

WORKING
PAPERS IN
RESPONSIBLE
BANKING &
FINANCE

**Green Lending in a FinTech
Era: The Role of Geographic
Dispersion and Internal
Governance**

*By Zhaoyan Liu, Xiaoqing
(Maggie) Fu, John O.S. Wilson*

Abstract: We investigate how FinTech adoption influences green lending in commercial banks. Using panel data from listed Chinese banks (2010–2024), we find that FinTech adoption does not consistently increase green lending. In banks with widely dispersed branch networks, FinTech reduces green lending due to increased agency frictions and coordination challenges inherent in such structures. However, strong internal governance (characterised by effective monitoring, standardised procedures, and strategic alignment) can mitigate these frictions and enable banks to realise the benefits of FinTech. Our findings suggest that the success of FinTech depends on the ability of banks to integrate technology across their networks. Geographic dispersion raises implementation costs. Robust governance enhances the capacity of banks to deploy FinTech effectively. This suggests that practices and policies designed to improve corporate governance can augment the impacts of FinTech on green lending.

WP N° 26-005

1st Quarter 2026



Green Lending in a FinTech Era: The Role of Geographic Dispersion and Internal Governance

Zhaoyan Liu^a, Xiaoqing (Maggie) Fu^b, John O.S. Wilson^{c,*}

Abstract

We investigate how FinTech adoption influences green lending in commercial banks. Using panel data from listed Chinese banks (2010–2024), we find that FinTech adoption does not consistently increase green lending. In banks with widely dispersed branch networks, FinTech reduces green lending due to increased agency frictions and coordination challenges inherent in such structures. However, strong internal governance (characterised by effective monitoring, standardised procedures, and strategic alignment) can mitigate these frictions and enable banks to realise the benefits of FinTech. Our findings suggest that the success of FinTech depends on the ability of banks to integrate technology across their networks. Geographic dispersion raises implementation costs. Robust governance enhances the capacity of banks to deploy FinTech effectively. This suggests that practices and policies designed to improve corporate governance can augment the impacts of FinTech on green lending.

Keywords: Green lending, Banking, FinTech, Geographic dispersion, Corporate governance

JEL classification: G21, G30, G34

^a Navel University of Engineering, Wuhan, China

^b Faculty of Business Administration, University of Macau, Avenida da Universidade, Macau SAR, China.

^c Centre for Responsible Banking & Finance, Business School, Gateway Building, University of St Andrews, St Andrews, Fife, KY16 9RJ, UK. * Corresponding author. Email: jsw7@st-andrews.ac.uk.

Declarations of interest: none.

1. Introduction

The global green transition will necessitate trillions of dollars of investment annually over the coming decades, and require the involvement of the banking industry (De Haas, 2025; Huang et al., 2021).¹ As financial intermediaries and liquidity creators (Berger & Bouwman, 2009), banks have a pivotal role in addressing climate change by reallocating credit to low-emission (green) industries and away from brown counterparts (Degryse et al., 2023; Reghezza et al., 2022), enabling financially constrained firms to reduce pollution, invest in green projects (Xu et al., 2022), and fund low-carbon technologies (Degryse et al., 2022).

Prior evidence suggests green financing activities are associated with: banks' environmental attitudes (Degryse et al., 2023); demand for managing physical risks (Huang et al., 2021; Nguyen et al., 2022), and exposure to climate-related initiatives (such as the Paris Agreement); and country-specific regulations (Miguel et al., 2024; Reghezza et al., 2022). However, to date there is a paucity of evidence regarding the role of financial technology (FinTech) in driving green lending activities. This is in part explained by challenges relating to the measurement of FinTech adoption and green lending. In this paper, we seek to address this evidence gap.

The adoption of FinTech in banking offers a promising path for sustainable finance (UNEP, 2016). The long-standing challenge of insufficient climate data for lending (Thompson & Cowton, 2004) persists today, especially in emerging markets where available disclosures are often non-standardized, incomplete, and unverified, hindering effective risk assessment (Bolton et al., 2020; Jung et al., 2025). Moreover, traditional risk models often fail to incorporate environmental considerations in credit allocation decisions (Nguyen et al., 2022). The advent

¹ To encourage banks to participate in green and sustainable finance, various international frameworks have been launched. The most influential are: the Equator Principles (EP) managed by the Equator Principles Association, the Principles for Responsible Banking (PRB) initiated by UNEP Finance Initiative, and the Green Loan Principles (GLP) devised by the Loan Market Association.

of FinTech tools, which involves the application of powerful technologies such as artificial intelligence (AI), big data, and blockchain to financial services, has enhanced credit scoring and risk management (Gambacorta et al., 2024), enabling banks to process diverse environmental data more efficiently. These technologies help banks assess and track the environmental impact of investments (Sustainable Digital Finance Alliance, 2018), and adopt systems to support green lending activities (Dorfleitner & Braun, 2019). However, integrating FinTech into legacy banking systems introduces organisational challenges, given the impacts on operational models and decision-making structures and processes (Buchak et al., 2018). Consequently, any benefits flowing from FinTech adoption are likely to vary across banks based on their respective organisational agility.

To understand this variation, we draw upon the dynamic capabilities framework, which describes how organisations adapt and reconfigure resources in response to technological shifts (Teece et al., 1997). From this perspective, successfully translating a FinTech investment into strategic outcomes such as green lending is not merely a technical challenge, but a test of a bank's ability to manage large-scale organisational change. This capability can be severely impaired by internal frictions that can be critically influenced by geographic structure and internal governance.

FinTech adoption normally commences at a bank headquarters before being rolled out throughout branch networks. However, this process is complicated by geographic structure. For banks with widely dispersed branch networks, the distance of branches from headquarters creates significant operational hurdles, complicating managerial oversight and reducing branch-level engagement (Lim et al., 2024). These challenges give rise to internal agency frictions between headquarters and branches, which differ from traditional shareholder-manager conflicts. While traditional governance tools such as the board of directors are designed to address the latter, they are less effective at mitigating these intra-organisational

frictions. We argue that strong internal governance, characterised by robust monitoring systems, standardised procedures, and clear reporting lines is crucial to overcoming these distance-related internal agency frictions. This ensures that the strategic benefits of FinTech, envisioned by senior management located at bank headquarters are implemented across the entire branch network. Therefore, internal governance becomes crucial for restoring banks' dynamic capabilities and consequently, a key factor in driving successful FinTech adoption and green lending.²

In order to investigate the impact of FinTech adoption on green lending, we examine how the FinTech-green lending relationship is shaped by the interplay between banks' geographic structure and internal governance characteristics. We use the Chinese commercial banking industry as a setting. Such a setting offers several advantages for our investigation. First, China is a bank-based economy in which loans (rather than bonds and stocks) serve as the primary mode for external financing (Jiang et al., 2020). According to China Statistics Yearbooks, corporate financing is predominantly sourced from commercial bank loans, with bonds and equities accounting for only a small proportion of overall funding (Jiang et al., 2020). Given their dominant role in China's financial system and the policy-driven nature of this sector (Hachem, 2025), regulators have enacted policies aimed at incentivising banks' participation in green lending (Chen et al., 2024). Appendix A summarises the key regulatory policies.

The 2012 issuance of the Green Credit Guidelines (GCG) established a comprehensive and legally enforceable framework mandating banks to integrate green lending into their core activity. At year-end 2024, the aggregate outstanding balance of green loans exceeded 36

² This proposition aligns with recent findings that agency problems arising from geographic expansion are most pronounced in poorly governed banks (Levine et al., 2021), highlighting the critical role of governance in managing dispersed operations.

trillion yuan (c. \$5 trillion) in China (People’s Bank of China, 2025).³ The size and global prominence of this form of lending makes China an ideal laboratory for the present study. China has developed a unified taxonomy for classifying and labelling green loans (Appendix B) and mandates regular disclosure requirements for such loans (Huang et al., 2023). This ensures consistency and comparability of green loan data across Chinese banks.⁴ China has also emerged as a leading FinTech market (Cumming et al., 2019; Ding et al., 2022). Its rapidly evolving FinTech ecosystem provides financial institutions with a rich and accessible range of solutions that facilitate the adoption and implementation of technologies.

Our dataset covers all listed banks in China over the 2010-2024 period. In order to successfully investigate the interplay between FinTech adoption and geographic dispersion, we address measurement challenges. Prior studies have employed technology-related inputs (Mirza et al., 2023) and textual analysis of FinTech-related keywords in media, search engines, or annual reports to measure bank FinTech involvement (Chen & Shen, 2024; Wang et al., 2020; Wu et al., 2023). These measures depend on survey data or subjective keyword selection (Ahmad et al., 2023), and may fail to adequately capture banks’ actual adoption and use of FinTech. In order to address this, we use banks’ adoption of digital lending platforms (Wu et al., 2025).⁵ The digital lending platform, which replaces traditional human-based lending processes, demands significant investment. This investment not only reflects the strategic commitment of banks but also illustrates the implementation of FinTech solutions.

To capture the geographic spread of banks’ activities, we develop a distance-adjusted

³ China’s cumulative issuance of green bonds, by the end of 2024, reached just over 0.5 trillion US dollars, being the third largest green bond market in the world (see <https://www.climatebonds.net/data-insights/publications/china-sustainable-debt-state-market-report-2024>). The substantial scale difference between green bonds and green loans once again confirms the characteristic of China’s financing activities being dominated by loans from commercial banks.

⁴ In contrast, other countries lack equivalent enforceability and thus have limited availability of comparable data on green loans.

⁵ We adopt this measure from Wu et al. (2025), who use it as a proxy for “bank digitalisation”. We refer to it as “FinTech adoption” as it directly captures the implementation of new financial technologies into a bank’s core lending operations, which is the focus of our study.

branch dispersion index. Previous studies measure geographic diversification or dispersion using one minus the Herfindahl-Hirschman index (HHI) of bank assets (or deposits) across different regions (Chu et al., 2020; Goetz et al., 2016).⁶ However, these measures overlook the geographic distance between headquarters and branches. While Deng and Elyasiani (2008) do adjust for deposit dispersion by incorporating headquarters-branch distance. This measure tends to underestimate true distance, given its reliance on zip code rather than precise geolocation.⁷

Banks in China must obtain licences from regulatory authorities before establishing branches. These licences are displayed publicly on the official websites of the regulatory authorities and contain detailed location information for each branch. In the present study, we utilise headquarters and branch latitude-longitude coordinates to compute precise geodesic distances, and adjust a conventional dispersion measure calculated as one minus branch-share HHI (based on the distribution of branches instead of deposits or assets). Consequently, our distance-adjusted branch dispersion index reflects both how widely a bank has spread its branches and the (weighted) average distance of these branches from the head office. The resulting index captures more precisely the geographic dispersion of banks, which is likely to be relevant for monitoring, coordination, and ease of technology rollout.

The interplay between FinTech adoption, geographic dispersion, and internal governance on green lending is assessed via a series of interaction terms. We first examine the

⁶ HHI of bank assets (deposits) is computed as the sum of the squared ratios of assets (deposits) from all bank branches in each region to the sum of total assets (deposits) in all regions where a bank operates. There are other measures of geographical dispersion in non-banking studies. For example, García and Norli (2012) and Platikanova and Mattei (2016) compute geographic dispersion for US firms based on state name counts in 10-K filings. Gao et al. (2008) employ a dummy variable to indicate whether a firm is geographically dispersed across different regions. In international business research, geographic dispersion is simply measured as the number of countries in which a firm operates or the number of foreign subsidiaries (Kafouros et al., 2018; Yildirim & Efthyvoulou, 2018).

⁷ For example, the zip-code-based method would assign a distance of zero to a headquarters and a branch located within the same large urban zip code, even if they are several miles apart. Our approach overcomes this precise limitation by using latitude and longitude coordinates to calculate the actual geodesic distance, ensuring no such underestimation occurs.

two-way interaction between FinTech adoption and geographic dispersion. We then introduce a three-way interaction term to examine whether strong internal governance moderates the influence that geographic dispersion has on the relationship between FinTech adoption and green lending. Our empirical strategy relies on fixed-effects models to control for unobserved time-invariant bank characteristics and common macroeconomic conditions. The primary econometric specification is a two-way fixed-effects model, which accounts for both bank-specific unobserved heterogeneity and year-specific common shocks. To mitigate concerns of reverse causality, all independent variables are lagged by one year.

By way of preview, the results of our empirical analysis suggest that FinTech adoption negatively impacts the green lending of banks that are more geographically dispersed. This supports the view that the managerial diseconomies, information asymmetries and monitoring costs often associated with dispersed branch networks creates significant agency frictions that hinder the effective deployment of FinTech. Recognising that internal characteristics may mitigate these distance-related agency frictions, and shape the capacity of banks for technology adoption, we further investigate the moderating role of internal governance. The significant positive coefficient on the triple interaction term of FinTech adoption, geographic dispersion and internal governance (together with the results of slope difference tests) suggests that when accompanied by higher-quality internal governance, highly dispersed banks can engage in more green lending by leveraging FinTech. This suggests that robust internal governance is critical for overcoming the managerial diseconomies and agency costs associated with geographic dispersion. Thus, allowing banks to realise the benefits of FinTech adoption for green lending. These findings remain robust across a battery of tests, including: alternative measures of internal governance; different sample periods and sub-samples of banks; and an instrumental variable approach to account for endogeneity.

Our findings shed light on the conditions necessary for FinTech adoption to foster green

lending. For managers, FinTech should not be regarded as a simple plug-and-play solution. Rather the decision to adopt new technologies must be treated as a major organisational change, where FinTech investments are matched by improvements in corporate governance, particularly within large, geographically dispersed banks.

We contribute to the nascent literature on the interplay between FinTech and green finance. Prior studies have established a link between FinTech and green lending. He et al. (2024) and Wan et al. (2023) use text-based FinTech indices for Chinese banks, identifying U-shaped and positive associations, respectively.⁸ These studies use ex-post financial performance indicators as mediators. A particularly relevant study is Wu et al. (2025), who provide a foundational analysis of how the adoption of digital lending platforms affects banks' capital allocation. They argue that these platforms enhance efficiency by helping banks resist political pressures and improve internal risk controls, thereby shifting capital away from high-risk sectors. Building on their work, we also use the adoption of digital lending platforms as a measure of technology adoption, but pivot the inquiry from general risk-based capital reallocation to the pursuit of a specific strategic objective, in the form of green lending. This shift in focus is critical. While Wu et al. show that FinTech helps banks avoid extending risky loans, our study explores the conditions under which FinTech helps banks do pursue strategic green objectives. We argue that prior studies, including Wu et al. have largely overlooked how ex-ante organisational characteristics moderate the impact of FinTech on such strategic lending goals. We address this gap by investigating how geographic dispersion and internal governance shape the FinTech-green lending nexus. Our key finding is that for geographically dispersed banks, FinTech adoption can paradoxically hinder green lending due to internal frictions, an effect that is reversed by strong internal governance. This provides a more nuanced understanding that not only contributes to the green finance literature, but also helps reconcile

⁸ Mirza et al. (2023) find a positive relationship for European banks.

the mixed results produced by prior studies by highlighting the crucial role of organizational context.

Our study also advances the literature on the consequences of technological change and organisational structure, behaviour and performance. Prior evidence highlights the impacts of technological advances on labour (Berg et al., 2018; Jiang et al., 2025); branch networks (Berger, 2003; Dornseifer, 2025; Glode et al., 2025), and firm performance (Hsu, 2009; Qiu & Wan, 2015). While recent studies call for a greater focus on organisational context (Mishra et al., 2022; Sun et al., 2024), the specific channels through which this context operates remains underexplored. We integrate agency theory into a dynamic capabilities framework to argue that geographic dispersion creates internal agency frictions that directly impede a bank's dynamic capabilities during FinTech rollout. Moreover, we augment prior evidence that suggests that external governance (analyst coverage and institutional investors) mitigates the agency costs associated with geographic expansion (Levine et al., 2021), by demonstrating the role of internal governance in resolving the agency frictions that arise during a period of technological implementation.

Finally, we contribute to the literature on the impacts of bank-level geographic dispersion and expansion. Prior studies have focused on advanced economies (Deng et al., 2020; Goetz et al., 2013), and measured dispersion using asset or deposit concentration. These approaches may fail to fully capture the challenges of managing branches at distance. We contribute to this literature via the development of a novel distance-adjusted branch dispersion index using precise geolocational data. This measure is designed to more accurately reflect the monitoring, coordination, and rollout costs associated with the adoption and implementation of new technologies. Moreover, we are the first to apply such a granular measure in an emerging market. This is significant given that the effects of geographic dispersion are likely to be different in bank-dominated institutional contexts, where banks face unique regulatory

pressures and internal governance challenges, compared to their counterparts in the market-based systems of advanced economies (Jiang et al., 2020). Our findings provide novel insights into how operational structure impacts technology adoption within these distinct financial systems. Thus enriching the literature on bank dispersion and expansion. The remainder of the paper is structured as follows. Section 2 provides a discussion of related literature and develops hypotheses. In Section 3, we describe our data and explain the construction of variables and empirical strategy. Section 4 presents our main results. The results of robustness checks are presented in Section 5. Section 6 concludes.

2. Literature and Hypothesis Development

The discourse regarding the economic effects of technology in banking is not new. Foundational research, exemplified by Berger (2003), established that technological progress spanning information technology and early forms of financial technologies such as credit scoring are key drivers of productivity and profitability in the banking industry. The contemporary FinTech revolution represents the latest and perhaps most disruptive wave of this long-standing trend. Accordingly, a large body of recent literature documents the multifaceted benefits of modern FinTech adoption, which include improved efficiency (Berg et al., 2020; Wu et al., 2025); and reduced risk (Chen & Shen, 2024; Wang et al., 2020), and enhanced productivity in new ways (Charoenwong et al., 2024). However, this narrative often overlooks the organisational challenges and adaptation costs associated with FinTech adoption. The successful integration of FinTech into banking activities is not necessarily guaranteed, but rather depends upon various organisational characteristics (Sun et al., 2024). Legacy systems and processes can hinder scalability and innovation. FinTech also necessitates higher IT skills (Jiang et al., 2025), which require resources for training and reskilling. Without this, technology may be under-utilised or even mis-used. Resistance to change and institutional

inertia can further obstruct the alignment and integration of FinTech in existing structures (Chen et al., 2014). Consequently, the net effect of FinTech on green lending reflects a balance between technological benefits and organisational adaptation costs. The dynamic capabilities framework provides an appropriate theoretical lens for understanding how banks manage this trade-off (Teece et al., 1997; Winter, 2003). This posits that a firm's ability to successfully integrate new technologies and reconfigure resources successfully is a core capability. Moreover, agency theory (Fama & Jensen, 1983) acts as a useful supporting framework in explaining how geographic dispersion creates agency frictions that can impede a bank's dynamic capabilities while strong internal governance can mitigate such frictions.

2.1. Geographic dispersion and distance-related agency frictions

Relative to geographically concentrated counterparts, geographically dispersed firms suffer from imperfect information flows (or information asymmetries) between headquarters and divisions (Landier et al., 2009). These asymmetries, exacerbated by distance, enable rent-seeking and hinder executive oversight (Goetz et al., 2016; Levine et al., 2021). In the context of banking organisations, geographically distant branches face less scrutiny, and employees may become disengaged (Lim et al., 2024). Physical separation also weakens shared context and team effectiveness (Cramton & Webber, 2005), increases institutional inertia (Chen et al., 2014), and excludes remote staff from decision-making (Gibson & Gibbs, 2016).

Geographic expansion raises agency costs and exacerbates frictions (Doukas & Pantzalis, 2003; Lim et al., 2024) in banking. The rollout of a complex technology like FinTech is particularly prone to these frictions. Viewed through the lens of agency theory (Jensen, 1986; Jensen & Meckling, 1976), the headquarters (principal) delegates the task of new technology implementation to branch managers (agents). Branch managers, facing their own local pressures and performance targets, may prioritise their own interests (by maintaining existing

routines) and resist the likely disruptions caused by a top-down technology adoption mandate. This resistance creates a divergence of interests between the principal and agent.

In order to ensure goal alignment, banks must engage in monitoring activities with associated costs. Geographic distance is likely to impair the principal's ability to monitor the effort expended by the agent. Prior evidence suggests that geographic distance reduces oversight and control, lowering bank valuation (Berger et al., 2005; Berger & DeYoung, 2001). Headquarters cannot easily verify whether distant branches are: diligently adopting new digital processes; providing adequate staff training; or fully integrating FinTech solutions into credit assessments. This difficulty in monitoring distant branches increases the agency costs of implementing FinTech.

Coordination enables resource deployment and learning across dispersed units (Luo, 2000), but distance-induced agency conflicts diminish these capabilities. Such frictions amplify the adaptation costs of FinTech. Branch managers may resist centralised platforms or misuse them. Effective rollout requires intensive monitoring, which is more challenging in banks that are dispersed geographically. This leads to our first hypothesis:

Hypothesis 1. *FinTech adoption is negatively (positively) associated with green lending in banks that are more (less) geographically dispersed.*

2.2. Corporate governance and agency friction mitigation

If distance-related agency frictions heighten the challenges of FinTech adoption, corporate governance may reduce these frictions. According to agency theory, good governance mitigates agency problems by reducing information asymmetries, and improving decision-making and oversight (Fama & Jensen, 1983; Levine et al., 2021). A strand of banking literature explores governance tools addressing agency issues (Anginer et al., 2018 on board attributes; Berger et al., 2016 on ownership structure; DeYoung et al., 2013 on executive compensation; and Levine

et al., 2021 on analysts and investors). However, these mechanisms target mainly conflicts between (external) shareholders and (internal) managers rather than between headquarters and branches within the same organisation. Consequently, internal governance is more relevant for mitigating these intra-firm, distance-induced frictions.

From this perspective, a firm comprises diverse agents with varying interests and growth opportunities, and its output reflects the collective effort of various managers from different hierarchies (Acharya et al., 2011). This shift focuses from owner-manager conflicts to the complex relationships between stakeholders within the firm's hierarchy. This intra-firm hierarchical perspective is particularly important for banks. Unlike many non-financial corporations, banking institutions often operate through multi-layered organisational hierarchies, with decision-making authority devolved through an extensive network of branches. Branch managers and headquarters executives may differ in objectives, information, and risk preferences. Effective internal governance procedures seek to align these interests and ensure branch-level activities support strategic goals. These include formal and informal systems, standardised procedures, performance metrics, audits, and reporting structures that ensure the management of risk and regulatory compliance (Li et al., 2024; Paletta & Alimehmeti, 2016).

Geographic dispersion intensifies agency frictions and weakens dynamic capabilities during FinTech rollout. Higher adoption and adaptation costs may outweigh benefits, leading to reduced lending at geographically dispersed banks. If internal governance improves monitoring, it can offset these frictions by reducing the associated costs of geographic dispersion. Thus enabling banks to more fully realise the benefits associated with the adoption and rollout of FinTech. Levine et al. (2021) find that agency problems arising from geographic expansion are more evident in poorly governed banks. However, the authors provide little by way of theoretical explanation or link to dynamic capabilities. In the present setting, we posit

that geographic dispersion-induced frictions and diminished capabilities can be alleviated by strong internal governance. This leads to our second hypothesis:

***Hypothesis 2.** The negative (positive) association between FinTech adoption and green lending at banks with greater (lesser) geographic dispersion is alleviated (reinforced) by more effective internal governance.*

3. Research Design

3.1. Data and variable construction

We construct an unbalanced bank-level panel, comprising all 42 listed banks in China during the 2010-2024 period. The sample includes six state-owned commercial banks (SCBs); nine joint-stock commercial banks (JCBs); 17 city commercial banks (CCBs); and 10 rural commercial banks (RCBs). These banks account collectively for over 80% of industry assets (Wang et al., 2020). The start of the sample period is determined by the availability of data on green loans.

3.1.1. Green lending

Commercial banks in China are required to report green loan balances to regulators in compliance with a unified classification catalogue for green industries (see Appendix B). This provides reliable and comparable data for green loans. Some banks voluntarily disclose green loan information to the public through annual ESG, or social responsibility reports, from which we manually collect data. Following prior research (Mirza et al., 2023; Zhou et al., 2022), green lending is measured as the proportion of green loans to total loans (*Green loan ratio*).

3.1.2 FinTech adoption

Drawing upon Wu et al. (2025), we proxy banks' FinTech adoption using the introduction of digital lending platforms. A digital lending platform is a comprehensive credit management

solution that combines various digital technologies such as AI, big data, and machine learning with financial services (Wu et al., 2025). Unlike conventional FinTech measures, such as: text-based indexes (Sun et al., 2024; Wang et al., 2020); FinTech-related patent applications (Zhao et al., 2022); establishment of FinTech subsidiaries (Zhang et al., 2020); and investments related to technology adoption (Mirza et al., 2023), the launch of a digital lending platform captures banks' actual implementation and adoption of FinTech innovations directly. *FinTech adoption*, takes a value of one for a bank in a given year if the bank has adopted the digital lending platform by that year.⁹

3.1.3. Geographic dispersion

We obtain the location information on bank branches from the China Stock Market and Accounting Research (CSMAR) database. To address the limitations of conventional geographic dispersion measures, we first visualise the geographic distribution of branches for several representative banks in Figure 1. We select two SCBs based on the largest and smallest number of branches. We then illustrate the distribution of branches in Figure 1-(a) and 1-(b) respectively. Similarly, Figure 1-(c) and 1-(d) illustrate the branch distribution of two representative JCBs. These figures provide valuable insights regarding the extent to which a bank expands its branch network. The branch distribution of the seventeen CCBs in our sample is illustrated in Figure 1-(e), while Figure 1-(f) presents the branch distribution of the ten RCBs. These distributions show that CCBs and RCBs primarily operate within a single province or city where they were founded (Luo et al., 2015). Greater dispersion can manifest either as a larger number of branches established in a wider range of areas or as increased distances between headquarters and those branches. However, the latter dimension is overlooked for the most part in prior literature. Given the crucial role of distance in information flows within

⁹ The adoption time for each bank is presented in Table 9 of Wu et al. (2025).

organisations and the inherent link between geographic dispersion and distance as depicted in Figure 1, it is crucial to consider headquarter-branch distance when gauging geographic dispersion (Landier et al., 2009).

[Figure 1 insert here]

To create our distance-adjusted branch dispersion index, we draw upon Deng and Elyasiani (2008) and Yildirim and Efthyvoulou (2018), but innovate by integrating two distinct dimensions of dispersion into a single measure. The first component captures the *breadth* of a bank's network by measuring how widely its branches are spread across different provinces. We calculate this using a conventional dispersion metric equal to one minus the HHI of the bank's branch distribution. A higher value indicates that the bank's branches are less concentrated and more evenly distributed across the country. The second component captures the *depth* of dispersion by measuring the physical distance between banks headquarters and its constituent branches. We first calculate the precise geodesic distance from each bank's headquarters to each of its constituent branches. Then, for each province a bank operates in, we compute the average headquarter-branch distance. These provincial averages are then combined into a single, bank-level weighted-average distance, where the weights are the proportion of a bank's branches in each province. Finally, our composite distance-adjusted branch dispersion index is the product of the breadth of the branch distribution and the weighted-average distance from headquarters (scaled by the sample median). Appendix C provides the computational steps in the derivation of this index.

Our distance-adjusted branch dispersion index measure is continuous and increases in value with the degree of geographic dispersion. A bank scores high on our index if it has a branch network that is both widely spread across many provinces, and is on average located at distance from headquarters. Consequently, it provides a more comprehensive picture of geographic dispersion than traditional metrics, given that it is based solely on the spatial

distribution of bank branches, independent of banks' assets or deposits across regions. This allows us to capture more accurately the monitoring and coordination challenges that are central to our study. Overall, our distance-adjusted branch dispersion index captures both the extent to which a bank has spread its branches geographically, and the (weighted) average distance of these branches from the head office. Changes in geographic dispersion can either result from changes in distribution of branches across provinces, or when branches move farther away from (or closer to) headquarters within the same province.

3.1.4. Internal governance

To measure internal governance, we require a metric that captures the mechanisms for mitigating intra-firm agency frictions (between headquarters and branches), rather than the more commonly studied external agency conflicts (between shareholders and managers). Traditional corporate governance measures, such as board characteristics, ownership structure, and management compensation, are designed primarily to address the latter. They are less suited for our study because an independent board, for example, may effectively monitor the CEO on behalf of shareholders, but it provides little insight into how well headquarters monitors and coordinates an extensive network of distant branches. Therefore, we employ the internal control index provided by the DIB Internal Control and Risk Management database. This measure is designed to assess the quality of a firm's internal operational and monitoring systems.

The DIB internal control index is a points-based measure for Chinese listed firms, compiled by the independent data provider DIB Business Risk Management Incorporated. The computation system is grounded in the internationally recognized COSO (Committee of Sponsoring Organisations of the Treadway Commission) framework, which partitions a firm's internal control system into five core components, comprising: internal environment; risk

assessment; control activities; information and communication; and monitoring (Chen, 2023). Using public disclosures from official sources, including annual reports and internal control assessment reports, DIBO evaluates a firm's performance on each component and aggregates the scores into a single index. Given its credibility, the DIBO index has been used in the literature to study internal control (Chen, 2023; Lennox & Wu, 2022).

This index is particularly well-suited for our study for two reasons. First, its computation is grounded in the COSO framework, which evaluates components directly relevant to mitigating distance-induced frictions, such as control activities (ensuring standardised FinTech implementation) and monitoring (overseeing progress in remote branches). Second, by capturing the quality of formal procedures, reporting structures, and internal audits, the DIBO index directly reflects a bank's capacity to ensure that strategic goals set at the headquarters are consistently executed across its entire network. Following prior research (Chen, 2023), we use the natural logarithm of the internal control index, which we define as *Governance* in our regression analysis.

3.1.5. Control variables

We use a myriad of bank level characteristics in our estimable model(s). We control for bank size, given that larger banks own more financial resources to (potentially) allocate to green businesses. *Size* is calculated as the natural logarithm of total assets. Following Zhou et al. (2022), *Efficiency* is defined as the ratio of earning assets to total assets. The *Loan loss provision* and *Capital adequacy* ratios, which reflect credit risk tolerance and management capabilities (Cummings & Durrani, 2016) may also influence its decisions regarding green loan issuance. Since the cost-to-income ratio may affect the volume of green credit (He et al., 2024), we include *Cost/Income* as a control. Considering that green lending represents a new growth opportunity that can be better exploited by more-capable managers (Levine et al., 2021), the

proportion of nonperforming to total loans (*Nonperforming loan*) is used as a proxy for management capability. The loan-to-assets ratio (*Loans/Assets*), calculated as gross loans divided by total assets, and the deposit-to-assets ratio (*Deposits/Assets*), calculated as total deposits divided by total assets, capture the dependency of a bank's business on borrowers and depositors (Kara et al., 2022).

According to Degryse et al. (2023), banks' green awareness and attitudes matter for green lending. We proxy green awareness (*Green awareness*) by counting the membership of Equator Principles (EP) and Principles for Responsible Banking (PRB) for each bank. As signatories to these initiatives banks signal commitment to aligning activities with climate objectives (Degryse et al., 2023). Green lending in China is also guided by regulatory policies, with major banks being mandated to report green loan balances to the central bank (Huang et al., 2021). Whether a bank is part of a pilot scheme or not may greatly affect its willingness to extend green loans. Thus, a dummy variable (*Pilot*) indicating whether a bank is within the green credit pilot scheme is also controlled.¹⁰

3.2. Estimable model

To examine the impact of FinTech adoption on green lending of banks with varying degrees of geographic dispersion, we construct the following regression model:

$$\begin{aligned} \text{Green loan ratio}_{i,t} = & \alpha_0 + \alpha_1 \text{Fintech adoption}_{i,t-1} \times \text{Dispersion}_{i,t-1} + \alpha_2 \text{Fintech adoption}_{i,t-1} \\ & + \alpha_3 \text{Dispersion}_{i,t-1} + \delta \text{Controls}_{i,t-1} + v_i + \gamma_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where i and t denote bank and year respectively. *Green loan ratio* $_{i,t}$ is the ratio of green to total loans of bank i at year t . We apply one-year lags to all right-hand-side variables in order

¹⁰ The green credit pilot scheme is a central feature of China's top-down regulatory approach to green finance. A group of "pilot" banks, mainly large state-owned and joint-stock banks, face mandatory green lending requirements, with senior management's performance evaluations directly tied to these outcomes. For all other "non-pilot" banks, green lending is voluntary and encouraged through soft guidance. This variable thus controls for the strong regulatory mandate imposed on the pilot group.

to mitigate potential concerns regarding reverse causality. $Fintech\ adoption_{i,t-1}$ is assigned a value of one for bank i in year $t - 1$ if the bank has launched the digital lending platform by that year. $Dispersion_{i,t-1}$ measures the degree of geographic dispersion of bank i in year $t - 1$. $Controls_{i,t}$ represents a vector of control variables, including *Size*, *Efficiency*, *Loan loss provision*, *Capital adequacy*, *Cost/income*, *Nonperforming loan*, *Loans/assets*, *Deposits/assets*, *Green awareness*, and *Pilot*. Table 1 presents detailed variable definitions. We also incorporate bank fixed effects, v_i , to control for the impact of time-invariant bank-level characteristics, as well as year fixed effects, γ_t , to account for time-varying macroeconomic factors such as variations in demand and business cycles (Degryse et al., 2023; Kafouros et al., 2018). $\varepsilon_{i,t}$ is the error term. Following existing banking literature (Luu et al., 2023; Wu et al., 2025), standard errors are clustered at the bank level.

Our key variable of interest is the interaction term $Fintech\ adoption_{i,t-1} \times Dispersion_{i,t-1}$. A positive coefficient on $Fintech\ adoption_{i,t-1} \times Dispersion_{i,t-1}$ implies that the adoption of digital lending platforms in banks that are more geographically dispersed enhances green lending, while a negative coefficient suggests that the adoption of digital lending platforms in such banks tends to reduce green lending (Hypothesis 1).

In order to investigate whether and how bank internal governance affects the association between FinTech adoption and green lending of banks with differing geographic dispersion, we estimate the following model:

$$\begin{aligned}
Green\ loan\ ratio_{i,t} = & \beta_0 + \beta_1 Fintech\ adoption_{i,t-1} \times Dispersion_{i,t-1} \times Governance_{i,t-1} \\
& + \beta_2 Fintech\ adoption_{i,t-1} \times Dispersion_{i,t-1} + \beta_3 Fintech\ adoption_{i,t-1} \times Governance_{i,t-1} \\
& + \beta_4 Dispersion_{i,t-1} \times Governance_{i,t-1} + \beta_5 Fintech\ adoption_{i,t-1} + \beta_6 Dispersion_{i,t-1} \\
& + \beta_6 Governance_{i,t-1} + \theta Controls_{i,t-1} + v_i + \gamma_t + \varepsilon_{i,t}
\end{aligned} \tag{2}$$

where $Governance_{i,t-1}$ represents internal governance quality of bank i in year $t - 1$. The coefficient on the three-way interaction term, $Fintech\ adoption_{i,t-1} \times Dispersion_{i,t-1} \times$

$Governance_{i,t-1}$, reflects the combined and contingent effects of FinTech adoption, geographic dispersion, and internal governance on green lending.

When estimating equations (1) and (2), all continuous variables are winsorised at the 1st and 99th percentiles in order to ensure that the results are not driven by outliers. Since the two models contain interaction terms, all non-binary independent variables are mean-centred in order to attenuate any potential threat of multicollinearity (Aiken & West, 1991). The correlation coefficients among the variables used in our regression models are reported in Appendix D. Most of the coefficients are lower than 0.3. To further mitigate concerns regarding multicollinearity, we report variance inflation factors (VIF).

[Table 1 insert here]

4. Main Results

This section presents the empirical findings of our study. We begin with a descriptive summary of the variables, followed by the main regression results testing our hypotheses.

4.1. Summary statistics and univariate analysis

Panel A of Table 2, presents descriptive statistics of the variables used in our main regressions based on the full sample of banks. The *Green loan ratio* ranges between 0% and 38.2%, suggesting a significant disparity in green lending across Chinese commercial banks. Meanwhile, the mean value of the *Green loan ratio* is 5.85%, suggesting that green loans constitute only a minor proportion of total loans on average. This suggests that the banking sector in China still possesses significant potential for participating in green lending. *FinTech adoption* has a mean of 0.768, implying that approximately 77% of our bank-year observations are from banks that have adopted digital lending platforms.

Panel B of Table 2 presents a comparison of key variables between two sub-samples,

which are divided based on the adoption status of digital lending platforms. The mean difference t-test for *Green loan ratio* indicates a significant increase in green lending after the adoption of digital lending platforms. However, this does not necessarily imply that the growth is driven by FinTech adoption. Given that *FinTech adoption* is time-related, it is difficult to disentangle its independent impact on green lending from other time-varying factors (such as increased regulatory pressure on banks green lending participation, demand-side fluctuations, and general macroeconomic conditions) that may also influence green lending practices. Therefore, while the observed increase in green lending before and after the adoption of digital lending platforms is sizeable (doubled), further rigorous empirical analysis is required to establish a clearer relationship to account for potential confounding variables.

Panel C and D of Table 2 report the results of mean difference tests for key variables between banks with above- and below-average levels of geographic dispersion and governance quality respectively. Panel C shows that geographically concentrated banks (with a dispersion index below the average) extend more green loans compared to geographically dispersed counterparts (with a dispersion index above the average). The observed difference is 3.1% (significant at the 1% level). Considering the sample average green loan ratio is 5.85%, this difference is economically substantial, representing more than half of the average ratio. Panel D further indicates that banks with lower-than-average internal control quality provide fewer green loans than those with higher-than-average internal control quality. The observed difference in this case is 1.48%, significant at the 5% level. These results imply that greater geographic dispersion and weaker internal governance may hinder banks' participation in green lending. This provides preliminary evidence regarding the linkage and direction regarding the influence of geographic structure and internal governance on banks' dynamic capabilities in adapting to technological change.

[Table 2 insert here]

4.2. Hypothesis testing

Table 3 reports the impact of FinTech adoption on green lending, as well as the variation in this relationship according to geographic dispersion (Equation (1)). The dependent variable in all columns is one-year forward *Green loan ratio*. The variance inflation (VIF) values, all below 1.8 (much lower than the threshold of 10), indicate that there are no concerns regarding multicollinearity (Aiken & West, 1991). Prior to assessing the interaction between FinTech adoption and geographic dispersion, we first check whether FinTech adoption influences green lending. The model specification in Column (1) includes only *FinTech adoption*, while the model in Column (2) builds upon Column (1) by adding control variables. In both models, the coefficients on *FinTech adoption* are statistically insignificant. This provides preliminary evidence that corroborates our assertion that while FinTech offers technical advantages for green lending, these benefits may be compromised by deficiencies in organisational adaptability. If the organisational adaptability costs offset or outweigh the technical benefits, banks would not increase green lending following FinTech adoption.

[Table 3 insert here]

In columns (3) – (5) of Table 3, we test whether geographical dispersion hinders the effective adoption of FinTech use in green lending. Column (3) presents the results without control variables, while Column (4) introduces control variables without bank and year fixed effects. In Column (5), control variables and bank and year fixed effects are included. The results suggest a consistent significant negative coefficient on the interaction term, *FinTech adoption* \times *Dispersion*, suggesting that FinTech negatively affects green lending of banks that are more geographically dispersed. This finding is consistent with our argument that longer distances and more dispersed branch networks lead to increased managerial and monitoring costs, which hamper the potential benefits of FinTech. Notably, this finding does not imply

that FinTech enhances the involvement of geographically concentrated banks on green lending.

To facilitate interpretation of our results, we plot the interactions in Figure 2 with the high/low test values set at one standard deviation above/below the mean value. The figure clearly shows two distinct patterns. For banks with high geographic dispersion (the dashed line), there is a visible downward slope, suggesting that as these banks move from non-adoption to adoption of FinTech, their green lending declines. In stark contrast, for banks with low dispersion (the solid line), the line is nearly flat, indicating no discernible impact. Following Aiken and West (1991), a simple slope test is conducted to confirm this visual intuition. We find that the relationship between FinTech adoption and green loan provision is significantly negative when dispersion is high ($b = -0.045$, $t = -2.107$, $p = 0.031$). There is no significant effect of FinTech adoption on green lending participation when dispersion is low ($b = -0.003$, $t = -0.622$, $p = 0.534$). The coefficient of -0.045 implies that for a bank with a geographic dispersion one standard deviation above the mean, adopting FinTech is associated with a 4.5 percentage point reduction in its green loan ratio. To understand what this means in practice, we compare this to the sample average. Given that the mean green loan ratio in our sample is just 5.85% (Table 2, Panel A), this 4.5 percentage point decline represents a 77% reduction relative to the mean. Such a substantial decline is not merely a statistical artifact, but instead signifies a near-complete reversal of a bank's green lending strategy. In practical terms, for a typical dispersed bank, this would mean that the frictions and costs associated with FinTech rollout effectively wipe out any existing momentum in green lending. This illustrates a critical barrier to leveraging FinTech for green lending, and is consistent with the argument in Sun et al. (2024) that the value of technological investments is not unconditional, but rather constrained by the organisational context where implementation takes place. Overall, the results of the simple slope test support our regression results and partly confirm our Hypothesis 1 that, due to decreased dynamic capabilities resulting from distance-related agency frictions,

FinTech adoption is negatively associated with the green lending in geographically more dispersed banks, albeit no significant association is observed for geographically concentrated banks.

[Figure 2 insert here]

We next investigate whether strong internal controls can mitigate the aforementioned challenges. To gain a preliminary understanding of the direction of this moderation, we first explore the direct influence of internal controls on the link between FinTech adoption and green lending. Column (1) of Table 4 reports the results. The significant positive coefficient on *FinTech adoption* \times *Governance* suggests that for banks with high-quality internal governance, FinTech adoption has a positive impact on green lending. This is consistent with our prediction that banks with more robust internal governance have stronger dynamic capabilities, enabling more effective organisational adaptation to technological changes, and releasing the benefits of FinTech for green lending activities. In columns (2) – (4) of Table 4, we focus on the interplay among FinTech adoption, geographic dispersion, and internal governance. Column (2) presents the results without control variables, while the Column (3) introduces control variables without controlling for bank and year fixed effects. The model in Column (4) includes control variables, while also controlling for bank and year fixed effects, which is the setting of equation (2). All the results provide significantly positive coefficients on the three-way interaction, *FinTech adoption* \times *Dispersion* \times *Governance*, indicating that the influence of FinTech adoption on banks' provision of green loans depends not only on the degree of geographic dispersion, but also on effective internal governance.

[Table 4 insert here]

In order to further confirm the direction of this moderation, we plot the slopes for the four relevant cases (combining high/low dispersion and high/low governance) in Figure 3. The figure reveals a divergence in outcomes for highly dispersed banks. When internal governance

is low (the solid line with black circles), FinTech adoption is associated with a sharp decline in green lending. However, when internal governance is high (the solid line with white diamonds), the relationship completely reverses, showing a steep positive association. For geographically concentrated banks, governance quality does not produce such a significant divergence; both lines remain relatively flat and close to each other. We then conduct slope difference tests following Dawson and Richter (2006). Our findings suggest that there are significant differences between the slopes of “high dispersion, high governance” and “high dispersion, low governance” ($p = 0.019$) banks. However, no significant differences are observed for low dispersion banks ($p = 0.834$). This suggests that internal governance is more relevant in moderating the relationship between FinTech adoption and green lending for geographically dispersed banks, but not for geographically concentrated counterparts. The simple slope tests we conduct further confirm that, for highly geographically dispersed banks, the relationship between FinTech adoption and green lending is significantly positive when governance effectiveness is high ($b = 0.168, t = 2.342, p = 0.02$), but remains significantly negative when governance effectiveness is low ($b = -0.104, t = -2.369, p = 0.018$). For a highly dispersed bank (at one standard deviation above the mean), moving from weak governance (one standard deviation below the mean) to strong governance (one standard deviation above the mean) fundamentally alters the outcome of FinTech adoption. The impact on the green loan ratio swings from a significant decrease of 10.4 percentage points to a significant increase of 16.8 percentage points. This swing of over 27 percentage points is not only statistically significant but also economically relevant. In practice, this means that for a dispersed bank, internal governance is not merely an incremental improvement factor but the decisive switch that determines whether FinTech adoption is an enabler or impediment to promoting green lending. These findings support Hypothesis 2 that more effective internal governance mitigates the negative impact of FinTech on green lending for more geographically dispersed banks. This

powerful result underscores that for complex organisations, the success of technological adoption is fundamentally a question of governance.

Overall, our findings suggest that the impacts of technology adoption depend on organisational structure. For a bank that adopts FinTech, strong internal governance transforms geographic dispersion from a liability to a net positive for green lending. This effectively counteracts the negative impacts of geographic dispersion and enables the bank to leverage its FinTech capabilities across a wide network. The findings align to some extent with the proposition that banks implementing substantial climate strategies are those that incorporate changes at the governance level (Furrer et al., 2011).

[Figure 3 insert here]

5. Additional Tests

In order to ensure the validity of our main findings, we conduct a battery of additional tests, including: sub-sample analyses; using alternative measures of internal governance; different sample period; and an instrumental variable approach to address endogeneity.

5.1. Nationwide banks versus regional banks

A potential concern arises from the extent of branching restrictions for different types of banks, which may compromise the comparability of our measure of geographic dispersion. In China, banks of different ownership type are subject to different branching regulations. SCBs and JCBs can operate nationwide, while CCBs and RCBs are confined largely to their home province or municipality. These differences across different ownership types implies that our distance-adjusted branch dispersion index may not be comparable across all banks. For SCBs and JCBs, it reflects strategic choice, while for CCBs and RCBs, it is largely determined by regulation. Pooling these banks in a single regression could lead to biased estimates by

conflating the effects of strategy with the effects of regulation. We conduct a sub-sample analysis where we partition the full sample into two groups, comprising: a nationwide group of SCBs and JCBs; and a regional group of CCBs and RCBs to address this issue.

Table 5 presents the results. For nationwide banks, shown in columns (1) and (2), the interaction term *FinTech adoption* \times *Dispersion* remains negative and statistically significant. This suggests that for these strategically unconstrained banks, greater geographic dispersion, in isolation weakens the benefits of FinTech adoption on green lending. However, this relationship is altered by corporate governance. In column (2), the three-way interaction term, *FinTech adoption* \times *Dispersion* \times *Governance*, is positive and highly significant. As such, these results are consistent with our main findings.

For regional banks, in columns (3) and (4), the initial interaction *FinTech adoption* \times *Dispersion* is also negative and significant. This suggests that even within their limited geographic territories, dispersion presents significant challenges. However, in column (4), the three-way interaction term *FinTech adoption* \times *Dispersion* \times *Governance* is small and statistically insignificant. This implies that, in contrast to nationwide counterparts, corporate governance does not play a significant moderating role in the relationship between FinTech, dispersion, and green lending for regional banks.

This divergence in findings is insightful and aligns with our core theory. For nationwide banks, geographic dispersion is a high-stakes strategic choice to operate in a complex, heterogeneous, and highly competitive national market. Managing such a network magnifies the internal agency frictions we theorise. Consequently, the role of internal governance in aligning incentives, standardising processes, and ensuring a coherent FinTech rollout across diverse regions becomes not just beneficial, but critically important. The strategic complexity is high, making the moderating effect of governance both powerful and statistically detectable. In contrast, for regional banks, geographic dispersion is largely a by-product of regulatory

constraints, confining them to a more homogenous and familiar home province. While distance-related frictions still exist, their scale and complexity are significantly lower. The strategic challenges are less severe, and the operational environment is more uniform. In this context, while good internal governance is undoubtedly valuable, its role as a moderating force to overcome dispersion-related challenges is less critical and therefore less likely to be statistically significant. Our results thus suggest that the economic value of internal governance as a moderating mechanism is most pronounced when firms undertake complex strategic actions, such as nationwide expansion.

[Table 5 insert here]

5.2. *Alternative measures of internal governance*

We move beyond the general internal control index to examine the role of governance capabilities specifically tailored to the FinTech era. We employ two metrics, strategy for digitalisation (*DigiStrategy*) and management for digitalisation (*DigiManagement*), from the Peking University Commercial Bank Digital Transformation Index (Chen & Shen, 2024). *DigiStrategy* quantifies the strategic emphasis a bank places on digital transformation, measured by the frequency of digital-related keywords in its annual reports. *DigiManagement* assesses the structural integration of technology into the bank's operations, encompassing its organisational architecture, the digital expertise of its management and board, and its external technology partnerships. These variables allow us to test whether a bank's explicit technology orientation and tangible technology management capacity are moderating the relationship between FinTech adoption and green lending.

The results, presented in Table 6, confirm this more nuanced hypothesis. In Column (2), where Governance is replaced by *DigiStrategy*, the three-way interaction term is positive and highly significant ($p < 0.01$). This indicates that a clear and well-communicated strategic focus

on digitalisation is crucial for ensuring that FinTech adoption translates into enhanced green lending, particularly within geographically dispersed banks. A well-articulated digital strategy, as captured by our *DigiStrategy* measure, provides a clear top-down mandate. This mandate serves to legitimise the allocation of critical resources (such as budget for staff training and IT support) and helps align performance metrics and incentives with the goals of digital implementation. By ensuring that even distant branches are both equipped and motivated to adopt the new technology, such a strategy can directly counteract the coordination and monitoring challenges inherent in geographic dispersion. Thus, enabling FinTech to better support green lending across the entire network. In Column (4), we use *DigiManagement* as a measure of the capability for governing technology. The three-way interaction term is again positive and significant ($p < 0.1$). Using this measure, shifts the focus from strategic intent to tangible capability. This suggests that having concrete digital technology management structures in place, directors with technology backgrounds, and active collaborations with tech firms are key factors in successfully translating FinTech investments into green lending outcomes, especially when facing the challenges of a dispersed branch network. This soft infrastructure of digital governance equips the bank with the necessary expertise and agility to manage a geographically dispersed operational footprint in the FinTech era.

While these alternative measures offer valuable insights into digital-specific governance capabilities, we acknowledge their limitations. The *DigiStrategy* measure (based on textual analysis of annual reports) may capture strategic intent or even “cheap talk” more than it captures actual implementation quality. Similarly, the *DigiManagement* index, while capturing important structural aspects like board expertise and technology partnerships, does not directly measure the effectiveness of these structures in day-to-day operations. Nevertheless, the fact that our findings remain consistent across our main DIBO index (which measures broad internal control quality) and these two digitalisation-focused proxies

significantly strengthens the overall validity of our conclusion that governance is a critical catalyst for geographically dispersed banks leveraging FinTech to achieve green lending goals.

[Table 6 insert here]

5.3. *Alternative sample period*

Green lending participation of Chinese banks is driven largely by regulation. The 2012 publication of the GCG marked a significant milestone for China's green finance policy system and served as a pivotal moment for banks to adopt green credit business practices (Huang et al., 2023; Luo et al., 2021). As can be seen from Appendix A, new regulatory policies on green lending have been introduced almost every year since 2012. To ensure our findings are robust within this specific policy-driven regime, we re-estimate our models on a sample starting from 2013 onwards.¹¹ Table 7 presents these results. The signs and statistical significance of our key interaction terms remain consistent across all three governance measures, confirming that our findings are stable over time.

[Table 7 insert here]

5.4. *Addressing Endogeneity: instrumental variable approach*

A banks' willingness to engage in green lending may also shape their decision regarding FinTech adoption. Indeed, other factors may drive both FinTech adoption and green lending participation of banks. Thus, causing endogeneity. While our main identification strategy (where we use one-year lags for all independent variables) reduces concerns of reverse causality, we further apply an instrumental variable approach to rule out any remaining endogeneity concerns. We instrument for *FinTech adoption* using the natural logarithm of the geographic distance from a bank's headquarters to Hangzhou (*Distance to Hangzhou*). The

¹¹ Although the GCG were issued in 2012, the policy has only been in effect since 2013.

validity of this instrument depends on relevance and exclusion criteria.

The relevance condition requires that the instrument is strongly correlated with the endogenous variable. This condition is well-motivated in our context. Hangzhou is the geographic centre of China's FinTech revolution, home to industry giants such as Alibaba and its Ant Group (Alipay), which are the largest FinTech service providers in China (Ding et al., 2022). Proximity to this vibrant FinTech hub facilitates knowledge spillovers, provides access to a specialised talent pool, and exposes banks to intense competitive pressure from FinTech firms. Therefore, banks headquartered closer to Hangzhou face lower costs and greater incentives for FinTech adoption. We expect a strong negative correlation between a bank's distance to Hangzhou and its likelihood of adopting FinTech.

The exclusion restriction condition requires that the instrument affects the outcome variable only through its influence on FinTech adoption, and not through any other channel. We argue this assumption is plausible for several reasons. A bank's green lending strategy is determined by: national-level green finance policies; exposure to specific industries; internal risk management framework; and overall corporate charter. There is no strong theoretical or economic reason to believe that a bank's geographic distance to Hangzhou in itself would systematically influence its portfolio decisions regarding green loans. While Hangzhou is a major economic city, its unique national influence is overwhelmingly concentrated in the digital technology and e-commerce sectors. Thus, its geographic gravity effect on other banks is specifically channelled through technology and innovation, rather than through broader factors (heavy industry presence or general environmental policy leadership) that would independently shape a bank's green lending. Therefore, the instrument isolates the exogenous variation in FinTech adoption driven by geographic proximity to China's primary FinTech hub.

Table 8 presents the results of two-stage least squares (2SLS) instrumental variable approach. The first-stage result based on the full sample, shown in Column (1) of Panel A,

confirm the instrument's relevance. The coefficient on *Distance to Hangzhou* is negative and highly significant, implying that banks more distant from Hangzhou are less likely to adopt FinTech.¹² The second-stage results in columns (2) and (3) corroborate our main findings. After instrumenting for FinTech adoption, the two-way interaction *FinTech adoption* \times *Dispersion* remains negative and significant, while the crucial three-way interaction *FinTech adoption* \times *Dispersion* \times *Governance* remains positive and significant.

Finally, we address a potential issue arising from the fact that all SCBs are headquartered in Beijing. This geographic concentration of banks' headquarters means that a significant subset of our sample has an identical value for the instrument, which could potentially give this single location undue influence over the estimation. To mitigate this concern, Panel B of Table 8 presents the instrumental variable analysis on an alternative sample of banks that excludes all SCBs. The results are consistent, with the three-way interaction term remaining positive and significant.

[Table 8 insert here]

In summary, the battery of tests conducted in this section confirms the robustness of our central findings. Our results hold when we analyse nationwide and regional banks separately, revealing insightful nuances about the role of free expansion in creating agency frictions. The results also remain consistent when we employ alternative digitalisation-focused measures of governance, and when we restrict the sample period to the post-GCG policy era. Finally, our instrumental variable approach helps mitigate concerns about endogeneity. Across all sample, and model specifications, the core conclusion is unchanged. The ultimate impact of FinTech adoption on green lending is not predetermined by the technology itself, but is contingent upon the interplay between a bank's geographic dispersion and its internal governance capacity. In

¹² The Kleibergen-Paap rk Wald F statistic of 50.51 exceeds the Stock-Yogo weak ID test critical value at 10%. This allows us to reject the hypothesis of a weak instrument (Gull et al., 2022).

other words, strong internal governance is a critical factor that enables geographically dispersed banks to overcome internal frictions and successfully translate FinTech investments into enhanced green lending performance.

6. Conclusions

This study is motivated by the need to understand how FinTech adoption influences the supply of green loans in commercial banks, especially in emerging markets where bank financing dominates (González, 2025; Jiang et al., 2020). While prior research has focused largely on capital markets and green bonds, the role of banks in the green transition remains underexplored. Given the growing integration of FinTech into banking operations, it is timely to examine whether and how this technological shift supports sustainable finance goals.

Our analysis reveals that FinTech adoption does not uniformly enhance green lending. Instead, its impact is contingent upon organisational characteristics. Specifically, geographic dispersion and internal governance. Banks with greater geographic dispersion face intensified agency frictions, which hinder effective FinTech implementation and reduce green lending. Conversely, banks with strong internal governance structures are better equipped to manage these frictions, enabling them to realise the benefits of FinTech adoption.

These findings contribute to the literature by highlighting the importance of organisational context in shaping the outcomes of technological change. While FinTech offers advanced tools for credit scoring, risk management, and environmental data processing, its effectiveness depends on the ability of banks to integrate these tools across branch networks. Geographic dispersion complicates this integration by increasing adaptation costs and reducing operational coherence. Internal governance through mechanisms such as performance monitoring, standardised procedures, and internal audits mitigates these challenges and restores dynamic capabilities.

Despite these insights, our study has limitations. First, the analysis is based on data from listed Chinese banks, which may limit the generalisability of the findings to other contexts. Future research could extend the framework to banks in other emerging and developed economies to validate the results. Second, while the study uses proxies for FinTech adoption and internal governance, more granular data on specific technology platforms or governance practices could provide deeper insights. Third, the cross-sectional nature of the data constrains our ability to capture long-term effects and dynamic changes in bank behaviour.

The practical implications of this study are significant. For bank executives, the findings indicate the need to assess organisational readiness prior to implementing FinTech solutions. Investments in technology should be accompanied by efforts to strengthen internal governance, especially in geographically dispersed institutions. Training, standardisation, and monitoring systems are essential to ensure consistent application and maximise the benefits of FinTech. For policymakers, our results highlight the importance of supporting institutional capacity building in banking. Regulatory frameworks should encourage banks to adopt governance practices that facilitate technology integration. In emerging markets, where banks play a central role in financing the real economy, targeted policies that promote both FinTech adoption and internal governance can assist the green transition. Moreover, central banks and financial regulators could consider offering incentives or guidance for banks to improve their internal control systems as part of broader sustainability and digitalisation agendas.

Overall, our findings suggest that FinTech adoption can support green lending, but its success depends on the organisational context in which it is implemented. Geographic dispersion and internal governance are critical factors that shape banks' dynamic capabilities and determine whether technology investments translate into intended outcomes. By recognising and addressing these factors, banks and policymakers can better harness FinTech to advance sustainable finance goals.

References

- Acharya, V. V., Myers, S. C., & Rajan, R. G. (2011). The internal governance of firms. *The Journal of Finance*, 66(3), 689-720. <https://doi.org/10.1111/j.1540-6261.2011.01649.x>
- Ahmad, R., Xie, C., Wang, P., Liu, B., Zainir, F., & Mohsin, M. I. A. (2023). FinTech innovation, stability and efficiency: Evidence from Malaysian bank industry. *International Journal of Finance & Economics*, 30(1), 221-241. <https://doi.org/10.1002/ijfe.2917>
- Aiken, L. S., & West, S. G. (1991). *Multiple regression : testing and interpreting interactions*. Newbury Park, CA: Sage Publications.
- Anginer, D., Demircuc-Kunt, A., Huizinga, H., & Ma, K. (2018). Corporate governance of banks and financial stability. *Journal of Financial Economics*, 130(2), 327-346. <https://doi.org/10.1016/j.jfineco.2018.06.011>
- Berg, A., Buffie, E. F., & Zanna, L.-F. (2018). Should we fear the robot revolution? (The correct answer is yes). *Journal of Monetary Economics*, 97, 117-148. <https://doi.org/10.1016/j.jmoneco.2018.05.014>
- Berg, T., Burg, V., Gombović, A., & Puri, M. (2020). On the rise of FinTechs: Credit scoring using digital footprints. *The Review of Financial Studies*, 33(7), 2845-2897. <https://doi.org/10.1093/rfs/hhz099>
- Berger, A. N. (2003). The economic effects of technological progress: Evidence from the banking industry. *Journal of Money, Credit, and Banking*, 35(2), 141-176. <https://doi.org/10.1353/mcb.2003.0009>
- Berger, A. N., & Bouwman, C. H. S. (2009). Bank liquidity creation. *The Review of Financial Studies*, 22(9), 3779-3837. <https://doi.org/10.1093/rfs/hhn104>
- Berger, A. N., & DeYoung, R. (2001). The effects of geographic expansion on bank efficiency. *Journal of Financial Services Research*, 19(2), 163-184. <https://doi.org/10.1023/a:1011159405433>
- Berger, A. N., Miller, N. H., Petersen, M. A., Rajan, R. G., & Stein, J. C. (2005). Does function follow organizational form? Evidence from the lending practices of large and small banks. *Journal of Financial Economics*, 76(2), 237-269. <https://doi.org/10.1016/j.jfineco.2004.06.003>
- Berger, A. N., Imbierowicz, B., & Rauch, C. (2016). The roles of corporate governance in bank failures during the recent financial crisis. *Journal of Money, Credit and Banking*, 48(4), 729-770. <https://doi.org/10.1111/jmcb.12316>
- Bolton, P., Després, M., Pereira da Silva, L. A., Samama, F., & Svartzman, R. (2020). *The green swan: Central banking and financial stability in the age of climate change*. Bank for International Settlements.
- Brickley, J. A., Linck, J. S., & Smith, C. W. (2003). Boundaries of the firm: evidence from the banking industry. *Journal of Financial Economics*, 70(3), 351-383. [https://doi.org/10.1016/s0304-405x\(03\)00170-3](https://doi.org/10.1016/s0304-405x(03)00170-3)
- Buchak, G., Matvos, G., Piskorski, T., & Seru, A. (2018). FinTech, regulatory arbitrage, and the rise of shadow banks. *Journal of Financial Economics*, 130(3), 453-483. <https://doi.org/10.1016/j.jfineco.2018.03.011>
- Chalmers, K., Hay, D., & Khlif, H. (2018). Internal control in accounting research: A review. *Journal of Accounting Literature*, 42(1), 80-103. <https://doi.org/10.1016/j.acclit.2018.03.002>
- Charoenwong, B., Kowaleski, Z. T., Kwan, A., & Sutherland, A. G. (2024). RegTech: Technology-driven compliance and its effects on profitability, operations, and market structure. *Journal of Financial Economics*, 154, 103792. <https://doi.org/10.1016/j.jfineco.2024.103792>

- Chen, J., Cumming, D., Hou, W., & Lee, E. (2014). CEO accountability for corporate fraud: Evidence from the split share structure reform in China. *Journal of Business Ethics*, 138(4), 787-806. <https://doi.org/10.1007/s10551-014-2467-2>
- Chen, Q., & Shen, C. (2024). How FinTech affects bank systemic risk: Evidence from China. *Journal of Financial Services Research*, 65(1), 77-101. <https://doi.org/10.1007/s10693-023-00421-7>
- Chen, T. (2023). Common auditors and internal control similarity: Evidence from China. *The British Accounting Review*, 55(2), 101173. <https://doi.org/10.1016/j.bar.2022.101173>
- Chen, W., Cao, Y., Dong, Y., & Ma, D. (2024). Environmental regulations and corporate cash holdings. *British Accounting Review*, 101388. <https://doi.org/10.1016/j.bar.2024.101388>
- Chen, W., Zhang, J. J., & Zhou, G. (2023). Internal governance and corporate social responsibility performance. *Journal of Business Finance & Accounting*, 51(7-8), 2201-2238. <https://doi.org/10.1111/jbfa.12783>
- Cheng, Q., Lee, J., & Shevlin, T. (2015). Internal governance and real earnings management. *The Accounting Review*, 91(4), 1051-1085. <https://doi.org/10.2308/accr-51275>
- Chu, Y., Deng, S., Xia, C., & Strahan, P. (2020). Bank geographic diversification and systemic risk. *The Review of Financial Studies*, 33(10), 4811-4838. <https://doi.org/10.1093/rfs/hhz148>
- Cramton, C. D., & Webber, S. S. (2005). Relationships among geographic dispersion, team processes, and effectiveness in software development work teams. *Journal of Business Research*, 58(6), 758-765. <https://doi.org/10.1016/j.jbusres.2003.10.006>
- Cumming, D., Guariglia, A., Hou, W., & Wu, Z. (2019). Chinese capital markets: challenges to the China model. *European Journal of Finance*, 25(6), 460-464. <https://doi.org/10.1080/1351847x.2019.1571725>
- Cummings, J. R., & Durrani, K. J. (2016). Effect of the Basel Accord capital requirements on the loan-loss provisioning practices of Australian banks. *Journal of Banking & Finance*, 67, 23-36. <https://doi.org/10.1016/j.jbankfin.2016.02.009>
- Dornseifer, F. (2025). *Does fintech expansion lead to banking deserts?* [Unpublished manuscript].
- Dawson, J. F., & Richter, A. W. (2006). Probing three-way interactions in moderated multiple regression: Development and application of a slope difference test. *Journal of Applied Psychology*, 91(4), 917-926. <https://doi.org/10.1037/0021-9010.91.4.917>
- De Haas, R. (2025). Sustainable Banking. In A. N. Berger, P. Molyneux, & J. O. S. Wilson (Eds.), *The Oxford Handbook of Banking: 4th Edition* (pp. 376-404). Oxford: Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780198897071.013.17>
- Degryse, H., Goncharenko, R., Theunisz, C., & Vadasz, T. (2023). When green meets green. *Journal of Corporate Finance*, 78, 102355. <https://doi.org/10.1016/j.jcorpfin.2023.102355>
- Degryse, H., Roukny, T., & Tielens, J. (2022). Asset overhang and technological change. *CEPR Discussion Paper No. 17507*. <https://cepr.org/publications/dp17507>
- Deng, S., & Elyasiani, E. (2008). Geographic diversification, bank holding company value, and risk. *Journal of Money, Credit and Banking*, 40(6), 1217-1238. <https://doi.org/10.1111/j.1538-4616.2008.00154.x>
- Deng, S., Mao, C. X., & Xia, C. (2020). Bank geographic diversification and corporate innovation: Evidence from the lending channel. *Journal of Financial and Quantitative Analysis*, 56(3), 1065-1096. <https://doi.org/10.1017/s0022109020000083>
- 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. <https://doi.org/10.1017/s0022109012000646>

- Ding, N., Gu, L., & Peng, Y. (2022). FinTech, financial constraints and innovation: Evidence from China. *Journal of Corporate Finance*, 73, 102194. <https://doi.org/10.1016/j.jcorpfin.2022.102194>
- Dorfleitner, G., & Braun, D. (2019). FinTech, digitalization and blockchain: Possible applications for green finance. In Migliorelli, ., Dessertine, P. (eds.) *The Rise of Green Finance in Europe* (pp. 207-237). Basingstoke: Palgrave.
- Doukas, J. A., & Pantzalis, C. (2003). Geographic diversification and agency costs of debt of multinational firms. *Journal of Corporate Finance*, 9(1), 59-92. [https://doi.org/10.1016/s0929-1199\(01\)00056-6](https://doi.org/10.1016/s0929-1199(01)00056-6)
- Fama, E. F., & Jensen, M. C. (1983). Separation of ownership and control. *The Journal of Law and Economics*, 26(2), 301-325. <https://doi.org/10.1086/467037>
- Furrer, B., Hamprecht, J., & Hoffmann, V. H. (2011). Much ado about nothing? How banks respond to climate change. *Business & Society*, 51(1), 62-88. <https://doi.org/10.1177/0007650311427428>
- Gambacorta, L., Huang, Y., Qiu, H., & Wang, J. (2024). How do machine learning and non-traditional data affect credit scoring? New evidence from a Chinese fintech firm. *Journal of Financial Stability*, 73, 101284. <https://doi.org/10.1016/j.jfs.2024.101284>
- Gao, W., Ng, L., & Wang, Q. (2008). Does geographic dispersion affect firm valuation? *Journal of Corporate Finance*, 14(5), 674-687. <https://doi.org/10.1016/j.jcorpfin.2008.08.004>
- García, D., & Norli, Ø. (2012). Geographic dispersion and stock returns. *Journal of Financial Economics*, 106(3), 547-565. <https://doi.org/10.1016/j.jfineco.2012.06.007>
- Gibson, C. B., & Gibbs, J. L. (2016). Unpacking the concept of virtuality: The effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation. *Administrative Science Quarterly*, 51(3), 451-495. <https://doi.org/10.2189/asqu.51.3.451>
- Glode, V., Ordoñez, G., & Ramadorai, T. (2025). Technological progress and rent seeking. *The Review of Financial Studies*, 38(4), 1259-1289. <https://doi.org/10.1093/rfs/hhae031>
- Goetz, M. R., Laeven, L., & Levine, R. (2013). Identifying the valuation effects and agency costs of corporate diversification: Evidence from the geographic diversification of U.S. banks. *Review of Financial Studies*, 26(7), 1787-1823. <https://doi.org/10.1093/rfs/hht021>
- Goetz, M. R., Laeven, L., & Levine, R. (2016). Does the geographic expansion of banks reduce risk? *Journal of Financial Economics*, 120(2), 346-362. <https://doi.org/10.1016/j.jfineco.2016.01.020>
- González, V. M. (2025). Influence of legal environment and banking system on trade credit in private firms. *Journal of Business Finance & Accounting*, 52(4), 1762–1783. <https://doi.org/10.1111/jbfa.12862>
- Gull, A. A., Atif, M., & Hussain, N. (2022). Board gender composition and waste management: Cross-country evidence. *The British Accounting Review*, 55(1), 101097. <https://doi.org/10.1016/j.bar.2022.101097>
- Hachem, K. (2025). Banking in China. In A. N. Berger, P. Molyneux, & J. O. S. Wilson (Eds.), *The Oxford Handbook of Banking: 4th Edition* (pp. 989–1015). Oxford: Oxford University Press. <https://doi.org/https://doi.org/10.1093/oxfordhb/9780198897071.013.35>
- He, Z., Ge, F., Ban, S., Min Du, A., & Sheehan, M. (2024). FinTech's influence on green credit provision: Empirical evidence from China's listed banking sector. *Research in International Business and Finance*, 70, 102394. <https://doi.org/10.1016/j.ribaf.2024.102394>
- Hsu, P.-H. (2009). Technological innovations and aggregate risk premiums. *Journal of*

- Financial Economics*, 94(2), 264-279. <https://doi.org/10.1016/j.jfineco.2009.01.002>
- Huang, B., Punzi, M. T., & Wu, Y. (2021). Do banks price environmental transition risks? Evidence from a quasi-natural experiment in China. *Journal of Corporate Finance*, 69, 101983. <https://doi.org/10.1016/j.jcorpfin.2021.101983>
- Huang, Z., Gao, N., & Jia, M. (2023). Green credit and its obstacles: Evidence from China's green credit guidelines. *Journal of Corporate Finance*, 82. <https://doi.org/10.1016/j.jcorpfin.2023.102441>
- Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, 76(2), 323-329. <https://doi.org/http://www.jstor.org/stable/1818789>
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360. [https://doi.org/10.1016/0304-405x\(76\)90026-x](https://doi.org/10.1016/0304-405x(76)90026-x)
- Jiang, F., Jiang, Z., & Kim, K. A. (2020). Capital markets, financial institutions, and corporate finance in China. *Journal of Corporate Finance*, 63, 101309. <https://doi.org/10.1016/j.jcorpfin.2017.12.001>
- Jiang, W., Tang, Y., Xiao, R. J., & Yao, V. (2025). Surviving the FinTech disruption. *Journal of Financial Economics*, 171. <https://doi.org/10.1016/j.jfineco.2025.104071>
- Jung, H., Engle, R. F., & Berner, R. (2025). CRISK: Measuring the climate risk exposure of the financial system. *Journal of Financial Economics*, 171. <https://doi.org/10.1016/j.jfineco.2025.104076>
- Kafourous, M., Wang, C., Mavroudi, E., Hong, J., & Katsikeas, C. S. (2018). Geographic dispersion and co-location in global R&D portfolios: Consequences for firm performance. *Research Policy*, 47(7), 1243-1255. <https://doi.org/10.1016/j.respol.2018.04.010>
- Kara, A., Nanteza, A., Ozkan, A., & Yildiz, Y. (2022). Board gender diversity and responsible banking during the COVID-19 pandemic. *Journal of Corporate Finance*, 74, 102213. <https://doi.org/10.1016/j.jcorpfin.2022.102213>
- Landier, A., Nair, V. B., & Wulf, J. (2009). Trade-offs in staying close: Corporate decision making and geographic dispersion. *Review of Financial Studies*, 22(3), 1119-1148. <https://doi.org/10.1093/rfs/hhm042>
- Lennox, C. S., & Wu, X. (2022). Mandatory internal control audits, audit adjustments, and financial reporting quality: Evidence from China. *Accounting Review*, 97(1), 341-364. <https://doi.org/10.2308/tar-2020-0152>
- Levine, R., Lin, C., & Xie, W. (2021). Geographic diversification and banks' funding costs. *Management Science*, 67(5), 2657-2678. <https://doi.org/10.1287/mnsc.2020.3582>
- Li, Q., Hu, S., & Shi, W. (2024). Internal control weakness and corporate divestitures. *Journal of Management*. <https://doi.org/10.1177/01492063241274284>
- Lim, I., Nguyen, D. D., Nguyen, L., & Wilson, J. O. S. (2024). Proximity to bank headquarters and branch efficiency: Evidence from mortgage lending. *Journal of Money, Credit and Banking*. <https://doi.org/10.1111/jmcb.13142>
- Luo, D., Dong, Y., Armitage, S., & Hou, W. (2015). The impact of foreign bank penetration on the domestic banking sector: new evidence from China. *European Journal of Finance*, 23(7-9), 752-780. <https://doi.org/10.1080/1351847x.2014.1003314>
- Luo, S., Yu, S., & Zhou, G. (2021). Does green credit improve the core competence of commercial banks? Based on quasi-natural experiments in China. *Energy Economics*, 100. <https://doi.org/10.1016/j.eneco.2021.105335>
- Luo, Y. (2000). Dynamic capabilities in international expansion. *Journal of World Business*, 35(4), 355-378. [https://doi.org/10.1016/s1090-9516\(00\)00043-2](https://doi.org/10.1016/s1090-9516(00)00043-2)
- Luu, H. N., Nguyen, L. H., & Wilson, J. O. S. (2023). Organizational culture, competition and

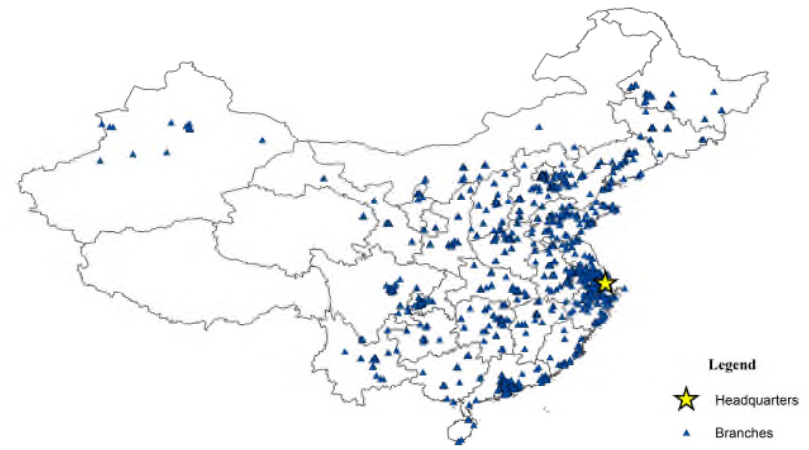
- bank loan loss provisioning. *European Journal of Finance*, 29(4), 393–418. <https://doi.org/10.1080/1351847X.2022.2053732>
- Miguel, F., Pedraza, A., & Ruiz-Ortega, C. (2024). Climate-change regulations: Bank lending and real effects. *Journal of Financial Stability*, 70, 101212. <https://doi.org/10.1016/j.jfs.2023.101212>
- Mirza, N., Umar, M., Afzal, A., & Firdousi, S. F. (2023). The role of FinTech in promoting green finance, and profitability: Evidence from the banking sector in the euro zone. *Economic Analysis and Policy*, 78, 33-40. <https://doi.org/10.1016/j.eap.2023.02.001>
- Mishra, P., Prabhala, N., Rajan, R. G., & Ramadorai, T. (2022). The relationship dilemma: Why do banks differ in the pace at which they adopt new technology? *Review of Financial Studies*, 35(7), 3418-3466. <https://doi.org/10.1093/rfs/hhab118>
- Nguyen, D. D., Ongena, S., Qi, S., & Sila, V. (2022). Climate change risk and the cost of mortgage credit. *Review of Finance*, 26(6), 1509-1549. <https://doi.org/10.1093/rof/rfac013>
- Paletta, A., & Alimehmeti, G. (2016). SOX disclosure and the effect of internal controls on executive compensation. *Journal of Accounting, Auditing & Finance*, 33(2), 277-295. <https://doi.org/10.1177/0148558x16630445>
- People's Bank of China. (2025). *Statistical report on loan allocation of financial institutions in the fourth quarter of 2024*. Retrieved from <http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/5588566/index.html>
- Platikanova, P., & Mattei, M. M. (2016). Firm geographic dispersion and financial analysts' forecasts. *Journal of Banking & Finance*, 64, 71-89. <https://doi.org/10.1016/j.jbankfin.2015.11.012>
- Qiu, J., & Wan, C. (2015). Technology spillovers and corporate cash holdings. *Journal of Financial Economics*, 115(3), 558-573. <https://doi.org/10.1016/j.jfineco.2014.10.005>
- Reghezza, A., Altunbas, Y., Marques-Ibanez, D., Rodriguez d'Acari, C., & Spaggiari, M. (2022). Do banks fuel climate change? *Journal of Financial Stability*, 62. <https://doi.org/10.1016/j.jfs.2022.101049>
- Sun, Z., Liu, L., Johan, S., & Zhao, L. (2024). FinTech adoption and corporate greenwashing: A technology affordance perspective. *British Journal of Management*, 36(3), 978-1002. <https://doi.org/10.1111/1467-8551.12879>
- Sustainable Digital Finance Alliance. (2018). *Digital technologies for mobilizing sustainable finance: Applications of digital technologies to sustainable finance*. Retrieved from: https://unepinquiry.org/wp-content/uploads/2018/10/Digital_Technologies_for_Mobilizing_Sustainable_Finance.pdf
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533. [https://doi.org/10.1002/\(sici\)1097-0266\(199708\)18:7<509::Aid-smj882>3.0.Co;2-z](https://doi.org/10.1002/(sici)1097-0266(199708)18:7<509::Aid-smj882>3.0.Co;2-z)
- Thompson, P., & Cowton, C. J. (2004). Bringing the environment into bank lending: implications for environmental reporting. *British Accounting Review*, 36(2), 197-218. <https://doi.org/10.1016/j.bar.2003.11.005>
- UNEP. (2016). *FinTech and sustainable development: Assessing the implications*. Retrieved from: https://unepinquiry.org/wp-content/uploads/2016/12/FinTech_and_Sustainable_Development_Assessing_the_Implications.pdf
- Wan, S., Lee, Y. H., & Sarma, V. J. (2023). Is FinTech good for green finance? Empirical evidence from listed banks in China. *Economic Analysis and Policy*, 80, 1273-1291. <https://doi.org/10.1016/j.eap.2023.10.019>
- Wang, R., Liu, J., & Luo, H. (2020). FinTech development and bank risk taking in China. *The European Journal of Finance*, 27(4-5), 397-418.

- <https://doi.org/10.1080/1351847x.2020.1805782>
- Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, 24(10), 991-995. <https://doi.org/10.1002/smj.318>
- Wu, S., Tian, H., & Wang, C. (2025). Bank digitalization and capital reallocation. *Journal of Business Ethics*, 199(3), 583-601. <https://doi.org/10.1007/s10551-024-05844-3>
- Wu, X., Jin, T., Yang, K., & Qi, H. (2023). The impact of bank FinTech on commercial banks' risk-taking in China. *International Review of Financial Analysis*, 90, 102944. <https://doi.org/10.1016/j.irfa.2023.102944>
- Xu, Q., Kim, T., & Jiang, W. (2022). Financial constraints and corporate environmental policies. *Review of Financial Studies*, 35(2), 576-635. <https://doi.org/10.1093/rfs/hhab056>
- Yildirim, C., & Efthyvoulou, G. (2018). Bank value and geographic diversification: regional vs global. *Journal of Financial Stability*, 36, 225-245. <https://doi.org/10.1016/j.jfs.2018.04.003>
- Zhang, A., Wang, S., Liu, B., & Liu, P. (2020). How FinTech impacts pre- and post-loan risk in Chinese commercial banks. *International Journal of Finance & Economics*, 27(2), 2514-2529. <https://doi.org/10.1002/ijfe.2284>
- 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, 102552. <https://doi.org/10.1016/j.jimonfin.2021.102552>
- Zhou, X. Y., Caldecott, B., Hoepner, A. G. F., & Wang, Y. (2022). Bank green lending and credit risk: an empirical analysis of China's Green Credit Policy. *Business Strategy and the Environment*, 31(4), 1623-1640. <https://doi.org/10.1002/bse.2973>

Figure 1 Geographic distribution of branches of selected banks in our sample



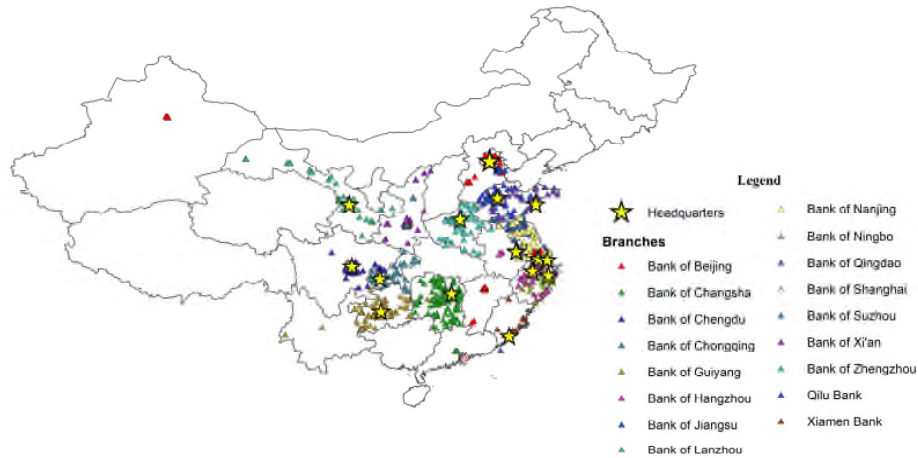
(a) Postal Savings Bank of China



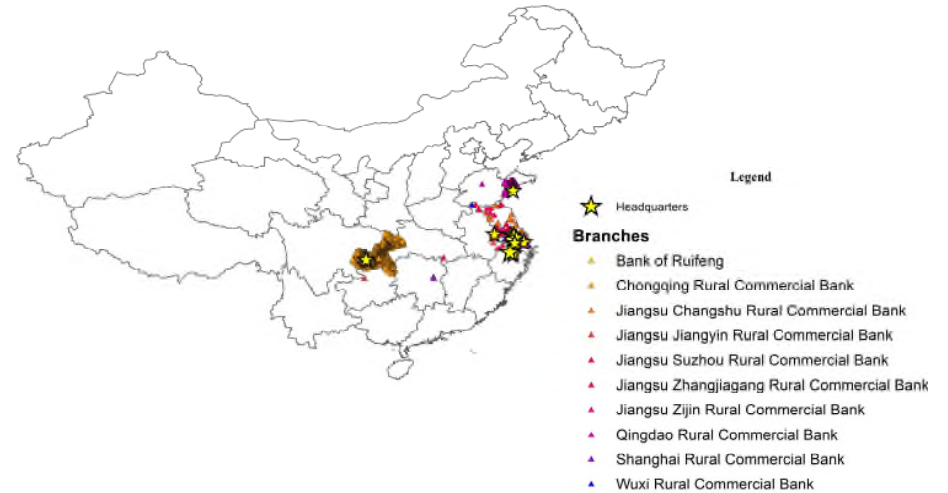
(b) Bank of Communications



(c) China Minsheng Bank



(d) China Zheshang Bank

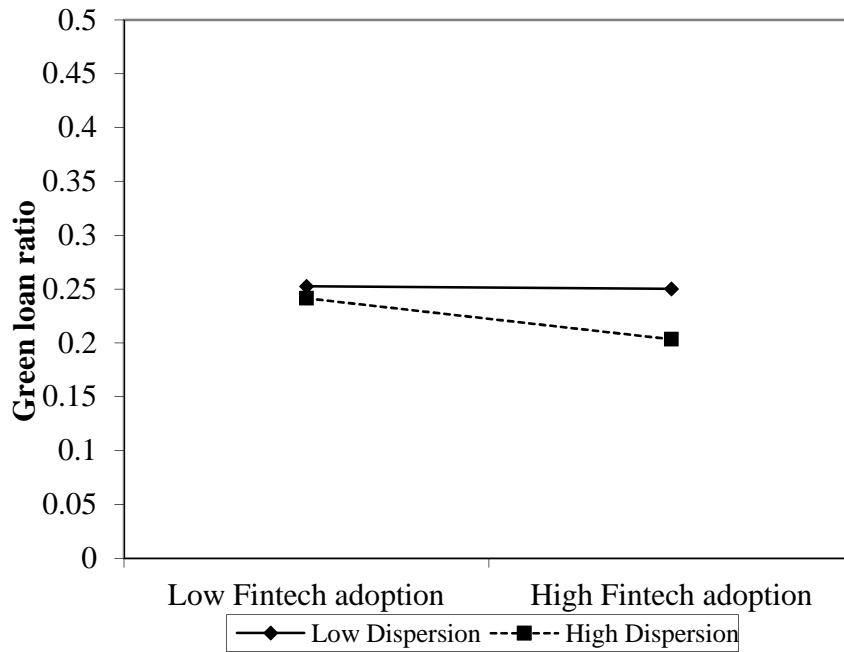


(e) All CCBs in the sample

(f) All RCBs in the sample

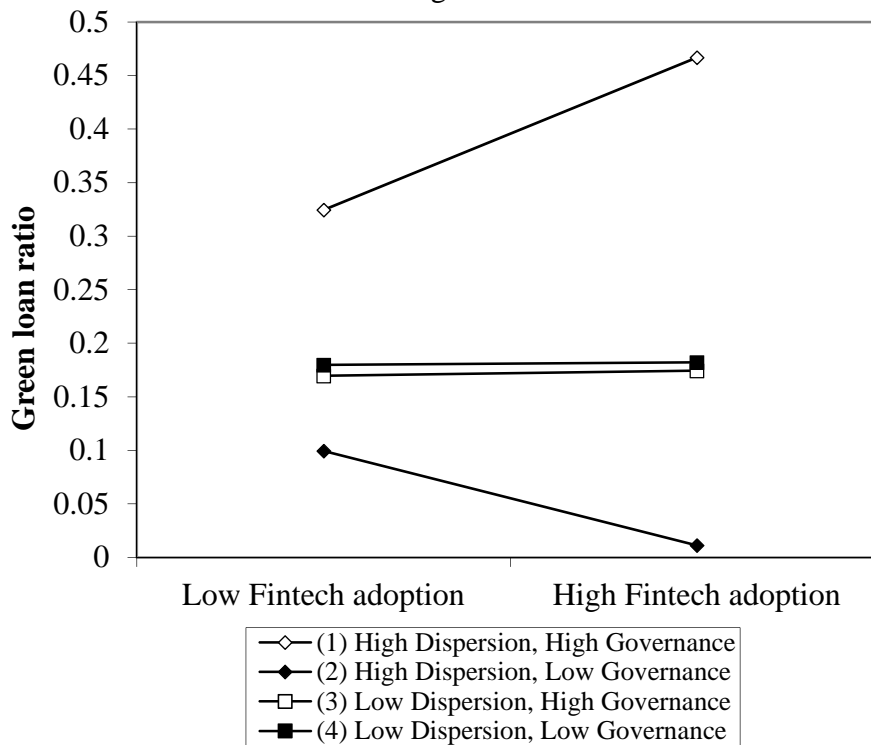
Notes: This figure illustrates the geographic distribution of headquarters and branches for selected Chinese commercial banks. The maps visually represent the varying degrees of geographic dispersion across different bank types. In all panels, headquarters are marked by a star, and individual branches are represented by smaller markers. Panels (a) and (b) depict the branch networks of two SCBs, selected to represent the maximum and minimum branch network size within this category in our sample. Panels (c) and (d) illustrate the branch distributions for two representative JCBs. Similar to SCBs, these banks operate with nationwide branching licenses. Panel (e) aggregates the branch locations of all seventeen CCBs in our sample. Each bank's branches and headquarters are denoted by a unique colour-marker combination as specified in the legend. The distributions are visibly more concentrated, typically clustering within the province of the bank's headquarters, consistent with their regional branching restrictions. Panel (f) aggregates the branch locations of all ten RCBs in our sample. The branch networks of RCBs are even more geographically constrained, generally operating within the city and surrounding counties where the bank is headquartered.

Figure 2 Two-way interaction between FinTech adoption and dispersion on green loan ratio



Notes: This figure plots the marginal effect of FinTech adoption on the green loan ratio at high and low levels of geographic dispersion. The plot visually represents the two-way interaction effect reported in Table 3, Column (5).

Figure 3 Three-way interaction among FinTech adoption, dispersion, and governance on green loan ratio



Notes: This figure plots the three-way interaction among FinTech adoption, geographic dispersion, and internal governance on the green loan ratio, based on the results from Table 4, Column (4).

Table 1 Variable definitions.

Variable	Definition	Data Source
Dependent variable		
<i>Green loan ratio</i>	The proportion of green loan balance in total loan balance of a bank.	Banks' social responsibility reports or annual reports
Independent variables		
<i>FinTech adoption</i>	Indicator variable that equals one for a specific bank in a given year if the bank has launched the digital lending platform by that year.	Wu et al. (2025)
<i>Dispersion</i>	Distance-adjusted branch dispersion index, constructed as the product of branch dispersion and weighted average headquarter-branch distance scaled by the median distance of the sample, where branch dispersion is calculated as one minus HHI of bank branches across provinces, and weighted average headquarter-branch distance is calculated as the average distance of all branches in the province from its headquarters and the weights being each province's branches as a fraction of all institutions of the bank.	CSMAR and author construction
<i>Governance</i>	The natural logarithm of internal control index.	DIB database
Control variables		
<i>Size</i>	The natural logarithm of total assets.	CSMAR
<i>Efficiency</i>	The ratio of earning assets to total assets.	CSMAR
<i>Loan loss provision</i>	The ratio of loan loss provisions to total assets.	CSMAR
<i>Capital adequacy</i>	Bank Tier 1 and Tier 2 capital divided by risk-weighted assets.	CSMAR
<i>Cost/Income</i>	Cost-to-income ratio.	CSMAR
<i>Nonperforming loan</i>	Non-performing loan ratio, calculated as outstanding non-performing loans divided by total assets.	CSMAR
<i>Loans/Assets</i>	Total loans divided by total assets.	CSMAR
<i>Deposits/Assets</i>	Total deposits divided by total assets.	CSMAR
<i>Green awareness</i>	The number of a bank's membership in EP and PRB.	Official websites of EP and PRB, author processed
<i>Pilot</i>	Binary variable that takes a value of one if the bank is a green credit pilot bank, and zero otherwise.	Regulatory documents
Additional variables		
<i>DigiStrategy</i>	An index measuring a bank's strategic focus on digital transformation, constructed based on the frequency of digital-related keywords in its annual reports.	Peking University Commercial Bank Digital Transformation Index
<i>DigiManagement</i>	A composite index assessing the integration of digital technology into the bank's governance and management, covering its digital architecture, digital talent (on the board and executive team), and external technology partnerships.	

Notes: This table provides the definitions of variables used in this study.

Table 2 Summary statistics.

Panel A: Full sample	N	Mean	Std.	Min	p25	Median	p75	Max
<i>Green loan ratio</i>	393	0.0585	0.0575	0.0000	0.0167	0.0489	0.0778	0.3824
<i>FinTech adoption</i>	393	0.7684	0.4224	0.0000	1.0000	1.0000	1.0000	1.0000
<i>Dispersion</i>	393	0.1149	0.2158	0.0021	0.0311	0.0330	0.0875	1.3025
<i>Governance</i>	393	6.4564	0.1458	5.6369	6.4002	6.4563	6.5264	6.8844
<i>Size</i>	393	14.5700	1.5908	11.3065	13.2386	14.6613	15.7834	17.7037
<i>Efficiency</i>	393	0.8764	0.1049	0.0009	0.8577	0.8957	0.9201	1.0480
<i>Loan loss provision</i>	393	0.0339	0.0382	0.0144	0.0260	0.0312	0.0379	0.7760
<i>Capital adequacy</i>	393	0.1374	0.0202	0.0988	0.1261	0.1349	0.1463	0.3386
<i>Cost/Income</i>	393	0.3040	0.0580	0.1238	0.2711	0.2969	0.3288	0.6482
<i>Nonperforming loan</i>	393	0.0128	0.0037	0.0053	0.0096	0.0129	0.0152	0.0247
<i>Loans/Assets</i>	393	0.5136	0.0762	0.2704	0.4687	0.5235	0.5670	0.7156
<i>Deposits/Assets</i>	393	0.6537	0.0930	0.4428	0.5793	0.6411	0.7328	0.9123
<i>Green awareness</i>	393	0.2036	0.4621	0.0000	0.0000	0.0000	0.0000	2.0000
<i>Pilot</i>	393	0.4758	0.5001	0.0000	0.0000	0.0000	1.0000	1.0000

Panel B: FinTech adoption	Not adopted		Adopted		Mean difference t-test
	N	Mean	N	Mean	Below vs. Above
<i>Green loan ratio</i>	91	0.0292	302	0.0674	-0.0382***
<i>FinTech adoption</i>	91	0.0000	302	1.0000	-1.0000
<i>Dispersion</i>	91	0.1297	302	0.1105	0.0193
<i>Governance</i>	91	6.5301	302	6.4343	0.0958***

Panel C: Dispersion	Below mean		Above mean		Mean difference t-test
	N	Mean	N	Mean	Below vs. Above
<i>Green loan ratio</i>	313	0.0649	80	0.0338	0.0310***
<i>FinTech adoption</i>	313	0.7827	80	0.7125	0.0702
<i>Dispersion</i>	313	0.0421	80	0.3997	-0.3575***
<i>Governance</i>	313	6.4579	80	6.4508	0.0071

Panel D: Governance	Below mean		Above mean		Mean difference t-test
	N	Mean	N	Mean	Below vs. above
<i>Green loan ratio</i>	168	0.0501	225	0.0649	-0.0148**
<i>FinTech adoption</i>	168	0.7440	225	0.7867	-0.0426
<i>Dispersion</i>	168	0.1407	225	0.0957	0.0450**
<i>Governance</i>	168	6.3740	225	6.5180	-0.1439***

Notes: This table summarises the descriptive statistics for the variables included in our main analyses. Panel A focuses on the full sample, whereas Panels B, C, and D present univariate t-tests for subsamples based on *FinTech adoption*, *Dispersion*, and *Governance*, respectively. Variable definitions are presented in Table 1. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3 FinTech adoption and green lending: the role of geographic dispersion.

	(1)	(2)	(3)	(4)	(5)
<i>FinTech adoption</i> × <i>Dispersion</i>			-0.0528***	-0.1161***	-0.0325**
			(0.0175)	(0.0412)	(0.0149)
<i>FinTech adoption</i>	-0.0073 (0.0053)	-0.0022 (0.0043)	-0.0063 (0.0055)	0.0139** (0.0065)	-0.0027 (0.0044)
<i>Dispersion</i>		0.0047 (0.0110)	0.0072 (0.0138)	-0.0264** (0.0118)	0.0027 (0.0115)
<i>Size</i>		-0.0190 (0.0210)		0.0057** (0.0024)	-0.0131 (0.0193)
<i>Efficiency</i>		0.0024 (0.0062)		0.0063 (0.0138)	0.0024 (0.0057)
<i>Loan loss provision</i>		-0.0233** (0.0093)		0.0344* (0.0200)	-0.0215** (0.0091)
<i>Capital adequacy</i>		0.1469 (0.1032)		0.3246** (0.1405)	0.1564 (0.1050)
<i>Cost/Income</i>		0.0865 (0.0660)		-0.1417** (0.0593)	0.0806 (0.0576)
<i>Nonperforming loan</i>		-1.3675* (0.7869)		-1.5952** (0.7241)	-1.2655 (0.7786)
<i>Loans/Assets</i>		-0.0381 (0.0547)		-0.1163** (0.0542)	-0.0435 (0.0488)
<i>Deposits/Assets</i>		-0.0477 (0.0422)		0.0370 (0.0422)	-0.0231 (0.0411)
<i>Green awareness</i>		0.0307*** (0.0065)		0.0608*** (0.0168)	0.0265*** (0.0062)
<i>Pilot</i>		-0.0009 (0.0115)		0.0117 (0.0110)	0.0044 (0.0120)
Constant	0.0672*** (0.0040)	0.3551 (0.3358)	0.0642*** (0.0044)	-0.0007 (0.0755)	0.2536 (0.3079)
Bank FE	Yes	Yes	Yes	No	Yes
Year FE	Yes	Yes	Yes	No	Yes
Observations	352	352	352	352	352
Adjusted R ²	0.9121	0.9359	0.9228	0.6882	0.9393
Mean VIF	1.0000	1.7478	1.0801	1.7584	1.7584

Notes: This table reports the results examining the impact of FinTech adoption on green lending in general, as well as the variation of this relationship across different geographic structures. The dependent variable in all columns is green loan ratio. All independent variables are lagged by one year to reduce reverse causality concerns. Columns (1) and (2) investigate the association between FinTech adoption and green loan ratio, where Column (1) excludes control variables and Column (2) includes those variables. Columns (3) – (5) investigate the role of geographic dispersion on the association between FinTech adoption and green loan ratio, where Column (3) excludes control variables, Column (4) includes control variables but does not control for bank and year fixed effects, and Column (5) includes controls as well as bank and year fixed effects. The variable of interest is *FinTech adoption* × *Dispersion*, which indicates the deterioration of green lending in banks with greater geographic dispersion following the adoption of FinTech. Variable definitions are presented in Table 1. Standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4 FinTech adoption and green lending: the role of geographic dispersion and internal governance.

	(1)	(2)	(3)	(4)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>		0.7054** (0.3218)	1.0697* (0.5458)	0.5679** (0.2550)
<i>FinTech adoption</i> × <i>Dispersion</i>		-0.0348** (0.0149)	-0.0889*** (0.0295)	-0.0211* (0.0120)
<i>FinTech adoption</i> × <i>Governance</i>	0.0222* (0.0122)	0.0802*** (0.0286)	0.0869 (0.0520)	0.0601** (0.0231)
<i>Dispersion</i> × <i>Governance</i>		0.2915** (0.1310)	0.4915* (0.2542)	0.2995** (0.1304)
<i>FinTech adoption</i>	-0.0009 (0.0043)	0.0009 (0.0054)	0.0209*** (0.0055)	0.0018 (0.0046)
<i>Dispersion</i>	0.0042 (0.0110)	0.0380 (0.0234)	-0.0103 (0.0107)	0.0193 (0.0172)
<i>Governance</i>	-0.0045 (0.0044)	0.0208* (0.0118)	0.0624* (0.0313)	0.0199* (0.0109)
<i>Size</i>	-0.0162 (0.0213)		0.0043 (0.0032)	-0.0159 (0.0196)
<i>Efficiency</i>	0.0024 (0.0062)		0.0077 (0.0137)	0.0015 (0.0051)
<i>Loan loss provision</i>	-0.0246** (0.0095)		0.0257 (0.0165)	-0.0220** (0.0095)
<i>Capital adequacy</i>	0.1467 (0.1041)		0.2380 (0.1472)	0.0981 (0.0924)
<i>Cost/Income</i>	0.0827 (0.0648)		-0.1274** (0.0585)	0.0828 (0.0523)
<i>Nonperforming loan</i>	-1.3419 (0.8150)		-1.3107* (0.6948)	-1.0960 (0.7618)
<i>Loans/Assets</i>	-0.0415 (0.0545)		-0.1137** (0.0506)	-0.0558 (0.0449)
<i>Deposits/Assets</i>	-0.0515 (0.0426)		0.0298 (0.0458)	-0.0322 (0.0404)
<i>Green awareness</i>	0.0306*** (0.0065)		0.0537*** (0.0147)	0.0236*** (0.0059)
<i>Pilot</i>	-0.0008 (0.0118)		0.0134 (0.0125)	0.0091 (0.0137)
Constant	0.3480 (0.3428)	-0.0789 (0.0769)	-0.3838** (0.1589)	0.1767 (0.3001)
Bank FE	Yes	Yes	No	Yes
Year FE	Yes	Yes	No	Yes
Observations	352	352	352	352
Adjusted R ²	0.9359	0.9311	0.7107	0.9442
Mean VIF	1.7858	1.8423	2.0003	2.0003

Notes: This table reports the results examining the role of internal governance in mitigating the dampening impact of geographical dispersion on the enabling potential of FinTech. The dependent variable in all columns is green loan ratio. All independent variables are lagged by one year to reduce reverse causality concerns. Column (1) investigates the direct influence of internal governance on the link between FinTech adoption and green lending. Columns (2) – (4) examine the complicated interplay among FinTech adoption, geographic dispersion, and internal governance, and the combined impact on green lending, where Column (2) excludes control variables, Column (3) includes control variables but does not control for bank and year fixed effects, and Column (4) includes controls as well as bank and year fixed effects. The variable of interest is *FinTech adoption* × *Dispersion* × *Governance*, indicating that the influence of FinTech adoption on the provision of green loans depends on the complicate interplay between geographic dispersion and internal governance of banks. Variable definitions are presented in Table 1. Standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5 FinTech adoption and green lending: nationwide banks vs. regional banks.

	Nationwide banks:		Regional banks:	
	SCBs & JCBs		CCBs & RCBs	
	(1)	(2)	(3)	(4)
<i>FinTech adoption</i> × <i>Dispersion</i>	-0.0503* (0.0248)	-0.0286** (0.0132)	-0.0270** (0.0112)	-0.0262** (0.0105)
<i>FinTech adoption</i> × <i>Governance</i>		0.1567*** (0.0327)		0.0540 (0.0553)
<i>Dispersion</i> × <i>Governance</i>		-0.6658 (1.9304)		0.1354 (0.1063)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>		1.5626*** (0.2630)		0.0703 (0.1595)
<i>FinTech adoption</i>	-0.0056 (0.0071)	0.0032 (0.0085)	-0.0043 (0.0100)	-0.0019 (0.0091)
<i>Dispersion</i>	-0.3277 (0.8662)	-0.2275 (0.8568)	0.0479* (0.0266)	0.0451 (0.0283)
<i>Governance</i>	-0.0031 (0.0075)	-0.0588 (0.1703)	0.0238* (0.0129)	0.0183 (0.0150)
<i>Size</i>	-0.0301 (0.0226)	-0.0322 (0.0184)	-0.0044 (0.0244)	-0.0131 (0.0274)
<i>Efficiency</i>	0.0148** (0.0055)	0.0120* (0.0056)	-0.0080 (0.0048)	-0.0066 (0.0045)
<i>Loan loss provision</i>	-0.9158 (0.6058)	-1.1370*** (0.3310)	-0.0170** (0.0076)	-0.0164** (0.0077)
<i>Capital adequacy</i>	0.2373** (0.0875)	0.0367 (0.0541)	-0.1288 (0.1841)	-0.0990 (0.1898)
<i>Cost/Income</i>	0.0211 (0.0762)	-0.0025 (0.0595)	0.1000 (0.0781)	0.1091 (0.0804)
<i>Nonperforming loan</i>	-1.4191 (1.2345)	-1.3321 (0.9276)	-0.7041 (0.8909)	-0.6841 (0.8540)
<i>Loans/Assets</i>	-0.0138 (0.0461)	-0.0396 (0.0377)	-0.0370 (0.0709)	-0.0454 (0.0710)
<i>Deposits/Assets</i>	-0.0433 (0.0789)	-0.0637 (0.0538)	-0.0805 (0.0777)	-0.0904 (0.0780)
<i>Green awareness</i>	0.0220** (0.0093)	0.0129* (0.0062)	0.0217*** (0.0047)	0.0210*** (0.0044)
<i>Pilot</i>	-	-	0.0099 (0.0145)	0.0097 (0.0148)
Constant	0.6085 (0.4136)	1.0608 (1.0079)	0.0166 (0.3750)	0.1676 (0.4389)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	178	178	174	174
Adjusted R ²	0.9538	0.9720	0.9089	0.9088
Mean VIF	2.3632	9.8167	1.8517	2.1409

Notes: This table reports the results of a sub-sample analysis, which was conducted to address the institutional heterogeneity in branching regulations between nationwide (SCBs & JCBs) and regional (CCBs & RCBs) banks. The dependent variable in all columns is green loan ratio. All independent variables are lagged by one year to reduce reverse causality concerns. Columns (1) and (2) present the results for nationwide banks, while Columns (3) and (4) show the results for regional banks. All specifications include control variables as well as bank and year fixed effects. Variable definitions are presented in Table 1. Standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6 FinTech adoption and green lending: alternative governance measures.

	Governance =		Governance =	
	DigiStrategy		DigiManagement	
	(1)	(2)	(3)	(4)
<i>FinTech adoption</i> × <i>Dispersion</i>	-0.0326** (0.0153)	-0.0547*** (0.0135)	-0.0327** (0.0149)	-0.0481*** (0.0120)
<i>FinTech adoption</i> × <i>Governance</i>		0.0001** (0.0000)		0.0001 (0.0001)
<i>Dispersion</i> × <i>Governance</i>		-0.0003*** (0.0001)		-0.0002 (0.0006)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>		0.0002*** (0.0001)		0.0007* (0.0003)
<i>FinTech adoption</i>	-0.0028 (0.0044)	-0.0155** (0.0069)	-0.0030 (0.0046)	-0.0079 (0.0058)
<i>Dispersion</i>	0.0039 (0.0123)	0.0183 (0.0134)	0.0026 (0.0117)	-0.0021 (0.0123)
<i>Governance</i>	0.0000 (0.0000)	-0.0001* (0.0000)	-0.0000 (0.0001)	-0.0001 (0.0001)
<i>Size</i>	-0.0133 (0.0192)	-0.0093 (0.0165)	-0.0147 (0.0190)	-0.0183 (0.0165)
<i>Efficiency</i>	0.0022 (0.0058)	0.0029 (0.0054)	0.0027 (0.0056)	0.0024 (0.0047)
<i>Loan loss provision</i>	-0.0214** (0.0093)	-0.0170** (0.0081)	-0.0219** (0.0093)	-0.0161* (0.0083)
<i>Capital adequacy</i>	0.1546 (0.1054)	0.1663* (0.0958)	0.1553 (0.1038)	0.1854* (0.0935)
<i>Cost/Income</i>	0.0826 (0.0585)	0.0778 (0.0529)	0.0764 (0.0638)	0.0728 (0.0618)
<i>Nonperforming loan</i>	-1.2930 (0.7723)	-1.5987** (0.6985)	-1.2459 (0.7896)	-1.2087 (0.7954)
<i>Loans/Assets</i>	-0.0443 (0.0490)	-0.0381 (0.0462)	-0.0445 (0.0485)	-0.0490 (0.0442)
<i>Deposits/Assets</i>	-0.0252 (0.0409)	-0.0232 (0.0415)	-0.0220 (0.0405)	-0.0232 (0.0391)
<i>Green awareness</i>	0.0262*** (0.0063)	0.0242*** (0.0058)	0.0263*** (0.0060)	0.0259*** (0.0056)
<i>Pilot</i>	0.0044 (0.0118)	-0.0131 (0.0103)	0.0047 (0.0118)	-0.0074 (0.0124)
Constant	0.2556 (0.3064)	0.2139 (0.2638)	0.2794 (0.3067)	0.3399 (0.2716)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	352	352	352	352
Adjusted R ²	0.9392	0.9439	0.9392	0.9435
Mean VIF	1.7750	6.1643	1.7966	7.5002

Notes: This table reports the results of a robustness check using alternative measures of governance—*DigiStrategy* and *DigiManagement*—to re-examine the moderating effect of governance. The dependent variable in all columns is green loan ratio. All independent variables are lagged by one year to reduce reverse causality concerns. Columns (1) and (2) use *DigiStrategy* as the governance measure, while Columns (3) and (4) use *DigiManagement*. The variable of interest is *FinTech adoption* × *Dispersion* × *Governance*, where Governance is represented by the alternative digital governance metrics. All models include a full set of control variables and both bank and year fixed effects. Variable definitions are presented in Table 1. Standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 7 FinTech adoption and green lending: sample period starting from 2013.

	(1)	(2)
Panel A: Governance = Internal control index		
<i>FinTech adoption</i> × <i>Dispersion</i>	-0.0360** (0.0134)	-0.0238** (0.0109)
<i>FinTech adoption</i> × <i>Governance</i>		0.0419* (0.0246)
<i>Dispersion</i> × <i>Governance</i>		0.2628** (0.1273)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>		0.6451*** (0.2218)
Explanatory variables & Controls	Yes	Yes
Bank FE	Yes	Yes
Year FE	Yes	Yes
Observations	323	323
Adjusted R ²	0.9460	0.9519
Mean VIF	2.0825	2.1681
Panel B: Governance = DigiStrategy		
<i>FinTech adoption</i> × <i>Dispersion</i>	-0.0364** (0.0139)	-0.0549*** (0.0133)
<i>FinTech adoption</i> × <i>Governance</i>		0.0000 (0.0000)
<i>Dispersion</i> × <i>Governance</i>		-0.0003*** (0.0001)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>		0.0002*** (0.0001)
Explanatory variables & Controls	Yes	Yes
Bank FE	Yes	Yes
Year FE	Yes	Yes
Observations	323	323
Adjusted R ²	0.9461	0.9490
Mean VIF	2.1316	7.2508
Panel C: Governance = DigiManagement		
<i>FinTech adoption</i> × <i>Dispersion</i>	-0.0360*** (0.0132)	-0.0484*** (0.0115)
<i>FinTech adoption</i> × <i>Governance</i>		0.0000 (0.0001)
<i>Dispersion</i> × <i>Governance</i>		0.0003 (0.0007)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>		0.0004 (0.0004)
Explanatory variables & Controls	Yes	Yes
Bank FE	Yes	Yes
Year FE	Yes	Yes
Observations	323	323
Adjusted R ²	0.9459	0.9487
Mean VIF	2.1442	10.4029

Notes: The table presents the results of a robustness check conducted on a sample period starting from 2013. The analysis is presented in three panels, each using a different measure of governance. The dependent variable in all columns is green loan ratio. All independent variables are lagged by one year to reduce reverse causality concerns. Panel A uses the internal control index, Panel B uses *DigiStrategy*, and Panel C uses *DigiManagement* as the moderating variable. Specifications include the full set of explanatory and control variables and control for bank and year fixed effects. The control variables are the same as in previous regressions, including *Size*, *Efficiency*, *Loan loss provision*, *Capital adequacy*, *Cost/income*, *Nonperforming loan*, *Loans/assets*, *Deposits/assets*, *Green awareness*, and *Pilot*. Variable definitions are presented in Table 1. Standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 8 FinTech adoption and green lending: instrumental variable approach.

Dependent variable:	First stage		Second stage	
	(1)	(2)	(3)	(3)
	FinTech adoption	Green loan ratio	Green loan ratio	Green loan ratio
Panel A: Full sample				
<i>Distance to Hangzhou</i>	-0.2500*** (0.0358)			
<i>FinTech adoption</i> × <i>Dispersion</i>		-0.0598** (0.0273)		-0.0653** (0.0265)
<i>FinTech adoption</i> × <i>Governance</i>				0.0844** (0.0385)
<i>Dispersion</i> × <i>Governance</i>				-0.1378 (0.1469)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>				1.0621** (0.4774)
<i>FinTech adoption</i>		-0.0108 (0.0394)		0.0032 (0.0295)
<i>Dispersion</i>	0.3757*** (0.0949)	0.0627 (0.0447)		0.0997* (0.0521)
<i>Governance</i>	-0.1152 (0.1069)	0.0011 (0.0086)		-0.0029 (0.0164)
Controls	Yes	Yes		Yes
Bank FE & Year FE	Yes	Yes		Yes
Observations	352	352		352
Adjusted R ²	0.7581	0.7734		0.7779
Kleibergen-Paap rk Wald F statistic	50.51	-		-
Stock-Yogo weak ID test critical value at 10% maximal IV size	16.38	-		-
Mean VIF	1.7290	2.2091		2.2749
Panel B: Alternative sample				
<i>Distance to Hangzhou</i>	-0.2118*** (0.0387)			
<i>FinTech adoption</i> × <i>Dispersion</i>		-0.0529** (0.0258)		-0.0584** (0.0257)
<i>FinTech adoption</i> × <i>Governance</i>				0.0823* (0.0408)
<i>Dispersion</i> × <i>Governance</i>				-0.1368 (0.1534)
<i>FinTech adoption</i> × <i>Dispersion</i> × <i>Governance</i>				0.9718** (0.4743)
<i>FinTech adoption</i>		-0.0005 (0.0385)		0.0135 (0.0302)
<i>Dispersion</i>	0.3149*** (0.0922)	0.0559 (0.0448)		0.0904* (0.0522)
<i>Governance</i>	-0.2119 (0.1842)	0.0157 (0.0105)		0.0106 (0.0177)
Controls	Yes	Yes		Yes
Bank FE & Year FE	Yes	Yes		Yes
Observations	281	281		281
Adjusted R ²	0.7484	0.7670		0.7710
Kleibergen-Paap rk Wald F statistic	27.21	-		-
Stock-Yogo weak ID test critical value at 10% maximal IV size	16.38	-		-
Mean VIF	1.9601	2.2542		2.1993

Notes: This table presents the results of the two-stage least squares instrumental variable analysis used to address potential endogeneity of FinTech adoption. Panel A presents results for the full sample, while Panel B uses an alternative sample excluding SCBs. In both panels, Column (1) reports the first-stage regression where *FinTech adoption* is the dependent variable. Columns (2) and (3) report the second-stage results, where the dependent variable is green loan ratio and all independent variables are lagged by one year to reduce reverse causality concerns. *Distance to Hangzhou* is used as the instrument for FinTech adoption. All models include control variables and bank and year fixed effects. The control variables are the same as in previous regressions, including *Size*, *Efficiency*, *Loan loss provision*, *Capital adequacy*, *Cost/income*, *Nonperforming loan*, *Loans/assets*, *Deposits/assets*, *Green awareness*, and *Pilot*. Variable definitions are presented in Table 1. Standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Appendix A. Key regulatory policies for green lending in China

Year	Policy document	Policymaker	Main contents
2007	Opinions on Implementing Environmental Protection Policies and Regulations to Prevent Credit Risks	MEE, PBC, CBRC	Strengthen the coordination of credit risk management and environmental protection; intensify environmental supervision and management.
2012	Green Credit Guidelines	CBRC	<p>Banks shall promote green credit as a strategy, effectively identify, assess, monitor, control or mitigate environmental and social risks, disclose green credit related information. The green credit management system is refined from the aspects of organisational structure, policies and capacity building, lending process management, internal management and information disclosure, and supervision and inspection.</p> <p>Roles and responsibilities for banks' board of directors and senior management constitute the organisational structure part. Specifically, banks' board of directors shall promote concepts related to green credit, develop a sustainable business model that allows win-win for banks and the society at large, and is responsible for defining and evaluating the implementation of banks' green credit growth strategy. The senior management of banks shall follow boards' decisions, be responsible for the process management of green credit implementation and green credit information disclosure to the board or the regulators.</p>
2013	Green Credit Statistics System	CBRC	<p>The scope of green credit statistics is defined (for the first time). Banks are required to report green loans and their environmental benefits according to a pre-defined table. Loans to enterprises with major environmental and safety risks also need to be reported.</p>
2014	Notice on Key Performance Indicators of Green Credit Implementation	CBRC	<p>All banks are required to facilitate and thoroughly carry out self-assessment of their green credit implementation following the requirements of the green credit KPI and submit self-evaluation reports to the CBRC. The key indicators include functions of the board of directors in setting up and supervising green credit strategy, the establishment of senior management systems to ensure the implementation of green credit, designation of green credit lead management department, customer classification management regarding environmental and social risks, innovation in green credit processes/services/products, employee training on green credit concepts, green credit due diligence and approval process, etc.</p>
2016	Guidelines on Establishing the Green Financial System	PBC, MoF, NDRC, MEE, CBRC, etc.	<p>The green financial system is defined as the institutional arrangements to support green transition through green credit, green bond, green stock index and related products, green development fund, green insurance, carbon finance and other financial instruments, and related policies. A series of policy stimulus are proposed to mobilize and encourage more capital to invest in green sectors while restricting investment in polluting sectors. The guidelines encourage commercial banks to evaluate loans and exposures to assets in high environmental risk areas, and to quantify related risks.</p>
2017	Implementation Plan of Green Bank Evaluation for Chinese Banking Industry	CBA	<p>The CBRC will conduct green bank evaluation (including qualitative and quantitative evaluation) annually in main banks including the development financial institution, policy banks, SCBs and JCBs, and will gradually enlarge the evaluation scope to small and medium-sized commercial banks in the future. The quantitative evaluation indicators include organisational administration (30% weighting, including board responsibilities that account for the highest weight of 12%), policy and institutional capacity building (25%),</p>

			process management (25%), internal control and information disclosure (15%), supervision and inspection (5%).
2018	Green Credit Performance Evaluation Scheme for Depository Financial Institutions in Banking	PBC	The PBC will carry out the work of green credit performance evaluation quarterly. The green credit performance evaluation indicators are divided into two parts: quantitative (80% weighting) and qualitative (20% weighting). Quantitative indicators include the proportion of green loan balance, the market share of green loan balance, the proportion of green loan increment, the year-on-year growth rate of green loan balance and the non-performing rate of green loans; qualitative index score is given by the PBC's rating based on daily operation and the results of quantitative indicators of the bank.
2020	Measures for the Performance Evaluation of Commercial Banks	MoF	The proportion of green loan balance in total outstanding loans is included in the assessment of commercial banks serving national development goals and the real economy.
2021	Green Finance Performance Evaluation Scheme for Financial Institutions in Banking	PBC	Revisions to the 2018 green credit performance evaluation scheme, which enlarges the evaluation scope from green credit to all green financial businesses, including but not limited to, green loans, green securities, green equity investments, green leasing, green trust, and green wealth management, etc.
2022	Green Finance Guidelines for the Banking and Insurance Sectors	CBIRC	Compared with the 2012 Green Credit Guidelines, the green finance guidelines expand the scope of financial institutions following the guidelines from banks to insurers. Banking and insurance institutions are required to promote green finance at a strategic level, focus on ESG risks of customers, and carry out full-coverage ESG supervision.

Notes: This table lists the key green lending-related policies for the banking sector in China. The policies were sorted by the authors with referring to the official government documents and the Green Finance Platform (<https://www.greenfinanceplatform.org/financial-measures/browse/country/china-192>). PBC is the People's Bank of China, CBRC is the China Banking Regulatory Commission (later known as the CBIRC), MEE is the Ministry of Ecology and Environment of the People's Republic of China, NDRC is the National Development and Reform Commission of the People's Republic of China, MoF is the Ministry of Finance of the People's Republic of China, CBA is the China Banking Association, CSRC is the China Securities Regulatory Commission.

Appendix B. Classification catalogue of green loans in China

1. Energy-saving and Environmental Protection Industry

- 1.1 High-efficiency Energy-saving Equipment Manufacturing
 - 1.2 Advanced Environmental Protection Equipment Manufacturing
 - 1.3 Resource Recycling Equipment Manufacturing
 - 1.4 New Energy Vehicles and Green Ship Manufacturing
 - 1.5 Energy-saving Retrofitting
 - 1.6 Pollution Control
 - 1.7 Resource Circular Utilisation
-

2. Clean Production Industry

- 2.1 Green Upgrade of Industrial Parks
 - 2.2 Non-toxic and Harmless Raw Material Substitution and Hazardous Waste Management
 - 2.3 Production Process Waste Gas Treatment and Disposal and Resource Comprehensive Utilisation
 - 2.4 Production Process Water-saving and Wastewater Treatment and Disposal and Resource Comprehensive Utilisation
 - 2.5 Production Process Waste Residue Treatment and Disposal and Resource Comprehensive Utilisation
-

3. Clean Energy Industry

- 3.1 New Energy and Clean Energy Equipment Manufacturing
 - 3.2 Clean Energy Facility Construction and Operation
 - 3.3 Clean and Efficient Use of Traditional Energy
 - 3.4 Efficient Operation of Energy Systems
-

4. Ecological Environment Industry

- 4.1 Ecological Agriculture
 - 4.2 Ecological Protection
 - 4.3 Ecological Restoration
-

5. Greening of Infrastructure

- 5.1 Energy-saving and Green Building
 - 5.2 Green Transportation
 - 5.3 Environmental Infrastructure
 - 5.4 Urban Energy Infrastructure
 - 5.5 Sponge City
 - 5.6 Greening and Landscaping
-

6. Green Services

- 6.1 Consulting Services
 - 6.2 Project Operation and Management
 - 6.3 Project Assessment, Audit, and Verification
 - 6.4 Monitoring and Testing
 - 6.5 Technology and Product Certification and Promotion
-

Notes: This table lists the green industry classification catalogue (translated) used by Chinese banks to identify green loans. Only those loan proceeds allocated to these specified industries can be labelled as green loans. The catalogue comprises six primary categories, 30 secondary categories, and 211 tertiary categories. For the sake of brevity, only the primary and secondary categories are presented herein.

Appendix C. Construction of the distance-adjusted branch dispersion index

First, we construct a conventional *branch dispersion* measure, calculated as one minus HHI of bank branches across provinces ($i = 1, 2, \dots, m$), where HHI is the sum of squared ratios of the number of branches in each province where a bank operates to the number of all institutions (including all branches and the headquarters) of the bank:

Branch dispersion = 1 – HHI of branches

$$= 1 - \sum_{i=1}^m \left(\frac{\text{number of branches in province } i}{\text{total institutions of the bank}} \right)^2$$

$$i = 1, 2, \dots, m \text{ (} m = \text{total number of provinces)} \quad (\text{A.1})$$

In the next step, we compute the distance (d_j) in kilometres between a bank's headquarters and its branches ($j = 1, 2, \dots, n$) using the latitudes and longitudes of the headquarters and branches. We then calculate the *weighted average distance* between a bank's headquarters and the provinces it operates in, with the headquarter-province mean distance calculated as the average distance of all branches in the province from its headquarters and the weights being each province's branches as a fraction of all institutions of the bank:

$$\text{Weighted avg distance} = \sum_{i=1}^m (\text{weight}_i \times \text{headquarter_province mean distance}_i)$$

$$= \sum_{i=1}^m \left(\text{share of branches in province } i \times \frac{\sum_{j=1}^{k_i} d_{i,j}}{k_i} \right)$$

$$i = 1, 2, \dots, m \text{ (} m = \text{total number of provinces),}$$

$$j = 1, 2, \dots, n \text{ (} n = \text{total number of branches),}$$

$$k_i = \text{total number of branches in province } i \quad (\text{A.2})$$

Finally, we define distance-adjusted branch dispersion index as the product of branch dispersion (equation (A.1)) and a relative distance measure calculated as the weighted average distance (equation (A.2)) scaled by the median distance across all banks in the sample:¹³

¹³ Similar to Deng and Elyasiani (2008), we use the median distance as the scale factor. Alternative measures such as mean distance or maximum distance can also serve as a scaling factor.

$$\text{Distance_adjusted branch dispersion} = \text{Branch dispersion} \times \frac{\text{Weighted avg distance}}{\text{Median distance}} \quad (\text{A.3})$$

Appendix D. Correlation matrix

	Green loan ratio	FinTech adoption	Dispersion	Governance	Size	Efficiency	Loan loss provision	Capital adequacy	Cost/Income	Nonperforming loan	Loans/Assets	Deposits/Assets	Green awareness	Pilot
Green loan ratio	1.0000													
FinTech adoption	0.2802***	1.0000												
Dispersion	-0.1963***	-0.0377	1.0000											
Governance	0.1008**	-0.2775***	-0.0410	1.0000										
Size	0.4167***	0.0344	-0.1789***	0.1800***	1.0000									
Efficiency	0.0246	-0.0592	-0.0775	0.0319	0.1763***	1.0000								
Loan loss provision	-0.0283	0.0902*	0.0197	-0.0226	-0.1433***	-0.1023**	1.0000							
Capital adequacy	0.3056***	0.3562***	-0.0470	0.0400	0.2248***	-0.0021	0.0090	1.0000						
Cost/Income	-0.1459***	-0.1666***	-0.2247***	0.1097**	-0.0989*	-0.0064	0.0409	-0.0452	1.0000					
Nonperforming loan	-0.0107	0.1847***	-0.1615***	-0.3681***	0.0829	0.1077**	-0.0435	0.0356	-0.2795***	1.0000				
Loans/Assets	0.0367	0.2071***	-0.3346***	0.0625	0.1815***	0.1319***	0.0374	0.2498***	0.1325***	0.0452	1.0000			
Deposits/Assets	-0.2062***	-0.2067***	-0.2329***	0.2652***	-0.0172	0.0919*	0.0908*	0.1837***	0.4622***	-0.1976***	0.3861***	1.0000		
Green awareness	0.6899***	0.2029***	-0.1330***	0.0572	0.2260***	-0.0057	-0.0228	0.1555***	-0.0365	-0.0051	0.0191	-0.2282***	1.0000	
Pilot	0.3363***	0.1244**	-0.1410***	-0.0308	0.7686***	0.1636***	-0.1182**	0.0861*	-0.1329***	0.2792***	0.3021***	-0.1712***	0.2311***	1.0000

Notes: This table provides the correlation matrix of the variables used in this study. *Observations* = 393. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.



The Centre for Responsible Banking & Finance
CRBF Working Paper Series
Department of Finance, University of St Andrews
The Gateway, North Haugh,
St Andrews, Fife,
KY16 9RJ.
Scotland, United Kingdom
<https://crbf.wp.st-andrews.ac.uk/>



Recent CRBF Working papers published in this Series

First Quarter | 2026

26-004 **Shumiao Ouyang, Hayong Yun, Xingjian Zheng:** AI as Decision-Maker: Ethics and Risk Preferences of LLMs.

26-003 **Anjan V. Thakor:** Organizational Higher Purpose, Employee Effort and Firm Financial Performance.

26-002 **J. Michael Collins and Carly Urban:** The Devil is in the Details: State-mandated Personal Finance Education and Financial Well-being.

26-001 **José M. Liñares-Zegarra and John O.S. Wilson:** Technology Adoption and Productivity: Evidence from UK SMEs.

Fourth Quarter | 2025

25-023 **Carly Urban:** What is the Educational Cost of Mandating Personal Finance Education?

25-022 **Diemo Dietrich and Thomas Gehrig:** Talk and the City: How Far to Trust Bankers (Not) Calling for Bailouts?

25-021 **Kais Bouslah, Jose M. Liñares-Zegarra, Ahmed Marhfor:** Stakeholder Orientation and Investment Efficiency: Disentangling the Effect on Intangible and Tangible Investments.

25-020 **Duc Duy Nguyen, Steven Ongena, Shusen Qi, Vathunyoo Sila, Yibing Wang:** Biodiversity Risk and Small Business Lending.

25-019 **Khanh Hoang, Linh Pham, Vu Trinh, ..., Harris Vu:** Government-sourced Categorical Economic Policy Uncertainty.



University of St Andrews
Scotland's first university

600 YEARS
1413 – 2013