INSTITUTO
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DE LISBOA

The Impact of Fintech on the Operations of Chinese Commercial Banks

LAN Jiayi

Doctor of Management

Supervisors:
PhD José Paulo Afonso Esperança, Full Professor,
ISCTE University Institute of Lisbon
PhD LIU Bo, Professor,
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December, 2025

BUSINESS
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Jury:

PhD Leandro Luís Ferreira Pereira, Full Professor,
Iscte - Instituto Universitário de Lisboa
PhD António Rui Carvalho Carvalho, Associate Professor,
Universidade Lusófona
PhD Fernando Alberto Freitas Ferreira, Full Professor,
Iscte – Instituto Universitário de Lisboa
PhD TENG Ying, Professor,
UESTC - University of Electronic Science and Technology of China
PhD José Paulo Afonso Esperança, Full Professor,
Iscte – Instituto Universitário de Lisboa

December, 2025

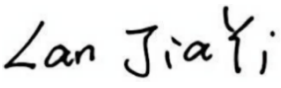
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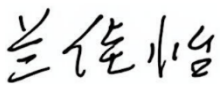
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Name: LAN Jiayi

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作者签名： 日期：2025.12.16

姓名(拼音)：LAN Jiayi

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Abstract

Commercial banks are the core of China's financial system, and the integration of Financial Technology (Fintech) is a key driver for optimizing operational efficiency and risk management. Exploring Fintech's impact on Chinese commercial banks can effectively help these institutions adjust technological application strategies, enhance competitiveness, and enable regulators to formulate targeted financial technology policies.

This study is based on an empirical study of the 2007–2022 financial data of 351 Chinese commercial banks from the China Research Data Services Platform (CNRDS). It analyzes Fintech's impact on three core dimensions: credit risk, bank governance, and operating performance. Furthermore, the study tests the heterogeneous impacts of Fintech across different bank types (listed vs. unlisted), regions (eastern, central, western), and sizes (large vs. small/local), and verifies findings through robustness tests. Fintech index, information asymmetry, capital adequacy ratio, agency costs, and ROA all have significant effects on the study's conclusions.

The main contribution of this thesis is to reveal Fintech's multi-dimensional impact mechanism on Chinese commercial banks, which not only helps commercial banks (especially unlisted, central-region, and small-scale ones) leverage Fintech to improve credit security, governance effectiveness, and operating performance, but also provides empirical support for promoting the healthy integration of Fintech and the commercial banking industry.

Keywords: Commercial bank, Fintech, Credit risk, Bank governance, Operating performance
JEL: C38, C52

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Resumo

Os bancos comerciais são o núcleo do sistema financeiro da China, e a integração da Tecnologia Financeira (*Fintech*) é um fator-chave para otimizar a sua eficiência operacional e gestão de riscos. Explorar o impacto da *Fintech* nos bancos comerciais chineses pode efetivamente ajudar essas instituições a ajustar as estratégias de aplicação tecnológica, aumentar a competitividade e fornecer contributos para os reguladores formularem políticas direcionadas de *Fintech*.

Esta tese conduz um estudo empírico baseado em dados financeiros de 2007-2022 de 351 bancos comerciais chineses da China Research Data Services Platform (CNRDS) para analisar os impactos da *Fintech* em três dimensões principais: risco de crédito, governança bancária e desempenho operacional. Além disso, o estudo testa os impactos heterogéneos das Fintech em diferentes tipos de bancos (cotados vs. não cotados), regiões (leste, centro, oeste) e tamanhos (grandes vs. pequenos/locais) e verifica os resultados através de testes de robustez. O índice *Fintech*, a assimetria de informação, o rácio de adequação de capital, os custos de agência e o retorno sobre os ativos (ROA) têm efeitos significativos nas conclusões do estudo.

A principal contribuição deste estudo consiste na identificação do mecanismo de impacto multidimensional da tecnologia financeira nos bancos comerciais chineses, que não só ajuda os bancos comerciais (especialmente os não cotados, da região central e de pequena escala) a alavancar o uso da *Fintech* para melhorar a segurança do crédito, a eficácia da governança e o desempenho operacional, mas também fornece suporte empírico para promover a integração saudável da *Fintech* no setor bancário comercial.

Palavras-chave: Banco comercial, Fintech, Risco de crédito, Governação Empresarial, Desempenho operacional

JEL: C38, C52

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摘要

商业银行是我国金融体系的核心，金融科技（Fintech）的融合成为优化商业银行运营效率与风险管理的关键驱动力。通过探究金融科技对中国商业银行的影响，能够有效帮助商业银行调整科技应用策略、提升核心竞争力，同时为监管部门制定有针对性的金融科技政策提供参考。

本论文基于中国研究数据服务平台（CNRDS）351 家商业银行 2007-2022 年的财务数据进行实证研究，从信贷风险、银行治理和经营绩效三个核心维度分析了金融科技的影响机制，进一步检验了金融科技在不同银行类型（上市/非上市）、地域分布（东/中/西部地区）及规模特征（大型/中小型）下的异质性影响，并通过稳健性检验验证了相关研究结论。研究结果表明：银行金融科技发展水平、信息不对称程度、资本充足率、代理成本及资产收益率（ROA）等变量对研究结论均具有显著影响。

本文主要贡献在于系统揭示了金融科技对中国商业银行的多维影响机制：既有助于商业银行（特别是非上市、中部地区及小规模银行）借助金融科技提升信贷安全、治理效能与经营绩效，又为推动金融科技与商业银行有效融合提供了实证依据。

关键词：商业银行，金融科技，信用风险，银行治理，经营绩效

JEL: C38, C52

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Acknowledgements

First and foremost, I would like to express my deepest gratitude to my two supervisors, Professor José Paulo Afonso Esperança and Professor Liu Bo, for their invaluable guidance and unwavering support throughout the entire process of this thesis. From the initial conception of the research topic to the final revision of the manuscript, Professor José Paulo Afonso Esperança and Professor Liu Bo have consistently provided profound academic insights, rigorous critical feedback, and patient advice that have been instrumental in shaping the direction and quality of this work. Their meticulous approach to research, profound expertise in commercial bank and Fintech and dedication to nurturing academic growth have not only helped me overcome numerous challenges during the research but also inspired me to pursue excellence in my future academic endeavors.

I also owe a heartfelt thanks to my family for their constant love, understanding, and encouragement. Their unwavering belief in me has been a strong source of motivation, especially during the difficult periods of research and writing. Whether it was providing a peaceful environment for study, offering emotional support when I faced setbacks, or simply cheering me on, their selfless contributions have made this journey possible. I am truly grateful for their patience and sacrifice, which have allowed me to focus on my academic goals without hesitation.

Additionally, I would like to extend my sincere appreciation to my friends and classmates. During the course of this thesis, we have engaged in countless meaningful discussions, shared ideas, and supported each other through the ups and downs of the research process. Their valuable suggestions, constructive critiques, and companionship have not only enriched my understanding of the subject but also made the academic journey more enjoyable and fulfilling. I am fortunate to have such a supportive community of peers who have motivated me to push my limits and strive for better results. Without their assistance, the completion of this thesis would not have been possible.

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致谢

首先，我谨向我的两位导师 José Paulo Afonso Esperança 教授和刘波教授致以最深切的谢意。从论文选题构思到最终稿的修订，他们始终以深厚的学术造诣、严谨的批判思维给予了耐心的指导和帮助，确保本论文的顺利完成。José Paulo Afonso Esperança 教授与刘波教授在商业银行与金融科技领域的精深专业素养、一丝不苟的治学态度，以及对学术传承的倾情投入，不仅帮助我克服了研究过程中的诸多困境，更激励我在未来学术道路上追求卓越。

衷心感谢我的家人始终如一的理解、支持与关爱，他们不仅为我提供宁静的学习环境，还在我遭遇挫折时给予情感慰藉和精神鼓舞，他们无私的付出始终是我前行路上最坚实的后盾。特别在研究与写作最艰难的阶段，正是家人坚定的信任给予了我持续奋进的动力，他们的包容与奉献使我能心无旁骛地追求学术理想。

同时，我要向挚友与同窗们表达诚挚的感激。在研究过程中，我们进行的无数次思想碰撞、知识共享与相互扶持，极大地拓展了我的研究视野。他们宝贵的建议、富有建设性的批评以及温暖陪伴，不仅深化了我对研究主题的认知，更让这段学术旅程充满收获与欢欣。很荣幸身处这样互助共进的学术集体，他们的激励促使我不断突破自我，追求更卓越的成果。若没有他们的帮助，本文的完成将难以实现。

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List of Abbreviations

Abbreviation	Full Name
ABC	Agricultural Bank of China
AT	Total-Asset Turnover Ratio
BSC	Balanced Scorecard
BOC	Bank of China
CCB	China Construction Bank
CI	Cost-Income Ratio
CNRDS	China Research Data Services Platform
CR	Cost Ratio
CSR	Corporate Social Responsibility
EVA	Economic Value Added
FCA	Financial Conduct Authority
Fintech	Financial Technology
FSB	Financial Stability Board
GDP	Gross Domestic Product
ICBC	Industrial and Commercial Bank of China
Lev	Leverage Ratio
NEC	National Economic Council
NI	Net Interest Margin
PCA	Principal Component Analysis
ROA	Return on Assets
ROE	Return on Equity
TARP	Troubled Asset Relief Program

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Chapter 1: Introduction

1.1 Background and significance

1.1.1 Background

Commercial banks play a dual role as enterprise and financial hubs, and as a core component of the modern financial system further attracting widespread attention due to their corporate nature. Whether it is policy makers, regulators, internal bank managers or even the vast number of bank depositors, they will naturally pay attention to the operations of commercial banks. From a macro perspective, the operations of commercial banks is directly related to the stability and development of the economy, and has a profound impact on the safety and soundness of the entire financial system; from a micro perspective, it determines the growth and progress of each commercial bank. Therefore, the study of commercial bank operations has always been an extremely important field in financial research and has also been the focus of financial practice (H. Wei & Liu, 2005). With the rapid development of financial technology (hereafter Fintech), the challenges faced by commercial banks' operations have become increasingly complex and diverse. Traditional commercial bank management research has been unable to adapt to the needs of the new competitive situation and changes in the business environment. It is of great necessity and practical significance to study the operations of commercial banks under the background of Fintech development.

The three most important aspects of commercial bank operations are credit risk management, corporate governance, and operating performance (Yao & Song, 2021). The main risk faced by commercial banks is credit risk, which is defined as the situation where the borrower or counterparty fails to perform its contractual obligations as agreed, resulting in the bank suffering economic losses. Credit risk is crucial in bank operations and directly affects the financial stability and profitability of banks. It is the core of bank risk management. Secondly, corporate governance of commercial banks is a framework on how to manage, supervise and organize the internal structure and operations of banks, aiming to ensure that banks operate in a transparent, responsible and effective manner, thereby protecting the rights and interests of shareholders and other stakeholders to the greatest extent. Effective bank governance can protect the rights and interests of bank shareholders, customers, employees and other

stakeholders. A sound bank governance framework can promote the operating efficiency of commercial banks. Through clear division of responsibilities and effective decision-making mechanisms, the coordination and execution efficiency within the organization can be improved. Finally, the operating performance of commercial banks is directly related to their profitability. The survival of enterprises requires banks to aim for profitability. In addition to bringing stable income and profits, good operating performance will also improve the competitiveness and sustainability of banks. At the same time, positive operating performance helps commercial banks maintain adequate capital levels, ensuring that they can cope with risks and meet regulatory requirements when facing adverse economic conditions or emergencies.

With the rapid development of information technology, Fintech has shown significant growth on a global scale. As an innovation engine that cannot be ignored in the global Fintech field, China has witnessed the rise of many Fintech companies in recent years, such as Alibaba, Tencent, JD and other pioneers. They have reshaped the traditional payment ecosystem with cutting-edge technological innovations. and new financial services architecture, significantly improving the convenience and customer experience of financial transactions (Arner et al., 2016).

Currently, China's economy is in a period of transition from high-speed growth to a high-quality development goal. Exploring how to promote high-quality economic development has become an important issue that needs to be resolved urgently. In the "*13th Five-Year Plan*" of National Science and Technology Innovation Plan released in 2016, China's Fintech policy direction has been clearly pointed out. Among them, blockchain and artificial intelligence, as important underlying technologies of Fintech, have been promoted to the level of national strategic height. The People's Bank of China released the "Fintech Development Plan (2019-2021)" in 2019, which aims to establish and improve the infrastructure for China's Fintech development. The plan points out the need to strengthen strategic layout and enhance Fintech innovation (M. Li et al., 2024). In 2022, the central bank released the second phase of the Fintech development plan, which marks that China's Fintech field has entered a new stage of accumulation of advantages from the early stage of infrastructure construction. The rapid development of Fintech not only supports the digital transformation of traditional financial institutions, but also plays an important role in promoting financial service innovation, improving efficiency and customer experience. With the implementation of this plan, China's Fintech industry will face more development opportunities and challenges. The widespread penetration of Fintech had a profound impact on the traditional operating paradigm and market positioning of traditional commercial banks, forcing commercial banks to adopt proactive

strategies in order to gain a firm foothold in the increasingly fierce market competition (W. H. Li & Jiang, 2017). Under this evolving trend, Chinese commercial banks have begun to explore the application of Fintech, aiming to use Fintech to empower business operations, enhance operational competitiveness, optimize business structure, and improve risk management and control mechanisms. In this context, it is important to shed new light on how does Fintech affect the credit risk management, promote the corporate governance, and affect commercial banks' operating performance. These issues are of common concern to the financial academic community and the industry. Research on these problems not only has important practical significance, but also has far-reaching forward-looking value.

1.1.2 Significance

The rapid development of Fintech is an important driving force for China's economic transformation and high-quality development. The application of Fintech has greatly improved the efficiency and quality of financial services (X. Lin, 2014). These technologies may optimize financial processes, enhance risk management capabilities and provide customers with more convenient and personalized services. With the continuous application of these cutting-edge technologies, the financial industry is undergoing profound changes, seeking more efficient resource allocation and service model innovation. This not only meets diversified financial needs, but also provides new development opportunities and growth points for Chinese commercial banks (Ba & Bai, 2016). This thesis aims to study the impact of Fintech on the operations of commercial banks.

This study examines whether the growing prominence of financial technology (Fintech) exerts a positive influence on the operations of commercial banks. Specifically, it investigates the impact of Fintech development on credit risk management, corporate governance, and operational performance, as well as the underlying economic logic, transmission channels, and mechanisms through which these effects occur. By doing so, this research contributes to a deeper understanding of how Fintech facilitates the transformation and development of the banking industry, and provides a theoretical and empirical basis for policy formulation and strategic decision-making in commercial banks.

(1) Theoretical significance of the research

From a theoretical perspective, the rise and rapid expansion of Fintech have brought new perspectives and challenges to traditional financial theories and banking business models. In the past, financial theories were largely based on offline operations and manual services, while Fintech has revolutionized the underlying architecture of financial services through online

platforms and intelligent services. In-depth research on the application of Fintech in the banking industry has not only deepened the analysis of financial innovation, technology integration and bank transformation mechanisms, but also injected new insights and academic materials into the theoretical system of Fintech, but also promoted the close connection between theory and practice, and promoted the integration and development of financial disciplines across fields.

Firstly, in traditional banking studies, banks, as financial intermediaries, play an important role in the financial system through functions such as information processing and risk management (Ding, 2009). However, with the rise of Fintech, traditional banking theory faces new challenges and opportunities. Fintech has introduced new technologies such as big data, artificial intelligence, blockchain and cloud computing, which have not only changed the business model of banks, but also challenged traditional banking views. By studying the application of Fintech in Chinese commercial banks, it is helpful for the financial community to expand and deepen traditional banking studies and form a modern banking theory framework based on information technology.

Secondly, studying the impact of Fintech on the business operations of commercial banks is helpful to test the theory of information asymmetry in the credit market (Yao & Song, 2021). Information asymmetry is a common phenomenon in the credit market, and the resulting adverse selection and moral hazard problems are important causes of credit risk. Financial economics introduces theories such as principal-agent theory and signaling theory to explore how to alleviate the problem of information asymmetry, but academics still have limited understanding of whether Fintech can effectively reduce information asymmetry and improve information transparency through means such as big data analysis, real-time monitoring and intelligent processing. Combined with the actual situation of China's financial system, studying the role of Fintech in alleviating information asymmetry in the credit market can promote the test of the theory of information asymmetry in the credit market, explore new information disclosure and risk management mechanisms, and provide theoretical support for the healthy development of China and also the global banking industry (Gu & Yang, 2018).

Thirdly, this thesis sorts out and summarizes the existing literature, supplements and improves the definition of relevant concepts of Fintech based on previous research, explains the development process of Fintech, and identifies relevant influencing factors and mechanisms through empirical quantitative analysis. This thesis will explore the impact of Fintech on the operations of commercial banks, and analyze the impact and mechanism from the three perspectives of credit risk, bank governance and operating performance. It delves into the different types of banks, providing empirical evidence for the enrichment of the theoretical

framework of banking and opening paths for subsequent research.

(2) Practical significance of research

From a practical perspective, at the 2019 Banking and Insurance Supervision and Management Work Conference, the China Banking and Insurance Regulatory Commission clearly stated that it is necessary to vigorously support private enterprises and small and micro enterprises, and encourage various financial institutions to improve the efficiency of financial services through various technical means (Xu & Ma, 2019). Financial-related policy makers and regulators attach importance to the application and promotion of Fintech by commercial banks. For policy makers, understanding how Fintech affects the operations of commercial banks is crucial to formulating a reasonable policy framework, which is conducive to policy makers to better and faster promote Fintech policies in the new environment. At the same time, regulators are faced with the dual tasks of promoting the development of Fintech and maintaining financial stability. On the one hand, regulators need to encourage banks to adopt advanced technical means to improve risk management capabilities and service quality; on the other hand, regulators also need to strengthen the monitoring of Fintech risks to ensure that the application of new technologies will not bring instability to the financial system. Therefore, regulators also need to understand the impact of Fintech on the operations of commercial banks, so as to consider how to balance the innovation and risks brought by Fintech, ensure the stability and fairness of the financial market, and provide quantitative and qualitative basis for regulators to issue corresponding laws and regulations and specific supervision implementation (W. H. Li & Jiang, 2017).

For financial institutions, in-depth research on how Fintech affects the operations of commercial banks can provide valuable strategic guidance. It contributes to the understanding of how Fintech impacts the accuracy of risk assessment, the internal governance structure and processes, and the profitability and cost structure of banks. In summary, it contributes to the improvement of commercial banks' operational capabilities, and to overcome problems and mistakes faced in the process of developing Fintech as highlighted by Yao and Song (2020).

1.2 Research contents and methods

1.2.1 Research contents

The full text is divided into seven chapters. The main contents of each chapter are as follows:

Chapter 1: Introduction. First, the research background is outlined, and the significance of

the research topic is explained from both theoretical and practical perspectives. Secondly, the general research content, the overall technical roadmap and contribution of the thesis are introduced.

Chapter 2: Literature review. The research on Fintech, especially the literature on its impact on the operations of commercial banks is reviewed, and the corresponding research results on the three aspects of commercial bank credit risk, bank governance and operating performance is sorted out, and a comprehensive review is conducted.

Chapter 3: Data Sources and Variable Construction. It presents the data employed and construct the explanatory variables and explained variables required for the empirical study.

Chapters 4-6: Empirical results and discussion about the impact of Fintech on the credit risk, governance, and operating performance of commercial banks, respectively. Firstly, it proposes testable theory-based hypotheses from theoretical analysis. Next, it presents the descriptive statistics and correlation analysis, and then empirically test the impact of Fintech on credit risk, governance, and operating performance of commercial banks. Finally, the heterogeneity analysis discusses whether different bank sizes, listing statuses, and different geographical distributions have significant differences in the impact of Fintech.

Chapter 7: Conclusion and future research. It summarizes the main conclusions and implications of this research, discusses the limitations and puts forward the prospects for future research.

1.2.2 Methods

The empirical research strategy of this thesis includes regression analysis, chart analysis, trend analysis, causality testing, mechanism testing, and heterogeneity analysis. This thesis considers the representativeness of banks and the availability of data, and extracts the unbalanced panel data of 351 commercial banks in China from 2007 to 2022 from the CNRDS (China Research Data Service) database, which is a very authoritative academic database and many top-tier journal papers use it, as the research sample (P. Guo & Shen, 2015). Since the period experienced the intersection of the two development stages of financial technology, it can objectively reflect the impact of financial technology on China's commercial banks. This sample includes 59 listed banks and 292 unlisted banks. The 351 banks include 6 state-owned commercial banks, 198 rural commercial banks, 124 city commercial banks, 12 joint-stock commercial banks, 3 foreign banks, 7 private banks, and 1 other commercial bank. The continuous variables in the data are winsorized at the upper and lower 1% level to avoid the influence of extreme values, and after retaining the non-missing values of the variables, the

final sample has a total of 1980 observations.

1.2.3 Contribution

The existing literature has not reached a consensus on the impact of Fintech on commercial banks. Early studies explored the impact of emerging technologies and institutions on the banking industry, especially focusing on the impact of Internet finance, and many findings showed a negative impact of Fintech on commercial banks' performance. However, in recent years, with the increasingly clear definition of the Fintech concept and the progress in data acquisition, the conclusions of most studies have found that Fintech is beneficial to the banking industry. The fundamental reason for this difference in viewpoints lies in the different research perspectives: early research focused more on the costs of emerging technologies adoption by the banking industry, while recent research focuses more on how banks use Fintech to innovate and develop, and pays more attention to the impact of Fintech empowerment on commercial banks.

Empirically, many studies on the impact of Fintech on commercial banks use data at the provincial level to construct Fintech indexes instead of using individual banks or directly adopting the method of constructing an Internet finance index as a proxy indicator. The two current measurement indicators fail to fully capture the rapid development of core technologies such as big data and artificial intelligence, and the construction standards of these indicators lack consistency. Moreover, these methods examine how Fintech affects banks relatively indirectly, and may not reflect the substantial changes brought about by the application of Fintech to commercial banks. In addition, many studies focus on the impact of Fintech on specific indicators of commercial banks, lacking a comprehensive consideration of the overall operations of commercial banks, which may lead to a narrow perspective of policy recommendations.

In contrast, this thesis contributes to the literature by analyzing the impact of Fintech on commercial bank operations from the three key dimensions of credit risk, governance level and operating performance, and put forward targeted policy recommendations based on this, aiming to provide a more comprehensive perspective and help financial institutions and policymakers to make practical decisions, and quantitatively measuring the impact of Fintech from multiple dimensions at the individual level of commercial banks, which is more direct and in-depth, and to a certain extent fills the gap of existing literature.

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Chapter 2: Literature Review

2.1 Research on Fintech

2.1.1 The emergence and evolution of Fintech

Although Fintech has become a recent hot topic, its core, the integration of information technology and finance, has been discussed for decades. King and Levine (1993) argued that the operational mechanisms of financial systems were pivotal to economic growth—a theoretical underpinning essential to contextualizing the emergence and evolution of Fintech. Allen et al. (2002) argued that the conceptualization of e-finance and its core research agendas laid an essential theoretical groundwork for investigating the emergence and evolution of Fintech. They defined e-finance as the delivery of financial services and the operations of financial markets through electronic communication and computational technologies. After analyzing the history of Fintech development, Xue and Hu (2020) proposed that the development of Fintech can be divided into three stages, namely germination, start-up and development. They believe that the maturity of today's Fintech is sufficient to become the core driving force for promoting the economy to move towards higher quality development. However, Zalan and Toufaily (2017) revealed that Fintech innovations—digital technology-driven innovations by financial services providers—were widely deemed disruptive to the financial services industry, a key dimension for analyzing The emergence and evolution of Fintech. They clarified that their paper aimed to investigate industry participants' perceptions of digital disruption and the strategies incumbents adopted to address Fintech challengers. Their study contributed unique insights to disruptive innovation literature, particularly Fintech in emerging markets, highlighting that this collaborative strategy conflicted with conventional recommendations for incumbents in disruptive innovation theory.

Fintech combines the fields of finance and technology. Although its name intuitively explains the intertwining of finance and technology, academics and practitioners are still exploring the description of its nature and boundaries, and have not achieved a precise consensus definition. Many international and Chinese organizations have put forward their own views on Fintech. According to the British Financial Conduct Authority (FCA) in 2015, Fintech is the enabling tool that empowers financial service providers to cross the intermediary link and

establish direct contact with end users, thus realizing the decentralization of financial transactions intermediation. In the 2016 statement of the Financial Stability Board (FSB), the connotation of Fintech refers to the changes in the financial industry triggered by technological innovation. This change has the effect of redefining business models, optimizing business processes, and creating innovative products. Fintech has disrupted the structure of financial markets and profoundly impacted the functions of financial institutions and the delivery model of financial services. It not only changes the way traditional finance operates, but also provides new paths and opportunities for future development. The U.S. National Economic Council (NEC) pointed out in 2017 that technologies that can have a significant effect on the operating model of the financial industry can be classified as Fintech. The "Fintech Development Plan (2019-2021)" was released by the People's Bank of China, in which Fintech innovation is regarded as a product driven by technology, which promotes the innovation of financial products, improves the operating strategies of financial institutions, and optimizes the development of financial businesses. process, thereby improving the quality development and efficiency of the financial industry.

Similarly, academic studies have proposed incisive definitions and unique insights, enriching the theoretical framework and cognitive dimensions of this field. Ba and Bai (2016) believe that Fintech is essentially a technological approach that embeds technological power into the financial services field, aiming to benefit the general public and optimize industry performance by reducing costs and improving efficiency. The view of Y. Ma and Liu (2017) revealed that central to analyzing the emergence and evolution of Fintech, was that Fintech represents a series of far-reaching technologies that can significantly change the nature of financial transactions and the way financial services are provided. They noted that around 2014, the term "Fintech"—an abbreviation of "Financial Technology"—began to be widely adopted to denote the influx of technological tools, platforms, and ecosystems that enhanced the accessibility, efficiency, and affordability of financial services and products, with crowdfunding as merely one component of Fintech. Pi and Zhao (2014) pointed out that Fintech is financial innovation driven by cutting-edge technology. It innovates the traditional financial business model and opens a new chapter in the financial services field, indicating the future direction of the industry.

2.1.2 Characteristics of Fintech

As the latest technology to improve or replace traditional financial services, Fintech has greatly improved the degree of financialization and service efficiency by integrating big data, artificial

intelligence, blockchain, and other advanced technologies. The Fintech field exhibits a series of significant characteristics, including its important characteristics such as innovation, accuracy, efficiency, inclusiveness and disintermediation. A distinctive feature of Fintech is its technology-driven innovation. This innovation is not only reflected in products and services but also in business models, promoting the rapid iteration and development of financial services. Fintech also emphasizes accuracy and can accurately capture customer needs and provide customized services through big data analysis. Fintech can improve efficiency, as it optimizes processes through automation and algorithms, speeds up the integration and transmission of information, improves the accuracy of financial operations and reduces costs.

Fintech is also inclusive, enabling more people to enjoy efficient and convenient financial services, and strengthening the protection of financial consumers. Secondly, it can benefit small and medium-sized enterprises, giving full play to its inclusive benefits at both the production and consumption ends. Finally, Fintech can effectively weaken or even eliminate the status of traditional financial intermediaries, achieve financial decentralization, and realize a direct connection between the demand side and the supply side of funds.

Kotarba (2016) pointed out that, in the context of exploring the Characteristics of Fintech, Fintech's inherent traits—innovative spirit, professional focus, and technological agility—enabled it to rapidly deliver efficient solutions to complex financial challenges, thereby demonstrating its transformative potential and value in modern financial services. X. Zhou et al. (2024) found that with the empowerment of Fintech, the accuracy of commercial banks' credit supply to small and micro enterprises has been significantly improved. W. H. Li and Jiang (2017) pointed out that Fintech has significantly reduced service costs and improved the economic efficiency of financial operations. Through technological empowerment, the response speed and processing capabilities of financial services have been greatly improved, achieving efficiency improvements. Arner et al. (2016) argued that, Fintech's core trait lies in significantly optimizing service costs and efficiency in payment and settlement, investment and financing, and risk management, thereby comprehensively improving financial operational efficiency and quality; they also pointed out that regulatory changes and technological advancements post-2008 Global Financial Crisis were fundamentally reshaping financial markets, services and institutions, with RegTech (technology applied in regulatory monitoring, reporting and compliance) emerging at their intersection. Yin (2017) argued that the promotion and application of Fintech has opened up a path to formal financial networks for those who have not yet been integrated into the traditional banking system, are in poverty, and are marginalized in economic activities. At the same time, it also brings a more convenient and

efficient financial service experience to existing customer groups.

M. Li et al. (2024) argued that banks' empowerment of Fintech has a structural inclusive effect on urban entrepreneurial activities to a certain extent and effectively promoted the entrepreneurial activities of small-scale market entities. Arner et al. (2020) claimed that Fintech is a key driving force in promoting inclusive finance. Demertzis et al. (2018) contended that, regarding the Characteristics of Fintech, Fintech—characterized by the integration of new business models and technological innovation—exerted an unprecedented impact on the status of existing financial service providers and market organizers, indicating that the financial intermediary structure might undergo fundamental changes and drive the financial industry into a fast lane of innovation and transformation. Z. Zhao (2017) suggested that blockchain technology relies on innovative means such as distributed data storage, encryption algorithms and consensus mechanisms to create a new distributed "transparent general ledger" in the Internet era, which can achieve the decentralization of financial information. Schueffel (2021) argued that, business processes could be executed without the intervention of financial intermediaries through the application of blockchain-like programming logic, a key technical characteristic underpinning decentralized financial models, thereby fostering the "rise of peer-to-peer financial contracts".

2.2 Research on commercial bank operations

2.2.1 Commercial bank credit risk

Many scholars are committed to exploring the field of bank credit risk, and their academic contributions are too numerous to mention. Given this, we focus specifically on literature reviews that provide an in-depth analysis of the determinants of bank credit risk. First of all, the macroeconomic environment has a profound impact on banking business risks, which has been understood and emphasized by many cutting-edge researchers. Rajan (1994) argued that, focusing on commercial bank credit risk, they proposed a business cycle theory to explain how such risk evolves with economic fluctuations, pointing out that excessive credit growth during economic booms might weaken loan quality and thereby elevate credit risk, while credit contraction in economic recessions could increase borrowers' default probability and further raise credit risk levels; they further questioned why changes in credit policies seemed to correlate with changes in the circumstances of credit demanders in a rational profit-maximizing world—where banks should only maintain a credit policy of lending if and only if borrowers

held positive net present value projects—arguing that rational bank managers with short-term horizons would formulate credit policies that both influenced and were influenced by other banks and demand-side conditions, which gave rise to a theory of low-frequency business cycles driven by bank credit policies, and noted that evidence from the New England banking crisis in the early 1990s was consistent with the theory's assumptions and predictions. These findings help us better understand the cyclical characteristics of credit risk and provide a theoretical basis for financial institutions to adjust risk management strategies in different economic environments.

Borio and Zhu (2012) argued that focusing on commercial bank credit risk, they identified the "risk-taking channel" of monetary policy—a previously underemphasized link between monetary policy and economic agents' risk perception and pricing—as a core mechanism through which monetary policy influences bank credit risk, pointing out that a persistent loose monetary policy environment, characterized by long-term low interest rates, would drive banks to lower credit approval thresholds and increase lending to higher-risk projects, thereby pushing up overall credit risk levels, while also concealing the risk of triggering irrational asset price surges and bubble formation that, once burst, would severely impact banks' balance sheets, inevitably leading to a surge in credit losses and non-performing loans and posing a serious threat to banks' financial stability. Angeloni and Faia (2013) revealed that, focusing on commercial bank credit risk, they constructed a macroeconomic model incorporating banks optimized for vulnerability to runs to explore the transmission of monetary policy and its interaction with bank capital regulation in the context of risky banks, and they found that both monetary expansion and positive productivity shocks would drive up bank leverage ratios and increase credit risk—explaining that monetary expansion was typically accompanied by rapid credit growth, prompting banks to expand operations with higher leverage and thus elevate their risk exposure, while positive productivity shocks, despite boosting economic growth, would incentivize banks to engage more actively in risky investments and further raise credit risk levels.

In addition, Antzoulatos and Tsoumas (2014) found that, focusing on commercial bank credit risk, a bank's credit risk was affected by its own management quality and the credit rating of its host country, pointing out that countries with higher credit ratings generally had better macroeconomic environments and stricter regulatory measures to help reduce banks' credit risk, while management quality—encompassing the bank's governance structure, risk management capabilities, and internal control mechanisms—had a direct impact on credit risk, with banks with higher management levels typically able to identify and manage risks more effectively,

thereby lowering their credit risk; they further developed a model to examine the expected government support for banks rated by Moody's and Fitch, explicitly incorporating governments' capacity and willingness to provide support when needed as well as their concerns about moral hazard (i.e., that expected support might induce banks to take on greater risks).

Market characteristics are also important factors affecting bank credit risks. The degree of market competition, interest rate levels and market structure will all have an impact on banks' risk-taking behavior. Banks in highly competitive markets may lower lending standards and increase riskier loans to maintain market share, thereby increasing credit risk. Changes in interest rate levels will affect the profitability of banks and the repayment ability of borrowers. Rising interest rates will usually increase the burden on borrowers and increase default rates. The bank's characteristics, such as capital structure, asset quality and operating strategy, also have an important impact on credit risk. Banks with higher capital adequacy ratios generally have stronger risk resilience, while banks with poorer asset quality face higher default risks. In terms of business strategies, banks that adopt conservative credit policies and strict risk control measures generally have lower credit risks. Some literature has discussed the impact of market characteristics on bank credit risk.

Boyd and De NicolÓ (2005) found that commercial banks might increase their credit risk-taking behavior in less competitive markets, as in an environment lacking competitive pressure, they tend to loosen risk control measures to pursue higher profits. They further noted that a large body of literature had concluded that when facing intensified competition, banks would rationally select riskier portfolios, and pointed out that such literature had exerted a significant influence on regulators and central bankers. However, Wagner (2011) showed that the impact of market competition on commercial bank credit risk would be reversed when banking institutions adjusted their loan portfolio decisions; specifically, when banks could diversify the risks of their loan portfolios, increased competition would instead prompt them to adopt more prudent risk management strategies, thereby reducing overall credit risk. He further explored board independence and competence as separate but inherently interconnected facets of board efficacy—elements pertinent to commercial bank credit risk governance, as board decisions exert a pivotal influence on banks' risk-taking conduct. Furthermore, Martinez-Miera and Repullo (2010) revealed that there exists a U-shaped relationship between market competition and commercial bank credit risk; specifically, when market competition is low, banks tend to increase credit risk-taking to pursue higher returns, while in an environment of intense competition, they may relax lending standards to attract customers, thereby elevating credit risk.

They further noted that a substantial body of theoretical literature had posited that competition diminishes banks' franchise values and drives them to assume greater credit risk, but recent scholarly work had challenged this conclusion by arguing that lower interest rates charged by banks amid competition incentivize borrowers to opt for safer investment projects, which in turn reduces banks' risk exposure. However, they pointed out that this counterargument failed to account for the fact that lower interest rates also curtail banks' revenue streams from performing loans. By incorporating this overlooked effect into their analysis, they demonstrated that a U-shaped relationship between market competition and commercial banks' credit risk (and thus their failure risk) typically emerges. Jiménez et al. (2013) found that the aforementioned "U-shaped" relationship primarily exists in the loan market, indicating that the degree of competition in the loan market exerts a significant impact on commercial banks' credit risk-taking behaviors. They pointed out that a recent study by Martinez-Miera and Repullo (2010) had theoretically demonstrated the existence of a nonlinear relationship between bank competition and risk-taking in the loan market, and they tested this hypothesis using data from the Spanish banking system. Overall, they emphasized that the results highlighted the empirical relevance of the Martinez-Miera and Repullo model, even though further analyses across other banking markets were required. Hellmann and Puri (2000) found that the motivation of commercial banks to engage in credit risk-taking would be significantly reduced when the banking industry engaged in market collusion

Finally, some studies examined the impact of bank characteristics on bank credit risk. Saunders et al. (1990) pointed out that, in the context of the impact of bank characteristics on bank credit risk, banks controlled by shareholders have incentives to take higher credit risks than those controlled by management—they argued that shareholder-controlled banks are more likely to pursue high-risk, high-return investment strategies to maximize shareholder interests, while managerially controlled banks may focus more on sound operations and avoid excessive credit risks. Kwan and Eisenbeis (1997) found that, in the context of the impact of bank characteristics on bank credit risk, inefficiency exerts a positive influence on credit risk, demonstrating that banks with inefficient operations tend to have inadequate management and weaker risk control capabilities, thereby leading to higher credit risks. Jeitschko and Jeung (2005) showed that, an increase in bank capital levels would first lead to a rise in credit risk and then a reduction in it—they explained that an initial increase in capital might encourage banks to expand their loan scale and enhance risk-taking, but when the capital adequacy ratio reached a certain level, their risk control capabilities would be strengthened and credit risks would start to decline. Podpiera and Weill (2008) found that, there is a significant serial correlation between

credit risk (manifested as non-performing loans) and bank cost efficiency, noting that banks with lower cost efficiency are more prone to management and operational problems, thereby increasing credit risk. They further investigated the causal relationship between non-performing loans and cost efficiency to identify the deep determinant of bank failures, a topic relevant given that a substantial number of bank failures occurred in transition countries from the 1990s to the early 2000s, which were linked to rising non-performing loans and deteriorating bank cost efficiency. They extended the Granger causality model proposed by Berger et al. (2005) by applying GMM dynamic panel estimators to a panel dataset of Czech banks spanning 1994 to 2005. Their findings supported the bad management hypothesis, which posits that deteriorations in cost efficiency precede increases in non-performing loans. Consequently, they argued that banking supervisors should focus on enhancing banks' cost efficiency to reduce the likelihood of bank failures in transition countries. Delis and Kouretas (2011) pointed out that bank credit risk will also be affected by its capital adequacy ratio. Banks with high capital adequacy ratios generally have greater risk resilience and therefore have lower credit risks. Fiordelisi et al. (2011) showed that, bank credit risk is also affected by their capital adequacy ratio—banks with high capital adequacy ratios generally possess stronger risk resilience and thus exhibit lower credit risks. They further noted that a recent strand of research regarded the low-interest-rate environment from the early to mid-2000s as a factor that had triggered an elevated appetite for risk-taking among banks in pursuit of higher yields. To explore this, they utilized approximately 18,000 annual observations of euro area banks spanning the period 2001–2008, and presented robust empirical evidence that low interest rates indeed significantly increased bank risk-taking. This result held firm across multiple different specifications, which accounted for factors such as the potential endogeneity of interest rates and/or the dynamics of bank risk. Notably, among the banks of large euro area countries, this effect was less pronounced for French institutions, which had maintained an average relatively low level of risky assets. Finally, their analysis of the distributional effects of interest rates on bank risk-taking arising from individual bank characteristics revealed that the impact of interest rates on risky assets was mitigated for banks with higher equity capital (a key bank characteristic linked to credit risk resilience) and amplified for banks with higher off-balance sheet items. Khan et al. (2017) studied the relationship between funding liquidity and bank risk-taking, and showed that bank size and capital buffers typically restrict banks from assuming more credit risks, while banks with strong funding liquidity can respond more flexibly to market changes, thereby reducing their risk exposure. They further examined this relationship using quarterly data of U.S. bank holding companies spanning 1986 to 2014, and found evidence that banks with lower funding liquidity

risk—proxied by higher deposit ratios—tend to take more credit risk. Specifically, they found that a reduction in banks' funding liquidity risk heightened their risk-taking, as indicated by higher risk-weighted assets, greater liquidity creation, and lower Z-scores. However, their results also confirmed that bank size and capital buffers usually constrained banks from taking on more risk when their funding liquidity risk was lower. Additionally, during the Global Financial Crisis, banks with lower funding liquidity risk assumed less risk. They noted that the findings of their study had implications for bank regulators who advocate for stricter liquidity and capital requirements for banks under Basel III. M. A. Chen et al. (2019) found that risk capital plays a key role in the impact of capital adequacy ratios on credit risk, noting that this finding revealed how capital adequacy regulations affect financial institutions' risk management strategies through risk capital—thereby providing new insights for policy formulation and credit risk control in the context of the impact of bank characteristics on bank credit risk. They further provided large-scale evidence regarding the occurrence and value of Fintech innovation: using patent filing data spanning 2003 to 2017, they applied machine learning techniques to identify and classify innovations based on their underlying technologies. Their analysis showed that most Fintech innovations generated substantial value for innovators, with blockchain technology being particularly valuable. For the financial sector as a whole, the most valuable types of innovations were the Internet of Things (IoT), robo-advising, and blockchain. They also found that innovations exerted more negative impacts on financial industries when they involved disruptive technologies from non-financial startups; however, market leaders that invested heavily in their own innovation efforts could avoid most of these negative value effects.

In general, the literature on the determinants of bank credit risk mainly starts from perspectives such as the macro environment, market characteristics, and bank characteristics. However, in the current environment of the rapid development of Fintech, there is still a lack of literature on how credit risk will be affected by Fintech. Although some studies have explored the role of Fintech in improving bank operational efficiency and customer experience, there is still a lack of systematic research on its specific impact on credit risk. The research gap in this area will limit the industry and regulators' comprehensive understanding of the role and effect of Fintech in bank risk management. Therefore, we will focus on exploring the impact mechanism of Fintech applications on bank credit risk through empirical research. We will also examine the heterogeneous impact of Fintech on the credit risk of different types of banks (such as large banks, small and medium-sized banks, and Internet banks).

2.2.2 Commercial bank governance

The exploration of corporate governance has long been ingrained in commercial enterprises in a broad sense, and research in this field has become increasingly sophisticated and has almost reached a mature stage. Although many in-depth analyzes of the governance challenges of commercial banks have recently emerged in the academic world, and these studies have made significant progress, there has yet to be a systematic governance theory system that specifically addresses the unique attributes of commercial banks. Given this, this section will first review and refine previous academic research results on the definition of commercial bank governance.

In a document issued by the Basel Committee in 2006, the Basel Committee gave the most internationally recognized definition of corporate governance of commercial banks. The document defined commercial bank governance as the board of directors and senior management achieving comprehensive control over bank operations through daily decision-making and analysis. Bank governance covers a wide range. First of all, it includes the boundaries of banking business activities and management and operation methods. Secondly, it includes how to protect the legal rights of relevant parties in the bank and solve the problem of interest distribution among bank stakeholders. Finally, bank governance also requires maintaining safety. stability and liquidity, focusing on the bank's profitability, and ultimately ensuring the bank's stable operations. This comprehensive governance structure ensures that the bank can continue to develop and respond to various challenges in a complex financial environment. In China, the most authoritative definition of commercial bank governance comes from the "Commercial Bank Governance Guidelines" issued by the China Banking Regulatory Commission in 2013. The guidelines clearly state that the governance structure system of commercial banks widely covers everything from shareholders' meetings to the board of directors, supervisory board, and senior management, and explores the intricate interactions between shareholders and various stakeholders. This system not only focuses on building a reasonable organizational framework, defining clear responsibility boundaries, and establishing implementation standards, but also goes deep into the balanced mechanism of governance to ensure that decision-making, implementation, supervision, and incentive measures can be closely coordinated and operate smoothly.

Furthermore, the guidelines establish the core essence of bank governance, that is, each governance entity needs to maintain independent operations while effectively achieving mutual checks, balances and collaboration, and promoting a significant improvement in overall governance effectiveness. This principle aims to create a governance environment that both

stimulates vitality and ensures robust operations. To achieve this goal, banks need to establish a sound incentive mechanism and constraint system to ensure that the decision-making process is scientific and efficient, the execution links are strong and in place, and the supervisory function is fully exerted, thereby promoting the sustainable development of commercial banks. The definitions and principles proposed in the Guidelines clearly distinguish between general enterprise corporate governance and commercial bank corporate governance, while emphasizing the importance of an overall perspective under the concept of stakeholder governance. It advocates that bank governance should adopt a comprehensive and balanced perspective, treating the rights and interests of all stakeholders as equally critical, and shaping bank decisions and behaviors on this basis to achieve synergy and stability in the financial system.

In the initial stage of academic research on corporate governance, commercial banks were regarded as an external regulatory mechanism that played a pivotal role in the corporate governance framework, effective capital allocation and the promotion of industrial evolution. Early research on the governance structure of commercial banks tended to treat them as regular enterprises and directly apply the governance theory applicable to ordinary companies. However, as the research deepened, people gradually realized that the governance characteristics and operating mechanisms of commercial banks actually require a unique governance model that is different from that of ordinary enterprises.

Diamond and Dybvig (1983) argued that the core function of commercial banks lies in liquidity creation, which is accomplished by allocating illiquid assets and supplying highly liquid liability products; they further demonstrated that bank deposit contracts can deliver superior allocations compared to exchange markets, thereby explaining how banks vulnerable to runs are able to attract deposits. They noted that investors face privately observed risks that generate a demand for liquidity, and that traditional demand deposit contracts designed to provide liquidity exhibit multiple equilibria—one of which is a bank run. They emphasized that such bank runs in their model inflict real economic harm rather than merely reflecting other underlying issues, and explored contracts capable of preventing runs; their analysis revealed that there are circumstances where government-provided deposit insurance can yield superior contractual arrangements. Accordingly, they advocated that the governance theory of commercial banks should be systematically sorted out based on general corporate governance theory, with tailored research conducted to address the unique characteristics of the banking industry, which is integral to optimizing the aforementioned liquidity creation function and mitigating run risks through effective commercial bank governance. Caprio and Levine (2002)

attributed the fundamental difference in governance structure between the banking sector and general corporations to the rigorous regulatory environment they operate under, contending that such high-intensity regulatory requirements have shaped the unique governance models and practices of banks. They further employed standard corporate governance theories to highlight the distinctive problems confronting the corporate governance of financial intermediaries—particularly commercial banks—and integrated this theoretical perspective with international observations to propose policy recommendations. They noted that standard agency theory defines the corporate governance problem in terms of how equity and debt holders influence managers to act in the best interests of capital providers, and emphasized that commercial banks, as a core type of financial intermediary, possess special attributes that intensify these standard corporate governance challenges. Moreover, they pointed out that pervasive government involvement creates additional impediments to effective corporate control in the banking sector. They concluded that addressing the governance issues specific to commercial banks demands special attention and an approach that clarifies the role of governmental authorities, which echoes their earlier assertion that regulatory environments are pivotal in shaping the unique governance landscape of the banking industry distinct from general corporations.

W. A. Li and Cao (2005) pointed out that commercial banks are not only different from conventional enterprises in terms of contractual agreements, product design and capital allocation, but also have unique internal and external governance structures. Internally, it is reflected in the layout of the equity structure and the operating mechanism of the board of directors; externally, it is manifested in governance measures such as the strictness of the regulatory framework and the standardization of mergers and acquisitions. Therefore, they emphasized that the essence of bank governance lies in the ingenious integration of general corporate governance principles with the unique operating environment of commercial banks to build a governance system that can respond to both general market rules and bank-specific needs. Q. Yang and Yang (2006) analyzed the dual sources of the particularity of commercial bank governance in their economics paper.

On the one hand, these unique characteristics are rooted in the inherent operational characteristics of banks, including the structure of their balance sheets, the diversity of financial products, and the complex principal-agent relationship. On the other hand, the different faces of bank governance mechanisms in dealing with differences in internal and external environments are also key factors that cannot be ignored: in terms of internal governance, banks rely heavily on public trust and social recognition, which shows that reputation and trust are their core competitiveness; from the perspective of external governance, bank governance relies

heavily on government supervision and support. The government is not only a rule maker, but also a guardian of market order. Mullineux (2006) argued that commercial banks serve as the key hub through which small and medium-sized enterprises (SMEs) obtain credit resources, and that they play a core role in facilitating the rational allocation of capital and funding as well as enhancing the governance efficiency of SMEs; he further sought to examine the implications of banks' fiduciary duty to both depositors and shareholders, alongside the government's fiscal duty to taxpayers under deposit insurance schemes, for commercial bank corporate governance (CG). To address this objective, he outlined and evaluated recent academic contributions within the context of literature on information asymmetry in the banking sector. He found that sound corporate governance of commercial banks necessitates regulatory intervention to balance the interests of depositors and taxpayers with those of shareholders. Notably, he highlighted the originality of his work in bridging the gap between the literature on bank regulation rooted in information asymmetry and the body of research on corporate governance, thereby enriching the theoretical framework for understanding how regulatory and fiduciary considerations shape effective commercial bank governance— a prerequisite for banks to fulfill their pivotal role in supporting SMEs' credit access and governance improvement.

In addition, given their fundamental position in the payment mechanism, commercial banks have the mission of safeguarding national economic stability and the interests of the public, so they are more prudent in risk-taking. C. Z. Li (2011) pointed out that the main characteristics of the banking industry can be summarized into three points: first, the uniqueness of the capital structure, in which the capital composition and high leverage operations of banks are different from those of other industries; second, the concealment of bank asset information, in which opacity adds complexity to the operations of banks; third, banks are subject to strict supervision. Given their key role in the economic system, banks face more stringent regulatory constraints. Essentially, the essence of bank governance lies in the appropriate adjustment of the bank's power application process. The core goal is to optimize the power exercise model, aiming to coordinate the relationship between multiple stakeholders such as accountants, shareholders and senior managers, ensure the effectiveness of the supervision mechanism, and promote the effective fulfillment of the responsibilities of various stakeholders.

In the field of bank governance research, academic researchers around the world often cite the corporate governance analysis paradigm of general industries. The research focus is on the in-depth understanding of the internal governance structure. The topics covered mainly revolve around the ownership structure and nature of ownership, and the organization of the board of directors and supervisory board. W. A. Li and Cao (2004) pointed out that in the corporate

governance structure of banks, centralized equity allocation can play a positive role in promoting. Laeven and Levine (2009) conducted the first empirical assessment of theories regarding bank risk-taking, ownership structures, and national bank regulations, and reported their findings based on an analysis of 296 banks across 48 countries using detailed bank-level data. They focused on conflicts between bank managers and owners over risk, and demonstrated that bank risk-taking varies positively with the relative power of shareholders within each bank's corporate governance structure—consistent with their observation that banks with an absolute controlling shareholder tend to exhibit a higher level of risk-taking. They further showed that the relationship between bank risk and regulatory measures (including capital regulations, deposit insurance policies, and restrictions on bank activities) depends critically on the bank's ownership structure, such that the actual sign of the marginal effect of regulation on risk differs with the degree of ownership concentration. These findings highlighted that the same regulatory policy exerts divergent impacts on bank risk-taking depending on the specific corporate governance structure of each bank, underscoring the inextricable link between ownership structure (a core dimension of commercial bank governance), shareholder power, and the effectiveness of government supervision in shaping bank risk preferences. However, J. Zhu (2005) came to the opposite research result: the higher the concentration of bank equity, the more unsatisfactory its operating performance will be. Ferri (2009) found that "New Tigers" (including city commercial banks) outperformed state-owned commercial banks, which were burdened with non-performing loans from unprofitable state-owned enterprises, and that this outperformance was attributable not only to superior corporate governance (characterized by multiple shareholders as opposed to full government ownership) but also to favorable market positioning. He conducted a field survey on 20 city commercial banks from three provinces with different levels of economic development, and the results showed that city commercial banks in the eastern region performed better, while those controlled by state-owned enterprises performed worse. He emphasized that geographical factors and policies exerted a significant impact on bank performance, and that reform of state-owned commercial banks was essential to enhance the overall quality of China's banking sector—findings that underscored the pivotal role of corporate governance structure (a core dimension of commercial bank governance) and market positioning in determining bank operational performance, as well as the necessity of targeted institutional reforms for state-owned commercial banks amid regional economic disparities.

Haw et al. (2010) pointed out that concentrated ownership control impairs bank performance, while legal institutions and private monitoring can mitigate this adverse effect;

they further noted that government intervention may be counterproductive, and that the relationship between control concentration and bank operating characteristics is complex. To explore these issues, they conducted an investigation on the relationships between concentrated control, a suite of bank operating characteristics, and legal and regulatory frameworks using an extensive sample of listed commercial banks from East Asia and Western Europe. They found that, compared with widely held banks, those with concentrated control exhibited poorer performance, lower cost efficiency, higher return volatility, and greater insolvency risk. They also documented that legal systems and private monitoring effectively alleviated the detrimental impacts of concentrated control, whereas official disciplinary power played a weak role in bank governance and government intervention exacerbated the adverse effects of concentrated control. Additionally, they provided further evidence that the relationships between control concentration and bank operating characteristics were curvilinear and varied depending on the types of controlling owners. Overall, their findings supported the argument that country-level institutions play a crucial role in constraining insider expropriation, and that private monitoring mechanisms are more effective than public rules and supervision in enhancing commercial bank governance—reinforcing their initial assertion regarding the mitigating effect of private monitoring and the counterproductive nature of inappropriate government intervention in the context of concentrated ownership. Saghi-Zedek and Tarazi (2015) found that ownership structure plays a pivotal role in commercial bank governance, noting that greater cash flow rights held by controlling shareholders can significantly enhance banks' market valuation and even mitigate the positive impact of legal protection on valuation; they further empirically investigated the effect of shareholders' excess control rights (where control rights exceed cash-flow rights) on European commercial banks' profitability and risk, as well as how the 2007–2008 global financial crisis modified this impact. They found that the presence of excess control rights was associated with lower profitability, higher earnings volatility, and greater default risk both before the crisis (2002–2006) and in the later stage of the crisis (2009–2010); conversely, during the 2007–2008 crisis years, excess control rights improved profitability, reduced earnings volatility, and no longer exerted an influence on default risk. Further evidence from their study revealed that, regardless of the period, the effect of excess control rights on profitability and risk was more pronounced in family-controlled banks and in countries with relatively weak shareholder protection rights, and that this effect was primarily significant at intermediate and high levels of excess control rights. Overall, their findings contributed to the literature on the corporate governance determinants of banks' performance during the 2007–2008 global financial crisis and carried several policy implications, reinforcing the centrality of

ownership structure—including both cash flow rights and excess control rights—as a core dimension of commercial bank governance.

Shehzad et al. (2010) found that excessive concentration of equity in the hands of a few large shareholders may induce controlling shareholders to abuse their influence, harm the interests of minority shareholders, and thus exert a negative impact on the improvement of bank performance; they further examined the effect of bank ownership concentration on two key indicators of bank riskiness, namely non-performing loans and capital adequacy ratios. Using balance sheet data averaged over 2005–2007 for approximately 500 commercial banks across more than 50 countries, they found that concentrated ownership—proxied by different levels of shareholding—significantly reduced a bank's non-performing loans ratio when conditional on supervisory control and shareholder protection rights. Furthermore, they documented that ownership concentration had a positive impact on the capital adequacy ratio under the condition of shareholder protection. They also noted that at low levels of shareholder protection rights and supervisory control, ownership concentration still reduced bank riskiness. These findings collectively underscored the dual-sided role of ownership concentration (a core dimension of commercial bank governance) in shaping bank outcomes: while excessive concentration posed risks of minority shareholder expropriation and hindered performance improvement, appropriate concentration could mitigate specific bank risks under certain institutional and supervisory conditions, highlighting the complexity of ownership structure's role in commercial bank governance.

Iannotta et al. (2007) analyzed that ownership concentration exerts no significant effect on bank profitability; they further compared the performance and risk profiles of 181 large banks across 15 European countries over the 1999–2004 period to evaluate the impact of alternative ownership models and the degree of ownership concentration on the banks' profitability, cost efficiency, and risk levels. Three key findings emerged from their analysis. First, after controlling for bank-specific characteristics, country-level factors, and time effects, mutual banks and government-owned banks demonstrated lower profitability than privately owned banks despite their relatively lower cost levels. Second, public sector banks exhibited poorer loan quality and higher insolvency risk compared to other types of banks, whereas mutual banks achieved better loan quality and lower asset risk than both private and public sector banks. Finally, consistent with their initial analysis, they found that ownership concentration had no significant impact on a bank's profitability, yet a higher degree of ownership concentration was associated with improved loan quality, reduced asset risk, and lower insolvency risk. These observed differences, coupled with variations in asset composition and funding mix across bank

types, indicated that distinct ownership forms correspond to different financial intermediation models, thereby highlighting the heterogeneous roles of ownership structure—both in terms of ownership type and concentration degree—in the governance of commercial banks, particularly with respect to risk management and cost-profit trade-offs.

Grove et al. (2011) found only a weak correlation between bank ownership concentration and performance, asserting that high ownership concentration does not necessarily improve banks' operating performance, thus challenging prior assumptions about the direct, deterministic impact of ownership structure on commercial bank governance and performance. They further explored whether corporate governance could explain the performance of U.S. public commercial banks before the financial crisis, measuring multiple governance dimensions in a sample of 236 such banks. Their key findings showed that corporate governance factors better explained financial performance than loan quality: leverage was negatively associated with both financial performance and loan quality; CEO duality was negatively linked to financial performance; executive incentive pay was positively related to financial performance but had a negative long-term association with loan quality; and financial performance had a concave relationship with both board size and average director age. They also found weak evidence of an association between financial performance and anti-takeover devices, board meeting frequency, or affiliated committees. Theoretically, they applied agency theory to the banking sector, noting that the governance-performance linkage might differ from general corporate contexts due to the industry's unique regulatory and business environment, and suggested alternative theoretical frameworks as their agency theory-based predictions lacked sufficient empirical support. Practically, their consistent finding of a negative association between leverage and performance provided support for ongoing financial reforms on Tier I capital limits for banks.

Aebi et al. (2012) showed that even major shareholders such as institutional investors seemed unable to play an effective supervisory role in bank risk control and thus failed to significantly boost banks' operating performance; they further investigated the association between risk management-related corporate governance mechanisms—including the presence of a chief risk officer (CRO) on the executive board and the CRO's reporting line (whether to the CEO or directly to the board of directors)—and banks' performance during the 2007/2008 financial crisis. They measured bank performance by buy-and-hold returns and ROE, while controlling for standard corporate governance variables such as CEO ownership, board size, and board independence. Their key findings indicated that banks in which the CRO reported directly to the board of directors rather than the CEO (or other corporate entities) exhibited

significantly higher (i.e., less negative) stock returns and ROE during the crisis. In contrast, they found that standard corporate governance variables were mostly non-significantly or even negatively related to banks' performance during the crisis, which highlighted that specific risk management-oriented mechanisms within commercial bank governance frameworks exerted a more critical role in mitigating crisis-induced performance downturns than conventional governance factors, whereas major shareholders lacked effective supervisory capacity in bank risk control and performance enhancement.

Private banks and foreign-funded banks are often considered to have higher performance. This view has been reflected in many studies on the impact of the nature of equity ownership of commercial banks. For example, Hasan and Marton (2003) pointed out that banks with high foreign participation suffered lower efficiency losses. They analyzed the evolution of the Hungarian banking sector during its transition from a centrally planned to a market-oriented economy, identifying that early restructuring initiatives, flexible privatization approaches, and liberal policies toward foreign banks' engagement with domestic institutions collectively fostered the development of a relatively stable and increasingly efficient banking system. Their empirical findings revealed that foreign-owned banks and domestic lenders with elevated foreign ownership involvement exhibited reduced operational inefficiency, a result that not only validated their core proposition regarding foreign participation but also underscored the role of foreign capital introduction as a viable strategy for enhancing commercial bank governance and operational efficiency amid economic transition. Berger et al. (2005) analyzed Argentine bank data from 1993 to 1999 to explore the potential impacts of equity nature on banks' operational performance, revealing that state-owned banks typically underperformed local private or foreign banks over the long term. They examined jointly the static, selection, and dynamic effects of domestic, foreign, and state ownership on bank performance, arguing that it was critical to incorporate indicators of all relevant governance effects within a single empirical model; "non robustness" checks, which intentionally excluded certain indicators, corroborated this assertion. Drawing on the 1990s Argentine dataset, their strongest and most robust findings centered on state ownership: they identified a selection effect whereby banks slated for privatization had exhibited particularly weak performance prior to the process, as well as a dynamic effect marked by dramatic performance improvements following privatization—though they noted that much of this measured enhancement stemmed from segregating nonperforming loans into residual entities, leaving the privatized banks with "good" asset portfolios. These results underscored the pivotal role of ownership type as a core dimension of commercial bank governance, with state ownership exerting multifaceted, context-dependent

influences on operational performance. Tomar and Bino (2012) analyzed data from 14 banks listed on the Amman Stock Exchange over the 1997–2006 period and found that ownership structure and board composition, core elements of corporate governance, exerted a significant influence on bank performance. They noted that higher institutional holdings and increased insider shareholding ratios enhanced operational efficiency, with banks holding majority institutional ownership achieving the highest performance. Insider shareholding ratios in this context referred to the ownership percentages of managers and board members. The authors conducted a linear regression analysis to investigate the relationship between corporate governance factors and bank performance. The factors under examination included ownership structure, board composition and board size. Surprisingly, they found that board size had no significant impact on performance. These findings underscored the critical role of specific corporate governance attributes in shaping commercial bank operational efficiency, while also indicating that not all conventional governance metrics exert a meaningful effect on bank performance. Claessens et al. (2001) found that foreign banks achieved higher profitability than domestic banks in developing countries but lower profitability in developed countries, while noting that divergent views on the relative performance of foreign and domestic banks also existed. They examined the extent and impact of foreign presence in domestic banking markets using 7,900 bank observations across 80 countries over the 1988–1995 period, analyzing how net interest margins, overhead costs, taxes paid, and profitability differed between the two types of banks. Their empirical results validated the core finding on the heterogeneous profitability of foreign banks across developing and developed economies. Additionally, they revealed that an increased presence of foreign banks was associated with reduced profitability and narrower net interest margins for domestic banks. These findings underscored the heterogeneous effects of cross-border ownership on banking sector performance, highlighting a critical dimension of commercial bank governance linked to foreign participation and market competition across economies at varying development stages. Bonin et al. (2005) found that there was no significant difference in profitability between state-owned and private banks, arguing that bank performance was not solely determined by ownership attributes. They investigated the impact of ownership—particularly strategic foreign ownership—on bank efficiency across eleven transition countries, using an unbalanced panel dataset of 225 banks with 856 observations covering the 1996–2000 period. They employed stochastic frontier estimation to calculate profit and cost efficiency, directly accounting for time and country effects, and conducted second-stage regressions using these efficiency measures alongside ROA to examine the influence of ownership type. Their results confirmed that privatization alone was insufficient to enhance

bank efficiency, as state-owned banks were not appreciably less efficient than domestic private banks. They also found that foreign-owned banks were more cost-efficient and provided better services than other banks, especially when they had a strategic foreign owner. Additionally, the remaining state-owned banks exhibited lower service efficiency, which aligned with the hypothesis that the more efficient banks were privatized first in transition countries. These findings underscored that ownership attributes, a core dimension of commercial bank governance, had heterogeneous effects on bank performance and efficiency, rather than exerting a deterministic influence solely through the distinction between state and private ownership.

Borisova et al. (2012) explored the role of government shareholding in corporate governance structures, addressing the question of how the dramatic increase in direct government ownership of publicly-traded corporations—driven by the global financial crisis and marking the largest rise in state intervention since the Great Depression—would impact the governance of erstwhile private companies. The authors conducted their investigation using a sample of firms from the European Union, a region with relatively familiar active government participation, covering 373 entities from 14 member states over the 2003–2008 period. The sample included banking institutions and 113 publicly owned enterprises. Their main finding revealed that government ownership was associated with lower governance quality overall. Further analysis demonstrated notable heterogeneity across legal systems: government shareholding ratios correlated with lower governance levels in civil law countries, while the relationship between government ownership and governance quality was positive in common law countries. Additionally, they found that the preferential voting rights attached to golden shares exerted an especially damaging effect on governance quality. These results underscored the context-dependent nature of government ownership's impact on corporate governance, and the inclusion of banking institutions in the sample lent relevance to the findings for understanding the role of state shareholding in commercial bank governance.

The level of governance here is judged based on the Corporate Governance Quantitative Index (CGQ) provided by RiskMetrics, which combines widely adopted governance effectiveness indicators. However, it is interesting to note that in areas governed by common law systems, government ownership and governance quality show a positive coupling trend. China also has research on the governance effects of the nature of equity. For example, Ding (2009) argued that the ROA of state-owned banks is significantly dragged down by their state-owned nature, which is mainly attributed to the lack of efficiency in state-owned capital management. Similarly, compared with emerging private banks, state-owned banks are at a

disadvantage in terms of ROA. C. Zhao et al. (2009) studied the governance structure of three types of commercial banks from 2005 to 2006, and found that there was an "inverted U-shaped" relationship between bank performance and government shareholding ratio that first increased and then decreased. The underlying reason is inseparable from the dual impact of government equity participation faced by Chinese commercial banks during the transformation period. On the one hand, the spillover effects brought by government equity participation stimulated the banks' positive motivation, while on the other hand, the accompanying political cost effects It poses a negative constraint to banks. Under different shareholding levels, the game and balance of these two effects jointly shape the unique "inverted U-shaped" performance between bank performance and government shareholding. J. Y. Sun (2008) explored the intrinsic relationship between the corporate governance structure of Bank of China and the bank's profitability, risk control, liquidity adjustment and growth potential, and pointed out that the impact of the nature of equity on bank profitability is not decisive.

In the analysis of the governance effects of commercial banks, the discussion of board of directors' structure is a key issue and has always been a focus area of academic research. Relying on data from European and American commercial banks, Andres and Vallelado (2008) found that the impact of board size on bank performance exhibited an inverted U-shaped nonlinear relationship; they further pointed out that the proportion of external independent directors and the frequency of board meetings exerted a significant positive effect on banks' operating performance. They tested hypotheses regarding the dual supervisory and advisory roles of corporate boards using a sample of large international commercial banks, adopting a two-step system estimator to address the well-known endogeneity issue in the corporate governance literature and demonstrating the empirical and theoretical superiority of this estimator over ordinary least squares and within estimators. Beyond the inverted U-shaped relationship between board size and performance, they also identified an identical nonlinear link between bank performance and the proportion of non-executive directors, aligning with their insights on external independent directors. Their results indicated that board composition and size were closely tied to directors' capacity to monitor and advise bank management, with larger boards that were not excessively independent proving more efficient in fulfilling these dual functions and creating greater value for their institutions. All these relationships remained robust even after they controlled for performance measurement metrics, the weight of the banking industry in each country, and bank ownership factors. These findings underscored the critical role of board structural characteristics in commercial bank governance, providing empirical evidence for how optimized board design could enhance supervisory and advisory

effectiveness to influence overall bank performance. Pathan (2009) found that bank boards strongly reflecting shareholders' interests, particularly those with a streamlined structure and fewer constraints, could promote bank risk-taking; conversely, CEOs' decision-making control inhibited such risk-taking behavior. These conclusions were verified through multi-angle risk proxy variables and different statistical methods, and were consistent with banks' actual operating environment. They examined the relevance of bank board structure to bank risk-taking using a sample of 212 large U.S. bank holding companies over the 1997–2004 period, encompassing 1534 observations. Their empirical results showed that strong boards, defined as those reflecting more of shareholders' interests and characterized by small size and fewer restrictions, exerted a positive effect on bank risk-taking. In contrast, CEO power, referring to the CEO's ability to control board decisions, had a negative impact on bank risk-taking. These findings were consistent with the bank contracting environment and robust to several proxies for bank risk-taking as well as different estimation techniques, underscoring the critical role of board structure and CEO power as core dimensions of commercial bank governance in shaping banks' risk-taking behaviors. Persico (2004) argued that a large board size might dampen members' enthusiasm for collecting or analyzing information when the cost of information gathering remained high. He explored a theoretical framework where identical agents incurred costs to gather information before aggregating it through voting processes. Recognizing that information functioned as a public good in this context, he posited that the provision of information would fall short of the social optimum. He further contended that an effective voting rule needed to fulfill dual functions: incentivizing agents to acquire information and enabling the efficient aggregation of collected information. Crucially, he demonstrated that a voting rule requiring a large plurality—such as unanimity in the extreme case—to overturn the status quo could only be optimal if the information available to each individual agent was sufficiently accurate. This key finding held independently of voters' preferences and the cost of information acquisition. These insights shed light on the informational dynamics within corporate decision-making bodies, a critical dimension of commercial bank governance, by highlighting how board size and voting mechanisms could interact to influence the quality of information utilization in board-level decisions.

Adams and Mehran (2012) revealed that the natural logarithm of board size exhibited a positive correlation with Tobin's Q, using detailed data on 35 bank holding companies (BHCs) over the 1964–1985 period. They addressed a long-standing gap in the literature, prompted by the subprime crisis which highlighted the limited academic understanding of bank governance, by analyzing the relationship between board governance and performance in their sample. The

authors found that board independence bore no relation to performance, where performance was measured by a proxy for Tobin's Q, while their core finding on the positive link between board size and performance remained robust and was not driven by merger and acquisition activities. They further noted that board expansion was critical, providing new evidence that increases in board size resulting from the addition of directors who also served on subsidiary boards might create value as BHC complexity increased, a phenomenon that exerted a significant impact on the growth of board size. Concluding their study, they argued that governance regulation should take into account the unique features of bank governance, underscoring the distinctiveness of board structure dynamics in the context of commercial bank governance. Beltratti and Stulz (2012) examined the relationship between corporate governance characteristics and the financial performance of banks during the credit crunch period from July 2007 to December 2008, a period when overall bank performance was the worst since the Great Depression and significant cross-sectional variation existed in the stock returns of large global banks. They selected 164 multinational banks with assets exceeding US$50 billion as their research sample and utilized this variation in stock returns to evaluate the factors contributing to banks' poor performance during the crisis. Their core finding revealed that banks whose board decisions prioritized shareholder-friendly outcomes exhibited relatively lower buy-and-hold returns during this tumultuous period. Further, they found that these shareholder-friendly banks were not less risky prior to the crisis and reduced loans more significantly during the crisis, a result that posed a substantial challenge to the argument that poor bank governance was a major cause of the crisis. Additional empirical results showed that better-performing banks had lower leverage and lower returns immediately before the crisis, supporting theories that emphasize the fragility of banks financed with short-term capital market funding. They also noted that differences in banking regulations across countries were generally uncorrelated with bank performance during the crisis, except that large banks from countries with more restrictions on bank activities performed better and decreased loans less. These findings underscored the complex interplay between corporate governance, capital structure, regulatory environments, and bank performance during systemic financial crises, a critical dimension of commercial bank governance research in turbulent market conditions. Erkens et al. (2012) found that during the 2007–2008 financial crisis, financial institutions with governance structures favoring more independent boards and higher institutional ownership suffered deteriorating stock returns, a result derived from their investigation into the influence of corporate governance on financial firms' performance during the crisis period. They conducted the research using a unique dataset of 296 financial firms from 30 countries that stood at the

center of the crisis. Their core findings confirmed that firms with a greater proportion of independent directors and higher institutional ownership experienced significantly worse stock returns during the tumultuous period. Further exploration revealed two key underlying reasons: first, firms with higher institutional ownership had taken excessive risks prior to the crisis, which led to larger shareholder losses during the crisis; second, firms with more independent boards raised more equity capital during the crisis, resulting in a wealth transfer from existing shareholders to debtholders. Overall, their findings enriched the relevant literature by identifying specific corporate governance determinants of financial firms' performance during the 2007–2008 crisis, and the inclusion of financial institutions in the sample lent important implications for understanding how governance structures centered on board independence and institutional ownership could shape risk-taking behaviors and performance outcomes in the context of commercial bank governance during systemic financial crises.

W. K. Wang et al. (2012) found that board characteristics, the proportion of outside directors, the average director age, and CEO/chairman dual status have a negative impact on performance, while the number of committees and the employment of the Big Four audit firms have a positive impact. Adams (2011) revealed that U.S. banks receiving Troubled Asset Relief Program (TARP) funding during the recent financial crisis generally had larger boards of directors than those that did not receive such government assistance. She further explored whether boards of financial firms should be blamed for the crisis, conducting a comparative analysis using a large sample of nonfinancial and financial firm data spanning the 1996–2007 period. She documented that the governance of financial firms was, on average, not obviously worse than that of nonfinancial firms; in fact, when measured by simple governance scores and governance indices, banks and nonbank financial firms generally appeared better governed than their nonfinancial counterparts. She also found that bank directors earned significantly less compensation than their peers in nonfinancial firms, and that banks receiving bailout money had more independent boards than other banks. These results suggested that the governance measures focused on in recent governance policies were insufficient to describe the governance failures attributed to financial firms. Moreover, she argued that recent governance reforms might have to shoulder some of the blame placed on the boards of financial firms, underscoring the need to reconsider conventional governance metrics and reform directions in the context of commercial bank governance, particularly regarding the unique characteristics of financial institutions and the efficacy of post-crisis regulatory interventions.

On the one hand, Devriese et al. (2004) advocated that from the perspective of creditors, especially depositors and other debt holders of the bank, independent directors without equity

ties are more respected than directors who are financially dependent on the bank. This is because independent directors are more likely to focus on proper management supervision, rather than just keeping an eye on the ups and downs of stock prices or other short-term goals that are closely linked to their compensation, highlighting their unique value in ensuring the sound operations of banks. Adams and Ferreira (2007) showed that excessive board independence could inhibit information creation, impair the board's advisory and guidance functions, and potentially weaken its supervisory responsibilities. They analyzed the consequences of the board's dual role as both advisor and monitor of management, identifying a critical trade-off for CEOs in disclosing information to the board: sharing information would enable the board to provide better advice, yet an informed board would also conduct more intensive supervision of management. Since an independent board acted as a tougher monitor, the CEO might be reluctant to share information with it—a dynamic that reflected top managers' sensitive response to information control rights, especially when independent directors' supervisory drive surpassed that of dependent directors. On the basis of this theoretical framework, they argued that management-friendly boards could be optimal for corporate governance. Using insights derived from their model, they further analyzed the differences between sole and dual board systems and highlighted several policy implications of their analysis. These findings underscored the nuanced relationship between board independence and governance effectiveness, offering important insights for commercial bank governance by illuminating how board structure could shape information flows, advisory quality, and supervisory intensity within financial institutions. Faleye and Krishnan (2017) found that board independence reduced bank risks, with such effects specifically manifested in the optimization of borrowers' long-term S&P credit ratings and the increase in financial covenants within loan contracts; notably, this risk-mitigation mechanism did not involve banks leveraging syndicated loan decision-making processes to avoid credit risks. They investigated the impact of bank governance on risk-taking behaviors in commercial lending, revealing that banks with more effective boards were less likely to extend loans to riskier borrowers. This effect was confined to periods of distress in the banking industry and was more pronounced at banks that had established board-level credit committees. Further, they documented that in the aftermath of the Russian default—an event that exogenously imposed distress conditions on U.S. banks—banks with more effective boards exhibited a significantly lower propensity to lend to high-risk borrowers. These results suggested that value-maximizing banks tended to ration credit to riskier borrowers precisely when such firms might face credit constraints, indicating that bank governance regulations could carry potential unintended consequences. These findings

illuminated the specific channels through which board independence, a core dimension of commercial bank governance, exerted risk-mitigating effects in credit operations, while also highlighting the context-dependent nature of such governance mechanisms in shaping banks' lending behaviors. Larcker et al. (2007) found that the CEO's dual role as chairman of the board exerted a negative impact on corporate performance. They addressed the inconsistent results in empirical research examining the association between typical corporate governance measures and various accounting and economic outcomes, arguing that these mixed findings were partially attributable to the challenge of generating reliable and valid measures for the complex construct of corporate governance. The authors analyzed data from 2,106 firms spanning financial and non-financial sectors over the 2002–2003 period, utilizing exploratory principal component analysis as a statistical tool. From 39 structural governance indicators—including board characteristics, stock ownership, institutional ownership, activist stock ownership, the existence of debtholders, the mix of executive compensation, anti-takeover variables, and the CEO's dual role as board chairman—they extracted 14 composite governance indices representing distinct dimensions of corporate governance. Their results showed that these 14 indices had a mixed association with abnormal accruals, little relation to accounting restatements, but possessed some ability to explain future operating performance and future excess stock returns. The inclusion of financial sector firms in their sample lent relevance to these findings for commercial bank governance, highlighting the complexity of measuring governance effectiveness and the necessity of considering multiple distinct governance dimensions rather than isolated indicators when evaluating the impact of governance structures on organizational performance.

On the other hand, with the help of the EVA index scoring method, M. Pan and Xie (2008) found that the proportion of independent directors is inversely related to bank performance. In addition, the level of executive compensation is significantly driven by the merger of the positions of chairman and president in the board of directors' leadership structure, while the proportion of independent directors has minimal impact on executive compensation. He and Liu (2010) found that there is a positive correlation between the performance improvement of commercial banks and the increase in the proportion of independent directors. Xi and Wu (2012) analyzed panel data of 14 banks and revealed the positive correlation between board characteristics such as size and proportion of independent directors and bank performance, the negative correlation between bank asset size, and the impact of bank state-owned nature on performance. W. A. Li et al. (2014) found that during the financial crisis, the age and education heterogeneity of the Board of Directors of Bank of China will reduce risk-taking, and the role

of chairman and CEO has a negative moderating effect on gender and education heterogeneity. Coincidentally, Xie and Tang (2013) pointed out that in the decision-making process of corporate governance, the diversity of independent directors did not show an effective moderating effect, and no obvious correlation was observed between the heterogeneity of independent directors and corporate performance. .

It was not until the early 1990s that academic research began to explore the important role of executive compensation in bank governance. However, with the successive banking crises, research in this field gradually gained a high level of academic and industry attention. Attention has now become one of the indispensable core topics in bank governance research. Houston and James (1995) found that there was only a slight positive correlation between the compensation of bank top managers and bank performance. They examined whether executive compensation in the banking sector was structured to promote risk-taking behavior. Their results showed that, on average, bank CEOs received less cash compensation, were less likely to participate in stock option plans, held fewer stock options, and obtained a smaller proportion of their total compensation from options and stock compared to CEOs in other industries. The authors further analyzed cross-sectional differences in the structure of compensation contracts within the banking industry. They identified a positive and significant relationship between the importance of equity-based incentives and the value of a bank's charter. This finding was inconsistent with the hypothesis that compensation policies in banking were designed to encourage risk-taking. These insights shed light on the unique characteristics of executive compensation as a dimension of commercial bank governance, highlighting that the structure of bank managers' compensation differed markedly from that of non-financial firms and did not serve to promote risk-taking in the manner some theoretical frameworks might predict. Jagtiani and John (2018) found that the performance correlation within bank CEO compensation systems exhibited a specific pattern: it showed an inverse trend with the leverage levels of financial institutions, while bearing a positive correlation with the supervision intensity of bank regulators and subordinated creditors. Their research contextualized the evolving banking industry landscape amid Fintech advancement, where advanced technology, big data, and complex artificial intelligence and machine learning algorithms have delivered tangible benefits to both consumers and lenders. Fintech simultaneously holds the potential to disrupt traditional financial models and generate new categories of risk. Against this backdrop, regulators worldwide are working diligently and thoughtfully to safeguard consumer interests, maintain financial stability, and foster an environment conducive to the safe innovation of Fintech. These findings underscored the context-dependent nature of performance correlations

in bank CEO compensation structures, revealing that such correlations are shaped by core financial indicators like leverage and external oversight factors including regulatory intensity. The interplay between compensation design, financial risk metrics, regulatory dynamics and Fintech-driven industry transformation also highlights critical considerations for commercial bank governance in optimizing executive incentive mechanisms to balance performance alignment, risk control and adaptive responses to technological change. Bebchuk et al. (2010) analyzed that during the period from 2000 to 2008, the executive compensation mechanism of the Bear Stearns and Lehman brothers inadvertently promoted excessive risk-taking at the company level. I. H. Cheng et al. (2010) found that firms with higher overall top management compensation typically exhibited stronger risk preferences. They examined the relationship between compensation and risk-taking in financial firms using an overlooked insight from principal-agent contracting theory involving hidden actions and risk-averse agents, arguing that total compensation had to increase with firm risk if the sensitivity of pay to stock price did not vary with stock price volatility. Controlling for firm size, they identified a correlation between total executive compensation and risk metrics including firm beta, return volatility, and exposure to the ABX subprime index. They also found no link between insider ownership and these risk measures, nor between compensation or firm risk and governance variables; instead, both rose with institutional investor ownership, indicating heterogeneous investors incentivized varying risk levels. These results applied to non-financial firms too, and from the perspective of commercial bank governance, underscored the critical connection between top management compensation and risk preferences, offering implications for designing executive incentive mechanisms to balance performance incentives and risk control. Deyoung et al. (2013) pointed out that before the financial crisis, U.S. banks adjusted their CEO compensation structures to encourage executives to exploit regulatory deregulation and debt securitization opportunities for bank expansion, which simultaneously created higher risks. They examined how CEO compensation contract terms of large commercial banks between 1994 and 2006 interacted with the banks' risky business policy decisions. Using delta and vega as proxy variables for CEO incentives, they found a significant relationship between banks' non-traditional business income and high-risk compensation designs. They also identified that bank CEOs took more risk in response to contractual risk-taking incentives, while bank boards adjusted CEO compensation both to encourage executives to seize new growth opportunities and to moderate excessive risk-taking. These relationships were strongest in the latter half of the sample period, after deregulation and technological changes had expanded banks' risk-taking capacities. From the perspective of commercial bank governance, these findings highlight the critical role of

CEO compensation structure design in shaping banks' risk-taking behaviors and strategic choices, especially amid regulatory and market changes.

Fahlenbrach and Stulz (2011) argued that CEO option compensation and cash bonuses had no relationship with bank performance during the financial crisis. They examined the relationship between large commercial banks' crisis performance in 2008 and CEO incentives as well as share ownership before the crisis, and also explored whether CEOs reduced their equity stakes in anticipation of the crisis. Their findings showed no evidence that banks with CEO incentives better aligned with shareholder interests performed better during the crisis; instead, there was some indication that such banks performed worse in terms of both stock returns and accounting return on equity. Additionally, option compensation did not exert an adverse impact on bank performance amid the crisis. They further found that bank CEOs did not reduce their shareholdings in anticipation of or during the crisis, nor was there evidence that they hedged their equity exposure, leading to extremely large wealth losses for these executives. From the perspective of commercial bank governance, these results challenge the conventional view that aligning CEO incentives with shareholder interests enhances crisis resilience, offering important implications for the design of executive incentive and equity holding mechanisms in banking institutions. Erkens et al. (2012) found that during the 2007–2008 financial crisis, the financial institutions with the weakest performance were not those that compensated their CEOs through equity incentives such as restricted stocks or stock options, but rather those that integrated equity incentives into their overall compensation systems. They investigated the influence of corporate governance on the performance of financial firms amid the same crisis, utilizing a unique dataset of 296 financial firms from 30 countries that stood at the core of the turmoil. They revealed that firms with more independent boards and higher institutional ownership experienced significantly worse stock returns during the crisis period. Further exploration identified two key underlying reasons: first, firms with higher institutional ownership had taken on more risk prior to the crisis, which resulted in larger shareholder losses during the crisis; second, firms with more independent boards raised more equity capital during the crisis, leading to a wealth transfer from existing shareholders to debtholders. Overall, their findings added to the existing literature by examining the corporate governance determinants of financial firms' performance during the 2007–2008 financial crisis, and provided important insights for commercial bank governance by highlighting how specific governance structures and compensation arrangements could shape performance outcomes and risk dynamics for banking institutions facing systemic financial shocks.

Companies with non-equity incentives, such as cash bonuses based on annual profit targets,

are particularly vulnerable in China. H. Wei and Liu (2005) showed that the payment of high salaries to middle and senior managers in sample banks failed to significantly promote the improvement of bank performance. However, X. B. Chen (2005) found that there is a positive relationship between the bank's ROA and bank executive compensation. Through an in-depth analysis of China's listed banks, Song et al. (2007) also obtained the result that there is an obvious positive correlation between bank CEO compensation and bank performance. Based on a detailed examination of the panel data of China's listed banks from 2005 to 2009, J. Y. Sun and Xu (2011) found that the effective compensation mechanism has a significant role in promoting bank performance in a sample of non-state-owned listed banks. In contrast, within a banking system controlled by the central or local government, the effect of such incentive mechanisms is significantly weakened, implying the potential constraints of ownership background on the effectiveness of compensation incentive mechanisms. Some literature in China also puts forward the view that executive compensation has a negative impact on bank performance. On the contrary, using the SFC research framework, Wen (2015) contended that moderate restraint on executive compensation is necessary and important , especially for those joint-stock banks with significant influence. Similarly, Hong et al. (2014) revealed that increasing executive compensation incentives may prompt urban commercial banks and rural commercial banks to adopt more aggressive risk strategies; in sharp contrast, state-owned banks and Joint-stock banks are more likely to adopt a prudent risk management attitude under the same conditions.

2.2.3 Commercial banks' operating performance

In the field of commercial bank performance evaluation, scholars have used a variety of analytical techniques and methods to quantify and interpret the operational effectiveness of banks. These studies range from financial ratios to complex economic models, and from traditional accounting performance indicators to cutting-edge efficiency and productivity analysis. Considering that the core goal of this thesis is to explore how Fintech affects the operations of commercial banks, we will focus on sorting out the literature related to the driving factors of commercial bank operating performance.

The driving factors of commercial bank operating performance are numerous and complex. According to numerous relevant research literature, various influencing factors can be roughly divided into two categories: internal factors of the bank and external environment. For the outside of banks, for example, through a detailed analysis of the interaction between the financial system structure and macroeconomic performance, Ben Naceur and Goaied (2008)

found that the direct effect of macroeconomic growth and inflation levels on bank profitability is not significant. The first conclusion provides a new perspective for understanding the determinants of bank earnings, arguing that we should consider broader economic and financial environment factors when evaluating bank performance. Bolt et al. (2012) argued that the operating conditions of the macroeconomy had a significant impact on the scale of bank loans, and this impact was further transmitted to commercial banks' operating performance; they also explored the relationship between bank profitability and economic activity. They found that when accounting for the stronger co-movement between bank profits and economic activity during deep recessions, the impact of output growth on bank profitability was much greater than that typically documented in existing literature. Among the various components of bank profits, loan losses served as the primary driver of this result. Additionally, they revealed that long-term interest rates in the preceding years were important determinants of bank profits during periods of high economic growth, and their findings remained robust regardless of whether aggregate or individual bank data was used—these findings underscored the close links between macroeconomic dynamics and commercial banks' operating performance by identifying key factors that shape banks' profit levels and overall operational outcomes. Dietrich and Wanzenried (2011) found that economic growth, especially the increase in Gross Domestic Product (GDP), has a significant positive effect on the operating performance of commercial banks and can promote banks' business expansion and profitability. Based on an empirical analysis of detailed data on China's regional commercial banks, D. Zhang et al. (2016) pointed out that in the context of the cooling real estate market, if the real estate asset portfolio of regional commercial banks fails to adjust in time to cope with risks, the bank will be easily experiencing operating stress, which highlighted the close link between real estate investment volatility and the margin of safety of bank performance. Focusing on the policy turning point of the liberalization of the deposit interest rate ceiling in 2012, Yuan (2017) used the Difference-in-Difference method to examine the specific impact of interest rate relaxation on the operating performance of commercial banks. The study found that interest rate liberalization has had obvious negative consequences on the performance of commercial banks, and this phenomenon is particularly severe among small and medium-sized banks. This suggests that the interest rate marketization reform has put forward higher requirements for banks' operating environment and strategic adjustments, and is particularly challenging. Risk management and adaptability of small and medium-sized banks.

Subsequently, in Xu and Ma (2019), using the Equator Principle as the starting point, analyzed the environmental risks faced by commercial banks and used a double difference

model for empirical testing. The results showed that following the Equator Principles can promote the improvement of bank operating performance in the short term, but in the long term, strict environmental standards may erode banks' profit margins, thereby negatively dragging operating performance. Tian and Li (2020) found that the liquidity creation ability of Chinese commercial banks will be significantly inhibited when policy uncertainty increases, especially in regional banks with weak competitiveness; banks performance improvement could alleviate this inhibitory effect in the short term, but the long-term effect showed an "inverted U-shaped" pattern. Similarly, Yan and Shen (2022) compared the performance of banks with different equity types based on the historical data of 158 banks during the Republic of China from 1928 to 1937, and found that the operating performance of government-run banks was significantly worse than that of private banks. J. Liu et al. (2022) found that the deepening of financial openness may weaken bank performance by increasing the non-performing loan ratio. At the same time, for developed economies, the impact of financial openness on bank operating performance first increased positively and then turned to suppression, which also showed the "Inverted U-shaped" pattern.

Through an investigation of European commercial banks, Vennet (2002) found that there was a direct causal relationship between the management efficiency and operating performance. De Haan and Poghosyan (2012) studied the key factors affecting bank profitability and found that factors such as total assets, cost-to-income ratio and leverage ratio played a major role; they also examined whether bank earnings volatility depended on bank size and the degree of concentration in the banking sector. Using quarterly data of non-investment banks in the United States from the first quarter of 2004 to the fourth quarter of 2009, and controlling for management quality, leverage and diversification, they found that bank size reduced return volatility. They further revealed that the negative impact of bank size on bank earnings volatility (in absolute terms) decreased with the increase of market concentration, and that larger banks located in concentrated markets had experienced higher volatility during the recent financial crisis—these findings on earnings volatility and its determinants are closely linked to commercial banks' operating performance, as earnings stability and profitability are core indicators reflecting the effectiveness of banks' operational management. Saeed (2013) confirmed that the capital structure of commercial banks had a positive effect on improving their operating performance; he also examined the impact of capital structure on the performance of Pakistani banks, extending the empirical research on the determinants of bank capital structure within a single country over the five-year period from 2007 to 2011. He utilized data from banks listed on the Karachi Stock Exchange (including data from the Bank of China

in Pakistan) and applied multiple regression models to estimate the relationship between capital structure and banking performance. Performance was measured by ROA, return on equity, and earnings per share, while the determinants of capital structure included the long-term debt-to-capital ratio, short-term debt-to-capital ratio, and total debt-to-capital ratio. His findings validated a positive relationship between these capital structure determinants and the performance of the banking industry, which directly underscores the role of capital structure in shaping commercial banks' operating performance as a core dimension of their operational effectiveness. Naidu (2011) explored the determinants of the capital structure of South African banks and sought best practices to improve the value and efficiency of banks. Although the study did not reach a definitive conclusion, it provided an analytical basis for understanding the dynamics of capital structure and its impact on the stability of the South African banking system and economic structure. Cornett et al. (2016) found that during the financial crisis, banks fulfilling more corporate social responsibility (CSR) tended to achieve better financial performance—a core indicator of commercial banks' operating performance. They examined the CSR-financial performance association in the context of the recent financial crisis, revealing a significant positive correlation between CSR scores and financial performance, indicating banks were rewarded for social responsibility. They further found that the largest banks pursued socially responsible activities far more extensively than smaller ones, with a sharp post-2009 increase in CSR strengths and decline in CSR concerns.

Doan et al. (2018) examined the relationship between income diversification and bank efficiency across 83 countries from 2003 to 2012, and they also evaluated how ownership structure moderated the impact of such diversification on banks' cost efficiency—a core dimension of commercial banks' operating performance. Using a stochastic frontier approach to estimate cost efficiency, they found that increased diversification tended to improve bank efficiency, yet the resulting benefits were offset by heightened exposure to volatile non-interest activities, which weakened the positive effect of diversification to a certain extent. With regard to ownership structure, they revealed that state-owned banks with fewer volatile income sources exhibited lower efficiency in income diversification. They further found that more diversified foreign-owned banks tended to be less efficient in developed countries, whereas increased foreign bank ownership enhanced the benefits of diversification in developing countries following the financial crisis. Nourani et al. (2019) used the DEA method and found that Malaysian banks performed best, ASEAN banks were less efficient in long-term asset utilization, and there was a positive relationship between capital structure and overall bank performance. Z. Pan (2013) analyzed the relationship between capital adequacy ratio and bank

profitability, and found that the former had a significant promoting effect on the latter; however, when the capital adequacy ratio of large banks is too high, continuing to increase capital may have a negative impact on profitability. In view of the negative effects, it is recommended that banks should optimize capital management, adopt differentiated regulatory strategies, and improve profitability through innovative profit models and business transformation. M. S. Wang and Liu (2013) studied the influencing factors of bank profitability. They found that non-interest income and net interest margin have a positive effect. Among them, state-owned banks performed better in terms of non-interest income; they also pointed out that national joint-stock banks and the non-interest business of city commercial banks needs to be developed. X. M. Li (2011) used principal component analysis to show that bank performance will improve due to the increase in core capital adequacy ratio. Y. Guo et al. (2012) found that among the factors of bank operating performance, equity concentration and capital adequacy ratio are two important factors. At the same time, the equity nature of the bank will affect the effects of these factors, especially the state-owned nature will further enhance the positive effects of these factors. Q. J. Zhang and Chen (2022) found that increasing bank digital investment can effectively optimize bank governance. The rationality of managers, agency costs and technical efficiency affect this relationship. The digitalization of non-state-owned banks is more conducive to governance improvement, while the growth of the digital economy, rising financing costs, asset-strengthening earnings and shrinking non-interest income are driving force for the banks' Fintech development.

2.3 Research on the impact of Fintech on commercial bank operations

First of all, the liability business of commercial banks is facing profound changes brought about by Fintech. By introducing innovative financial solutions, Fintech has affected the attractiveness and management methods of bank deposits, wealth management and other liability products. Delong and Deyoung (2007) found that the proliferation of Internet finance reduced commercial banks' checking account balances while increasing money market fund account balances, which adjusted deposit composition, boosted bank profits notably, transformed banking business models, and exerted profound impacts on customer behavior. They also proposed a new explanation for the lack of value creation identified in most academic studies on bank mergers, conjecturing that large bank acquisitions were a novel phenomenon without a history of best practices to guide managers or investors. They hypothesized that merging banks and investors pricing mergers learned by observing information spillovers from

prior bank M&As, and their evidence from 216 M&As of large, publicly traded U.S. commercial banks between 1987 and 1999 supported these conjectures, consistent with semi strong stock market efficiency. D. Li and Xu (2014) found that Internet financial management products have obvious advantages over traditional bank deposit products in terms of financial flexibility and return, and have shown irresistible charm to investors, which has undoubtedly diverted banks' low-cost capital pools. In the long run, the booming Internet financial management industry is gradually reshaping the risk management ecology of assets and liabilities in the banking industry. By competing with traditional commercial banks, they will cause fluctuations in the cost and interest rates of banks to raise funds, exposing commercial banks to operational risks, causing hidden dangers that are difficult to eliminate easily. J. Chen and Wang (2016) argued that the booming development of Internet financial management business has undoubtedly brought short-term performance pressure to commercial banks, but in the long run, its disruptive effect is still unclear. In fact, it is more likely to inspire commercial banks to accelerate the pace of reform, promote industry transformation, prompt banks to actively respond to market changes, and reconstruct business models to maintain competitiveness. Zhan et al. (2018) showed that Internet finance has had a significant impact on bank credit channels under monetary policy by reshaping banks' liability structures, demonstrating its important role in the financial system that cannot be ignored. They provided a new perspective for understanding how Internet finance affects macroeconomic policies.

The profound impact of Fintech on the asset business of commercial banks is also one of the hot topics in financial academic research and has been discussed in detail in many literatures. According to the analysis of Hancock et al. (1999) revealed that advances in information technology, foundational to Fintech, intensified competition in the banking industry. This intensified competition adversely affected commercial banks' loan businesses and compelled them to re-evaluate their credit strategies. They noted that Fintech's impact on commercial banks' risk management constituted the core and most complex link in their asset operations. Additionally, they found that consolidating banks' back-office operations such as payment processing, which is a key part of bank operations, exhibited large scale economies. The consolidation of the Federal Reserve's Fedwire payment system contributed to one-fourth of its average cost reduction, though technical progress beyond technology-adjusted input prices was minimal. Lapavitsas and Dos Santos (2008) argued that technological progress, foundational to Fintech, enabled commercial banks to significantly enhance information disclosure and accessibility. This enhancement played a key role in optimizing loan operations as technological application simplified loan procedures, strengthened banks' risk control

capabilities and fostered healthier more transparent lending relationships. They also noted that technological innovation drove recent changes in the conduct and character of banking but exerted contradictory impacts. Money-dealing transactions became cheaper yet investment costs rose and a broader range of services had to be provided, leaving bank cost efficiency unimproved. Additionally, banks developed computationally intensive 'arms length' techniques for creditworthiness assessment and risk management, which allowed them to generate new revenue streams from individual lending and money market mediation fees. This shift signaled a decline of relational banking. Moreover, new technology and related practices facilitated foreign banks' entry into developing countries where they could exploit technologically demanding arms length niches in domestic markets. This development did not improve the efficiency of host banking systems nor increase credit availability to the productive sector. Z. Liu (2016) elaborated on the role of Internet technology in improving banks' risk management capabilities, and further pointed out that this can effectively reduce banks' risk-taking levels. However, it also pointed out that the demonstration effect, competitive effect and impact of Internet technology on deposit and loan businesses may have a complex effect on banks' operating efficiency, profitability and risk-taking. It may not only reduce risks, but also increase risk-taking under certain circumstances. In the research of Yao and Song (2020), the effectiveness of the application of Fintech in reducing banks' risk economic capital was confirmed, indicating its positive role in risk management. However, they also observed that the improvement in bank profitability may partially offset the risk mitigation effect brought by Fintech, emphasizing the importance of banks still need to be alert to potential risks in a high-profit environment. Yao and Song (2021) further studied the impact of Fintech on the economic capital mechanism of commercial banks' credit risk. Research results showed that Fintech promoted the transparency of information circulation by effectively reducing the information asymmetry between transaction parties, thereby significantly reducing the economic capital requirements for credit risks borne by commercial banks.

In addition, C. M. Li et al. (2022) argued that integrating cutting-edge technologies foundational to Fintech enabled banking institutions to stimulate positive technology spillover effects and effectively alleviate information asymmetry in credit transactions. This not only strengthened banks' risk management capabilities and operational efficiency but also promoted the expansion of business diversification, thereby achieving risk diversification and enhancing their own anti-risk capacity. They further found that in the context of Fintech innovation development, commercial banks' adoption of Fintech innovation improved their risk management capabilities and thus reduced risk-taking. Their mechanism analysis showed that

banks relied on Fintech innovation to reduce risk-taking by increasing operating income, improving capital adequacy ratios, optimizing operational performance and enhancing risk control capabilities. Additionally, heterogeneity analysis revealed that this risk-reducing effect was more pronounced in larger state-owned joint-stock and highly competitive commercial banks, with consistent results after addressing endogeneity issues and conducting a series of robustness tests. X. F. Li and Yang (2021) confirmed that Fintech can effectively alleviate banks' risk exposure. This significant impact is more obvious in large state-owned banks, joint-stock banks, and city commercial banks.

At the same time, some studies assert that Fintech will increase the risk-taking of commercial banks. X. Lin (2014) argued that technical security issues, business continuity risks, and legal and regulatory compliance problems derived from Internet information technology can all spread to the banking system through intricate business connections, and the impact on its stability and security cannot be ignored. Using an Internet finance index constructed based on text data analysis, P. Guo and Shen (2015) quantitatively measured the development degree of Internet finance and its impact on the financial system. This research provides new methods and perspectives for an in-depth understanding of the risk transmission mechanism of Internet finance. They found that the expansion of Internet finance led banks to adopt more radical operating policies to cope with the challenges of emerging financial formats. Qiu et al. (2018) found that the development of Fintech has promoted the substantial marketization of deposit interest rates, and this change has weakened the profitability of banks. Under the influence of Fintech, bank deposit costs tend to rise, and coupled with the decline in loan interest rates caused by intensified market competition, banks' net interest income has been squeezed and profitability has been significantly affected. In addition, Gu and Yang (2018) found that the increase in risk-taking caused by Fintech clearly overwhelms its potential suppression of risks in terms of reducing management costs. K. Wang et al. (2017) found that with the integration of technology, the way banks handle risks showed a non-linear trend, indicating that there may be a non-linear complexity between the evolution of Fintech and the risks borne by banks association. In the study of S. Wang et al. (2021), the relationship between Internet finance and commercial banks' risk-taking is characterized as an "inverted U-shaped" curve that first increases and then decreases. At first, the emergence of Internet finance intensified market competition, and commercial banks were forced to increase risk-taking; then, as the relationship between the two deepened and the integration of technology, the enhancement of banks' risk control capabilities prompted their risk-taking levels to return to rationality. During this process, joint-stock banks and city commercial banks experienced more severe initial shocks, but joint-

stock banks showed strong recovery and adaptability in the later period by their more proficient applications in the field of Fintech.

Another series of studies directly focus on exploring whether Fintech can improve bank governance and operating performance. L. Lin et al. (2001) believed that the rise of Internet finance, an early form of Fintech, broke the traditional boundaries between financial institutions and significantly lowered industry entry barriers. This Fintech-related trend not only catalyzed technological innovation in the traditional banking industry but also notably enhanced banks' operational efficiency. They further proposed a new perspective on financial intermediation and markets, discussing how this analytical framework could shed light on the understanding of finance in the era of the Internet and IT revolution, help explain the financial innovations over the past few decades, and examine competition issues as well as the strategies that financial institutions should adopt to respond. J. Zhao et al. (2022) revealed that Fintech innovation exerts a dual impact on the operations of Chinese commercial banks. Using patent indicators and a Fintech index, alongside a generalized method of moments model to address endogeneity, they found that Fintech innovation generally reduces banks' profitability and asset quality, with this negative impact being more pronounced for large state-owned commercial banks. Conversely, it improves banks' capital adequacy and operational management efficiency, though this positive effect is less significant for policy banks and state-owned commercial banks. They further noted that banks' own specific Fintech capabilities, as measured by patent applications and claims, exert similar dual effects on their operational performance. X. H. Chen et al. (2021) used questionnaire surveys and structural equation model analysis to find that Fintech products have significantly improved customer satisfaction and employee efficiency of Chinese commercial banks, especially in terms of perceived usefulness. Although the perceived difficulty of use negatively affects customer satisfaction, but unexpectedly compensates for this shortcoming by improving service quality and employee performance, providing a two-way perspective for the optimization and application of bank Fintech. Lee et al. (2021) argued that Fintech innovation exerts dual beneficial impacts on the operations of Chinese commercial banks, enhancing both their cost efficiency and the technology they adopt. To examine Fintech's influence on China's banking industry from 2003 to 2017, they constructed comprehensive Fintech industry development indices and four subcategory indices using enterprise-level Fintech data. They also measured relevant efficiency scores for Chinese banks across different ownership structures by applying the stochastic meta frontier approach. Their analysis revealed that state-owned commercial banks exhibited the lowest cost efficiency and operated with inferior technology relative to other banks. When assessing Fintech's specific

operational effects, they confirmed that Fintech innovations not only improved banks' cost efficiency but also upgraded the technology they employed. This dual beneficial impact on commercial bank operations was more pronounced for innovations related to market support services. Phan et al. (2020) showed that the growth of Fintech firms exerts a negative impact on commercial bank operations, specifically undermining bank performance. They developed this hypothesis and tested it in Indonesia, a market with impressive Fintech growth, using a sample of 41 banks and Fintech firm data. Through multiple additional tests and robustness checks—including sensitivity analyses on bank characteristics, examinations of the Global Financial Crisis's effects, and the use of alternative estimators—they confirmed that their core conclusion, that Fintech growth negatively predicts bank performance, remains valid.

Coincidentally, Haddad and Hornuf (2023) found that the establishment of Fintech startups exerts a positive impact on the operations of incumbent commercial banks, alongside improving overall financial stability. Using a large global sample of financial institutions from 87 countries over the period 2005–2018, they revealed a positive relationship between Fintech startup formations and the performance of incumbent institutions. They further found that Fintech startup establishments reduce the stock return volatility of incumbent institutions and lower their systemic risk exposure. These findings confirmed that Fintech startups not only boost the operational performance of commercial banks but also enhance financial stability. K. Zhu and Guo (2024) that Fintech-empowered digitalization exerts a positive impact on commercial bank operations by improving the service efficiency and customer experience of inclusive finance, while also boosting other business income and overall bank performance. They noted that in recent years, Chinese commercial banks have increasingly leveraged Fintech to expand credit supply in key inclusive finance areas, amid performance pressures from impulsive lending and fee reduction and profit-sharing behaviors. Their analysis revealed that traditional inclusive lending faces cost-benefit asymmetry, leading to a phenomenon where loan balances increase without corresponding profit growth or even result in losses—primarily affecting small and micro enterprises and negatively impacting bank performance. However, Fintech-driven digital inclusive finance effectively mitigates these negative impacts and enhances bank performance. They further pointed out that the positive operational effects of Fintech stem from its risk adjustment mechanism, which reduces information asymmetry and transaction costs. According to the analysis of J. Sun and He (2015), from 2000 to 2014, the proportion of deposits in the financing structure of China's banking industry dropped sharply. Internet financial products driven by Fintech, such as Yu'ebao, are known for their customer stickiness, capital liquidity, the information transparency and convenient channels, which successfully diverted

bank deposits and raised bank capital costs. This directly squeezes banks' profit margins in deposit and loan interest rates, forcing the banking industry to innovate traditional business models through technological innovation and service upgrades to improve market competitiveness and internal efficiency.

X. Liu and Yang (2017) revealed that in the competition and cooperation game between commercial banks and Internet financial companies, a series of mergers, acquisitions and reorganization events may occur. By integrating the characteristics of Internet finance, these reorganized banking institutions can not only optimize their business structure, but also significantly enhance profitability. Using text analysis method, Yu et al. (2020) found the profitability of commercial banks has been significantly suppressed by the widespread application of Fintech. W. Yang et al. (2020) constructed a bank Fintech index to quantitatively analyze the effect of Fintech on the total factor productivity of commercial banks, and found that the advancement of Fintech has significantly boosted total factor productivity of joint-stock banks and banks located in the eastern economy. M. Liu (2021) found that the relationship between Fintech and bank performance has experienced an "inverted U-shaped" change of first boosting and then suppressing, and Fintech has a more significant effect on improving the performance of large and medium-sized banks. Xiong et al. (2021) pointed out that Fintech may put certain pressure on the operating performance of commercial banks in the short term. This is due to the high investment in the early stage and the uncertainty in the market adaptation process. However, looking forward to the future, the impact of Fintech long-term technological spillover effects will gradually emerge. By optimizing banks' operating processes, enhancing customer experience and broadening service boundaries, substantial improvements in bank operating performance can be achieved.

Chapter 3: Data Sources and Variable Construction

3.1 Data sources and samples

This study considers the representativeness of banks and the availability of data, and extracts the unbalanced panel data of 351 Chinese commercial banks from 2007 to 2022 from the CNRDS *(China Research Data Services Platform)* database as the research sample. Since this period just happens to be the intersection of two development stages of Fintech, it can objectively reflect the impact of Fintech on Chinese commercial banks. Among them, there are 59 listed banks and 292 non-listed banks. Overall, there are 6 state-owned commercial banks, 198 rural commercial banks, 124 city commercial banks, 12 joint-stock commercial banks, 3 foreign-funded banks, 7 private banks, and 1 other commercial bank. The continuous variables in the data are winsorized at the 1% level at both ends to avoid the influence of extreme values. After retaining the non-missing values of the variables, there are 1980 observation values in the final sample.

3.2 Variable construction

3.2.1 Independent variable

(1) Core Independent Variable: Commercial Bank Fintech Index

To better describe the Fintech index at the bank level, reflect the Fintech development level of commercial banks, and scientifically measure the Fintech development level of banks, it is particularly important. This research draws on the methods of constructing the enterprise-level Internet finance index based on text mining by P. Guo and Shen (2015) and the digital transformation index of commercial banks by S. H. Wang and Xie (2021), and innovatively constructs the Fintech index of Chinese commercial banks (Fintech). In addition, this research also refers to the practices of M. Liu (2021) and Huang and Huang (2023), and uses the frequency statistics of four relevant terms related to bank Fintech in the database of the China Research Data Services Platform (CNRDS) (the frequency of informatization-related terms, the frequency of intelligent-related terms, the frequency of digital-related terms, and the frequency of Internet-related terms) as the source of indicators. The China Research Data Services

Platform (CNRDS), based on the annual report texts disclosed by hundreds of Chinese commercial banks, adopts a relatively common list of Fintech keywords. These keywords are divided into four classification lists: informatization, intelligentization, digitalization, and internetization. For each bank's annual report in each year, the number of keywords belonging to these four classification lists is calculated respectively, thus obtaining the corresponding four types of bank Fintech frequency statistics. Subsequently, this thesis uses the principal component analysis (PCA) method on these four frequency statistics to construct the Fintech index variable (Fintech) at the bank level and standardize it. Table 3.1 lists the Fintech keyword lists of the four categories.

Table 3.1 Fintech keyword list

Informatization	**Intelligentization**	**Digitalization**	**Internetization**
Information sharing	Artificial intelligence	Mobile payment	Mobile Internet
Information management	High-end intelligence	Third-party payment	Industrial Internet
Information integration	Industrial intelligence	NFC	Industrial Internet of Things
Information software	Mobile intelligence	Smart energy	Internet solutions
Information system	Intelligent control	Network connection	Internet technology
Information network	Intelligent terminal	Smart wearable devices	Internet thinking
Information terminal	Intelligent mobile	Smart agriculture	Internet action
Information center	Intelligent management	Intelligent transportation	Internet business
Informatization	Intelligent factory	Intelligent manufacturing	Internet mobile
Networked information sharing	Intelligent logistics	Intelligent healthcare	Internet application
Networking	Intelligent manufacturing	Intelligent warehousing	Internet marketing
Industrial information	Intelligent warehousing	Intelligent customer service	Internet strategy
Industrial communication	Intelligent technology	Smart home	Internet platform
Cloud ecosystem	Intelligent device	Intelligent investment advisory	Internet model
Cloud service	Intelligent production	Intelligent culture and tourism	Internet business model
Cloud platform	Intelligent networking	Intelligent environmental protection	Internet ecosystem
Cloud computing	Intelligent system	Smart grid	E-commerce
Stream computing	Intelligentization	Intelligent marketing	Electronic commerce
Graph computing	Automatic control	Digital marketing	Internet
In-memory computing	Automatic monitoring	Unmanned retail	Internet +
Secure multi-party computation	Automatic surveillance	Internet finance	Online-offline
Brain-inspired computing	Automatic detection	Digital finance	Online- to-offline
Green computing	Automatic production	Fintech	Online and offline
Cognitive computing	Numerical control	Quantitative finance	O2O
Converged architecture	Integration	Open banking	B2B
Hundred-million-level concurrency	Integration technology	Data management	C2C
level storage	Integrated solution		B2C
Internet of Things	Integrated control		C2B
Cyber-physical system	Integrated system		China Electronic
Blockchain	Industrial cloud		Commerce Association
Digital currency	Future factory		E-commerce system
	Intelligent fault diagnosis		

Informatization	Intelligentization	Digitalization	Internetization
Distributed computing	Life-cycle management	Data mining	
Differential privacy technology	Manufacturing execution system	Data network	
Intelligent financial contract	Virtualization	Data platform	
Intelligent bank	Virtual manufacturing	Data center	
Information management system	Intelligent payment	Data science	
Management information system	Business intelligence	Digital control	
National Information Center	Image understanding	Digital technology	
	Investment decision-making support system	Digital communication	
	Intelligent data analysis	Digital network	
	Intelligent robot	Digital intelligence	
	Machine learning	Digital terminal	
	Deep learning	Digitalization	
	Semantic search	Big data	
	Biometric technology	Text mining	
	Face recognition	Data visualization	
	Voice recognition	Heterogeneous data	
	Identity verification	Credit reporting	
	Autonomous driving	Augmented reality	
	Natural language processing	Mixed reality	
	Numerical control machinery	Virtual reality	
	Numerical control machine tool		
	Numerical control system		

Source: China Research Data Services Platform (CNRDS)

To gain a deeper understanding of the data related to these four words frequencies, this thesis plots the trend charts of the mean word frequencies of banks with different listing types (see Figure 3.1 to Figure 3.2 for details).

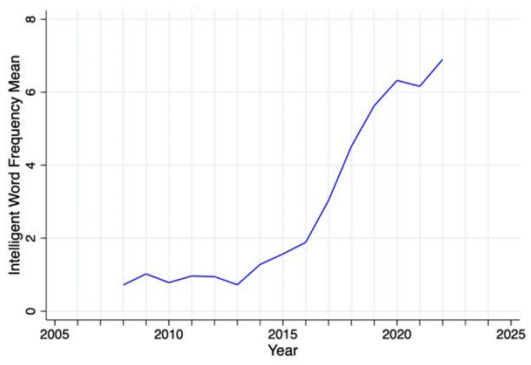


Figure (a) Trend of Intelligent Words in China's Commercial Banks

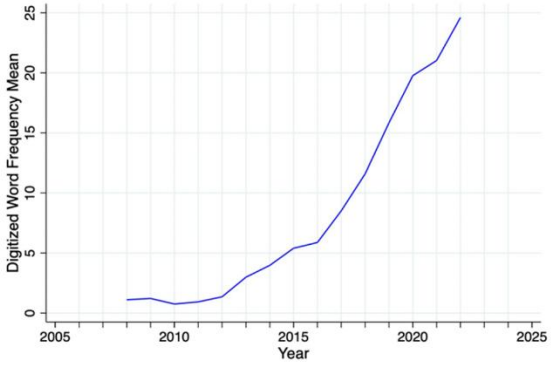


Figure (b) Trend of Digital Words in China's Commercial Banks

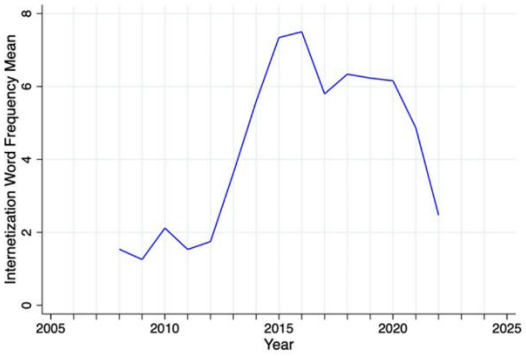


Figure (c) Trend of Internetization Words in China's Commercial Banks

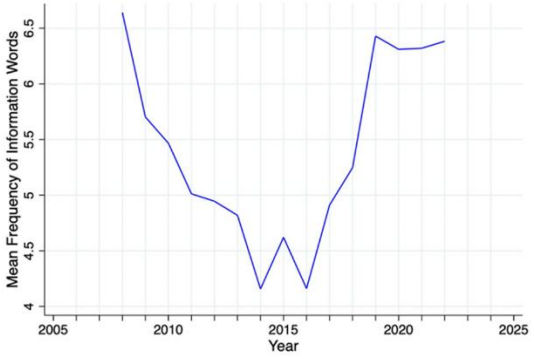


Figure (d) Trend of Information Technology Words in China's Commercial Banks

Figure 3.1 Trend of words in China's commercial banks

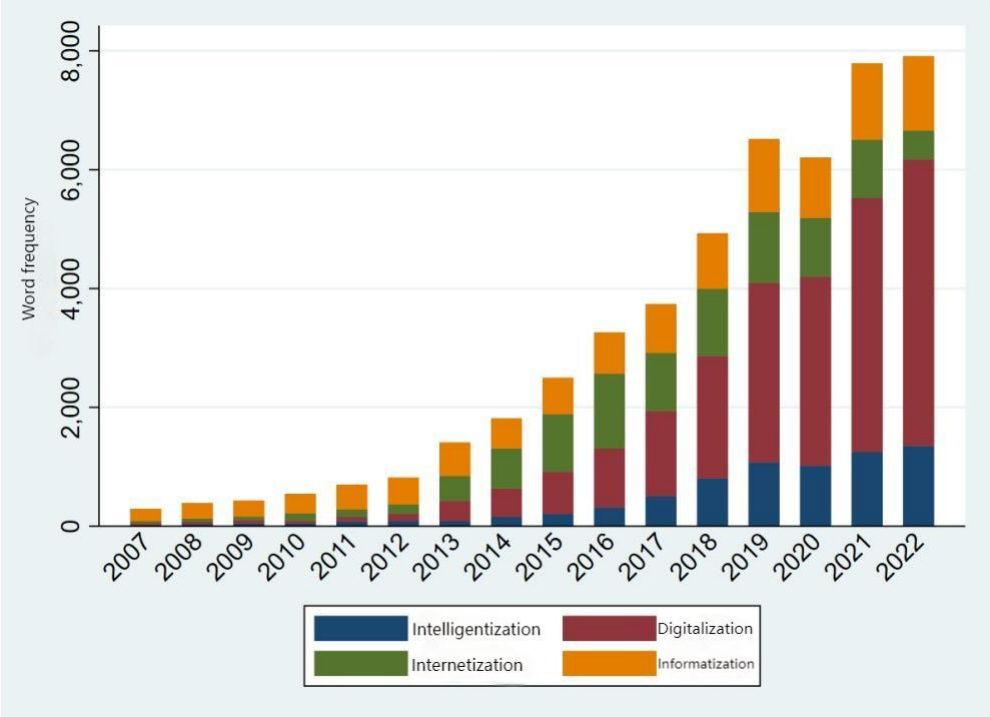


Figure 3.2 Overall frequency of words related to Fintech in commercial banks

The specific steps of the PCA for the Fintech index are as follows:

Suppose this thesis stacks the Fintech word-frequency statistical dataset into a matrix $X_{m\times n}$, where $m = 4$, which means the rows of the matrix correspond to the 4 word-frequency statistical

categories, and *n* is equal to the number of samples in each category's word-frequency statistics. Define the following variance-covariance matrix C:

$$\boldsymbol{C = (c_{ij})_{m\times m}, c_{ij} = cov(X_i, X_j), i, j = 1, 2, \dots, m}$$
$$\boldsymbol{C = \frac{1}{m-1} X^T X} \tag{3.1}$$

Diagonalize the covariance matrix of the above-mentioned dataset to obtain its eigenvalues and eigenvectors. The diagonal elements of Λ are the eigenvalues.

$$\boldsymbol{C = \frac{1}{m-1} X^T X = P \Lambda P^{-1}}$$
$$\boldsymbol{P^{-1}\left(\frac{1}{m-1} X^T X\right) P = \Lambda} \tag{3.2}$$

In this thesis, the eigenvectors in P are called principal components. Right-multiplying the original dataset X by P is equivalent to transforming the coordinate axes of the original dataset. The original coordinate axes are the original variables, and the new coordinate axes are the principal components. This transformation achieves the following purposes: while ensuring no information loss, it makes the new variables after the transformation uncorrelated. The magnitude of the eigenvalues of the covariance matrix of the original dataset X represents the variance magnitude of each principal component in explaining the new data. Therefore, the magnitude of the eigenvalues corresponding to each principal component of the new dataset represents the importance of that principal component. Subsequently, this can be used to screen the principal components to achieve the purpose of removing redundancy. In this thesis, the eigenvectors are arranged horizontally in descending order of their eigenvalues and are named the first principal component, the second principal component, the third principal component, and the fourth principal component from left to right. According to the PCA analysis results, the first four principal components explain 71.63%, 13.59%, 11.40%, and 3.38% of the total variance, respectively. The first principal component alone explains 71.63% of the variance, which is highly representative in capturing the main variations in Fintech word-frequency statistics. This thesis selects this first principal component. To ensure the standardization of scores, this thesis calculates the minimum value of the principal component scores and subtracts this minimum value from all scores to convert all scores into non-negative values. After completing the standardization process, the Fintech index used in this thesis is finally obtained.

The above Figure 3.1 to Figure 3.2 respectively presents the word frequency situations used in this study to construct the Fintech index of commercial banks. Firstly, Figure 3.1(a) reveals the changes in the average usage frequency of intelligent words by Chinese commercial banks, covering the period from 2007 to 2022. During this period, a continuous upward trend can be

observed. From 2007 to 2010, the usage frequency of intelligent words was relatively stable, but starting from 2010, there was a significant increase in this frequency. Especially after 2015, the growth rate accelerated significantly until it reached the highest point in 2020. This phenomenon implies that with the continuous advancement of technological progress and digital transformation, Chinese commercial banks are paying more and more attention to using intelligent technologies to enhance their competitiveness and service capabilities. This may be the result jointly driven by the increasingly fierce market competition and technological innovation. Looking ahead, it is expected that this trend will continue, as more financial institutions will be committed to introducing cutting-edge technologies and innovative strategies to improve operational efficiency and the quality of customer service.

Figure 3.1(b) presents the trend of the mean value of the digital word frequency of Chinese commercial banks from 2007 to 2022. The horizontal axis represents the year, and the vertical axis shows the mean value of the word frequency. The line extends from the lower left to the upper right, reflecting that the digitalization process of Chinese commercial banks has been continuously improving over time. In particular, around 2010, the curve of the number of digital word frequencies showed a steep climb, indicating a significant increase in the speed of bank digitalization, which may suggest that the industry faced key changes or technological innovations during this period. Overall, the graph shows the increasing popularity and deepening of the application of digital technologies in the banking sector, reflecting the process of Chinese commercial banks actively responding to challenges and embracing innovation against the backdrop of technological progress and social evolution.

The curve in Figure 3.1(c) shows a fluctuating pattern of first rising, then falling, and then rising again, roughly in an inverted U-shape, indicating that the Internet-based process of Chinese commercial banks grew steadily in the initial stage, and after reaching the highest value, it began to decline rapidly. On the one hand, this may reflect that during the period from 2012 to 2017, due to the popularity of smartphones, China's technology experienced a boom in the mobile Internet, further promoting the Internet-based process of Chinese commercial banks. The whole process shows that the understanding and practice of Chinese commercial banks in the application of Internet technologies have gone through ups and downs. As the boom of China's mobile Internet fades, the Internet-based process of Chinese commercial banks has finally returned to stability and maturity. On the other hand, it may be because Chinese commercial banks have achieved Internet-based operations during this stage, resulting in a significant reduction in the marginal benefits brought by further Internet-based development, thus reducing the motivation of banks to continue promoting Internet-based operations. Based

on the above two possible reasons, the frequency of words reflecting the Internet-based process began to decline rapidly in the annual reports of commercial banks. Figure 3.1(d) shows the trend of the mean value of the informatization word frequency of Chinese commercial banks. The curve shows that the informatization process of Chinese commercial banks has not been smooth sailing, but has experienced troughs and rebounds. The informatization word frequency of banks almost kept declining from 2007 to 2016, and it only started to rise from 2016. The possible reason is that in the early stage, Chinese commercial banks had already completed the basic informatization construction before 2007. Compared with intelligence, digitalization, and Internet-based operations, the status of informatization was relatively secondary between 2007 and 2016. With the rapid development of Fintech, banks began to explore new information technology deployments in 2016, such as using technologies like big data and artificial intelligence to improve service quality and risk management capabilities. New technologies require new informatization investments, and banks once again increased their investment in informatization and technological upgrades to cope with new market and technological challenges. Therefore, the frequency of mention of related words rose again.

Finally, Figure 3.2 shows a stacked bar chart of the frequency statistics of words in the annual reports of various categories of Chinese commercial banks each year, namely intelligence, digitalization, Internet-based operations, and informatization. The vertical axis represents the word frequency count, and the horizontal axis represents the year. The colors of the bars are blue for intelligence, red for digitalization, green for Internet-based operations, and yellow for informatization. It can be seen from the chart that the word frequencies of these three categories are increasing year by year, among which the growth of digitalization is the most significant, followed by Internet-based operations, and then intelligence. The total word frequency of informatization is the lowest among these four categories. This chart may reflect that the importance of digital technologies and Internet services in the banking business has been increasing in recent years, and digital transformation and Internet financial services have continuously become the hot topics of Fintech.

Figures 3.3(a) to 3.3(d), respectively, present the word frequency situations of commercial banks of different scales. Firstly, looking at the trend chart of the mean value of the Internet-based word frequency, from 2007 to 2010, both large-scale banks and small-scale banks had a low level of Internet-based development with little fluctuation. After that, the Internet-based level of large-scale banks began to rise significantly after 2010 and reached its peak between 2015 and 2020. While the Internet-based level of small-scale banks was relatively stable, and although it increased, the overall level was not high. This phenomenon reflects that large-scale

banks are more active in the application of Internet technologies, probably because they have stronger resources and technical capabilities, enabling them to carry out more and earlier Internet-based operations. The informatization trend chart shows that the informatization level of large-scale banks remained high from 2007 to 2010 but then gradually declined, and it didn't start to rise again until 2015 and declined again after 2020. The informatization level of small-scale banks was relatively stable but fluctuated greatly. The rapid early development of informatization in large-scale banks may be related to their early construction of informatization systems. However, with the emergence and upgrading of new technologies, the limitations of the old systems became apparent, resulting in fluctuations in the informatization level.

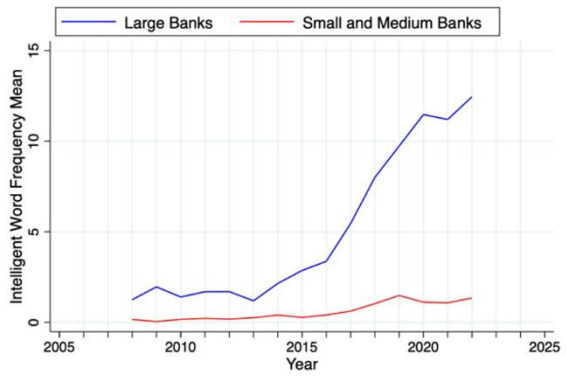


Figure (a) Trend of Intelligent Word Frequency in Banks of Different Sizes

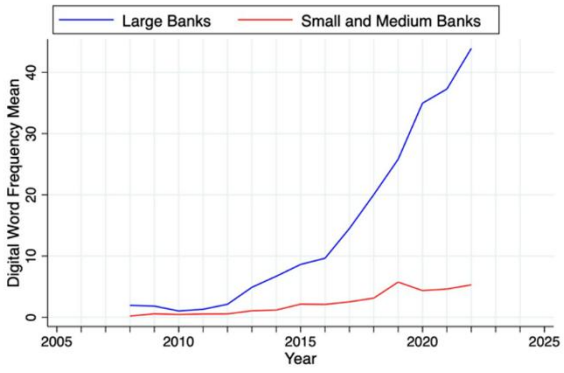


Figure (b) Trend of Digital Word Frequency in Banks of Different Sizes

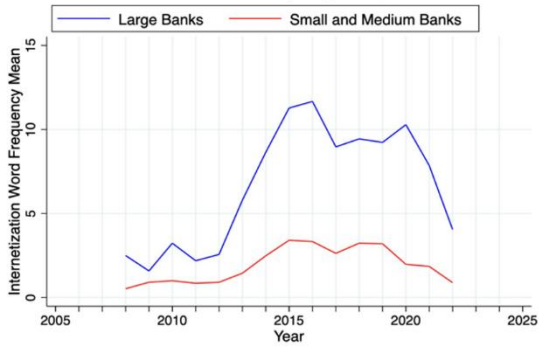


Figure (c) Trend of Internetization Word Frequency in Banks of Different Sizes

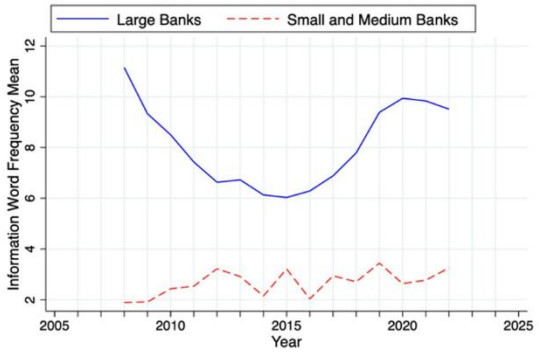


Figure (d) Trend of Information Word Frequency in Banks of Different Sizes

Figure 3.3 Trend of words frequency in banks of different sizes

In terms of intelligence, from 2007 to 2015, both large-scale banks and small-scale banks had a low level of intelligence. After 2015, the intelligence level of large-scale banks began to increase rapidly and reached its peak in 2020. While small-scale banks also increased during this period, the increase was not significant. The rapid development of large-scale banks in intelligence reflects their investment in and application of new technologies such as big data and artificial intelligence, which further improved their operational efficiency and service quality. In terms of digitalization, from 2007 to 2015, the digitalization development of large-

scale banks was slow, but it showed a rapid upward trend after 2015 and reached a significant peak in 2020. Meanwhile, small-scale banks maintained a relatively stable growth throughout the period, with a small increase. The rapid development of digitalization in large-scale banks indicates that they have stronger capabilities and willingness in the investment and application of digital technologies, especially in the context of the rapid development of Fintech. Large-scale banks take the lead in using Fintech tools. In conclusion, large-scale banks show a more active development trend in Internet-based operations, digitalization, informatization, and intelligence, reflecting their advantages in resources, technology, and strategic layout. While small-scale banks develop relatively slowly, probably limited by their resources and technical capabilities, they are also gradually following these trends.

As can be seen from the four trend charts in Figure 3.4, the mean values of word frequencies of Chinese commercial banks of different listing types in terms of intelligence, digitalization, Internet-based operations, and informatization show significant changing trends, which reflect the application and development of Fintech in the banking industry. Firstly, regarding the mean value of intelligent word frequencies, A-share listed banks and A+H-share listed banks showed a significant growth trend after 2015, especially that A+H-share listed banks reached their peak around 2020. This indicates that these banks have invested a large amount of resources in intelligence and actively applied artificial intelligence and other intelligent technologies to improve operational efficiency and the quality of customer service. The mean values of intelligent word frequencies of unlisted banks and H-share listed banks are relatively low and change gently, suggesting that the progress of these banks in intelligent applications is relatively slow. Secondly, the trend chart of the mean value of digital word frequencies shows a similar pattern, and the growth of A-share listed banks and A+H-share listed banks after 2015 is particularly significant. Digital transformation is regarded by these banks as an important means to enhance competitiveness. Through the application of digital technologies such as big data and blockchain, the operational efficiency and service capabilities of banks have been significantly improved. The mean values of digital word frequencies of unlisted banks and H-share listed banks are relatively low, reflecting that their investment in and progress in digitalization are relatively limited. In terms of Internet-based operations, the mean values of word frequencies of A-share and A+H-share listed banks increased rapidly around 2015 but declined after 2020, which may be related to the maturity of Internet technologies and the decline of market enthusiasm. The mean values of Internet-based word frequencies of unlisted banks and H-share listed banks remain at a low level, indicating that their progress in this area is relatively slow. Finally, the trend of the mean value of informatization word frequencies also

shows a similar pattern. The growth of A-share and A+H-share listed banks after 2015 is particularly obvious, reflecting the positive attitude and rapid progress of these banks in informatization construction. The mean values of word frequencies of unlisted banks and H-share listed banks are relatively stable, reflecting their relative conservatism in informatization.

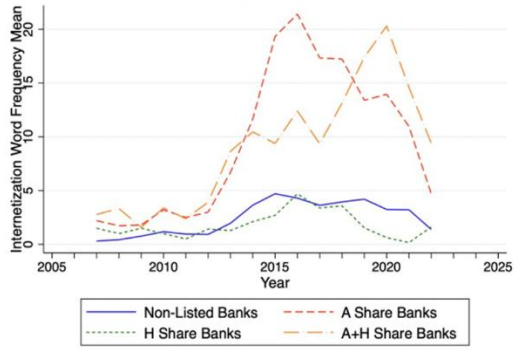


Figure (a) Trend of Internetization Word Frequency in Listed Banks of Different Types

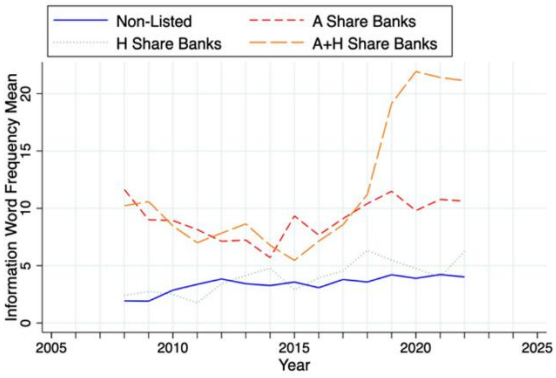


Figure (b) Trend of Information Word Frequency in Listed Banks of Different Types

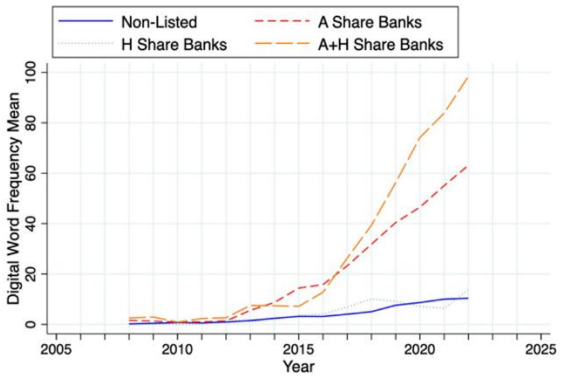


Figure (c) Trend of Digital Word Frequency in Listed Banks of Different Types

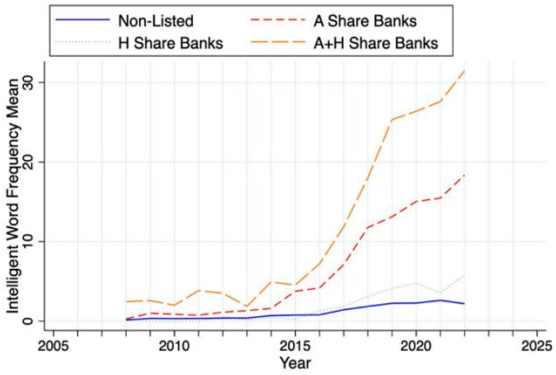


Figure (d) Trend of Intelligent Word Frequency in Listed Banks of Different Types

Figure 3.4 Trend of words frequency in listed banks of different types

Overall, the statistical trend charts of these four word-frequencies indicate that banks of different listing types show significant differences in various aspects of Fintech. A-share and A + H-share listed banks have made rapid progress and invested more in intelligence, digitalization, Internet-based operations, and informatization, while unlisted banks and H-share listed banks are relatively conservative and progress slowly. These trends reflect the different strategies and paths of Chinese banks in response to the wave of Fintech, providing important evidence for further research on the impact of Fintech on bank operations.

Based on CNRDS data, we can sort out the changing trends of the non-performing loan ratios (NPL) of different types of commercial banks. As can be seen from Figure 3.5, during the period from 2007 to 2022, the overall non-performing loan ratio (NPL) of Chinese commercial banks has undergone significant changes, showing an obvious fluctuating trend. From 2007 to 2010, the non-performing loan ratio dropped significantly from a relatively high

2.5% to nearly 1.0%. During this period, China's economy was growing rapidly, and the overall asset quality of the banking industry was significantly improved. In addition, the strict regulatory measures of the regulatory authorities after the financial crisis and the improvement of the internal risk management capabilities of banks have also promoted the decline of the non-performing loan ratio to a certain extent. However, from 2010 to 2015, the non-performing loan ratio rebounded and then maintained a fluctuating upward trend. Especially after 2015, the non-performing loan ratio rose again to nearly 1.5%. In this year, as China's economic growth rate slowed down, the operating pressure of some industries and enterprises increased, leading to an increase in the non-performing loans of banks. In addition, during the process of economic structure adjustment, the exposure of risks in traditional industries and industries with overcapacity also aggravated the problem of non-performing loans of banks. From 2015 to 2020, the non-performing loan ratio continued to rise and reached its peak in 2020. At the same time, China's economy faced downward pressure, and some enterprises had difficulties in operation, resulting in an increase in the non-performing loan ratio. In addition, the increase in global economic uncertainties and the decline in external demand also had a negative impact on the operating conditions of Chinese enterprises, further pushing up the non-performing loan ratio of banks. After 2020, the non-performing loan ratio declined and tended to be stable. This may be because the state has introduced a series of policy measures to support economic and financial stability, helping enterprises tide over difficulties, and the problem of non-performing loans of banks has been alleviated to a certain extent. At the same time, the adjustment and optimization of banks in risk management and credit policies have also played a positive role in controlling the non-performing loan ratio.

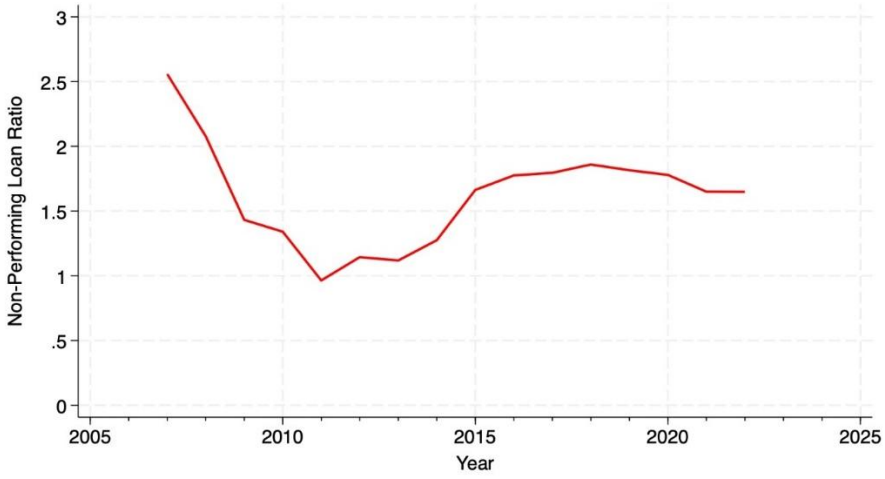


Figure 3.5 Trends in commercial banks' non-performing loan ratios

According to the data from CNRDS, this thesis can sort out the changing trends of NPL of different types of commercial banks. As can be seen from Figure 3.6, during the period from

2007 to 2022, the NPL of different types of Chinese commercial banks showed obvious changing trends. The non-performing loan ratio of state-owned commercial banks showed a downward trend from 2007 to 2010, then tended to be stable, and increased slightly after 2015. This trend shows that state-owned commercial banks have been relatively effective in risk control after the financial crisis, but the non-performing loan ratio rebounded under the circumstances of the slowdown of the economic growth rate and the intensification of market competition. Overall, NPL of various types of commercial banks all decreased from 2007 to 2010, indicating that the risk control and asset management of the banking industry have achieved certain results during this period. However, since 2015, the non-performing loan ratio has generally shown a slight upward trend, reflecting the impact of the slowdown of the economic growth rate, the intensification of market competition, and the rise of risks in some industries on the asset quality of banks. Given this, whether the credit risks borne by commercial banks will be affected and the potential influencing paths behind it have become the core issues of common concern for government regulatory authorities and financial institutions in the context of the rapid development of Fintech. This thesis aims to analyze and discuss this complex issue, hoping to provide valuable insights for the research and practice in this field.

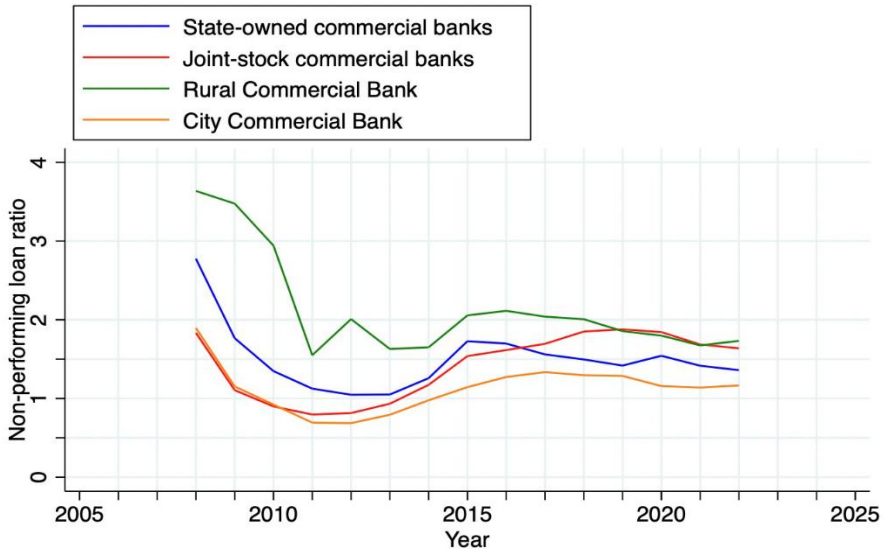


Figure 3.6 Trends in non-performing loan ratios by bank type over time

(2) Control Variables

Drawing on existing literature (Jin et al., 2020; Xiong et al., 2021), the control variables of this study are planned to be selected as theROA reflecting the operating performance level of banks, the cost-income ratio (CI) reflecting operating efficiency, the bank capital structure (Leverage), and the proportion of fixed assets (Tang) reflecting the asset liquidity of banks;

macroscopically, it mainly includes the growth rate of China's gross domestic product (GDP_Growth) reflecting the level of China's economic development and the growth rate of the money supply (M2_Growth) reflecting the monetary policy environment.

3.2.2 Dependent variable

3.2.2.1 Credit risk

(1) Dependent variable: bank credit risk

The key indicators for bank risk assessment include the proportion of weighted risk assets, expected default rate, stock price volatility, Z-value, and non-performing loan ratio. Given that this research focuses on the field of credit risk, referring to the research of Papadopoulos (2019), this thesis selects the bank non-performing loan ratio (NPL) as the core indicator to represent the credit risk status of banks. The higher the non-performing loan ratio, the higher the credit risk of the bank.

(2) Mechanism variables

This thesis selects the operating cost ratio (CR) of banks, that is, the ratio of the total expenditure of banks to their total assets, as a proxy indicator for testing hypothesis. If a commercial bank shows a high operating efficiency, the proportion of its expenditure relative to its total assets should tend to be at a low level. Furthermore, if the application of Fintech can effectively reduce the operating cost ratio (CR) of banks, this data indicates that Fintech has indeed brought an improvement in the overall operating efficiency of banks.

This thesis selects the proportion of loans to the largest customer (Loanr1) and the proportion of loans to the top ten customers (Loanr10) as proxy indicators of loan concentration to test hypothesis. When the values of the proportion of loans to the largest customer (Loanr1) and the proportion of loans to the top ten customers (Loanr10) are high, this reflects that the concentration of bank credit resources is high; that is, loans are more concentrated among a limited number of major credit customers.

3.2.2.2 Bank governance

(1) Dependent variable: bank governance level

Similar to corporate governance, there are complex relationships of mutual promotion and substitution among various links of bank governance. Banks must study and evaluate their operating conditions from a highly comprehensive perspective. Considering the availability of data, this study refers to the method of Q. J. Zhang and Chen (2022) and uses the factor analysis method in STATA software. Multiple variables related to bank governance are selected from

the CNRDS database, such as audit fees, concurrent positions, the number of directors, the proportion of independent directors, the proportion of management shareholding, and the total management compensation. Then, the potential factors representing the bank governance level are extracted through the factor analysis method. The factors extracted by factor analysis represent the unobservable common characteristics in the original variables, and these characteristics explain the correlations among the original variables statistically. Through the rotation step, this thesis further optimizes the structure of the factors, making each factor related to as few variables as possible, thereby enhancing the interpretability of the results. Finally, the generated factor scores are used as the bank governance index, which is the weighted sum of the scores of each variable on each factor. Finally, to eliminate the impact of extreme values, the variable is winsorized with 1% at both ends. The index calculated through factor analysis effectively summarizes various aspects of bank governance and can be used as a comprehensive indicator in empirical analysis to measure the governance levels of different banks. The higher the index, the higher the bank governance level.

(2) Mechanism variables

Within the rigorous framework of the agency-cost theory, the root cause of agency costs is rooted in the asymmetry of interests between shareholders and management and the complexity derived from the separation of ownership and management rights. Q. Yang and Yang (2006) analyzed the unique enterprise form of Chinese commercial banks. Their internal structures form a multi-dimensional principal-agent system, intricately interweaving the debt-contract relationship between depositors and banks, the credit-cooperation framework between lenders and banks, and the complex authorization-and-agency chain between shareholders and management. This thesis focuses on the components of agency costs, specifically covering supervision costs, incentive costs, and residual losses caused by information asymmetry and decision-making biases. M. S. Wang and Xu (2017) further analyzed on this basis and pointed out that the continuous increase in management agency costs may stem from the deficiencies of the incentive mechanism, which prompts management to tend to pursue personal interest maximization, thus having a boosting effect on the bank's overall agency costs. This perspective not only reveals the internal logic of the increase in agency costs but also provides an important theoretical reference for optimizing the corporate governance structure and improving the incentive mechanism. In response to this, previous studies have revealed multiple paths for Fintech services to reduce bank agency costs: First, from the perspective of supervision costs, banks can use digital technologies to monitor management behavior, significantly improving supervision efficiency and expecting to control supervision costs within

a reasonable range. Second, Fintech empowers banks to enhance their information-collection and-processing capabilities, effectively alleviating the persistent problem of information asymmetry in the principal-agent relationship and opening up a new way to reduce management agency costs. In summary, the widespread application of bank Fintech is expected to lead to a decline in agency costs, which will have a positive and direct impact on the bank's corporate governance structure, promoting it to become more efficient and transparent. This thesis is based on the internal relationship between the agency costs of general enterprises and corporate governance and refers to the research of X. R. Li and Zhang (2014) to use the management-expense ratio (i.e., the ratio of management expenses to operating income) as an indicator to measure the management agency costs of banks. Specifically, the higher the value of the management-expense ratio (denoted as Mangfee), the higher the management agency costs of the bank management. This measurement method helps to accurately capture the impact of management behavior on the bank's operating efficiency.

Continuing the theoretical analysis from the perspective of alleviating information asymmetry, this thesis believes that Fintech also improves the readability of commercial bank annual reports through intelligent tools. For example, artificial-intelligence technology can be used for natural-language processing and automatic report generation, making the annual report content clearer and more understandable. Intelligent data-visualization platforms have the ability to refine and transform complex financial data into intuitive charts and graphs, greatly facilitating users' in-depth understanding and accurate grasp of the financial report content. This not only improves the readability of the annual report but also enhances the quality and transparency of bank information disclosure. Therefore, based on the relevant sample data of the readability of commercial bank annual reports (total number of words; average number of words in a sentence; proportion of adverbs and conjunctions, and so on.) selected from the CNRDS database, this thesis uses the principal-component analysis method in STATA software to calculate the readability index of commercial bank annual reports (Readability) through score weighting and standardizes it.

3.2.2.3 Bank operating performance

(1) Dependent variable: bank operating performance

ROA is an indicator commonly used by many researchers to measure bank operations (M. Li et al., 2024; Yuan, 2017). ROA, as a key financial indicator for measuring a company's core competitiveness and growth potential, is of great significance. It is not only an indispensable benchmark for evaluating corporate performance but also influences a company's strategic

decision-making on whether to operate with debt. Looking at the research context at home and abroad, the evaluation of corporate performance has evolved, and a diversified indicator system has been constructed, including the DuPont analysis system, economic value added (EVA), balanced scorecard (BSC), etc. The continuous development in this field demonstrates its dynamic adaptability and forward-looking nature. Given the uniqueness and development status of China's capital market, when selecting corporate-performance evaluation indicators in this thesis, based on the DuPont analysis system, special attention is focused on the ROA as the core indicator. ROA, as a direct yardstick for measuring a company's financial health, can accurately reflect a company's operating results and profitability. Its advantages lie in its simple operation and high data reliability, providing a solid and reliable basis for corporate performance evaluation.

(2) Mechanism variables

This thesis refers to the research of Xiong et al. (2021) and uses the net interest margin (defined as the natural logarithm of the difference between operating income and net interest income) as an intermediate variable to test the overall impact of Fintech development on bank operating performance. An increase in the net interest margin will also lead to an increase in operating income. Conversely, if the net interest margin decreases, the bank's ROA will decline. The net interest margin also reflects the bank's interest-spread management and asset-liability-structure optimization capabilities.

Secondly, the operating cost of a commercial bank refers to the expenses incurred during its operation. This thesis refers to the research of J. J. Li and Jiang (2021) and uses the cost-income ratio (CI) as a key indicator to measure the cost-control efficiency of banks. It effectively reflects the balance between cost control and income generation during the bank's operation. The lower the cost-income ratio, the lower the cost for a commercial bank to generate the same income, indicating a better cost-control effect of the commercial bank and a greater promoting effect on the bank's operating performance.

In addition, regarding the operating efficiency of commercial banks, this thesis refers to existing literature and uses the total-asset turnover ratio (AT) as its proxy variable for measurement (C. M. Li et al., 2022; Zou et al., 2015). It is defined as the ratio of operating income to total assets. The total asset turnover ratio is usually used as an important indicator to evaluate a bank's operating capabilities. There is a positive correlation between the total asset turnover ratio of a commercial bank and its operating efficiency. The popularization of Fintech can simultaneously improve the business efficiency and management efficiency of the banking industry. As the bank's profitability increases, the operating performance of commercial banks

also improves.

3.2.2.4 Summary

To summarize, the variable definitions for credit risk, governance, and operating performance are listed in Panel A, Panel B, and Panel C, respectively in Table 3.2.

Table 3.2 Variable definitions

Variable Type	Variable Name	Variable Definition
Panel A: Variable Definitions for Credit Risk		
Dependent Variable	Non-performing Loan Ratio	Balance of non-performing loans / Total loans at the end of the period
Core Independent Variable	Bank Fintech Development Index	Construct the Fintech development index of commercial banks through relevant word frequency statistics and the principal component analysis method
Control Variables	ROA	Net profit / Total assets
	Cost-income Ratio	Operating cost / Operating income
	Proportion of Fixed Assets	Total fixed assets / Total assets
	Leverage Ratio	Total liabilities / Total assets
	GDP Growth Rate	Actual year-on-year growth rate of GDP
	M2 Money Supply Growth Rate	Growth rate of broad money M2
Mechanism Variables	Operating Cost Ratio	Total expenditure / Total assets
	Proportion of Loans to the Top Ten Customers	Total loans to the top ten loan customers / Total loans
	Proportion of Loans to the Largest Customer	Loan amount to the largest loan customer / Total loans
Panel B: Variable Definitions for Bank Governance		
Dependent Variable	Level of Bank Governance	Constructed through the factor analysis method
Core Independent Variable	Bank Fintech Development Index	The commercial bank Fintech development index is constructed by using the principal component analysis method through relevant word frequency statistics
Control Variables	Return on Capital	Net Profit / Total Assets
	Cost-Income Ratio	Operating Cost / Operating Income
	Proportion of Fixed Assets	Total Fixed Assets / Total Assets
	Leverage Ratio	Total Liabilities / Total Assets
	GDP Growth Rate	Actual Year-on-Year Growth Rate of GDP
	M2 Supply Growth Rate	Growth Rate of Broad Money M2
Mechanism Variables	Management Expense Ratio	Management Expense / Operating Income
	Readability of Commercial Bank Annual Reports	The readability index of commercial bank annual reports is constructed by using the principal component analysis method through relevant word frequency statistics

Variable Type	Variable Name	Variable Definition
Panel C: Variable Definitions for Bank Operating Performance		
Dependent Variable	ROA	Net Profit / Total Assets
Independent Variable	Bank Fintech Development Index	Construct the Fintech Development Index of Commercial Banks through relevant word frequency statistics and by using the principal component analysis method.
Control Variable	Return on Capital	Net Profit / Total Assets
	Bank Size	Logarithm of Total Assets
	Cost-to-Income Ratio	Operating Cost / Operating Income
	Proportion of Fixed Assets	Total Fixed Assets / Total Assets
	Leverage Ratio	Total Liabilities / Total Assets
	GDP Growth Rate	Actual Annual Year-on-Year GDP Growth Rate
	Growth Rate of M2 Supply	Growth Rate of Broad Money M2
Mechanism Variable	Return on Capital	Net Profit / Total Assets
	Bank Size	Logarithm of Total Assets

Chapter 4: Impact of Fintech on the Credit Risk of Chinese Commercial Banks

4.1 Introduction

Commercial bank credit, as a key component of indirect financing, is of utmost significance to China's financial system. From a macro perspective, the risk management and control of commercial banks are directly related to the stable operations of the overall financial system, and its importance cannot be overstated. From a micro-economic perspective, Chinese commercial banks mainly rely on credit business as their core operating activity. The quality of credit has a significant impact on the profitability and asset security of these banks. By providing loans to customers, banks can obtain substantial interest income, which is usually the main source of income for most banks. In addition, an effective credit management strategy not only helps to enhance the bank's reputation but also attracts more potential customers and investors, thus further promoting the development of the bank. Conversely, if a bank has too many non-performing loans, it may seriously erode its capital base and may lead to severe liquidity problems. Once this occurs, it will pose a major threat to the overall stability and sustainable operation ability of the bank. Therefore, for Chinese commercial banks, effectively managing and controlling credit risk to ensure the quality of credit assets is a crucial task.

In the current economic environment, the integration of Fintech and various back-end technologies is giving rise to a series of diversified front-end financial innovations. The in-depth integration of Fintech and the diversified integration of back-end technologies are constantly spurring the trend of diversified front-end financial innovations, bringing extensive and profound changes to the structure and service model of the financial industry. Against this background, commercial banks, as the solid foundation of the traditional financial system, are actively conforming to the development trend of Fintech, fully launching the magnificent journey of strategic transformation, and spontaneously engaging in the forefront of Fintech research and practice, thus promoting the vigorous development of the banking industry in the field of Fintech. Particularly, the stability of the banking system plays a vital role in the stability of the overall financial and economic situation. The potential risks within the banking system also have a non-negligible impact on the stable operations of the real economy and the financial

market. Meanwhile, bank credit business, as a key pillar supporting modern social financing needs, also plays an indispensable role in this process. The accompanying credit risk has become a prominent manifestation of the bank's risk system. Driven by Fintech, the banking industry is undergoing continuous changes and development. During this process, its impact on bank credit risk is becoming increasingly significant and cannot be ignored, and it may indirectly spread to the overall economic and financial stability framework, having far-reaching implications.

Commercial bank credit risk refers to the risk of loss caused by borrowers' default or inability to repay debts on time. In the wave of the rapid advancement of Fintech, commercial banks are facing an intertwined situation of unprecedented new challenges and broad opportunities. On the one hand, the rapid development and application of Fintech have brought many changes to commercial banks. By introducing big data technology, commercial banks can conduct in-depth mining and analysis of massive data, thereby achieving accurate risk assessment and prediction. This big-data-based risk control method can help banks understand customers more comprehensively and, effectively identify potential risks, and improve the efficiency of credit risk management. On the other hand, Fintech may also exacerbate credit risk. Although Fintech has introduced many advanced data analysis and machine-learning algorithms, they may not be able to capture important signals in certain unstructured data, or they may be overly reliant on automated decision-making, which is prone to extreme risks. Moreover, due to lagging supervision, there may be many potential credit risk hazards. Given this, the goal of this thesis is to use econometric methods to explore the effect of Fintech on the credit risk of Chinese commercial banks, reveal the hidden mechanism, and accordingly put forward relevant strategic suggestions. This chapter aims to provide a solid theoretical basis and practical guidance for the practice and popularization of Fintech in the credit business of the banking industry and has great theoretical and practical significance.

Theoretically, this thesis enriches and deepens the connotation and transmission channels of Fintech in the new era. When exploring the multi-dimensional effects of Fintech on the credit risk assessment mechanism of commercial banks, this thesis focuses on its substantial impact and conducts detailed empirical analysis, aiming to clarify whether Fintech constitutes a key factor in the change of commercial bank credit risk. In addition, this thesis explores the core elements driving the significant impact of Fintech in the field of commercial banks, analyzes the similarities and differences in the effects of Fintech on the credit risks of different types of commercial banks, helps the long-term development of Fintech enterprises, and provides theoretical support for the construction of the regulatory framework and system. This has

important theoretical significance for improving the regulatory mechanism of Chinese Fintech enterprises and also lays a solid foundation for follow-up research. This research aims to bring new perspectives and insights to the research field of credit risk in the Chinese banking industry. This thesis will introduce the latest data to enrich and improve the existing research on bank credit risk, connect Fintech with credit risk, and provide more reference materials for scholars studying credit risk. Secondly, compared with many pieces of literature that rely on news reports obtained through keyword searches, this research adopts a novel measurement method. It uses the frequencies of Fintech words in four categories: intelligentization, digitalization, Internet-based, and informatization, extracted from the CNRDS (China Research Data Services Platform), and integrates them into a Fintech index for each bank through factor analysis. This method enables this thesis to verify and examine the impact of Fintech on credit risk from a new perspective. Such a new measurement method helps this thesis to more accurately understand and evaluate the role of Fintech and provides more valuable data support for related research. Finally, research on the specific mechanisms by which Fintech affects bank credit risk is relatively scarce. Through empirical analysis, this thesis can gain an in-depth understanding of the relationship between Fintech and credit risk and fill the gaps in existing research. The research results of this thesis not only help to improve banks' understanding of Fintech in the field of credit risk but also enable people to better understand how Fintech affects the operation and management of banks.

Practically, in the current economic environment, the credit risk of commercial banks is one of the key issues of concern for regulatory authorities. To ensure the operational safety of commercial banks, the stability of the national financial system, and the sustainable and healthy development of the national economy, regulatory authorities need to adopt effective means to monitor and manage these risks. The development of Fintech provides new possibilities for solving this problem. By studying how Fintech affects credit risk, regulatory authorities can more accurately assess the potential risks brought by Fintech and formulate corresponding regulatory strategies accordingly. In addition, with the continuous development of Fintech, the traditional regulatory model can no longer meet the actual needs. Therefore, this research helps to design a new regulatory system that conforms to the development trend of Fintech. Through the research on the relationship between Fintech and credit risk, this thesis can assist regulatory agencies in deepening their understanding of credit risk and response strategies, to achieve precise supervision of commercial banks, maintain the stability of the national financial system, and thus promote the sound and sustainable development of China's financial industry.

In addition, the development of Fintech provides new opportunities for the credit risk

management of commercial banks. Through the research on how Fintech affects credit risk, commercial banks can gain the necessary insights to make informed decisions on whether to promote the development of Fintech. This also helps commercial banks to effectively integrate Fintech with credit risk management according to their actual situations, use Fintech to refine their credit risk management strategies, and thus improve their overall operational efficiency and stability.

4.2 Research questions

The impact of Fintech on credit risk is an important topic in current financial research. The core goal of this research is to analyze the changes in the credit risk of Chinese commercial banks after the application of Fintech and the underlying mechanism. The specific research questions include the following aspects:

Firstly, what are the specific impacts of Fintech on the credit risk of Chinese commercial banks? This question aims to clarify the direct and indirect impacts of Fintech on commercial bank credit risk from different dimensions. Through empirical analysis, it is possible to reveal the specific manifestations and effects of Fintech in reducing or increasing credit risk. In particular, the research will focus on the application of Fintech in loan approval, risk assessment, post-loan management, etc., and how it affects the credit risk level of banks by improving data analysis capabilities, optimizing risk prediction models, and enhancing business process efficiency.

Secondly, what is the mechanism of Fintech's impact on credit risk? This research will explore the specific mechanisms through which Fintech affects the credit risk of commercial banks. It is hypothesized that Fintech can directly improve the risk management of banks by reducing information asymmetry, increasing transparency, and enhancing risk control capabilities. In addition, the indirect impacts of Fintech in customer relationship management, product innovation, and market competition will also be examined, and how they affect the credit risk status of banks by optimizing resource allocation and improving service quality.

Thirdly, when different types of banks (such as state-owned banks, joint-stock banks, city commercial banks, and rural commercial banks) apply Fintech, are there differences in the impact on credit risk? Different types of banks have significant differences in resource endowments, business strategies, and regulatory environments, which may lead to different application effects of Fintech. This research will reveal the similarities and differences in the application of Fintech among various types of banks through comparative analysis and explore

their specific performances and effects in credit risk management, aiming to provide targeted strategic suggestions for different types of banks.

Fourthly, are there differences in the application effects of Fintech between large-scale banks and small-scale banks? Large banks usually have more resources and technical capabilities and can better integrate and apply Fintech, while small-scale banks may face challenges such as limited resources and backward technology. This research will compare the specific application effects of Fintech between large banks and small-scale banks through data analysis and explore the moderating role of the scale factor on the relationship between Fintech and credit risk.

In summary, the impact of Fintech on credit risk is an important topic in current financial research. This thesis aims to explore the specific impacts of Fintech on the credit risk of Chinese commercial banks and its mechanism. The specific research questions include the following aspects:

1. What are the specific impacts of Fintech on the credit risk of Chinese commercial banks?

This question aims to clarify the direct and indirect impacts of Fintech on commercial bank credit risk from different dimensions. Through empirical analysis, it is possible to reveal the specific manifestations and effects of Fintech in reducing or increasing credit risk.

2. What is the mechanism of Fintech's impact on credit risk?

3. Are there differences in the application effects of Fintech between large-scale banks and small-scale banks?

4. Are there differences in the application effects of Fintech among banks with different geographical distributions?

5. Are there similar differences among banks with different listing statuses?

6. Is there a difference in this impact between national and local commercial banks?

4.3 Theoretical analysis and research hypotheses

Firstly, the application of Fintech helps to enhance the risk identification capabilities of bank loan approval and post-loan management, thus effectively reducing credit risk. On the one hand, during the loan preparation stage, banks can efficiently process massive credit-related data with the help of big data analysis, machine learning, and other technologies and explore the background information of customers. This helps to alleviate the information asymmetry problem between banks and loan customers, enabling banks to more accurately assess the solvency and credit status of borrowers, thereby effectively reducing the generation of non-

performing loans and lowering credit risk (S. B. Liu et al., 2021; Roy et al., 2018; T. Sun & Vasarhelyi, 2018; Twala & Cartwright, 2010). On the other hand, during the subsequent management process after loan issuance, banks can use advanced digital technologies to create a more accurate early-warning system. This system can effectively conduct forward-looking analyses of borrowers' credit risks, ensuring continuous and real-time monitoring and tracking of credit risks. This greatly improves the efficiency of banks in identifying and classifying high-default-risk loans, thus effectively reducing potential credit risk (Kvamme et al., 2018; X. J. Ma et al., 2018; Malekipirbazari & Aksakalli, 2015; C. Wang et al., 2018).

Secondly, the deployment of Fintech also mainly reflects in reshaping the decision-making and behavior of bank management. A clear digital promotion strategy helps to foster and develop the digital management thinking of commercial banks, enabling management to build a more scientific risk management framework, thus enhancing risk management capabilities and effectively reducing the occurrence of credit risk (Du et al., 2021). Fintech has brought about the optimization of the organizational structure, optimized internal coordination and information transmission within banks, improved overall bank management, and thus made bank decisions efficient and reasonable, enabling better risk management coordination and decision-making, and further reducing credit risk (Y. Guo et al., 2022; Lee et al., 2021).

Based on the above analysis, the following hypothesis is proposed:

H4-1: The larger the Fintech adoption, the lower the credit risk of commercial banks.

The integration of digital technology into the financial industry has created huge productivity potential for banking institutions. Fintech reduces the costs in financial service areas such as payment and settlement, capital financing, and risk control, and improves their efficiency, thereby enhancing the performance and quality of financial activities (Arner et al., 2016). Fintech innovation enhances the efficiency and accuracy of banks in information processing, thus optimizing the business processes of commercial banks in customer acquisition, loan approval, and deposit management (Muganyi et al., 2022). The application of Fintech breaks through the time-space limitations of traditional financial services for commercial banks, enabling bank services to seamlessly extend in a virtual environment. Internet-based services significantly reduce the marginal cost of financial transactions and greatly reduce the reliance on human resources, thus significantly enhancing the overall operational efficiency of financial institutions (Zhai et al., 2023). Therefore, the following hypothesis is proposed:

H4-2: Fintech adoption reduces bank credit risk by improving the operational efficiency level of banks and reducing bank operating costs.

Loan concentration has always been an important factor affecting credit risk. Many

international and Chinese agreements or regulations, including the Basel Accords, commercial bank regulations, and the guiding principles of the China Banking Regulatory Commission, have set strict and specific limits on the concentration of customer loans. If a bank overconcentrates its loan portfolio, it usually leads to a significant increase in the credit risk it faces. This increase in concentration may weaken the bank's risk-diversification ability, making the economic fluctuations of a single borrower or a specific industry have an excessive impact on the bank's asset quality (Boyd & De NicolÓ, 2005; Duellmann & Masschelein, 2007; Rossi et al., 2009; C. X. Zhou & Mao, 2018). The innovative product and service development of Fintech and the enhancement of risk-identification skills help financial institutions expand the scope of credit services for small-scale enterprises and individual customers, thus enhancing the popularity and accessibility of credit resources (M. Cheng & Qu, 2020). Fintech has significantly accelerated the expansion and deepening of inclusive finance. With innovative service models and technical means, it has effectively broken through the barriers of traditional financial services, making financial services more convenient and efficient in reaching every corner of society and expanding the boundaries and diversity of bank credit (Arner et al., 2020; M. Li et al., 2024; Yin, 2017; M. Zhang & Yang, 2019). Therefore, it is speculated that Fintech may increase the diversity of bank loan portfolios, reduce bank loan concentration, and thus lower credit risk. Therefore, the following hypothesis is proposed:

H4-3: Fintech adoption reduces credit risk by reducing loan concentration.

4.4 Empirical results

4.4.1 Descriptive statistical analysis

This section of descriptive statistical analysis reveals the differences and characteristics of the full sample, listed banks, and non-listed banks in each variable, providing basic data support for subsequent empirical analysis. Through these statistics in Table 4.1, we can initially understand the distribution and differences of Fintech and other financial indicators among different banks, and reveal the basic characteristics of the sample data, including the mean, median, standard deviation, skewness, kurtosis, and other statistics of variables such as the Fintech index (Fintech), non-performing loan ratio, ROA, asset-liability ratio, capital adequacy ratio, asset liquidity, cost-income ratio, GDP growth rate, and M2 growth rate.

Table 4.3 Descriptive statistics of variables

Panel A	Sample Size	Mean	Median	Standard Deviation	Skewness	Kurtosis
Fintech	1980	1.130	0.512	1.746	3.346	17.532
Non-performing Loan Ratio	1980	1.619	1.470	0.924	1.671	7.744
ROA	1980	0.008	0.008	0.004	0.293	3.367
Asset-Liability Ratio	1980	0.925	0.926	0.020	-1.439	7.398
Capital Adequacy Ratio (%)	1980	13.670	13.210	2.527	1.902	8.775
Asset Tangibility	1980	0.007	0.006	0.005	1.592	6.177
Cost-Income Ratio	1980	0.614	0.600	0.130	0.481	3.186
GDP Growth Rate	1980	9.713	9.159	4.246	0.737	3.624
M2 Growth Rate	1980	11.772	11.012	3.871	2.134	9.000
Panel B	**Descriptive Statistics of Variables of Listed Banks**					
Fintech	666	2.091	0.351	0.902	2.081	7.960
Non-performing Loan Ratio	666	1.391	0.710	1.340	2.621	16.244
ROA	666	0.009	0.009	0.003	0.447	3.102
Asset-Liability Ratio	666	0.930	0.930	0.015	-0.687	6.199
Capital Adequacy Ratio (%)	666	13.319	13.070	2.108	1.868	10.902
Asset Tangibility	666	0.006	0.006	0.004	2.203	9.038
Cost-Income Ratio	666	0.583	0.574	0.105	0.530	3.901
GDP Growth Rate	666	10.318	10.098	4.208	0.740	3.146
M2 Growth Rate	666	12.615	11.33	4.492	1.751	6.542
Panel C	**Descriptive Statistics of Variables of Non-Listed Banks**					
Fintech	1314	0.643	0.351	0.902	4.189	36.050
Non-performing Loan Ratio	1314	1.734	1.590	0.996	1.367	6.170
ROA	1314	0.008	0.008	0.003	0.447	3.012
Asset-Liability Ratio	1314	0.922	0.924	0.022	-1.433	6.724
Capital Adequacy Ratio (%)	1314	13.801	13.320	2.699	1.812	7.746
Asset Tangibility	1314	0.007	0.006	0.138	1.406	5.274
Cost-Income Ratio	1314	0.629	8.533	3.689	0.347	2.870
GDP Growth Rate	1314	9.020	8.533	3.689	0.464	3.397
M2 Growth Rate	1314	11.012	11.345	3.438	2.344	10.971

On the one hand, in the descriptive statistics of the full sample (Panel A), the mean of Fintech is 1.130, the median is 0.512, and the standard deviation is 1.746, showing a large dispersion of the data and a high degree of right-skewness (skewness is 3.346). The mean of the non-performing loan ratio is 1.619, the standard deviation is 0.924, and the skewness is 1.671, indicating significant differences in the non-performing loan ratio among different banks. The mean of the ROA is 0.008, showing that the overall profitability of banks is low and the distribution is uniform (the standard deviation is 0.006, and the skewness is 0.923). The mean values of the asset-liability ratio and the capital adequacy ratio are 0.925 and 13.670, respectively, with small standard deviations, indicating that most banks are relatively consistent in these two indicators. The mean values of asset liquidity and the cost-income ratio are low,

0.007 and 0.614 respectively, but the skewness of the cost-income ratio is 0.130, showing a certain degree of right-skewness. The mean of the GDP growth rate is 9.304, indicating rapid economic growth.

On the other hand, for the sample of listed banks (Panel B), the mean of Fintech is 2.091, significantly higher than the mean of the full sample, and the skewness is 2.081, indicating that listed banks invest more in Fintech. The mean of the non-performing loan ratio is 1.391, lower than the mean of the full sample, indicating that the asset quality of listed banks is relatively good. The mean of the ROA is 0.009, higher than the full sample, indicating that the profitability of listed banks is stronger. The mean of the capital adequacy ratio is also higher than the full sample, 27.333 and 13.319 respectively, showing the advantages of listed banks. The mean values of asset liquidity and the cost-income ratio are 0.006 and 0.583, respectively, showing the good performance of listed banks in liquidity management and cost control. The mean of the GDP growth rate is 10.318, which is slightly higher than the full sample.

Finally, in the sample of non-listed banks (Panel C), the mean of Fintech is 0.643, significantly lower than the full sample and the sample of listed banks, and the kurtosis is as high as 36.050, showing a highly concentrated data distribution. The mean of the non-performing loan ratio is 1.734, higher than the full sample, showing that the non-performing loan problem of non-listed banks is more serious. The mean of the ROA is the same as the full sample, the mean of the asset-liability ratio is 0.922, close to the full sample, and the mean of the capital adequacy ratio is 13.801, higher than the full sample. The mean values of asset liquidity and the cost-income ratio are 0.007 and 0.629, respectively, showing the disadvantages of non-listed banks in these two indicators. The mean of the GDP growth rate is 9.020, which is slightly lower than the full sample.

To avoid the problem of multicollinearity in the regression model, a correlation analysis of variables is carried out before the regression. The specific results are shown in Table 4.2.

Table 4.4 Variable correlation matrix

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Non-performing Loan Ratio	1.000								
Fintech	-0.096	1.000							
ROA	-0.435	-0.039	1.000						
Capital Adequacy Ratio	-0.162	0.607	-0.012	1.000					
Asset-Liability Ratio	-0.045	0.001	-0.106	0.268	1.000				

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Asset Tangibility	0.170	-0.160	0.161	-0.177	-0.132	1.000			
Cost-Income Ratio	0.517	0.052	-0.765	-0.071	-0.030	0.003	1.000		
GDP Growth Rate	-0.116	-0.130	0.230	-0.039	0.133	0.074	-0.196	1.000	
M2 Growth Rate	-0.209	-0.182	0.253	-0.038	0.235	0.154	-0.203	0.296	1.000

Table 4.2 shows the correlation coefficients between variables, revealing their mutual relationships. The core variables are the non-performing loan ratio and the Fintech index, and other variables include the ROA, bank size, leverage ratio, asset tangibility, cost-income ratio, GDP growth rate, and M2 growth rate.

Firstly, the correlation coefficient between the Fintech index and the non-performing loan ratio is -0.096. Although it is low, it is negative, indicating that the development of Fintech has a certain negative correlation with reducing the non-performing loan ratio of banks, supporting the previous empirical analysis conclusion that Fintech can help reduce bank credit risk. The correlation coefficient between the ROA and the non-performing loan ratio is -0.435, indicating that banks with a higher ROA have a relatively lower non-performing loan ratio, and there is a significant negative correlation between the two. This shows that the profitability of banks is closely related to their credit risk management, and higher profitability can help banks better cope with non-performing loans. The correlation coefficient between the leverage ratio and the non-performing loan ratio is -0.045, almost no correlation, indicating that the leverage ratio has little impact on the non-performing loan ratio of banks. The correlation coefficient between asset tangibility and the non-performing loan ratio is 0.170, showing a positive correlation. This may be because banks with high asset tangibility have a relatively fixed asset structure and poor flexibility, thus increasing credit risk. The correlation coefficient between the cost-income ratio and the non-performing loan ratio is 0.517, the highest positive correlation, indicating that a higher cost-income ratio is closely related to a higher non-performing loan ratio. This means that ineffective cost control will significantly increase the credit risk of banks. The correlation coefficient between the GDP growth rate and the non-performing loan ratio is -0.116. Although it is low, it is negative, indicating that a higher economic growth rate helps to reduce the non-performing loan ratio of banks, supporting the mitigating effect of economic growth on bank credit risk. The correlation coefficient between the M2 growth rate and the non-performing loan ratio is -0.209, showing a weak negative correlation. This indicates that the growth of the money supply helps to reduce the non-performing loan ratio of banks, possibly because the loose

monetary policy helps to improve the liquidity and credit conditions of banks.

In summary, the results of the variable correlation analysis show that there is no obvious multicollinearity among the variables. The development of Fintech, the ROA, bank size, GDP growth rate, and M2 growth rate have a certain positive impact on reducing the non-performing loan ratio, while the cost-income ratio and asset tangibility are positively correlated with the non-performing loan ratio, indicating that an increase in these two factors will increase the credit risk of banks.

4.4.2 Model design

To analyze the impact of Fintech on credit risk, this thesis estimates the following regression models.

$$\boldsymbol{NPL_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \varepsilon_{i,t}} \quad (4.1)$$

$$\boldsymbol{NPL_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + \varepsilon_{i,t}} \quad (4.2)$$

$$\boldsymbol{NPL_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_i + \varepsilon_{i,t}} \quad (4.3)$$

Where $NPL_{i,t}$ represents the credit risk of bank I in year t. $Fintech_{i,t}$ represents the internal Fintech development of bank i in year t. $Control_{i,t}$ is the additional bank control variable, including the proportion of fixed assets (Tang), bank leverage ratio (Leverage), cost-income ratio (CIR), GDP growth rate (GDP_Growth), and M2 money supply (M2_Growth). $Year$ is the time-fixed effect, and ε represents the clustered robust error term, with the clustering level being the individual. All variable definitions are shown in Table 3.2.

It is worth noting that when studying the impact of the Fintech index on the credit risk of Chinese commercial banks and the subsequent bank governance and operating performance, this research chooses not to use firm fixed effects but only adds time fixed effects. This decision is based on the following reasons:

Firstly, the focus of this research is to analyze the changes over time, such as the impact of the development of Fintech on bank credit risk. Using time-fixed effects can effectively capture these trends in the macroeconomic environment. Secondly, considering the complexity of the model and the fitting problem, adding firm fixed effects may lead to overfitting of the model; that is, the model is too complex to effectively summarize the overall trend of the data. Excessive model complexity not only increases the computational cost but also may cause the problem of multicollinearity, thus affecting the stability and reliability of parameter estimation. By only using time-fixed effects, this research can simplify the model structure, focus on the core research question, and avoid unnecessary estimation problems. For the above-mentioned

considerations, in the subsequent fixed-effect regressions, this thesis follows the same approach.

4.4.3 Regression results

4.4.3.1 Baseline regression results

Table 4.3 presents the benchmark regression results of the impact of Fintech on bank credit risk. To explore the correlation between the development of bank Fintech and credit risk, this thesis first conducts an empirical analysis using Model (4-1). The regression results show that in Model (4-1), the coefficient of the Fintech index is -0.045, which is significant at the 1% level. This indicates that the application of Fintech significantly reduces the credit risk of banks. This is probably because Fintech improves the data analysis ability and the accuracy of the risk assessment model, enabling banks to more accurately evaluate the creditworthiness of borrowers, thereby reducing the probability of non-performing loans. Fintech can also enhance the efficiency and transparency of the loan approval process, reduce operational risks and information asymmetry, and thus lower the overall credit risk of banks. In Model (4-2), after adding more control variables, the coefficient of the Fintech index further drops to -0.064, and it is still significant at the 1% level. This result further supports the role of Fintech in reducing credit risk. The addition of control variables such as ROA and the asset-liability ratio (Lev) shows the impact of these factors on bank credit risk. In particular, the significantly positive coefficient of the asset-liability ratio indicates that a higher asset-liability ratio may be associated with higher credit risk. This may be because a higher proportion of fixed assets restricts the bank's liquidity, thereby increasing the risk exposure. In Model (4-3), after further adding time fixed effects, the coefficient of the Fintech index is -0.057, and it is significant at the 1% level. The addition of time-fixed effects controls the impact of external factors such as the macroeconomic environment and policy changes on bank credit risk, making the negative impact of the Fintech index more robust. This shows that regardless of the control conditions, the application of Fintech significantly reduces the credit risk of banks. This may be due to the wide application of Fintech in risk management and internal control, which improves the bank's ability to manage and respond to credit risks.

Table 4.5 Baseline results: The impact of Fintech on bank credit risk

Variables	Credit Risk		
	(4-1)	(4-2)	(4-3)
Lag_Fintech	-0.045***	-0.064***	-0.057***
	(0.012)	(0.011)	(0.019)
Lag_ROA		-16.986*	-13.196
		(9.163)	(26.910)
Lag_Lev		-0.967	-0.429
		(1.483)	(2.972)
Lag_Tang		28.273***	26.427***
		(4.162)	(5.593)
Lag_CI		1.938***	2.073***
		(0.246)	(0.550)
Lag_CAR		-0.040***	-0.031
		(0.011)	(0.020)
Lag_Gdpgr		-0.008*	0.000
		(0.005)	(.)
Lag_M2gr		-0.035***	0.000
		(0.005)	(.)
Time Fixed Effect	NO	NO	YES
R^2	0.009	0.237	0.275
Adj R^2	0.009	0.233	0.265
Observations	1429	1423	1423

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

Overall, the significant negative impact of Fintech on bank credit risk has been verified under different models, demonstrating the importance of Fintech in modern bank risk management. The application of Fintech can not only improve the risk assessment and management capabilities of banks but also optimize business processes and internal control mechanisms, significantly reducing credit risk.

4.4.3.2 Mechanism test

To verify H4-2, this study first conducts an empirical analysis of the mechanism based on the construction of Model (4-3). The estimation results in Column 3 of the table show that:

$$\boldsymbol{CR_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (4.4)$$

$$\boldsymbol{Loanr1_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (4.5)$$

$$\boldsymbol{Loanr10_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (4.6)$$

Where $CR_{i,t}$ is the operating cost ratio of bank i in year t, $Loanr1_{i,t}$ is the loan amount of the largest loan customer of bank i in year t divided by the total loans, and $Loanr10_{i,t}$ is the total loan amount of the top ten largest loan customers of bank i in year t divided by the total loans. $Year_t$ is the time-fixed effect of the bank, and $\varepsilon_{i,t}$ is the standard error. The regression results of the mechanism test are shown in Table 4.4.

Table 4.6 Mechanism test: The impact of Fintech on bank credit risk

Variables	***CR***	***Loanr*1**	***Loanr*10**
	(4-4)	**(4-5)**	**(4-6)**
Lag_Fintech	-0.000	-0.236**	-2.523***
	(-0.26)	(-2.23)	(-4.93)
Lag_ROA	0.975***	-376.2**	-2334.7**
	(10.11)	(47.660)	(-3.62)
Lag_Lev	-0.040***	3.686	-59.59
	(-4.62)	(0.25)	(-0.93)
Lag_Tang	0.029	20.79	-30.61
	(0.99)	(0.74)	(-0.17)
Lag_CI	0.033***	-2.339	0.617
	(9.33)	(-0.78)	(1.15)
lag_*CAR*	-0.000**	0.179	-18.81
	(-3.46)	(1.34)	(-1.45)
Constant	0.028*	4.654	115.0
	(2.91)	(0.28)	(1.84)
Time Fixed Effect	YES	YES	YES
R^2	0.483	0.113	0.204
Adj R^2	0.475	0.097	0.187
Observations	1,401	1156	917

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

To verify H4-2, this thesis first conducts a test based on Model (4-3), and the regression results are shown in Table 4.4. The estimation results in Column (4-4) of Table 4.4 show that Fintech does not have a significant impact on the operating cost ratio, indicating that Fintech may not reduce the credit risk of commercial banks by improving the overall management efficiency of banks. Therefore, H4-2 is rejected. Similarly, to verify H4-3, this thesis uses Models (4-5) and (4-6) for regression tests. From the estimation results in Columns (4-4) and (4-5) of Table 4.4, it can be seen that Fintech significantly reduces the loan concentration at the 5% and 1% levels, respectively. This indicates that Fintech mainly reduces the credit risk faced by banks by reducing the loan concentration and achieving the effect of diversifying loan risks.

4.4.3.3 Heterogeneity analysis

In the previous chapter, this thesis tested the impact of the popularization of Fintech on bank credit risk and its mechanism. However, the differential impacts of Fintech on reducing credit risk among different types of banks and regions have not been fully analyzed. Therefore, to understand the actual effect of Fintech in bank risk management, this chapter will conduct in-depth regression analysis to explore the heterogeneous impact of Fintech on credit risk. This thesis will conduct detailed tests from the dimensions of the bank's listing status, regional economic development level, and bank size, revealing the differential effects of Fintech under different backgrounds. This analysis not only provides a scientific basis for the practical application of Fintech but also offers a powerful decision-making reference for policymakers

and bank managers.

Table 4.5 Panel A shows the results of the heterogeneity test of the impact of the Fintech index on the credit risk of banks with different listing types. Model (1) and Model (2) in Table 4.5 Panel A respectively examine the impact of the Fintech index on the credit risk of non-listed banks and listed banks. The coefficient and significance of the core Independent Variable, the Fintech index (Fintech), show its differential impacts on different types of banks. In Model (1), for non-listed banks, the coefficient of the Fintech index is significant at the 5% level. This indicates that Fintech has a significant negative impact on the credit risk of non-listed banks. Non-listed banks usually face higher credit risks, possibly due to their lower market status and smaller asset size. The application of Fintech can help these banks improve their credit assessment process, enhance their risk control capabilities, and reduce information asymmetry, thus effectively reducing their credit risk. This impact may be particularly important because non-listed banks may lack the transparency and regulatory constraints of listed banks, and Fintech provides an alternative means to improve governance and risk management. In Model (2), for listed banks, the coefficient of the Fintech index is significant at the 10% level. This indicates that Fintech can also reduce the credit risk of listed banks, but its impact is relatively small. Listed banks usually have stronger capital strength, technical capabilities, and market status, and have established relatively complete risk management systems. The introduction of Fintech further enhances the risk control capabilities of these banks, but due to the high baseline, its marginal effect may not be as obvious as that in non-listed banks. These banks are more inclined to use Fintech to optimize existing processes and services rather than relying entirely on it for a transformation in risk management.

Table 4.7 Heterogeneity test: The impact of Fintech on the credit risk

Variables	**Credit Risk**	
Panel A	**The Impact of Fintech on the Credit Risk of Different Listing Types of Banks**	
	Non-Listed Bank	Listed Bank
	(1)	(2)
Lag_Fintech	-0.139**	-0.020*
	(0.047)	(0.011)
Lag_ROA	-15.185	-14.398
	(30.587)	(36.141)
Lag_Lev	1.346	-2.782
	(3.911)	(3.999)
Lag_Tang	22.597***	26.896*
	(6.639)	(12.761)
Lag_CI	2.296***	1.053
	(0.592)	(0.853)
Lag_CAR	-0.028	-0.038
	(0.027)	(0.023)
Lag_Gdpgr	0.000	0.000

Variables	Credit Risk	
	(.)	(.)
Lag_M2gr	0.000	0.000
	(.)	(.)
Time Fixed Effect	YES	YES
R^2	0.265	0.281
Adj R^2	0.248	0.254
Observations	867	556
Panel B	**The Impact of the Fintech Index on the Credit Risk of Banks in Different Regions**	
	Eastern regions	Central regions	Western regions
	(1)	(2)	(3)
Lag_Fintech	-0.039***	-0.220***	-0.033
	(0.012)	(0.061)	(0.039)
Lag_ROA	5.431	-6.575	-25.067
	(11.239)	(30.212)	(22.996)
Lag_Lev	-0.750	9.485**	-0.506
	(1.783)	(4.121)	(3.275)
Lag_Tang	30.323***	38.243***	19.408**
	(5.299)	(11.119)	`(7.923)
Lag_CI	2.492***	1.771***	1.567***
	(0.304)	(0.644)	(0.545)
Lag_CAR	-0.046***	0.026	0.024
	(0.014)	(0.031)	(0.024)
Lag_Gdpgr	0.000	0.000	0.000
	(.)	(.)	(.)
Lag_M2gr	0.000	0.000	0.000
	(.)	(.)	(.)
Time Fixed Effect	YES	YES	YES
R^2	0.247	0.479	0.439
Adj R^2	0.231	0.423	0.386
Observations	997	194	231
Panel C	**The Impact of Fintech on the Credit Risk of Commercial Banks of Different Sizes**	
	Large-scale banks	Small-scale banks
	(1)	(2)
Lag_Fintech	-0.026**	-0.344***
	(0.011)	(0.089)
Lag_ROA	-33.261	-29.621
	(26.600)	(33.783)
Lag_Lev	-3.971	1.000
	(2.367)	(4.074)
Lag_Tang	18.858***	19.828***
	(7.029)	(8.800)
Lag_CI	1.522**	2.154***
	(0.641)	(0.708)
Lag_CAR	-0.003	-0.049
	(0.020)	(0.032)
Lag_Gdpgr	0.000	0.000
	(.)	(.)
Lag_M2gr	0.000	0.000
	(.)	(.)
Time Fixed Effect	YES	YES

Variables	Credit Risk	
R^2	0.354	0.280
Adj R^2	0.338	0.254
Observations	837	586
Panel D	**The Impact of Fintech on the Credit Risk of Commercial Banks of Different Natures**	
	National commercial banks	Local commercial banks
	(1)	(2)
Lag_Fintech	-0.048***	-0.086**
	(0.015)	(0.033)
Lag_ROA	-9.864	-45.476
	(23.868)	(35.852)
Lag_Lev	1.167	-4.938
	(2.579)	(4.340)
Lag_Tang	23.135***	12.965
	(7.578)	(9.642)
Lag_CI	1.290	3.205***
	(0.742)	(0.713)
Lag_CAR	-0.031*	-0.025
	(0.017)	(0.033)
Lag_Gdpgr	0.000	0.000
	(.)	(.)
Lag_M2gr	0.000	0.000
	(.)	(.)
Time Fixed Effect	YES	YES
R^2	0.314	0.372
Adj R^2	0.298	0.348
Observations	837	586

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

In summary, the impact of Fintech on credit risk shows significant heterogeneity between non-listed banks and listed banks. Non-listed banks, due to their disadvantages in governance, transparency, and market status, can benefit more from the application of Fintech and significantly reduce credit risk by enhancing risk control capabilities. In listed banks, although the application of Fintech also helps to reduce credit risk, its role is relatively limited. This finding has important implications for policymakers and bank managers, indicating that differential Fintech application strategies should be developed for different types of banks, especially to increase policy support for non-listed banks to enhance their risk control capabilities, so as to promote the stable development of the entire banking system.

Table 4.5 Panel B shows the results of the heterogeneity test of the impact of the Fintech index on the credit risk of banks in different regions. Model (1), Model (2), and Model (3) in Table 4.5 Panel B respectively examine the impact of the Fintech index (Fintech) on credit risk in the eastern, central, and western regions. The results show the differential impacts of Fintech in different regions. In Model (1), for banks in the eastern region, the coefficient of the Fintech index is significant at the 1% level. This indicates that Fintech significantly reduces the credit

risk of banks in the eastern region. The eastern region has a developed economy, and the Fintech infrastructure and technology applications are relatively mature. Through the extensive application of Fintech, banks can more effectively conduct credit assessments and risk management, reducing the incidence of non-performing loans. In addition, the popularity of Fintech has made financial institutions in the eastern region perform well in terms of information transparency and compliance, further reducing credit risk. In Model (2), for banks in the central region, the coefficient of the Fintech index is significant at the 1% level. It is worth noting that in the central region, the negative impact of the Fintech index is more significant than that in the eastern region, which may reflect a higher marginal effect of Fintech in this region. Banks in the central region may be in the stage of promoting Fintech applications. The introduction of Fintech has greatly improved their risk management and credit assessment capabilities, thus significantly reducing credit risk. Since the economic development level of the central region is slightly lower than that of the eastern region, the application of Fintech may bring more significant governance and management benefits. In Model (3), for banks in the western region, the coefficient of the Fintech index does not reach the significance level. This indicates that the impact of Fintech on the credit risk of banks in the western region is not significant. The western region has a relatively underdeveloped economy, resulting in a slow pace of Fintech promotion and application in this region, and thus its impact on the credit risk of regional banks is not obvious. Banks in the western region have limited capabilities and resources in technology applications, making the effect of Fintech in enhancing credit risk management not significant. In addition, banks in the western region may rely more on traditional management models, lacking the necessary technical support and infrastructure, so that the potential advantages of Fintech cannot be fully realized.

Overall, the impact of Fintech on credit risk shows significant heterogeneity in different regions. The eastern region, due to the extensive application of Fintech and high-level technological maturity, has significantly reduced credit risk; the central region, in the stage of promoting Fintech applications, has a significant marginal effect; while the western region, due to the relative lag in economic and technological development, has an non-significant impact of Fintech on credit risk. The above results suggest that bank managers and policymakers should develop differential Fintech application strategies according to regional characteristics, especially to increase support for Fintech development in the central and western regions, so as to promote the balanced development of the financial systems in various regions and enhance the overall stability.

Table 4.5 Panel C shows the results of the heterogeneity test of the impact of the Fintech

index on the credit risk of commercial banks of different sizes, analyzing the different performances of the core Independent Variable, the Fintech index (Fintech), in large-scale banks and small-scale banks. This analysis reveals the differential impacts of Fintech on credit risk in banks of different sizes. In Model (1), for large-scale banks, the coefficient of the Fintech index is -0.026, and it is significant at the 5% level. This indicates that Fintech has a significant negative impact on the credit risk of large-scale banks. Large-scale banks usually have strong capital strength and technical reserves and can effectively apply Fintech means to optimize credit assessment, risk management, and internal control. The introduction of Fintech has enhanced the information-processing capabilities and the accuracy of customer credit risk assessment of these banks, thereby reducing the incidence of non-performing loans. Large-scale banks can more easily obtain high-quality data resources and advanced technical support, enabling them to fully utilize the advantages of Fintech.

In Model (2), for small-scale banks, the coefficient of the Fintech index is significant at the 1% level. This finding reveals that the negative effect of Fintech on the credit risk of small-scale banks is more prominent. Compared with large-scale banks, Fintech has a more significant and direct impact on the credit risk management of small-scale banks. This may be because small-scale banks traditionally rely more on manual and experience-based judgment, and the application of Fintech provides them with much-needed modern risk-control tools. Fintech helps small-scale banks improve credit approval efficiency, reduce information asymmetry, and strengthen the monitoring and management of non-performing assets. However, due to limitations in resources and technical capabilities, small-scale banks may face greater challenges in the initial application of Fintech, so its negative impact on credit risk is more significant.

Overall, the impact of Fintech on credit risk shows significant heterogeneity in banks of different sizes. Large-scale banks can use Fintech to further optimize their existing risk management systems and significantly reduce credit risk; small-scale banks have significantly enhanced their credit risk management capabilities with the help of Fintech, significantly reducing their risk exposure. This result has important implications for bank managers and policymakers, indicating that when promoting the development of Fintech, differential strategies should be adopted for banks of different sizes, especially to provide more technical support and resources for small-scale banks to help them better cope with credit risks and improve their operational levels.

Table 4.5 Panel D shows the results of the heterogeneity test of the impact of the Fintech index on the credit risk of national commercial banks and local commercial banks. Model (1)

and Model (2) respectively examine the impact of the Fintech index (Fintech) on national commercial banks and local commercial banks, revealing its differential impacts on different types of banks. In Model (1), for national commercial banks, the coefficient of the Fintech index is significant at the 1% level. This indicates that Fintech significantly reduces the credit risk of national commercial banks. National commercial banks usually have a large-scale, wide-ranging business, stronger technical reserves, and capital strength, and they can widely apply Fintech to optimize their risk-control systems. The application of Fintech has enhanced the risk assessment capabilities of these banks, improved the management process of non-performing loans, and provided more unified and standardized risk-control measures nationwide, thus effectively reducing the overall credit risk. In Model (2), for local commercial banks, the coefficient of the Fintech index is significant at the 5% level. In terms of credit risk mitigation, local commercial banks have achieved more significant results through Fintech compared with national commercial banks, demonstrating a stronger positive effect. This may be because local commercial banks traditionally rely more on regional resources and interpersonal networks, and the introduction of Fintech provides them with more scientific and systematic credit assessment tools, helping them achieve a qualitative leap in risk management. The application of Fintech enables these banks to assess the credit risks of borrowers more accurately, reduces information asymmetry, and lowers the incidence of non-performing loans. However, due to the limited resources and scale of local commercial banks compared with national commercial banks, the breadth and depth of their Fintech applications may be limited. Therefore, in the initial stage, Fintech has a more significant impact on their credit risk.

In summary, national commercial banks and local commercial banks show distinct heterogeneous characteristics in terms of the impact of Fintech on credit risk, and this difference cannot be ignored. National commercial banks can utilize their resource and technical advantages to further improve their risk-control systems through Fintech, thereby reducing credit risk. Local commercial banks have significantly improved their risk management levels with the help of Fintech, especially in the initial application stage. Policymakers and bank managers should formulate corresponding Fintech application strategies according to the types and characteristics of banks to give full play to the potential of Fintech in reducing credit risk and enhancing the stability and competitiveness of the entire banking industry.

4.5 Conclusions

Studying the impact of Fintech on the credit risk of commercial banks is not only a need to

adapt to national policy guidance but also an important measure to enhance the stability of the financial system. An in-depth analysis of the deep-level application of Fintech in the credit process and an exploration of its internal mechanism in credit risk management can provide precise and scientific strategic guidance for commercial banks, helping them optimize risk management practices and better utilize technological means to improve risk management levels. At the same time, this research also helps to identify and solve problems that may arise during the application of Fintech, ensuring that Fintech promotes the innovative development of banking business under the premise of being safe and controllable. In addition, Fintech also plays a key role in enhancing the inclusiveness of financial services. Through technical means, banks can more effectively reach long-tail customers, provide personalized and intelligent financial services, promote the fair distribution of financial resources, and drive the high-quality development of the economy.

This thesis uses the financial data of Chinese commercial banks from 2007 to 2022 through the CNRDS database and uses STATA software to construct and measure the bank Fintech index by principal component analysis of relevant word frequencies in four dimensions. A study was conducted on the impact of bank Fintech on its credit risk, and the following key findings were obtained. Firstly, through benchmark regression analysis, this thesis observes that the Fintech index shows a significant positive effect in effectively reducing bank credit risk. This finding indicates that the development of Fintech has generally enhanced the credit security of banks. Secondly, the mechanism test further reveals the specific path by which Fintech affects credit risk. The study finds that the Fintech index can effectively reduce bank credit risk by reducing information asymmetry and increasing capital adequacy ratios. This shows that Fintech not only improves the bank's ability to obtain and process borrower information but also enhances the financial soundness of banks in the face of potential credit risks. Finally, the impact of Fintech on credit risk shows significant heterogeneity among different types and sizes of banks. Firstly, in the test of distinguishing between listed and unlisted banks, Fintech significantly reduces the credit risk of unlisted banks, while its impact on listed banks is relatively small. This may be because unlisted banks are relatively weak in governance structure and risk management, and the introduction of Fintech significantly enhances their risk-control capabilities. Secondly, in the regional heterogeneity analysis, Fintech significantly reduces the credit risk of banks in the eastern and central regions, especially in the central region, where its marginal effect is more obvious. This indicates that banks in the central region are in the stage of promoting Fintech applications, and the introduction of technology has greatly improved their risk-management levels. In contrast, due to the slow economic growth and technological

integration in the western region, the effect of Fintech in regulating credit risk is not significant. Finally, when comparing banks of different sizes, this thesis finds that Fintech has a particularly prominent role in mitigating the credit risk of small-scale banks, and its impact depth exceeds that on large-scale banks. Small-scale banks traditionally rely more on experience and manual operations, and the application of Fintech provides them with modern risk-control tools, significantly enhancing their risk-management capabilities. National commercial banks can utilize their resource and technical advantages to further improve their risk-control systems through Fintech, thereby reducing credit risk; local commercial banks have significantly improved their risk-management levels with the help of Fintech, especially in the initial application stage. Overall, Fintech, as an important innovative tool, has a positive impact on bank credit risk management, but its role is limited by factors such as the bank's listing status, regional development level, and size. Policymakers and bank managers should formulate differential Fintech application strategies based on these heterogeneous characteristics to improve the risk-management level and stability of the banking industry.

Based on the conclusions of this study, the following policy recommendations are put forward to strengthen and improve the supervision of bank Fintech. Firstly, regulatory authorities should formulate and improve relevant laws and regulations on Fintech and establish a sound regulatory framework. The rapid development of Fintech has brought many innovations and conveniences, but it also comes with new risks and challenges. Regulatory authorities should update regulations promptly to ensure the development of Fintech based on safety and compliance. Secondly, encourage banks and financial institutions to increase investment in Fintech. The research finds that Fintech has a particularly significant effect in these banks. Therefore, the government and regulatory authorities should provide appropriate policy support and incentives to help these banks better utilize Fintech to reduce credit risk. Thirdly, strengthen information sharing and data protection. Fintech reduces credit risk by reducing information asymmetry, which requires a good information-sharing mechanism among banks. Regulatory authorities should promote the establishment of a safe and efficient information-sharing platform while strictly protecting data privacy to prevent data leakage and abuse.

The continuous advancement of Fintech has undoubtedly brought complex changes to the credit business environment of Chinese commercial banks, potentially exacerbating credit risks. In this macro-context, commercial banks need to rationally view the two-edged sword effect of Fintech, seize the innovation opportunities it brings, and prudently respond to the accompanying challenges. Specifically, this study puts forward the following suggestions: (1) In the face of fierce market competition, banks should rely on their profound credit business

foundation and rich customer data resources to continuously optimize their risk-control frameworks and marketing strategies, prevent blind expansion of credit scales, and strengthen the monitoring and adjustment of the business innovation process to ensure innovation quality and effectively contain risk accumulation. (2) Focusing on the positive role of Fintech in optimizing the credit process, alleviating information asymmetry, and reducing operating costs, banks should strengthen services to long-tail customers and promote the digital transformation of credit business. By building more refined pre-loan risk-control models and combining advanced technologies such as big data and artificial intelligence, banks can steadily promote financial innovation, activate the potential of the long-tail market, and ensure a reasonable balance between risks and returns. (3) In view of the profound impact of emergencies such as the pandemic and macro-economic fluctuations, commercial banks should leverage their accumulated market insights to seek new breakthroughs in Fintech applications. Develop forward-looking strategic plans and a solid financial support system, integrate the power of Fintech with continuously expanding data resources, and strengthen the intelligence and refinement of the risk-management system. In particular, upgrade the access thresholds and monitoring mechanisms for credit business, deepen data analysis capabilities, fully tap the potential of Fintech in reducing information asymmetry, thereby effectively reducing customer acquisition costs, accurately assessing risks, and enhancing the sustainability and risk-resistance of operations. In addition, raise the requirements for banks' risk management and capital adequacy ratios. Fintech can reduce credit risk by increasing capital adequacy ratios. Regulatory authorities should set higher capital requirements and supervise the capital management of banks to ensure that banks have sufficient capital buffers to cope with potential risks.

Finally, strengthen the prudential supervision of Fintech applications. Regulatory authorities should closely monitor the actual effects and potential risks of Fintech applications and regularly evaluate and adjust regulatory policies. In particular, prevent systemic risks brought about by Fintech to ensure the stability and security of the financial system. This thesis also proposes measures to prevent and control potential risks of bank Fintech. On the one hand, the government should introduce comprehensive regulatory laws when supervising bank Fintech, including access and exit principles, information disclosure requirements, risk-monitoring indicators, risk-reserve requirements, and other measures. On the other hand, commercial banks should effectively monitor and isolate new bank Fintech risks by strengthening employee training, standardizing employee behavior, checking technical application defects, and formulating emergency plans. In conclusion, by improving the

regulatory system of Fintech, the positive role of Fintech in reducing credit risk can be maximally exerted, promoting the sound development of the banking industry and the stability of the financial system.

Chapter 5: Impact of Fintech on the Governance Level of Chinese Commercial Banks

5.1 Introduction

With the rapid development of the global Fintech industry, China has become a frontier market for Fintech applications and innovations. The rapid development of Fintech has not only had a profound impact on traditional financial business models but also posed new challenges and opportunities to the governance levels of commercial banks. Especially driven by advanced technologies such as big data, artificial intelligence, and blockchain, Fintech is gradually penetrating into every business link of banks, improving banks' operational efficiency and risk-management capabilities. At the same time, the application of Fintech also puts forward new requirements for the internal governance structures and management models of commercial banks. How to effectively use Fintech to improve the governance level has become an important topic urgently needed to be explored in the academic and practical circles. The key to improving the governance effectiveness of the banking industry not only lies in the improvement of the external regulatory system but also requires the deepening and strengthening of the internal governance mechanism. In the face of the booming digital economy, the banking industry is actively embracing the Fintech revolution to promote industry transformation and upgrading. In this process, the extensive application of technological innovation and digital tools has significantly enhanced banks' information-capture and analysis capabilities, effectively alleviated the problem of information asymmetry, promoted the scientific and rational decision-making process, and thus greatly improved the governance effectiveness of the banking industry. Strengthening the governance capabilities of banks not only means enhancing the sustainability of their profit models and the refinement of risk prevention and control but also is the key for the banking industry to maintain its leading position and build core competitiveness in the tide of digital transformation. By continuously optimizing the internal governance structure and enhancing the ability of technology integration and innovation, the banking industry can more flexibly and efficiently respond to market changes, seize the development opportunities brought by the digital economy, and thus stand out in the fierce market competition (Q. J. Zhang & Chen, 2022). Therefore, improving the governance level

through Fintech is extremely important for the healthy development of China's banking industry and the entire financial system. Generally speaking, as the competition pressure of commercial banks continues to increase, it is essential for managers and shareholders to pay attention to corporate governance efficiency, which is also the guarantee for the long-term development of commercial banks. In the current digital context, Fintech has become an indispensable consideration for commercial banks to enhance their competitiveness and achieve long-term development. Secondly, due to the need for multi-disciplinary integration in governance evaluation, there is currently a lack of empirical research on the quality of bank governance and its influencing mechanisms from the Fintech perspective. Thirdly, if commercial banks want to achieve sustainable development, they must also pay attention to green governance, and Fintech can provide some new ideas and methods for green governance.

Studying how Fintech affects the governance level of commercial banks has important theoretical and practical significance. At present, Chinese commercial banks are still in the exploration stage of developing Fintech. Although some banks have carried out a series of innovative work by applying new Fintech tools, most banks have not regarded Fintech as their core competitiveness, and there is still much room for improvement in related capabilities in many aspects, which urgently need further development. In addition, the popularization of Fintech promotes the process in which companies use transformative information technologies to trigger major reforms in organizational routines, business processes, resources and capabilities, market strategies, etc. Existing research shows that Fintech innovation tools can further play a positive role in aspects such as corporate capital allocation, financing costs, and audit pricing, and can help companies improve operational efficiency and reduce management costs to a certain extent (Che et al., 2021; Q. Y. Li et al., 2023). In addition, there is relatively little literature on Fintech and bank governance. Therefore, from a theoretical perspective, this research is of great significance.

Firstly, this thesis will inject new content into the research on Chinese bank governance, provide new data, and further enrich the research on bank governance. Through empirical analysis of the relationship between Fintech and bank governance levels, this thesis attempts to explore how to improve the bank governance level from a new perspective. Specifically, this thesis will use the financial data of commercial banks to explore the role of Fintech in bank governance, fill the gaps in existing literature in this regard, and provide new evidence for the academic community. Secondly, this thesis will expand and enrich the relevant theories on the relationship between Fintech and bank governance. In the current research literature, there is relatively little research on the influencing mechanism of Fintech on bank governance. Through

empirical exploration of the relationship between Fintech and bank governance levels, this thesis can not only make up for banks' insufficient understanding of Fintech but also provide certain reference value for the academic and industrial circles, helping people better understand how Fintech affects bank operations and governance. Finally, there is a scarcity of literature exploring the relationship between Fintech and bank governance from the perspective of management agency costs. This thesis studies whether Fintech affects the bank governance level by reducing agency costs. This exploration can not only expand the research ideas of scholars and enrich the theoretical framework but also provide theoretical support for banks' strategies in Fintech applications. By studying the impact of Fintech on agency costs, this thesis provides a new perspective for understanding the specific path of Fintech in improving bank governance, and thus provides theoretical and empirical support for improving the bank governance level.

Meanwhile, studying how Fintech affects the governance level of commercial banks has important practical significance. Soto Setzke et al. (2023) emphasized that traditional industrial enterprises need to integrate big-data technology into their organizational structures, business processes, and operation models to achieve modern transformation. Van Veldhoven and Vanthienen (2022) pointed out that the transformation of digital technology will have a profound impact on innovation and entrepreneurship and all aspects of social and economic development. In the fierce market competition environment, it has become an inevitable choice for enterprises to achieve sustainable development through digital innovation and entrepreneurship. For example, the development of Fintech has prompted banks to continuously innovate in information technology, data analysis, intelligent risk control and so on, enhancing the transparency and efficiency of banks, and thus effectively reducing information asymmetry and moral risks. Secondly, Fintech provides banks with more accurate and timely risk-management tools. Through big-data analysis and artificial intelligence algorithms, banks can more comprehensively monitor and predict their operating risks, which is helpful to improve the level of internal control and compliance management. In addition, the application of Fintech has also promoted the transformation and innovation of banking business models, optimized business processes, improved service quality, and enhanced banks' competitiveness and market adaptability. Finally, with the empowerment of Fintech, banks can better achieve accurate positioning of customer needs and differential services, thereby enhancing customer satisfaction and loyalty. These functions not only provide strong theoretical support for the management practices of commercial banks but also lay the foundation for promoting the overall governance level of the banking industry and help to achieve the stability and

sustainable development of the financial system.

Fintech provides important reference value for policymakers and can promote the positive interaction between Fintech and bank governance, which is mainly reflected in the following aspects: Firstly, the development of Fintech provides policymakers with rich data and analysis tools. Through big-data analysis, artificial intelligence, and blockchain technology, policymakers can obtain more comprehensive and real-time financial market information and understand the operating conditions and risk levels of financial institutions. These data provide a solid foundation for formulating more accurate and effective regulatory policies and help to achieve dynamic monitoring and risk early-warning of the financial market. Secondly, Fintech innovation provides policymakers with new regulatory means and tools. For example, the application of RegTech can improve regulatory efficiency and accuracy through automated compliance monitoring and intelligent risk assessment, and reduce the compliance costs of financial institutions. At the same time, the application of technologies such as smart contracts can also promote the transparency and traceability of financial transactions, reduce financial crimes and money-laundering behaviors, and enhance the integrity of the financial market. Thirdly, the development of Fintech has promoted the inclusiveness and accessibility of the financial market. Policymakers can draw on these innovations to promote the reform and innovation of financial policies. For example, through mobile payments and Internet finance, Fintech can more widely cover people who have not been reached by traditional financial services, promoting the implementation of inclusive financial policies. Policymakers can support the development of Fintech enterprises to promote financial innovation, improve the coverage and quality of financial services, and enhance the inclusiveness of financial services. In addition, the application of Fintech has promoted the transformation of financial institutions' business models and the optimization of governance structures. Policymakers can formulate policy measures to encourage innovation and transformation by studying and learning from these transformation experiences, promoting the Fintech and business-model innovation of financial institutions, and enhancing their competitiveness and risk-resistance capabilities. For example, through policy guidance, financial institutions are encouraged to invest in technology research and development and applications, promoting the in-depth integration of Fintech and banking services and enhancing the governance level and operational efficiency of banks. Finally, the development of Fintech requires a sound legal and regulatory framework. Policymakers can accumulate experience through the regulatory practice of Fintech innovation, continuously improve relevant laws, regulations, and regulatory policies, and form a regulatory system suitable for the development of Fintech. This not only helps to prevent and resolve

financial risks but also creates a good policy environment for the healthy development of Fintech, promotes the positive interaction between Fintech and bank governance, and realizes the stability and sustainable development of the financial market.

5.2 Research questions

The research on corporate governance began with the process of Chinese enterprise reform, especially in the context of the restructuring of state-owned enterprises. X. Q. Wei (2022) pointed out that the development process of Chinese corporate governance can be divided into four stages: the introduction of the concept, the construction of the framework, the establishment of management mechanisms, and the improvement of efficiency. Although there are various views on the definition of corporate governance in the Chinese academic community, the view put forward by Professor Li Weian in his Japanese-language book "*Research on Chinese Corporate Governance*" in 1998 has been widely recognized (W. A. Li, 1998). He believes that corporate governance is a key mechanism that coordinates the rights and interests of various stakeholders of an enterprise through a series of internal or external, official or non-official management systems or institutions, to improve the management efficiency of the enterprise and protect the rights and interests of all parties of the enterprise. This view emphasizes the importance of corporate governance in enterprise management and interest coordination and provides a theoretical basis for enterprises to achieve efficient and sustainable development in the fierce market environment.

Corporate governance refers to the use of various mechanisms to restrict the self-interested behaviors of managers or major shareholders, thereby protecting the overall interests of the company and the rights and interests of shareholders. These self-interested behaviors may include conservative investment, high-risk investment, and eroding the company's value through improper means. As an emerging technical means, Fintech can alleviate these problems in many aspects and thus improve the level of corporate governance.

Firstly, Fintech improves information transparency through big-data and artificial-intelligence technologies, which helps to prevent the self-interested behaviors of managers and major shareholders. In the traditional corporate-governance structure, information asymmetry is one of the important reasons for the abuse of power by managers and major shareholders. Fintech can collect, process, and analyze a large amount of enterprise data in real-time, enabling shareholders and other stakeholders to have a more comprehensive understanding of the actual operating conditions of the company. Such transparency increases the supervision of

management behaviors and reduces the probability of self-interested behaviors. Secondly, Fintech strengthens internal control and compliance management through smart contracts and blockchain technology. A smart contract is a self-executing agreement based on blockchain technology that can automatically execute and record various transactions and decision-making processes within the company. Through this technology, enterprises can embed automated rules and processes in various business links to ensure the compliance and transparency of all decisions and operations. The non-tamperability and distributed characteristics of blockchain technology also provide a reliable technical guarantee for auditing and tracking management behaviors. Thirdly, Fintech promotes the market-based supervision mechanism of corporate governance. The rise of Internet finance platforms and social media has made it more convenient for small-scale shareholders and external investors to express their opinions and participate in corporate governance. Through Fintech platforms, shareholders can vote, make suggestions, and participate in company decisions more conveniently, strengthening the supervision and restraint of management by shareholders.

In addition, these platforms can also gather a large amount of market information and analysis tools to help shareholders better understand the governance situation of the company and the performance of management. Finally, the application of Fintech in risk management and investment decision-making helps to avoid the excessive risk-taking behaviors of managers. By using big-data analysis and machine-learning algorithms, companies can more accurately evaluate the risks and returns of various investment projects and develop more scientific and reasonable investment strategies. This not only reduces the high-risk investment behaviors of managers caused by insufficient information or judgment errors but also improves the overall risk-management level of the company and protects the interests of shareholders. Generally speaking, the impact of Fintech on the governance level of banks is an important issue in current bank research. This thesis aims to explore how Fintech affects the governance level of Chinese commercial banks. With the expansion of the power of managers, the opportunity for them to influence the management decisions of company shareholders for personal gain also increases. Therefore, the specific research questions of this thesis include the following aspects:

1. What are the specific impacts of Fintech on the governance level of Chinese commercial banks?

2. What is the mechanism of Fintech’s impact on bank governance?

3. Are there differences in the application effects of Fintech between large-scale banks and small-scale banks?

4. Are there differences in the application effects of Fintech among banks with different

geographical distributions?

5. Are there similar differences among banks with different listing statuses?
6. Is there a difference in this impact between national and local commercial banks?

5.3 Theoretical analysis and research hypotheses

The agency theory was first proposed by Meckling and Jensen (1976). It mainly explores the conflicts and agency costs between principals and agents due to inconsistent interests. This theory aims to analyze the relationship between the two and the potential problems caused by differences in goals and propose possible solutions. In the governance of commercial banks, bank management (agents) may make decisions that harm the interests of shareholders (principals). This conflict of interest usually leads to information asymmetry and moral hazards. The agency theory points out that when the interests of agents and principals are not completely consistent, agents may pursue the maximization of personal interests rather than the maximization of corporate value, thereby increasing agency costs. The application of Fintech can effectively alleviate this problem. For example, through big-data analysis and artificial-intelligence technologies, shareholders and other stakeholders can obtain real-time operating data of banks and understand the risk status and decision-making processes of banks, thereby improving information transparency and reducing information asymmetry. At the same time, the smart contracts and automated risk-control systems provided by Fintech can immediately monitor and evaluate the decisions of management, reducing agency costs. This not only helps to protect the interests of shareholders but also can enhance the overall operational efficiency and governance level of banks (Jensen & Meckling, 2019). Q. Yang and Yang (2006) pointed out that modern corporate-governance research is mainly based on the principal-agent theory and takes a relatively negative attitude toward the management power of corporate executives. They hold the view that with the continuous expansion of the power scope of the CEO, the possibility of the CEO using power to influence the management decisions of company shareholders for personal gain has also increased significantly. Therefore, the root cause of the agency problem is often traced back to the power foundation of senior managers. In other words, the greater the power held by senior executives, the more frequent and complex the agency problems will be. However, it is worth noting that the current agency-theory framework often focuses too much on the power dimension of the CEO and the power game between the CEO and the board of directors, but to a certain extent, it ignores the complex power structure and distribution mechanism within the senior-management team, which constitutes a gap in the

comprehensive understanding of the problem. This neglect makes the agency theory unable to provide effective guidance for senior management teams to make strategic decisions in the interests of the company. On the other hand, Shao and Liu (2009) proposed that the main problem during the CEO's tenure is not the conflict of interest between the CEO and board members. It is unrealistic to simply regard the CEO as an opportunistic agent or a fully responsible steward because the fundamental goal of corporate governance is not to minimize agency costs but to maximize shareholder interests. Therefore, enterprises should establish a dynamic development view of CEO power and management capabilities, emphasizing the appropriate distribution and reasonable exercise of power. Through this dynamic view, enterprises can more effectively manage the power structure at the senior management level, ensure that the management team always takes the overall interests of the company as the core in the decision-making process, and thus achieve the ultimate goal of corporate the maximization of shareholder interests. Their research further shows that in modern corporate governance, not only the power balance between senior executives and the board of directors needs to be paid attention to, but also the power structure and dynamic changes within the senior-management team should be emphasized. Only in this way can agency problems be effectively reduced, and the company can be promoted to develop continuously and healthily in the fierce market competition.

From the perspective of optimizing information transparency, the application of Fintech has greatly accelerated the speed and depth of information transmission, constructed a closely integrated digital ecosystem, broadened the boundaries of information sharing, effectively reduced information errors among various governance subjects, and strengthened the supervision and restraint mechanism of management behaviors, curbing potential opportunistic tendencies. Specifically, the in-depth integration of Fintech has significantly enhanced the enterprise's ability to capture, analyze, and integrate information, promoting the seamless flow of information within the enterprise. This is expected to break the information barriers in the traditional organizational structure, bridge the "information island" phenomenon among governance levels, and reduce the degree of information asymmetry among internal departments, business units, shareholders, management, and employees, thereby building an efficient and transparent organizational-governance structure and power-restraint system (C. Y. Zhao et al., 2021). At the same time, the big-data integration platform supported by Fintech has opened up a new path to alleviate the information gap between enterprises and external stakeholders, creating a more open and transparent governance atmosphere. This change not only broadens the vision of corporate governance but also stimulates the enthusiasm of external

subjects such as investors and creditors, to participate in corporate governance. By constructing an external supervision mechanism, it strengthens the supervision of listed companies and prompts management to abide by laws and moral norms and perform their duties diligently. Fintech, through its powerful data-processing and analysis capabilities, realizes the free flow of information across departments and levels. Not only does it alleviate the internal information-asymmetry phenomenon, but also the information exchange between enterprises and the outside world becomes smoother. The application of Fintech essentially constructs a wide-ranging and close-knit information-sharing network, which greatly improves the transparency and efficiency of corporate governance (Loebbecke & Picot, 2015). In this network framework, external investors and creditors can more quickly and accurately grasp the operating dynamics of enterprises, participate in the corporate-governance process, and form an effective supervision and restraint on management. This series of Fintech-driven changes not only enhances the transparency and efficiency of corporate governance but also wins higher market trust and reputation for enterprises, laying a solid foundation for their long-term and stable development. In summary, the role of Fintech in optimizing information transparency, accelerating information transmission, and constructing a transparent governance mechanism is of great importance.

The development of Fintech has had a profound impact on the internal governance of commercial banks. Specifically, Fintech provides advanced data-processing and analysis tools, enabling banks to more efficiently manage and monitor internal operations and improving management efficiency. From specific cases, since 2018, the Industrial and Commercial Bank of China has started to use blockchain technology to build an enterprise-level blockchain platform, realizing real-time cross-bank and cross-border settlement and clearing. Through smart contracts and blockchain technology, ICBC can track and monitor every transaction throughout the process to ensure the transparency and compliance of transactions (Industrial and Commercial Bank of China, 2019). In addition, in 2019, ICBC launched a big-data-based risk-early-warning system. Through the real-time monitoring of customer transaction behaviors, it can identify and warn of potential risks, further strengthening internal control and risk management (Industrial and Commercial Bank of China, 2020). The Agricultural Bank of China introduced an intelligent risk-control system into its corporate governance in 2020. Through big-data and artificial-intelligence technologies, ABC can conduct comprehensive dynamic monitoring and evaluation of customers' credit risks, market risks, and operational risks (Agricultural Bank of China, 2020). In addition, in 2021, ABC used blockchain technology to achieve full-process management of supply-chain finance, thereby improving the

financing efficiency and transparency of upstream and downstream enterprises in the supply chain (Agricultural Bank of China, 2021). Since 2018, Bank of China has developed an enterprise credit rating system based on big-data analysis. By analyzing multi-dimensional data such as enterprise financial data, transaction behaviors, and market performance, BOC can more comprehensively and accurately evaluate the credit status of enterprises. This system not only improves the scientificity and objectivity of credit-decision-making but also reduces the risks caused by information asymmetry (Bank of China, 2019). In addition, in 2019, the Bank of China optimized its international trade financing business using blockchain technology and smart contracts. By tracking and verifying every cross-border transaction in real-time, it ensured the transparency and security of transactions (Bank of China, 2020).

Overall, Fintech integrates big data and advanced artificial-intelligence technologies to achieve real-time monitoring and in-depth analysis of all-around business data in the banking industry. This innovation not only enables the precise capture of potential risks but also significantly improves the timeliness and effectiveness of risk response, ensuring the stable operations of banking businesses. These technical means not only improve the efficiency of data processing but also enhance the agility and accuracy of bank risk management. In addition, the application of blockchain technology ensures the transparency and non-tamperability of transaction records, enhancing the effectiveness of internal audit and compliance management, and thus improving the internal governance level of banks (Z. Zhang & Wu, 2020). On the other hand, L. Zhou (2020) emphasized in his research that the digital process of banks is based on the cornerstone of informatization. This process involves the comprehensive integration and refined optimization of existing information systems and seamlessly embeds cutting-edge technology elements such as artificial intelligence and the Internet of Things, aiming to completely transform the governance structure of banks and lead their operational efficiency to achieve a leap-forward development and enter a new era of higher efficiency. Qi and Xiao (2020) also observed that the surging wave of the digital economy is reshaping the internal management structure of enterprises with unprecedented force, driving their management models to transform in a more networked and interconnected direction. This process not only accelerates the innovation and diversification of product design but also significantly improves the efficiency and advancement of the overall corporate-governance system, jointly building a new cornerstone for enhancing enterprise competitiveness. The research and development and wide-scale adoption of these emerging technologies not only mark a fundamental transformation in management methods but also inject strong impetus into the all-around development of enterprises, leading them to a more prosperous future. Therefore, this research

hypothesizes that the development of Fintech can significantly improve the internal governance level of commercial banks.

Based on the above analysis, the following hypothesis is proposed:

H5-1: The larger the Fintech adoption, the higher the internal governance level of commercial banks.

The agency theory points out that the conflict of interest between management and shareholders may lead to an increase in agency costs (Jensen and Meckling, 1976), and Fintech can improve the bank governance level by reducing agency costs. Fintech provides intelligent risk-control systems and automated compliance tools, reducing the reliance on human judgment and lowering operational risks and moral hazards. For example, smart contracts can automatically execute and monitor transaction processes, reducing the space for human intervention and enhancing the transparency and reliability of transactions. Big data and AI technologies can monitor and evaluate the decisions of management in real time, timely discover and correct potential deviations and risks, and reduce agency costs. Q. Yang and Yang (2006) pointed out in their in-depth research that Chinese commercial banks, as a unique type of enterprise organization, have a complex and multi-level principal-agent network within their internal structures. This network widely covers the close relationship based on creditor-debtor relationships between depositors and banks, the delicate balance of credit contracts between lenders and banks, and the multi-dimensional interweaving of authorization-agency relationships between shareholders and management. These complex relationship chains not only profoundly reflect the dynamic interaction and game among multiple stakeholders but also have a far-reaching and complex impact on the formulation of commercial bank operating strategies and the optimization of governance structures. Further, the research of M. S. Wang and Xu (2017) analyzed the internal causes of the rise in management agency costs, pointing out that the imperfect incentive mechanism and the management's tendency to pursue personal interest maximization complement each other and jointly constitute the key factors driving up the bank's agency costs. The interweaving of these factors not only reveals the complexity of the bank's internal governance but also emphasizes the importance of optimizing the incentive mechanism and strengthening the supervision of management behavior. However, the application of Fintech is regarded as an effective way to alleviate this problem. Specifically, from the perspective of regulatory effectiveness, Fintech enables banks to monitor the behavior of management precisely, significantly improving the efficiency and cost-effectiveness of supervision. At the same time, the in-depth penetration of Fintech significantly enhances the bank's efficiency in information collection and analysis, effectively alleviating the challenge of

information asymmetry widely existing in the principal-agent framework, thus laying a solid foundation and providing a powerful technical support and solution for reducing management agency costs. Therefore, this study hypothesizes that Fintech will reduce management agency costs and thus improve the bank governance level.

Based on the above analysis, the following hypothesis is proposed:

H5-2: Fintech adoption improves the bank governance level by reducing management agency costs.

In existing research, Q. J. Zhang and Ou (2023) used the data of Chinese-listed commercial banks to test whether banks can improve their governance levels by increasing investment in Fintech. They found that mechanisms such as the rationality of managers, management agency costs, and technical efficiency all affect the relationship between Fintech and bank governance. B. H. Lin et al. (2023) used the data of A-share listed companies to conduct an empirical study and found that digital transformation significantly improves corporate governance levels mainly by alleviating information asymmetry. That is to say, establishing a perfect market information disclosure mechanism is crucial for creating a good market investment environment. This can not only effectively supervise the operating conditions of enterprises but also increase the cost of enterprise fraud, thus safeguarding the interests of all parties and solving the information asymmetry problem between investors and enterprises (P. C. Wang et al., 2020). Similarly, when Fintech is applied to the banking business, it can greatly improve information transparency. Through big-data analysis, banks can collect and process a large amount of customer and market data in real time. This ability to obtain and process real-time data enables banks to more accurately understand the financial status, transaction behaviors, and credit risks of enterprises and customers. High-transparency information helps to reduce information asymmetry, enabling management, shareholders, and other stakeholders to have a more comprehensive understanding of the company's operating conditions and make more scientific decisions.

In addition, Fintech can promote information sharing and collaboration within and outside the bank. By building Fintech platforms, banks can achieve information intercommunication among different departments and reduce the phenomenon of internal information silos. For example, since 2019, China Construction Bank has launched the "Smart Government Affairs" platform to improve the corporate governance level through Fintech means. This platform uses big data, artificial intelligence, and blockchain technologies to achieve data sharing and business collaboration between government departments and banks (China Construction Bank, 2020). Subsequently, P. C. Wang et al. (2020) emphasized that improving the transparency and

accuracy of information disclosure can significantly weaken the barriers of information asymmetry between enterprises and investors, thereby optimizing the resource allocation efficiency of the capital market. This optimization process not only accelerates the smooth flow of technology and capital to high-quality real economy but also strengthens the function of the capital market as a key hub in the economic system, promoting the full release and upgrade of economic vitality.

Based on the above analysis, the following hypothesis is proposed:

H5-3: Fintech adoption improves the bank governance level by alleviating information asymmetry.

5.4 Empirical results

5.4.1 Descriptive statistical analysis

To explore the impact of Fintech on the governance level of Chinese commercial banks, this thesis first conducts descriptive statistical analysis to display the basic statistical characteristics of each variable, providing basic data support for subsequent empirical analysis. The mean value of the core Independent Variable, Fintech, is 1.130, indicating that during the research period, the Fintech development level of commercial banks has increased to some extent. However, its standard deviation is as high as 1.746, and the skewness and kurtosis are 3.346 and 17.532, respectively, showing that the distribution of Fintech development levels has obvious right-skewness and peak-ness characteristics. This means that most banks have a low Fintech level, but there are a few banks whose investment and development in Fintech far exceed the average level, showing significant heterogeneity.

The mean value of the Dependent Variable bank governance index is 0.081, the median is -0.141, and the standard deviation is 0.823, indicating that the governance levels of most banks are relatively low and there are large differences. Its skewness and kurtosis are 4.173 and 22.756, respectively, showing that the distribution of the governance index is extremely right-skewed and peak-shaped, meaning that the governance levels of most banks are concentrated in a relatively low range, but there are a few banks whose governance levels are significantly higher than the average level. In addition, the descriptive statistical situations of other control variables have been analyzed above (see Table 5.1 for details) and will not be elaborated here.

Table 5.8 Descriptive statistics of main variables (Bank governance)

Variables	Sample Size	Mean	Median	Standard Deviation	Skewness	Kurtosis
Bank Governance Index	1954	0.081	-0.142	0.823	4.173	22.756
Fintech	1954	1.130	0.512	1.750	3.342	17.491
ROA	1954	0.008	0.008	0.004	0.293	3.373
Asset-Liability Ratio	1954	0.924	0.926	0.020	-1.465	7.524
Capital Adequacy Ratio	1954	13.685	13.240	2.482	1.916	8.867
Tangibility of Assets	1954	0.007	0.006	0.005	1.609	6.237
Cost-Income Ratio	1954	0.614	0.600	0.130	0.479	3.187
GDP Growth Rate	1954	9.536	9.169	3.982	0.535	3.139
M2 Growth Rate	1954	11.706	11.012	3.854	2.214	9.398

Table 5.2 shows the results of the correlation analysis among variables. The focus is on analyzing the relationship between the core Independent Variable (Fintech) and the Dependent Variable (bank governance), as well as assessing the existence of multicollinearity. Firstly, there is a significant positive correlation between Fintech and bank governance, with a correlation coefficient of 0.162. This indicates that the development of Fintech is conducive to improving the governance level of banks. This finding is in line with expectations, suggesting that Fintech has a positive impact on bank governance by improving information transparency, optimizing internal control, and enhancing risk management capabilities. In addition to the core variables, other variables also show different degrees of correlation. Firstly, the correlation coefficient between the non-performing loan ratio and bank governance is 0.029. Although the correlation is low, it is positive, indicating that an increase in the non-performing loan ratio may have a certain impact on bank governance. The correlation coefficient between the ROA and bank governance is 0.094, showing a weak positive correlation, indicating that an improvement in profitability can, to a certain extent, help improve bank governance. The correlation coefficient between asset tangibility and bank governance is 0.138, showing a positive correlation, indicating that banks with higher asset tangibility may have a better governance level. The correlation coefficient between the cost-income ratio and bank governance is -0.080, indicating that the higher the cost-income ratio, the lower the bank governance level may be, which is consistent with the negative impact of low cost-efficiency on governance. Among the control variables, the correlation coefficient between the GDP growth rate and bank governance is 0.052, and the correlation coefficient between the M2 growth rate and bank governance is 0.086, both showing weak positive correlations, reflecting that the impact of the macroeconomic environment on bank governance is relatively small. The correlations between Fintech and other variables also provide some valuable information. For example, the correlation coefficient between Fintech and the capital adequacy ratio is 0.319, showing a

relatively strong positive correlation, indicating that the development of Fintech may help improve the capital adequacy ratio of banks. In addition, the negative correlation (-0.0925) between Fintech and the non-performing loan ratio indicates that Fintech may, to a certain extent, reduce the non-performing loan ratio of banks. Finally, there is no obvious multicollinearity among the variables because the correlation coefficients among the variables are generally low. For example, the correlation coefficient between bank governance and the ROA is 0.094, and the correlation coefficient between bank governance and the non-performing loan ratio is 0.029. These low correlation coefficients indicate that the risk of multicollinearity among these variables is small.

Table 5.9 Main variable correlation analysis (Bank governance)

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Bank Governance Index	1.000										
Fintech	0.162	1.000									
Non-performing Loan Ratio	0.029	-0.0925	1.000								
ROA	0.094	-0.038	-0.426	1.000							
Capital Adequacy Ratio	0.309	0.319	-0.159	-0.020	1.000						
Leverage Ratio	0.002	0.007	-0.046	-0.106	0.267	1.000					
Tangibility of Assets	0.138	-0.158	0.168	0.161	-0.177	-0.132	1.000				
Cost-Income Ratio	-0.080	0.050	0.501	-0.765	-0.071	-0.030	0.003	1.000			
Capital Adequacy Ratio	0.075	0.048	-0.080	0.140	-0.187	-0.668	-0.009	-0.119	1.000		
GDP Growth Rate	0.052	-0.131	-0.116	0.231	-0.041	0.131	0.008	-0.197	-0.035	1.000	
M2 Growth Rate	0.086	-0.182	-0.208	0.251	-0.040	0.237	0.152	-0.201	-0.118	0.298	1.000

As can be seen from Figure 5.1, during the period from 2007 to 2022, the overall governance level of Chinese commercial banks showed a gradually decreasing trend. This trend indicates that although the Chinese banking industry has made significant progress in many aspects, it faces many challenges in terms of governance level. During the period from 2007 to 2010, the bank governance level experienced a relatively stable decline. Although there were some fluctuations in individual years, the overall trend was a gradual decline. This may be related to the changes in the market environment after the financial crisis. The financial crisis exposed many governance problems in the banking system. Although regulatory authorities strengthened the supervision of banks, the improvement of the bank governance level was not obvious in the short term. During the period from 2010 to 2015, the decline rate of the governance level accelerated. During this period, China's economic growth rate slowed down, the banking industry faced increasing operating pressure, and the non-performing loan ratio increased, further affecting the bank governance level. At the same time, the rapid development of Fintech and Internet finance had an impact on the traditional banking business model, and the bank governance level failed to keep up with the pace of change promptly. After 2015, the bank governance level continued to decline, but the decline rate slowed down. This may be because, after a period of adjustment, banks began to gradually adapt to the new market environment and technological changes. At the same time, regulatory authorities also introduced a series of policy measures aimed at improving the bank governance level. However, as can be seen from the figure, the effectiveness of these measures may take a longer time to show, and there are still many difficulties in improving the bank governance level.

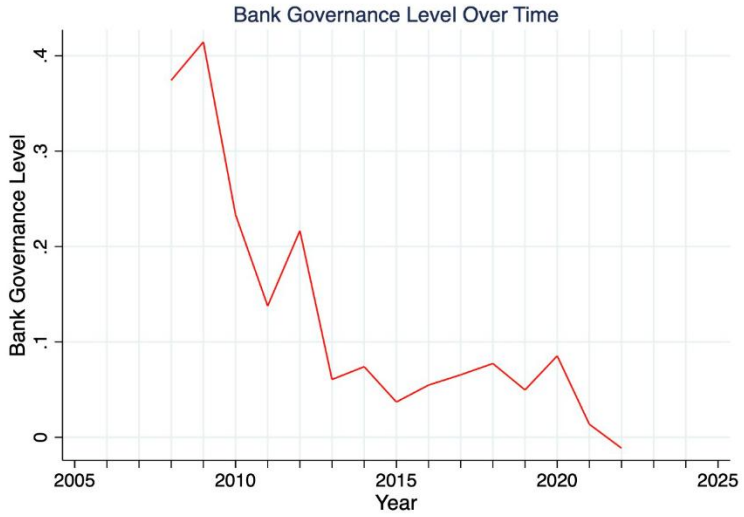


Figure 5.7 Trends in the governance level of Chinese commercial banks

5.4.2 Empirical model design

To analyze the impact of bank Fintech on the bank governance level, this thesis estimates the following regression models.

$$\boldsymbol{Bankgov_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \varepsilon_{i,t}} \quad (5.1)$$

$$\boldsymbol{Bankgov_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + \varepsilon_{i,t}} \quad (5.2)$$

$$\boldsymbol{Bankgov_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (5.3)$$

This study constructs the panel-data model as above. Bank governance is the dependent Variable, and this indicator is constructed through the factor analysis method. The core Independent Variable is the bank Fintech index (Fintech), which is constructed by the principal-component analysis method. Controls are control variables, and $Year_t$is the time fixed effect. $\varepsilon_{i,t}$ is the random disturbance term.

The focus of this study is to analyze the changes over time, such as the impact of the development of Fintech on the bank governance level. Using only time-fixed effects can effectively capture these trends in the macroeconomic environment. The deeper reasons have been explained in detail in the previous chapter and will not be repeated here.

5.4.3 Regression results

5.4.3.1 Baseline regression results

Table 5.3 shows the fixed-effects regression analysis results of the Fintech index (Fintech) on bank governance, including three models. Each column shows the impact of the Fintech index on bank governance under different control variables and time-fixed effects. In Model (5-1), the coefficient of the Fintech index is significant at the 1% level. This indicates that Fintech has a significant positive impact on bank governance. Fintech significantly improves the governance level of banks by providing more efficient risk-management tools, enhancing transparency, and improving internal control mechanisms. In addition, the application of Fintech promotes the development of information technology, improves the quality of bank information disclosure, and enhances management efficiency, thus improving bank governance. In Model (5-2), more control variables are added, and the coefficient of the Fintech index is still significant at the 1% level. This result further supports the finding of Model (5-1), indicating that even after controlling for more variables, the positive impact of Fintech on bank governance remains significant. Control variables such as ROA, leverage ratio, and asset-

liability ratio have an important impact on the Fintech index. For example, the significantly positive coefficient of ROA indicates that banks with stronger profitability are more likely to improve their governance levels through Fintech. The significantly positive coefficient of the leverage ratio (Lev) shows that banks with high leverage ratios may rely more on Fintech to strengthen their risk management and internal control to maintain the stability of their governance structures. Finally, in Model (5-3), time-fixed effects are further added, and the coefficient of the Fintech index is significant at the 5% level. This indicates that after controlling for time effects, the positive impact of Fintech on bank governance is still significant. The addition of time-fixed effects controls the impact of external factors, such as the macroeconomic environment and policy changes on bank governance, making the coefficient of the Fintech index more robust. This result further verifies the important role of Fintech in improving bank governance.

Table 5.10 Baseline results: The impact of bank Fintech on bank governance

Variables	**Bank Governance**		
	(5-1)	**(5-2)**	**(5-3)**
Lag_Fintech	0.119***	0.140***	0.141**
	(0.013)	(0.014)	(0.032)
Lag_ROA		18.158	20.515**
		(11.120)	(4.286)
Lag_Lev		4.831***	4.852**
		(1.800)	(0.977)
Lag_Tang		20.609***	20.693
		(5.052)	(9.789)
Lag_CI		-0.182	-0.190
		(0.298)	(0.175)
Lag_CAR		0.042***	0.042
		(0.013)	(0.019)
Lag_Gdpgr		0.011*	0.000
		(0.006)	(.)
Lag_M2gr		0.017***	0.000
		(0.006)	(.)
Time Fixed Effect	NO	NO	YES
R^2	0.054	0.100	0.105
Adj R^2	0.053	0.095	0.092
Observations	1429	1423	1423

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

In summary, this thesis finds that Fintech has a significant positive impact on bank governance, and this impact is verified under different models and control variables. Fintech significantly improves the governance level of banks by enhancing information transparency, optimizing risk management, and improving internal control mechanisms. Banks should actively invest in and apply Fintech to enhance their governance capabilities and overall performance. At the same time, regulatory authorities should encourage the development of

Fintech, provide support policies, and ensure its effective application in the banking industry to enhance the stability and efficiency of the entire financial system. These findings provide important references for policymakers and bank managers and promote the banking industry to develop in a more transparent, efficient, and stable direction.

5.4.3.2 Mechanism test

To explore the mechanism of Fintech's impact on the governance level of Chinese commercial banks, based on the previous analysis of the agency theory and the information asymmetry theory, the following fixed-effects models are constructed:

$$\boldsymbol{Mangfee_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \varepsilon_{i,t}} \quad (5.4)$$

$$\boldsymbol{Mangfee_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (5.5)$$

$$\boldsymbol{Readability_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \varepsilon_{i,t}} \quad (5.6)$$

$$\boldsymbol{Readability_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (5.7)$$

where $Mangfee_{i,t}$ is the management-expense ratio of bank i in year t, and $Readability_{i,t}$ represents the readability of the annual report of commercial banks. In Models (5-4) and (5-6), this thesis first analyzes the situation without adding control variables and time fixed effects, while in Models (5-5) and (5-7), control variables are added. $Year_t$ is the time fixed effect of the bank, and $\varepsilon_{i,t}$is the random disturbance term. The regression results of the mechanism test are shown in Table 5.4 below.

Table 5.11 Mechanism test: The impact of Fintech on bank governance

Variables	Mangfee			Readability		
	(5-4)	(5-5)	(5-5)	(5-6)	(5-7)	(5-7)
Lag_Fintech	-0.008***	-0.006***	-0.006***	0.497***	0.496***	0.485***
	(0.001)	(0.001)	(0.001)	(0.020)	(0.020)	(0.042)
Lag_Lev		0.164	0.132		2.960	2.737
		(0.138)	(0.226)		(2.627)	(4.967)
Lag_Tang		3.913***	3.749***		-14.701**	-9.253
		(0.387)	(0.925)		(7.357)	(12.209)
Lag_CI		0.301***	0.312***		-1.330***	-1.692**
		(0.015)	(0.046)		(0.288)	(0.504)
Lag_CAR		0.003***	0.003		-0.070***	-0.078**
		(0.001)	(0.002)		(0.020)	(0.036)
Lag_Gdpgr		0.001**	0.000		0.007	0.000
		(0.000)	(.)		(0.009)	(.)
Lag_M2gr		0.002***	0.000		-0.005	0.000
		(0.000)	(.)		(0.010)	(.)
Time Fixed Effect	NO	NO	YES	NO	NO	YES
R^2	0.030	0.297	0.308	0.307	0.340	0.349
Adj R^2	0.029	0.293	0.299	0.307	0.337	0.340
Observations	1408	1402	1402	1429	1423	1423

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

Table 5.4 shows the results of the test of the impact of the Fintech index on the bank governance level, analyzed from two aspects: the management-expense ratio and the readability of financial reports. By examining the coefficients of the Fintech index (Fintech) in different models, this thesis can understand its specific transmission mechanism on bank governance. In Column 1 to Column 3, the dependent variable is the management-expense ratio, and the coefficients of the Fintech index are all negative and significant at the 1% level (-0.008, -0.006, and -0.006 respectively). This result indicates that the application of Fintech significantly reduces the management expense ratio of banks. It means that the higher the development level of Fintech, the lower the management-expense ratio. This result supports the hypothesis that the implementation of Fintech can improve efficiency and reduce the internal agency costs of banks. The mechanism verification results of this study are consistent with the findings of B. H. Lin et al. (2023), that is, Fintech significantly promotes the improvement of corporate governance levels by effectively reducing agency costs. Specifically, in the deep structure of the bank governance system, the problem of management agency costs, especially the significant existence of supervision costs and incentive costs, is often further highlighted due to the imperfect incentive mechanism or the excessive emphasis of management on personal interests. This situation inevitably becomes a major obstacle to improving the internal governance efficiency of banks. It not only weakens the efficiency and transparency of the governance system but also may lead to conflicts of interest and decision-making biases, thus hurting the stable operation and long-term development of banks. Therefore, re-examining and optimizing the incentive mechanism of management to ensure its consistency with the overall interests of the bank has become the key to improving the bank governance level and promoting sustainable development. However, with the wide application of Fintech in the banking field, on the one hand, the in-depth application of digital technology has significantly improved the internal information transparency of banks, laying a solid foundation and providing strong support for alleviating the problem of management agency costs. On the other hand, banks can use these advanced technologies to achieve more precise and efficient supervision of management behavior, thus effectively reducing supervision costs and promoting a comprehensive upgrade and leap in bank governance efficiency. This process not only demonstrates the key role of technology in the modernization of bank governance but also paves a more solid path for the future sustainable development of the banking industry. Based on the above analysis, the management-agency-cost channel mechanism is verified; that is, bank Fintech can improve the governance level of banks by reducing the management agency costs of bank management.

In Column (4) to Column (6), the dependent variable is the financial-report-readability variable constructed through the factor-analysis method, and the coefficients of the Fintech index are all positive and significant at the 1% level (0.497, 0.496, and 0.485, respectively). This indicates that Fintech significantly improves the readability of the bank's financial reports. It means that the higher the development level of Fintech, the higher the readability of the annual report, thus effectively alleviating information asymmetry. This result also supports the hypothesis that the implementation of Fintech can improve the disclosure quality of annual reports and reduce information asymmetry. Specifically, Fintech also improves the readability of commercial bank annual reports through intelligent tools. For example, artificial intelligence technology can be used for natural language processing and automatic report generation, making the annual report content clearer and more understandable. Intelligent data and visualization tools help to transform complex or difficult-to-understand financial data into more intuitive graphs, further helping users better understand the report content. This not only improves the readability of the annual report but also enhances the quality and transparency of bank information disclosure. This helps investors, regulatory authorities, and other stakeholders better understand the operation and financial status of banks, thereby enhancing the effectiveness and transparency of bank internal governance. By improving information disclosure and governance structure, commercial banks can better manage risks, improve operational efficiency, and achieve sustainable development.

In summary, Fintech significantly improves the governance level of banks by reducing the management expense ratio and enhancing the readability of financial reports. These results verify the positive role of Fintech in improving the operational efficiency and information transparency of banks. Banks should continue to increase investment in Fintech and utilize its advantages in cost control and information management to further optimize the internal governance structure and improve the quality of external reports. At the same time, regulatory authorities should encourage the wide application of Fintech, provide policy support, and ensure its effective promotion in the banking industry to enhance the stability and transparency of the overall financial system. This research provides important empirical evidence for policymakers and bank managers and emphasizes the key role of Fintech in modern bank governance.

5.4.3.3 Heterogeneity test

To explore the impact of Fintech on the governance of different types of banks, this thesis conducts a heterogeneity test. By classifying banks into different listing statuses, geographical locations, and bank sizes, this thesis conducts regression analyses on the bank governance

variables of these types of banks, respectively. This heterogeneity test aims to reveal the differences in the effects of Fintech under different governance structures and market environments to more comprehensively understand how it affects bank governance. The specific regression results are shown in Table 5.5.

Table 5.12 Heterogeneity test: The impact of Fintech on bank governance

Variables	**Bank Governance**	
Panel A	**The Impact of Fintech on the Governance of Different Listing Types of Banks**	
Variables	Non-listed banks	Listed banks
	(1)	(2)
Lag_Fintech	-0.045	0.173***
	(0.049)	(0.026)
Lag_ROA	2.509	101.730***
	(3.207)	(36.458)
Lag_Lev	-1.331	18.409***
	(1.608)	(6.164)
Lag_Tang	-1.306	87.456***
	(1.231)	(15.321)
Lag_CI	0.059	-0.512
	(0.141)	(0.853)
Lag_CAR	0.017***	0.103***
	(0.004)	(0.038)
Lag_Gdpgr	0.000	0.000
	(.)	(.)
Lag_M2gr	0.000	0.000
	(.)	(.)
Time Fixed Effect	YES	YES
R^2	0.036	0.187
Adj R^2	0.013	0.157
Observations	867	556
Panel B	**The Impact of the Fintech Index on the Governance of Banks in Different Regions**	
	Eastern regions	Central regions	Western regions
	(1)	(2)	(3)
Lag_Fintech	0.158***	-0.123	-0.009
	(0.017)	(0.067)	(0.000)
Lag_ROA	22.657	-5.825	-10.770
	(15.911)	(18.115)	(16.373)
Lag_Lev	5.601**	5.450	0.202
	(2.524)	(3.401)	(2.335)
Lag_Tang	31.096***	4.067	-1.012
	(7.501)	(6.557)	`(5.192)
Lag_CI	-0.415	0.014	-0.644***
	(0.430)	(0.310)	(0.205)
Lag_CAR	0.061***	0.022	-0.008
	(0.020)	(0.028)	(0.014)
Lag_Gdpgr	0.000	0.000	0.000
	(.)	(.)	(.)
Lag_M2gr	0.000	0.000	0.000
	(.)	(.)	(.)
Time Fixed Effect	YES	YES	YES

Variables	Bank Governance		
R^2	0.125	0.194	0.193
Adj R^2	0.107	0.106	0.116
Observations	997	194	231
Panel C	**The Impact of Fintech on the Governance of Commercial Banks of Different Sizes**		
	Large-scale banks	Small-scale banks	
	(1)	(2)	
Lag_Fintech	0.142**	-0.096	
	(0.064)	(0.057)	
Lag_ROA	84.922	-1.835	
	(81.318)	(13.949)	
Lag_Lev	6.011	1.364	
	(5.968)	(1.485)	
Lag_Tang	61.193	-3.227	
	(48.403)	(4.720)	
Lag_CI	0.719	-0.109	
	(0.770)	(0.367)	
Lag_CAR	0.083	0.017*	
	(0.079)	(0.010)	
Lag_Gdpgr	0.000	0.000	
	(.)	(.)	
Lag_M2gr	0.000	0.000	
	(.)	(.)	
Time Fixed Effect	YES	YES	
R^2	0.187	0.057	
Adj R^2	0.167	0.023	
Observations	837	586	
Panel D	**The Impact of Fintech on the Governance of Commercial Banks of Different Natures**		
	National commercial banks	Local commercial banks	
	(1)	(2)	
Lag_Fintech	0.206***	-0.080***	
	(0.089)	(0.022)	
Lag_ROA	24.978	-0.004	
	(35.363)	(14.477)	
Lag_Lev	7.615	1.381	
	(7.026)	(1.986)	
Lag_Tang	29.384	2.249	
	(25.954)	(7.518)	
Lag_CI	-0.486	0.012	
	(0.452)	(0.013)	
Lag_CAR	0.074	-0.138	
	(0.063)	(0.371)	
Lag_Gdpgr	0.000	0.000	
	(.)	(.)	
Lag_M2gr	0.000	0.000	
	(.)	(.)	
Time Fixed Effect	YES	YES	
R^2	0.177	0.106	
Adj R^2	0.158	0.072	
Observations	888	535	

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

Table 5.5 Panel A shows the results of the heterogeneity test of the impact of the Fintech

index on the governance levels of different types of banks (non-listed banks and listed banks). Analyzing the performance of the Fintech index (Fintech) in different models reveals its differential impacts on the bank governance levels. In Model (1), for non-listed banks, the coefficient of the Fintech index does not reach the significance level. This indicates that Fintech has no significant impact on the bank governance level of non-listed banks. Non-listed banks may face certain obstacles in the application and implementation of Fintech, such as insufficient funds, limited technical capabilities, and low acceptance of technological innovation by management, resulting in Fintech not being able to significantly improve their governance levels. In addition, non-listed banks may rely more on traditional management and operation models and fail to fully utilize the governance advantages brought by Fintech. However, in Model (2), for listed banks, the coefficient of the Fintech index is significant at the 1% level. This indicates that Fintech significantly improves the bank governance level of listed banks. Listed banks usually have stronger capital strength and technical reserves and can more widely and apply Fintech means to improve their governance structures. Fintech enhances the governance levels of listed banks by improving information transparency, optimizing risk management, and improving internal control. In addition, listed banks face stricter regulatory requirements and market supervision, and the application of Fintech helps them better meet these requirements and improve their market competitiveness and reputation.

Overall, the impact of Fintech on the bank governance level shows significant heterogeneity between non-listed banks and listed banks. Listed banks can fully utilize Fintech to improve their governance levels due to their strong resource and technical capabilities, while the effect of Fintech on non-listed banks is not significant. This finding suggests that policymakers and bank managers need to consider the actual situations of different types of banks and formulate differential policies and strategies to promote the wide application of Fintech. For non-listed banks, technical support and capital investment should be strengthened to help them overcome the obstacles in Fintech application and improve their governance levels. For listed banks, Fintech innovation and application should be continuously promoted to further enhance their market competitiveness and governance capabilities.

Table 5.5 Panel B shows the results of the heterogeneity test of the impact of the Fintech index on the governance of banks in different regions. By analyzing the impact of the Fintech index (Fintech) on the bank governance levels of banks in the eastern, central, and western regions, the differential regional impacts of Fintech on bank governance are revealed. The performance of the core Independent Variable, the Fintech index, in different regions shows its regional differences in the impact on bank governance. In Model (1), for banks in the eastern

region, the coefficient of the Fintech index is significant at the 1% level. This indicates that Fintech significantly improves the bank governance level in the eastern region. The eastern region has a developed economy and a sound Fintech infrastructure, and banks are in a leading position in terms of technology application and innovation capabilities. These banks can more widely adopt Fintech to improve information transparency, optimize risk management, and improve internal control, thus significantly improving the governance level. The fierce market competition in the eastern region also makes the application of Fintech an important means to enhance competitiveness.

In Model (2), for banks in the central region, the coefficient of the Fintech index does not reach the significance level. This result indicates that Fintech has no significant impact on the bank governance in the central region. Banks in the central region may face limitations in resources and technical capabilities in the application of Fintech, and their promotion and implementation of Fintech are not as mature as those in the eastern region. Although banks in the central region have also tried to introduce Fintech, its effect has not been significantly reflected in the improvement of the bank governance level. Similarly, in Model (3), for banks in the western region, the coefficient of the Fintech index also does not reach the significance level. This indicates that Fintech has no significant impact on the bank governance in the western region. The overall economic development level in the western region is relatively backward, and banks have a low acceptance and application level of Fintech. The application of Fintech in the western region may face more technical obstacles and cost limitations, resulting in its limited contribution to the improvement of the bank governance level. In addition, banks in the western region may rely more on traditional operation and management models, and the potential benefits of Fintech have not been fully realized.

Overall, the impact of Fintech on bank governance shows significant heterogeneity in different regions. The eastern region, due to its developed economy and mature Fintech applications, has significantly improved the bank governance level. However, in the central and western regions, due to limitations in economic development and technical conditions, the impact of Fintech on bank governance is relatively limited. This result provides important references for policymakers, indicating that regional differences should be considered when promoting the application of Fintech, and targeted policies and support measures should be formulated for different regions. In the future, more support should be given to the application of Fintech by banks in the central and western regions to enhance their technical capabilities and governance levels and promote the balanced development of the banking industry nationwide.

Table 5.5 Panel C shows the results of the heterogeneity test of the impact of the Fintech index on the governance of commercial banks of different sizes. By examining large-scale banks and small-scale banks respectively, it reveals the differential effects of the Fintech index (Fintech) in banks of different sizes. In Model (1), for large-scale banks, the coefficient of the Fintech index is 0.142 and is significant at the 5% level. This indicates that Fintech has a significant positive impact on the governance level of large-scale banks. Large-scale banks usually have stronger capital strength and technical reserves and can invest more resources in the application and development of Fintech. The application of Fintech in these banks not only improves information transparency and risk-management efficiency but also improves internal control and compliance management. The wide application of Fintech enables large-scale banks to better adapt to market changes and regulatory requirements and enhances their governance levels. In contrast, in Model (2), the coefficient of the Fintech index for small-scale banks does not reach the significance level. This indicates that Fintech has no significant impact on the governance level of small-scale banks. Small-scale banks have limitations in terms of funds, technical capabilities, and market coverage, and may find it difficult to effectively implement Fintech innovation. Although Fintech can, to a certain extent, improve the operational efficiency of small-scale banks, due to their scale and resource limitations, the potential advantages of Fintech have not been fully realized, and thus, it has not significantly improved their governance levels.

Overall, the impact of Fintech on the bank governance level shows significant heterogeneity in banks of different sizes. Large-scale banks can fully utilize Fintech to improve their governance levels due to their resource and technical advantages, while small-scale banks face more limitations in resource and technical applications, and the improvement effect of Fintech on their governance levels is not significant. This finding suggests that bank managers and policymakers need to consider the differences in bank sizes when promoting the development of Fintech and formulate corresponding policies and strategies. For large-scale banks, continuous support should be provided for their investment and innovation in the Fintech field. For small-scale banks, more technical support and funds should be provided to promote their development in Fintech applications to enhance the overall governance level and competitiveness of the banking industry.

Table 5.5 Panel D shows the heterogeneous impact of the Fintech index on the governance of commercial banks of different natures. Model (1) and Model (2) respectively examine the situations of national commercial banks and local commercial banks and analyze the different impacts of the core Independent Variable, the Fintech index (Fintech), on bank governance. In

Model (1), for national commercial banks, the coefficient of the Fintech index is 0.206 and is significant at the 1% level. This indicates that Fintech significantly improves the governance level of national commercial banks. National commercial banks usually have high technical capabilities and resource investment and can more effectively utilize Fintech to optimize their internal control and governance structures. The application of Fintech has enabled these banks to make significant progress in information transparency, risk management, and compliance management, thus greatly enhancing their governance levels. In addition, the wide-ranging business scope and diverse customer groups of national commercial banks make them highly dependent on Fintech to maintain their competitive advantages and market shares.

By contrast, in Model (2), for local commercial banks, the coefficient of the Fintech index is -0.080 and is significantly negative at the 1% statistical level. This indicates that Fintech has a significant negative impact on the governance level of local commercial banks. Local commercial banks may face greater implementation costs and technical adaptation challenges due to relatively insufficient resources and technical capabilities, resulting in poor application effects of Fintech or even negative impacts. Secondly, the market positioning and business models of national banks are diverse, and Fintech can more effectively meet their diversified customer needs, enhancing customer satisfaction and governance levels. However, the customer groups of local banks are relatively homogeneous, and the standardization and automation of Fintech may not fully meet their customer needs and may even reduce customer experience and loyalty. In addition, local banks may lack sufficient capabilities and resources to cope with the risk management and compliance challenges brought by emerging Fintech, which may also lead to a decline in governance levels. The performance of other control variables also provides further insights. For example, the leverage ratio (Lev) shows a positive relationship in national commercial banks, suggesting that higher leverage may require stronger governance to control risks. However, this relationship is not significant in local commercial banks, possibly due to their lower scale and business complexity.

In summary, the impact of Fintech on the bank governance level shows significant heterogeneity between national and local commercial banks. National commercial banks can fully utilize Fintech to enhance their governance levels due to their strong technical capabilities and resources, while the effect of Fintech on local commercial banks is not significant. Policymakers and bank managers should formulate differential Fintech application strategies according to the characteristics and needs of different types of banks to ensure that the potential of Fintech in enhancing the bank governance level is fully exploited. Especially for local commercial banks, technical support and capital investment should be strengthened to help

them overcome technical and resource limitations and improve their governance levels.

4.6.3.4 Robustness test

Table 5.6 shows the results of the robustness test of the Fintech index (Fintech) after constructing the bank governance index using the Principal Component Analysis (PCA) method. This robustness test aims to verify the robustness of the results obtained from using the factor-analysis method to construct the bank governance index. The three models in the table respectively show the impact of the Fintech index on the bank governance level under different control variables and time-fixed effects.

Table 5.13 Robustness test: The impact of Fintech on the governance

Variables	**Bank Governance (PCA)**		
	(1)	**(2)**	**(3)**
Lag_Fintech	0.086***	0.120***	0.118***
	(0.020)	(0.020)	(0.038)
Lag_ROA		2.898	9.665
		(16.575)	(3.445)
Lag_Lev		4.016	4.438
		(2.682)	(1.860)
Lag_Tang		41.897***	42.509
		(7.529)	(17.488)
Lag_CI		-0.495	-0.514
		(0.445)	(0.634)
Lag_CAR		0.040**	0.042
		(0.020)	(0.021)
Lag_Gdpgr		0.014	0.000
		(0.009)	(.)
Lag_M2gr		0.019*	0.000
		(0.010)	(.)
Time Fixed Effect	NO	NO	YES
R^2	0.013	0.053	0.060
Adj R^2	0.012	0.048	0.047
Observations	1429	1423	1423

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

In Model (1), the coefficient of the Fintech index is 0.086 and is significant at the 1% level. This indicates that regardless of whether the factor-analysis method or the principal-component analysis method is used, the positive impact of the Fintech index on bank governance remains significant. The application of Fintech can effectively improve information transparency, optimize risk management, and improve internal control, thus significantly enhancing the bank's governance level. This result verifies the important role of Fintech in enhancing bank governance. In Model (2), after adding more control variables, the coefficient of the Fintech index is 0.120 and is significant at the 1% level. With the increase of control variables, the coefficient of the Fintech index increases, indicating that the positive impact of Fintech is more

obvious. Control variables such as ROA and the leverage ratio (Lev) have a certain impact on bank governance. For example, the asset-liability ratio shows a significant positive relationship in all models, especially after controlling other variables; its impact is more significant, reflecting the importance of high-quality assets in enhancing the bank governance level. In Model (3), after further adding time fixed effects, the coefficient of the Fintech index is 0.118 and is significant at the 1% level. This result further verifies the robust positive impact of Fintech on the bank governance level. The addition of time-fixed effects controls the impact of the macroeconomic environment and policy changes on bank governance, making the coefficient of the Fintech index more robust. The results show that regardless of the control of fixed effects and control variables, the positive impact of the Fintech index on bank governance remains consistent, further demonstrating the important position of Fintech in modern bank governance.

Generally speaking, the results of using the principal-component analysis method to construct the bank governance index are consistent with those of using the factor-analysis method before, showing the robust positive impact of the Fintech index on bank governance. The results of this robustness test strengthen the confidence in the key role of Fintech in enhancing the bank governance level. It further indicates that Fintech, as an effective governance tool, can not only optimize the internal management of banks but also enhance their external transparency and compliance. Policymakers and bank managers should continue to support and promote the development of Fintech to improve the governance level and market competitiveness of the banking industry.

5.5 Conclusions

This thesis focuses on the issue of how Fintech affects bank governance and explores its mediating effects in alleviating information asymmetry and reducing agency costs. Based on the solid foundation of the principal-agent theory and the information-asymmetry theory, this thesis systematically reviews and analyzes the literature on the bank governance impact mechanism and the Fintech impact mechanism on bank governance from two dimensions, and then proposes three core hypotheses: First, Fintech can actively promote the optimization of the bank governance structure; second, Fintech can indirectly improve the bank governance level by strengthening the transparency of information disclosure and governance effectiveness, and this process depends on the effective alleviation of information asymmetry; third, Fintech can further promote the improvement of bank governance by reducing management agency costs.

To verify the above hypotheses H5-1 to H5-3, this thesis carefully selects variables and constructs appropriate analysis models. Specifically, this thesis collects the annual financial data of 351 Chinese commercial banks from 2007 to 2022 and uses the fixed-effects model to analyze the substantial impact of the Fintech index on the governance performance of commercial banks. In addition, the study also considers the heterogeneity of bank size and listing status to reveal the diversity of Fintech impact effects. The results of the overall regression analysis strongly show that the development of Fintech has a significant and positive promoting effect on commercial bank governance. Specifically, Fintech significantly enhances the governance effectiveness of banks by improving information transparency, refining risk management, and strengthening internal control mechanisms. When analyzing the impact mechanism, this thesis finds that the development of Fintech not only effectively reduces the management agency costs of banks but also significantly improves the readability of annual report texts, both of which have a positive impact on the improvement of the bank governance system and the enhancement of governance capabilities. Therefore, the research conclusions of this thesis provide strong theoretical support and practical guidance for the application of Fintech in the field of bank governance.

In addition, the in-depth analysis of the empirical research reveals the significant heterogeneous impact of Fintech in the field of bank governance. Specifically, first, in terms of listing-status differences, the results show that Fintech has a significant promoting effect on the governance level of listed banks, while it has no obvious effect on non-listed banks. This is attributed to the fact that listed banks, with their stronger capital bases and technical accumulations, can more effectively use Fintech means to enhance information transparency, optimize risk-management systems, and internal-control mechanisms; in contrast, non-listed banks are relatively lagging in this regard and are difficult to fully unleash the potential of Fintech. Second, the regional-difference analysis further shows that banks in the eastern region benefit significantly from the positive impact of Fintech, while the central and western regions do not show similar effects. This reflects that due to the prosperous economy and sound Fintech infrastructure in the eastern region, banks can more efficiently use these technologies to enhance governance effectiveness; on the contrary, banks in the central and western regions are slightly inferior in terms of technology adoption and market competitiveness, limiting the role of Fintech in enhancing their governance levels. Third, the comparison in terms of bank size also reveals the differential impact of Fintech. Large-scale banks, with their dual advantages of capital and technology, have achieved significant results in the application of Fintech and effectively improved their governance structures; on the contrary, it shows that Fintech has a

significant negative impact on the governance level of local commercial banks. Local commercial banks may face greater implementation costs and technical adaptation challenges due to relatively insufficient resources and technical capabilities, resulting in poor application effects of Fintech or even negative impacts. Second, the market positioning and business models of national banks are diverse, and Fintech can more effectively meet their diversified customer needs, enhancing customer satisfaction and governance levels. However, the customer groups of local banks are relatively homogeneous, and the standardization and automation of Fintech may not fully meet their customer needs and may even reduce customer experience and loyalty. In addition, local banks may lack sufficient capabilities and resources to cope with the risk-management and compliance challenges brought by emerging Fintech, which may also lead to a decline in governance levels. Finally, through the robustness test of reconstructing the bank governance index using the principal-component analysis method, the results still confirm the robust positive effect of Fintech on bank governance, further strengthening the reliability and scientific nature of the conclusions of this thesis.

Chapter 6: Impact of Fintech on the Operating Performance of Chinese Commercial Banks

6.1 Introduction

In the research framework of Ba and Bai (2016), the integration path of Fintech is clearly divided into three stages: the initial stage of financial IT, the subsequent wave of Internet finance, and the current booming Fintech 3.0 era. The transformative change has not only injected strong impetus into the deepening of China's financial supply-side reform but also significantly enhanced the supporting effectiveness of financial services for the real economy. At the same time, it has played a crucial role in the effective prevention and resolution of financial risks. At present, the cooperation between banks and technology companies is becoming increasingly close. Emerging technologies such as big data analysis, artificial intelligence, and blockchain have penetrated into every link of financial services, greatly improving the efficiency and quality of financial services and effectively reducing operating and risk management costs. These technological innovations have not only led the in-depth transformation of the financial industry but also injected strong impetus into the continuous development and innovation of Fintech, painting a blueprint full of unlimited possibilities for the future of the financial industry. With the continuous evolution of Fintech, the financial industry is bound to usher in more far-reaching changes and unprecedented development opportunities. Fintech will not only continue to promote the innovative upgrading of banking business models but also become an important driving force for the sustainable development of the financial industry and an indispensable key element in the modern financial system. According to the research and estimation of China's Qianzhan Industry Research Institute, the revenue scale of China's Fintech industry in 2017 and 2018 was 654.14 billion yuan and 969.88 billion yuan respectively, and it is expected to reach nearly 2 trillion yuan in 2020.

On the other hand, the development of scientific and technological innovation has always been inseparable from the strong support of finance. Looking back at history, Jiaozi, the world's earliest paper currency born in the Song Dynasty, not only greatly promoted the convenience of business activities but also profoundly promoted the parallel development of technological innovation and economic prosperity. Looking at the global context, the rise of the modern

commercial banking system, investment banks, and venture-capital mechanisms has built a solid financial backing for successive scientific and technological revolutions and industrial transformations. These financial institutions not only act as capital providers but also play a key role in resource optimization and allocation and the transformation of scientific and technological achievements into real productive forces. Entering the new era, developing tech-finance has become a crucial part of promoting the high-quality development of finance and an important component of building a financial-power strategy. This is not only an inevitable response to the needs of high-quality economic development but also an urgent task to lay a solid material and technical foundation for building a modern socialist country in all respects. The Central Financial Work Conference has taken a far-reaching perspective, clearly stating that "we must unswervingly adhere to the path of Chinese-characteristic financial development" and emphasizing the need to "increase financial support for new technologies, new fields, and new markets and accelerate the cultivation of new engines of economic growth and competitive advantages." This strategic orientation profoundly reveals that the financial industry, in the new-era context, needs to pay more attention to the growth and innovation of emerging technology fields and actively provide customized and high-performance financial services and capital support. Especially for cutting-edge technology fields such as artificial intelligence, big data, and blockchain, financial institutions should continuously innovate financial products and service models to promote the rapid commercialization and wide-spread application of scientific and technological achievements, thereby stimulating market innovation vitality and injecting inexhaustible impetus into the continuous development of the economic and social fields. Through the deep integration of finance and technology, a new chapter of high-quality economic development can be jointly created.

At the symposium of provincial-and ministerial-level senior leaders on promoting the high-quality development of the financial industry, General Secretary Xi Jinping delivered a speech of far-reaching significance, profoundly expounding on the core essence and development path of financial work and emphasizing the need to "earnestly implement the strategic deployments of the Central Financial Work Conference." This important speech has established the fundamental principles and action guidelines for guiding tech-finance onto the right track. By increasing financial support for scientific and technological innovation, more funds and resources can be effectively injected into emerging industries, accelerating the growth of technology-based enterprises. At the same time, optimizing the financial service system and enhancing service efficiency will further unleash the potential of scientific and technological innovation and promote the rapid transformation of scientific research achievements into

market applications. In this context, exploring the specific impact of Fintech on the operating performance of Chinese commercial banks not only has great practical significance but also contains rich academic value. The primary task is to clarify whether the widespread application of Fintech has indeed improved bank operating performance and analyze the underlying mechanism. Secondly, analyzing the differences in the application effectiveness of Fintech among different types of commercial banks and their causes is also an important issue. Finally, clearly depicting the impact path and effect of Fintech on bank operating performance will provide valuable references for policymakers, helping to optimize the Fintech regulatory framework and promote the sound development of the financial industry. This research aims to explore through rigorous empirical analysis whether Fintech has a significant impact on the operating performance of Chinese commercial banks, reveal its internal mechanism, and accordingly put forward constructive policy recommendations. These efforts aim to provide a solid theoretical basis and practical guidance for the widespread application and promotion of Fintech in the banking industry and promote the deep integration and common development of Fintech and the banking industry.

6.2 Research questions

With the rapid advancement of the Fintech wave, its penetration and integration in the commercial banking field have become increasingly deep, and it has become a key driving force for the innovation, upgrading, and sustainable development of the banking industry. Fintech, with its significant advantages in improving operational efficiency, reducing transaction costs, strengthening risk management, and optimizing customer experience, is gradually reshaping the operating paradigm and industry competition ecology of commercial banks. However, the specific mechanism of the impact of Fintech on the operating performance of commercial banks and its differential manifestations among different types of banks still lack comprehensive and in-depth research support. Given this, this research is committed to filling this research gap and analyzing the impact mechanism of Fintech on the operating performance of Chinese commercial banks from multiple dimensions. The research framework will revolve around two cores: one is to accurately describe the direct impact of Fintech on bank operating performance; the other is to explore the internal mechanisms through which Fintech affects bank operating performance, revealing its adaptation strategies and effectiveness differences under different market environments and bank characteristics. This research aims not only to deepen the theoretical understanding of how Fintech empowers the operating performance of commercial

banks but also to provide solid data support and strategic inspiration for policymakers and bank management. This thesis firmly believes that through scientific planning and effective guidance on the rational application of Fintech in the banking industry, the overall operational efficiency and competitiveness of Chinese commercial banks can be significantly improved, injecting strong impetus into the stable development and innovative prosperity of the banking industry. Therefore, this research not only has far-reaching theoretical exploration significance but also has urgent practical guiding value, aiming to contribute policy wisdom and practical solutions to the deep integration of Fintech and the banking industry.

Generally speaking, whether the popularization of Fintech will improve the operating performance of commercial banks is an important topic in current bank research. This chapter attempts to answer the following questions:

1. What are the specific impacts of Fintech on the operating performance of Chinese commercial banks?

2. What is the mechanism of Fintech's impact on operating performance?

3. Are there differences in the application effects of Fintech between large-scale banks and small-scale banks?

4. Are there differences in the application effects of Fintech among banks with different geographical distributions?

5. Are there similar differences among banks with different listing statuses?

6. Is there a difference in this impact between national and local commercial banks?

In recent years, the booming development of the Internet has accelerated the deep integration of financial services and technology, giving birth to the cutting-edge business model of Fintech, and the related research literature has rapidly accumulated. However, the current research focus mostly centers on Internet companies, constructing Fintech development evaluation systems from the perspective of technology giants. As the cornerstone of the financial service system, commercial banks lack quantitative analysis of their Fintech development paths, especially systematic research from the banks' perspectives. This thesis aims to fill this research gap by innovatively constructing a Fintech index for Chinese commercial banks and analyzing the practical achievements, unique advantages, and challenges faced by banks in the application of Fintech through quantitative methods. This helps to understand the role and value of the banking industry in the Fintech wave. The empirical research of this thesis reveals that the promoting effect of Fintech on the operating performance of commercial banks shows significant heterogeneous characteristics. Specifically, listed banks, with their advantages in the capital market, can more effectively use Fintech to improve their

ROA, demonstrating stronger market competitiveness and profitability; in contrast, non-listed banks have not significantly benefited from the adoption of Fintech. In addition, regional differences cannot be ignored. Banks in the eastern region, relying on sound Fintech infrastructure, have significantly enhanced their ROA levels, while banks in the central and western regions, due to resource and technical bottlenecks, have seen a relatively limited boosting effect of Fintech on their ROA, highlighting the unbalanced application of Fintech among regions. In terms of scale differences, large-scale banks, with their strong resource reserves and technical strength, are more proficient in the application of Fintech, effectively optimizing their operational processes, improving service quality, and thus significantly promoting ROA growth; while small-scale banks, due to resource limitations, have relatively weak application effects of Fintech. The robustness test further consolidates the above findings, confirming the general positive effect of Fintech on banks' ROA. At the policy-enlightenment level, this thesis provides targeted suggestions for policymakers and regulatory authorities, including optimizing the Fintech regulatory framework to adapt to the rapidly changing market environment, strengthening the construction of the Fintech talent team, and increasing support for Fintech innovation projects. These suggestions aim to promote the healthy and sustainable development of the Fintech industry and provide practical paths for commercial banks to use Fintech to improve their operating performance. This research integrates the two dimensions of empirical exploration and theoretical analysis, not only conclusively verifying the profound impact of Fintech on the operating performance of the banking industry and the complex operating logic behind it but also providing a forward-looking theoretical perspective and practical solutions for Chinese commercial banks in their strategic transformation and pursuit of high-quality growth paths in the Fintech wave. Analyzing the positive effect of Fintech on improving the operating efficiency of Chinese commercial banks is of immeasurable practical significance for promoting the deepening of the modernization reform of the financial system and accelerating the economic transformation to a high-quality development stage. Given the crucial role of joint-stock commercial banks in supporting the growth of small-scale enterprises, enhancing their service efficiency has undoubtedly become the key to promoting the prosperity of these economic micro-entities and stimulating market vitality. Therefore, exploring how Fintech empowers commercial banks is not only related to the transformation and upgrading of banks themselves but also an important issue for optimizing and upgrading the entire economic system.

Since the formal establishment of the Financial Technology Committee of the People's Bank of China in 2017, this institution has closely adhered to the pulse of economic and social

development, actively responded to the national strategic plan for deepening the integrated and innovative application of Fintech, and highly valued Fintech as a key driving force in the process of reforming the financial regulatory system. Therefore, this research aims to achieve two goals: On the one hand, joint-stock commercial banks can achieve a significant improvement and qualitative leap in operating efficiency by integrating Fintech resources and accurately identifying and overcoming various obstacles in business development. This process not only promotes the profound transformation of banks into fully digital, intelligent, and open entities but also builds a solid foundation for their sustainable development, ensuring the stability and long-term nature of their future growth paths. The significant positive effect of Fintech on improving the operating efficiency of Chinese commercial banks has irreplaceable strategic value and practical significance for deepening the modernization transformation of the financial system and driving the economy onto a higher-quality development track. It not only optimizes the efficiency of financial resource allocation but also promotes the innovation of financial service models, laying a solid foundation for building a more open, inclusive, and efficient financial system.

On the other hand, it provides empirical evidence for the government and regulatory authorities to optimize the Fintech regulatory framework and guide the sound development of the Fintech industry. This research will analyze how Fintech becomes a key force for banks to improve their operating performance and enhance market competitiveness, aiming to provide scientific decision-making references for policymakers and promote the balance between the stability and innovation capabilities of the financial system. This research not only aims to optimize banks' service capabilities for small-scale enterprises but also endeavors to consolidate the foundation for the continuous growth of the national economy. By carefully analyzing the multi-dimensional impact of Fintech on bank operating performance, this thesis aims to provide bank management with practical Fintech application strategies, helping them accurately use Fintech tools, improve their operation and management levels, understand the profound impact of Fintech on core businesses and financial performance, and thus formulate more forward-looking strategic plans and investment decisions, leading the innovation and transformation of banking business models and opening a new chapter in the deep integration of finance and technology.

6.3 Theoretical analysis and research hypotheses

6.3.1 Analysis of the impact of Fintech on the operating performance of commercial banks

The development of Fintech has brought significant changes to commercial banks, affecting multiple aspects of their operating performance. Theoretically, Fintech has a positive impact on the operating performance of commercial banks by improving operational efficiency, reducing costs, optimizing risk management, and improving customer service. As an indispensable and crucial part of China's financial market, commercial banks, compared with other financial institutions, significantly exhibit advantages such as large asset scales and high credibility. However, in the context of the wide-spread application of digital technology, with the booming rise of a series of tech-finance companies, the limitations of the traditional business models of commercial banks have become increasingly prominent. Specifically, their business processes are relatively long, business handling is strictly restricted by physical outlets, and other shortcomings have gradually emerged. At the same time, these tech-finance companies, with the innovative power of digital technology, have achieved efficient optimization of business processes, not only greatly improving business-handling efficiency but also significantly enhancing risk-control capabilities. With these core competitive advantages, they have successfully diverted a considerable part of the financial market share from commercial banks, attracted a large amount of customer deposits originally belonging to commercial banks (Boot, 2011), and actively provided a rich variety of loan products and services. In other words, the stronger the implementation of Fintech, the stronger the business strategy. Banks hope to enhance corporate value by integrating digital technology into their operations and processes (Zhai et al., 2023). The application of Fintech tools will help improve the bank's reputation and attract more customers. This will help banks compete and grow (Ardito et al., 2021; C. Lin & Kunnathur, 2019). At the same time, the application of parameter transfer will help strengthen communication among leaders, employees, and customers. In addition, this will help improve operating costs (C. Lin & Kunnathur, 2019). The application of Fintech will help save time, optimize operating processes, and better manage risks. Therefore, banks will improve customer service quality (Boufounou et al., 2022), reduce operating costs, and improve work efficiency, also improving the bank's performance.

Based on the perspective of the dynamic-capabilities theory (D. Liu et al., 2023), in the face of the continuous shrinkage of market share, commercial banks urgently need to take the initiative to change and focus on the transformation path of cost optimization, quality

improvement, and efficiency enhancement. Fintech has emerged as the core engine for the transformation and upgrading of commercial banks in this context. It has not only profoundly reshaped traditional business models but also powerfully driven the transformation of the banking business towards diversification and intelligence. This transformation has significantly enhanced the comprehensive service capabilities of commercial banks (Luo, 2019), laying a solid foundation for the leap in operating performance. From the perspective of the financial-innovation theory, financial innovation is recognized as the key lever for improving financial operation efficiency (R. X. Wang & Yu, 2004). With the help of Fintech, commercial banks can greatly reduce information asymmetry, enhance the information transparency between banks and a large number of corporate and individual customers, and effectively reduce transaction costs. Furthermore, Fintech empowers commercial banks to capture and integrate customer information based on digital technology, conduct in-depth mining using advanced data-analysis tools, and thus quickly customize highly personalized customer service solutions (Z. H. Li et al., 2022). The implementation of this precision-marketing strategy has effectively activated the potential customer group, achieved a leap from potential demand to actual business transformation, broadened the income channels of commercial banks, and further consolidated and enhanced their operating performance. Therefore, Fintech is not only a profound revolution in the traditional business models of commercial banks but also a core strategic pillar for them to maintain a leading position and achieve sustainable development in the highly competitive financial market. Therefore, based on the above analysis, the following hypothesis is proposed:

H6-1: The larger the Fintech adoption, the better the operating performance of Chinese commercial banks.

6.3.2 Mechanism analysis of the impact of Fintech development on the operating performance of commercial banks

Driven by Fintech, the operating processes and service paradigms of the banking industry are undergoing unprecedented profound transformations. This process potentially has a positive impact on itsROA by enhancing the net interest margin. According to the core viewpoint of the interest-spread management theory, the net interest margin is a key yardstick for measuring a bank's operating efficiency and profitability. Banks construct a reasonable spread between the cost of borrowing and lending funds through elaborate interest-spread strategies to achieve their profit targets. Specifically, a higher net interest margin indicates that banks have achieved more favorable returns in deposit and loan businesses, which undoubtedly injects strong impetus into

the growth of the bank's net interest income and the improvement of its ROA. Numerous empirical studies have also confirmed that the net interest margin has a significant positive effect on ROA. For example, Demirgüç-Kunt and Huizinga (1999)'s groundbreaking research pointed out that the net interest margin is one of the core elements shaping a bank's profitability. Angbazo (1997)'s further analysis also revealed the close connection between a high net interest margin and a bank's large profitability. Regarding the impact of Fintech on the net interest margin, its application has opened up new paths for improving bank operating efficiency. With the help of cutting-edge technologies such as big data analysis, artificial intelligence, and blockchain, banks can achieve precise control over risk pricing and in-depth customer profiling, thereby obtaining more favorable spreads in deposit and loan businesses. In addition, Fintech also helps banks optimize asset allocation, improve the efficiency of fund utilization, and effectively curb the rise of the non-performing loan ratio, further promoting the widening of the net interest margin. The growth of the net interest margin directly reflects the enhancement of a bank's profitability. As a core indicator for measuring a bank's spread income, the net interest margin is not only related to the growth of interest income but also affects the bank's cost-control and risk-management levels. Fintech, through process reengineering, cost reduction, and the improvement of customer service efficiency, enables banks to obtain a higher net interest margin. This improvement is not only reflected in the increase of interest income but also covers the effective compression of costs and the optimization of risk management, jointly building a solid foundation for the bank's profitability. Therefore, based on the above analysis, the following hypothesis is proposed:

H6-2: The Fintech adoption improves the operating performance of commercial banks by enhancing the net interest margin.

From the perspective of the cost structure of commercial banks, in the initial stage of Fintech development, banks indeed need to invest heavily in infrastructure construction and the recruitment and training of emerging-technology talents, which may potentially increase operating costs in the short term. However, as the Fintech strategy is advanced in depth, banks gradually establish a highly automated service system with low reliance on manual intervention. This system not only greatly improves business-processing efficiency but also transcends geographical boundaries, and its advantages gradually become apparent. In this context, banks have achieved significant cost reductions in key cost items such as labor costs (e.g., employee salaries), regulatory fees, and daily maintenance, and the magnitude of these cost reductions far exceeds the cost increase brought about by initial investments, thus realizing the optimization of the overall cost structure and paving the way for the improvement of operating performance.

The application of Fintech has also profoundly changed the service quality and customer experience of banks, laying a solid foundation for the long-term and sustainable development of banks. Banks promote the comprehensive onlineization of their businesses by adopting cutting-edge technologies and establishing intelligent branches, which break through the time-and-space limitations of traditional service models. This allows customers to flexibly and conveniently meet various financial needs while greatly improving service efficiency and response speed (M. Li et al., 2024). This transformation has enabled the cost-growth rate of commercial banks to lag behind the expansion of customer scale and business boundaries, achieving effective marginal-cost reduction (X. Wang, 2015). Regarding the long-standing pain point of information asymmetry in the credit business, banks traditionally need to spend a large amount of resources on customer-information collection and screening, resulting in high time and labor costs. In post-loan management, to ensure the safe recovery of funds, continuous regulatory resources need to be invested. Even so, the risk of loan losses cannot be completely avoided. However, with its powerful data-processing capabilities, Fintech, through technical means such as text mining, analyzes customers' consumption habits and transaction behaviors (Mocetti et al., 2017), achieves precise matching between customers and financial products through refined data models, and accurately grasps customers' credit demands, credit statuses, and repayment abilities. This process not only broadens the boundaries of information flow in the credit market, effectively alleviates the problem of information asymmetry between banks and enterprises (Y. T. Wang & Luo, 2022), but also reduces the loan-default risk (L. H. Guo & Zhu, 2021), effectively curbs moral hazards and adverse selection phenomena, and improves the operational efficiency and risk-management level of commercial banks' credit business. Therefore, based on the above analysis, Fintech reduces its operating costs, and thus, the following hypothesis is proposed:

H6-3: The Fintech adoption enables commercial banks to reduce their operating costs, thereby improving the operating performance of commercial banks.

On the other hand, from the perspective of efficiency improvement, commercial banks, relying on the power of Fintech, actively expand their market territory, strengthen their differential-service capabilities, and restructure their internal management frameworks. This series of strategic deployments has promoted the comprehensive improvement of customer acquisition, product marketing effectiveness, fund-allocation efficiency, and organizational-operation effectiveness, thus greatly enhancing the overall operating efficiency of commercial banks. Specifically, the transformation driven by Fintech not only brings about profound changes in the business boundaries and operating models of commercial banks but also explores

potential customer resources and enhances their market penetration. In the face of the fierce competition from Fintech companies, which create new service models and platforms with advanced technologies and attempt to erode the traditional customer base of commercial banks, commercial banks actively respond by building online and intelligent service platforms, achieving a magnificent transformation from single deposit-and-loan businesses to comprehensive financial-service ecosystems (M. F. Liu & Wang, 2021). In this process, commercial banks utilize big-data technology to accurately capture market demands and develop customized financial products with the help of Fintech tools (C. C. Wang et al., 2018), meeting customers' personalized needs more flexibly and diversely. In addition, commercial banks, by creating one-stop online service platforms and deepening strategic cooperation with third-party financial partners, have broken through the limitations of traditional physical branches, achieving seamless docking and one-stop experience of financial services (C. Wang et al., 2018). This innovative service model not only attracts a large number of new customer groups but also enhances the stickiness and loyalty of existing customers by improving the service experience. At the same time, commercial banks actively embrace the small-scale enterprise market, lower the cooperation threshold through Fintech means, expand the service coverage, enable the efficient circulation of customer funds, and improve the fund-utilization efficiency. This series of measures not only broadens the boundaries of market demand but also effectively improves commercial banks' market-response speed and competitiveness. Commercial banks have achieved a qualitative leap in efficiency through Fintech transformation, laying a solid foundation for maintaining a leading position and achieving sustainable development in the complex and changeable financial environment. Therefore, based on the above analysis, the following hypothesis is proposed:

H6-4: Fintech adoption enhances the operating efficiency of commercial banks, thereby improving the operating performance of commercial banks.

6.4 Empirical results

6.4.1 Descriptive statistical analysis

In this chapter, the core Independent Variable of the regression is still the Fintech index constructed by the principal-component analysis method, and the Dependent Variable is the bank's ROA. This sub-chapter will elaborate and analyze the ROA of different listing types of banks and the change trend of the ROA of the four major banks.

According to the data in CNRDS, this thesis can sort out the change trends of the ROA of Chinese commercial banks with different listing types. As can be seen from Figure 6.1, during the period from 2007 to 2023, the ROA of Chinese commercial banks with different listing types generally showed a downward trend. From 2007 to 2010, the ROA of various types of banks generally showed a fluctuating upward trend. Especially before the 2008 global financial crisis, the ROA of each bank increased, which may be due to the enhanced profitability of banks during the economic boom. From 2010 to 2015, the ROA of various types of banks declined to varying degrees. During this period, the global economic recovery was weak, China's economic growth rate slowed down, and the intensifying competition in the banking industry affected the profitability of banks. At the same time, regulatory authorities strengthened the requirements for banks' capital adequacy ratios and risk control, which may also have suppressed the ROA of banks to a certain extent. After 2015, the ROA of various types of banks continued to decline, especially during the period from 2015 to 2020, with a relatively significant decline. The implementation of economic-structure adjustment and de-leveraging policies squeezed the profit margins of banks. In addition, with the development of Fintech, the traditional business models of the banking industry faced challenges, and the transformation of profit models had not been fully realized, resulting in a further decline in ROA. After 2020, although the ROA of various types of banks continued to decline, the decline rate slowed down, and there was a slight recovery in some years. This may be because the banking industry, in the process of adapting to the new environment and new technologies, gradually found new profit-growth points. At the same time, during the pandemic, the government introduced a series of policies to support economic and financial stability, which also provided certain support for the banking industry. Overall, the ROA of non-listed banks was the lowest among all types of banks, and the downward trend was the most obvious, reflecting their disadvantaged position in market competition. The ROA of A-share listed banks and A + H-share listed banks was relatively high and more stable, which may be attributed to their strong capital strength and market resources. The ROA of H-share listed banks was between that of non-listed banks and A-share listed banks.

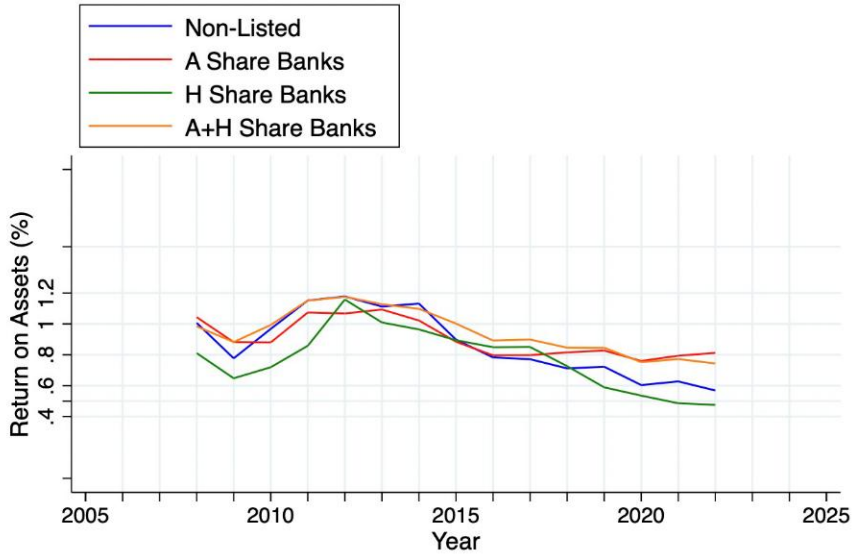


Figure 6.8 Trends in ROA of Chinese commercial banks with different listing types

In addition, due to the important market position and influence of the four major banks in China's banking industry. As state-owned banks, they not only dominate China's banking asset scale and shoulder the important responsibility of maintaining the stability of the national economic and financial system but also play a significant role internationally. Therefore, their operating performance is directly related to the stability and development of the entire banking industry, and it is necessary to analyze the ROA of the four major banks separately.

From Figure 6.2, it can be seen that during the period from 2007 to 2022, the ROA of China's four major commercial banks (Bank of China, Industrial and Commercial Bank of China, Agricultural Bank of China, and China Construction Bank) generally showed a fluctuating downward trend, but the specific change trends of each bank were different. Firstly, for China Construction Bank (the black line), from 2007 to 2015, its ROA generally increased. Especially after the 2008 financial crisis, the growth rate was relatively fast, and it reached its peak in 2015 and then began to decline. This may be because CCB carried out effective risk management and business expansion after the financial crisis, enhancing its profitability. However, with the slowdown of economic growth and the intensification of competition, its ROA started to decline. The ROA of Industrial and Commercial Bank of China (the red line) also showed an upward trend from 2007 to 2010. It gradually reached its peak after 2010 and then, similar to CCB, showed a downward trend. As one of the largest commercial banks in the world, ICBC's scale effect and business diversity promoted the improvement of its profitability in the early stage, but it also faced challenges from the macro-economy and industry competition. The ROA of Bank of China (the blue line) increased slightly from 2007 to 2010, but it was generally stable. Then, there was a significant upward trend from 2010 to 2015. After

reaching its peak, it began to decline. BOC has advantages in international business and cross-border finance. The growth of these businesses in the early stage enhanced its profitability, but later, it was affected by global economic uncertainties and market competition in China, resulting in a decline in ROA. The ROA of Agricultural Bank of China (the green line) fluctuated from 2007 to 2010 but generally increased. After 2010, it increased rapidly and reached its peak in 2015, and then declined. ABC's business is more concentrated in rural and agricultural-related fields. In the early stage, its profitability was enhanced by the support of the rural economy and policies. However, with the economic-structure adjustment and market changes, ABC's ROA also showed a downward trend.

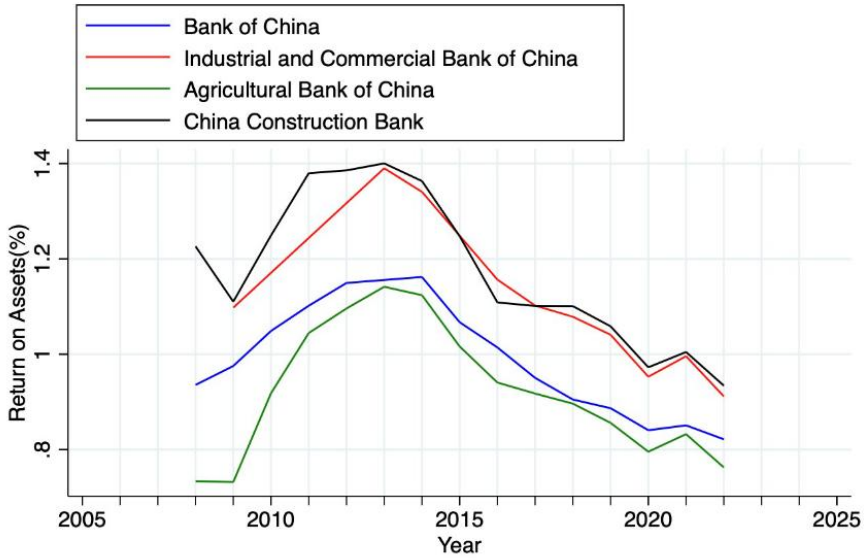


Figure 6.9 Trends in ROA of the four major banks

Overall, the four major banks reached their ROA peaks around 2015 and then showed a downward trend. According to the latest "Analysis Report on Chinese Listed Banks 2023" released by Ernst & Young, the main factors leading to the decline of banks' ROE and ROA are as follows: First, the narrowing of the net interest margin led to a reduction in banks' net interest income. Second, the decline in non-interest income led to a slowdown in operating income growth. Third, the deleveraging of interbank business led to a relatively low equity multiplier. In 2022, the net interest margin of listed banks further narrowed, and non-interest income declined, resulting in a slowdown in profit growth. Coupled with the stricter reduction of banks' leverage by strong regulation, the equity multiplier remained at a low level. These factors restricted the improvement of capital return efficiency.

6.4.2 Empirical model design

To analyze the impact of bank Fintech on operating performance, following the previous

discussion, this thesis estimates the following regression models:

$$\boldsymbol{ROA_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \varepsilon_{i,t}} \quad (6.1)$$

$$\boldsymbol{ROA_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + \varepsilon_{i,t}} \quad (6.2)$$

$$\boldsymbol{ROA_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (6.3)$$

where i represents the bank and t represents time. $ROA_{i,t}$ represents the operating performance of bank i in year t. *Fintech* reflects the internal Fintech development of bank i in year t, which is constructed by the principal-component analysis method. $Control_{i,t}$ is the bank control variable, including the proportion of fixed assets (Tang), bank leverage ratio (Leverage), cost-income ratio (CI), GDP growth rate (GDP_Growth), and M2 money supply (M2_Growth). $Year_t$ is the bank-time fixed effect, and ε represents the clustered robust error term, with the clustering level being the individual. Since the focus of this research is on analyzing the changes over time, such as the impact of the development of Fintech on the bank governance level. Using only time-fixed effects can effectively capture these trends in the macroeconomic environment. The deeper reasons have been explained in detail in Chapter 3 of this thesis and will not be repeated here.

6.4.3 Regression results

6.4.3.1 Baseline regression results

Table 6.1 shows the results of the fixed-effects regression model analyzing the impact of Fintech on bank operating performance (ROA), especially the regression coefficients and significance of the Fintech index (Fintech) in different models. The performance of the core Independent Variable, the Fintech index, in different models is worthy of in-depth exploration. In Model (6-1), the regression coefficient of the Fintech index is -0.000, and it is significant at the 10% level. This negative relationship, although significant, has a coefficient close to zero, indicating that the impact of Fintech on the bank's ROA is extremely weak. These results may reflect the direct negative impact of Fintech on bank performance when time effects are not considered. The possible reason is that in the initial stage, the application of Fintech requires high upfront investment, and these investments may not be immediately transformed into significant returns in the short term, resulting in a slight decline in ROA.

Table 6.14 Baseline results: The impact of Fintech on bank operating performance

Variables	ROA	ROA	ROA
	(6-1)	(6-2)	(6-3)
Lag_Fintech	-0.000*	0.001***	0.001**
	(0.000)	(0.000)	(0.000)
Lag_Lev		-0.020***	-0.021**
		(0.005)	(0.009)
Lag_Tang		0.055***	0.043*
		(0.028)	(0.024)
Lag_CI		-0.016***	-0.014***
		(0.001)	(0.001)
Lag_CAR		0.000	0.000
		(0.000)	(0.000)
Lag_Gdpgr		0.000***	0.000
		(0.000)	(.)
Lag_M2gr		0.000***	0.000
		(0.000)	(.)
Time Fixed Effect	NO	NO	YES
R^2	0.002	0.479	0.521
Adj R^2	0.001	0.477	0.515
Observations	1429	1423	1423

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

However, when time-fixed effects are added in Model (6-2) and Model (6-3), the regression coefficients of the Fintech index become positive and are significant at the 1% and 5% levels, respectively. The coefficient of Model (6-2) is 0.001, and that of Model (6-3) is also 0.001. This indicates that after considering time effects, the impact of Fintech on the bank's ROA becomes significant and positive. This change may be because the time-fixed effects control other time-related external shocks and macroeconomic fluctuations, making the positive impact of Fintech more obvious. In addition, this result reveals that with time, the application of Fintech in the banking industry has gradually matured and begun to show its potential effects of improving efficiency and enhancing profitability. The application of Fintech, including big-data analysis, blockchain technology, and artificial intelligence, can improve the operating efficiency of banks, reduce operating costs, and provide more accurate and personalized financial services. These technological advancements are ultimately reflected in the bank's profitability, leading to a significant increase in ROA.

6.4.3.2 Mechanism test

Generally speaking, in Model (6-1), there is only a single core Independent Variable, the Fintech index (Fintech), without considering other control variables. In this case, the negative and significant coefficient of the Fintech index may be due to the omission of other important influencing factors, resulting in omitted-variable bias in the model. This bias may cause the coefficient of the Fintech index to deviate from its true value. In contrast, Models (6-2) and (6-

3), by controlling variables and time-fixed effects, capture the influencing factors more comprehensively, thus enabling the positive effect of the Fintech index to be reflected. This analysis emphasizes the importance of considering relevant influencing factors and fixed effects in regression analysis to ensure the accuracy and interpretability of the results.

$$\boldsymbol{NI_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (6.4)$$

$$\boldsymbol{CI_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (6.5)$$

$$\boldsymbol{AT_{i,t} = \alpha + \beta_1 FinTech_{i,t-1} + \beta_2 Controls_{i,t-1} + Year_t + \varepsilon_{i,t}} \quad (6.6)$$

where $NI_{i,t}$ is the net interest margin of bank i in yeart, $CI_{i,t}$ is the cost-income ratio of bank i in year t, and $AT_{i,t}$ is the total-asset turnover ratio of bank i in year t. $Year_t$ is the bank-time fixed effect, and $\varepsilon_{i,t}$ is the standard error. The results of the mechanism test are shown in Table 6.2 below.

Table 6.15 Mechanism test: The impact of Fintech on bank operating performance

Variables	Net Interest Margin	Operating Cost	Total Asset Turnover
	(6-4)	(6-5)	(6-6)
Lag_Fintech	0.651***	-0.004**	0.001***
	(0.063)	(0.002)	(0.000)
Lag_Lev	12.879*	-0.929***	-0.107***
	(6.472)	(0.230)	(0.011)
Lag_Tang	-4.204	-4.204	0.176***
	(19.988)	(19.988)	(0.032)
Lag_CI	-1.535**		-0.004***
	(0.629)		(0.001)
Lag_CAR	-0.098**	-0.013***	-0.000***
	(0.042)	(0.002)	(0.000)
Lag_Gdpgr	0.000	0.000	0.000
	(.)	(.)	(.)
Lag_M2gr	0.000	0.000	0.000
	(.)	(.)	(.)
Time-Fixed Effect	YES	YES	YES
R^2	0.378	0.203	0.296
Adj R^2	0.370	0.193	0.287
Observations	1393	1423	1423

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

Table 6.2 shows the results of the mechanism test of the impact of the bank Fintech index (Fintech) on ROA, analyzed through three mechanism variables: the net interest margin (NI), operating cost (CI), and total-asset turnover ratio (AT). In each model, the core Independent Variable, the Fintech index (Fintech), shows a significant impact, revealing its different transmission mechanisms on bank performance. In Model (6-4), the impact of the Fintech index on the net interest margin is significantly positive and at the 1% level. This result indicates that the application of Fintech improves the bank's net interest margin. Fintech enables banks to more effectively price and manage their balance sheets by improving credit assessment, risk

management, and customer service, thereby increasing the net interest margin. The improvement of the net interest margin directly reflects the enhancement of the bank's profitability, which is also an important channel through which Fintech has a positive impact on ROA. In Model (6-5), the impact of the Fintech index on the operating cost is significantly negative and at the 5% level. This shows that the application of Fintech helps to reduce the operating costs of banks. By adopting big-data analysis, artificial intelligence, and automation technologies, banks can improve operating efficiency and reduce labor and operating costs. These technologies not only optimize internal processes but also improve customer-service efficiency, reducing cost expenditures. The reduction of operating costs, in turn, improves the bank's profitability, which is another important mechanism through which Fintech has a positive impact on ROA. In Model (6-6), the impact of the Fintech index on the total-asset turnover ratio is significantly positive and at the 1% level. The increase in the total asset turnover ratio indicates that Fintech improves the utilization efficiency of bank assets. Fintech provides more accurate data analysis and more efficient asset-allocation tools, enabling banks to turn over their assets more quickly and improve the utilization efficiency of assets. An increase in the total asset turnover ratio means that banks can generate more income under the same asset scale, which further improves ROA.

In summary, the Fintech index significantly enhances the bank's profitability through three mechanisms: increasing the net interest margin, reducing operating costs, and improving the total-asset turnover ratio. The application of Fintech benefits banks in many aspects, including optimizing credit decisions, improving operating efficiency, and enhancing asset management. These benefits are not only reflected in short-term cost savings and income increases but also in the long-term improvement of competitiveness and market share. In addition, these results also have important practical significance and policy implications. Banks should actively invest in and apply Fintech to improve their overall operating efficiency and profitability. At the same time, regulatory authorities should provide a supportive policy environment to encourage Fintech innovation and ensure the stable development and competitiveness improvement of the banking industry. The effective application of Fintech not only helps to improve the operating performance of banks but also can promote the efficiency and stability of the entire financial system, providing stronger support for economic development.

6.4.3.3 Heterogeneity test

To explore the impact of Fintech on the operating income of different types of banks, this thesis conducts a heterogeneity test. By classifying banks into A-share listed banks, A + H-share listed

banks, H-share listed banks, and non-listed banks, this thesis conducts regression analyses on the return-on-assets variable of these types of banks, respectively. This heterogeneity test aims to reveal the differential effects of Fintech in different market environments to more comprehensively understand its impact on bank operating performance. The specific regression results are shown in Table 6.3.

Table 6.16 Heterogeneity test: The impact of Fintech on bank operating performance

Variables	**ROA**		
Panel A	**The Impact of the Fintech Index on the ROA of Different Types of Bank**		
	non-listed banks	listed banks	
	(1)	(2)	
Lag_Fintech	-0.000	0.000***	
	(0.000)	(0.000)	
Lag_Lev	-0.024**	-0.005	
	(0.009)	(0.016)	
Lag_Tang	0.039	0.047**	
	(0.030)	(0.020)	
Lag_CI	-0.015***	-0.012***	
	(0.001)	(0.002)	
Lag_CAR	0.000	0.000	
	(0.000)	(0.000)	
Lag_Gdpgr	0.000	0.000	
	(.)	(.)	
Lag_M2gr	0.000	0.000	
	(.)	(.)	
Time-Fixed Effect	YES	YES	
R^2	0.535	0.510	
Adj R^2	0.525	0.492	
Observations	867	556	
Panel B	**The Impact of the Fintech Index on the ROA of Banks in Different Regions**		
	eastern regions	central regions	western regions
	(1)	(2)	(3)
Lag_Fintech	0.000***	0.000	0.001**
	(0.000)	(0.000)	(0.000)
Lag_Lev	-0.028***	-0.009	-0.016
	(0.005)	(0.013)	(0.013)
Lag_Tang	0.040**	-0.021	0.079
	(0.041)	(0.041)	`(0.058)
Lag_CI	-0.015***	-0.001***	-0.012***
	(0.001)	(0.002)	(0.002)
Lag_CAR	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Lag_Gdpgr	0.000	0.000	0.000
	(.)	(.)	(.)
Lag_M2gr	0.000	0.000	0.000
	(.)	(.)	(.)
Time-Fixed Effect	YES	YES	YES
R^2	0.507	0.635	0.635
Adj R^2	0.498	0.597	0.602
Observations	997	194	231

Variables	ROA	
Panel C	**The Impact of the Fintech Index on the ROA of Banks of Different Sizes**	
	large-scale banks	small-scale banks
	(1)	(2)
Lag_Fintech	0.000***	-0.000
	(0.000)	(0.000)
Lag_Lev	-0.025**	-0.020*
	(0.011)	(0.011)
Lag_Tang	0.001	0.046
	(0.024)	(0.031)
Lag_CI	-0.012***	-0.016***
	(0.001)	(0.001)
Lag_CAR	0.000	-0.000
	(0.000)	(0.000)
Lag_Gdpgr	0.000	0.000
	(.)	(.)
Lag_M2gr	0.000	0.000
	(.)	(.)
Time-Fixed Effect	YES	YES
R^2	0.601	0.496
Adj R^2	0.592	0.479
Observations	837	586
Panel D	**The Impact of Fintech on the ROA of Commercial Banks of Different Natures**	
	national commercial banks	local commercial banks
	(1)	(2)
Lag_Fintech	0.000***	0.000
	(0.000)	(0.000)
Lag_Lev	-0.005	-0.053***
	(0.011)	(0.008)
Lag_Tang	0.038	0.006
	(0.023)	(0.037)
Lag_CI	-0.014***	-0.011***
	(0.001)	(0.002)
Lag_CAR	0.000	0.000
	(0.000)	(0.000)
Lag_Gdpgr	0.000	0.000
	(.)	(.)
Lag_M2gr	0.000	0.000
	(.)	(.)
Time-Fixed Effect	YES	YES
R^2	0.602	0.493
Adj R^2	0.594	0.474
Observations	888	535

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

Table 6.3 Panel A shows the results of the heterogeneity test of the impact of the Fintech index on the ROA of different types of banks (non-listed banks and listed banks). The significant difference in the impact of the core Independent Variable, the Fintech index (Fintech), on different types of banks reflects the different mechanisms and effects of Fintech in different types of banks. In Model (1), for non-listed banks, the coefficient of the Fintech

index does not reach the significance level. This result indicates that in non-listed banks, the Fintech index has no significant impact on the ROA. This may be because non-listed banks are lagging in the application and popularization of Fintech, or they have insufficient investment in resources and technology, resulting in Fintech not being able to effectively improve their profitability. In addition, non-listed banks may face higher operational and management challenges, and the potential advantages of Fintech cannot be fully realized. However, in Model (2), for listed banks, the coefficient of the Fintech index is significant at the 1% level. This indicates that in listed banks, the Fintech index has a significant positive impact on the ROA. Listed banks usually have stronger capital strength and technical reserves and can adopt and apply Fintech more quickly, thereby improving their operational efficiency and service quality. The application of Fintech in listed banks not only optimizes internal management processes but also enhances customer experience and market competitiveness, ultimately improving the ROA.

The reasons behind this heterogeneous phenomenon can be analyzed from several aspects. Firstly, due to their financing capabilities in the capital market and higher governance levels, listed banks can invest more actively in Fintech, promoting the rapid implementation and application of technology. Fintech is fully utilized in these banks, thus bringing significant improvements in operating performance. Secondly, the listed banks have a wide market coverage and a large customer base. The application of Fintech can more effectively tap into customer needs, provide personalized services, and enhance customer loyalty and business growth. In addition, the relatively mature risk-management systems and technical support of listed banks enable the advantages of Fintech in risk control and compliance to be fully reflected, further consolidating their profitability. In contrast, non-listed banks face greater challenges in the application of Fintech due to limitations in capital and technical resources. These banks may lack sufficient funds and technical support, resulting in poor implementation effects of Fintech projects. In addition, the relatively small market scale and customer base of non-listed banks make it difficult to fully realize the advantages of Fintech. Therefore, the application of Fintech in non-listed banks has limited effect on improving ROA.

Overall, when the Fintech index acts on different types of banks, it shows significant differences and heterogeneity in its impact on their ROA. Listed banks, due to their advantages in capital strength, technical reserves, and market coverage, can better utilize Fintech to improve operating performance, while non-listed banks, due to limitations in resources and technology, have limited effects of Fintech on improving their performance. This finding has important implications for policy-making and management practices in the banking industry.

Policymakers should provide differential support measures according to the characteristics of different types of banks to promote the wide application of Fintech in the banking industry. At the same time, bank managers should formulate reasonable Fintech development strategies based on their conditions to fully tap the potential of Fintech in improving operating performance.

Table 6.3 Panel B shows the results of the heterogeneity test of the impact of the Fintech index on the ROA of banks in different regions. The table divides Chinese banks into those in the eastern, central, and western regions and analyzes the impact of the Fintech index (Fintech) on the ROA of banks in these regions. The performance of the core Independent Variable, the Fintech index, in different regions reflects significant differences in the application and effects of Fintech among regions. In Model (1), for banks in the eastern region, the coefficient of the Fintech index is significant at the 1% level. This indicates that Fintech has a significant positive impact on the ROA of banks in the eastern region. The possible reason is that the eastern region has a developed economy, and the application of Fintech is relatively widespread and mature. Banks in this region have obvious investments and application effects in Fintech. These banks can use advanced Fintech means to optimize business processes, improve operating efficiency, reduce costs, and thus enhance profitability.

However, in Model (2), for banks in the central region, the coefficient of the Fintech index does not reach the significance level. This result indicates that in the central region, Fintech has no significant impact on the ROA of banks. This may be because the Fintech development level in the central region is between that of the eastern and western regions. Although there is some applications, it has not reached the level of improving bank performance. Banks in the central region may have insufficient investment and application breadth and depth in Fintech, resulting in a non-significant improvement effect on ROA. In Model (3), for banks in the western region, the Fintech index is significant at the 5% level. This shows that Fintech also has a significant positive impact on the ROA of banks in the western region. Although the overall economic and Fintech development levels in the western region are relatively backward, in these regions, the application of Fintech may bring more obvious marginal benefits. Banks in the western region can improve their operating efficiency and service quality through the introduction of Fintech, thereby enhancing their profitability.

The reasons behind this regional heterogeneity phenomenon can be analyzed from several aspects. Firstly, the eastern region has a developed economy and a relatively mature financial market. Banks in this region started applying Fintech earlier and invested more, resulting in more significant technological application effects. Secondly, although the central region has

made some progress in economic development and Fintech application, there is still a gap compared with the eastern region, and the application of Fintech has not yet reached the stage of fully realizing its potential. Finally, due to the relatively low starting point in the western region, the introduction of Fintech can bring greater room for improvement and significant benefit enhancements.

These results not only reveal the heterogeneous impact of Fintech on banks in different regions but also provide important policy implications. The government and regulatory authorities should formulate differential Fintech development strategies according to the actual situations of different regions. The eastern region should continue to lead Fintech innovation, the central region should increase Fintech investment to promote its widespread application, and the western region should focus on supporting infrastructure construction and technology introduction to ensure that Fintech can be more widely applied in the banking industry, improving the efficiency and stability of the overall financial system. In summary, the impact of Fintech on the ROA of banks shows significant heterogeneity in different regions, reflecting the differences in economic development levels, technological application capabilities, and market environments among regions. By formulating regional-differential policy measures to promote the balanced development of Fintech across the country, the goals of enhancing the overall competitiveness of the banking industry and promoting high-quality economic development can be achieved.

Table 6.3 Panel C shows the results of the heterogeneity test of the impact of the Fintech index on the ROA of banks of different sizes (large-scale banks and small-scale banks). The significant difference in the impact of the core Independent Variable, the Fintech index (Fintech), on different-sized banks reflects the differences in the application effects and impact mechanisms of Fintech in banks of different sizes. In Model (1), for large-scale banks, the coefficient of the Fintech index is significant at the 1% level. This indicates that Fintech has a significant positive impact on the ROA of large-scale banks. Large-scale banks usually have more abundant funds and resources and can invest heavily in the development and application of Fintech. By introducing Fintech, these banks have optimized business processes, improved operating efficiency, and achieved significant results in risk management and customer service. The application of Fintech enables large-scale banks to better manage their balance sheets, thereby enhancing their profitability. In Model (2), for small-scale banks, the coefficient of the Fintech index does not reach the significance level. This result indicates that in small-scale banks, the Fintech index has no significant impact on the ROA. Small-scale banks face greater challenges in the application of Fintech due to limitations in funds and technical resources.

Although Fintech can provide some operational optimization and cost savings for small-scale banks, due to their limited resources, the potential advantages of Fintech cannot be fully realized. Therefore, small-scale banks have not significantly improved their ROA through the application of Fintech.

The reasons behind this heterogeneous phenomenon can be analyzed from several aspects. Firstly, large-scale banks have stronger capital strength and technical reserves, enabling them to invest more resources in the research, development, and application of Fintech, ensuring the rapid implementation and effective application of technology. These banks have improved the automation level of their businesses through Fintech, optimized customer-relationship management, and made significant progress in data analysis and risk control. Secondly, small-scale banks face dual limitations in funds and technology in the application of Fintech, resulting in relatively weak implementation effects of their Fintech projects. Although small-scale banks can achieve some business improvements through Fintech, their overall benefits have not been significantly enhanced.

Overall, the application of Fintech in large-scale banks has significantly improved their ROA, while its impact on small-scale banks is not significant. This result reflects the scale effect in the application of Fintech. Large-scale banks, due to their stronger financial and technical capabilities, can make more full use of the advantages of Fintech, thus significantly improving their operating performance. In contrast, the limitations in resources and capabilities of small-scale banks make it difficult for the application of Fintech to fully realize its potential. Therefore, the development of Fintech should consider the differences in bank sizes and formulate corresponding strategies and measures to ensure that banks of different sizes can benefit from the progress of Fintech. These findings have important implications for bank managers and policymakers. Large-scale banks should continue to increase investment in Fintech and promote technological innovation and application, while small-scale banks need policy and financial support to gradually enhance their technological application capabilities, ensuring that Fintech can be widely applied in the entire banking industry and enhancing the competitiveness and stability of the industry as a whole.

Table 6.3 Panel D shows the heterogeneous impact of the Fintech index on the ROA of commercial banks of different natures. Model (1) and Model (2) respectively analyze the impact of the Fintech index (Fintech) on the ROA of national commercial banks and local commercial banks, revealing its differential performance in different types of banks. In Model (1), for national commercial banks, the coefficient of the Fintech index is 0.000 and is significant at the 1% level. This indicates that Fintech improves the ROA of national commercial banks. National

commercial banks usually have strong technical capabilities and resources and can apply Fintech to a greater extent for business optimization and innovation. Fintech helps these banks maintain their competitive advantages in the fierce market competition by improving operating efficiency, optimizing customer service, and expanding digital products, thereby enhancing their ROA. In addition, the wide-ranging business scope of national commercial banks enables them to better manage risks and increase returns using Fintech, which also contributes to the growth of ROA. In Model (2), for local commercial banks, the coefficient of the Fintech index is 0.000 and does not reach the significance level. This indicates that Fintech has no significant impact on the ROA of local commercial banks. Local commercial banks usually have relatively small scales, limited technology and resources, and the depth and breadth of Fintech application are relatively insufficient. Although Fintech can, to a certain extent, help these banks improve operating efficiency and customer service, due to limitations in technical capabilities and market scale, its impact on the ROA is relatively limited. Local commercial banks may rely more on traditional business models and regional resources, and the application of Fintech has not significantly improved their asset-return performance.

In summary, the impact of Fintech on the ROA shows significant heterogeneity between national and local commercial banks. National commercial banks can use Fintech to improve operating efficiency and market competitiveness, thus significantly increasing the ROA, while local commercial banks, due to limitations in resources and technology, have not significantly benefited from the application of Fintech. This result suggests that bank managers and policymakers should formulate suitable Fintech development strategies according to the scale and resource conditions of banks to fully tap the potential of Fintech in enhancing bank operating performance and promoting the overall improvement of the banking industry's efficiency.

6.5 Robustness test

Table 6.4 shows the robustness test of the bank Fintech index on the bank's ROA. This study follows the existing literature (Xiong et al., 2021) and uses the natural logarithms of operating income (Ln_Income) and net profit (Ln_Netprofit) as alternative variables for operating performance to conduct the robustness test. The performance of the core Independent Variable, the Fintech index (Fintech), in each column provides evidence for the robustness of its impact on bank performance. In Models (1) to (3), with the logarithm of operating income (Ln_Income) as the dependent variable, the coefficients of the Fintech index are all significant at the 1% level.

This indicates that the Fintech index has a significant positive impact on operating income, and the result remains consistent regardless of whether time-fixed effects are controlled. This means that the application of Fintech significantly increases the operating income of banks. By introducing Fintech, banks can optimize their business processes, improve operating efficiency, and provide more accurate services, thereby increasing income sources.

Table 6.17 Robustness test: The impact of Fintech on bank operating performance

Variables	**Ln_Income**			**Ln_Netprofit**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Lag_Fintech	0.572***	0.583***	0.586***	0.585***	0.608***	0.610***
	(0.020)	(0.020)	(0.064)	(0.025)	(0.021)	(0.065)
Lag_Lev		10.522***	10.501*		13.449***	13.326***
		(2.562)	(5.315)		(2.675)	(5.151)
Lag_Tang		-11.222	-11.953		-12.806*	-12.879
		(7.175)	(13.011)		(7.498)	(13.353)
Lag_CI		-2.074***	-2.007***		-4.206***	-4.195***
		(0.281)	(0.589)		(0.295)	(0.599)
Lag_CAR		-0.095***	-0.097***		-0.076***	-0.079**
		(0.020)	(0.029)		(0.020)	(0.031)
Lag_Gdpgr		0.011	0.000		0.010	0.000
		(0.008)	(.)		(0.009)	(.)
Lag_M2gr		0.013	0.000		0.025**	0.000
		(0.009)	(.)		(0.010)	(.)
Time-Fixed Effect	NO	NO	YES	NO	NO	YES
R^2	0.355	0.452	0.454	0.323	0.482	0.484
Adj R^2	0.355	0.449	0.447	0.322	0.479	0.477
Observations	1428	1423	1423	1425	1420	1420

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

In Models (4) to (6), with the logarithm of net profit (Ln_Netprofit) as the dependent variable, the coefficients of the Fintech index are also all significant at the 1% level. This further indicates that the Fintech index also has a significant positive impact on net profit. Similarly, regardless of whether time-fixed effects are controlled, the results are robust. This shows that the application of Fintech not only increases the income of banks but also effectively controls costs and improves overall profitability. Fintech directly increases the net profit of banks by improving risk management and customer satisfaction, reducing the non-performing loan ratio and operating costs.

The consistency of the robustness test results indicates that the positive impact of Fintech on bank performance is verified under different alternative variables. These results strengthen the confidence in the positive role of Fintech in enhancing bank performance. Whether it is operating income or net profit, Fintech significantly promotes the financial performance of banks. Through this series of robustness tests, it can be concluded that the application of Fintech has a significant positive impact on both the operating income and net profit of banks. This

further proves that Fintech, as an effective tool for enhancing bank performance, fully demonstrates its advantages in business process optimization, risk management, and customer service. Therefore, banks should continue to increase investment in and application of Fintech and utilize the opportunities brought by technological progress to improve their competitiveness and profitability.

6.6 Conclusions

The development of Fintech is profoundly reshaping the operating logic and models of China's banking industry, achieving a profound transformation from extensive coverage to personalized and precise services. This not only improves the customer experience but also injects strong impetus into the development of commercial banks, promoting the prosperity of the entire banking industry. Looking ahead, bank Fintech, as the core trend of industry evolution, has an increasingly significant positive impact on the operating performance of commercial banks. This thesis begins with a systematic review of the development process of China's Fintech in recent years, analyzes the multiple factors influencing its development, and the opportunities and challenges that have emerged during this process. Subsequently, based on a solid theoretical foundation, this thesis explores the all-around impact of Fintech on the operating performance of commercial banks, especially focusing on three dimensions: widening the net interest margin, reducing operating costs, and enhancing operating efficiency, and analyzes the mechanism of Fintech. In addition, this thesis also examines the differences in the operating performance of commercial banks under the influence of Fintech and accordingly puts forward several research hypotheses, aiming to reveal the potential and challenges of Fintech in enhancing the operating performance of commercial banks.

This thesis, through regression analysis, conclusively reveals that bank Fintech has a significant positive promoting effect on its operating performance (measured by ROA); that is, there is a positive correlation between the improvement of Fintech development level and the accelerated growth of commercial bank operating performance. Further analysis shows that the expansion of the net interest margin, the reduction of operating costs, and the enhancement of operating efficiency play key mediating roles in this process, jointly constituting the core path for Fintech to promote bank performance growth. To explore the differential impacts of Fintech, this thesis conducts heterogeneity analysis from multiple dimensions. Firstly, in terms of listing status, Fintech has a strong effect on the ROA of listed banks, while it is relatively non-significant for non-listed banks. This may be attributed to the advantages of listed banks in

market competitiveness and technological application capabilities. Secondly, in terms of regional differences, banks in the eastern region are significantly more positively affected by Fintech than those in the central and western regions. This may be related to the more complete Fintech infrastructure and more intense market competition environment in the eastern region. Thirdly, in terms of bank size, large-scale banks have significantly improved their ROA after applying Fintech, highlighting their strong technological application capabilities and resource allocation advantages, while small-scale banks have relatively limited ROA improvement effects due to resource and technical constraints. In addition, national commercial banks have significantly improved their operating efficiency and market competitiveness through Fintech, and their ROA has significantly increased; local commercial banks, due to resource and technical bottlenecks, have not fully enjoyed the dividends brought by Fintech. To ensure the robustness of the research conclusions, this thesis conducts tests with multiple alternative variables and control variables. The results show that whether using the natural logarithm of operating income or net profit as an alternative indicator for ROA, Fintech consistently shows a positive impact, which further consolidates the positive role of Fintech in enhancing bank performance. At the same time, by controlling key variables such as the leverage ratio and cost-income ratio, this thesis more comprehensively reveals the multiple factors affecting bank performance and deepens the understanding of the mechanism of Fintech.

In summary, this study not only clarifies the multiple paths and differential effects of Fintech in enhancing bank performance but also provides strong support for the strategic formulation of the banking industry during the digital transformation. In the future, banks and regulatory authorities should formulate precise policies based on the specific situations of different banks and the market environment to promote the effective application of Fintech, to achieve an overall leap in the competitiveness of the banking industry and the stable development of the financial system.

Chapter 7: Conclusions and Future Research

7.1 Research conclusions

This thesis uses the financial data of Chinese commercial banks from 2007 to 2022 from the CNRDS (China Research Data Services Platform) database to explore the impact of Fintech on the operations of Chinese commercial banks using STATA software. This thesis focuses on three core areas: credit risk, bank governance, and operating performance. Through the empirical analysis of 351 Chinese commercial banks, the following main conclusions are drawn:

Firstly, in terms of credit risk, this thesis finds that the Fintech index has a significant positive impact on the reduction of bank credit risk. Further mechanism tests reveal the specific ways in which Fintech affects credit risk. The study finds that the Fintech index can effectively reduce bank credit risk by reducing information asymmetry and increasing the capital adequacy ratio. This shows that Fintech not only improves the bank's ability to obtain and process borrower information but also enhances the bank's financial stability when facing potential credit risks. In addition, the impact of Fintech on credit risk shows significant differences among different types and sizes of banks. In the comparison between listed and unlisted banks, Fintech has a significant effect on reducing the credit risk of unlisted banks, while its impact on listed banks is relatively small. In the regional heterogeneity analysis, Fintech significantly reduces the credit risk of banks in the eastern and central regions, especially in the central region, where its marginal effect is more obvious. This indicates that banks in the central region are in the stage of promoting Fintech applications, and the introduction of technology has greatly improved their risk-management levels. In contrast, due to the lag in economic development and technology application in the western region, the impact of Fintech on credit risk is not significant. In the comparison of banks of different sizes, Fintech significantly reduces the credit risk of small-scale banks, and its influence is greater than that on large-scale banks. Small-scale banks traditionally rely more on experience and manual operations, and the application of Fintech provides them with modern risk-control tools, significantly enhancing their risk-management capabilities.

Secondly, regarding bank governance, the regression analysis results show that the development of Fintech has a significant and positive impact on commercial bank governance.

Specifically, Fintech significantly enhances the governance effectiveness of banks by improving information transparency, refining risk management, and perfecting internal control mechanisms. When analyzing the impact mechanism, this thesis finds that Fintech reduces the management agency costs of banks and improves the readability of annual report texts. Both aspects play a positive role in improving the bank governance system and enhancing governance capabilities. In addition, this research analyzes the significant heterogeneous impact of Fintech on bank governance. Specifically, in terms of listing-status differences, the results show that Fintech promotes the governance level of listed banks, while its impact on non-listed banks is not obvious. In the regional-difference analysis, the results show that banks in the eastern region significantly benefit from the positive impact of Fintech, while the central and western regions do not show similar effects. This reflects that due to the developed economy and complete Fintech infrastructure in the eastern region, banks can more efficiently use these technologies to enhance governance effectiveness; in contrast, banks in the central and western regions are relatively insufficient in technology adoption and market competitiveness, limiting the role of Fintech in enhancing their governance levels. Finally, in the comparison of bank sizes, large-scale banks, with their advantages in capital and technology, have achieved significant results in the application of Fintech and effectively improved their governance structures. However, local commercial banks, due to limitations in resources and technical capabilities, may face greater implementation costs and technical adaptation challenges, resulting in poor application effects of Fintech or even negative impacts. The customer groups of local commercial banks are relatively single, and the standardization and automation of Fintech may not fully meet customer needs and may even reduce customer experience and loyalty. In addition, when facing the risk-management and compliance challenges brought by emerging Fintech, local banks may lack sufficient capabilities and resources to respond, thus leading to a decline in governance levels.

Finally, in terms of operating performance, the regression analysis reveals that bank Fintech has a significant positive promoting effect on its operating performance (measured by ROA), that is, there is a positive correlation between the improvement of Fintech development level and the enhancement of commercial bank operating performance. Further analysis shows that the increase in the net interest margin, the reduction of operating costs, and the enhancement of operating efficiency play key mediating roles in this process, jointly constituting the core path for Fintech to promote bank performance growth. To explore the diversity of Fintech's impact, this thesis conducts heterogeneity analysis from multiple perspectives. Firstly, in terms of listing status, Fintech significantly increases the ROA of listed banks, while its impact on non-

listed banks is relatively limited, which may be due to the advantages of listed banks in market competitiveness and technological application capabilities. Secondly, the regional-difference analysis shows that banks in the eastern region are significantly more positively affected by Fintech than those in the central and western regions, which may be related to the more complete Fintech infrastructure and more intense market competition environment in the eastern region. Secondly, in terms of bank size, large-scale banks have significantly improved their ROA after applying Fintech, highlighting their strong technological application capabilities and resource-allocation advantages, while small-scale banks have relatively limited ROA improvement effects due to resource and technical constraints. In addition, national commercial banks have significantly improved their operating efficiency and market competitiveness through Fintech, and their ROA has increased significantly; while local commercial banks, due to insufficient resources and technology, have not fully utilized the advantages brought by Fintech. To ensure the robustness of the research conclusions, this thesis conducts tests using multiple alternative variables and control variables. The results show that whether using the natural logarithm of operating income or net profit as an alternative indicator for ROA, Fintech consistently shows a positive impact, which further consolidates the finding of the positive role of Fintech in enhancing bank performance.

7.2 Research limitations and future research

This thesis also has some limitations, which pave the way for future research. For example, the sample period analyzed includes the COVID period, which may have affected the variables and created some noise, and more bank level control variables could be considered. The second limitation relates to the significant differences in size of some groups such as listed versus non-listed banks. In addition, based on the research conclusions of this thesis, more future research can be further expanded and deepened in many aspects, especially in the impact of Fintech on bank credit risk, governance level, and operating performance. Firstly, in terms of credit risk, although this study has revealed that Fintech significantly reduces bank credit risk, future research can further explore the specific impact paths and effectiveness differences of different types of Fintech (such as big-data analysis, artificial intelligence, blockchain, etc.) on credit risk. In particular, it is necessary to study how to effectively use these technologies in banking business practices to improve risk identification and management capabilities. In addition, with the continuous changes in the financial market and the emergence of new financial instruments, future research can also explore the role and effectiveness of Fintech in dealing with emerging

risks and sudden risk events.

Secondly, regarding the bank governance level, future research should further explore the adaptability and effectiveness differences of Fintech under different regulatory environments and institutional backgrounds. Although this study finds that Fintech has a significant positive effect on bank governance, the regulatory policies and market environments of different regions and countries vary, which may affect the actual application effects of Fintech. Therefore, future research can start from an international-comparison perspective, explore the differences in Fintech development paths and governance effects in different countries and regions, and analyze the causes of these differences. In addition, research can also focus on the heterogeneous impact of Fintech on the governance of different types of banks (such as state-owned banks, private banks, foreign-funded banks, etc.) and explore the advantages and disadvantages of these banks in Fintech applications. In terms of operating performance, although this study shows that Fintech has a significant positive impact on performance indicators such as bank ROA, future research can further explore the impact mechanisms of Fintech on other key performance indicators. Especially in the context of the constantly changing global economic and financial environment, how Fintech helps banks improve their ability to respond to external shocks and maintain stable operating performance is a question worthy of in-depth research. In addition, future research can also explore the impact of Fintech on the long-term performance of banks. Especially through longitudinal data analysis, it can reveal the dynamic impact of Fintech on bank performance at different development stages.

Overall, the application of Fintech in the banking industry is still in a stage of rapid development and change. Future research should pay more attention to exploring the potential and challenges of emerging Fintech, especially in research on technological innovation, regulatory adaptability, and market competitiveness. At the same time, with the global development of Fintech, researchers can strengthen cross-national comparative research, explore the Fintech development experiences and best practices of different countries and regions, and provide theoretical support and practical guidance for the development of global Fintech. In short, the impact of Fintech on the banking industry is multi-dimensional and dynamic. Future research should continue to explore its role and potential in improving bank efficiency, enhancing governance levels, and reducing risks in the constantly changing financial environment.

Bibliography

Adams, R. B. (2011). Governance and the financial crisis. *International Review of Finance*, *12*(1), 7-38.

Adams, R. B., & Ferreira, D. (2007). A theory of friendly boards. *Journal of Finance*, *62*(1), 217-250.

Adams, R. B., & Mehran, H. (2012). Bank board structure and performance: evidence for large bank holding companies. *Journal of Financial Intermediation*, *21*(2), 243-267.

Aebi, V., Sabato, G., & Schmid, M. (2012). Risk management, corporate governance, and bank performance in the financial crisis. *Journal of Banking & Finance*, *36*(12), 3213-3226.

Allen, F., Mcandrews, J., & Strahan, P. (2002). E-finance: an introduction. *Journal of Financial Services Research*, *22*, 5-27.

Andres, P. D., & Vallelado, E. (2008). Corporate governance in banking: the role of the board of directors. *Journal of Banking & Finance*, *32*(12), 2570-2580.

Angbazo, L. (1997). Commercial bank net interest margins, default risk, interest-rate risk, and off-balance sheet banking. *Journal of Banking & Finance*, *21*(1), 55-87.

Angeloni, I., & Faia, E. (2013). Capital regulation and monetary policy with fragile banks. *Journal of Monetary Economics*, *60*(3), 311-324.

Antzoulatos, A. A., & Tsoumas, C. (2014). Institutions, moral hazard and expected government support of banks. *Journal of Financial Stability*, *15*, 161-171.

Ardito, L., Raby, S., & Albino, V. (2021). The duality of digital and environmental orientations in the context of SMEs: implications for innovation performance. *Journal of Business Research*, *123*, 44-56.

Arner, D. W., Barberis, J., & Buckey, R. P. (2016). FinTech, regtech, and the reconceptualization of financial regulation. *Northwestern Journal of International Law and Business*, *37*, 371.

Arner, D. W., Buckley, R. P., Zetzsche, D. A., & Veidt, R. (2020). Sustainability, FinTech and financial inclusion. *European Business Organization Law Review*, *21*, 7-35.

Ba, S., & Bai, H. (2016). 金融科技的发展历程与核心技术应用场景探索 [The development history of financial technology and exploration of core technology application scenarios]. *Tsinghua Financial Review*, (11), 99-103.

Bebchuk, L. A., Cohen, A., & Spamann, H. (2010). The wages of failure: executive compensation at Bear Stearns and Lehman 2000-2008. *Yale Journal on Regulation*, *27*, 257.

Beltratti, A., & Stulz, R. M. (2012). The credit crisis around the globe: why did some banks perform better? *Journal of Financial Economics*, *105*(1), 1-17.

Ben Naceur, S., & Goaied, M. (2008). The determinants of commercial bank interest margin and profitability: evidence from Tunisia. *Frontiers in Finance and Economics*, *5*(1), 106-130.

Berger, A. N., Clarke, G. R. G., Cull, R., Klapper, L., & Udell, G. F. (2005). Corporate governance and bank performance: a joint analysis of the static, selection, and dynamic effects of domestic, foreign, and state ownership. *Journal of Banking & Finance*, *29*(8-9), 2179-2221.

Bolt, W., De Haan, L., Hoeberichts, M., Van Oordt, M. R. C., & Swank, J. (2012). Bank profitability during recessions. *Journal of Banking & Finance*, *36*(9), 2552-2564.

Bonin, J. P., Hasan, I., & Wachtel, P. (2005). Bank performance, efficiency and ownership in transition countries. *Journal of Banking & Finance*, *29*(1), 31-53.

Boot, A. W. (2011). Banking at the crossroads: how to deal with marketability and complexity?

Review of Development Finance, *1*(3), 167-183.
Borio, C., & Zhu, H. (2012). Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism? *Journal of Financial Stability*, *8*(4), 236-251.
Borisova, G., Brockman, P., Salas, J. M., & Zagorchev, A. (2012). Government ownership and corporate governance: evidence from the EU. *Journal of Banking & Finance*, *36*(11), 2917-2934.
Boufounou, P., Mavroudi, M., & Toudas, K. (2022). Digital transformation of the Greek banking sector in the COVID era. *Sustainability*, *14*(19), 14-19.
Boyd, J. H., & De NicolÓ, G. (2005). The theory of bank risk taking and competition revisited. *Journal of Finance*, *60*(3), 1329-1343.
Caprio, G., & Levine, R. (2002). Corporate governance in finance: concepts and international observations. In R. E. Litan, M. Pomerleano, & V. Sundararajan (Eds.), *Financial sector governance: The roles of the public and private sectors* (pp. 17-50). Brookings Institution Press.
Che, D. X., Dai, M. Y., & Wu, F. (2021). 企业数字化转型对融资成本的影响与机制研究 [Research on the impact and mechanism of enterprise digital transformation on financing costs]. *Financial Regulation Research*, (12), 56-74.
Chen, J., & Wang, J. (2016). 互联网金融理财产品余额宝对商业银行业务的影响——基于事件分析法的研究 [The impact of the Internet financial product Yu'ebao on commercial banking business: a study based on event analysis]. *Inquiry into Economic Issues*, (1), 167-173.
Chen, M. A., Wu, Q., & Yang, B. (2019). How valuable is FinTech innovation? *Review of Financial Studies*, *32*(5), 2062-2106.
Chen, X. B. (2005). 中国商业银行薪酬激励机制分析 [Analysis of the compensation incentive mechanism of Chinese commercial banks]. *Journal of Finance*, (7), 76-94.
Chen, X. H., You, X., & Chang, V. (2021). FinTech and commercial banks' performance in China: a leap forward or survival of the fittest? *Technological Forecasting and Social Change*, *166*, 166-182.
Cheng, I. H., Hong, H., & Scheinkman, J. A. (2010). *Yesterday's heroes: compensation and creative risk-taking*. National Bureau of Economic Research.
Cheng, M., & Qu, Y. (2020). Does bank fintech reduce credit risk? Evidence from China. *Pacific-Basin Finance Journal*, *63*, 60-76.
Claessens, S., Demirgüç-Kunt, A., & Huizinga, H. (2001). How does foreign entry affect domestic banking markets? *Journal of Banking & Finance*, *25*(5), 891-911.
Cornett, M. M., Erhemjamts, O., & Tehranian, H. (2016). Greed or good deeds: an examination of the relation between corporate social responsibility and the financial performance of US commercial banks around the financial crisis. *Journal of Banking & Finance*, *70*, 137-159.
De Haan, J., & Poghosyan, T. (2012). Bank size, market concentration, and bank earnings volatility in the US. *Journal of International Financial Markets, Institutions and Money*, *22*(1), 35-54.
Delis, M. D., & Kouretas, G. P. (2011). Interest rates and bank risk-taking. *Journal of Banking & Finance*, *35*(4), 840-855.
Delong, G., & Deyoung, R. (2007). Learning by observing: Information spillovers in the execution and valuation of commercial bank M&As. *Journal of Finance*, *62*(1), 181-216.
Demertzis, M., Merler, S., & Wolff, G. B. (2018). Capital markets union and the fintech opportunity. *Journal of Financial Regulation*, *4*(1), 157-165.
Demirgüç-Kunt, A., & Huizinga, H. (1999). Determinants of commercial bank interest margins and profitability: some international evidence. *The World Bank Economic Review*, *13*(2), 379-408.
Devriese, J., Dewatripont, M., Heremans, D., & Nguyen, G. (2004). Corporate governance,

regulation and supervision of banks. *Financial Stability Review*, *2*(1), 95-120.

Deyoung, R., Peng, E. Y., & Yan, M. (2013). Executive compensation and business policy choices at U.S. commercial banks. *Journal of Financial and Quantitative Analysis*, *48*(1), 165-196.

Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy*, *91*(3), 401-419.

Dietrich, A., & Wanzenried, G. (2011). Determinants of bank profitability before and during the crisis: evidence from Switzerland. *Journal of International Financial Markets, Institutions and Money*, *21*(3), 307-327.

Ding, J. (2009). 中国上市银行股权结构与绩效研究——基于创新指标的实证 [On the shareholding structure of China's listed banks and performance: an empirical study based on innovative indicators]. *Contemporary Finance & Economics*, (8), 62-68.

Doan, A. T., Lin, K. L., & Doong, S. C. (2018). What drives bank efficiency? The interaction of bank income diversification and ownership. *International Review of Economics & Finance*, *55*, 203-219.

Du, E. L., Ji, M., & Yuan, B. (2021). 我国中小银行以数字化转型促进高质量发展研究 [Research on Chinese small and medium-sized banks promoting high-quality development through digital transformation]. *Journal of Northwest University (Philosophy and Social Sciences Edition)*, *51*(1), 109-116.

Duellmann, K., & Masschelein, N. (2007). A tractable model to measure sector concentration risk in credit portfolios. *Journal of Financial Services Research*, *32*, 55-79.

Erkens, D. H., Hung, M., & Matos, P. (2012). Corporate governance in the 2007–2008 financial crisis: evidence from financial institutions worldwide. *Journal of Corporate Finance*, *18*(2), 389-411.

Fahlenbrach, R., & Stulz, R. M. (2011). Bank CEO incentives and the credit crisis. *Journal of Financial Economics*, *99*(1), 11-26.

Faleye, O., & Krishnan, K. (2017). Risky lending: does bank corporate governance matter? *Journal of Banking & Finance*, *83*, 57-69.

Ferri, G. (2009). Are new tigers supplanting old mammoths in China's banking system? Evidence from a sample of city commercial banks. *Journal of Banking & Finance*, *33*(1), 131-140.

Fiordelisi, F., Marques-Ibanez, D., & Molyneux, P. (2011). Efficiency and risk in European banking. *Journal of Banking & Finance*, *35*(5), 1315-1326.

Grove, H., Patelli, L., Victoravich, L. M., & Xu, P. T. (2011). Corporate governance and performance in the wake of the financial crisis: evidence from US commercial banks. *Corporate Governance: An International Review*, *19*(5), 418-436.

Gu, H., & Yang, L. (2018). 互联网金融与银行风险承担:基于中国银行业的证据 [Internet finance and bank risk-taking: evidence from the chinese banking sector]. *World Economy*, (10), 75-100.

Guo, L. H., & Zhu, K. D. (2021). 金融科技, 银行风险与经营业绩——基于普惠金融的视角 [Fintech, bank risk and operating performance——from the perspective of inclusive finance]. *Studies of International Finance*, (7), 56-65.

Guo, P., & Shen, Y. (2015). 互联网金融对商业银行风险承担的影响:理论解读与实证检验 [The impact of internet finance on commercial banks' risk-taking: theoretical interpretation and empirical test]. *Finance & Trade Economics*, (10), 102-116.

Guo, Y., Wei, Z. Q., & Fang, Y. (2022). 金融科技布局, 银行信贷风险与经营绩效——来自商业银行与科技企业战略合作的证据 [Fintech layout, bank credit risk and operating performance: evidence from strategic cooperation between commercial banks and technology enterprises]. *Journal of Financial Research*, *508*(10), 20-38.

Guo, Y., Zhang, Z., & Yan, J. (2012). 资本结构与股权结构对商业银行综合绩效的影响 [The impact of capital structure and ownership structure on comprehensive performance in commercial banks]. *Chinese Journal of Management*, *9*(7), 1052-1057.

Haddad, C., & Hornuf, L. (2023). How do fintech start-ups affect financial institutions' performance and default risk? *European Journal of Finance*, *29*(15), 1761-1792.

Hancock, D., Humphrey, D. B., & Wilcox, J. A. (1999). Cost reductions in electronic payments: the roles of consolidation, economies of scale, and technical change. *Journal of Banking & Finance*, *23*(2-4), 391-421.

Hasan, I., & Marton, K. (2003). Development and efficiency of the banking sector in a transitional economy: Hungarian experience. *Journal of Banking & Finance*, *27*(12), 2249-2271.

Haw, I.-M., Ho, S. S. M., Hu, B., & Wu, D. (2010). Concentrated control, institutions, and banking sector: an international study. *Journal of Banking & Finance*, *34*(3), 485-497.

He, W., & Liu, Q. (2010). 我国上市公司高管背景特征与财务重述行为研究 [Research on the background characteristics and financial restatement behavior of executives in my country's listed companies]. *Management World*, (7), 144-155.

Hellmann, T., & Puri, M. (2000). The interaction between product market and financing strategy: the role of venture capital. *Review of Financial Studies*, *13*(4), 959-984.

Hong, Z., Shen, Y., & Wu, W. (2014). 高管薪酬激励会导致银行过度冒险吗?——来自中国房地产信贷市场的证据 [Does executive compensation promote bankers' excessive risk taking? Evidence from chinese real estate lending market]. *China Economic Quarterly*, *13*(4), 1585-1614.

Houston, J. F., & James, C. (1995). CEO compensation and bank risk Is compensation in banking structured to promote risk taking? *Journal of Monetary Economics*, *36*(2), 405-431.

Huang, L., & Huang, S. G. (2023). 数字金融, 居民劳动参与及家庭财务脆弱性 [Digital finance, residents' labor participation and household financial vulnerability]. *Journal of Technology Economics*, *42*(12), 1-18.

Iannotta, G., Nocera, G., & Sironi, A. (2007). Ownership structure, risk and performance in the European banking industry. *Journal of Banking & Finance*, *31*(7), 2127-2149.

Jagtiani, J., & John, K. (2018). Fintech: the impact on consumers and regulatory responses. *Journal of Economics and Business*, *100*, 1-6.

Jeitschko, T. D., & Jeung, S. D. (2005). Incentives for risk-taking in banking – a unified approach. *Journal of Banking & Finance*, *29*(3), 759-777.

Jensen, M. C., & Meckling, W. H. (2019). Theory of the firm: managerial behavior, agency costs and ownership structure. In G. Aras & D. Crowther (Eds.), *Corporate Governance* (pp. 77-132). Gower.

Jiménez, G., Lopez, J. A., & Saurina, J. (2013). How does competition affect bank risk-taking? *Journal of Financial Stability*, *9*(2), 185-195.

Jin, H. F., Li, H. J., & Liu, Y. L. (2020). 金融科技, 银行风险与市场挤出效应 [Fintech, bank risk and market crowding-out effect]. *Journal of Finance and Economics*, *46*(5), 110-125.

Khan, M. S., Scheule, H., & Wu, E. (2017). Funding liquidity and bank risk taking. *Journal of Banking & Finance*, *82*, 203-216.

King, R. G., & Levine, R. (1993). Finance, entrepreneurship and growth. *Journal of Monetary economics*, *32*(3), 513-542.

Kotarba, M. (2016). New factors inducing changes in the retail banking customer relationship management (CRM) and their exploration by the fintech industry. *Foundations of Management*, *8*(1), 69-78.

Kvamme, H., Sellereite, N., & Aas, K. (2018). Predicting mortgage default using convolutional

neural networks. *Expert Systems with Applications*, *102*, 207-217.
Kwan, S., & Eisenbeis, R. A. (1997). Bank risk, capitalization, and operating efficiency. *Journal of Financial Services Research*, *12*(2), 117-131.
Laeven, L., & Levine, R. (2009). Bank governance, regulation and risk taking. *Journal of Financial Economics*, *93*(2), 259-275.
Lapavitsas, C., & Dos Santos, P. L. (2008). Globalization and contemporary banking: on the impact of new technology. *Contributions to Political Economy*, *27*(1), 31-56.
Larcker, D. F., Richardson, S. A., & Tuna, I. R. (2007). Corporate governance, accounting outcomes, and organizational performance. *Accounting Review*, *82*(4), 963-1008.
Lee, C. C., Li, X., Yu, C. H., & Zhao, J. (2021). Does fintech innovation improve bank efficiency? Evidence from China's banking industry. *International Review of Economics & Finance*, *74*, 468-483.
Li, C. M., He, S., Tian, Y., Sun, S., & Ning, L. (2022). Does the bank's FinTech innovation reduce its risk-taking? Evidence from China's banking industry. *Journal of Innovation & Knowledge*, *7*(3), 7-23.
Li, C. Z. (2011). 商业银行公司治理机制的特殊性 [The peculiarities of corporate governance mechanism of commercial banks]. *Economic Herald*, (7), 54-55.
Li, D., & Xu, Y. (2014). 互联网理财对银行冲击的深层思考 [In-depth reflections on the impact of Internet financial management on banks]. *International Finance*, (5), 64-67.
Li, J. J., & Jiang, S. C. (2021). 银行金融科技与普惠金融的商业可持续性——财务增进效应的微观证据 [Bank fintech and the commercial sustainability of inclusive finance: microscopic evidence of financial enhancement effect]. *China Economic Quarterly*, (3), 889-908.
Li, M., Wang, Z., He, G., & Wang, Y. (2024). 银行业金融科技创新、结构性普惠效应与创业活力 [Bank fintech, structural inclusion effect and entrepreneurial vitality]. *Journal of Management World*, *40*(6), 195-224.
Li, Q. Y., Zhi, J., & Liu, X. Q. (2023). 企业数字化转型与资本配置效率 [Enterprise digital transformation and capital allocation efficiency]. *Statistics & Information Forum*, (3), 70-83.
Li, W. A. (1998). *Research on Chinese corporate governance*. Tax Management Association.
Li, W. A., & Cao, T. (2004). 股权结构、治理机制与城市银行绩效——来自山东、河南两省的调查证据 [Ownership structure, governance mechanism and performance of urban banks: evidence from shandong and he'nan]. *Economic Research Journal*, (12), 4-15.
Li, W. A., & Cao, T. (2005). 商业银行公司治理——基于商业银行特殊性的研究 [Firm management in commercial banks-based upon a study on commercial bank's specific characteristics]. *Nankai Journal*, (1), 83-89.
Li, W. A., Liu, Z., & Gu, L. (2014). 董事会异质性、董事会断裂带与银行风险承担——金融危机下中国银行的实证研究 [Board heterogeneity, board fault lines and bank risk taking: an empirical study of Chinese banks during the financial crisis]. *Financial and Trade Research*, (5), 87-98.
Li, W. H., & Jiang, Z. S. (2017). 金融科技(FinTech)发展与监管:一个监管者的视角 [The development and supervision of fintech: from the perspective of regulators]. *Financial Regulation Research*, (3), 1-13.
Li, X. F., & Yang, P. (2021). 金融科技、市场势力与银行风险 [Fintech,market power and bank risk]. *Modern Economic Science*, *43*(1), 45-57.
Li, X. M. (2011). "三性"原则下中国上市商业银行资本结构与绩效关系研究 [A study on the relationship between capital structure and performance of listed commercial banks in China under the principle of "three characteristics"]. *Management World*, (2), 173-174+177.

Li, X. R., & Zhang, R. J. (2014). 股权激励影响风险承担：代理成本还是风险规避？ [Equity incentive affects risk-taking: agency cost or risk aversion?]. *Accounting Research*, (1), 57-63.

Li, Z. H., Chen, H. L., & Zhang, X. D. (2022). 金融科技对商业银行盈利能力的影响 [The impact of fintech on the profitability of commercial banks]. *Journal of Zhongnan University of Economics and Law*, (5), 56-68.

Lin, B. H., Li, B. X., & Zhang, T. (2023). 数字化转型能否提升公司治理水平？——基于中国 A 股上市公司的经验证据 [Can digital transformation improve corporate governance level?——Empirical evidence from Chinese A-share listed companies]. *Reform of Economic System*, (5), 176-182.

Lin, C., & Kunnathur, A. (2019). Strategic orientations, developmental culture, and big data capability. *Journal of Business Research*, *105*, 49-60.

Lin, L., Geng, X., & Whinston, A. (2001). A new perspective to finance and competition and challenges for financial institutions in the internet era. In Bank for International Settlements (Ed.), *Electronic finance: A new perspective and challenges* (pp. 13-25). BIS.

Lin, X. (2014). 互联网金融与商业银行业务的融合与发展研究 [A study of the integration and development of internet finance and commercial bank's business]. *Finance Forum*, *19*(10), 21-28.

Liu, D., You, J., & Zhang, L. Y. (2023). 金融科技对农村商业银行绩效的影响：“契机”还是“阻力”——以江苏省为例 [The impact of fintech on the performance of rural commercial banks: "opportunity" or "resistance"——a case study of Jiangsu Province]. *Chinese Rural Economy*, (11), 122-139.

Liu, J., Li, W., & Zhang, W. (2022). 金融开放有利于银行经营绩效的提升吗?:基于银行贷款的中介效应检验 [Is financial openness conducive to the improvement of bank performance: intermediary effect test based on bank loans]. *World Economy Studies*, (2), 12-25.

Liu, M. (2021). 金融科技与商业银行系统性风险——基于对中国上市银行的实证研究 [Fintech and commercial banks' systemic risk an empirical study on listed banks in China]. *Wuhan University Journal (Philosophy & Social Science)*, *74*(2), 119-134.

Liu, M. F., & Wang, Q. (2021). 金融科技对商业银行绩效的影响——理论与实证研究 [The impact of fintech on commercial bank performance: theoretical and empirical research]. *Finance Forum*, *26*(3), 60-70.

Liu, S. B., Zhang, Y. Z., & Liang, J. H. (2021). 金融科技与金融创新研究进展 [Research progress on fintech and financial innovation]. *Economic Perspectives*, (3), 126-144.

Liu, X., & Yang, D. (2017). 互联网金融背景下商业银行并购重组选择差异的效率研究——基于商业银行异质性的 Malmquist 指数实证分析 [Research on efficiency of different mergers and acquisitions choices of different commercial banks against the background of internet financing-an empirical analysis based on malmquist index in different banks]. *Studies of International Finance*, (10), 65-75.

Liu, Z. (2016). 互联网金融对商业银行风险承担的影响研究 [Research on the impact of Internet finance on commercial banks' risk-taking]. *Finance & Trade Economics*, (4), 71-85+115.

Loebbecke, C., & Picot, A. (2015). Reflections on societal and business model transformation arising from digitization and big data analytics: a research agenda. *The Journal of Strategic Information Systems*, *24*(3), 149-157.

Luo, Y. (2019). 金融科技时代银行的功能演变 [The functional evolution of banks in the fintech era]. *China Finance*, (24), 64-65.

Ma, X. J., Sha, J. L., & Niu, X. Q. (2018). 基于 LightGBM 算法的 P2P 项目信用评级模型

的设计及应用 [Design and application of credit rating model for P2P projects based on LightGBM algorithm]. *Journal of Quantitative & Technical Economics*, *35*(5), 144-160.

Ma, Y., & Liu, D. (2017). Introduction to the special issue on Crowdfunding and FinTech. *Financial Innovation*, *3*, 1-4.

Malekipirbazari, M., & Aksakalli, V. (2015). Risk assessment in social lending via random forests. *Expert Systems with Applications*, *42*(10), 4621-4631.

Martinez-Miera, D., & Repullo, R. (2010). Does competition reduce the risk of bank failure? *The Review of Financial Studies*, *23*(10), 3638-3664.

Meckling, W. H., & Jensen, M. C. (1976). Theory of the firm: managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305-360.

Mocetti, S., Pagnini, M., & Sette, E. (2017). Information technology and banking organization. *Journal of Financial Services Research*, *51*, 313-338.

Muganyi, T., Yan, L., & Yin, Y. (2022). Fintech, regtech, and financial development: evidence from China. *Financial Innovation*, *8*(1), 1-20.

Mullineux, A. (2006). The corporate governance of banks. *Journal of Financial Regulation and Compliance*, *14*(4), 375-382.

Naidu, W. (2011). *The implications of capital structure theory and regulation for South African Banking Institutions*. University of Pretoria (South Africa).

Nourani, M., Ting, I. W. K., Lu, W.-M., & Kweh, Q. L. (2019). Capital structure and dynamic performance: evidence from asean-5 banks. *Singapore Economic Review*, *64*(3), 495-516.

Pan, M., & Xie, L. (2008). 中国上市银行内部治理的有效性——基于内生性视角的实证研究 [Efficiency of internal mechanisms of corporate governance in Chinese listed commercial banks: an empirical study based on endogenous perspective]. *Management Scientist (Academic Edition)*, (6), 509-519+557.

Pan, Z. (2013). 商业银行资本充足性对盈利能力影响的实证研究 [An empirical study of the impacts of the commercial bank's capital adequacy to the profit ability]. *South China Finance*, (11), 43-46.

Papadopoulos, P. (2019). *Essays in bank lending* [Doctoral dissertation]. University of Surrey (United Kingdom).

Pathan, S. (2009). Strong boards, CEO power and bank risk-taking. *Journal of Banking & Finance*, *33*(7), 1340-1350.

Persico, N. (2004). Committee design with endogenous information. *Review of Economic Studies*, *71*(1), 165-191.

Phan, D. H. B., Narayan, P. K., Rahman, R. E., & Hutabarat, A. R. (2020). Do financial technology firms influence bank performance? *Pacific-Basin Finance Journal*, *62*, 62-75.

Pi, T., & Zhao, T. (2014). 互联网金融:范畴、革新与展望 [Internet finance: category,innovation and prospects]. *Finance & Economics*, (6), 22-30.

Podpiera, J., & Weill, L. (2008). Bad luck or bad management? Emerging banking market experience. *Journal of Financial Stability*, *4*(2), 135-148.

Qi, Y. D., & Xiao, X. (2020). 数字经济时代的企业管理变革 [Enterprise management reform in the era of digital economy]. *Management World*, *36*(6), 135-152.

Qiu, H., Huang, Y., & Ji, Y. (2018). 金融科技对传统银行行为的影响——基于互联网理财的视角 [How does fintech development affect traditional banking in China?The perspective of online wealth management products]. *Journal of Financial Research*, (11), 17-29.

Rajan, R. G. (1994). Why bank credit policies fluctuate: a theory and some evidence. *Quarterly Journal of Economics*, *109*(2), 399-441.

Rossi, S. P., Schwaiger, M. S., & Winkler, G. (2009). How loan portfolio diversification affects risk, efficiency and capitalization: a managerial behavior model for Austrian banks. *Journal*

of Banking & Finance, *33*(12), 2218-2226.
Roy, A., Sun, J., & Mahoney, R. (2018, April 7). *Deep learning detecting fraud in credit card transactions*. 2018 Systems and Information Engineering Design Symposium (SIEDS), Charlottesville, Virginia, USA.
Saeed, M. M. (2013). Impact of capital structure on banking performance (a case study of Pakistan). *Interdisciplinary Journal of Contemporary Research in Business*, *4*(10), 393-403.
Saghi-Zedek, N., & Tarazi, A. (2015). Excess control rights, financial crisis and bank profitability and risk. *Journal of Banking & Finance*, *55*, 361-379.
Saunders, A., Strock, E., & Travlos, N. G. (1990). Ownership structure, deregulation, and bank risk taking. *Journal of Finance*, *45*(2), 643-654.
Schueffel, P. (2021). Defi: decentralized finance - an introduction and overview. *Journal of Innovation Management*, *9*(3), 1-11.
Shao, J. B., & Liu, Y. (2009). 权力循环视角下的公司治理研究综述 [Review of corporate governance research from the perspective of power cycle]. *Foreign Economics & Management*, *10*(10), 54-58.
Shehzad, C. T., De Haan, J., & Scholtens, B. (2010). The impact of bank ownership concentration on impaired loans and capital adequacy. *Journal of Banking & Finance*, *34*(2), 399-408.
Song, Z., Chen, Q., & Zhang, Z. (2007). 上市银行董事会治理与银行绩效 [Empirical analysis on the relationship between board governance and performance of china's listed banks]. *Finance Forum*, (5), 35-40.
Soto Setzke, D., Riasanow, T., & Böhm, M. (2023). Pathways to digital service innovation: the role of digital transformation strategies in established organizations. *Information Systems Frontiers*, *25*(3), 1017-1037.
Sun, J., & He, C. (2015). 大数据时代的互联网金融创新及传统银行转型 [Internet finance innovation and traditional bank transformation based on big data]. *Finance & Economics*, (1), 11-16.
Sun, J. Y. (2008). 银行股权结构、治理机制与综合绩效关系的实证研究 [An empirical study on bank's ownership structure,governance mechanism and comprehensive performance]. *Finance Forum*, *13*(8), 3-8.
Sun, J. Y., & Xu, N. (2011). 高管薪酬契约与商业银行综合绩效——基于我国上市银行的实证分析 [Executive compensation contract and the banks' comprehensive performance——empirical analysis on china's listed banks]. *Journal of Central University of Finance & Economics*, (8), 29-34.
Sun, T., & Vasarhelyi, M. A. (2018). Predicting credit card delinquencies: an application of deep neural networks. *Intelligent Systems in Accounting, Finance and Management*, *25*(4), 174-189.
Tian, G., & Li, S. (2020). 经济政策不确定性与银行流动性创造:来自中国的经验证据 [Economic policy uncertainty and the creation of bank liquidity: empirical evidence from China]. *Economic Research Journal*, *55*(11), 19-35.
Tomar, S., & Bino, A. (2012). Corporate governance and bank performance: evidence from Jordanian banking industry. *Jordan Journal of Business Administration*, *8*(2), 353-372.
Twala, B., & Cartwright, M. (2010). Ensemble missing data techniques for software effort prediction. *Intelligent Data Analysis*, *14*(3), 299-331.
Van Veldhoven, Z., & Vanthienen, J. (2022). Digital transformation as an interaction-driven perspective between business, society, and technology. *Electronic Markets*, *32*(2), 629-644.
Vennet, R. V. (2002). Cost and profit efficiency of financial conglomerates and universal banks in Europe. *Journal of Money, Credit and Banking*, *34*(4), 1050-1080.
Wagner, A. F. (2011). Board independence and competence. *Journal of Financial*

Intermediation, *20*(1), 71-93.

Wang, C., Han, D., & Liu, Q. (2018). A deep learning approach for credit scoring of peer-to-peer lending using attention mechanism LSTM. *IEEE Access*, *7*, 2161-2168.

Wang, C. C., Dang, C., & Xu, F. (2018). 互联网金融背景下的金融创新和财富管理研究 [Research on financial innovation and wealth management under the background of internet finance]. *Management World*, *34*(12), 168-170.

Wang, K., Wu, Q., & Li, J. (2017). 金融科技与商业银行风险承担——基于中国银行业的实证分析 [Fintech and commercial bank risk taking: an empirical analysis based on China's banking industry]. *Modernization of Management*, *37*(6), 100-104.

Wang, M. S., & Liu, X. (2013). 商业银行收入结构对盈利能力的影响研究——基于中国 14 家上市银行面板数据的分析 [Research on the impact of income structure of commercial banks on profitability: analysis based on panel data of 14 listed banks in china]. *Nankai Business Review*, *16*(2), 143-149.

Wang, M. S., & Xu, Z. H. (2017). 银行债权治理与公司内部治理间的互动效应研究——基于管理层代理成本的实证分析 [Research on the interactive effect between bank debt governance and corporate internal governance: An empirical analysis based on managerial agency costs]. *China Soft Science*, (12), 100-115.

Wang, P. C., Wu, J., & Sun, B. X. (2020). 信息披露质量对上市公司盈余预测准确性影响研究 —— 基于管理层讨论与分析 (MD&A) 视角的分析 [Research on the impact of information disclosure quality on the accuracy of listed companies' earnings forecasts——An analysis based on the perspective of management discussion and analysis (MD&A)]. *Price: Theory & Practice*, (12), 62-65.

Wang, R. X., & Yu, P. (2004). 金融创新理论研究综述 [Review of financial innovation theory research]. *Economic Perspectives*, (5), 90-94.

Wang, S., Li, Y., & Gao, R. (2021). 互联网金融对商业银行风险承担的影响研究——基于中国 30 家商业银行的实证分析 [Research on the impact of internet finance on the risk taking of commercial banks-based on the empirical analysis of 30 commercial banks in china]. *Journal of Financial Development Research*, (1), 56-62.

Wang, S. H., & Xie, X. L. (2021). 知而后行？管理层认知与银行数字化转型 [Knowledge before action? Managerial cognition and bank digital transformation]. *Financial Review*, *13*(6), 78-97.

Wang, W. K., Lu, W. M., & Lin, Y. L. (2012). Does corporate governance play an important role in BHC performance? Evidence from the U.S. *Economic Modelling*, *29*(3), 751-760.

Wang, X. (2015). 互联网金融助解“长尾”小微企业融资难问题研究 [Research on internet finance helping to solve the financing difficulty of "long-tail" small and micro enterprises]. *Journal of Financial Research*, *423*(9), 128-139.

Wang, Y. T., & Luo, S. C. (2022). 金融科技与商业银行经营绩效——基于风险承担的中介效应分析 [Fintech and commercial bank operating performance - an analysis based on the mediating effect of risk-taking]. *Finance Forum*, *27*(4), 12.

Wei, H., & Liu, J. (2005). 商业银行内部治理机制及其对银行绩效的影响 [Management mechanism within commercial bank and its influence on the performance of the bank]. *Nankai Journal*, (1), 77-82.

Wei, X. Q. (2022). *Digital transformation and corporate governance level* [Master's thesis]. University of International Business and Economics.

Wen, F. (2015). 银行部门薪酬与经济金融系统的稳定性:中美比较——资产值波动冲击下基于 SFC 的研究 [Research on the bank pay and stability in macroeconomic and financial system: comparison between china and the united states——analysis based on the sfc model under the asset fluctuation]. *Studies of International Finance*, (11), 47-57.

Xi, Y., & Wu, Y. (2012). 董事会特征、公司治理与银行绩效——基于我国 14 家商业银行面板数据的实证分析 [Board characteristics, corporate governance and bank performance: an empirical analysis based on panel data of 14 commercial banks in China]. *Modern Management Science*, (9), 47-50.

Xie, W., & Tang, Q. (2013). 公司治理与风险承担——来自中国上市公司的经验证据 [Corporate governance and risk taking: empirical evidence from chinese listed companies]. *Research on Financial and Economic Issues*, (1), 91-97.

Xiong, J., Zhang, Y., & Dong, X. (2021). 金融科技对商业银行经营绩效的影响：挤出效应还是技术溢出效应？[How does financial technology affect business performance of commercial banks: crowding-out effect or technology spillover effect?]. *Economic Review*, (3), 89-104.

Xu, F., & Ma, J. (2019). 中国商业银行执行环境风险管理政策对其经营绩效的影响——以赤道原则为例 [The impact of China's commercial banks' implementation of environmental risk management policies on their operating performance: taking the equator principle as an example]. *Macroeconomics*, (9), 14-26.

Xue, Y., & Hu, J. (2020). 金融科技助推经济高质量发展：理论逻辑、实践基础与路径选择 [Fintech promotes high-quality economic development: theoretical logic,practical basis and path choices]. *Reform*, (3), 53-62.

Yan, H., & Shen, L. (2022). 制度环境、银行所有权与经营绩效——基于民国时期 158 家银行营业报告的实证研究 [Institutional environment, bank ownership and business performance: an empirical research based on the business reports of 158 banks in the republic of china]. *Journal of Finance and Economics*, *48*(1), 154-168.

Yang, Q., & Yang, L. (2006). 商业银行公司治理的特殊性研究 [Research on the peculiarities of corporate governance of commercial banks]. *New Finance*, (4), 43-46.

Yang, W., Xu, H., Tan, X., & Xue, X. (2020). 金融科技与商业银行效率——基于 DEA-Malmquist 模型的实证研究 [Fintech and commercial bank efficiency - an empirical study based on dea malmquist model]. *Studies of International Finance*, (7), 56-65.

Yao, T., & Song, L. (2020). 金融科技对商业银行风险的影响及异质性研究[Research on the influence and the heterogeneity of fintech on the risk of commercial banks]. *Journal of Yunnan University of Finance and Economics*, *36*(12), 53-63.

Yao, T., & Song, L. (2021). 金融科技对商业银行信用风险的经济资本影响研究 [Research on the impact of financial technology on the economic capital of commercial banks' credit risk]. *Science and Technology Management Research*, *41*(1), 104-110.

Yin, Y. (2017). 金融科技时代要更加关注普惠金融消费者权益保护 [In the era of financial technology, more attention should be paid to the protection of the rights and interests of inclusive finance consumers]. *China Banking*, (9), 42-44.

Yu, B., Zhou, N., & Huo, Y. (2020). 金融科技对商业银行盈利能力的影响——基于动态面板 GMM 模型的实证检验 [The impact of fintech on the profitability of commercial banks: an empirical test based on dynamic panel gmm model]. *South China Finance*, (3), 30-39.

Yuan, Q. (2017). 放松存款利率管制降低了银行绩效吗? [Does unlocking deposit interest rate restriction reduce bank performance?]. *Economic Survey*, *34*(6), 142-146.

Zalan, T., & Toufaily, E. (2017). The promise of fintech in emerging markets: not as disruptive. *Contemporary Economics*, *11*(4), 415.

Zhai, R. X., Ho, P. H., & Lin, C. Y. (2023). Bank CEO risk-taking incentives and bank lending quality. *Review of Quantitative Finance and Accounting*, *60*(3), 949-981.

Zhan, M., Zhang, C., & Shen, J. (2018). 互联网金融发展与货币政策的银行信贷渠道传导 [Development of internet finance and the bank lending transmit channel of monetary policy]. *Economic Research Journal*, *53*(4), 63-76.

Zhang, D., Cai, J., Liu, J., & Kutan, A. M. (2016). Real estate investments and financial stability: evidence from regional commercial banks in China. *European Journal of Finance*, *24*(16), 1388-1408.

Zhang, M., & Yang, J. (2019, December 29-30). *Research on financial technology and inclusive finance development*. 6th International Education, Economics, Social Science, Arts, Sports and Management Engineering Conference (IEESASM 2018), Qingdao, Shandong, China.

Zhang, Q. J., & Chen, S. (2022). 数字经济发展、银行数字化投入与银行治理 [Digital economy development, banks' digital investment and bank governance]. *Research on Economics and Management*, *43*(8), 31-55.

Zhang, Q. J., & Ou, Y. D. (2023). 数字化转型提升了银行经营效率吗？—— 来自上市商业银行的经验证据 [Does digital transformation improve bank operating efficiency? Empirical evidence from listed commercial banks]. *Accounting and Economics Research*, *37*(3), 89-108.

Zhang, Z., & Wu, F. (2020). Moral hazard, external governance and risk-taking: evidence from commercial banks in China. *Finance Research Letters*, *37*, 37-52.

Zhao, C., Yang, J., & Xia, Q. (2009). 中国转型期商业银行的公司治理与绩效研究 [A study on corporate governance and performance of commercial banks in China's transition period]. *Management World*, (7), 46-55.

Zhao, C. Y., Wang, W. C., & Li, X. S. (2021). 数字化转型如何影响企业全要素生产率 [How does digital transformation affect total factor productivity of enterprises]. *Finance & Trade Economics*, *42*(7), 16.

Zhao, J., Li, X., Yu, C. H., Chen, S., & Lee, C. C. (2022). Riding the FinTech innovation wave: FinTech, patents and bank performance. *Journal of International Money and Finance*, *122*, 122-139.

Zhao, Z. (2017). 以区块链技术推动互联网金融稳健发展研究 [Research on promoting steady development of internet finance with blockchain technology]. *Economic Review*, (11), 112-117.

Zhou, C. X., & Mao, Y. (2018). 城市商业银行贷款集中度对资产质量影响的研究 [Research on the impact of loan concentration on asset quality of city commercial banks]. *Journal of Business Economics*, *38*(9), 86-96.

Zhou, L. (2020). 完善公司治理，促进股份制银行高质量发展 [Improve corporate governance to promote high-quality development of joint-stock banks]. *China Rural Finance*, (18), 6-10.

Zhou, X., Zhou, Z., Fan, X., & Yu, Y. (2024). 金融科技赋能下商业银行小微企业信贷供给精准性的影响因素研究——基于双中介模型 [Research on the influencing factors of the accuracy of smes credit supply from commercial banks under the intervention of fintech: based on a double-intermediary model]. *Financial Theory & Practice*, (2), 97-109.

Zhu, J. (2005). 基于 EVA 的中小银行绩效与治理结构关系分析 [A probe into the relationship between performance and corporate governance of small medium bank based on eva]. *Study of Finance and Economics*, (5), 53-62+72.

Zhu, K., & Guo, L. (2024). Financial technology, inclusive finance and bank performance. *Finance Research Letters*, *60*, 60-71.

Zou, X. M., Zhang, M., & Gao, B. (2015). 资产证券化与商业银行盈利水平：相关性, 影响途径与危机冲击 [Asset securitization and commercial bank profitability: correlation, impact paths and crisis shocks]. *The Journal of World Economy*, (11), 144-167.

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Webliography

Agricultural Bank of China. (2020, March 31). *2019 Annual report of Agricultural Bank of China*. Agricultural Bank of China. Retrieved May 1, 2025, from https://vip.stock.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?id=5984218

Agricultural Bank of China. (2021, March 31). *2020 Financial statements and audit report*. Agricultural Bank of China. Retrieved May 1, 2025, from https://vip.stock.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?id=5984218

Bank of China. (2019, March 30). *2018 Annual report of Bank of China*. BOC. Retrieved May 1, 2025, from https://vip.stock.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?id=5137438

Bank of China. (2020, March 28). *2019 Annual report of Bank of China*. BOC. Retrieved May 1, 2025, from https://money.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?stockid=601988&id=5976905

China Construction Bank. (2020, March 30). *2019 Annual report of China Construction Bank*. CCB. Retrieved May 1, 2025, from https://money.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?stockid=601939&id=5978052

Industrial and Commercial Bank of China. (2019, March 29). *2018 Annual report of Industrial and Commercial Bank of China*. ICBC. Retrieved May 1, 2025, from https://money.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?stockid=601398&id=5131069

Industrial and Commercial Bank of China. (2020, March 28). *2019 Annual report of Industrial and Commercial Bank of China*. ICBC. Retrieved May 1, 2025, from https://vip.stock.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?id=5977456