FinTech Competition, Deposit Funding Costs, and Bank Interest Margins: The Role of Digital Transformation in China

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ABSTRACT

Purpose: To examine how FinTech competitive exposure relates to customer deposit funding costs and net interest margins, and whether digital investment conditions these relationships in Chinese banking.

Method: Public annual reports provide 48 bank year records for eight listed Chinese banking groups during 2019–2024. The primary financial analysis uses 32 observations for 2020–2023. Lagged investment models use 26 observations from seven banks. Competitive exposure combines the 2019 retail deposit share with changes in the Peking University provincial digital payment index. Bank and year fixed effects, bank cluster intervals, an enumerated wild bootstrap and influence analyses assess conditional relationships.

Findings: Mean net interest margin falls from 2.299% in 2019 to 1.790% in 2023, while mean deposit cost rises from 1.809% to 1.901%. None of the five hypotheses receives clear support. The digital interaction is negative for deposit costs and margins, but both intervals span zero. Measurement choices, differential trends and influential banks limit interpretation.

Originality/Implications: This pilot study provides an exploratory, accounting-based framework for jointly examining external digital payment development, reported deposit funding costs, technology investment and net interest margins. Its transparent measurement and disclosure procedures offer a basis for extending the analysis to more diverse banking institutions. The findings do not establish that technology expenditure protects interest margins under FinTech competition.

Keywords: FinTech competition; deposit funding costs; net interest margin; digital transformation; Chinese commercial banks; panel data.

INTRODUCTION

Digital finance changes the conditions under which banks compete for funds, maintain customer relationships and price loans. Financial technology firms can enter individual services without reproducing the entire banking organisation, while large technology platforms combine financial products with existing commercial networks and customer information. These changes raise a specific question for commercial banks: whether digital transformation can preserve the funding advantages that support interest margins when customers face a wider range of financial alternatives. The issue concerns the price and stability of deposits as well as the distribution of lending activity between banks and other providers (Boot et al., 2021; Stulz, 2019).

China provides an important setting for this question because the relationship between financial technology and established banking involves payment platforms, digitally distributed financial products and banks' own technological responses. However, the presence of digital services does not itself establish the intensity of competition faced by an individual bank. Financial technology can substitute for a banking service, complement an existing bank relationship, or change the interface through which that service reaches the customer. Distinguishing these possibilities is necessary before interpreting digital activity as evidence of

disintermediation or assuming that every bank experiences the same competitive shock (Frost et al., 2019; Thakor, 2020).

Deposit funding costs provide a useful point of connection between these market developments and bank performance. Depositors receive a package of interest payments, liquidity, convenience and security. A bank that provides valuable transaction services can attract funds without matching the highest available market return. Competition may weaken this advantage when customers can compare products more easily or transfer balances with less effort. The resulting funding pressure can appear through higher deposit remuneration, a shift towards more expensive deposit categories, or the replacement of departing deposits with other liabilities. These mechanisms are related but should be distinguished empirically (Drechsler et al., 2017; Egan et al., 2017).

Net interest margin captures the difference between interest income and interest expense relative to average earning assets. It therefore connects asset pricing with funding conditions, but it does not measure the entirety of banking performance. A bank can experience a lower margin alongside growth in fee income, changes in provisions or an expansion of earning assets. Research on low interest rates shows why a decline in the margin cannot automatically be attributed to technological competition or interpreted as a corresponding decline in total profitability (Altavilla et al., 2018; Claessens et al., 2018).

Digital transformation may alter these relationships through opposing mechanisms. Better applications, integrated customer information and more effective service delivery can improve convenience and strengthen existing relationships. At the same time, digital channels can reduce switching barriers and expose banks to more price sensitive customers. Evidence concerning digital banking and deposit franchise values makes this ambiguity particularly relevant. Digital investment is consequently examined as a potential conditioning factor, rather than treated as a guarantee of stronger margins or cheaper deposits (Koont et al., 2024; Verhoef et al., 2021).

The study examines whether competitive exposure relates to reported deposit costs and margins, and whether digital investment conditions these relationships. Eight listed banking groups provide public financial disclosures. The framework distinguishes the deposit funding channel from other margin adjustments and recognises that deposit interest expense already enters net interest income. The empirical analysis therefore examines joint financial adjustment rather than assuming that a deposit cost coefficient identifies an independent causal mechanism.

The contribution concerns the measurement and joint assessment of these relationships within a common accounting setting. Five hypotheses organise the analysis. Bank and year effects distinguish persistent institutional differences from shared annual developments, while sensitivity checks examine dependence on individual banks and differential trends. The observational design permits conditional associations, with causal direction remaining unresolved (Rohrer, 2018).

THEORETICAL FOUNDATIONS AND CORE CONSTRUCTS

FinTech competition and financial intermediation theory

FinTech competition refers to pressure on banks arising from technology enabled financial alternatives and the changing conditions under which customers obtain financial services. It differs from a bank's internal use of technology and from a general measure of digital economic development. A market may display considerable digital activity without strong substitution away from bank deposits. Conversely, a narrowly targeted financial product can create meaningful competitive pressure even when aggregate digital indicators change little. This distinction guides the choice and interpretation of an empirical competition measure (Thakor, 2020).

Contemporary financial intermediation theory provides a framework for understanding these effects. Intermediaries create value by processing information, organising transactions, providing liquidity and using their balance sheets to transform claims. Technological change can modify the cost or location of these

functions without eliminating the need for intermediation. Boot et al. (2021) distinguish developments in information collection and processing from developments in communication and distribution. This distinction explains why a platform may control the customer relationship while a bank continues to supply funding or credit behind that interface.

Competition for deposits can arise when alternative services make the opportunity cost of holding a conventional bank balance more visible. Faster payments and more accessible financial products may allow customers to manage transaction balances more actively. Banks may respond by raising rates or offering additional services. These responses need not produce a uniform movement in deposit costs: payment providers can also increase the use of bank transfers, and the economic effect depends on how liquidity and payment services are organised. The distinction between substitution and complementarity is consequently part of the model rather than a matter resolved by terminology (Verdier, 2024).

Competition can also operate through the asset side of a bank. Digitally enabled lenders may compete for borrowers or change their expectations about application speed, accessibility and pricing. Banks can respond through their own digital services, cooperation with external providers or changes in business mix. The extent of the challenge depends on the service involved and on the advantages retained by regulated intermediaries. Bank scale, deposit gathering capacity and the ability to integrate information across financial relationships remain potentially important sources of advantage (Stulz, 2019).

FinTech competition should therefore be interpreted in relation to the product market and the relevant bank exposure. Global evidence that digital credit is more developed in countries with higher banking markups establishes an association between financial innovation and market structure; it does not demonstrate that a particular Chinese bank's deposits face an equivalent level of competitive pressure. A defensible empirical proxy must specify which aspect of digital finance is observed and how differences in bank exposure are represented. The theory predicts possible changes in prices and relationships, while the adequacy of the proxy remains an empirical measurement question (Cornelli et al., 2023).

Deposit funding costs and the deposit franchise

Deposit funding costs represent the interest expense associated with customer deposits relative to the relevant deposit base. They are distinct from the cost of all interest bearing liabilities, which can include interbank borrowing and issued debt. The observed cost also depends on the composition of deposits, including maturity, currency and customer category. An increase can reflect higher prices within a category, a movement towards more expensive products, or both. These distinctions matter because competition may change the structure of funding even when the posted rate on an individual account remains unchanged.

The deposit franchise explains why this funding relationship has economic value. Deposits combine payment and liquidity services with a financial return, enabling banks with strong customer relationships to obtain funds below comparable market rates. Drechsler et al. (2021) show how low and relatively insensitive deposit remuneration interacts with the maturity structure of bank assets. Their analysis places the deposit relationship within the management of interest rate exposure, rather than treating deposits simply as short term borrowing that must reprice immediately with market rates.

Franchise value depends on the persistence of the underlying customer relationship. If depositors leave, the expected stream of funding benefits is reduced. A bank may then need to pay more for replacement funds, contract assets or alter its balance sheet. Recent theory connects the potential loss of the deposit franchise with bank vulnerability and the joint management of capital and asset duration. The implication for this study is that low current deposit costs do not, by themselves, establish a durable funding advantage; the stability of the deposit base also matters (Drechsler et al., 2026).

Digital transformation and dynamic capabilities

Digital transformation concerns changes in how an organisation creates and delivers value through digital technologies. It extends beyond purchasing equipment or moving an existing service online. The concept

includes the integration of information, changes in operating routines, revised customer interfaces and the development of business models that use these resources effectively. A disclosed technology investment measure captures a relevant input into this process, but it cannot represent every dimension of transformation or establish how successfully that investment has been implemented (Vial, 2019).

Dynamic capabilities theory helps explain why similar technological inputs may generate different outcomes across banks. The relevant capability is the capacity to recognise changing opportunities, organise an effective response and adjust existing resources and activities. Business model design and implementation depend on these capabilities, rather than on the possession of technology alone. Applied to banking, the framework suggests that an investment can support deposit retention only when systems, service design and organisational decisions translate it into value for customers (Teece, 2018).

Several mechanisms could support a protective role. Integrated customer information can improve the relevance of financial services. More convenient applications can reduce transaction effort, while reliable digital channels can extend service access. A bank may consequently retain operating balances without relying entirely on higher remuneration. These are theoretical pathways linking digital investment to the proposed moderation effect. Their relevance depends on whether customers value the services delivered and whether the bank can provide them efficiently within the wider business model (Verhoef et al., 2021).

Competing mechanisms require equal attention. Digital access can make balances more mobile, lower the effort of comparing alternatives and attract customers who respond more quickly to changes in relative returns. Koont et al. (2024) examine how digital banking can reduce the stickiness of deposits and increase sensitivity to monetary conditions. This evidence does not determine the Chinese relationship, but it challenges the assumption that a more developed digital channel necessarily stabilises funding. The empirical sign of an interaction between competitive pressure and digital investment must therefore be established rather than presumed.

Digital transformation also has implications beyond pricing. More extensive use of platforms, customer data and automated systems can alter dependencies, operational risks and market structure. Large technology firms may bring efficiency and inclusion benefits while creating concerns about concentration and the control of information. The relevant strategic question is consequently which capabilities protect a bank's customer relationships under particular competitive conditions. The framework treats digital investment as a potential source of adaptation whose effects remain contingent on implementation, business mix and the organisation of the financial ecosystem (Doerr et al., 2023).

LITERATURE REVIEW

FinTech competition and deposit funding costs

The funding response to FinTech competition depends on whether digital alternatives weaken the services that make bank deposits attractive. Payment convenience, the accessibility of alternative investments and the ease of moving balances can change the return that customers require to retain deposits. Banks may then raise remuneration, offer alternative products or change the composition of their funding. The deposits channel literature provides a theoretical basis for this response because deposit pricing depends on market power and the opportunity cost of holding bank balances (Drechsler et al., 2017).

Evidence from China already links financial technology with changes in deposit business. In a working paper, Buchak et al. (2021) examine exposure to a platform distributed money market fund and document deposit outflows and responses through products offering market interest rates. Ge et al. (2025) analyse technological and regulatory changes in China's deposit market, including differences between large and small banks' strategies. These studies establish that the competition and funding connection has an existing empirical foundation. They also show why regulation, bank characteristics and the type of financial alternative need to enter its interpretation.

Recent international evidence strengthens the pricing mechanism while identifying boundaries. Cumming et

al. (2026) find that FinTech competition raises deposit costs among smaller US financial institutions, with size and geographical diversification affecting exposure. The Chinese application therefore concerns the relevance of this mechanism under different banking and policy conditions. A positive relationship is expected where digital alternatives increase the return required to retain customer funds. The prediction concerns the conditional association observed across bank exposures.

H1: Greater FinTech competitive pressure is positively associated with deposit funding costs.

Deposit funding costs and bank interest margins

Deposit funding costs enter a bank's interest margin through interest expense. An increase in the price of deposits reduces net interest income when other components remain unchanged. The balance sheet nevertheless determines the strength of that relationship. Banks can adjust asset yields, replace liabilities or change the amount of earning assets supported by deposits. Research on the deposit franchise explains how funding prices, customer relationships and asset maturity interact within this joint financial structure (Drechsler et al., 2021).

Evidence on the monetary environment demonstrates why the relationship requires conditioning. Borio et al. (2017) relate bank profitability to interest rate levels and the yield curve, while Claessens et al. (2018) show that persistent low rates can compress bank interest margins. Bank characteristics also matter: operating costs, efficiency and business diversification are associated with margin differences in the Euro Area (Angori et al., 2019). These findings motivate separating deposit remuneration from the common conditions that affect both sides of the balance sheet.

Chinese evidence further indicates that funding composition and funding prices should be distinguished. Jiang et al. (2022) examine deposit competition alongside interbank funding and show how alternative funding arrangements affect bank specialisation. A reduced form deposit cost coefficient consequently combines a direct accounting connection with adjustments elsewhere in the bank. The proposed negative relationship is economically meaningful, but its estimation alone cannot demonstrate a causal funding mechanism or establish that competition produced the observed repricing.

H2: Higher deposit funding costs are negatively associated with bank net interest margins.

FinTech competition and bank interest margins

FinTech competition can affect margins through deposit remuneration and through the pricing and composition of assets. Digitally enabled lenders can compete for borrowers, while changes in information processing can alter the cost of screening and distributing credit. Banks may pass part of any efficiency gain to customers through lower loan prices. Studies of lending technologies and digital information support these mechanisms, although their estimates concern specific lending markets and cannot directly determine the margin response of Chinese banks (Berg et al., 2020; Fuster et al., 2019).

Research in China presents evidence of pressure and adaptation. Chen et al. (2023) associate regional FinTech development with lower bank loan spreads. Katsiampa et al. (2022) document changes in margins, costs and prudential performance as incumbent banks and FinTech lenders adapt over time. Zhao et al. (2022) report different associations across profitability, asset quality, management efficiency and capital adequacy. Together, these findings support distinguishing net interest margin from a general judgement about whether technology improves bank performance.

Complementarity remains possible. Tang (2019) finds that platform lending can substitute for bank credit in some segments while complementing it in others. Banks may also use external technology to improve distribution or operate through partnerships. A negative margin prediction is therefore conditional on competitive repricing outweighing the funding and asset benefits available to an incumbent. It concerns a total conditional relationship before the deposit cost variable is introduced into the margin equation.

H3: Greater FinTech competitive pressure is negatively associated with bank net interest margins.

Digital transformation and the competition to funding cost relationship

Digital transformation can influence the nonprice attributes that customers receive from a deposit relationship. Effective service integration may make a bank more convenient, improve the relevance of its products and support the retention of transaction balances. Dynamic capabilities theory associates successful adaptation with the capacity to organise resources and revise business models as conditions change. Its implication is that technological expenditure may help a bank respond to competition when that expenditure is translated into valued services and workable organisational routines (Teece, 2018).

Chinese research identifies potential benefits while examining outcomes beyond deposit prices. Lee et al. (2021) relate FinTech innovation to cost efficiency, and Shen et al. (2025) examine improvements in commercial bank cost efficiency associated with digital transformation. Liu et al. (2024) connect open banking with bank performance through lending rates and liability structure. These findings support the possibility that internal digital development changes a bank's response to its environment, while leaving the specific moderation of deposit funding costs open to examination. Greater digital access can also make deposits more mobile. Koont et al. (2024) show how digital banking can increase deposit sensitivity to interest rates and reduce the persistence of the deposit franchise. The proposed buffering effect therefore competes with an amplification mechanism. The directional hypothesis follows the customer service and retention argument; the analysis must allow the interaction to be weak, absent or opposite in sign. A disclosed investment measure provides evidence about an input into transformation, with implementation quality remaining partly unobserved.

H4: Digital transformation weakens the positive association between FinTech competitive pressure and deposit funding costs.

Digital transformation and the competition to margin relationship

Digital transformation can condition the relationship between competition and margins through several connected decisions. Better information and distribution may support more effective loan pricing, while stronger customer services may preserve relatively inexpensive deposits. Cooperation with financial technology firms can also provide access to capabilities that banks would otherwise develop internally. Research on bank and FinTech alliances shows that these organisational responses differ across institutions, making the nature of adaptation relevant to the performance relationship (Hornuf et al., 2021).

The expected benefits do not imply an automatic increase in interest margins. Citterio et al. (2024) associate digital transformation with European bank profitability and identify nonlinearities and delays, while Chinese studies examine profit efficiency, credit risk and profitability using different measures and samples (Cheng & Qu, 2020; Ren et al., 2024). These outcomes capture different dimensions of banking activity. Operational cost savings, for example, can raise overall profits without directly widening a ratio based on interest income and expense. The buffering hypothesis concerns the competitive relationship at different observed levels of digital development. It predicts that better adaptation reduces the margin compression associated with external competitive pressure. The competing switching mechanism and possible benefits passed to borrowers can weaken or reverse that pattern. Conditional effects must consequently be evaluated over combinations of competition and digital investment represented in the data, with uncertainty around both the interaction and the resulting marginal relationships (Hainmueller et al., 2019).

H5: Digital transformation weakens the negative association between FinTech competitive pressure and bank net interest margins.

Research Gap

The existing literature already addresses technological competition, Chinese deposit business and digital bank adaptation. Ge et al. (2025) is particularly close because it examines how technology and regulatory

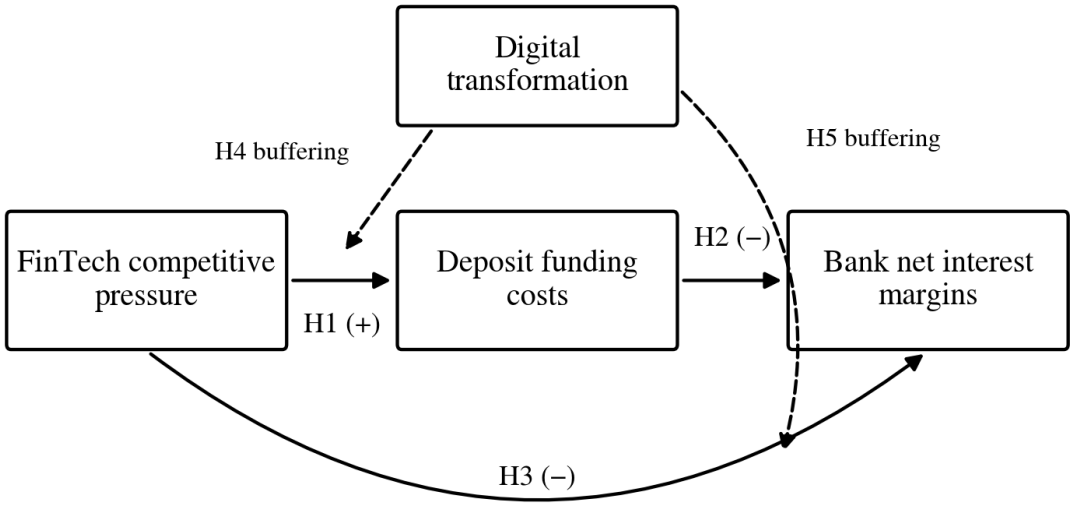
shocks change China's bank deposit market. Cumming et al. (2026) directly investigates the funding cost response to FinTech competition, while Liu et al. (2024) considers bank technology, liability structure and performance in China. These studies provide a foundation for a more focused examination of how deposit prices and interest margins move together under different levels of internal digital investment.

The question addressed here concerns the alignment of these relationships within a common accounting setting. The framework connects competitive pressure with reported deposit costs, examines the associated margin relationship and evaluates whether digital investment conditions both outcomes. This focus helps distinguish an external competitive environment from an internal technological response. It also separates funding remuneration from broader operating efficiency, and interest margins from total profitability. Those distinctions matter when comparing studies that use different digital indicators and different definitions of bank performance (Boot et al., 2021; Vial, 2019). The resulting framework provides a documented basis for extending disclosure-based comparisons to a wider range of banking institutions, subject to the availability and comparability of financial and technology investment data.

Theoretical Model

The model contains three principal relationships: FinTech competitive pressure to deposit funding costs, deposit funding costs to net interest margin, and competitive pressure to net interest margin. Digital transformation conditions the first and third relationships. H1 and H3 describe the pressure associated with external alternatives; H2 connects the funding price to the bank's interest result; H4 and H5 describe the proposed capacity of internal adaptation to attenuate those relationships. Bank and year fixed effects account for stable institutional differences and common annual developments. The model treats the deposit pathway as a theoretically proposed channel whose consistency can be assessed from the observed financial relationships.

Figure 1Theoretical model of competitive pressure funding costs and margins



Note. Dashed arrows indicate proposed moderation. Investment density proxies digital transformation. The arrows do not establish causal identification.

METHODOLOGY

Research design and public data sources

The study uses an exploratory panel of eight listed Chinese banking groups. The banks comprise Agricultural Bank of China, Bank of China, Bank of Communications, China Construction Bank, Industrial

and Commercial Bank of China, Postal Savings Bank of China, China Merchants Bank and Ping An Bank. Selection requires accessible public reports containing separately identified customer deposit costs and net interest margins. These institutions provide variation in retail funding and business models, but the selection is purposive and does not represent the population of Chinese commercial banks. The primary outcome window is 2020–2023. Financial observations from 2019 establish the exposure baseline, while 2024 disclosures provide a descriptive extension where available.

Annual reports supply net interest margins, customer deposit cost rates, technology investment, total assets and the baseline retail deposit share. The extraction records each reporting year, monetary unit, consolidation boundary, original source and page. Later restated comparative figures take precedence over earlier versions when the report identifies an accounting change. Original and restated figures remain separately identified. For example, reclassification of credit card instalment income affects Ping An's historical margin comparisons. No unreported technology expenditure is inferred from expenditure growth statements. This procedure preserves the distinction between absent disclosure and a genuine zero.

The external digital indicator is the payment subindex of the Peking University Digital Financial Inclusion Index of China. The underlying workbook identifies provincial observations from 2011 to 2023 and explains that the index is constructed from platform activity across several dimensions. The payment component is used to reduce conceptual overlap with bank technology investment and to focus on a service closely related to transaction deposits. It measures digital payment development rather than a complete product market competition index. The official provincial series is retained with the analysis data, together with the aggregation rule (Guo et al., 2020).

Variables and measurement

Net interest margin, NIM, is the report's net interest income relative to average interest earning assets, expressed as a percentage. The deposit funding cost, DFC, is the separately reported average cost of customer deposits, also expressed as a percentage. It is not replaced by total interest expense divided by total liabilities. Where numerator and denominator components are disclosed, the ratio is independently recalculated to assess rounding and transcription. These accounting measures preserve information about realised balance sheet outcomes that a staff perception scale cannot reproduce.

The common payment indicator is the unweighted annual mean of the payment subindex across the 31 mainland provincial units. It represents the average provincial index, not the volume of all transactions in China. Its logarithmic change relative to 2019 is denoted F. The baseline retail deposit share, s, is recorded from the 2019 bank disclosure. The centred exposure loading B is the difference between that share and the eight bank mean, divided by ten percentage points. The constructed exposure E equals B multiplied by F. This design distinguishes bank exposure from a countrywide digital series that would otherwise be absorbed by year effects.

The resulting coefficient has a narrow interpretation. It describes whether banks with different initial retail funding shares move differently as the common payment index changes. It does not estimate the national effect of FinTech competition. Retail shares can also condition the response to monetary easing, deposit maturity changes and the pandemic. The exposure is therefore a theoretically motivated proxy whose interpretation is assessed against alternative explanations, rather than an instrument or an exogenous shock. Research on observational inference supports making this distinction explicit (Rohrer, 2018).

Digital investment is measured as disclosed technology input relative to year end total assets. The ratio is converted to basis points, logged and lagged by one year. Logging reduces the effect of scale differences, and lagging improves temporal ordering while avoiding the contemporaneous operating revenue denominator. The lagged log ratio is centred at its mean in the common estimation sample. It remains an investment input proxy: expenditure does not establish successful system implementation, organisational capability or customer adoption. Reported spending boundaries are retained, including any parent bank versus consolidated group differences, and their influence is assessed through exclusions and interpretation (Vial, 2019; Verhoef et al., 2021).

Table 1 Variables and operational definitions

Variable	Observed measure	Interpretation
FinTech exposure E	Centred 2019 retail deposit share × log change in the provincial payment mean	Differential exposure proxy; not a national causal effect
Deposit cost	Reported customer deposit interest cost (%)	Price and composition of deposit funding
Net interest margin	Reported net interest income / average earning assets (%)	Interest result, distinct from overall profitability
Digital investment D	Lagged log of IT input / assets, centred	Input into transformation; not achieved capability
B and F	Baseline retail loading and common payment change	Main effects absorbed by bank and year effects
BD, FD and ED	Full interaction hierarchy	Lower order terms retained for moderation

Note. RMB million. Rates are percentages; changes use percentage points. Digital density is IT input / assets × 10,000.

Analytical sample and reporting scope

The analytical profile comprises bank identities, reporting years, funding structure and disclosure coverage. No questionnaire responses enter the estimates. No interviews were conducted for the present study.

Table 2 Bank profile and financial endpoints

Bank	Type	Retail share 2019 %	NIM 2019 %	NIM 2023 %	Deposit cost 2023 %
ABC	State owned	58.57	2.23	1.60	1.78
BOC	State owned	44.19	1.89	1.59	2.09
BOCOM	State owned	32.80	1.58	1.28	2.33
CCB	State owned	47.94	2.32	1.70	1.77
CMB	Joint stock	37.28	2.59	2.15	1.62
ICBC	State owned	45.60	2.30	1.61	1.89
PAB	Joint stock	23.95	2.95	2.38	2.20
PSBC	State owned	87.86	2.53	2.01	1.53

Note. ABC, BOC, BOCOM, CCB, ICBC and PSBC identify the six large state owned banks. CMB is China Merchants Bank; PAB is Ping An Bank. Shares follow source deposit classifications.

Estimated Model

The baseline equations include bank and year fixed effects. Bank effects absorb persistent institutional differences, while year effects absorb shocks shared across the sampled banks. The deposit cost equation relates DFC to E and lagged digital investment D. The corresponding margin equation initially excludes DFC to describe the overall conditional exposure association. A third equation introduces DFC to examine the funding price relationship within the same sample. Changes in the exposure coefficient across these equations are descriptive and are not interpreted as a mediated causal effect.

The moderation equations retain the complete hierarchy implied by the exposure construction. Because E equals B multiplied by F, the product ED is a three factor interaction. The model therefore includes BD and FD alongside E, D and ED; bank and year effects absorb the time invariant B and the common F main effects. This prevents the moderation coefficient from silently imposing zero lower order interactions. H4 concerns a negative ED coefficient in the deposit cost equation. H5 concerns a positive ED coefficient in the margin equation. The interaction coefficient is reported with its uncertainty. The limited panel does not permit a precise assessment of conditional response surfaces (Hainmueller et al., 2019).

$$DFC_{it} = \alpha_i + \lambda_t + a\,E_{it} + \gamma\,D_{it} + \varepsilon_{it}$$

$$NIM_{it} = \mu_i + \tau_t + c\,E_{it} + \theta\,D_{it} + b\,DFC_{it} + u_{it}$$

$$Y_{it} = \eta_i + \kappa_t + \beta\,E_{it} + \gamma\,D_{it} + q\,BD_{it} + r\,FD_{it} + \delta\,ED_{it} + v_{it}$$

Y denotes deposit cost or net interest margin in the moderation equations. The total margin association is estimated without DFC in P2. The coefficient δ evaluates how digital investment changes the retail funding gradient of the common payment association.

Estimation and sensitivity analysis

Ordinary least squares with explicit fixed effect indicators estimates each equation. The primary financial panel and the smaller digital complete case panel are reported separately. Models used to discuss changes in coefficients share the same complete case rows. Missing investment disclosures remain missing and are not interpolated or substituted with values from other banks. The analysis reports coefficients, cluster adjusted standard errors, confidence intervals, residual degrees of freedom, root mean squared error and incremental explanatory power beyond the bank and year effects.

Uncertainty is clustered by bank using the CR1 finite sample adjustment, with the design matrix rank including the fixed effects. Conventional intervals use the Student distribution with seven degrees of freedom for the eight bank financial sample and six for the seven bank digital sample. Selected coefficients also receive a null imposed wild cluster bootstrap assessment, enumerating 256 and 128 Rademacher sign patterns respectively. Enumeration removes simulation error from resampling; it does not make the procedure an exact randomisation test or resolve the limitations of a small observational panel (MacKinnon et al., 2023; Abadie et al., 2023; Pustejovsky & Tipton, 2018).

Sensitivity analysis removes one bank at a time while holding the original exposure definitions and centring constants fixed. It reports coefficient ranges and sign reversals rather than presenting each omission as an independent confirmation. A retail share specific linear time trend examines whether the exposure association mainly reflects generic differential trends. An expanded 2019–2023 specification using contemporaneous investment examines sensitivity to timing and the available sample. These checks assess dependence on influential banks, functional form and measurement choices. They cannot remove endogeneity, establish an exclusion restriction or support population wide causal conclusions.\

RESULTS

The financial series contains 48 observed bank year records for 2019–2024. Forty records cover the common

financial and digital payment period of 2019–2023. The primary outcome panel contains 32 observations from 2020–2023, with 2019 providing the baseline exposure. The digital specifications use 26 observations from seven banks. Ping an lacks disclosed absolute technology inputs for the first two lagged years. Bank of Communications remains in the financial analysis but is excluded from the primary digital specifications because its technology input boundary expands in 2021 without an exact restated earlier level. The records are retained in the data and enter a separate sensitivity specification.

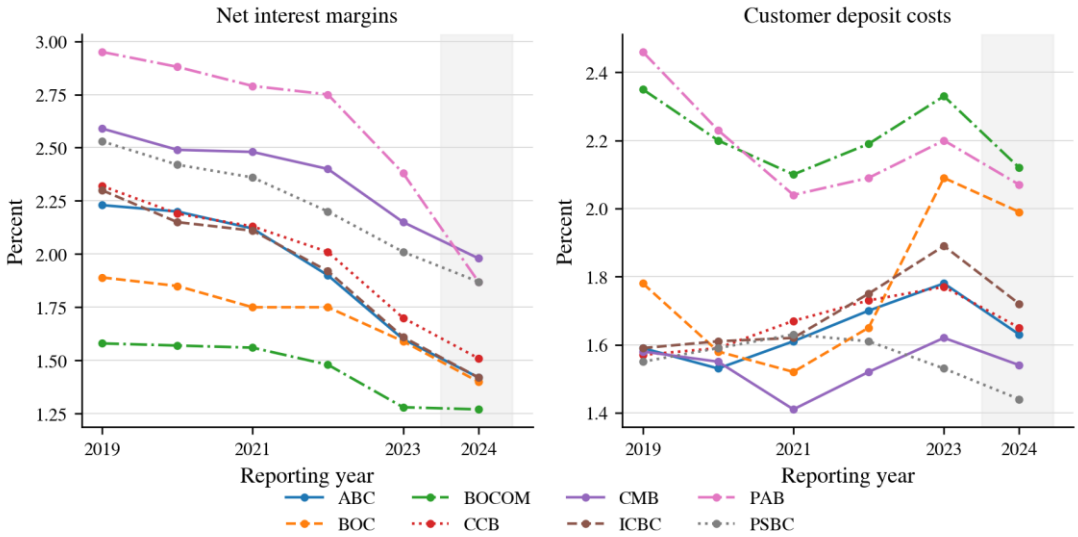
Average NIM across the eight banks falls from 2.299% in 2019 to 1.790% in 2023, a decline of 50.875 basis points. Average deposit cost rises from 1.809% to 1.901% over the same endpoints. The movement is uneven over time: the cost mean falls to 1.700% in 2021 before increasing. The 2024 extension shows average NIM of 1.593% and deposit cost of 1.770%. These are equal bank averages rather than asset weighted measures of China's banking industry. The payment subindex mean also fluctuates, declining from 277.131 in 2019 to 255.323 in 2023. It is therefore inappropriate to describe the observed index as a continuously increasing competitive shock.

Table 3 Equal bank financial means and the common payment indicator

Year	NIM %	Deposit cost %	Payment mean	Financial records
2019	2.299	1.809	277.131	8
2020	2.219	1.735	284.787	8
2021	2.163	1.700	274.589	8
2022	2.051	1.780	252.228	8
2023	1.790	1.901	255.323	8
2024	1.593	1.770	Unavailable	8

Note. 2019 is the exposure baseline. Primary financial outcomes cover 2020–2023. The 2024 financial extension is descriptive; no payment index was extrapolated.

Figure 2 Reported bank margins and customer deposit costs



Note. Series use the latest identified restated comparisons. Shading identifies the 2024 descriptive extension.

Financial data reconciliation and measurement consistency

Reliability concerns the reproducibility and comparability of the financial extraction. The 48 reported deposit cost rates can be reconstructed from the disclosed deposit interest expense and average deposit balance. The largest absolute difference is 0.004844 percentage points, consistent with rates reported to two decimal places. This reconciliation supports transcription accuracy; it does not validate the competition proxy. Historical NIM restatements and source boundaries are recorded separately. The digital input measure captures spending relative to organisational scale, leaving the implementation and effectiveness of transformation unobserved. Data reliability was assessed through source traceability, consistent definitions, ratio reconstruction and disclosure coverage. The economic interpretations of the competition and investment proxies were considered separately.

Table 4 Financial data consistency and model diagnostics

Assessment	Treatment	Evidence or reason
Deposit cost reconstruction	Applicable	48 ratios; maximum discrepancy 0.004844 percentage points
Source consistency	Applicable	Restated comparisons and definition changes identified
Design matrix and VIF	Applicable	Full rank; maximum within VIF 3.829

Estimation samples

F1–F3 use all 32 financial observations. P1–P5 use the same 26 digital complete cases, permitting comparison of the exposure, funding cost and interaction coefficients within a common sample.

Descriptive Statistics and Data Coverage

Across the 40 common period financial observations, mean NIM is 2.104% with a standard deviation of 0.414 percentage points; mean deposit cost is 1.785% with a standard deviation of 0.285. Digital investment density is available for 38 records and averages 8.299 basis points of total assets. This density combines reported technology inputs with asset scaling and should be interpreted in relation to its disclosed scope. The payment series contains all 31 provinces in each of the five common years, giving 155 underlying observations.

Table 5 Descriptive statistics for the common 2019–2023 period

Variable	**N**	**Mean**	**SD**	**Minimum**	**Maximum**
Net interest margin (%)	40	2.104	0.414	1.280	2.950
Deposit cost (%)	40	1.785	0.285	1.410	2.460
Digital investment density (bps assets)	38	8.299	2.872	5.093	15.002
Technology input (RMB million)	38	15,729.974	6,817.454	5,045.000	27,246.000

Note. The 40 financial records include the 2019 baseline. Two undisclosed Ping An investment inputs

remain missing. No imputation is used.

Indicator Distinctions and Multicollinearity

The financial measures are conceptually distinct: DFC measures remuneration on deposits, NIM combines asset interest income with several funding expenses, and digital investment density measures a technological input. The payment subindex originates outside the banks' own spending disclosures. These distinctions reduce direct duplication of measurement but do not establish that the exposure isolates competition. In particular, the deposit interest expense included in DFC also contributes to the numerator of NIM.

These variables share accounting inputs, but their definitions and economic interpretations remain distinct. All model matrices have full column rank. The maximum variance inflation factor after fixed effect residualisation is 3.829. This excludes perfect collinearity in the fitted design without establishing causal identification or validating the competition proxy.

Hypothesis Estimates and Uncertainty

P1 estimates an exposure coefficient of 0.161 in the deposit cost equation, with a 95% cluster interval from −0.320 to 0.643 and wild bootstrap p = .578. The sign agrees with H1, but the uncertainty does not support a clear positive relationship. P3 estimates the deposit cost coefficient in the margin equation at 0.089, with an interval from −0.808 to 0.986 and wild p = .969. The estimate does not support the negative relationship proposed in H2. The result concerns residual variation after conditioning, rather than the arithmetic effect of an isolated increase in interest expense.

P2 estimates an exposure coefficient of 0.149 for NIM, with an interval from −0.421 to 0.719 and wild p = .547. Its sign is opposite to H3. In P4, the exposure by digital investment coefficient is −3.658, with an interval from −11.718 to 4.402 and wild p = .344. This estimate has the buffering sign predicted in H4 but is imprecise. P5 gives an interaction coefficient of −1.849, with an interval from −5.322 to 1.623 and wild p = .406. Its sign is opposite to the positive moderation proposed in H5. None of the five predictions receives clear empirical support.

Table 6 Hypothesis estimates in the common digital sample

Hyp.	Model	Expected sign	Coefficient	CR1 SE	95% interval	Wild p
H1	P1	Positive	0.161	0.197	[-0.320, 0.643]	0.578
H2	P3	Negative	0.089	0.367	[-0.808, 0.986]	0.969
H3	P2	Negative	0.149	0.233	[-0.421, 0.719]	0.547
H4	P4	Negative	-3.658	3.294	[-11.718, 4.402]	0.344
H5	P5	Positive	-1.850	1.419	[-5.322, 1.623]	0.406

Note. N = 26; seven bank clusters. Intervals use t with six degrees of freedom. Wild p values enumerate 128 null imposed sign patterns. None of the five hypotheses receives clear support.

Table 7 Exposure and funding estimates in the full financial panel

Model	Outcome	Term	Coefficient	95% interval	Wild p
F1	Deposit cost	E	0.043	[-0.650, 0.737]	0.93
F2	NIM	E	0.169	[-0.162, 0.501]	0.055

F3	NIM	E	0.165	[-0.209, 0.538]	0.078
F3	NIM	DFC	0.104	[-0.552, 0.761]	0.906

Note. N = 32; eight bank clusters. All equations include bank and year effects. Intervals use t with seven degrees of freedom; 256 bootstrap patterns are enumerated.

Model Fit and Influence Diagnostics

Overall R^2 ranges from .875 to .987 among P1–P5 because persistent bank differences and shared annual developments explain much of the variation. Incremental R^2 relative to a bank and year effects only model is .319 for P1, .078 for P2 and .090 for P3.

It rises to .490 for the deposit interaction model and .547 for the margin interaction model. These gains describe in sample fit. With 26 observations and 15 estimated parameters in P4 and P5, eleven residual degrees of freedom remain.

The improvement does not independently establish a reliable interaction or predictive performance. The margin interaction model has a root mean squared residual of 0.035 percentage points. The moderation design has a maximum observation leverage of .947 at ABC in 2020, indicating substantial dependence on individual records.

After bank and year effects, exposure correlates −.881 with a baseline retail share specific linear trend. These diagnostics reinforce the difficulty of separating competition from differential adjustment. A high overall R^2 does not confirm the theoretical framework.

Table 8 Model explanatory power and residual fit

Model	N	Banks	Rank	Overall R^2	Within R^2	RMSE
P0	32	8	12	0.984	0.031	0.050
F1	32	8	12	0.907	0.003	0.079
F2	32	8	12	0.985	0.092	0.049
F3	32	8	13	0.985	0.118	0.048
P1	26	7	12	0.875	0.319	0.066
P2	26	7	12	0.973	0.078	0.050
P3	26	7	13	0.973	0.090	0.050
P4	26	7	15	0.907	0.490	0.057
P5	26	7	15	0.987	0.547	0.035

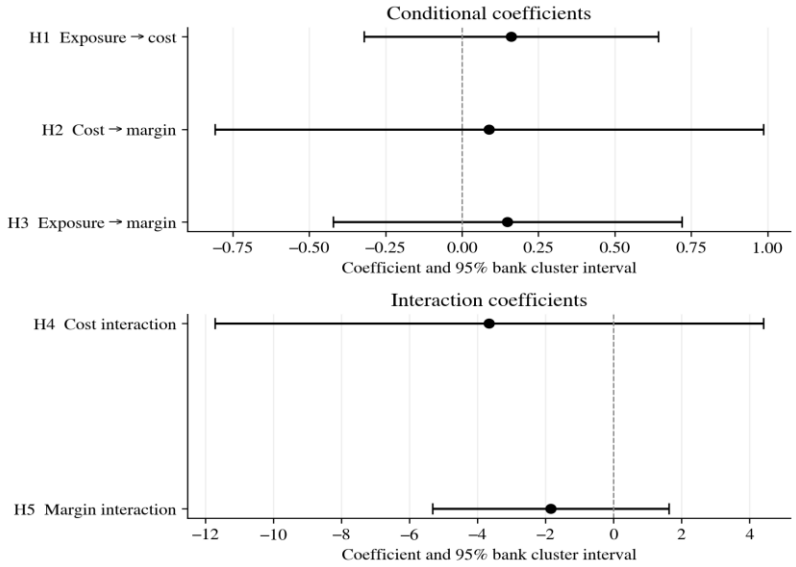
Note. Rank includes all bank and year indicators. Within R^2 measures improvement beyond those effects. RMSE uses the outcome percentage point scale and divides residual sum of squares by N.

Estimated Coefficients and Uncertainty

Figure 1 presents the hypothesised structure. Figure 3 displays the estimated coefficients and their

uncertainty. The arrows represent theory-guided observational relationships estimated in the bank and year fixed effect regressions.

Figure 3 Estimated hypothesis coefficients and bank cluster intervals



Note. Baseline coefficients and interactions use different regressor units. All intervals cross zero. The analysis is exploratory.

Influence and specification sensitivity

Influence analysis shows why the point estimates require caution. Removing one bank at a time changes the P1 exposure coefficient from 0.005 to 0.344, while the P2 margin coefficient ranges from 0.016 to 1.220. The P3 deposit cost coefficient changes sign, ranging from −0.567 to 0.357. The P4 interaction remains negative across these omissions but varies from −9.522 to −0.678. The P5 interaction ranges from −8.674 to 0.128 and therefore changes sign. Holding the original centres fixed ensures that these comparisons describe influence rather than a changing variable definition.

Adding a baseline retail share specific linear trend also changes the exposure estimates materially. The deposit equation coefficient becomes −0.429, and the margin coefficient becomes 0.428. Including Bank of Communications in the digital interaction specifications produces coefficients of −2.417 for deposit costs and −0.997 for margins. These results retain considerable uncertainty. The evidence does not distinguish a stable competitive mechanism from alternative differential trends with enough precision to support a general buffering conclusion. The finite panel provides documented financial patterns and estimates whose dependence on measurement and composition remains visible.

Table 9 Leave one bank out coefficient ranges

Model	Term	Minimum	Maximum	Sign changes
P1	E	0.005	0.344	No
P2	E	0.016	1.220	No
P3	DFC	-0.567	0.357	Yes
P4	ED	-9.522	-0.678	No
P5	ED	-8.674	0.128	Yes

Note. Original exposure definitions and centring constants are held fixed. These are influence diagnostics, not independent hypothesis confirmations.

Table 10 Observation leverage and model information

Model	N	Parameters	Residual df	Maximum leverage	Record
P1	26	12	14	0.766	PSBC 2020
P2	26	12	14	0.766	PSBC 2020
P3	26	13	13	0.795	PSBC 2020
P4	26	15	11	0.947	ABC 2020
P5	26	15	11	0.947	ABC 2020

Note. Leverage includes all bank and year indicators. The large moderation leverage qualifies the cluster uncertainty estimates. Exposure and the generic retail share time trend correlate −.881 after fixed effects.

DISCUSSION

The findings establish a decline in interest margins among the sampled banks, while leaving the proposed competitive mechanism unresolved. Mean NIM decreased from 2.30% in 2019 to 1.79% in 2023, equivalent to approximately 51 basis points. Mean deposit cost increased from 1.81% to 1.90% over the same interval, after initially declining during 2020 and 2021. These changes show that funding prices and margins followed different paths within the observation period. They are consistent with pressure on traditional intermediation, but their timing cannot identify the contribution of FinTech relative to monetary conditions, asset repricing or changes in deposit composition. Interest rate conditions can affect deposit spreads and bank earnings independently of technological competition (Wang, 2025).

China's interest rate reforms provide an additional institutional explanation for the different movements in deposit funding costs and net interest margins. The 2019 reform of the Loan Prime Rate (LPR) strengthened the transmission of market interest rates to bank lending rates, potentially affecting asset yields independently of FinTech competition (People's Bank of China [PBC], 2022). On the funding side, the June 2021 reform replaced the multiplier-based deposit rate ceiling with a benchmark-plus-basis-points mechanism. In April 2022, a market-oriented adjustment mechanism further encouraged banks to align deposit pricing with the one-year LPR and ten-year government bond yield (PBC, 2022). These reforms may have influenced deposit pricing and funding composition differently across banks. Lower lending yields and a shift towards higher-cost time deposits also contributed to margin pressure in China's banking sector during 2023 (World Bank, 2024). Although year fixed effects account for common annual shocks, they cannot exclude bank-specific responses to these reforms that correlate with baseline retail deposit shares. Such differences provide an alternative explanation for the estimated associations between FinTech exposure, deposit funding costs and net interest margins.

H1 receives no clear support. The exposure coefficient in the deposit cost equation is positive, at 0.161, but its interval spans negative and positive values and the wild bootstrap p value is 0.578. The direction accords with competition for transaction balances, yet the estimate remains imprecise. Previous evidence identifies deposit outflows and product responses around a specific Chinese platform innovation, and higher deposit costs following a defined competitive change in the United States (Buchak et al., 2021; Cumming et al., 2026). The present exposure measure instead combines initial retail funding with common payment

development. These designs capture different sources of variation, making coefficient magnitudes and inferential strength difficult to compare directly.

H2 is also unsupported. The conditional deposit cost coefficient is positive, at 0.089, with a wide interval and a wild bootstrap p value of 0.969. This result does not alter the accounting relationship between interest expense and net interest income. A regression coefficient describes joint balance sheet adjustment: banks paying higher deposit rates may also hold higher yielding assets, serve different borrowers or reprice lending and funding together.

After bank and year effects are removed, little independent pricing variation remains. Deposit franchises also differ in their ability to supply stable funding, while deposit value depends on capital and funding constraints (Drechsler et al., 2021; Bolton et al., 2025).

The positive exposure coefficient for NIM, at 0.149, provides no support for the negative relationship proposed in H3. Its uncertainty includes economically relevant associations in both directions. Research elsewhere finds adverse profitability associations with external FinTech growth, while Chinese evidence documents simultaneous improvements in some efficiency measures and deterioration in others (Phan et al., 2020; Zhao et al., 2022).

Competitive pressure may also operate through loan prices and market power, rather than exclusively through deposits (Chen et al., 2023; Cuadros-Solas et al., 2024). The present estimates cannot distinguish these channels or establish their relative importance.

The moderation results provide no clear evidence that digital investment protects funding costs or margins. The deposit cost interaction is negative, as proposed in H4, but remains imprecisely estimated. The NIM interaction is negative rather than the positive attenuation proposed in H5, and its interval also crosses zero. Expenditure can support systems integration and customer service, but investment intensity does not establish realised organisational capability. Efficiency gains may appear gradually, depend on implementation quality or benefit customers through lower prices rather than wider bank margins (Wang et al., 2021; Citterio et al., 2024). Evidence of adverse profitability associations during transformation further challenges a uniformly beneficial interpretation (Zhang, 2026).

The 2024 extension shows mean NIM declining to 1.59% while deposit cost falls to 1.77%. Lower funding prices therefore do not immediately reverse margin compression. Asset repricing, funding maturities and balance sheet composition require joint consideration. Distinct performance measures also matter: favourable stock market responses to FinTech development need not imply wider realised margins (Li et al., 2017). The evidence leaves the five hypothesised relationships unresolved.

CONCLUSION

This study examines FinTech exposure, deposit funding costs and net interest margins using public disclosures from eight Chinese banking groups. The analysis distinguishes the price of customer deposits from broader liability costs and treats digital expenditure as an input into transformation. Margin compression is substantial in the observed sample, but the estimated relationships do not provide clear support for the five hypotheses. The evidence therefore cannot establish that competitive digital payment development raised deposit costs, reduced margins or produced effects buffered by greater digital investment.

The study contributes an exploratory accounting-based approach that examines external digital payment development, reported deposit funding costs, technology investment and net interest margins within a common analytical framework. The documented measurement procedures and disclosure boundaries provide a foundation for further applications across different banking institutions. Extending the approach to unlisted city commercial and rural commercial banks, alongside more direct measures of deposit substitution and realised digital capabilities, would help assess whether the observed relationships extend across different banking models.

Implications of the study

The theoretical implication is that technological competition should be examined through separate funding, asset pricing and organisational channels. Deposit substitution provides a plausible mechanism, but the importance of transaction convenience, market conditions and bank responses can vary across institutions. Evidence that shadow banking changes the transmission of monetary conditions strengthens the case for studying the interaction between outside savings alternatives and conventional deposit franchises (Xiao, 2020). Digital transformation enters this relationship as a conditional organisational response, with benefits that may involve service quality, scale or resilience rather than margin preservation alone.

For bank management, the findings favour evaluating technology projects against specific operational outcomes. Relevant indicators include retention of active transaction accounts, the maturity composition of deposits, customer service performance and the cost of acquiring stable balances. Larger expenditure commitments should be assessed alongside implementation progress and changes in funding structure. Deposit pricing decisions also require a coordinated view of asset yields and maturity profiles. Maintaining a higher margin through more expensive or riskier lending would have different implications from retaining inexpensive transaction deposits through better services. The present estimates provide no basis for a universal investment threshold.

Comparable disclosure of technology expenditure and deposit pricing would improve regulatory assessment. Reporting could distinguish infrastructure maintenance, system development and operating expenses within consistent consolidation boundaries. Supervisory analysis should also distinguish customer benefits from bank profitability: accessible services can reduce financial rents, while rapid substitution can increase funding sensitivity. Assessment therefore requires service access, resilience and risk alongside margins. The unresolved estimates provide no basis for a universal policy prescription.

Limitations and Future Research Directions

The sample contains eight listed banking groups and four primary outcome years. It provides limited independent information about institutional responses, especially after accounting for bank and year effects. Digital specifications use 26 observations from seven banks, with unequal disclosure coverage. These constraints reduce statistical precision and limit the generalisability of the findings, particularly to unlisted city commercial and rural commercial banks whose funding structures and technology disclosures may differ from those of large listed institutions. Future research could extend the accounting-based approach to these banking categories where comparable disclosures are available, while incorporating longer observation periods to distinguish persistent business-model differences from short-term adjustments and changes in technology investment.

The exposure measure captures differences associated with initial retail deposit shares as a common payment index changes. It does not directly observe customers transferring balances to competing providers. Retail funding intensity may also influence responses to monetary easing, deposit maturities and pandemic conditions. These alternative explanations remain relevant even with fixed effects. Future studies could combine bank branch footprints, local platform activity and product level deposit flows. Greater geographical detail would also allow exposure to reflect the locations of deposit customers rather than the bank’s registered headquarters, particularly for nationally active banking groups. Clearly identified policy or technology changes could provide stronger designs where their institutional assumptions are credible.

Technology investment measures expenditure rather than successful transformation. Reporting boundaries differ across banks, and the change in BoCom's investment definition illustrates the difficulty of maintaining consistent comparisons. For BOC, ICBC, CMB and Ping An, Bank technology inputs are scaled by Group financial denominators, producing qualified investment ratios. Consolidated outcomes also include overseas business, whereas the payment indicator covers mainland China. Scaling expenditure by assets cannot resolve these scope differences. Future measures could combine consistent spending information with active digital usage, system integration and service performance. Such indicators should be evaluated separately before being combined into a broader capability measure.

Finally, deposit costs and margins reflect simultaneous pricing and portfolio decisions. The estimated pathways cannot identify a causal indirect effect, and lagging technology expenditure does not eliminate reverse causality or omitted influences. Future analysis could measure asset yields and funding composition directly, examine dynamic responses and quantify sensitivity to unobserved confounding (Cinelli & Hazlett, 2020). Interviews with treasury and technology managers could help explain specific adjustments, provided that accounts are linked to dated institutional evidence. These extensions would clarify when digital investment changes funding relationships and how those changes enter bank earnings.

Data Availability Statement

The analysis draws on publicly disclosed annual bank reports and the provincial payment subindex of the Peking University Digital Financial Inclusion Index of China (Guo et al., 2020). The accompanying analysis workbook documents the extracted bank-level observations, provincial index inputs, source locations and reported analytical outputs.

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