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Technology, regulation, and the transformation of bank deposit business in China☆

Xinyu Ge [a], Yan Liu [b,*], Yutong Yang [c]

[a] Business School, Soochow University, China
[b] Business School, Sun Yat-sen University, China
[c] National School of Development, Peking University, China

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ABSTRACT

During the past decade, technology innovations and regulatory reforms have been swiftly transforming deposit business in China's banking sector. To understand the 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. The paper then systematically examines 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, 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 engage in more aggressive deposit rate competition in less concentrated markets. Our findings provide a comprehensive account of the evolution in the banking sector, with various policy implications in navigating the ever-evolving financial landscape in China.

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, three major events have reshaped China's banking deposit market: first, the digitalization of banks has significantly improved, with FinTech innovations like Yu'E Bao disrupting traditional deposit collection methods and forcing banks to upgrade their deposit business through digital technologies; second, the removal of deposit rate ceilings in 2015, have intensified competition among banks and fundamentally transformed the deposit business landscape; third, the implementation of the new asset management regulation in 2017 has redirected funds back to traditional deposits by constraining shadow banking activities.

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* Corresponding author.
E-mail addresses: gexinyu@suda.edu.cn (X. Ge), liuy2696@sysu.edu.cn (Y. Liu), ytyang2022@nsd.pku.edu.cn (Y. Yang).

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Concurrently, mobile banking, digital branches, and internet lending, along with other digital financial technologies, are now widely used in various financial services.

On the one hand, 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%.[1] The monthly year-on-year growth rate even exceeded 80% at its peak. By launching wealth management products (WMPs) and other shadow banking businesses, commercial banks have effectively enhanced their funding competitiveness, though this came at the cost of reduced traditional deposit shares. On the other hand, since 2013, there was a rapid development of financial technology. Yu'E Bao and other emerging tools have gradually changed people's wealth management habits and promoted the digital transformation of China's commercial banks (Huang & Huang, 2018; Qiu et al., 2018). Understanding how banks respond to these three interconnected shocks—FinTech competition, deposit rate liberalization, and regulatory tightening—is crucial for comprehending the transformation of China's banking deposit business. Fig. 1 displays the trend and differences in innovative business and deposit structures of Chinese commercial banks in recent years.[2]

This paper investigates how commercial banks have responded to the technological progresses and regulatory reforms witnessed in the last decade, and in particular, focuses on the transformation of the deposit business of the banking sector. 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 the bank deposit business in China, with far reaching implications on the evolution of the banking sector and the macroeconomy. To give a comprehensive account of the changes in the bank deposit business, we examine three critical events: (1) the emergence of Yu'E Bao in 2013, marking the rapid advance of China's FinTech frontier; (2) the deposit rate ceiling liberalization in 2015, accomplishing the final step of the gradual interest rate marketization; and (3) the implementation of the new asset management regulation in 2017, putting a break to the explosive expansion of shadow banking in the prior decade.

By analyzing these sequence of shocks, we reveal a pattern of differentiated responses between large and small banks, where large banks leveraged their substantial capabilities to develop innovative business lines in response to external shocks, yet small banks embrace a more traditional approach of banking. This research contributes to understanding the strategic evolution of banking business models under regulatory reforms and technological disruption, offering insights for policymakers seeking to promote sustainable development across the banking sector while maintaining financial stability. Our findings highlight how regulatory changes catalyze business model innovation and how banks' adaptive capacities vary with their size and market positioning.

In this paper, we first develop a theoretical model that extends the framework of Matutes and Vives (2000) by incorporating bank size heterogeneity and wealth management business 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 is on analyzing the optimal strategies of large and small banks, and how these strategies are influenced by competition from non-banking financial institutions and regulatory changes.

The model yields several key conclusions. Small banks tend to set higher deposit rates compared to large banks, due to their disadvantage in market position. Competition from FinTech sectors firstly promotes large banks to engage in innovative channels. And their superior profitability enables them to adopt financial technology more readily, which further expands their funding capacity. In contrast, small banks keep focusing on deposit rate competition in the first stage. These responses highlight how bank size heterogeneity shapes strategic reactions to changes in the external market conditions.

To test our model predictions empirically, we focus on three aspects of deposit business: (1) traditional deposit business, (2) wealth management products that divert deposit funds to the off-balance-sheet business, and (3) digital technologies that aid in the innovation and upgrading of deposit business. We utilize panel data from 107 Chinese commercial banks spanning 2011–2014, 2014–2016, and 2016–2019 in sequel, exploiting three quasi-natural experiments, i.e., the launch of Yu'E Bao, deposit rate liberalization, and the new asset management regulation, respectively. Our empirical results reveal 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 intensified competition among banks, forcing small banks to raise deposit rates while simultaneously expanding their innovative business lines. After the implementation of the new asset management regulation, with shadow banking business being restricted, large banks further invested in 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.

Our contribution is threefold. First, by systematically analyzing the factors driving banks' deposit business from 2011 to 2019, the paper provides a more comprehensive and accurate understanding of the evolution of bank deposit business, the defining business of banking, in China. Second, through comprehensive regression analyses, the findings deepen our understanding of how different factors interact and shape banks' business choices. In particular, our results highlight that the responses of banks are size dependent: large banks have the necessary resources to invest in FinTech to circumvent the competition, whereas small banks have less choice but compete more aggressively. Third, deposit rate marketization is likely to have far-reaching implications for China's financial landscape and monetary policy environment. By intensifying deposit competition of the banking sector, more product innovations and advances in FinTech will emerge in the near future, posing both opportunities and challenges to the financial regulation and monetary authorities.

[1] CBIRC (2020) provides another set of statistics about the sizes of China's shadow banking sector, based on different methodologies. However, both results are in line with each other in terms of magnitudes and trends.

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

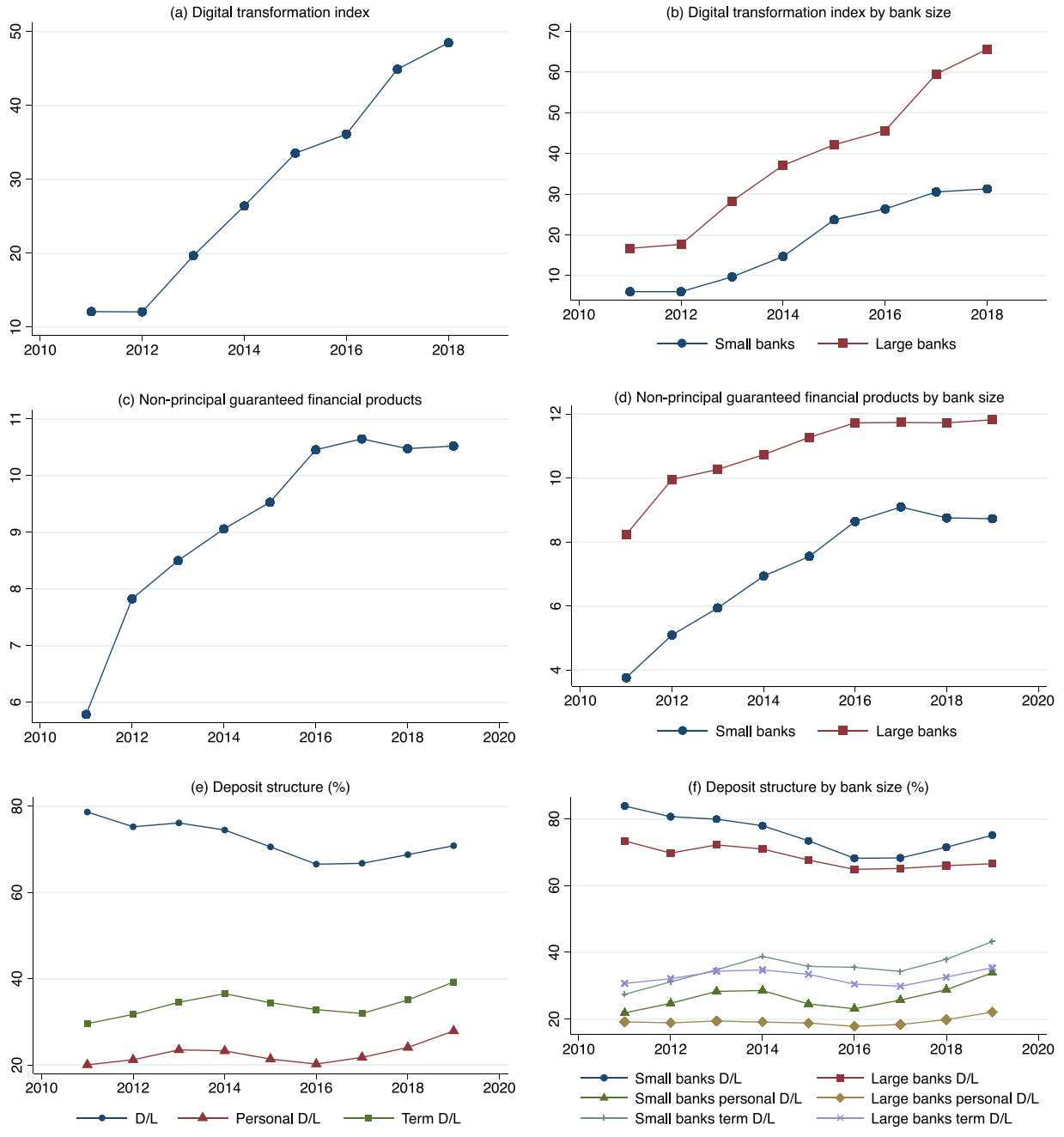

Fig. 1. Trend in DTI, Non-principal Guaranteed Financial Products and Deposit Structures of Chinese Commercial Banks.
Notes: In panel (c) and panel (d), the size of non-principal guaranteed financial products is presented in logarithmic form. In panel (e) and panel (f), D/L represents the ratio of deposits to total liabilities for each bank.
Data source: China Commercial Bank Digital Transformation Index Xie and Wang (2022), China Banking Database.

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

The global banking sector has undergone tectonic shifts through digital disruption, regulatory reforms, and funding structure changes. Deposits have always been the main source of funds for banks, and studies have shown that larger deposit bases enhanced bank performance (García-Herrero et al., 2009). Moreover, Chang et al. (2010) found that deposits positively correlate with regional economic growth in China during 1991–2005. While FinTech innovations since the 2010s have compressed traditional banks' net interest margins globally (Buchak et al., 2025), China's transformation presents unique institutional dynamics. Emerging from a Soviet-style mono-bank system, its banking evolution progressed through three phases: commercialization (1978–1994), partial privatization (1994–2008), and post-WTO modernization marked by geographic and operational constraints on foreign banks gradually lifted and shadow banking expansion (Berger et al., 2009; Fu & Heffernan, 2009; Xu, 2011). In the process, we 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 (Yi, 2009). A relatively complete marketized interest rate system has promoted the market-oriented development of commercial bank business (Yi, 2021). This duality of global convergence and institutional specificity frames our analysis of deposit business transformation.

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 developed rapidly, diversifying investment channels and leading to a shift in residents' asset allocations away from traditional bank deposits (Hachem, 2018; Yi, 2020; Yi & Song, 2008). Unlike western systems where capital markets dominate, China's bank-centric structure creates "shadow banking with Chinese characteristics" — regulatory arbitrage activities deeply embedded within commercial banks (CBIRC, 2020). Researches highlight how regulatory and competitive forces shape banks' business strategies. Firstly, with tighter liquidity regulation constraints, such as the strict enforcement of the 75% loan-to-deposit ratio (LDR) cap around 2008, Chinese banks began to engage in shadow banking activities such as issuing off-balance-sheet wealth management products (Allen et al., 2019; Barth et al., 2015; Chen et al., 2018; Guo & Zhao, 2017; Hachem & Song, 2021). A second reason for the rise of shadow banking is the role of local government financing needs, especially following the 2008–2010 stimulus plan (Acharya et al., 2025; Chen et al., 2018; Zhang & Chen, 2023; Zhang & Tsai, 2024; Zhu, 2021). Particularly relevant to our study is the competitive channel: intense deposit market competition drives banks toward shadow banking activities from traditional business (Ahn & Breton, 2014; Guo & Zhao, 2017), while market concentration may also affect bank efficiency and rent-seeking behavior (Berger & Hannan, 1998; Hicks, 1935; Koetter et al., 2012). As for its impact, 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.

Moving to recent years, China's FinTech development, marked by the launch of Yu'E Bao in 2013, has fundamentally transformed the financial landscape and banking business models. FinTech, broadly defined, encompasses the meaning of using digital technology to promote financial innovation and realize new financial business models in financing, payment, and investment (Huang & Huang, 2018). Studies document that FinTech competition affects banks through multiple channels: promoting digital transformation and improving operational efficiency (Huang & Huang, 2018; Shen & Guo, 2015), altering funding structure toward wholesale funding (Qiu et al., 2018), and driving innovation in wealth management products (Buchak et al., 2025). Particularly, Buchak et al. (2025) 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. Zhu and Lu (2023) systematically analyze how FinTech competition in China's deposit market affects banks' deposit demand and monetary policy transmission effectiveness, documenting that banks' strategic adjustments (e.g., innovative deposit products and deposit rate responses under interest rate liberalization) weaken the transmission of contractionary monetary policy. Recent evidence from Elekdag et al. (2025) provides a global perspective, documenting that increased FinTech presence correlates with heightened risk-taking by financial institutions, with moderation effects from institutional and regulatory frameworks.

Additionally, the literature documents significant heterogeneity in Chinese banks' strategic responses to external shocks, fundamentally shaped by their institutional characteristics and market positioning. Large state-owned banks primarily serve state-owned enterprises, while joint-stock banks operate nationally and city commercial banks focus on local markets with stronger SME orientation (Chong et al., 2013). This differentiation manifests in their responses to various challenges. Facing FinTech shocks, large banks significantly increase software IT investment while small banks maintain relationship-based approaches (He et al., 2022). Similarly, banks adopt distinct wealth management strategies. Large joint-stock banks are more aggressive in issuing wealth management products as a differentiation strategy, due to their competitive disadvantage in attracting traditional deposits, while state-owned banks with extensive branch networks issue fewer WMPs, mainly in response to competitive pressures (Wang et al., 2022). For large banks with poor asset quality, WMPs have also become an innovative tool for disposing of non-performing assets (Luo et al., 2019). These findings underscore how institutional features and strategic positioning crucially determine Chinese banks' evolutionary paths amid external challenges.

Building on this literature of heterogeneous responses of banks, we focus specifically on how banks' learning capabilities and financial strength shape their strategic responses to market competition. Bank size serves as a crucial proxy for these capabilities, influencing banks' ability to adopt cutting-edge technology and determine their development trajectory. Existing research provides preliminary evidence for this capability-driven differentiation: Zhu et al. (2016) documents that larger banks engage in greater scales of shadow banking business, while Shen and Guo (2015) demonstrates that technology spillovers from internet finance vary significantly based on banks' learning capabilities, which relate to their scale, organizational structure, and prior knowledge.

Furthermore, through case studies, Xie et al. (2018) confirms that banks with different asset scales and financial strengths adopt distinct transformation strategies in response to FinTech shocks. Using data from 107 Chinese commercial banks from 2011–2019, our study extends this line of inquiry by examining how banks of varying capabilities differentially respond to competitive pressures — with larger, more capable banks pursuing digital transformation and shadow banking business, while smaller banks rely more heavily on traditional deposit rate competition.

3. A model of bank deposit competition

3.1. Setup

This paper builds on the framework of Matutes and Vives (2000), extending it by incorporating bank size heterogeneity and wealth management products business. In this model, there are two types of banks: a large bank that acts as a monopolist and small banks that follow. The model spans three stages, corresponding to three representative shocks that have a significant impact on commercial banking business: Stage 1, FinTech shock (introduction of Yu'E Bao); stage 2, deposit rate marketization (deposit rate ceiling removal); and stage 3, the implementation of the new asset management regulation. The key distinction between large and small banks lies in their inherent market power, technological capabilities, and competitive responses. Investors, upon observing the interest rates offered by banks, decide how much to deposit in each bank, denoted by S_i, and how much to invest in WMPs, denoted by W_i. Investors are assumed to be risk-neutral, with a utility function that is linear in income.

3.1.1. Benchmark market environment

Prior to the introduction of Yu'E Bao, banks face the following deposit supply functions. For large bank,

$$S_B^0 = a_B + b_0 \cdot r_B - e \cdot w_B,$$

and for small bank:

$$S_S^0 = a_S + b_0 \cdot r_S - c \cdot r_B - e \cdot w_S.$$

Parameters of the supply functions satisfy the following restrictions.

Assumption 1. Deposit supply functions satisfy $b_0 > c > 0$, $a_B > a_S$, $e > 0$.

The restrictions have the following intuitive interpretations. First, 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. Indeed, 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. Moreover, b_0 stands for the elasticity of bank deposit supply with respect to its own interest rate, the magnitude of which also represents the overall degree of competition of the entire banking system. Lastly, c represents the impact of large bank deposit rates on small banks. Note that small bank deposit rate does not affect the deposit supply for the large bank. As mentioned before, large banks dominate small banks in deposit market country wide.[3]

Wealth management product supply functions are as follows. For large bank,

$$W_B^0 = \gamma \cdot w_B - \delta \cdot r_B - \mu \cdot w_S,$$

and for small bank,

$$W_S^0 = \gamma \cdot w_S - \delta \cdot r_S - \mu \cdot w_B.$$

Parameters of the supply functions satisfy the following restrictions.

Assumption 2. WMP supply function parameters satisfy $\mu > 0$, $\delta > 0$ and $\gamma > b_0$.

Analogous to the deposit supply functions, here μ reflects the cross-competition in WMPs, e relates to the internal substitution between deposits and WMPs, and $\gamma > b_0$ because that WMPs have higher interest rate sensitivity comparing with deposits.

[3] This does not mean small banks have no competitive edge over large banks. Indeed, if the focus is local bank market, say in the city level, then small local banks may enjoy a greater market share than large country wide banks. However, the assumption here is for the banking system over the entire country.

3.1.2. Introducing the FinTech shock

After the introduction of Yu'E Bao, the market environment changes as follows. h and p represent the impact of Yu'E Bao on deposits and WMPs respectively, where $h = p = 0$ before the shock and $h, p > 0$ after. Similarly, $b = b_0$ before the shock and $b > b_0$ after, reflecting intensified competition. Large banks face deposit supply

$$S_B = a_B + b \cdot r_B - e \cdot w_B - h \cdot r_e,$$

and small banks face deposit supply

$$S_S = a_S + b \cdot r_S - c \cdot r_B - e \cdot w_S - h \cdot r_e.$$

And for WMPs, large banks' supply function follows

$$W_B = \gamma \cdot w_B - \delta \cdot r_B - \mu \cdot w_S - p \cdot r_e,$$

while small banks' supply function follows

$$W_S = \gamma \cdot w_S - \delta \cdot r_S - \mu \cdot w_B - p \cdot r_e,$$

where r_e is the Yu'E Bao yield, which is exogenously determined.

3.1.3. Deposit rate regulation

The first major regulation we are concerned with is the deposit rate regulation. China has gradually removed tight control on the deposit rates for banks, and came to a full marketization of deposit rates only after 2015, when banks were allowed to set their deposit rates independently up to some prudential checks.[4]

Assumption 3. There is a deposit rate ceiling in stage 1 and 2, i.e., $r_i \leq \bar{r}$. After the new asset management regulation, the wealth management product constraint is effective, i.e., $w_i \leq r_i + \eta$.

3.1.4. Bank profit functions

Each bank's total profit consists of deposit business and wealth management business components:

$$\Pi_i = S_i \cdot (R_l - r_i) + W_i \cdot (R_h - w_i - C_i),$$

where R_l and R_h represent asset return rate corresponding to deposits and WMPs respectively, which we assume to be certain for simplicity. We also assume $R_h > R_l$ as wealth management products typically invest in higher-risk business activities. C_i is the additional cost for issuing WMPs, varying across banks.

Assumption 4. In stage 1, $C_B = C_1$, $C_S = C_1 + \Delta$, where $\Delta > 0$ and large enough to prevent small banks from offering wealth management products. While in stage 3 (after the new asset management rule), $C_B = C_S = C_2 > C_1$, where regulatory costs increase.

3.1.5. FinTech adoption decision

In addition to the benchmark market environment featuring deposit and WMPs, banks also need to make strategic decisions regarding financial technology adoption. Recent studies by Kutzbach and Pogach (2024) and 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 profits, 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:

$$\widetilde{\Pi}_i = (1 + \xi)\Pi_i - f = (1 + \xi)[S_i \cdot (R_l - r_i) + W_i \cdot (R_h - w_i - C_i)] - f.$$

[4] Although banks are required to obey the so called self-discipline mechanism in deposit pricing monitored by China Banking Association, which in turn is guided by the central bank, the pricing behavior of banks does change significantly since one bank can always choose to undercut other banks, as long as the deposit rate can be chosen by banks within a range, no matter how small it is.

3.2. Theoretical analysis of the three external shocks

3.2.1. FinTech shock as the introduction of yu'e bao

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 & 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 (Qiu et al., 2018; Zhan et al., 2018).

Proposition 1 (*Heterogeneous Bank Responses to FinTech Shock*)**.** *Under the FinTech shock introduced by Yu'E Bao, when a deposit rate ceiling $r_i \le \bar{r}$ exists and the wealth management cost differential Δ is sufficiently large, we have:*

1. *Large banks are more likely than small banks to adopt financial technology;*
2. *Large banks respond by offering wealth management products, while small banks primarily compete through higher deposit rates, leading to their deposit business showing higher sensitivity to the shock;*
3. *In areas with higher FinTech penetration (higher pressure from the non-banking sector), large banks exhibit more intensive digital transformation initiatives, while small banks respond through offering higher deposit rates to increase their deposit base.*

Proof. We first analyze the optimal decisions of banks and then compare the changes before and after the Yu'E Bao shock.

(1) Large banks are more likely to adopt financial technology

The condition for bank i to adopt FinTech is $\xi \Pi_i^* > f$. Based on the profit function after the Yu'E Bao shock, we can solve for the optimal decisions and corresponding profits of large and small banks.

The optimization problem for large banks is the following:

$$\max_{r_B, w_B} \Pi_B = S_B(R_l - r_B) + W_B(R_h - w_B - C_1) \quad \text{s.t.} \quad r_B \le \bar{r}.$$

Assuming the constraint is non-binding, the first-order conditions are

$$\frac{\partial \Pi_B}{\partial r_B} = bR_l - 2br_B - a_B + ew_B + hr_e - \delta R_h + \delta w_B + \delta C_1 = 0$$
$$\frac{\partial \Pi_B}{\partial w_B} = -eR_l + er_B + \gamma R_h - 2\gamma w_B - \gamma C_1 + \delta r_B + \mu w_S + pr_e = 0$$

Small banks, due to sufficiently large Δ, do not offer wealth management products ($W_S = 0$), and their optimization problem is:

$$\max_{r_S} \Pi_S = S_S(R_l - r_S) \quad \text{s.t.} \quad r_S \le \bar{r}.$$

The first-order condition is:

$$\frac{\partial \Pi_S}{\partial r_S} = bR_l - 2br_S - a_S + cr_B + hr_e = 0.$$

Solving these first-order conditions yields the optimal rates r_B^*, w_B^*, and r_S^*. From the second first-order condition for large banks, we have

$$w_B^* = \frac{\gamma R_h - \gamma C_1 + er_B - eR_l + \delta r_B + pr_e}{2\gamma}.$$

Substituting this into the profit functions, we can prove that $\Pi_B^* > \Pi_S^*$. This is because large banks have both deposit business advantages ($a_B > a_S$) and wealth management business ($W_B > 0, W_S = 0$). Therefore, under the same ξ and f, $\xi \Pi_B^* > \xi \Pi_S^*$, indicating that large banks are more likely to meet the FinTech adoption condition $\xi \Pi_i^* > f$.

(2) Large banks offer WMPs, while small banks focus on competing in deposits

From the solution above, large banks offer WMPs with yield $w_B^* > 0$, while small banks do not offer WMPs due to high costs. Therefore, large banks can adjust their wealth management product rates w_B to partially absorb the competitive pressure from Yu'E Bao, while small banks must focus solely on raising deposit rates. Moreover, small banks must respond not only to Yu'E Bao but also to large banks' adjusted rates, creating a compounding effect. The combination of these factors leads to that small banks are more likely to reach the deposit rate ceiling $\bar{r}$. □

3.2.2. Deposit rate marketization policy shock

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.

Proposition 2 (*Effects of Deposit Rate Ceiling Removal*)**.** *As deposit interest rate liberalization progresses and the cost differential in issuing WMPs between banks narrows, small banks gradually gain the ability to offer competitive WMPs.*

1. *Small banks increase deposit rates more significantly than large banks*
2. *Small banks begin to increase their market share in wealth management products, while their reliance on deposit business remains higher than that of large banks*

Proof. 1 Small banks increase deposit rates more.

Before the deposit rate ceiling is removed, if the constraint is binding, then $r_B^* = r_S^* = \bar{r}$. After removal, the optimal deposit rate is derived from the first-order condition. Solving for $r_B^\star$ and $r_S^\star$, we have

$$r_B^\star = \frac{bR_l - a_B + ew_B^\star + hr_e - \delta R_h + \delta w_B^\star + \delta C_1}{2b},$$
$$r_S^\star = \frac{bR_l - a_S + cr_B^\star + ew_S^\star + hr_e - \delta R_h + \delta w_S^\star + \delta C_S}{2b}.$$

Comparing the two rates, there is

$$r_S^\star - r_B^\star = \frac{a_B - a_S + cr_B^\star + e(w_S^\star - w_B^\star) + \delta(w_S^\star - w_B^\star) + \delta(C_S - C_1)}{2b}.$$

The first term $(a_B - a_S) > 0$ and the second term $cr_B^\star > 0$. The wealth management terms may be negative since typically $w_B^\star > w_S^\star$ due to $C_S > C_1$. However, when c or $(a_B - a_S)$ is sufficiently large (the large bank has sufficient monopoly power), the overall expression is positive, proving $r_S^\star > r_B^\star$. This demonstrates that small banks increase deposit rates more significantly than large banks.

(2) Small banks' choice in wealth management products.

Small banks now offer wealth management products with optimal yield:

$$w_S^\star = \frac{-eR_l + er_S^\star + \gamma R_h - \gamma C_S - \mu w_B^\star - pr_e + \delta r_S^\star}{2\gamma}.$$

Since small banks' wealth management business expands from zero in the first stage to positive in the second stage, their relative increase in wealth management income is proportionally larger than that of large banks. This represents a strategic expansion into a new business line for small banks, despite their continued focus on deposit-based competition. □

3.2.3. The new asset management regulation shock

The introduction of the Guiding Opinions on Standardizing the Asset Management Business of Financial Institutions (the new asset management regulation) 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.

Proposition 3 (*Impact of the new asset management regulation*)**.** *After the implementation of the new asset management regulation, when wealth management product costs increase* $(C_B = C_S = C_2 > C_1)$ *and a new constraint* $(w_i \le r_i + \eta)$ *is added*

1. *Competition from non-banking sectors weakens (b decreases), the deposit rate differential between small and large banks further widens, and the deposit size gap between large and small banks narrows*
2. *Market structure transforms: with wealth management yields decreasing, total wealth management product size shrinks, bank deposit size expands*

Proof. Due to increased wealth management costs and decreased yields, the total size of wealth management products shrinks. Simultaneously, funds flow to the deposit market, expanding bank deposit size. Small banks, facing more pronounced disadvantages in the wealth management market, further emphasize deposit competition.

We utilize the implicit function theorem. Under new asset management rules, with the binding constraint $w_i = r_i + \eta$, the first-order conditions for profit maximization are:

$$\frac{\partial \Pi_B}{\partial r_B} = -S_B + (R_l - r_B)(b - e) - W_B + (R_h - r_B - \eta - C_2)(\gamma - \delta) = 0,$$
$$\frac{\partial \Pi_S}{\partial r_S} = -S_S + (R_l - r_S)(b - e) - W_S + (R_h - r_S - \eta - C_2)(\gamma - \delta) = 0.$$

Taking the partial derivative of these conditions with respect to b yields

$$\frac{\partial^2 \Pi_B}{\partial r_B \partial b} = (R_l - r_B),$$
$$\frac{\partial^2 \Pi_S}{\partial r_S \partial b} = (R_l - r_S).$$

The second-order conditions are:

$$\frac{\partial^2 \Pi_B}{\partial r_B^2} = -2(b - e) - 2(\gamma - \delta),$$

Table 1
Overview of the sample for banks.

Panel A: Distribution by Bank Types			
Type	National Banks	Joint-stock Banks	City Commercial Banks
Number	5	12	90

Panel B: Distribution 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.

$$\frac{\partial^2 \Pi_S}{\partial r_S^2} = -2(b-e) - 2(\gamma - \delta).$$

By the implicit function theorem, we obtain

$$\frac{\partial r_B^\dagger}{\partial b} = \frac{R_l - r_B^\dagger}{2(b-e) + 2(\gamma - \delta)},$$
$$\frac{\partial r_S^\dagger}{\partial b} = \frac{R_l - r_S^\dagger}{2(b-e) + 2(\gamma - \delta)}.$$

Therefore

$$\frac{\partial (r_B^\dagger - r_S^\dagger)}{\partial b} = \frac{r_S^\dagger - r_B^\dagger}{2(b-e) + 2(\gamma - \delta)}.$$

Since $r_S^\dagger > r_B^\dagger$ and the denominator is positive under normal conditions, we have $\frac{\partial (r_B^\dagger - r_S^\dagger)}{\partial b} < 0$, or equivalently, $\frac{\partial (r_S^\dagger - r_B^\dagger)}{\partial b} > 0$. This indicates that when b decreases (banking competition weakens), the deposit rate differential widens. Thus the deposit size gap between large and small banks narrows correspondingly. □

4. Data and empirical specifications

4.1. Data

4.1.1. Data sample

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. We employ short panel regressions to isolate the effects of each shock, preventing potential confounding influences between different events and yielding more precise estimates. Our primary focus is on examining the immediate adjustments in commercial banks' business structures following each shock.

Bank level data mainly come from China Banking Database, a recently available comprehensive database for Chinese banking sector.[5] Moreover, we manually collect and compile data related to banks' wealth management products as dependent variables; specific data collection details are provided in Appendix. Data on banks' deposit business such as interest expenses on deposits, liability scales and characteristic data of commercial banks such as total assets, liquidity ratios, capital adequacy rates, and non-performing loan rates are all extracted from the CBD core data tables. Missing data are supplemented from commercial banks' annual reports, audit reports, and credit assessment reports. Our final sample consists of annual data of 107 commercial banks. An overview of the sample coverage is provided in Table 1.[6]

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 & Wang, 2022). This index 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.

[5] See, e.g. Dai et al. (2024) and Ge et al. (2023) for more information on the database. An overview of the database is also available in the following link: https://www.liuyanecon.com/data/.

[6] The sample size is primarily constrained by the availability and quality of wealth management product data for individual banks, which are off-balance-sheet activities disclosed in bank annual reports with varying completeness.

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 et al., 2020). 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

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. Following Ge et al. (2023) and Liu and Wang (2024), we construct the market concentration measures at the city level. Specifically, $HHID$ is constructed as follows:

$$HHID_{it} = \sum_{p} \frac{NB_{itp}}{NB_{it}} \times \sum_{i} \left(\frac{D_{itp}}{D_{tp}} \right)^2,$$

$$D_{itp} = \frac{NB_{itp}}{NB_{it}} \times D_{it}, \quad D_{tp} = \sum_{i} D_{itp},$$

where i denotes the ith bank, t denotes the year t, and p denotes the pth city; NB represents the number of bank branches, and D represents deposits. This HHI-based measure effectively captures the degree of banking concentration in local markets.

4.1.3. Large versus small banks

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 categories: large and small, based on their asset size in the year prior to each shock. Specifically, for each of the three shocks in our study, we use the median of total assets from the year immediately preceding the shock as the cutoff point. Banks with total assets above the median are classified as large banks, while those below the median are classified as small banks. This classification method 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. We select 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 2.

4.2.2. Empirical specification

Based on the research questions, this paper designs a unified short-panel regression to examine how banks with different sizes respond to three main shocks. For each exogenous shock, the regression primarily tests 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 baseline regression is specified as follows:

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

where b denotes bank and t denotes 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 the year preceding each shock. $POST_t$ represents a time dummy variable indicating periods after each shock occurred.

[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.

Table 2
Variable definition.

Variable	Description	Measurement
$HDeposit$	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 and Wang (2022)
MTI	Management Transformation Index for Commercial Banks	Xie and Wang (2022)
$Payment$	Payment Index under China's Digital Financial Usage Depth Index	Guo et al. (2020)
$HHID$	Bank Deposit Concentration	$\mathrm{HHID}_{it} = \sum_p \left(\frac{\mathrm{NB}_{itp}}{\mathrm{NB}_{it}} \times \sum_i \left(\frac{D_{itp}}{D_{tp}} \right)^2 \right)$
MSD	Bank Deposit Market Power	$\mathrm{MSD}_{it} = \sum_p \left(\frac{\mathrm{NB}_{itp}}{\mathrm{NB}_{it}} \times \frac{D_{itp}}{D_{tp}} \right)$
$Large_b$	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

$Large_b \times POST_t$ is the interaction term of $Large_b$ and $POST_t$, and its coefficient β is the core variable of interest in this paper, capturing the differential response of large banks compared to small banks following each shock. A positive and significant β indicates that large banks experienced a greater increase (or smaller decrease) in the outcome variable compared to small banks after the shock. 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}). Lastly, α_t represents time f.e., and α_b represents bank f.e.

When applying the regression to distinct shocks, the primary difference is the definition of the $POST_t$ variable. For Yu'E Bao shock, $POST_t = 1$ for years 2013 and after, and $POST_t = 0$ for years before 2013. When studying impact of deposit rate liberalization, $POST_t = 1$ for years 2016 and 2017, and $POST_t = 0$ for years before 2015. When it comes to the new asset management rules, $POST_t = 1$ for years 2017 and after, and $POST_t = 0$ for years before 2017. For each shock, we estimate the regression separately, maintaining the same specification but adjusting the $POST_t$ variable according to the timing of the specific event. This approach allows us to systematically examine how banks of different sizes respond to various policy and competitive changes in terms of their deposit strategies and business model innovations.

4.2.3. Descriptive statistics

Table 3 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.

5. Empirical results

5.1. The impact of Yu'E Bao's launch in 2013

To test Proposition 1 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 regression (1). The coefficient of interest, β, captures the differential response of large banks relative to small banks in the post-Yu'E Bao period. Table 4 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 f.e., standard errors clustered at bank level.

Table 3
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.

Table 4
Regression results of Yu'E Bao issuance impact.

	(1) $WMPR$	(2) DTI	(3) $HDeposit$	(4) $TDeposit$
$Large_b \times POST_t$	0.7112**	11.5038***	−0.0866*	−0.3778*
	(0.3034)	(2.1088)	(0.0518)	(0.2046)
$SIZE_{bt}$	0.7934	8.4121*	0.5674**	2.4685
	(0.8925)	(4.7371)	(0.2172)	(2.2632)
LIQ_{bt}	0.0013	−0.0097	−0.0023	−0.0058
	(0.0068)	(0.0513)	(0.0023)	(0.0066)
CAP_{bt}	−0.0601*	−0.4277***	−0.0059	0.0520
	(0.0331)	(0.1267)	(0.0096)	(0.0628)
NPL_{bt}	0.1689	−1.2730**	0.0189	0.1615
	(0.1247)	(0.5820)	(0.0266)	(0.1310)
Bank f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
# Banks	52	88	81	82
# Obs.	155	339	286	293
R^2	0.9422	0.8026	0.9940	0.8353

Note: Standard errors clustered at bank level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. $WMPR$ is the logarithm of wealth management product income. DTI is the Digital Transformation Index for commercial banks. $HDeposit$ is the logarithm of the balance of personal deposits. $TDeposit$ is the logarithm of the balance of time deposits. $Large_b$ is a dummy variable equal to 1 if the bank's asset size is above the median. $POST_t$ is a time dummy variable equal to 0 before 2013 and 1 afterwards.

The estimation results provide strong support for Proposition 1. 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 5 presents estimation results examining banks' heterogeneous responses to interest rate liberalization. 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 smaller banks significantly expanded their wealth management business lines relative to larger banks during this period. This asymmetric response can be attributed to the reduction in entry barriers and operational costs for WMPs, which disproportionately benefits smaller banks. While larger institutions had already established wealth management operations, smaller banks were able

Table 5
Regression results of deposit rate marketization.

	(1) ADR	(2) $TDeposit$	(3) $WMPR$	(4) DTI
$Large_b \times POST_t$	−0.2865***	−0.1949**	−0.7353*	−5.6781*
	(0.0978)	(0.0973)	(0.4145)	(2.9614)
$SIZE_{bt}$	−0.0118	0.2911	−0.4607	−8.3084
	(0.4621)	(0.2962)	(1.4002)	(8.5104)
LIQ_{bt}	−0.0005	0.0016	−0.0094	0.0752
	(0.0025)	(0.0021)	(0.0058)	(0.0912)
CAP_{bt}	0.0518*	−0.0103	−0.0729*	0.4518
	(0.0308)	(0.0349)	(0.0420)	(0.5795)
NPL_{bt}	−0.0142	0.0023	−0.1724	1.4098
	(0.0468)	(0.0429)	(0.1656)	(1.8168)
Bank f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
# Banks	98	85	68	96
# Obs.	288	236	186	282
R^2	0.6017	0.9158	0.9412	0.8070

Note: Standard errors clustered at bank level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. ADR is the average deposit rate of the bank. $TDeposit$ is the logarithm of the balance of time deposits. $WMPR$ is the logarithm of wealth management product income. DTI is the Digital Transformation Index for commercial banks. $Large_b$ is a dummy variable equal to 1 if the bank's asset size is above the median. $POST_t$ is a time dummy variable equal to 0 before 2015 and 1 afterwards.

to develop these business lines from a minimal base, thereby exhibiting more substantial relative growth. Also, from Column (4), smaller banks invested more aggressively in digital transformation compared to their larger counterparts during the post-reform period. This pattern aligns with theoretical predictions that as smaller banks experience increased profitability from new business lines such as WMPs, they allocate more resources toward digital infrastructure development.

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 and digital transformation. 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 results highlight how regulatory changes can reshape competitive dynamics within the banking sector by creating opportunities for smaller players to narrow capability gaps with established institutions.

Yi (2021) pointed out that marketization of interest rates should not only be "let go" but also "take shape", i.e., a gradualist top-down approach. 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 & Zhao, 2017). To examine how banks adjust their business strategies following the regulatory tightening of shadow banking, we estimate (1). The results in Table 6 reveal significant heterogeneity in banks' responses to the new asset management regulation. 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. These findings support Proposition 3, demonstrating how regulatory changes lead to divergent strategic responses between large and small banks.

5.4. Parallel trend test

The Difference-in-Differences (DID) methodology relies on the assumption of parallel trends between treatment and control groups prior to the shock. This paper employs the event study approach to test this assumption for the Yu'E Bao launch in 2013, as the other two events have insufficient pre-shock data.[9] Table 7 presents the parallel trend tests for all four main dependent variables, with 2012 as the base year. As shown, the 95% confidence intervals for all $Large_b \times 2011$ interaction terms contain zero, indicating no significant pre-shock differences between large and small banks. For $WMPR$ and DTI, the post-shock coefficients ($Large_b \times 2013$ and $Large_b \times 2014$) are mostly positive and statistically significant, confirming treatment effects after Yu'E Bao's

[9] Parallel trend tests are not conducted for the 2015 deposit rate ceiling removal and 2017 new asset management regulation as their corresponding panels contain only 3 years of data, insufficient for the minimum requirement of 2 pre-shock years needed for reliable testing.

Table 6
Regression results of wealth management business and digital transformation.

	(1) $WMPR$	(2) DTI	(3) ADR	(4) $Deposit$
$Large_b \times POST_t$	0.1385	12.7230***	−0.1629**	−0.0520**
	(0.1866)	(3.1997)	(0.0659)	(0.0199)
$SIZE_{bt}$	1.5912***	−26.1015**	−0.1775	0.7263***
	(0.5861)	(10.6336)	(0.2432)	(0.1174)
LIQ_{bt}	−0.0001	−0.0378	0.0002	−0.0002
	(0.0045)	(0.0767)	(0.0011)	(0.0004)
CAP_{bt}	−0.0004	0.5114	−0.0301*	−0.0142***
	(0.0284)	(0.5745)	(0.0166)	(0.0051)
NPL_{bt}	0.0186*	−0.8208	0.0032	−0.0071***
	(0.0106)	(0.9032)	(0.0082)	(0.0014)
Bank f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
# Banks	80	96	101	102
# Obs.	292	280	383	392
R^2	0.9188	0.7872	0.8133	0.9963

Note: Standard errors clustered at bank level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. $WMPR$ is the logarithm of wealth management product income. DTI is the Digital Transformation Index for commercial banks. ADR is the average deposit rate of the bank. $Deposit$ is the logarithm of the balance of deposits. $Large_b$ is a dummy variable equal to 1 if the bank's asset size is above the median. $POST_t$ is a time dummy variable equal to 0 before 2017 and 1 afterwards.

Table 7
Parallel trend test of Yu'E Bao's launch.

	(1) $WMPR$	(2) DTI	(3) $PerD$	(4) $fixedD$
$Large_b \times 2011$	0.3651	−1.6639	0.0187	0.8202
	[−0.5789, 1.3091]	[−4.3697, 1.0420]	[−0.0852, 0.1226]	[−0.5332, 2.1736]
$Large_b \times 2013$	0.8435	7.9173	−0.0536	−0.0108
	[0.1284, 1.5585]	[4.2644, 11.5703]	[−0.1298, 0.0226]	[−0.3712, 0.3496]
$Large_b \times 2014$	0.7466	13.7586	−0.1134	−0.1006
	[−0.0871, 1.5803]	[8.4483, 19.0689]	[−0.2336, 0.0068]	[−0.5189, 0.3178]
Control Var.	Yes	Yes	Yes	Yes
Bank f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
# Obs.	155	339	286	293
R^2	0.9650	0.8625	0.9959	0.8900

Note: 95% confidence intervals are reported in brackets. Standard errors are clustered at bank level. $WMPR$ is the logarithm of wealth management product income. DTI is the Digital Transformation Index for commercial banks. $PerD$ represents personal deposits. $fixedD$ represents fixed deposits. $Large_b$ is a dummy variable equal to 1 if the bank's asset size is above the median. Years 2011, 2013, and 2014 are interaction terms with the large bank indicator.

introduction. However, for personal deposits ($PerD$) and fixed deposits ($fixedD$), the parallel trend assumption holds pre-shock, but we observe no significant post-shock treatment effects, as confidence intervals for these variables in 2013 and 2014 also contain zero. This suggests that Yu'E Bao's launch had distinct impacts on banks' strategic responses (measured by $WMPR$ and DTI) but did not significantly influence deposit structure between large and small banks.

6. Heterogeneity analysis

Our theoretical framework suggests that banks' strategic responses to financial reforms vary with both the intensity of FinTech competition and the degree of market power. 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 8 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 $Large_i \times Post_t$ is larger in magnitude in high-penetration regions (13.4017) compared to low-penetration regions (8.6419). This pattern supports that large banks exhibit more intensive digital transformation initiatives in areas with stronger

Table 8
Heterogeneity results of Yu'E Bao launch: Alipay penetration.

	DTI		$TDeposit$	
	(1) Low Payment Index	(2) High Payment Index	(3) Low Payment Index	(4) High Payment Index
$Large_b \times POST_t$	8.6419**	13.4017***	−0.6512	−0.1177*
	(3.2226)	(2.6518)	(0.4480)	(0.0670)
$SIZE_{bt}$	4.6211	13.8023*	3.9771	0.4429
	(6.2664)	(7.4095)	(3.7214)	(0.3143)
LIQ_{bt}	0.0166	−0.0369	−0.0052	−0.0014
	(0.0644)	(0.0823)	(0.0141)	(0.0032)
CAP_{bt}	−0.2347	−0.4995***	0.2077	−0.0096
	(0.2733)	(0.1253)	(0.1930)	(0.0068)
NPL_{bt}	−1.0769*	−3.9038	0.2543	0.0080
	(0.5745)	(3.2553)	(0.1963)	(0.0768)
Bank f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
# Banks	40	48	37	45
# Obs.	149	190	120	173
R^2	0.5688	0.8263	0.4542	0.9940
t-test	$p = 0.1853$		$p = 0.1538$	

Notes: Standard errors clustered at bank level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. DTI is the Digital Transformation Index for commercial banks. $TDeposit$ is the logarithm of the balance of time deposits. $Large_b$ is a dummy variable equal to 1 if the bank's asset size is above the median. $POST_t$ is a time dummy variable equal to 0 before 2013 and 1 afterwards. $SIZE_{bt}$ is the logarithm of total assets. LIQ_{bt} is the bank liquidity ratio. CAP_{bt} is the bank capital adequacy ratio. NPL_{bt} is the bank non-performing loan rate.

Table 9
Heterogeneity results of deposit rate marketization: Alipay penetration and deposit concentration.

	MTI		ADR	
	(1) Low Payment Index	(2) High Payment Index	(3) Low Deposit Concentration	(4) High Deposit Concentration
$Large_b \times POST_t$	−3.0552	−14.7398**	−0.2732**	−0.3692
	(6.3215)	(6.5170)	(0.1182)	(0.2232)
$SIZE_{bt}$	−7.3906	−38.1700*	−0.6787	0.7582**
	(8.6315)	(22.2452)	(0.4737)	(0.2996)
LIQ_{bt}	0.0283	0.1852	−0.0023	0.0048
	(0.1463)	(0.2328)	(0.0022)	(0.0036)
CAP_{bt}	1.2489	−0.0293	0.0312	0.0384
	(0.7872)	(1.7456)	(0.0336)	(0.0330)
NPL_{bt}	−0.1504	3.7493	−0.0056	0.0143
	(2.9711)	(9.0970)	(0.0946)	(0.0466)
Bank f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
# Banks	44	52	54	44
# Obs.	126	156	159	129
R^2	0.5888	0.6425	0.6924	0.5077
t-test	$p = 0.803$		$p = 0.538$	

Notes: Standard errors clustered at bank level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. MTI is the Management Transformation Index for commercial banks. ADR is the average deposit rate of the bank. $Large_b$ is a dummy variable equal to 1 if the bank's asset size is above the median. $POST_t$ is a time dummy variable equal to 0 before 2015 and 1 afterwards. $SIZE_{bt}$ is the logarithm of total assets. LIQ_{bt} is the bank liquidity ratio. CAP_{bt} is the bank capital adequacy ratio. NPL_{bt} is the bank non-performing loan rate.

FinTech presence. Columns (3) and (4) reveal significant heterogeneity in deposit market responses. The negative coefficient on $Large_i \times Post_t$ is significant in high-penetration regions, indicating that small banks compete more aggressively for deposits in these markets.

6.2. Heterogeneity analysis of the deposit rate marketization policy of 2015

To investigate which aspects of digital transformation were most impacted among small banks following interest rate liberalization, we conduct a detailed analysis comparing the 3 dimensions of transformation indices between large and small banks. Our results reveal that management transformation was the primary dimension where small banks exhibited significant advantages over large banks post-liberalization. Table 9 presents the heterogeneity analysis focusing on the management transformation index (MTI) and average deposit rates (ADR) across different market environments.

Table 10
Heterogeneity results of new asset management regulation: Alipay penetration and deposit concentration.

	DTI		*Deposit*	
	(1) Low Payment Index	(2) High Payment Index	(3) Low Deposit Concentration	(4) High Deposit Concentration
$Large_b \times POST_t$	4.3498	18.9247***	−0.0002	−0.1081***
	(4.9323)	(5.2063)	(0.0223)	(0.0365)
$SIZE_{bt}$	−10.1632	−48.4982**	0.9845***	0.5579***
	(10.2183)	(19.3198)	(0.1893)	(0.1294)
LIQ_{bt}	0.1023	−0.3553**	−0.0004	−0.0001
	(0.0613)	(0.1588)	(0.0007)	(0.0005)
CAP_{bt}	−0.1018	2.8130	−0.0087*	−0.0172**
	(0.2852)	(1.7155)	(0.0046)	(0.0068)
NPL_{bt}	−0.4554	−15.3723***	−0.0047***	−0.0015
	(0.4533)	(4.6758)	(0.0013)	(0.0115)
Bank f.e.	Yes	Yes	Yes	Yes
Time f.e.	Yes	Yes	Yes	Yes
# Banks	45	51	53	49
# Obs.	130	150	204	188
R^2	0.6845	0.7882	0.9982	0.9946
t-test	$p = 0.0319$		$p = 0.0224$	

Notes: Standard errors clustered at bank level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. *DTI* is the Digital Transformation Index for commercial banks. *Deposit* is the logarithm of the balance of total deposits. $Large_b$ is a dummy variable equal to 1 if the bank's asset size is above the median. $POST_t$ is a time dummy variable equal to 0 before 2017 and 1 afterwards. $SIZE_{bt}$ is the logarithm of total assets. LIQ_{bt} is the bank liquidity ratio. CAP_{bt} is the bank capital adequacy ratio. NPL_{bt} is the bank non-performing loan rate.

Columns (1) and (2) demonstrate that the management transformation advantage of small banks was particularly pronounced in regions with high Alipay penetration. The coefficient of the interaction term ($Large_b \times POST_t$) is negative and statistically significant (−14.7398) in high payment index regions, while insignificant in low payment index areas. This suggests that fintech competition intensity serves as a catalyst for small banks to accelerate their organizational and management transformation, enabling them to respond more effectively to the changing competitive landscape. Columns (3) and (4) reveal that deposit rate competition is more intense in markets with lower deposit concentration. The negative and significant coefficient (−0.2732) in column (3) indicates that small banks in less concentrated markets raised their deposit rates more aggressively than large banks following liberalization, which is consistent with intuition.

6.3. 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.

The effect of regulation on banks' digital transformation exhibits significant heterogeneity across markets. The coefficient on $Large_i \times Post_t$ 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 analysis that the net effect of regulation depends on the relative strength of reduced market-wide competition versus sustained competitive pressure from alternative channels. The deposit market response also varies systematically with market structure. The negative coefficient on $Large_i \times Post_t$ 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 with less intense deposit competition. This heterogeneity demonstrating how the effectiveness of small banks' deposit-taking strategy depends on the relative changes in market-wide competition and inter-bank competition in local markets.

7. Conclusion

Under China's bank based financial system, commercial banks, as intermediaries of fund flows, play a significant role in the operation of the whole economy. In recent years, against the backdrop of deepening financial reforms, Chinese commercial banks have continued to evolve steadily. While maintaining overall business operations as usual, they have actively embraced financial technology, adapted digital transformation, and expanded diversified services, continually enhancing and innovating upon traditional financial services. Clarifying the internal factors and mechanisms 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 of 107 commercial banks over 2011 to 2019 from China Banking Database, 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 massive shadow banking regulation 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. Manually collected data of bank level wealth management products

To explore the evolution process of commercial banks' wealth management products and other shadow banking services, the author manually extract 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 was 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 extract related variables from the aforementioned sections and, after considering the research objectives and the completeness of the sample data, select 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.

Data availability

Data will be made available on request.

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