly year-on-year growth rate even exceeded 80% at its peak. By launching wealth management products and other shadow banking businesses, commercial banks have effectively enhanced their funding competitiveness. Since 2013, the rapid development of financial technology, such as Yu'E Bao and other emerging tools, has gradually changed people's wealth management methods and promoted the digital transformation of China's commercial banks (Huang and Huang, 2018; Qiu et al., 2018). Figure 1 visually display the trend and differences in innovative business and deposit structures of Chinese commercial banks in recent years.[1]

Considering China's financial reform process, what differentiated responses or development models have commercial banks of different sizes adopted in response to reform shocks? How have the highly digitized on-balance-sheet deposit business and off-balance-sheet wealth management business been promoted nowadays? These are the main questions this paper hopes to answer empirically. Specifically, what shocks in recent years have driven adjustments to the deposit business of commercial banks? How does intensified competition from external digital financial technologies affect the banks' deposit business? Do banks of different capabilities adopt differentiated business adjustment measures to cope with competition? As a key link in the interest rate marketization reform, what actual policy effects has the liberalization of the deposit rate ceiling produced? After the new asset management regulations restrict shadow banking, what differentiated business adjustment methods will commercial banks adopt? By theoretically and empirically studying these questions, we can help clarify the differentiated evolution process of commercial bank deposit business and its main influencing factors, contributing to a deeper understanding of bank behavior, recognizing the laws of differentiated development under different conditions, thereby promoting the sustainable and healthy development of commercial banks.

In this paper, we develop a theoretical model that extends the framework of Matutes and Vives (2000) by incorporating bank size heterogeneity to capture the differential behaviors of large and small banks. The model features a large bank acting as a monopolist and small banks that follow the leader's decisions in a competitive deposit market. Our primary focus

[1] The figure is based on the data of 107 sample banks in this article.

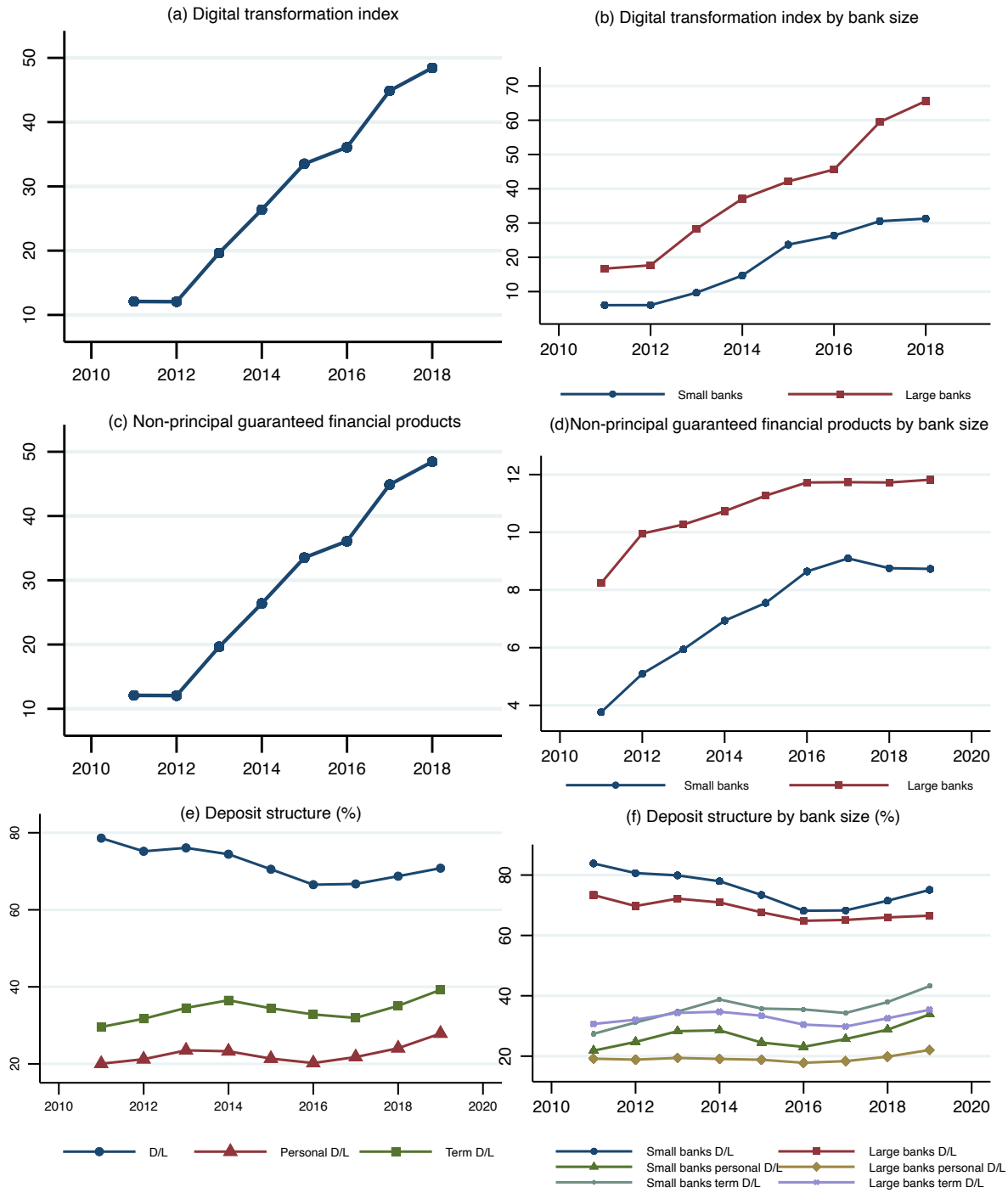

Figure 1: Trend in DTI, Non-principal Guaranteed Financial Products and Deposit Structures of Chinese Commercial Banks

Notes: In panel (c) and panel (d), the size of non-principal guaranteed financial products is presented in logarithmic form. In panel (e) and panel (f), D/L represents the ratio of deposits to total liabilities for each bank. Data source: China Commercial Bank Digital Transformation Index Xie and Wang (2022), China Banking Database.

is on analyzing the optimal strategies of large and small banks, and how these strategies are influenced by competition both within the banking sector and from non-banking financial institutions. The model also incorporates financial technology (FinTech) as a disruptive factor that differentially affects the deposit supply and profitability of banks of varying sizes.

The model yields several key conclusions. Small banks tend to set higher deposit rates compared to large banks, especially under increased inter-bank competition. While competition from non-banking sectors may drive convergence in these rates. Large banks consistently maintain funding advantages through innovative channels, with this advantage widening as competitive pressure increases. Additionally, large banks' superior profitability enables them to adopt financial technology more readily, allowing them to further expand their funding capacity through digital transformation and product innovation. These dynamics highlight how bank heterogeneity shapes strategic responses to financial reforms, including interest rate liberalization, shadow banking regulation, and FinTech advancement.

To verify our model predictions empirically in Chinese commercial banking sector, we select three dimensions as the objects of study for deposit business adjustment: traditional deposit business, wealth management products that guide deposit funds off-balance-sheet, and digital technologies that aid in the innovation and upgrading of deposit business. Then we construct an empirical model based on three major shocks that impacted banks' deposit business during the financial reform process in China from 2011 to 2019. The first shock was the launch of Yu'E Bao in 2013, marking the rapid advance of China's digital financial technology frontier, which intensified competition between banks and external financial technologies. The second was the lifting of the deposit rate ceiling in 2015, as a key part of the interest rate marketization reform, marking the nominal complete realization of interest rate marketization in China, which promoted internal deposit competition within the banking industry. The third was the end of 2017 when the strong regulatory policy "New Asset Management Rule" was issued, severely restricting wealth management products and other shadow banking businesses, aimed at preventing and resolving financial systematic risks, and promoting the return of off-balance-sheet wealth management funds to on-balance-sheet loans and deposits.

This paper tests our theoretical predictions utilizing short-panel data from 107 Chinese commercial banks spanning 2011-2014, 2014-2016 and 2016-2019, exploiting three quasi-natural experiments: the launch of Yu'E Bao, deposit rate liberalization and New Asset Management Rule. Our empirical analysis reveals systematic heterogeneity in banks' responses to these shocks. Following the introduction of Yu'E Bao, large banks significantly accelerated digital transformation and expanded wealth management products, while small banks competed more aggressively in the deposit market. The removal of deposit rate ceilings led small banks to raise deposit rates more substantially than large banks. And after the implementation of New Asset Management Rule, large banks further enhanced digital capabilities while small banks intensified deposit competition. Additional analyses show these strategic responses vary with local market structure and FinTech penetration, consistent with our model's predictions about how bank size and market competition jointly shape business evolution.

Compared to the existing literature, this paper's contribution is reflected in three aspects. Firstly, by systematically analyzing the impact factors and mechanisms of deposit business evolution in commercial banks from 2011 to 2019, it provides a more comprehensive and accurate

understanding of the evolution of bank deposit business. Secondly, by empirically testing the model's predictions through comprehensive regressions, it deepens the understanding of how different factors interact to shape the evolution of bank deposit business. Thirdly, the paper constructs indicators of banking market concentration and market power, providing a more accurate measure of the degree of competition within the banking industry, thus making the results more robust and reliable.

The paper is organized as follows: Section 2 contains the literature review; Section 3 provides a theoretical framework and derives testable hypotheses; Section 4 details the data and empirical specifications; Section 5 reports the baseline regression results, together with robustness tests; Section 6 conducts a heterogeneity analysis; and Section 7 concludes.

2 Literature Review

Commercial banks and their business structures are integral parts of the financial structure,[2] which reflects and in turn, impacts the economic structure. Studying the changes in financial structure and development helps to clarify the inner workings of China's macro-economy. In the course of the financial reforms over the past thirty years, China's financial asset totals have grown continuously, and financial deepening has rapidly progressed. The proportion of deposits in financial institution funding sources has declined, decreasing gradually from 57.3% in 1995 to 49.8% in 2018. Especially from 2008 to 2018, off-balance-sheet businesses and asset management have developed rapidly, diversifying investment channels and leading to a shift in residents' asset allocations away from traditional bank deposits (Yi and Song, 2008; Yi, 2020). In the same period, China gradually advanced the marketization of interest rates through a dual-track system in line with financial market construction, establishing the primary role of interest rates in the allocation of financial resources, and refining the indirect regulatory mechanism of market interest rates through monetary policy tools (Yi, 2009). A relatively complete marketized interest rate system has provided conditions for the central bank to implement monetary policy and also promoted the market-oriented development of commercial bank business (Yi, 2021).

Regarding the development of commercial bank business models, existing literature primarily focuses on the impact of individual shocks or factors on bank behavior. One focus is on the launch of Yu'E Bao in 2013, since then, China's FinTech development has fundamentally transformed the financial landscape. According to Huang and Huang (2018), definitions of digital finance,[3] financial technology,[4] and internet finance[5] by the Financial Stability Board

[2]The form, nature and relative size of various financial instruments and financial institutions.

[3]Traditional financial institutions and Internet companies use digital technology to realize financing, payment, investment and other new financial business models.

[4]Financial innovation driven by technological means, forming business models, technological applications, business processes, and innovative products that have significant impacts on financial markets, institutions, and services.

[5]A new model of financial services where traditional financial institutions and Internet companies use internet technology and information and communication technology to facilitate funding, payments, investments, and information intermediary services.

and ten committees of the People's Bank of China are conceptually similar, all encompassing the meaning of using digital technology to promote financial innovation and realize new financial business models in financing, payment, and investment. Studies document that FinTech competition affects banks through multiple channels: promoting digital transformation and improving operational efficiency (Shen and Guo, 2015; Huang and Huang, 2018), altering funding structure toward wholesale funding (Qiu et al., 2018), and driving innovation in wealth management products (Buchak et al., 2021). Particularly, Buchak et al. (2021) find that banks more exposed to Yu'E Bao competition tend to develop similar market-rate investment products, suggesting banks' strategic responses to FinTech challenges.

Meanwhile, research on shadow banking in China highlights how regulatory and competitive forces shape banks' business strategies. Different from other economies, China's indirect financing system dominated by banks determines that China's shadow banking exhibits "bank-centric characteristics," referred to as "the shadow of banks" (CBIRC, 2020). Most scholars believe that regulatory arbitrage is the main reason for shadow banking, with Chinese banks engaging in shadow banking activities mainly related to tighter liquidity regulation constraints (Barth et al., 2015; Chen et al., 2018; Guo and Zhao, 2017; Zhu et al., 2012). A second strand highlights the role of local government financing needs, especially following the 2008-2010 stimulus plan (Acharya et al., 2020; Chen et al., 2018; Zhang and Chen, 2023). Research has also examined how shadow banking shapes China's financial system: Gao et al. (2020) documents its evolving role from credit substitution to capital market activities, while Wang et al. (2019) shows how it creates a parallel track promoting interest rate liberalization. Particularly relevant to our study is the competitive channel: intense deposit market competition drives banks toward shadow banking activities (Ahn and Breton, 2014; Guo and Zhao, 2017), while market concentration may also affect bank efficiency and rent-seeking behavior (Hicks, 1935; Berger and Hannan, 1998; Koetter et al., 2012). While these studies examine individual factors' impacts on bank behavior, our paper provides a unified framework to analyze how banks of different sizes respond strategically to multiple financial reforms - FinTech innovation, interest rate liberalization, and shadow banking regulation. This systematic approach allows us to understand how bank heterogeneity and market structure jointly determine strategic responses to various policy and competitive shocks in China's evolving financial landscape.

Additionally, existing research seldom touches upon the impact of banks' own resource constraints on their development direction. We believe that in the face of market competition, a bank's ability to learn cutting-edge technology determines its behavior and development direction when responding to shocks. Specifically, a bank's size reflects its learning capability and financial strength. Larger, more capable banks are more likely to arrange digital transformation and engage in shadow banking business, while smaller banks tend to increase deposit rates to enhance the competitiveness of their deposit channels. There is limited empirical analysis in existing literature on the differentiated business development driven by technological advancements in commercial banks of varying capabilities. Zhu et al. (2016) studied the repo of financial assets among commercial banks in China from 2006 to 2012, finding that larger banks engage in greater scales of shadow banking business. Shen and Guo (2015) suggested that internet finance has led to technology spillovers for commercial banks, and the extent of such spillovers largely depends on the banks' learning capabilities. Due to differences in scale,

organizational structure, and prior knowledge, banks exhibit significant variations in learning abilities. Xie et al. (2018) noted through case studies that commercial banks with different asset scales and financial strengths adopt differentiated transformation and business development models in response to financial technology shocks.

In summary, existing research has not provided a comprehensive summary and review of the factors influencing the evolution of deposit business in commercial banks of different sizes under the backdrop of financial reform, and it has primarily focused on theoretical analysis. This may be due to the limited number of listed banks in China and the difficulty in obtaining data from non-listed banks. To address this gap, this paper attempts to use data from 107 Chinese commercial banks from 2011-2019 to quantify the impact of financial reforms on commercial banks' deposit business, thereby summarizing the main factors influencing the differentiated development of commercial banks.

3 Theoretical Framework and Empirical Hypotheses

3.1 Setup

This paper builds on the framework of Matutes and Vives (2000), extending it by incorporating bank size heterogeneity. In this model, there are two types of banks: a large bank that acts as a monopolist and small banks that follow. Banks compete for deposits by setting interest rates r_i $(i = B, S)$, while simultaneously facing competition from the non-banking sector. The key distinction between large and small banks lies in their inherent market power, technological capabilities, and competitive responses. Depositors, upon observing the interest rates offered by banks, decide how much to deposit in each bank, denoted by S_i. Depositors are assumed to be risk-neutral, with a utility function that is linear in income.

The deposit supply function for the large bank is given by:

$$S_B = a_B + b \cdot r_B,$$

and for the small bank:

$$S_S = a_S + b \cdot r_S - c \cdot r_B,$$

Assumption 1. *Assume that $b > c > 0$, $a_B > a_S > cR$, and $a_B < bR$, which ensure that the competition dynamics, baseline deposit supply, and deposit rates are economically feasible and lead to meaningful equilibrium results.*

a_B and a_S represent the baseline deposit supply for the large bank and small banks, respectively, reflecting the inherent ability of different banks to attract deposits in the absence of interest rate competition. a_B is relatively high due to factors such as brand recognition, extensive branch networks, and greater customer trust. While a_S is comparatively lower, reflecting their disadvantage in terms of resources, customer base, and market influence. The parameter b represents competition from the non-banking sector, with a larger b indicating stronger competition, implying that banks face a more elastic deposit demand. The parameter c represents the competition that small banks face from the large bank. A larger c indicates a stronger crowding-out effect by the large bank on small banks' deposits. Notably, c affects the behavior of small banks but does not influence the large bank's decision-making.

The expected profit for each bank is defined as:

$$\Pi_i = S_i \cdot (R - r_i),$$

where R is the return on assets for banks, which we assume to be certain for simplicity.

3.2 Introduction of Financial Technology

In addition to the basic competitive environment, banks face strategic decisions regarding financial technology adoption. Recent studies by Kutzbach and Pogach (2024); Puri et al. (2024) document that banks primarily respond to FinTech challenges through two channels: investing in proprietary digital capabilities or forming strategic partnerships with FinTech firms. To capture these strategic choices in our framework, we extend the basic model by incorporating technology adoption decisions.

When a bank chooses to adopt financial technology, it experiences two counteracting effects: an expansion effect through a fixed proportional increase (ξ) in deposit supply, reflecting enhanced customer reach and service efficiency; and a cost effect through a fixed implementation cost (f), representing expenses in infrastructure, talent acquisition, and system integration. Therefore, the profit function for a bank i that adopts FinTech can be expressed as:

$$\widetilde{\Pi}_i = (1 + \xi)S_i(R - r_i) - f,$$

where the tilde notation ($\sim$) denotes variables under technology adoption.

The technology adoption decision follows a threshold rule. A bank will choose to adopt FinTech if the resulting profit exceeds the profit without FinTech:

$$\widetilde{\Pi}_i > \Pi_i,$$

which implies:

$$\xi\Pi_i^* > f.$$

This threshold condition reveals an important asymmetry between large and small banks. Given that $\Pi_B^* > \Pi_S^*$ (as will be shown in the subsequent analysis), large banks face a lower effective adoption threshold due to their ability to spread fixed costs across a larger deposit base.

The deposit supply functions under technology adoption become:

$$\widetilde{S}_i = (1 + \xi)(a_i + b \cdot r_i).$$

This extension enriches our framework in several important ways. First, it captures the strategic complementarity between traditional banking advantages (a_B, a_S) and technological capabilities (ξ). Second, it introduces an additional source of bank heterogeneity through differential technology adoption capabilities. Third, it provides a mechanism to analyze how digital transformation affects market structure and competitive dynamics.

3.3 Static Comparative Analysis

We first solve the baseline equilibrium without technology adoption, then analyze how FinTech adoption affects the competitive dynamics.

3.3.1 Baseline Equilibrium

Given the large bank's deposit rate r_B, the small bank's profit maximization problem is:

$$\max_{r_S} \Pi_S = S_S(R - r_S) = (a_S + br_S - cr_B)(R - r_S).$$

The first-order condition yields:

$$r_S = \frac{c}{2b} r_B - \frac{1}{2b}(a_S - bR).$$

The large bank's profit maximization yields:

$$\max_{r_B} \Pi_B = S_B(R - r_B) = (a_B + br_B)(R - r_B),$$

with the optimal rate:

$$r_B^* = \frac{R}{2} - \frac{a_B}{2b}.$$

Consequently, the small bank's equilibrium rate is:

$$r_S^* = \frac{R}{2} - \frac{a_S}{2b} + \frac{bR - a_B}{4b^2} c.$$

Proposition 1 (Interest Rate Response to Competition)**.** *Under the condition $a_B < bR$:*

1. *The small bank sets higher deposit rates than the large bank in equilibrium*
2. *The interest rate differential widens as competition from the large bank (c) intensifies*
3. *When overall banking sector competition (b) increases, the interest rate differential may decrease under certain conditions*

Proof: First, the interest rate differential in equilibrium is:

$$r_S^* - r_B^* = \frac{2(a_B - a_S)b + (bR - a_B)c}{4b^2} > 0$$

Effect of Competition from the Large Bank: The derivative of the interest rate differential with respect to c is positive:

$$\frac{\partial(r_S^* - r_B^*)}{\partial c} = \frac{bR - a_B}{4b^2} > 0$$

This indicates that as competition from the large bank intensifies, small banks respond by raising their deposit rates more aggressively, widening the interest rate gap.

Effect of Overall Banking Sector Competition: The derivative with respect to b is:

$$\frac{\partial(r_S^* - r_B^*)}{\partial b} = \frac{c(2a_B - bR) + 2b(a_S - a_B)}{4b^3}$$

This derivative is negative when:

$$c(2a_B - bR) + 2b(a_S - a_B) < 0$$

Under this condition, increased competition from the non-banking sector leads to convergence in deposit rates between large and small banks. This reflects how external competitive pressure can moderate the strategic rate differentiation between banks of different sizes.

Note that technology adoption, while expanding deposit supply proportionally through parameter ξ, does not alter these comparative statics as the optimal interest rate choices remain unchanged.

Proposition 2 (Deposit Supply and Technology Advantage)**.** *The deposit supply differential between large and small banks:*

1. *Is positive in the baseline case and expands with technology adoption*
2. *Widens as competition from the large bank (c) intensifies*
3. *Shows decreasing marginal response to overall banking sector competition (b)*

Proof: In the baseline case, the equilibrium deposit supplies are:

$$S_B^* = \frac{a_B}{2} + \frac{b}{2}R$$
$$S_S^* = \frac{1}{2}a_S + \frac{bR}{2} + \frac{a_B - bR}{4b}c$$

The deposit supply differential is:

$$S_B^* - S_S^* = \frac{c}{4}R + \frac{2b - c}{4b}a_B - \frac{1}{2}a_S > 0$$

where the inequality holds because $a_B > a_S$ and $b > c$.

When the large bank adopts technology (as demonstrated in Proposition 3), its deposit supply expands proportionally while the small bank's remains unchanged:

$$\widetilde{S}_B^* - S_S^* = (1 + \xi)(S_B^*) - S_S^* > S_B^* - S_S^*$$

Effect of Competition from the Large Bank: The derivative of the supply differential with respect to c is:

$$\frac{\partial(S_B^* - S_S^*)}{\partial c} = \frac{bR - a_B}{4b} > 0$$

With technology adoption:

$$\frac{\partial(\widetilde{S}_B^* - S_S^*)}{\partial c} = \frac{bR - a_B}{4b} > 0$$

where the inequality holds because $bR > a_B$. This shows that increased competition from the large bank widens the deposit supply gap, with technology adoption maintaining this effect.

Effect of Overall Banking Sector Competition: The first and second derivatives with respect to b are:

$$\frac{\partial(S_B^* - S_S^*)}{\partial b} = \frac{ca_B}{4b^2} > 0$$
$$\frac{\partial^2(S_B^* - S_S^*)}{\partial b^2} = -\frac{ca_B}{2b^3} < 0$$

With technology adoption:

$$\frac{\partial(\widetilde{S}_B^* - S_S^*)}{\partial b} = \xi\frac{R}{2} + \frac{ca_B}{4b^2} > 0$$
$$\frac{\partial^2(\widetilde{S}_B^* - S_S^*)}{\partial b^2} = -\frac{ca_B}{2b^3} < 0$$

These results show that while increased banking sector competition expands the deposit supply differential, it does so at a decreasing rate, demonstrating the diminishing marginal effect of competition on market concentration. Technology adoption amplifies this effect but preserves the concave relationship.

Proposition 3 (Profit and Technology Investment)**.** *The equilibrium profit structure exhibits the following characteristics:*

1. *Large banks maintain higher profits than small banks, and thus are more likely to adopt financial technology*
2. *The large bank's profit increases with overall banking sector competition (b), while being unaffected by competition from itself (c)*
3. *Small banks' profits decrease with competition from the large bank (c)*

Proof: The equilibrium profits are:

$$\Pi_B^* = b\left(\frac{R}{2} + \frac{a_B}{2b}\right)^2$$
$$\Pi_S^* = b\left(\frac{a_S}{2b} + \frac{R}{2} + \frac{a_B - bR}{4b^2}c\right)^2$$

First, we show the profit differential is positive:

$$\Pi_B^* - \Pi_S^* = \frac{[2bR + (a_B + a_S) + \frac{a_B - bR}{2b}c][2(a_B - a_S)b + (bR - a_B)c]}{4b} > 0$$

where the inequality holds because $a_B > a_S$ and $bR > a_B$. Given that a bank adopts technology when $\xi\Pi_i^* > f$, the large bank is more likely to satisfy this condition due to its higher baseline profit.

Effect of Large Bank Competition: For the large bank:

$$\frac{\partial \Pi_B^*}{\partial c} = 0$$

indicating the large bank's profit is unaffected by its competitive pressure on small banks.

For small banks:

$$\frac{\partial \Pi_S^*}{\partial c} = \frac{b(a_B - bR)}{2b^2}(a_S + bR + \frac{a_B - bR}{2b}c) < 0$$

where the inequality holds because $bR > a_B$. This shows that increased competition from the large bank reduces small banks' profits.

Effect of Overall Banking Sector Competition: For the large bank:

$$\frac{\partial \Pi_B^*}{\partial b} = \frac{b^2R^2 - a_B^2}{4b^2} > 0$$

where the inequality holds because $bR > a_B$. This indicates that increased competition from the non-banking sector actually benefits the large bank.

These results show that small banks face profit erosion from increased large bank competition. And as the higher baseline profit of large banks makes them more likely to adopt financial technology, external financial technology innovations could further amplify the profit disparity between large and small banks.

3.4 Empirical Hypotheses

China's financial sector has undergone substantial reforms in recent years, with three pivotal developments - digital finance innovation, interest rate liberalization and shadow banking regulation - fundamentally reshaping commercial banks' deposit operations. This paper examines how banks' deposit business evolves in response to these reforms, considering both exogenous market forces and institutions' endogenous transformation capabilities. Firstly, the emergence of digital financial technologies, particularly big data, artificial intelligence, and Internet of Things, has transformed banks' capacity to modernize traditional financial services (Hong and Wang, 2021; Xie et al., 2020). Notably, competition from FinTech innovations such as Yu'E Bao has catalyzed banks' digital transformation initiatives and spurred the development of competitive wealth management products (Zhan et al., 2018; Qiu et al., 2018). Against this backdrop, we develop the following hypotheses regarding banks' strategic responses to FinTech-driven market disruptions:

- **Hypothesis 1: Technology Competition and Bank Response**
  - **H1-a:** In response to financial technology innovations, large banks are more likely to adopt digital technologies which manifests in two ways: accelerated digital transformation and launch of competitive wealth management products to counter FinTech challenges.
  - **H1-b:** In areas with higher FinTech penetration (higher ξ), large banks exhibit more intensive digital transformation initiatives, while small banks respond through offering higher deposit rates to increase their deposit base.

Since the reform and opening-up, the marketization of interest rates has been one of the most central reforms in China's economic and financial fields. A pivotal milestone occurred in October 2015 when the People's Bank of China eliminated deposit rate ceilings for commercial banks and rural cooperative financial institutions. This regulatory shift marked a critical transition in China's interest rate liberalization process, fundamentally altering the competitive dynamics in the deposit market (Yi, 2009, 2021). Our theoretical analysis suggests that amid heightened competition, small banks exhibit a systematic tendency to set higher deposit rates relative to large banks, with this interest rate differential responding to changes in market competition. Based on these insights, we hypothesize:

- **Hypothesis 2: Interest Rate Liberalization**
  - **H2-a:** Following the removal of deposit rate ceilings, small banks maintain systematically higher deposit rates than large banks. The intensity of this strategic response increases with the degree of inter-bank competition.

The post-2008 period witnessed substantial expansion of China's shadow banking sector, driven by regulatory arbitrage and competitive pressures. This expansion manifested through complex intermediation chains, maturity transformation, opaque structures, and implicit guarantees, leading to elevated systemic risks and increased macro leverage (Yi, 2020; CBIRC, 2020).

The introduction of the Guiding Opinions on Standardizing the Asset Management Business of Financial Institutions (hereafter 'new asset management rules') in 2017 marked a significant regulatory intervention, effectively constraining shadow banking activities and redirecting financial flows toward traditional banking channels. This regulatory tightening fundamentally altered the competitive landscape in the banking sector by limiting off-balance-sheet operations. Based on our theoretical framework and empirical evidence, we propose:

- **Hypothesis 3: Shadow Banking Regulation Effect**
  - **H3-a:** Following the implementation of 'new asset management rules', large banks accelerate digital transformation and wealth management innovation to maintain their competitive advantage, as the reduction in shadow banking activities (lower b) is offset by intensified inter-bank competition (higher c).
  - **H3-b:** Under this mixed competitive effect, small banks exhibit higher deposit rates to maintain their deposit base, and the net effect determined by the relative changes in market-wide competition (b) and inter-bank competition (c).

These hypotheses highlight the varying responses of large and small banks to financial reforms and competition pressures, supporting an understanding of how financial technology and regulatory shifts shape banks' strategic decisions.

4 Data and Empirical Model Settings

4.1 Data

4.1.1 Data Samples

This study examines three exogenous shocks occurring in June 2013, October 2015, and November 2017. Considering the gestation periods of financial technology products and policy formulation, the end of 2013, 2015, and 2017 are set as the baseline periods for these shocks, respectively. The sample intervals selected are 2011-2014, 2014-2016, and 2016-2019. This approach of using short panel regressions avoids the mutual interference of impacts, ensuring more accurate regression results. Additionally, the primary aim is to explore the short-term effects triggered by each shock, thereby observing recent changes in the business structure of commercial banks and the factors influencing these changes.

Data related to banks come from the core data tables in the China Banking Database and annual and audit reports of commercial banks. This study manually collected and compiled data related to banks' wealth management products as dependent variables; specific data collection details are provided in Appendix A. Data on banks' interest expenses on deposits, liability scales, and related deposit data were extracted from the CBD core data tables to serve as dependent variables and for grouping in the disposal group, along with characteristic data of commercial banks such as total assets, liquidity ratios, capital adequacy rates, and non-performing loan rates. Missing data were supplemented from commercial banks' annual reports, audit reports, and credit assessment reports. Ultimately, annual data from 107 com-

mercial banks nationwide were compiled, with the specific number and distribution of banks presented in Tables 1 and 2.

Table 1: Distribution of Bank Types

Type	National Banks	Joint-stock Banks	City Commercial Banks
Number	5	12	90

Table 2: Distribution of Banks by Year

Year	2011	2012	2013	2014	2015
Bank Count	92	94	95	98	102
Year	2016	2017	2018	2019	
Bank Count	107	105	104	104	

Note: The sample is an unbalanced panel data; the banks listed above include data for at least 4 years.

Another dependent variable, the measurement index for the degree of digital transformation of banks, uses the Chinese Commercial Banks Digital Transformation Index compiled by the Digital Finance Research Center at Peking University (Xie et al., 2018).[6] This index system measures the degree of digital transformation across key dimensions such as bank strategy, business, and management, and can comprehensively reflect the level of digitalization in commercial banks.

The index of the development level of external financial technology, used as another criterion for disposal group classification, employs the Payment and Money Fund Category Index under the City-Level China Digital Finance Usage Depth Index compiled by the Digital Finance Research Center at Peking University (Guo and Zhao, 2017). This index utilizes underlying data from Ant Financial's transaction accounts. The payment index reflects the penetration of Alipay, China's largest third-party payment platform, in the city, and the money fund index reflects the penetration of Yu'E Bao, the world's largest money fund. Thus, this index effectively indicates the development level of external financial technology and the competitive pressure it imposes on the banking industry.

4.1.2 Measuring Market Competition and Market Power

The study uses the concentration of bank deposits (HHID) as an indicator of internal market competition within the banking industry. A lower concentration index indicates more intense internal market competition. HHID is constructed as follows:

$$\text{HHID}_{it} = \sum_{p} \frac{\text{NB}_{itp}}{\text{NB}_{it}} \times \sum_{i} \left(\frac{D_{itp}}{D_{tp}} \right)^2$$

[6]Updated to 2018.

$$D_{itp} = \frac{\mathrm{NB}_{itp}}{\mathrm{NB}_{it}} \times D_{it}, \quad D_{tp} = \sum_{i} D_{itp}$$

Where i denotes the i-th bank, t denotes the year t, and p denotes the p-th city; NB represents the number of bank branches, and D represents deposits.

The market share of bank deposits (MSD) serves as an indicator of a bank's market power. It is constructed by weighting the market share of a bank's deposits and asset size in each city by the proportion of branches in that city to the total number of bank branches:

$$\mathrm{MSD}_{it} = \sum_{p} \frac{\mathrm{NB}_{itp}}{\mathrm{NB}_{it}} \times \frac{D_{itp}}{D_{tp}}$$

Where i denotes the i-th bank, t denotes the year t, and p denotes the p-th city; NB represents the number of bank branches, and D represents deposits.

4.1.3 Bank Group Classification

To explore the differentiated behavior of commercial banks in response to financial reform impacts and to test the model's conclusions, banks are classified into two groups: large and small, based on their size in the year prior to each shock. This classification allows the study to examine whether the theoretical predictions hold across different shocks, while mitigating potential endogeneity issues by using pre-shock information for group formation.

4.2 Empirical Methods

4.2.1 Variable Definitions and Descriptions

In accordance with the evolution of bank deposit business, this study's dependent variables encompass three dimensions: deposit business, bank wealth management products, and digital transformation.

Deposit Business Dimension: This study selects the average deposit rate (ADR) and the logarithm of personal deposit size ($HDeposit$) time deposit size ($TDeposit$), and total deposit size ($Deposit$) as the dependent variables. The average deposit rate is calculated by dividing the bank's annual interest expenses on deposits by the average of the deposit balances at the beginning and end of the year. The sizes of personal deposits, time deposits, and total deposits are obtained by taking the logarithm of their respective year-end balances.

Wealth Management Products Dimension: The focus is on the logarithm of bank wealth management product business revenue ($WMPR$). The revenue from the bank's wealth management products primarily contributes to fee and commission income; thus, the related fee income is used as the measure for wealth management product business revenue.

Digital Transformation Dimension: This study examines the Digital Transformation Index (DTI), which reflects the extent to which commercial banks utilize digital technologies, driven by internal and external factors.

Details on the main variables and calculation methods are provided in Table 3.

Table 3: Main Variables Description and Calculation Methods

Variable Name	Variable Description	Calculation Method
$HDeposit$	Scale of personal bank deposits	Logarithm of the balance of personal deposits
$TDeposit$	Scale of time bank deposits	Logarithm of the balance of time deposits
$Deposit$	Scale of bank deposits	Logarithm of the balance of deposits
ADR	Average deposit rate of the bank	Deposit interest expense * 2 / (Deposit balance at the beginning of the year + Deposit balance at the end of the year)
$WMPR$	Wealth management product income	Logarithm of the fee income associated with wealth management services
DTI	Digital Transformation Index for Commercial Banks	Xie Xuanli and Wang Shihui (2021)
$payment$	Payment Index under China's Digital Financial Usage Depth Index	Guo Feng et al. (2020)
$HHID$	Bank Deposit Concentration	$\text{HHID}_{it} = \sum_p \left(\frac{\text{NB}_{itp}}{\text{NB}_{it}} \times \sum_i \left(\frac{D_{itp}}{D_{tp}} \right)^2 \right)$
MSD	Bank Deposit Market Power	$\text{MSD}_{it} = \sum_p \left(\frac{\text{NB}_{itp}}{\text{NB}_{it}} \times \frac{D_{itp}}{D_{tp}} \right)$
$Large_b$	Dummy variable for the bank	1 if the bank's asset size is above the median, otherwise 0
$POST_t$	Time dummy variable	0 before the shock baseline period, otherwise 1
$SIZE_{bt}$	Size of the bank	Logarithm of total assets
CAP_{bt}	Bank capital adequacy ratio	Core capital / Total capital
LIQ_{bt}	Bank liquidity ratio	Liquid assets / Liquid liabilities
NPL_{bt}	Bank non-performing loan rate	Non-performing loan balance / Total loan amount

4.2.2 Empirical Model Setup

Based on the research questions, this paper designs three short-panel regression models. For each exogenous shock, the models primarily test the coefficients of interaction terms to assess the response of each variable. The variables examined mainly include those related to

the pricing and quantity of deposits[7] as well as variables related to innovative business models[8].

The first model investigates how banks adjust their deposit business in response to competition shocks from external financial technologies. Specifically, it explores the adjustments or innovations made by banks following the release of Yu'E Bao. The specific setup of the model is as follows:

$$y_{bt} = \beta \left(Large_b \times POST_t \right) + X_{bt}^{\top} \phi + \alpha_t + \alpha_b + \epsilon_{bt} \tag{1}$$

In this model, b denotes a sample bank and t represents the year. y refers to variables such as bank wealth management product business revenue ($WMPR$), Digital Transformation Index (DTI), and variables related to deposits (average deposit rate ADR, deposit size $Deposit$, personal deposit size $HDeposit$, and time deposit size $TDeposit$). $Large_b$ indicates whether bank b has an asset size above the median at the end of 2012. $POST_t$ represents a time dummy variable, where years prior to 2013 are assigned a value of 0, indicating that Yu'E Bao had not yet been issued, and years from 2013 onward are assigned a value of 1. $Large_b \times POST_t$ is the interaction term of $Large_b$ and $POST_t$, and its coefficient β is the core variable of interest in this paper. For example, taking the fee income from wealth management business as the dependent variable, β captures whether, after the issuance of Yu'E Bao, large banks compared to small banks have increased or decreased their fee income related to wealth management products. If this value is positive and significant, it indicates that after the impact of financial technology, large banks have increased their share of wealth management business compared to smaller banks. X_{bt} includes bank control variables such as bank size ($SIZE_{bt}$), liquidity ratio (LIQ_{bt}), capital adequacy ratio (CAP_{bt}), and non-performing loan rate (NPL_{bt}). α_t represents time fixed effects, and α_b represents bank fixed effects.

The second regression model explores the actual policy effects of lifting the cap on deposit rate fluctuations. The specific model setup is as follows:

$$y_{bt} = \beta \left(Large_b \times POST_t \right) + X_{bt}^{\top} \phi + \alpha_t + \alpha_b + \epsilon_{bt} \tag{2}$$

In this setup, the dependent variable y and the criteria for categorizing banks are consistent with Model (1). $Large_b$ indicates whether bank b has an asset size above the median, based on data from the year before the policy implementation. $POST_t$ represents a time dummy variable, where years before 2015 are assigned a value of 0, indicating that the cap on deposit rates had not yet been lifted, while the years 2016 and 2017 are assigned a value of 1. The coefficient β of $Large_b \times POST_t$ is the core variable of interest in this paper. Taking the average deposit rate as the dependent variable, this coefficient represents the trend in the change of the average deposit rate for larger banks relative to smaller banks after the lifting of the rate cap. If this value is positive and significant, it indicates that China's policy of marketizing deposit rates had a more pronounced effect on enhancing the competitiveness of deposit rates among smaller banks. The rest of the model settings are the same as in Model (1).

[7] Average deposit interest rate ADR, deposit size Deposit, personal deposit size HDeposit and time deposit size Tdeposit.

[8] Wealth management product revenue WMPR and Digital Transformation Index DTI.

The third regression model investigates how the business structure and model of banks with different sizes have evolved following the implementation of the New Asset Management Rule. The regression is conducted using event study methodology, with model settings similar to Models (1) and (2), and consistent control variables:

$$y_{bt} = \beta \left(Large_b \times POST_t \right) + X_{bt}^{\top} \phi + \alpha_t + \alpha_b + \epsilon_{bt} \tag{3}$$

In this model, y continues to represent the variables used in Models (1) and (2), while $Large_b$ remains unchanged, indicating whether a bank has an asset size above the median before the shock. $POST_t$ is a time dummy variable, where years before 2017 are assigned a value of 0, indicating that the new asset management regulations had not yet been enacted, and the years 2017 and afterward are assigned a value of 1. The coefficient β of $Large_b \times POST_t$ is the core variable of the model. Taking the revenue from wealth management products as the dependent variable, this coefficient reflects whether, after the release of the new asset management regulations, the income from wealth management products for larger banks has increased or decreased compared to smaller banks.

4.2.3 Descriptive Statistics

Table 4 provides descriptive statistics for the relevant variables. To exclude the influence of outliers, a winsorization procedure has been applied to certain variables (average deposit rate and capital adequacy ratio) at the (0.5%, 99.5%) level. It is observed that the standard deviation for the Digital Transformation Index, digital finance payment index, and money fund index of the sample banks is large. This variation is attributed to the differing levels of financial technology development across various banks and regions.

Table 4: Summary Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
$WMPR$	570	4.672	2.647	-4.423	10.969
DTI	744	30.057	24.440	0	192.556
$HDeposit$	762	10.934	1.694	3.960	16.178
$TDeposit$	768	11.394	1.984	-5.263	19.439
$Deposit$	901	12.035	1.606	6.909	16.950
ADR	853	2.166	0.521	1.026	4.116
$payment$	901	202.605	86.853	35.800	435.838
$HHID$	901	0.123	0.037	0	0.285
MSD	901	0.082	0.047	0	0.274
$bankSIZE$	901	12.456	1.634	7.522	17.220
LIQ	859	55.822	19.988	0.560	239.910
CAP	894	13.077	2.137	9.000	26.380
NPL	888	1.408	1.275	0	28.440

Note: Units of ADR, LIQ, CAP, and NPL are percentages.

5 Empirical Results and Analysis

5.1 The Impact of Yu'E Bao's Launch in 2013

To test Hypothesis 1-a regarding the heterogeneous responses of banks to FinTech competition, we employ a difference-in-differences framework that examines banks' strategic adjustments following the launch of Yu'E Bao. Specifically, we employ Model 1. The coefficient of interest, β_1, captures the differential response of large banks relative to small banks in the post-Yu'E Bao period. Table 5 presents the estimation results. Column (1) reports the impact on wealth management product income. Column (2) examines the digital transformation index, while columns (3) and (4) analyze personal deposit volume and time deposit volume, respectively. All specifications include bank-level controls and bank and time fixed effects, using robust standard errors.

Table 5: Regression Results of Yu'E Bao Issuance Impact

	(1)	(2)	(3)	(4)
	$WMPR$	DTI	$HDeposit$	$TDeposit$
$\text{Large}_b \times \text{POST}_t$	0.7112**	11.5038***	-0.0866**	-0.3778*
	(0.2912)	(1.7385)	(0.0406)	(0.2129)
SIZE_{bt}	0.7934	8.4121*	0.5674**	2.4685
	(0.8339)	(4.3982)	(0.2207)	(1.9280)
LIQ_{bt}	0.0013	-0.0097	-0.0023	-0.0058
	(0.0097)	(0.0507)	(0.0019)	(0.0052)
CAP_{bt}	-0.0601*	-0.4277***	-0.0059	0.0520
	(0.0338)	(0.1312)	(0.0151)	(0.0551)
NPL_{bt}	0.1689	-1.2730**	0.0189	0.1615
	(0.1338)	(0.5869)	(0.0243)	(0.1127)
cons	-5.3562	-81.0332	3.8276	-19.9505
	(10.9547)	(55.3546)	(2.8783)	(24.7610)
Bank Fixed Effects	Control	Control	Control	Control
Time Fixed Effects	Control	Control	Control	Control
Standard Errors	Robust	Robust	Robust	Robust
Bank Number	52	88	81	82
N	155	339	286	293
R^2	0.9428	0.8034	0.9941	0.8361

Note: The values in parentheses below the estimates are standard errors. *, **, *** respectively indicate significance at the 10%, 5%, and 1% levels.

The estimation results provide strong support for Hypothesis 1-a. The coefficient on $Large_i \times Post_t$ is positive and statistically significant in both column (1) and column (2), indicating that large banks, relative to their smaller counterparts, significantly expanded their wealth management operations and accelerated digital transformation following the introduction of Yu'E Bao, which indicates that our model's technology parameter ξ can be interpreted more broadly as enhancing banks' overall funding capacity rather than traditional deposits alone. The economic magnitude is substantial: large banks experienced a 71.1% increase in wealth

management income and an 11.5-point rise in their digital transformation index, aligning with our model that large banks are better positioned to adopt financial technology and develop innovative products due to their superior ability to absorb fixed adoption costs.

The negative and significant coefficients in columns (3) and (4) suggest that small banks experienced a relative increase in both personal deposits and time deposits compared to large banks. This is compatible with our model predictions that small banks' aggressive deposit-rate competition leads to a faster expansion in their deposit base. Collectively, these results reveal a clear divergence in banks' strategic responses to FinTech competition. Large banks leverage their technological advantage to expand into innovative business lines, whereas small banks intensify their deposit-taking competition to maintain market share.

5.2 The Deposit Rate Marketization Policy of 2015

Table 6 presents estimation results examining banks' heterogeneous responses to interest rate liberalization using Model 2. The significantly negative coefficient on $Large_i \times Post_t$ in Column (1) indicates that small banks averagely increased their deposit rates by 29 basis points more than large banks following the removal of rate ceilings (significant at the 1% level). This aggressive deposit pricing enabled small banks to expand their time deposits by 19.5% more than large banks, as shown in Column (2). Column (3) shows that small banks also increased their wealth management income more than large banks during this period. While this might seem at odds with our model's prediction that intensified inter-bank competition (higher c) reduces small banks' profits, it likely reflects small banks' strategic response: facing deposit rate liberalization, they not only competed more aggressively on deposit rates but also expanded wealth management business to diversify their funding sources and maintain overall competitiveness. This multi-channel strategy suggests that the impact of interest rate liberalization extends beyond the direct pricing effect captured in our theoretical framework.

Table 6: Regression Results of Deposit Rate Marketization

	(1)	(2)	(3)
	ADR	TDeposit	WMPR
$\text{Large}_b \times \text{POST}_t$	-0.2865***	-0.1949*	-0.7353*
	(0.0901)	(0.1072)	(0.0590)
SIZE_{bt}	-0.0118	0.2911	-0.4607
	(0.4117)	(0.2848)	(0.7176)
LIQ_{bt}	-0.0005	0.0016	-0.0094
	(0.0031)	(0.0024)	(0.1181)
CAP_{bt}	0.0518*	-0.0103	-0.0729
	(0.0281)	(0.0319)	(0.1509)
NPL_{bt}	-0.0142	0.0023	-0.1724
	(0.0524)	(0.0462)	(0.3359)
cons	1.9125	7.8595**	12.8387
	(5.1578)	(3.7576)	(0.4349)
Bank Fixed Effects	Control	Control	Control
Time Fixed Effects	Control	Control	Control
Standard Errors	Robust	Robust	Robust
Bank Number	98	85	68
N	288	236	186
R^2	0.6039	0.9163	0.9417

Overall, after the cap on deposit rates was lifted, competition among smaller banks significantly intensified; their average deposit rates increased notably, and they engaged in wealth management business. On the other hand, the policy had a relatively minor impact on larger banks, due to their certain monopolistic market positions; the nominal lifting of the cap did not fully stimulate deposit competition among larger banks. Additionally, implicit deposit rate ceilings have not been eliminated due to the presence of benchmark interest rates for loans and deposits, window guidance, and the dual-track financial system (Ji et al., 2016). The study also found that banks with a stronger deposit force significantly increased their wealth management business revenue after the marketization of interest rates, suggesting that the marketization policy propelled them to launch wealth management products to respond to

market competition.

Yi (2021) pointed out that marketization of interest rates should not only be "let go" but also "take shape." Due to market segmentation caused by the immaturity of financial markets and some fiscal and financial system issues, there are obstacles in "taking shape" and transmission of marketized rates, which is a significant contradiction in deepening the reform of interest rate marketization in China.

5.3 The Shadow Banking Regulatory Policy of 2017

Prior literature suggests that competition for wholesale funding is a key driver of shadow banking activities (Guo and Zhao, 2017). To examine how banks adjust their business strategies following the regulatory tightening of shadow banking, we estimate Model 3. The results in Table 7 reveal significant heterogeneity in banks' responses to the New Asset Management Rule. While the regulations effectively curtailed shadow banking activities across all banks, their strategic adjustments differ markedly by size. Large banks significantly accelerated their digital transformation initiatives. In contrast, small banks responded by raising deposit rates more aggressively and successfully expanded their traditional deposit base relative to large banks. These findings support Hypothesis 3-a, demonstrating how regulatory changes that simultaneously affect market-wide competition (b) and inter-bank competition (c) lead to divergent strategic responses between large and small banks.

Table 7: Regression Results of Wealth Management Business and Digital Transformation

	(1)	(2)	(3)	(4)
	WMPR	DTI	ADR	Deposit
$\text{Large}_b \times \text{POST}_t$	0.1385	12.7230***	-0.1629***	-0.0520**
	(0.1928)	(3.2463)	(0.0627)	(0.0212)
SIZE_{bt}	1.5912***	-26.1015**	-0.1775	0.7263***
	(0.5334)	(10.8040)	(0.2534)	(0.1023)
LIQ_{bt}	-0.0001	-0.0378	0.0002	-0.0002
	(0.0039)	(0.0751)	(0.0013)	(0.0004)
CAP_{bt}	-0.0004	0.5114	-0.0301*	-0.0142***
	(0.0305)	(0.5549)	(0.0165)	(0.0051)
NPL_{bt}	0.0186	-0.8208	0.0032	-0.0071*
	(0.0145)	(0.8730)	(0.0070)	(0.0040)
cons	-15.5151**	370.5937***	4.8832	3.2669**
	(6.8706)	(138.0563)	(3.2076)	(1.2887)
Bank Fixed Effects	Control	Control	Control	Control
Time Fixed Effects	Control	Control	Control	Control
Standard Errors	Robust	Robust	Robust	Robust
Bank Number	80	96	101	102
N	292	236	186	282
R^2	0.9433	0.7884	0.8140	0.9963

5.4 Robustness Checks

5.4.1 Use of Clustered Standard Errors

Considering that the three exogenous shocks examined in this paper (the launch of Yu'E Bao, the lifting of the cap on deposit rates, the implementation of the New Asset Management Rule) may have continuous effects over time on commercial banks' deposit business, this paper conducts robustness checks on the main regression results described earlier by further adopting clustered standard errors at the bank level. The regression results are shown in Table 8. The results reveal that while individual interaction term coefficients are no longer significant, the majority of the double interaction term coefficients remain significant, indicating that the main

regression results of this paper are robust.

Table 8: Regression Results with Bank Clustering Standard Errors

	(1)	(2)	(3)	
	$t = 2013$	$t = 2013$	$t = 2017$	
	$WMPR$	DTI	DTI	
$\text{Large}_b \times \text{POST}_t$	0.7112**	11.5038***	12.7230***	
	(0.3034)	(2.1088)	(3.1997)	
	(4)	(5)	(6)	(7)
	$t = 2013$	$t = 2013$	$t = 2015$	$t = 2015$
	$HDeposit$	$TDeposit$	$TDeposit$	$WMPR$
$\text{TREAT}_b \times \text{POST}_t$	-0.0866*	-0.3778*	-0.1949**	-0.7353*
	(0.0518)	(0.2046)	(0.0973)	(0.4145)

6 Heterogeneity Analysis

Our theoretical framework suggests that banks' strategic responses to financial reforms vary with both the intensity of FinTech penetration and the degree of market competition. To formally test these cross-sectional predictions, we extend our baseline analysis by examining how the main effects vary across different market environments. Specifically, we conduct subsample analyses based on measures of local FinTech penetration and banking market structure. This approach allows us to identify how the competitive environment shapes banks' responses to technological and regulatory changes.

6.1 Heterogeneity Analysis of the Impact of Yu'E Bao's Launch in 2013

To examine whether the impact of FinTech competition varies with local market conditions, we conduct subsample analyses based on regional Alipay penetration. Table 9 presents the heterogeneous effects, where we split the sample into high and low FinTech penetration regions based on the median level of Alipay usage. Columns (1) and (2) examine the digital transformation response. The coefficient on $\text{Large}_i \times \text{Post}_t$ is larger in magnitude in high-penetration regions (13.4017) compared to low-penetration regions (8.6419). This pattern supports our Hypothesis 1-b that large banks exhibit more intensive digital transformation initiatives in areas with stronger FinTech presence. Columns (3) and (4) reveal significant heterogeneity in deposit market responses. The negative coefficient on $\text{Large}_i \times \text{Post}_t$ is significant in high-penetration regions, indicating that small banks compete more aggressively for deposits in these markets.

Table 9: Regression Results of Alipay Penetration Heterogeneity

	(1) Low Payment Index	(2) High Payment Index	(3) Low Payment Index	(4) High Payment Index
	DTI	*DTI*	*TDeposit*	*TDeposit*
$\text{Large}_b \times \text{POST}_t$	8.6419***	13.4017***	-0.6512	-0.1177*
	(2.7179)	(2.3510)	(0.4690)	(0.0671)
SIZE_{bt}	4.6211	13.8023*	3.9771	0.4429
	(5.3344)	(7.2444)	(3.2575)	(0.2698)
LIQ_{bt}	0.0166	-0.0369	-0.0052	-0.0014
	(0.0735)	(0.0752)	(0.0130)	(0.0030)
CAP_{bt}	-0.2347	-0.4995***	0.2077	-0.0096
	(0.2768)	(0.1409)	(0.1735)	(0.0119)
NPL_{bt}	-1.0769*	-3.9038	0.2543	0.0080
	(0.5911)	(2.9798)	(0.1722)	(0.0857)
cons	-39.7032	-150.000	-38.1917	6.3113*
	(62.9939)	(95.3705)	(40.1082)	(3.5805)
Bank Fixed Effects	Control	Control	Control	Control
Time Fixed Effects	Control	Control	Control	Control
Standard Errors	Robust	Robust	Robust	Robust
Bank Number	40	48	37	45
N	149	190	120	173
R^2	0.5731	0.8276	0.4615	0.9940
t test	$p = 0.1853$		$p = 0.1538$	

6.2 Heterogeneity Analysis of the New Asset Management Regulation in 2017

To explore how the impact of shadow banking regulation varies with market structure, we examine the heterogeneous effects across regions with different levels of FinTech penetration and deposit market concentration. Table 10 presents estimates from subsample analyses.

Table 10: Regression Results of Heterogeneity in Alipay Penetration and Bank Deposit Concentration

	(1) Low Payment Index	(2) High Payment Index	(3) Low Deposit Concentration	(4) High Deposit Concentration
	DTI	*DTI*	*Deposit*	*Deposit*
$\text{Large}_b \times \text{POST}_t$	4.3498	18.9247***	-0.0002	-0.1081**
	(4.6083)	(4.9913)	(0.0220)	(0.0418)
SIZE_{bt}	-10.1632	-48.4982**	0.9845***	0.5579***
	(9.8481)	(20.7305)	(0.1598)	(0.1175)
LIQ_{bt}	0.1023	-0.3553**	-0.0004	-0.0001
	(0.0623)	(0.1553)	(0.0006)	(0.0005)
CAP_{bt}	-0.1018	2.8130*	-0.0087	-0.0172***
	(0.3291)	(1.6473)	(0.0055)	(0.0061)
NPL_{bt}	-0.4554	-15.3723**	-0.0047	-0.0015
	(0.5370)	(6.2316)	(0.0036)	(0.0149)
cons	148.3943	708.8808**	-0.1389	5.3345***
	(115.4244)	(287.9687)	(2.0734)	(1.4440)
Bank Fixed Effects	Control	Control	Control	Control
Time Fixed Effects	Control	Control	Control	Control
Standard Errors	Robust	Robust	Robust	Robust
Bank Number	45	51	53	49
N	130	150	204	188
R^2	0.6845	0.7882	0.9982	0.9946
t test	$p = 0.0319$		$p = 0.0224$	

The effect of regulation on banks' digital transformation exhibits significant heterogeneity across markets. The coefficient on $\text{Large}_i \times \text{Post}_t$ is positive and significant only in regions with high Alipay penetration, suggesting that large banks accelerate digital initiatives primarily where FinTech competition remains intense despite reduced shadow banking activities. This finding aligns with our theoretical prediction that the net effect of regulation depends on the relative strength of reduced market-wide competition (lower b) versus sustained competitive

pressure from alternative channels. The deposit market response also varies systematically with market structure. The negative coefficient on $\text{Large}_i \times \text{Post}_t$ is larger in magnitude and statistically significant only in highly concentrated markets. This pattern suggests that small banks' ability to compete through higher deposit rates following the regulatory shock is more pronounced in markets where they face less intense deposit competition. This heterogeneity provides empirical support for Hypothesis 3-b, demonstrating how the effectiveness of small banks' deposit-taking strategy depends on the relative changes in market-wide competition (b) and inter-bank competition (c) in local markets.

7 Conclusion

Under China's indirect financial system, commercial banks, as intermediaries of capital flow, play a significant role in the operation of the national economy. In recent years, against the backdrop of deepening financial reforms, Chinese commercial banks have continued to develop steadily. While maintaining overall robust business operations, they have actively embraced financial technology, driven digital transformation, and expanded diversified services, continually enhancing and innovating upon traditional financial services. Clarifying the internal factors and logic behind the adjustment and evolution of the business structure of Chinese commercial banks helps us to differentiate the business development strategies of various banks, thereby making policy formulation targeted and rational, focusing on regulatory priorities, and maintaining the healthy and stable development of the financial system.

This paper, based on comprehensive data from 107 commercial banks from 2011 to 2019, the Digital Transformation Index of Commercial Banks constructed by Peking University's Digital Finance Research Center, and the City-Level Digital Finance Usage Depth Index, explores the impact of rapid development in digital financial technologies, the marketization of deposit rates, and the New Asset Management Rule on commercial banks of different sizes. The study confirms that the rapid advancement of external digital financial technologies causes technological spillovers, pushing commercial banks to undergo digital transformation and launch shadow banking services to compete for funds. However, whether technological spillover can be realized depends largely on the learning capabilities and willingness of the commercial banks themselves, with larger banks facing intense market competition being better equipped and motivated to learn cutting-edge technologies. In contrast, smaller banks with less financial strength are more inclined to increase deposit rates to enhance their competitiveness in deposit channels, and thus, they are more sensitive to policies related to deposit rates.

The findings of this paper offer the following insights for commercial banks and policy-makers. First, commercial banks should not only pay attention to the competitive landscape within the banking industry but also to the competitive shocks from external financial technologies. Facing the rapid progress of digital financial technologies, commercial banks need to actively embrace the digital trend, combining their capabilities and market position to quickly adopt measures to compete for funds and minimize their impacts. Second, for policy-makers, the study shows that lifting the nominal cap on deposit rates has intensified the already fierce competition among smaller banks for deposits, while having a weaker policy effect on larger banks, which face less competitive pressure. This indicates that to further advance

the formation of marketized interest rates, China needs to provide more favorable conditions for deepening the reform of interest rate marketization. Third, competition from financial technologies and intense internal competition for deposits among banks have promoted the development of shadow banking activities, increasing the systemic risk of banks. In regulating shadow banking, regulatory focus should be placed on banks in intense market competition to maintain the stability and health of the financial system.

It should be noted that to avoid interference between shocks, this study is based only on short-panel data from two years before and after each shock, observing their short-term effects and considering only the evolution of bank deposit business. The long-term effects of each shock, or their impacts after further implementation and promotion, as well as the adjustments made by commercial banks on the asset side of their business under financial reform in China, and their impacts on the real economy, are directions for further in-depth research.

Appendix

Appendix A: Manually Collected Data Situation

To explore the evolution process of commercial banks' wealth management products and other shadow banking services, the author manually extracted data related to wealth management products from the annual and audit reports of 107 sample banks from 2011 to 2019. This includes the balances of non-principal-guaranteed wealth management products, principal-guaranteed wealth management products, total wealth management product balances, and fee income related to wealth management services. After 2014, the information disclosure of non-principal-guaranteed wealth management products by commercial banks is primarily located in the "Structured Entities not Consolidated" section, and principal-guaranteed wealth management products are accounted for within on-balance sheet deposit items and are not disclosed separately. Before 2014, due to the lack of specific disclosure requirements for off-balance-sheet operations such as wealth management products under Chinese accounting standards, data is largely missing, and some banks disclosed entrusted wealth management information under the off-balance "Entrusted Investments" item, where the balance of entrusted wealth management funds is equivalent to the balance of non-principal-guaranteed wealth management products. The balance of guaranteed return wealth management products was mainly disclosed under the "Other Liabilities" item. In addition, most commercial banks described the business conditions of asset management and wealth management services in the "Management Discussion and Analysis" section of the corporate annual report, involving information about various types of wealth management product balances and wealth management product business income. In manually extracting data, the author primarily extracted related variables from the aforementioned sections and, after considering the research objectives and the completeness of the sample data, selected the logarithm of the balance of non-principal-guaranteed wealth management products and the logarithm of fee income related to wealth management services as the dependent variables.

References

Acharya, V. V., J. Qian, Y. Su, Z. Yang, and others (2020): "In the shadow of banks: wealth management products and issuing banks' risks in China," Publisher: CEPR Discussion Paper No. DP14957. 6

Ahn, J.-H. and R. Breton (2014): "Securitization, competition and monitoring," *Journal of Banking & Finance*, 40, 195–210, publisher: Elsevier. 6

Barth, J. R., T. Li, W. Shi, and P. Xu (2015): "China's shadow banking sector: beneficial or harmful to economic growth?" *Journal of Financial Economic Policy*, 7, 421–445, publisher: Emerald Group Publishing Limited. 6

Berger, A. N. and T. H. Hannan (1998): "The efficiency cost of market power in the banking industry: A test of the "quiet life" and related hypotheses," *Review of economics and statistics*, 80, 454–465, publisher: MIT Press 238 Main St., Suite 500, Cambridge, MA 02142-1046, USA journals 6

Buchak, G., J. Hu, and S.-J. Wei (2021): "FinTech as a financial liberator," Tech. rep., National Bureau of Economic Research. 6

CBIRC (2020): "Joint Research Group of Two Departments at CBIRC," *Financial Regulation Research*, 1–23. 6, 12

Chen, K., J. Ren, and T. Zha (2018): "The nexus of monetary policy and shadow banking in China," *American Economic Review*, 108, 3891–3936, publisher: American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203. 6

Gao, B., X. Chen, and C. Li (2020): "Banking Property Rights Heterogeneity, Shadow Banking and the Effectiveness of Monetary Policy," *Economic Research Journal*, 55, 53–69. 6

Guo, Y. and J. Zhao (2017): "Deposit Competition, Shadow Banking and Bank Systemic Risk:Evidence from the Listed Banks in China," *Journal of Financial Research*, 81–94. 6, 14, 23

Hicks, J. R. (1935): "Annual survey of economic theory: the theory of monopoly," *Econometrica: Journal of the Econometric Society*, 1–20, publisher: JSTOR. 6

Hong, Y. and S. Wang (2021): "How Is Big Data Changing Economic Research Paradigms?" *Journal of Management World*, 37, 40–55+72+56. 12

Huang, Y. and Z. Huang (2018): "The Development of Digital Finance in China: Present and Future," *China Economic Quarterly*, 17, 1489–1502. 2, 5, 6

Ji, Y., Y. Tan, and Y. Huang (2016): "Dual-track Financing System and Interest ate Marketization in China," *Economic Research Journal*, 51, 45–57. 22

Koetter, M., J. W. Kolari, and L. Spierdijk (2012): "Enjoying the quiet life under deregulation? Evidence from adjusted Lerner indices for US banks," *Review of Economics and Statistics*, 94, 462–480, publisher: The MIT Press. 6

Kutzbach, M. J. and J. Pogach (2024): "Financial technology and relationship lending: Complements or substitutes?" *Journal of Financial Intermediation*, 59, 101101. 8

Li, W. (2019): "Economics of China's Shadow Banking:Definition, Composition, and Measurement," *Journal of Financial Research*, 53–73. 2

Matutes, C. and X. Vives (2000): "Imperfect competition, risk taking, and regulation in banking," *European economic review*, 44, 1–34. 2, 7

Puri, M., Y. Qian, and X. Zheng (2024): "From Competitors to Partners: Banks' Venture Investments in Fintech," *Available at SSRN*. 8

Qiu, H., Y. Huang, and Y. Ji (2018): "How does FinTech Development Affect Traditional Banking in China? The Perspective of Online Wealth Management Products," *Journal of Financial Research*, 17–29. 2, 6, 12

Shen, Y. and P. Guo (2015): "Internet Finance, Technology Spillover and Commercial Banks TFP," *Journal*

of Financial Research, 160–175. 6

Wang, H., H. Wang, L. Wang, and H. Zhou (2019): "Shadow banking: China's dual-track interest rate liberalization," *Available at SSRN 2606081*. 6

Xie, K., Z. Xia, and J. Xiao (2020): "The Enterprise Realization Mechanism of Big Data Becoming a Real Production Factor: From the Product Innovation Perspective," *China Industrial Economics*, 42–60. 12

Xie, X. and S. Wang (2022): "Digital Transformation of Commercial Banks in China: Measurement, Progress and Impact," *China Economic Quarterly*, 22, 1937–1956. 3

Xie, Z., X. Zhao, and Y. Liu (2018): "Fin-tech Driving and Strategic Digitization Transformation of Commercial Banks," *China Soft Science*, 184–192. 7, 14

Yi, G. (2009): "On the Market-based Interest Rate Reform," *Journal of Financial Research*, 1–14. 5, 12

——— (2020): "Revisiting China's Financial Asset Structure and Policy Implications," *Economic Research Journal*, 55, 4–17. 5, 12

——— (2021): "China's Interest Rate System and Market-Based Reform of Interest Rate," *Journal of Financial Research*, 1–11. 2, 5, 12, 23

Yi, G. and W. Song (2008): "The Evolution of China's Financial Assets Structure:1991—2007," *Economic Research Journal*, 4–15. 5

Zhan, M., C. Zhang, and J. Shen (2018): "Development of Internet Finance and the Bank Lending Transmit Channel of Monetary Policy," *Economic Research Journal*, 53, 63–76. 12

Zhang, L. and J. Chen (2023): "Local Government Financing,Regulatory Arbitrage and the Rise of China's Shadow Banking," *Nankai Economic Studies*, 143–162. 6

Zhu, J., S. Hu, and Z. Lu (2016): "The Causes and Economic Consequences of Commercial Banks' Engagement in Shadow Banking: From the Perspective of Outflow of Capital in Shadow Banking," *Journal of Financial Research*, 66–82. 6

Zhu, M., F. Ye, Q. Zhao, and Y. Wang (2012): "Regulation of Shadow Banking System——Analysis Based on a Model of Optimal Capital Regulation," *Studies of International Finance*, 49–57. 6