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FinTech Adoption and Corporate Greenwashing: A Technology Affordance Perspective

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Affordance theory suggests that technology offers certain opportunities or 'affordances' that can be exploited by users. In this context, we are exploring how FinTech adoption provides opportunities to address corporate greenwashing. Drawing on an affordance perspective, we assert that FinTech adoption effectively inhibits corporate greenwashing behaviour, primarily through facilitating green innovation and improving managerial efficiency. We also contend that the impact of FinTech adoption on reducing greenwashing behaviour is not uniform across all industries. It is more pronounced in heavy-polluting industries, indicating that FinTech has a greater effect in encouraging accurate disclosure of environmental information in environmentally sensitive sectors. Conversely, its impact is weaker in high-tech industries, which might already have strong environmental commitments. The findings contribute to the literature on sustainability, FinTech and governance.

Introduction

With the growing global emphasis on green transformation and sustainability, environmental performance has become a key factor for investors in assessing firm value (Lee and Raschke, 2023; Tang and Tang, 2018). Many companies are striving to project an eco-friendly image by disclosing their environmental efforts through annual or sustainability reports (Borgstedt *et al.*, 2019; Schmuck, Matthes and Naderer, 2018). However, some firms engage in greenwashing, using misleading descriptions or avoiding full disclosure (Huang, 2022; Lee and Raschke, 2023; Siano *et al.*, 2017). Greenwashing not only undermines the credibility of sustainability efforts but also slows progress towards a greener business environment (Delmas and Burbano, 2011). If unpunished, it could encourage other firms to follow suit (Hameed *et al.*, 2021; Nygaard and Silkoset, 2022; Wang, Ma and Bai, 2019). Despite this, corporate greenwashing has not received sufficient attention in academia (Ruiz-Blanco, Romero and Fernandez-Feijoo, 2022; Seele and Gatti, 2017), making it a pressing issue.

FinTech, recognized for its role in reshaping financial services through technology (Financial Stability Board, 2017), encompasses a broad spectrum of activities, from payment systems to asset management and risk management (Ahlstrom, Cumming and Vismara, 2018; Haddad and Hornuf, 2019). Some studies suggest that FinTech can drive innovation and sustainability (Cumming *et al.*, 2024; Cumming, Johan and Reardon, 2023; Gao and Jin, 2022; Yan *et al.*, 2022), while others raise concerns about its potential to exacerbate information asymmetries (Ahlstrom, Cumming and Vismara, 2018). This raises the question: Does FinTech reduce or increase corporate greenwashing? There has been little research on how FinTech adoption affects corporate greenwashing (Luo *et al.*, 2022; Yan *et al.*, 2022), revealing a gap in understanding the mechanisms behind this relationship (Liu and Li, 2024; Nygaard and Silkoset, 2022; Si Mohammed *et al.*, 2024; Xie *et al.*, 2023).

Corporate greenwashing is influenced not only by FinTech adoption but also by the contextual factors in which these technologies are applied (Majchrzak *et al.*, 2013; Orazalin, Ntim and Malagila, 2024). Ahlstrom, Cumming and Vismara (2018) call for further research on how governance mechanisms interact with financial innovations to impact firm performance. Since industries vary in their governance structures, it is important to study how FinTech adoption in specific industries may curb greenwashing, a topic that remains underexplored. To address this gap, we apply affordance theory to investigate the connection between FinTech and greenwashing. Affordance theory, which looks at how technology and contextual factors interact, is useful for explaining why FinTech has different effects on greenwashing across industries.

China provides a valuable context for studying FinTech and greenwashing due to its role as a global leader in FinTech innovation (Cumming *et al.*, 2019). Over the last decade, China has seen rapid growth in FinTech, with cities like Beijing and Shanghai emerging as major hubs (Das, 2019). Additionally, China has long prioritized green development and tackled greenwashing, as evidenced by its release of a greenwashing list in 2009 (Guo *et al.*, 2017). This ongoing commitment to environmental sustainability makes China an ideal setting to explore how FinTech adoption influences greenwashing (Cumming, Hou and Lee, 2016; Tang and Tang, 2018; Wang, Ma and Bai, 2019; Wu, Zhang and Xie, 2020; Zhang, 2022).

Our empirical analysis focuses on Chinese non-financial listed firms from 2011 to 2021. While FinTech emerged in the early twenty-first century, large-scale development in China has occurred mainly over the past decade. The availability of greenwashing data also makes this timeframe relevant. Our extended sample allows us to observe the evolution of FinTech and its influence on greenwashing. We argue that FinTech adoption curbs greenwashing by promoting green innovation and enhancing managerial efficiency. Additionally, we consider high-tech and heavy-polluting industries as key contextual affordances in our research framework. These industries interact with FinTech in unique ways, affecting how firms manage greenwashing.

Our study contributes to the literature in several ways. First, we apply affordance theory to FinTech and demonstrate how it can alleviate greenwashing, offering a new perspective that counters the view that FinTech merely amplifies information asymmetry (Ahlstrom, Cumming and Vismara, 2018). Instead, we support Cumming et al.'s (2024) argument that FinTech is a catalyst for sustainable business development. This research enriches both affordance theory and the FinTech literature by highlighting its role in promoting sustainability. Second, we address the largely overlooked issue of greenwashing within the sustainability literature. While previous research has focused on the positive aspects of sustainability and ESG in FinTech, such as crowdfunding (Cumming *et al.*, 2024), we broaden the scope by investigating the inverse dimension of sustainability greenwashing. Our study reveals the mechanisms through which FinTech can improve transparency and reduce greenwashing. Third, we explore how the impact of FinTech varies across different governance mechanisms and industries. Prior studies have noted that technologies can have different effects depending on the context in which they are adopted (Ahlstrom, Cumming and Vismara, 2018; Huang, Meoli and Vismara, 2020; Liu *et al.*, 2023). We expand this line of research by showing that FinTech's ability to curb greenwashing is stronger in heavy-polluting industries but weaker in high-tech industries, offering a nuanced understanding of how technological and contextual affordances interact.

In conclusion, our findings highlight the importance of context when assessing the impact of FinTech on corporate greenwashing. By examining the interplay between FinTech and industry-specific factors, we provide a deeper understanding of how FinTech can promote transparency and reduce deceptive environmental practices.

Theory and hypothesis development

FinTech: Features and applications

FinTech is characterized by technology-driven financial innovation (Pan *et al.*, 2018), differentiating itself from traditional finance through two key aspects: integration and precision. Integration refers to the combination of digital technology with traditional financial services, creating new business models (Borgstedt *et al.*, 2019; Collevecchio *et al.*, 2024). Precision focuses on matching financial services to user needs, enabling personalized solutions and improving business coverage and accuracy (Borgstedt *et al.*, 2019). FinTech also enhances managerial efficiency by providing real-time access to internal information, allowing for better monitoring of operations (Luo *et al.*, 2022).

Given these features, FinTech can play a pivotal role in advancing sustainable development and supporting green transformation. However, research on how FinTech influences firms' sustainability outcomes remains limited. Corporate greenwashing, where firms deceive the market about their environmental practices due to incomplete information and market asymmetry, poses significant challenges to sustainability (Huang, 2022). Previous studies have examined internal organizational factors and external institutional factors like environmental regulation and media exposure in mitigating greenwashing (Kolbjørnsrud, Amico and Thomas, 2016; Li *et al.*, 2023; Ruiz-Blanco, Romero and Fernandez-Feijoo, 2022; Wedari, Jubb and Moradi-Motlagh, 2021). However, the role of FinTech in reducing greenwashing remains underexplored. Investigating why some firms experience greater success in alleviating greenwashing despite using similar FinTech tools could uncover important insights into how firms and FinTech interact in diverse contexts (Huang, Meoli and Vismara, 2020; Liu *et al.*, 2023; Piccoli, 2016).

The affordance perspective of FinTech adoption

Affordance theory, initially proposed by Gibson (1977), has been widely used to explore how individuals or organizations with specific perceptions and skills adopt technology (Hutchby, 2014; Juris, 2012). In organizational management research, it emphasizes both the material attributes of technology and the subjective nature of organizations (Hutchby, 2001). Technology affordance often focuses on the ability of the design and function of a specific technology to meet a specific need in theory, without considering the factors of the actual application environment or context (Majchrzak *et al.*, 2013). Differently, contextual affordance is more focused on the actual use of the environment and context, referring to the ability of technology to meet a specific need in a specific environment or context (Liu *et al.*, 2023). In fact, the actual effect of technology affordance is often limited by the context in which it is used. For example, a headset with advanced noise cancellation may be more functional in a noisy environment, but its noise cancellation effect may not be obvious in a quiet environment. In this paper, we employ technology affordance theory encompassing technology affordances and contextual affordances to explore the relationship between FinTech adoption and corporate greenwashing behaviour. By integrating technology attributes with seemingly unrelated factors (Gibson, 1977), technology affordance theory allows for a comprehensive understanding of the interaction between corporate subjects and FinTech.

Technology affordances of FinTech adoption

A trade-off between benefits and costs is a key driver of greenwashing (Lyon and Maxwell, 2011; Sutherland, 2018; Zhang, 2023). How FinTech adoption influences the costs and benefits of greenwashing can be observed as follows.

First, FinTech adoption has greatly increased the cost and risk of corporate greenwashing. Firms and investors can leverage FinTech to store environment-related data, thereby enhancing the credibility and immutability of data, and improving the objectivity of environmental performance. This makes costly any attempt to conceal negative environmental information (i.e. greenwashing) through false data (Gai, Qiu and Sun, 2018). It means that firms will face huge cover-up costs, and there is also a high possibility of facing legal litigation and high fines (Erel and Liebersohn, 2022; Petersen and Rajan, 2002), thereby augmenting the difficulty of greenwashing. Second, FinTech adoption has compressed the potential benefits of greenwashing. Investors utilize big data analysis techniques and algorithms to analyse firms' production and operation (Liu and Li, 2024; Si Mohammed *et al.*, 2024), including energy consumption, emissions and other environmental issues. This encourages firms to engage in green production, energy conservation and emission reduction, in order to attract funds. This improvement in substantive action makes firms' unsustainable behaviour like greenwashing unnecessary (Liu and Li, 2024; Xie *et al.*, 2023).

Of course, some may counter that FinTech empowers various investors to dynamically monitor and trace information, potentially incentivizing firms to engage in greenwashing, especially when faced with poor performance. Although blockchain and other FinTech solutions provide immutability and traceability of data once it is on the chain (Chod *et al.*, 2020), they fail to guarantee the authenticity and accuracy of the source information. Therefore, firms are likely to undertake strategic information manipulation prior to the information uploading on the chain. In other words, FinTech might give rise to more severe information asymmetry. When the number of firms adopting FinTech is relatively small, it is more lucrative for them to greenwash. Conversely, as an increasing number of firms with transaction relevance upload data in the blockchain, it will facilitate information cross-validation (Cong and He, 2019). This also implies that when a firm engages in greenwashing unilaterally, it is highly likely to be detected due to inconsistent information provided by the associated firms in the supply chain. In such a scenario, the cost of greenwashing for firms increases, and accordingly, the willingness to greenwash decreases. Based on the above analysis, we propose the following benchmark assumption:

H1a: With more FinTech adoption, it can inhibit corporate greenwashing.

Mechanism of green innovation

The first important mechanism through which FinTech adoption mitigates greenwashing behaviour is by facilitating firms' green innovation. Green innovation refers to environmentally friendly innovations that effectively alleviate environmental impacts through developing new products and processes (Huang *et al.*, 2023). It involves a 'green walk' with substantive actions (Walker and Wan, 2012). We argue that the integration and precision offered by FinTech play a crucial role in facilitating green innovation, thereby suppressing corporate greenwashing behaviour.

First, FinTech can be applied to accurately identify the quality of corporate innovation (Metawa, Dogan and Taskin, 2022; Qu, Shao and Shi, 2020). By using complex algorithms and modelling techniques, precise project selection can be identified. Especially in the construction industry, this precise identification can assess the environmental impact of projects, improve their energy efficiency and environmental performance and capture green projects with high-quality potential

(Dangelico, Pujari and Pontrandolfo, 2017), thereby enhancing the overall quality of firms' green innovation efforts. This not only ensures investment returns but also realizes the sustainability of green projects (Cao, Cumming and Zhou, 2020; Seele and Gatti, 2017). Second, FinTech can be adopted to address the funding needs for corporate green innovation while ensuring stability and transparency (Ayyagari, Demirgüç-Kunt and Maksimovic, 2011; Gull *et al.*, 2023). As aforementioned, a distributed ledger through blockchain reduces the possibility of capital misappropriation and ensures that funds are allocated to high-quality green innovation projects. Currently, some well-known Chinese firms, such as JD.com and Huawei, are actively applying solutions based on smart contracts and digital currency. This application greatly contributes to the openness and transparency of the fund usage process, guaranteeing the quality of green innovation within firms.

In short, FinTech promotes firms to undertake genuine green actions by facilitating the identification of firms with substantial green innovations and guaranteeing the stability and transparency of green funds for their green activities. This renders greenwashing unprofitable for firms inclined to engage in it. For example, some firms that believe they can gain profits by emphasizing talk over action, making empty promises and concealing negative information will lose the significant investment required for development. Ultimately, this will restrain firms from engaging in greenwashing. Based on the above analysis, this paper proposes the following hypotheses:

H1b: FinTech adoption can inhibit corporate greenwashing by facilitating its green innovation.

Mechanism of managerial efficiency

The second important mechanism through which FinTech can reduce corporate greenwashing resides in elevating managerial efficiency (Park, 2018; Zhang, Yang and Bi, 2011). Managerial efficiency pertains to a firm's capacity to proficiently employ and orchestrate its resources for production and operational activities (Cui, Li and Li, 2020; Krasnikov and Jayachandran, 2008). Given that the trade-off between cost and benefit constitutes a crucial incentive for corporate greenwashing, we contend that FinTech's role can effectively enhance managerial efficiency and curtail operating costs, thereby further alleviating greenwashing.

FinTech can augment the managerial efficiency of FinTech-adopting firms by streamlining transaction processes. For example, transaction parties can bypass transfer banks and directly undertake peer-to-peer rapid and cost-effective payments via employing distributed ledger technology, thus enhancing transaction efficiency. Meanwhile, firms leverage FinTech to achieve data integration and sharing among internal departments, enabling top-down visualization. This assists firms in making efficient decisions and improving their business processing efficiency (Begenau, Farboodi and Veldkamp, 2018), which reduces the opportunities for individual departments to falsify information (Luo *et al.*, 2022). Besides, thanks to the observable and recordable big data platforms supported by FinTech, some firms monitor and analyse real-time fund usage and balance related to processes such as procurement, production, inventory and sales. This enables firms to improve the efficiency of fund utilization (Begenau, Farboodi and Veldkamp, 2018; Bollaert, Lopez-de-Silanes and Schwienbacher, 2021).

Firms are prone to adopt greenwashing as a marketing strategy, particularly when they confront pressure to cut costs and raise capital. When FinTech is effectively applied to enhance the managerial efficiency of firms, including transaction efficiency, businesses processing efficiency and capital utilization efficiency, this may largely diminish the motivation for firms to engage in greenwashing. Based on the above analysis, this paper proposes the following hypothesis:

H1c: FinTech adoption can inhibit corporate greenwashing by improving its managerial efficiency.

Contextual affordances of heavy-polluting industry and high-tech industry

Majchrzak *et al.* (2013) found that the same or similar technologies may produce diverse application effects among technology application subjects due to differences in context. We argue that FinTech adoption's effect on corporate greenwashing is not only closely related to technology affordances, but also largely depends on contextual affordances, such as the industrial contexts where firms operate. Obviously, heavy-polluting industries and high-tech industries are two industrial contexts that are highly relevant to corporate sustainability. Therefore, this research examines the important contextual affordances of heavy-polluting industries and high-tech industries to determine their influence on the adoption of FinTech in corporate greenwashing.

Heavy-polluting industry. Heavy-polluting industries are the first contextual factor to be examined in this paper. According to the *Guidelines for Environmental Information Disclosure of Listed Firms* issued by the Ministry of Environmental Protection of China, heavy-polluting industries cover 16 specific industries, including thermal power, iron and steel, coal, metallurgy and mining, and so on. Heavy-polluting industries are characterized by significant environmental pollution and high energy consumption (Petersen and Rajan, 2002), and face greater challenges in adjusting the industrial structure and undergoing a green transformation. Firms in heavy-polluting industries often have limited technological capabilities and high costs of transformation (Petersen and Rajan, 2002), making it difficult to meet stricter environmental regulations and invest in green technologies and processes (Gu *et al.*, 2021).

FinTech adoption plays a crucial role in inhibiting the greenwashing behaviour of firms in heavy-polluting industries. The efficient technology integration and precise docking offered by FinTech address the unique challenges faced by these firms in heavy-polluting industries, such as limited technological and financial resources. First, there is a huge funding gap in industrial restructuring and green transformation and upgrading of heavily polluting industries. Under stricter environmental supervision and legitimacy pressure, heavy-polluting industries are more dependent on the affordance of FinTech. The adoption of FinTech increases the financial transparency, thus helping to improve firms' credibility, attract investors and facilitate financial docking. In this way, FinTech adoption reduces the financing constraints of heavy-polluting firms in carbon emission reduction and energy conversion (Laeven, Levine and Michalopoulos, 2015; Shim and Shin, 2016). Second, most firms in heavy polluting industries are dominated by traditional industries with weaker technological foundations. FinTech adoption may help to optimize the production process. For example, firms can monitor and control production processes through digitalization and 'intelligentization' to reduce waste generation and emission (Pizzi, Cordo and Caputo, 2021; Steffen, 2018; Yuan, Ye and Sun, 2021), and promote the industrial upgrading of traditional heavy-polluting firms. Therefore, FinTech adoption will have a more significant effect on inhibiting the greenwashing behaviour of firms in heavy-polluting industries. Based on the above analysis, this paper proposes the following hypothesis:

H2a: In heavy-polluting industries, FinTech adoption strengthens the inhibitory effect on corporate greenwashing.

High-tech industry. Technological development is a key driving force for achieving green transformation and can inhibit corporate greenwashing. The high-tech industry involves the production of cutting-edge technological products in areas such as information technology, bioengineering and new materials (Pan *et al.*, 2018).

The interaction between high-tech industries and FinTech adoption may influence the ultimate effect of FinTech in inhibiting corporate greenwashing. Notably, the inherent innovation attributes of high-tech industries may strengthen green innovation. By integrating advanced technologies, such industries can perform risk prediction, decision control and energy consumption optimization, facilitating genuine green transformation within firms (Lee and Berente, 2012). Similarly, FinTech adoption supports corporate innovation by facilitating resource integration and monitoring funds flow, promoting green innovation by integrating FinTech technology into carbon emission projects, thereby suppressing greenwashing behaviour (Borgstedt *et al.*, 2019; Qu, Shao and Shi, 2020). In short, the development of high-tech industries and their inherent innovation attributes promotes green innovation and transformation within firms. FinTech adoption substitutes for these efforts through resource integration and financing monitoring. Therefore, the substitution effect between high-tech industries and FinTech adoption should be considered. Based on the above analysis, this paper proposes the following hypothesis:

H2b: In high-tech industries, FinTech adoption weakens the inhibitory effect on corporate greenwashing.

Based on the above arguments, we build the conceptual framework of this study (see Figure 1).

Methodology

Sample and data

Considering the data availability, the sample used in this paper is Chinese firms listed on the Shanghai and Shenzhen Stock Exchanges between 2011 and 2021. Data related to financial and other information were obtained from reputable sources: China Stock Market & Accounting Research (CSMAR) Database and China Research Data Service (CNRDS) Platform. These databases are widely recognized as authoritative sources of information on publicly listed firms in China. To ensure the quality and relevance of the sample, certain criteria were applied during the selection process. First, firms belonging to financial industries that are supervised by the China Banking Regulatory Commission and the China Securities Regulatory Commission were excluded; second, observations with insufficient information to evaluate greenwashing behaviour were excluded; third, observations with other missing data were also excluded. Ultimately, a final sample of 25,985 observations was generated, including 2991 listed firms from 79 non-financial industries. Table 1 provides information on sample firms by ownership and location.

Variable measurement

Dependent variable. Lyon and Maxwell (2011, p. 9) define greenwashing as the 'selective disclosure of positive information about a company's environmental or social performance, without full disclosure of negative information on these dimensions, so as to create an overly positive corporate image', while Walker and Wan (2012, p. 231) view greenwashing as 'symbolic information emanating from within an organization without

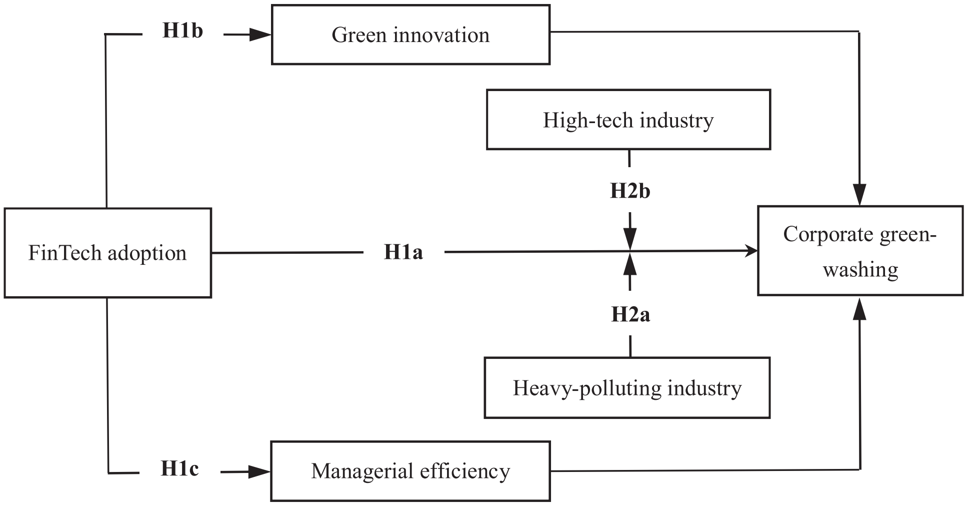

Figure 1. Conceptual framework

Table 1. Sample information by firm ownership and location

Province	Number of firms	State-owned enterprises	Non-state-owned enterprises
Guangdong	496	87	409
Zhejiang	386	31	355
Jiangsu	351	50	301
Beijing	258	103	155
Shanghai	220	63	157
Shandong	186	54	132
Fujian	109	27	82
Sichuan	107	38	69
Anhui	95	37	58
Hunan	87	35	52
Hubei	75	28	47
Henan	67	27	40
Liaoning	53	17	36
Hebei	50	22	28
Jiangxi	46	22	24
Tianjin	44	22	22
Shaanxi	43	26	17
Chongqing	40	14	26
Xinjiang	38	22	16
Shanxi	29	18	11
Jilin	28	16	12
Gansu	27	12	15
Yunnan	26	15	11
Guizhou	25	13	12
Heilongjiang	25	11	14
Guangxi	24	12	12
Inner Mongolia	20	7	13
Hainan	17	6	11
Ningxia	11	6	5
Qinghai	8	2	6
Total	**2991**	**843**	**2148**

substantive actions' or the 'discrepancy between symbolic and substantive actions'. In this paper, we focus on environmental greenwashing, and hence the environmental dimension of information disclosure. We see both selective information disclosure and symbolic information disclosure as representative forms of corporate greenwashing, as they involve the intentional distortion of environmental information disclosure to create a falsely positive corporate image to a large extent.

To measure greenwashing, following Huang and Huang (2020) and Li *et al.* (2023), we employed a two-step approach for content analysis. In the first step, we constructed an environmental information disclosure indicator system. Two of the authors independently coded all the reports, including annual reports and corporate social responsibility reports. The coding process was iterative until the coders could no longer identify any additional distinct and meaningful indicators. A comparison of the constructs indicates a high and satisfactory inter-coder rate ($k = 0.86$), and any disagreements were resolved through extensive discussions between all the authors. Ultimately, we obtained four key indicators[1] and 37 sub-indicators to capture a firm's environmental performance and actions. Table 2 provides detailed coding information about the environmental information disclosure indicator system of firms.

In the second step, referring to Walker and Wan (2012) and Huang and Huang (2020), the environmental information disclosure indicators in Table 2 were categorized into disclosed matters versus undisclosed matters, and qualitatively described disclosed matters versus quantitatively described disclosed matters like monetary and numerical information. The following

[1]Green debt and governance focuses on a firm's pollution emission status and the costs associated with pollution control measures; green effectiveness and benefits evaluates the outcomes of a firm's green governance efforts; green regulation and certification examines a firm's disclosure regarding its compliance with governmental green supervision and certifications related to green policies; and green management and construction assesses a firm's efforts in implementing green environmental protection measures.

Table 2. Environmental information disclosure indicator system of firms

First-level indicator	Second-level indicator
Green debt and governance	Description of wastewater discharges
	Description of waste gas (ozone-depleting substances, nitrogen-oxides) emissions
	Description of sulphur oxide gas emissions
	Description of greenhouse gas emissions
	Description of dust and smoke emissions
	Description of industrial solid waste generation
	Description of reduction and control of wastewater discharges
	Description of reduction and control of waste gas (ozone-depleting substances, nitrogen-oxides) emission
	Description of control of dust and smoke emissions
	Description of utilization and disposal of solid waste
	Description of control of noise, light pollution and radiation
	Description of cleaner production implementation
	Environmental investment expenditures or borrowings
	Environmental protection tax and pollutant discharge fee
	Emergency expenditures for major environmental issues
Green effectiveness and benefits	Description of the benefits of reducing pollution
	Description of wastage utilization revenue
	Description of environmental grants, subsidies, exemptions and incentive incomes
	Measures and results of energy conservation
	Description of environmental measures and improvements
	Attainment of the type and quantity of pollutant discharges
Green regulation and certification	Description of key pollution monitoring
	Description of pollutant discharge attainment
	Description of the environmental emergency matters
	Description of environmental violations
	Description of environmental petition cases
	Description of whether the firm has been certified by ISO14001 Environmental Management System
	Description of whether the firm has been certified by ISO9001 Quality Management System
Green management	Description of corporate environmental protection concept and policy, green organizational structure, green development model, etc.
	Achievement of past environmental targets and description of future environmental targets
	Descriptions of environmental management system, regulations and responsibilities, etc.
	Description of environmental education and training
	Description of social welfare activities, such as special environmental protection activities
	Descriptions of emergency response mechanisms for major environment-related emergencies, emergency measures and the treatment of pollutants
	Description of environmental honours or awards
	Description of the 'three simultaneous' system[a]
	Independent Social Responsibility Sustainability Report and Independent Environmental Report

Source: Authors' own elaboration.
[a]The 'three simultaneous' system is a fundamental environmental management system for construction projects in China. It requires that environmental protection facilities be designed, constructed and put into operation simultaneously with the main construction project. This ensures that environmental considerations are embedded throughout the entire project lifecycle.

equations are used to quantify selective information disclosure and symbolic information disclosure, respectively:

$$\text{Selective information disclosure} = 100 \times \left(1 - \frac{\text{number of disclosed matters}}{\text{total number of disclosed and undisclosed matters}}\right) \quad (1)$$

$$\text{Symbolic information disclosure} = 100 \times \frac{\text{number of qualitatively described disclosed matters}}{\text{number of disclosed matters}} \quad (2)$$

If an indicator item in Table 2 is disclosed in a firm's report, then the corresponding indicator item is assigned the value 1, otherwise 0. Among the disclosed items, if the description is quantitative, a value of 0 is assigned; otherwise 1. Take China Railway Construction as an example. Its 2018 Social Responsibility Report did not cover the description regarding the matter of industrial solid waste generation, thus this item was assigned the value 0; meanwhile, the firm claimed that it had engaged in environmental education and training, it did not disclose quantitative data such as the number of trainees, therefore it was seen as a qualitative disclosure in the disclosed matters, and assigned the value 1.

The degree of corporate greenwashing is then measured using the geometric mean of selective and symbolic information disclosures. This approach recognizes that greenwashing often results from the accumulation of selective information disclosure and symbolic information disclosure. The equation for calculating corporate greenwashing is presented as follows:

$$\text{Corporategreenwashing} = \sqrt{\text{selective information disclosure} \times \text{symbolic information disclosure}} \quad (3)$$

Independent variables. This paper addresses the challenge of constructing the independent variable: FinTech adoption. First, based on prior studies (e.g. Haddad and Hornuf, 2019; Merton, 1995), we established a dictionary of FinTech keywords. The dictionary segmented FinTech into four dimensions, namely, financial services, payment and settlement, information management and underlying technologies. See Figure A in the Appendix for details. Second, we applied web news to apply the dictionary. More precisely, due to the lack of data in existing official databases, Li *et al.* (2017) employed text mining technology to collect and analyse data related to FinTech services from the largest search engine and portal website in Korea. This allowed us to construct a firm-level FinTech adoption index. Referring to Li *et al.* (2017), we counted the total number of news pages in a given year related to each FinTech keyword of each firm on Baidu, a leading search engine and portal website in China. Third, the entropy method is used to construct the index of firm-level FinTech adoption. The specific steps to calculate the index of FinTech adoption are as follows:

1 Standardize the original data. The original data are normalized to eliminate the influence of dimension on index construction. The selected indicators are all positive indicators, thus the following equation is applied for data standardization:

$$Y_{ij} = \frac{X_{ij} - \min(X_i)}{\max(X_i) - \min(X_i)} i = 1, 2, \ldots, n; j = 1, 2, \ldots, m, \quad (4)$$

where X_{ij} represents the original data of item j in year i, and Y_{ij} is the data after dimensionless standardization of the original data.

2 Calculate the variation degree:

$$p_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}}, i = 1, 2, \ldots, n; j = 1, 2, \ldots, m \quad (5)$$

where p_{ij} represents the proportion of the index of item j in year i.

3 Calculate entropy:

$$E_j = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln p_{ij}, i = 1, 2, \ldots, n; j = 1, 2, \ldots, m \quad (6)$$

where E_j represents the entropy of the index of item j. When $p_{ij} = 0$, In p_{ij} is meaningless, therefore $E_j = 0$ is defined.

4 Calculate the weight of each index using information entropy:

$$w_j = \frac{1 - E_j}{\sum_{j=1}^{m} (1 - E_j)}, j = 1, 2, \ldots, m \quad (7)$$

where the weight of item j is w_j, and the difference coefficient of item j is $(1 - E_j)$.

5 Synthesize the first-level index using the weighted values:

$$S_i = \sum_{j=1}^{m} w_j \times Y_{ij}, i = 1, 2, \ldots, n; j = 1, 2, \ldots, m \quad (8)$$

For example, to obtain the level of FinTech adoption of Shenzhen Energy in 2020, we combined 'Shenzhen Energy' with FinTech keywords for each dimension in the advanced search of Baidu News and summarized the number of webpages retrieved by each dimension keyword in 2020 (13,071, 594, 1987 and 9268 pages, respectively), and performed logarithmic transformation to obtain the keyword webpage frequency in the four dimensions. After entropy weighting, we integrated the keyword webpage frequencies of Shenzhen Energy in four dimensions and obtained its level of FinTech adoption.

Moderating variables. Heavy-polluting industry is a dummy variable that takes the value 1 if the firm belongs to an industry categorized as a heavy-polluting industry, and 0 otherwise. The classification of heavy-polluting industries is based on the *Guidelines for the Classification of Listed Firms* issued by the China Securities Regulatory Commission in 2012. The specific industry codes associated with heavy-polluting industries are B06, B07, B08, B09, C17, C19, C22, C25, C26, C28, C29, C30, C31, C32, C33 and D44.

High-tech industry is also a dummy variable that takes the value 1 if the firm belongs to the high-tech industry sector, and 0 otherwise. The classification of high-tech firms is based on the directory of listed high-tech firms available in the CSMAR database.

Mediating variables. Green innovation refers to the innovative activities and achievements focused on environmental sustainability. It represents a firm's efforts in developing and implementing innovative technologies with positive environmental impacts (de Rassenfosse and Jaffe, 2018). To measure green innovation, Bakker *et al.* (2016) and Huang *et al.* (2023) suggest using the number of times a firm's green innovation patent has been cited by others. The rationale behind this approach is that a higher number of citations suggests greater recognition and influence of a firm's green innovation within the field. Therefore, this paper uses the number of green innovation patent citations in a firm in a given year to measure green innovation.

Managerial efficiency can be evaluated by the proficiency when a firm manages its economic or financial activities (Schefczyk, 1993). In this paper, managerial efficiency is measured by the proportion of costs incurred during these activities using the following equation (Sarkis, 2000):

$$\text{Managerial efficiency} = 1 - \frac{\text{sales expense} + \text{managerial expense} + \text{financial expense}}{\text{operational income}}. \quad (9)$$

Control variables. First, this paper includes several financial variables, corporate governance variables, R&D variables and location variables as controls to account for their potential effects on FinTech adoption and corporate greenwashing (Delmas and Burbano, 2011; Huang, Meoli and Vismara, 2020; Ruiz-Blanco, Romero and Fernandez-Feijoo, 2022). Table 3 shows the measurement of variables and their data sources.

Model settings

This paper constructs a benchmark regression model (Equation (10)) to test the relationship between FinTech adoption and corporate greenwashing. A moderating effect model (Equation (11)) is also established to examine the effect of heavy-polluting industry and high-tech industry on the benchmark model:

$$\text{Corporate greenwashing}_{i,t} = \alpha_0 + \alpha_1 \text{FinTech adoption}_{i,t} + \sum \alpha_x \text{Control}_{i,t} + \text{Year} + \text{Firm} + \text{Province} + \varepsilon_{i,t}. \quad (10)$$

$$\begin{aligned}\text{Corporate greenwashing}_{i,t} &= \beta_0 + \beta_1 \text{FinTech adoption}_{i,t} \\ &+ \beta_2 \text{heavy} - \text{polluting industry}_{i,t} \\ &(\text{or high} - \text{tech industry}_{i,t}) + \beta_3 \text{FinTech adoption}_{i,t} \\ &\times \text{heavy} - \text{polluting industry}_{i,t} \\ &(\text{or high} - \text{tech industry}_{i,t}) + \sum \beta_x \text{Control}_{i,t} + \text{Year} \\ &+ \text{Firm} + \text{Province} + \varepsilon_{i,t}. \quad (11)\end{aligned}$$

where corporate greenwashing$_{i,t}$ is the dependent variable, meaning the degree of greenwashing for firm i in year t; FinTech adoption$_{i,t}$ is the independent variable, indicating the extent of FinTech adoption for firm i in year t; heavy-polluting industry$_{i,t}$ is a proxy variable for heavy-polluting industry; high-tech industry$_{i,t}$ is a proxy variable for high-tech industry; Control$_{i,t}$ represents a set of control variables. Year, Firm and Province represent fixed effects for time, firm and regional location, respectively. The symbolic direction and significance of the coefficients α_1 and β_1 are observed to determine whether FinTech adoption has a positive or negative effect on the greenwashing behaviour of firms, while the symbolic direction and significance of the coefficient β_3 is observed to present the moderating effect of heavy-polluting industry or high-tech industry.

In addition, to test whether FinTech adoption affects corporate greenwashing through two mediation mechanisms of green innovation and managerial efficiency, this paper establishes a mediating effect model using Equations (12) and (13):

$$\begin{aligned}\text{Managerial efficiency}_{i,t}\ (\text{or green innovation quality}_{i,t}) &= \partial_0 \\ &+ \partial_1 \text{FinTech adoption}_{i,t} + \sum \partial_x \text{Control}_{i,t} + \text{Year} + \text{Firm} \\ &+ \text{Province} + \varepsilon_{i,t} \quad (12)\end{aligned}$$

$$\begin{aligned}\text{Corporate greenwashing}_{i,t} &= \gamma_0 + \gamma_1 \text{FinTech adoption}_{i,t} \\ &+ \gamma_2 \text{managerial efficiency}_{i,t} \\ &(\text{or green innovation quality}_{i,t}) + \sum \gamma_x \text{Control}_{i,t} + \text{Year} \\ &+ \text{Firm} + \text{Province} + \varepsilon_{i,t} \quad (13)\end{aligned}$$

Table 3. Variables measurement and data sources

Variable type	Variable name	Measurement	Data source
Dependent variable	Corporate greenwashing	See Equation (3)	Various official reports of a firm
Independent variable	FinTech adoption	FinTech adoption index	Authors' own
Moderating variables	Heavy-polluting industry	Valued 1 if a firm belongs to a heavy-polluting industry; otherwise, 0	CSMAR
	High-tech industry	Valued 1 if a firm belongs to a high-tech industry; otherwise, 0	
Mediating variables	Green innovation quality	Number of green innovation patent citations	CNRDS
	Managerial efficiency	See Equation (9)	CSMAR
Control variables	Return on investment	Measured by return on total assets, calculated through current investment income/(long-term equity investment current period end value + holding to maturity investment current period end value + trading financial assets current period end value + available for sale financial assets current period end value + derivative financial assets current period end value)	
	Cash flow ratio	Net cash flow from operating activities/total assets	
	Total asset turnover	Operating income/total average assets	
	Growth rate	Current year's operating income/previous year's operating income − 1	
	Loss	Valued 1 if the net profit is less than 0; otherwise, 0	
	Board members	The natural logarithm of the number of board members	
	Independent director ratio	The number of independent directors divided by the number of directors	
	CEO duality	Valued 1 if the chairman and CEO are the same person; otherwise, 0	
	Equity balance	The sum of the proportion of shares held by the second to the fifth major shareholders divided by the proportion of shares held by the largest shareholder	
	State ownership	Valued 1 if a firm is state owned; otherwise, 0	
	Firm listing age	The logarithm of the number of years that a firm has listed on the stock market	
	Sales expenses	The natural logarithm of sales expenses	
	R&D investment ratio	R&D expenditure divided by a firm's annual operating income	
	Environmental rewards	Valued 1 if a firm has received environmental rewards; otherwise, 0	CNRDS
	Environmental punishment	Valued 1 if a firm has received environmental punishments; otherwise, 0	
	Population density	Ratio of the number of permanent resident population in a province to the total area (square kilometre) of the province	China National Bureau of Statistics
	Per capita education years	The average number of years of education (including primary education, secondary education and higher education, etc.) received by the population in the province where a firm is located	

where managerial efficiency$_{i,t}$ (or green innovation quality$_{i,t}$) represents the mediating variable, the coefficient value γ_1 reflects the total effect of FinTech adoption$_{i,t}$ on corporate greenwashing$_{i,t}$, the coefficient value ∂_1 reflects the relationship between FinTech adoption$_{i,t}$ and managerial efficiency$_{i,t}$ (or green innovation quality$_{i,t}$) and the interaction term between the coefficient values ∂_1 and γ_2 reflects the mediating effect.

Empirical results

Descriptive statistics and correlation

Table 4 presents descriptive statistics for each variable. The results show that the maximum degree of corporate greenwashing is 98.32 and the minimum 25.82, suggesting a significant disparity in greenwashing practices among firms. The maximum value of FinTech adoption is 10.32, while the minimum value is 4.737, and the average value is 7.194. The uneven distribution of FinTech adoption, indicated by the large difference between the maximum and minimum values, indicates that different firms have varying degrees of engagement with FinTech adoption. The wide ranges between the maximum and minimum values across all financial variables suggest significant variations in the financial performance of the sampled firms.

To assess multicollinearity, this paper calculates the variance inflation factor (VIF) of variables, with the highest value of 1.67, which is below the commonly used threshold of 2.5, indicating that multicollinearity is not a serious problem.

Table 5 presents the correlation matrix of variables. The maximum correlation coefficient is 0.598. This indicates a low level of multicollinearity among the variables, which supports reasonable variable selection. Meanwhile, the correlation coefficient between FinTech and corporate greenwashing is significantly negative (−0.343), implying that there is a certain degree of greenwashing alleviation with FinTech adoption.

Table 4. Descriptive statistics

Variable	N	Mean	SD	Min	Max	VIF
Corporate greenwashing	25,895	84.55	14.72	25.82	98.32	
FinTech adoption	25,894	7.194	0.593	4.737	10.32	1.39
Return on investment	21,113	0.332	1.254	−1.091	17.70	1.00
Cash flow ratio	25,895	0.050	0.070	−0.742	0.726	1.14
Total asset turnover	25,894	0.640	0.442	−0.048	12.37	1.15
Growth rate	25,371	0.155	0.290	−0.490	2.077	1.10
Loss	25,895	0.097	0.296	0.000	1.000	1.11
Board members	25,893	2.125	0.199	1.099	2.890	1.61
Independent director ratio	25,893	0.376	0.056	0.143	0.800	1.47
CEO duality	25,895	0.293	0.455	0.000	1.000	1.14
Equity balance	25,894	0.369	0.287	0.001	1.000	1.06
State ownership	25,895	0.328	0.470	0.000	1.000	1.46
Firm listing age	25,895	2.013	0.891	0.000	3.434	1.35
R&D investment ratio	23,183	0.050	0.057	0.000	2.516	1.16
Sales expenses	25,602	18.04	2.390	0.000	25.03	1.27
Environmental rewards	25,895	0.032	0.176	0.000	1.000	1.02
Environmental punishment	25,895	0.001	0.037	0.000	1.000	1.00
Population density	25,484	6.295	0.915	2.683	8.275	1.58
Per capita education years	25,895	9.645	1.060	7.474	12.78	1.67
Heavy-polluting industry	25,895	0.287	0.452	0.000	1.000	
High-tech industry	25,895	0.657	0.475	0.000	1.000	

Hypothesis testing

We performed the Hausman test to select an appropriate model. The p-value obtained ($p < 0.05$) suggests that a fixed-effect model is more appropriate than a random-effect model. Table 6 presents the empirical results, where model (1) and model (2) represent the results without controlling firm, year and province fixed effects, model (3) represents the result without control variables and model (4) includes control variables. Both models consistently show significant negative correlations between FinTech adoption and corporate greenwashing behaviour. The results confirm H1a, indicating that FinTech adoption is likely to alleviate the greenwashing behaviour of firms.

To understand the mechanisms through which FinTech adoption affects corporate greenwashing behaviour, Table 7 demonstrates the results of the mediating effects. This paper examines two mediating variables: green innovation and managerial efficiency. Model (2) shows that FinTech adoption is positively and significantly correlated with green innovation ($\beta = 0.525$, $p < 0.01$). This implies that higher levels of FinTech adoption led to stronger green innovation of firms. The results in model (3) show that both FinTech adoption and green innovation have inhibitory effects on corporate greenwashing ($\beta = -4.781$, $p < 0.01$; $\beta = -0.665$, $p < 0.01$, respectively). Compared to model (1), the mediation effect size in model (3) is −0.349 (−0.665 × 0.525), accounting for 6.80% of the overall explanatory effect of FinTech adoption on corporate greenwashing. These findings support H1b that improving green innovation is an important channel for reducing corporate greenwashing through FinTech adoption.

Meanwhile, the results in model (4) indicate a significant and positive relationship between FinTech adoption and managerial efficiency ($\beta = 0.038$, $p < 0.01$). This implies that higher levels of FinTech adoption are associated with increased managerial efficiency in firms. Model (5) shows that both FinTech adoption and managerial efficiency have inhibitory effects on corporate greenwashing ($\beta = -5.130$, $p < 0.01$; $\beta = -11.641$, $p < 0.01$, respectively). When compared to model (1), the mediating effect size in model (5) is −0.442 (−11.641 × 0.038), accounting for 8.62% of the overall explanatory effect of FinTech adoption. These findings suggest that by improving managerial efficiency, FinTech adoption can reduce corporate greenwashing. Thus, H1c is confirmed. In addition, the Sobel test results confirm the presence of partial mediating effects, verifying that FinTech adoption can alleviate corporate greenwashing behaviour by enhancing both green innovation and managerial efficiency.

To further investigate the effect of FinTech adoption on corporate greenwashing behaviour in different industrial contexts, this paper introduces moderating variables into the regression model, namely heavy-polluting industry and high-tech industry, along with their interaction terms. In model (5) of Table 6, the coefficient of FinTech adoption remains significantly negative ($\beta = -4.263$, $p < 0.01$), and the coefficient of heavy-polluting industry is positive ($\beta = 3.689$). Notably, the regression coefficient of the interaction term FinTech adoption × heavy-polluting industry in model (5) of Table 6 is significantly negative ($\beta = -1.400$, $p < 0.01$).

Table 5. Correlation matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corporate greenwashing	1.000							
FinTech adoption	−0.343***	1.000						
Return on investment	0.028***	−0.028***	1.000					
Cash flow ratio	−0.150***	0.275***	−0.004	1.000				
Total asset turnover	−0.111***	0.124***	0.015**	0.104***	1.000			
Growth rate	0.021***	0.118***	0.001	0.024***	0.133***	1.000		
Loss	0.035***	−0.064***	−0.015**	−0.184***	−0.108***	−0.202***	1.000	
Board members	−0.153***	0.159***	−0.020***	0.050***	0.014**	−0.030***	−0.026***	1.000
Independent director ratio	0.022***	0.013**	0.002	−0.005	−0.018***	0.000	0.018***	−0.546***
CEO duality	0.103***	−0.090***	0.013*	−0.018***	−0.034***	0.048***	−0.020***	−0.175***
Equity balance	0.029***	−0.023***	0.001	−0.015**	−0.060***	0.037***	0.000	0.008
State ownership	−0.191***	0.184***	−0.032***	0.008	0.020***	−0.103***	0.041***	0.280***
Firm listing age	−0.224***	0.198***	−0.052***	0.017***	−0.004	−0.104***	0.147***	0.140***
R&D investment ratio	0.169***	−0.114***	−0.011	−0.042***	−0.234***	−0.009	0.044***	−0.104***
Sales expenses	−0.196***	0.299***	−0.008	0.112***	0.204***	0.014**	−0.037***	0.057***
Environmental rewards	−0.038***	−0.004	0.004	0.014**	0.013**	−0.025***	0.020***	0.061***
Environmental punishment	−0.012*	−0.009	−0.004	−0.006	0.002	−0.014**	0.023***	0.008
Population density	0.065***	0.034***	−0.004	0.010	0.062***	0.015**	−0.044***	−0.085***
Per capita education years	0.022***	0.131***	−0.014**	−0.012*	−0.032***	0.025***	−0.001	−0.062***

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Board members								
Independent director ratio	1.000							
CEO duality	0.099***	1.000						
Equity balance	−0.017***	0.050***	1.000					
State ownership	−0.051***	−0.304***	−0.212***	1.000				
Firm listing age	−0.015**	−0.242***	−0.132***	0.441***	1.000			
R&D investment ratio	0.043***	0.129***	0.104***	−0.178***	−0.151***	1.000		
Sales expenses	0.013**	0.001	−0.008	0.015**	0.120***	−0.044***	1.000	
Environmental rewards	−0.027***	−0.046***	−0.038***	0.068***	0.023***	−0.071***	−0.002	1.000
Environmental punishment	−0.007	−0.006	−0.004	0.018***	0.012*	−0.014**	0.009	0.029***
Population density	0.033***	0.097***	0.042***	−0.112***	−0.130***	0.117***	0.033***	−0.046***
Per capita education years	0.064***	0.047***	0.014**	0.016**	−0.010*	0.162***	0.069***	−0.064***

	(17)	(18)	(19)
Environmental punishment	1.000		
Population density	−0.007	1.000	
Per capita education years	−0.014**	0.598***	1.000

Note: ***p < 0.01; **p < 0.05; *p < 0.10.

This means that the inhibitory effect of FinTech adoption on corporate greenwashing behaviour becomes stronger in heavy-polluting industries. Thus, H2a is confirmed.

Figure 2 visually depicts the moderating role of heavy-polluting industry in the relationship between FinTech adoption and corporate greenwashing behaviour. The solid line labelled 'lower Hpi' illustrates a slightly negative relationship between FinTech adoption and greenwashing behaviour for firms in non-heavy-polluting industries. By contrast, the dotted line labelled 'higher Hpi' appears to demonstrate an explicit negative relationship between FinTech adoption and greenwashing behaviour for those firms in heavy-polluting industries. These findings are consistent with H1a, which suggests that FinTech adoption shows a significant inhibitory effect on corporate greenwashing. However, the presence of heavy-polluting industry offsets this inhibitory effect of FinTech adoption on corporate

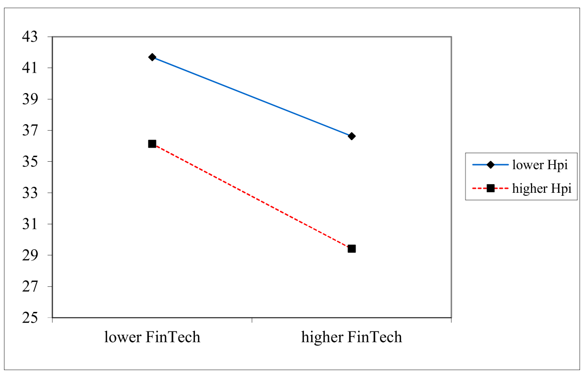

Figure 2. The moderating role of heavy-polluting industry

Table 6. Regression results of the relationship between FinTech adoption and corporate greenwashing behaviour

Variable	(1)	(2)	(3)	(4)	(5)	(6)
FinTech adoption	−8.507***	−6.259***	−7.283***	−5.130***	−4.263***	−5.666***
	(−58.77)	(−31.34)	(−51.08)	(−25.80)	(−18.97)	(−19.40)
Heavy-polluting industry					3.689	
					(1.47)	
High-tech industry						−4.710*
						(−1.91)
FinTech adoption × heavy-polluting industry					−1.400***	
					(−4.09)	
FinTech adoption × high-tech industry						0.866**
						(2.55)
Return on investment		0.193**		0.232***	0.203***	0.229***
		(2.41)		(3.14)	(2.79)	(3.09)
Cash flow ratio		−16.015***		−9.617***	−9.142***	−9.253***
		(−9.69)		(−6.06)	(−5.87)	(−5.83)
Total asset turnover		−1.466***		−1.391***	−0.971***	−1.462***
		(−5.92)		(−5.90)	(−4.19)	(−6.20)
Growth rate		2.579***		2.667***	2.379***	2.617***
		(6.93)		(7.58)	(6.89)	(7.44)
Loss		1.111***		1.728***	1.877***	1.714***
		(3.04)		(5.07)	(5.60)	(5.03)
Board members		−5.479***		−7.796***	−7.220***	−7.831***
		(−8.43)		(−12.67)	(−11.95)	(−12.74)
Independent director ratio		−5.984***		−12.006***	−11.640***	−11.767***
		(−2.74)		(−5.88)	(−5.81)	(−5.77)
CEO duality		0.244		0.457**	0.405*	0.446**
		(1.02)		(2.05)	(1.85)	(2.01)
Equity balance		−1.088***		−0.508	−0.682**	−0.523
		(−2.96)		(−1.47)	(−2.01)	(−1.52)
State ownership		−2.148***		−3.569***	−3.317***	−3.575***
		(−8.10)		(−13.77)	(−13.03)	(−13.79)
Firm listing age		−2.074***		−1.324***	−1.210***	−1.336***
		(−14.29)		(−9.42)	(−8.76)	(−9.51)
R&D investment ratio		22.149***		13.884***	7.647***	12.827***
		(11.55)		(7.06)	(3.93)	(6.49)
Sales expenses		−0.595***		−0.450***	−0.712***	−0.459***
		(−9.27)		(−6.95)	(−11.05)	(−7.08)
Environmental rewards		−0.880		−2.521***	−1.546***	−2.509***
		(−1.45)		(−4.37)	(−2.72)	(−4.35)
Environmental punishment		−2.404		−3.151	−2.186	−3.204
		(−0.93)		(−1.31)	(−0.93)	(−1.33)
Population density		0.486***		11.679**	12.509***	11.902**
		(3.36)		(2.51)	(2.74)	(2.56)
Per capita education years		0.566***		0.388	0.391	0.387
		(4.63)		(0.54)	(0.55)	(0.54)
Constant	145.746***	150.464***	136.940***	76.314**	69.825**	78.004**
	(139.48)	(63.00)	(133.12)	(2.51)	(2.34)	(2.57)
Firm FE	No	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Province FE	No	No	Yes	Yes	Yes	Yes
Observations	25,894	18,081	25,894	18,080	18,080	18,080
R-squared	0.118	0.190	0.253	0.309	0.334	0.310

Note: Unstandardized regression coefficients are shown with t values in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

greenwashing. Therefore, the results support H2a once again.

Model (6) in Table 6 shows that the regression coefficients of both FinTech adoption and high-tech industry are significantly negative ($\beta = -5.666$, $p < 0.01$; $\beta = -4.710$, respectively), indicating that both FinTech adoption and being in a high-tech industry benefit the reduction of corporate greenwashing. Furthermore, the regression coefficient of the interaction term FinTech adoption × high-tech industry in model (6) of Table 6 is significantly positive ($\beta = 0.866$, $p < 0.5$). This indicates a certain substitution effect between these two

Table 7. Regression results of the mediating effects of green innovation and managerial efficiency

Variable	(1) Corporate greenwashing	(2) Green innovation quality	(3) Corporate greenwashing	(4) Managerial efficiency	(5) Corporate greenwashing
Green innovation quality			−0.665***		
			(−7.83)		
Managerial efficiency					−11.641***
					(−11.86)
FinTech adoption	−5.130***	0.525***	−4.781***	0.038***	−4.684***
	(−25.80)	(30.13)	(−23.50)	(25.45)	(−23.24)
Return on investment	0.232***	−0.025***	0.216***	−0.001**	0.218***
	(3.14)	(−3.91)	(2.91)	(−2.28)	(2.94)
Cash flow ratio	−9.617***	−1.596***	−10.677***	−0.072***	−10.453***
	(−6.06)	(−11.46)	(−6.71)	(−5.98)	(−6.60)
Total asset turnover	−1.391***	−0.010	−1.397***	0.076***	−0.511**
	(−5.90)	(−0.46)	(−5.94)	(42.40)	(−2.08)
Growth rate	2.667***	0.088***	2.725***	0.011***	2.792***
	(7.58)	(2.84)	(7.76)	(4.03)	(7.97)
Loss	1.728***	−0.133***	1.640***	−0.053***	1.110***
	(5.07)	(−4.44)	(4.81)	(−20.57)	(3.23)
Board members	−7.796***	0.381***	−7.542***	0.018***	−7.580***
	(−12.67)	(7.06)	(−12.27)	(3.97)	(−12.37)
Independent director ratio	−12.006***	1.207***	−11.204***	0.038**	−11.563***
	(−5.88)	(6.75)	(−5.49)	(2.47)	(−5.69)
CEO duality	0.457**	0.023	0.472**	−0.001	0.446**
	(2.05)	(1.16)	(2.12)	(−0.57)	(2.01)
Equity balance	−0.508	−0.002	−0.509	−0.006**	−0.578*
	(−1.47)	(−0.06)	(−1.48)	(−2.31)	(−1.68)
State ownership	−3.569***	0.208***	−3.431***	0.034***	−3.168***
	(−13.77)	(9.13)	(−13.23)	(17.59)	(−12.17)
Firm listing age	−1.324***	0.071***	−1.277***	−0.001	−1.330***
	(−9.42)	(5.79)	(−9.09)	(−0.52)	(−9.50)
R&D investment ratio	13.884***	1.848***	15.113***	−0.734***	5.342**
	(7.06)	(10.72)	(7.67)	(−49.33)	(2.56)
Sales expenses	−0.450***	0.115***	−0.374***	−0.023***	−0.716***
	(−6.95)	(20.21)	(−5.71)	(−46.55)	(−10.47)
Environmental rewards	−2.521***	−0.017	−2.532***	0.025***	−2.225***
	(−4.37)	(−0.34)	(−4.40)	(5.82)	(−3.87)
Environmental punishment	−3.151	0.226	−3.001	0.032*	−2.782
	(−1.31)	(1.07)	(−1.25)	(1.74)	(−1.16)
Population density	11.679**	−0.164	11.570**	0.053	12.295***
	(2.51)	(−0.40)	(2.49)	(1.51)	(2.66)
Per capita education years	0.388	−0.068	0.343	0.006	0.464
	(0.54)	(−1.08)	(0.48)	(1.20)	(0.65)
Constant	76.314**	−4.925*	73.041**	0.498**	82.116***
	(2.51)	(−1.85)	(2.41)	(2.17)	(2.71)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Observations	18,080	18,080	18,080	18,080	18,080
R-squared	0.309	0.268	0.311	0.448	0.315

Note: Unstandardized regression coefficients are shown with t values in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

restraining forces, namely FinTech adoption and high-tech industry, on corporate greenwashing.

Figure 3 depicts the moderating effect of high-tech industry in the relationship between FinTech adoption and greenwashing behaviour of firms. A negative relationship between FinTech adoption and greenwashing is observed, which supports H1a once again. The solid line labelled ‘lower Hte’ displays a steeper negative slope, indicating a strong negative relationship between FinTech adoption and corporate greenwashing in non-high-tech industries. On the other hand, the dotted line labelled ‘higher Hte’ demonstrates a less steep slope, indicating a weaker negative relationship between FinTech adoption and corporate greenwashing in high-tech industries. This implies that in high-tech industries, the inhibitory effect of FinTech adoption on corporate

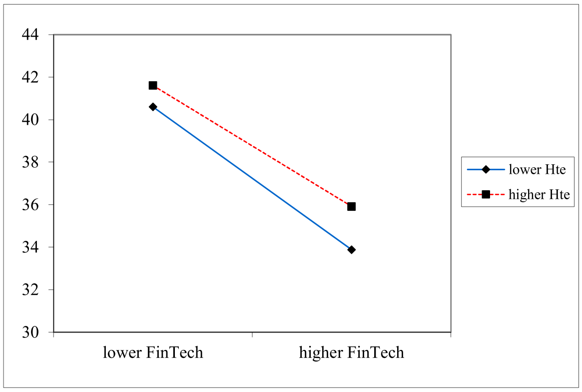

Figure 3. The moderating role of high-tech industry

greenwashing is weakened to some extent. Thus, H2b is confirmed once again.

Endogeneity and robustness tests

Corporate greenwashing behaviour is affected by many factors, and the problem of missing variables occurs inevitably in the regression. Meanwhile, a reverse causality may exist since corporate greenwashing behaviour might be forced to transform due to governmental regulation or social monitoring, thereby increasing the demand for financial services and affecting FinTech adoption. Therefore, to solve the endogeneity problem and potential reverse causality, this paper introduces IVs in a two-stage least squares (2SLS) regression. Two IVs are introduced to overcome the issues.

The first IV used is the penetration rate of higher education (Pro_edu) of each province, obtained from the National Bureau of Statistics of China from 2011 to 2021. Pro_edu is considered an appropriate IV for two reasons. First, the development of higher education is crucial for the rapid growth of FinTech. In general, FinTech is more accessible in regions with a higher level of higher education penetration rate. Second, historical higher education penetration rate is unlikely to have a direct impact on current corporate greenwashing, ensuring both relevance and exogeneity conditions are met. The second IV used is the 1-year lagged form of FinTech adoption (L.FinTech). Table 8 presents the results. In the first-stage regression, present in models (1), (3) and (5), the coefficients are significantly positive, satisfying the correlation conditions between the IVs and the endogenous variable. Meanwhile, the Kleibergen–Paap rk LM statistics reject under-identified IVs at the 1% significance level, the Kleibergen–Paap rk Wald F statistics are higher than the Stock–Yogo weak ID test critical values, rejecting weak IVs, and the Hansen J statistic rejects over-identified IVs. In the second-stage regression results present in models (2), (4) and (6), the coefficients remain significantly negative, generating similar results to those mentioned previously.

In addition, considering that the relationship between FinTech adoption and greenwashing may change over time, we introduce the time trend variable into the regression, and the results of model (7) show that the 'de-greenwashing' effect of FinTech adoption increases over time.

To ensure the robustness of the empirical results, this paper conducts regression analysis using alternative dependent variables: selective information disclosure and symbolic information disclosure. Table 9 shows the results of robustness tests, which are consistent with the results discussed earlier. This consistency provides further support for the hypotheses put forward in the study.

Further analysis

This paper further examines the mediating effect of green innovation and managerial efficiency on the relationship between FinTech adoption and corporate greenwashing behaviour in heavy-polluting industries. The result in model (1) of Table 10 shows a significant and strong alleviation effect of FinTech adoption on greenwashing in heavy-polluting industries ($\beta = -4.711$, $p < 0.01$), which verifies H2a. The results displayed in models (2) to (5) suggest that green innovation and managerial efficiency account for 12.10% and 16.17%, respectively, of the overall explanatory effect of FinTech adoption on corporate greenwashing behaviour in heavy-polluting industries. In comparison to the effect sizes of green innovation and managerial efficiency (6.80% and 8.62%, respectively) observed in the entire sample, the results indicate that when firms in heavy-polluting industries adopt FinTech, improving their managerial efficiency might be more effective at alleviating greenwashing compared to enhancing green innovation.

Meanwhile, this paper explores the mediating effect of green innovation and managerial efficiency on the relationship between FinTech adoption and corporate greenwashing behaviour in high-tech industries. The result in model (1) of Table 11 suggests that the greenwashing reduction effect of FinTech adoption is weakened in high-tech industries ($\beta = -3.943$, $p < 0.01$), verifying H2b. The results displayed in models (2) to (5) indicate that green innovation and managerial efficiency explain 6.26% and 4.43%, respectively, of the overall effect of FinTech adoption on corporate greenwashing behaviour in high-tech industries. Comparatively, when firms in high-tech industries adopt FinTech, improving green innovation appears to be a slightly more effective channel for reducing their greenwashing behaviour compared to enhancing managerial efficiency.

Table 8. Results of endogeneity tests

Variable	(1) First stage (Pro_edu) FinTech adoption	(2) Second stage (Pro_edu) Corporate greenwashing	(3) First stage (L.Fintech) FinTech adoption	(4) Second stage (L.Fintech) Corporate greenwashing	(5) First stage (All) FinTech adoption	(6) Second stage (All) Corporate greenwashing	(7) Time trend Corporate greenwashing
FinTech adoption		−32.381***		−8.313***		−8.491***	−2.695***
		(−8.39)		(−26.80)		(−27.43)	(−7.04)
Pro_edu	1.398***				0.968***		
	(9.72)				(8.62)		
L.FinTech			0.691***		0.689***		
			(117.19)		(116.96)		
Time trend							3.043***
							(7.52)
FinTech adoption × time trend							−0.402***
							(−7.43)
Return on investment	−0.007**	0.010	−0.003	0.178**	−0.003	0.176**	0.232***
	(−2.33)	(0.09)	(−1.15)	(2.06)	(−1.18)	(2.04)	(3.14)
Cash flow ratio	2.004***	36.774***	0.981***	−11.440***	0.973***	−11.073***	−9.739***
	(33.64)	(4.53)	(20.59)	(−6.30)	(20.45)	(−6.10)	(−6.14)
Total asset turnover	0.018*	−1.036***	0.015**	−1.540***	0.016**	−1.538***	−1.367***
	(1.93)	(−2.95)	(2.15)	(−5.94)	(2.28)	(−5.93)	(−5.79)
Growth rate	0.265***	9.519***	0.312***	3.082***	0.312***	3.132***	2.627***
	(19.40)	(8.30)	(29.55)	(7.83)	(29.59)	(7.95)	(7.48)
Loss	−0.036***	0.168	0.158***	1.152***	0.158***	1.145***	1.516***
	(-2.63)	(0.32)	(15.03)	(3.05)	(15.05)	(3.03)	(4.44)
Board members	0.376***	4.306**	0.101***	−5.178***	0.103***	−5.113***	−7.773***
	(15.67)	(2.53)	(5.36)	(−7.51)	(5.46)	(−7.41)	(−12.66)
Independent director ratio	1.026***	20.070***	0.331***	−4.672**	0.353***	−4.493*	−11.831***
	(12.67)	(4.09)	(5.24)	(−2.02)	(5.59)	(−1.94)	(−5.80)
CEO duality	−0.024***	−0.425	−0.006	0.223	−0.005	0.218	0.506**
	(−2.72)	(−1.22)	(−0.81)	(0.89)	(−0.68)	(0.87)	(2.28)
Equity balance	0.039***	−0.117	0.025**	−0.871**	0.026**	−0.864**	−0.477
	(2.85)	(−0.22)	(2.35)	(−2.26)	(2.48)	(−2.24)	(−1.39)
State ownership	0.092***	0.168	0.020***	−2.041***	0.022***	−2.026***	−3.471***
	(9.31)	(0.33)	(2.58)	(−7.28)	(2.87)	(−7.22)	(−13.24)
Firm listing age	0.058***	−0.534*	0.043***	−1.883***	0.043***	−1.868***	−1.563***
	(10.82)	(−1.76)	(8.95)	(−10.64)	(8.84)	(−10.55)	(−7.64)
R&D investment ratio	−0.849***	−0.050	−0.208***	20.941***	−0.211***	20.797***	13.785***
	(−11.96)	(−0.01)	(−3.78)	(10.42)	(−3.83)	(10.34)	(7.02)
Sales expenses	0.101***	2.060***	0.030***	−0.395***	0.030***	−0.376***	−0.455***
	(44.71)	(5.13)	(15.79)	(−5.42)	(15.77)	(−5.17)	(−7.01)
Environmental rewards	−0.070***	−2.927***	−0.054***	−1.188*	−0.048***	−1.203*	−2.593***
	(−3.08)	(−3.25)	(−3.06)	(−1.84)	(−2.73)	(−1.86)	(−4.50)
Environmental punishment	−0.194**	−7.215*	−0.083	−2.638	−0.089	−2.667	−3.017
	(−2.01)	(−1.96)	(−1.13)	(−0.99)	(−1.22)	(−1.00)	(−1.26)
Population density	−0.009*	0.017	−0.013***	0.428***	−0.007*	0.425***	0.021***
	(−1.71)	(0.08)	(−3.19)	(2.85)	(−1.76)	(2.82)	(3.20)
Per capita education years	−0.053***	2.679***	0.031***	0.829***	−0.061***	0.843***	0.206
	(−3.64)	(7.55)	(8.95)	(6.44)	(−5.42)	(6.54)	(0.28)
Constant	4.249***	235.922***	0.951***	157.520***	1.640***	158.087***	117.411***
	(32.22)	(18.11)	(13.73)	(60.27)	(15.52)	(60.48)	(13.35)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,081	18,081	16,727	16,727	16,727	16,727	18,080
R-squared	0.284	0.184	0.607	0.185	0.609	0.185	0.311
Kleibergen–Paap rk LM statistic		12.517***		528.360***		538.332***	
Kleibergen–Paap rk Wald F statistic		12.589		657.171		335.679	
Hansen J statistic		0.000		0.000		6.989***	
First-stage F statistic		96.57		126.24		126.30	

Note: Unstandardized regression coefficients are shown with t values in parentheses. ***p < 0.01; **p < 0.05; *p < 0.10.

Table 9. Results of robustness tests

	Selective information disclosure			Symbolic information disclosure		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
FinTech adoption	−6.561***	−5.809***	−7.108***	−2.808***	−1.975***	−3.185***
	(−26.42)	(−20.64)	(−19.48)	(−16.48)	(−10.19)	(−12.72)
Heavy-polluting industry		−1.640			8.324***	
		(−0.52)			(3.85)	
High-tech industry			−4.388			−3.740*
			(−1.42)			(−1.77)
FinTech adoption × heavy-polluting industry		−0.822*			−1.733***	
		(−1.92)			(−5.87)	
FinTech adoption × high-tech industry			0.887**			0.604**
			(2.09)			(2.07)
Return on investment	0.278***	0.246***	0.274***	0.158**	0.136**	0.156**
	(3.00)	(2.70)	(2.97)	(2.49)	(2.17)	(2.46)
Cash flow ratio	−12.111***	−11.647***	−11.649***	−5.610***	−5.206***	−5.448***
	(−6.11)	(−5.97)	(−5.87)	(−4.12)	(−3.87)	(−4.00)
Total asset turnover	−1.556***	−1.045***	−1.643***	−0.969***	−0.712***	−1.006***
	(−5.29)	(−3.60)	(−5.58)	(−4.80)	(−3.55)	(−4.97)
Growth rate	3.396***	3.046***	3.335***	1.641***	1.462***	1.616***
	(7.73)	(7.04)	(7.59)	(5.45)	(4.91)	(5.36)
Loss	2.406***	2.593***	2.389***	0.701**	0.787***	0.694**
	(5.65)	(6.18)	(5.61)	(2.40)	(2.72)	(2.38)
Board members	−9.349***	−8.678***	−9.396***	−5.042***	−4.659***	−5.057***
	(−12.17)	(−11.47)	(−12.24)	(−9.57)	(−8.94)	(−9.59)
Independent director ratio	−14.018***	−13.587***	−13.754***	−8.402***	−8.161***	−8.254***
	(−5.50)	(−5.41)	(−5.40)	(−4.80)	(−4.72)	(−4.72)
CEO duality	0.646**	0.588**	0.636**	0.166	0.129	0.158
	(2.33)	(2.15)	(2.29)	(0.87)	(0.69)	(0.83)
Equity balance	−0.711*	−0.932**	−0.732*	−0.118	−0.217	−0.123
	(−1.65)	(−2.20)	(−1.70)	(−0.40)	(−0.74)	(−0.42)
State ownership	−4.465***	−4.168***	−4.478***	−2.146***	−1.981***	−2.142***
	(−13.79)	(−13.07)	(−13.83)	(−9.66)	(−9.02)	(−9.64)
Firm listing age	−1.783***	−1.653***	−1.795***	−0.609***	−0.529***	−0.619***
	(−10.15)	(−9.56)	(−10.22)	(−5.06)	(−4.44)	(−5.13)
R&D investment ratio	17.301***	9.941***	15.927***	8.632***	4.563***	8.193***
	(7.04)	(4.08)	(6.45)	(5.12)	(2.72)	(4.83)
Sales expenses	−0.545***	−0.847***	−0.555***	−0.286***	−0.463***	−0.290***
	(−6.72)	(−10.50)	(−6.85)	(−5.14)	(−8.33)	(−5.22)
Environmental rewards	−3.252***	−2.072***	−3.224***	−1.298***	−0.690	−1.306***
	(−4.51)	(−2.91)	(−4.47)	(−2.62)	(−1.41)	(−2.64)
Environmental punishment	−4.267	−3.097	−4.326	−1.543	−0.944	−1.574
	(−1.42)	(−1.05)	(−1.44)	(−0.75)	(−0.46)	(−0.76)
Population density	19.250***	20.414***	19.502***	0.887	1.247	1.020
	(3.32)	(3.57)	(3.36)	(0.22)	(0.32)	(0.26)
Per capita education years	0.239	0.265	0.235	0.548	0.526	0.549
	(0.27)	(0.30)	(0.26)	(0.89)	(0.87)	(0.89)
Constant	38.945	31.747	40.298	124.311***	119.626***	125.881***
	(1.03)	(0.85)	(1.06)	(4.77)	(4.64)	(4.83)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,080	18,080	18,080	18,080	18,080	18,080
R-squared	0.322	0.343	0.323	0.169	0.188	0.169

Note: Unstandardized regression coefficients are shown with t values in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

Table 10. Regression results of the mediating effects of green innovation and managerial efficiency in heavy-polluting industries

Variable	(1) Corporate greenwashing	(2) Green innovation quality	(3) Corporate greenwashing	(4) Managerial efficiency	(5) Corporate greenwashing
Green innovation quality			−1.397***		
			(−6.25)		
Managerial efficiency					−31.753***
					(−11.02)
FinTech adoption	−4.711***	0.408***	−4.142***	0.024***	−3.963***
	(−10.83)	(14.79)	(−9.35)	(11.10)	(−9.11)
Return on investment	0.429***	−0.001	0.428***	0.000	0.435***
	(2.61)	(−0.12)	(2.61)	(0.21)	(2.67)
Cash flow ratio	−10.844***	−1.033***	−12.286***	−0.017	−11.375***
	(−3.09)	(−4.64)	(−3.51)	(−0.98)	(−3.28)
Total asset turnover	−1.903***	0.008	−1.892***	0.056***	−0.121
	(−3.89)	(0.25)	(−3.89)	(23.55)	(−0.24)
Growth rate	3.438***	0.144***	3.638***	0.017***	3.973***
	(4.05)	(2.67)	(4.30)	(4.07)	(4.73)
Loss	2.306***	−0.098**	2.169***	−0.046***	0.855
	(3.06)	(−2.05)	(2.89)	(−12.45)	(1.13)
Board members	−11.032***	0.399***	−10.474***	0.029***	−10.113***
	(−8.19)	(4.68)	(−7.79)	(4.40)	(−7.59)
Independent director ratio	−0.381	0.808***	0.748	0.038*	0.841
	(−0.08)	(2.67)	(0.16)	(1.65)	(0.18)
CEO duality	0.644	−0.130***	0.462	−0.011***	0.281
	(1.21)	(−3.85)	(0.87)	(−4.40)	(0.53)
Equity balance	0.181	0.001	0.183	0.001	0.197
	(0.22)	(0.03)	(0.23)	(0.13)	(0.25)
State ownership	−4.967***	0.199***	−4.688***	0.012***	−4.589***
	(−8.40)	(5.32)	(−7.94)	(4.13)	(−7.84)
Firm listing age	−1.603***	0.010	−1.589***	0.006***	−1.426***
	(−4.65)	(0.46)	(−4.62)	(3.32)	(−4.18)
R&D investment ratio	59.332***	3.273***	63.903***	−0.635***	39.182***
	(5.30)	(4.61)	(5.72)	(−11.62)	(3.49)
Sales expenses	−0.477***	0.087***	−0.356**	−0.013***	−0.902***
	(−3.38)	(9.68)	(−2.51)	(−19.47)	(−6.24)
Environmental rewards	−2.006**	−0.144**	−2.207**	−0.001	−2.032**
	(−2.15)	(−2.43)	(−2.37)	(−0.18)	(−2.20)
Environmental punishment	−3.450	0.567**	−2.657	0.025	−2.651
	(−0.92)	(2.39)	(−0.71)	(1.38)	(−0.72)
Population density	25.651**	0.751	26.700**	−0.070	23.429**
	(2.27)	(1.05)	(2.37)	(−1.27)	(2.10)
Per capita education years	1.072	−0.099	0.933	0.008	1.339
	(0.64)	(−0.94)	(0.56)	(1.03)	(0.81)
Constant	−20.285	−8.907*	−32.727	1.173***	16.964
	(−0.28)	(−1.95)	(−0.46)	(3.34)	(0.24)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Observations	5013	5013	5013	5013	5013
R-squared	0.277	0.289	0.283	0.441	0.294

Note: Unstandardized regression coefficients are shown with t values in parentheses. ***p < 0.01; **p < 0.05; *p < 0.10.

Discussion and conclusion

Using panel data of Chinese listed firms in non-financial industries during 2011 and 2021, this paper explores the influence of FinTech adoption on corporate greenwashing for the first time, which provides a novel perspective for FinTech research. The empirical findings reveal that FinTech adoption by non-financial firms significantly inhibits corporate greenwashing, indicating that it offers technology affordances and helps reduce information asymmetry in the Chinese markets. Furthermore, this research demonstrates that FinTech adoption promotes green innovation and enhances managerial efficiency, thus contributing to the reduc-

Table 11. Regression results of the mediating effects of green innovation and managerial efficiency in high-tech industries

Variable	(1) Corporate greenwashing	(2) Green innovation quality	(3) Corporate greenwashing	(4) Managerial efficiency	(5) Corporate greenwashing
Green innovation quality			−0.576***		
			(−6.00)		
Managerial efficiency					−13.423***
					(−11.78)
FinTech adoption	−3.943***	0.429***	−3.696***	0.013***	−3.122***
	(−15.44)	(18.14)	(−14.31)	(6.61)	(−11.86)
Return on investment	0.104	−0.024***	0.090	−0.001	0.079
	(1.20)	(−3.02)	(1.04)	(−1.46)	(0.92)
Cash flow ratio	−12.128***	−1.645***	−13.076***	−0.098***	−13.154***
	(−6.41)	(−9.39)	(−6.89)	(−6.01)	(−6.98)
Total asset turnover	−2.668***	−0.070***	−2.709***	0.059***	−1.702***
	(−9.84)	(−2.79)	(−10.00)	(25.55)	(−6.04)
Growth rate	2.761***	0.128***	2.834***	0.015***	2.842***
	(6.77)	(3.39)	(6.95)	(4.34)	(7.00)
Loss	1.463***	−0.126***	1.391***	−0.047***	0.741*
	(3.70)	(−3.45)	(3.52)	(−13.83)	(1.86)
Board members	−8.159***	0.385***	−7.937***	0.002	−7.689***
	(−11.19)	(5.71)	(−10.89)	(0.26)	(−10.59)
Independent director ratio	−12.664***	1.202***	−11.971***	−0.009	−11.944***
	(−5.12)	(5.24)	(−4.84)	(−0.42)	(−4.85)
CEO duality	0.490*	0.026	0.505**	−0.002	0.510**
	(1.94)	(1.10)	(2.00)	(−1.06)	(2.03)
Equity balance	0.279	0.041	0.303	−0.009**	0.190
	(0.69)	(1.10)	(0.75)	(−2.46)	(0.47)
State ownership	−3.042***	0.224***	−2.913***	0.046***	−2.447***
	(−9.77)	(7.78)	(−9.35)	(17.28)	(−7.80)
Firm listing age	−1.101***	0.064***	−1.064***	−0.013***	−1.045***
	(−6.45)	(4.07)	(−6.24)	(−9.03)	(−6.16)
R&D investment ratio	8.646***	1.575***	9.553***	−0.758***	−1.056
	(4.29)	(8.44)	(4.73)	(−43.82)	(−0.49)
Sales expenses	−0.984***	0.205***	−0.865***	−0.040***	−1.514***
	(−10.20)	(23.00)	(−8.80)	(−12.71)	(−14.28)
Environmental rewards	−2.290***	0.039	−2.268***	0.036***	−1.785**
	(−3.19)	(0.58)	(−3.16)	(5.79)	(−2.49)
Environmental punishment	−5.399*	0.245	−5.258*	0.043*	−4.604*
	(−1.93)	(0.95)	(−1.89)	(1.78)	(−1.66)
Population density	15.976***	−0.945*	15.431***	0.000	16.884***
	(2.99)	(−1.91)	(2.89)	(1.11)	(3.17)
Per capita education years	1.415*	−0.056	1.383	0.001	1.441*
	(1.67)	(−0.71)	(1.63)	(0.11)	(1.71)
Constant	41.506	−0.970	40.947	0.684***	48.831
	(1.18)	(−0.30)	(1.17)	(8.08)	(1.40)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Observations	12,698	12,698	12,698	12,698	12,698
R-squared	0.316	0.256	0.318	0.393	0.323

Note: Unstandardized regression coefficients are shown with t values in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$.

tion of corporate greenwashing behaviour. The contextual analysis also explores the moderating effects of heavy-polluting industries and high-tech industries. It finds a stronger inhibitory effect of FinTech adoption on corporate greenwashing behaviour in heavy-polluting industries. Conversely, in high-tech industries, there is a substitution effect, where the inhibitory effect of FinTech adoption on corporate greenwashing is significantly weakened for firms operating in this sector.

Theoretical implications

First, the research contributes to the emerging literature on FinTech by focusing on its role in addressing corporate greenwashing issues (Zhang *et al.*, 2022). While prior literature has debated the role of FinTech on information asymmetry, the findings present contrasting conclusions (Vismara, 2016). Most existing research contends that the adoption of FinTech mitigates information asymmetry. For instance, Du *et al.* (2020) construct a new type of supply chain financial platform which facilitates the information flow by using blockchain technology. Of course, some literature realizes that the emergence of FinTech may amplify information asymmetries between insiders and outsiders (Vismara, 2016). For instance, Zhou and Chen (2021) argue that the virtual nature of FinTech innovation aggravates the information asymmetries faced by regulators, and DeFusco, Tang and Yannelis (2022) suggest that welfare losses arise from information asymmetry in China's FinTech lending market. We elaborate on this discussion and uncover the specific effect of FinTech in the phenomenon of corporate greenwashing. Drawing upon affordance theory, we find that the adoption of FinTech is not readily employed to aggravate information asymmetry, but rather enhances the difficulty and cost of environmental information manipulation by firms through improving transparency. Our contribution lies in systematically exploring, for the first time, how the integration and precision features of FinTech compress the profit margin of corporate greenwashing behaviour, thus not only hindering the manipulation of environmental information disclosure, but also encouraging substantial environmental action and positive environmental performance. The findings highlight the alleviating effect of FinTech adoption for non-financial firms on artificially created information asymmetry. These observations raise scholars' attention on the positive and negative effects of FinTech adoption in terms of information asymmetry and contribute to FinTech research by complementing the positive effect of FinTech adoption from the perspective of corporate greenwashing.

Second, our findings contribute to the sustainability literature by addressing the previously neglected greenwashing in corporate sustainability. While prior studies have largely discussed the antecedents and mechanisms of corporate sustainability, the exploration of a reverse perspective of sustainability (i.e. corporate greenwashing alleviation) remains in its infancy (Hameed *et al.*, 2021; Wang, Ma and Bai, 2019; Wedari, Jubb and Moradi-Motlagh, 2021). Recent studies have explored and advanced how to curb corporate greenwashing from multiple perspectives, such as external institutional factors like environmental regulation and media coverage (Li *et al.*, 2023; Ruiz-Blanco, Romero and Fernandez-Feijoo, 2022). However, to the best of our knowledge, a dearth of prior literature has been devoted to addressing the intrinsic power of technology affordance on greenwashing alleviation. In accordance with this, by focusing on the practice of FinTech adoption in Chinese non-financial firms, this research fills the gap by systematically revealing the unique role and mechanisms of FinTech in alleviating greenwashing. Drawing on the technology affordance perspective, we argue that the affordances offered by FinTech can enhance green innovation and managerial efficiency, and further reduce greenwashing. Taken together, the role of FinTech and the two mechanisms we identified contribute to explaining the greenwashing alleviation outcome, thus enriching the theoretical framework of corporate sustainability literature.

Third, we contribute to the literature on governance by understanding how the greenwashing alleviation effect of FinTech adoption varies in different industrial contexts. Prior research recognizes that the effect of technology adoption can vary in different contexts (Majchrzak *et al.*, 2013). Ahlstrom, Cumming and Vismara (2018) suggest that governance through different legal and institutional conditions has played a pronounced role in shaping FinTech development, providing great opportunities for firms to improve their chances of success. For instance, since blockchain could reverse existing information asymmetries in the seafood industry, such innovation faces greater resistance and implementation challenges (Thompson and Rust, 2023). We add a new dimension to the governance literature by arguing that the governance in different industrial conditions and its intersection with FinTech provides a contextual affordance and significantly influences the possible outcome of FinTech adoption. We find that firms in heavy-polluting industries face stricter environmental supervision and higher pressure of green transformation and are more likely to reduce greenwashing from adopting FinTech, while the governance in high-tech firms supplements this effect of FinTech adoption due to their advanced governance structure and innovation capability. These findings provide implications for firms in other industrial contexts and conditions to address the governance challenges of FinTech and environmental information disclosure. The investigation regarding the interaction between technology affordance of FinTech and contextual affordances of different industries on corporate greenwashing contributes to a nuanced understanding of similar research on FinTech adoption in other industries and provides valuable solutions for addressing sustainability governance concerns faced by firms in various contexts.

Practical implications

The research findings in this paper provide significant managerial implications for firms in both China and other emerging countries. First, it is recommended that firms in emerging countries such as China recognize the significance of integrating FinTech adoptions into their innovation products and operational processes, which can greatly improve the quality of green innovation and managerial efficiency within these firms. Second, firms must fully grasp the affordances provided by FinTech to strengthen the green transformation, particularly in heavy-polluting industries.

The research findings also offer political implications for the Chinese government and other emerging country governments. First, it is recommended that governments strengthen the formulation of FinTech policies to create a supportive environment for the investment in FinTech infrastructure as well as the integration of FinTech adoption and green development. Second, governments should explore industrial differentiation when addressing corporate greenwashing issues. By identifying specific sectors or industries with serious greenwashing concerns and tailoring policies and incentives accordingly, governments can effectively address these challenges.

Limitations and future research directions

Several limitations should be addressed in future research. First, focusing solely on Chinese listed firms may restrict the generalizability of the findings to other emerging markets. To address this issue, future research should examine the proposed theoretical framework in diverse emerging markets, considering their unique institutional and technological contexts. This will help validate the applicability of the framework beyond China and contribute to a more comprehensive understanding of the relationship between FinTech adoption and greenwashing globally.

Second, this paper acknowledges the use of two industrial factors as moderators in the relationship between FinTech adoption and corporate greenwashing. To expand upon this theoretical framework, we are also aware of the possibility and challenges of broadening investigations to more specific industries, such as biotech manufacturing and transportation. In future studies, it is necessary to contemplate a tailor-made design for different industries and examine the generalization in more detailed contexts. This will enhance the understanding of how different contextual elements influence the relationship between FinTech adoption and corporate greenwashing and provide more valuable practical implications.

Third, this research mainly focuses on the impact of FinTech adoption on the greenwashing phenomenon yet fails to comprehensively explore the function of various FinTech categories. Although in this paper FinTech is considered as a general measure, and decomposing FinTech is not the objective of this study, it is necessary to investigate how different types of FinTech affect greenwashing in future research. A focus on one specific type of FinTech, or conducting comparative research on different types of FinTech, will contribute to a more comprehensive and nuanced understanding of the FinTech adoption–greenwashing relationship under exploration.

Appendix

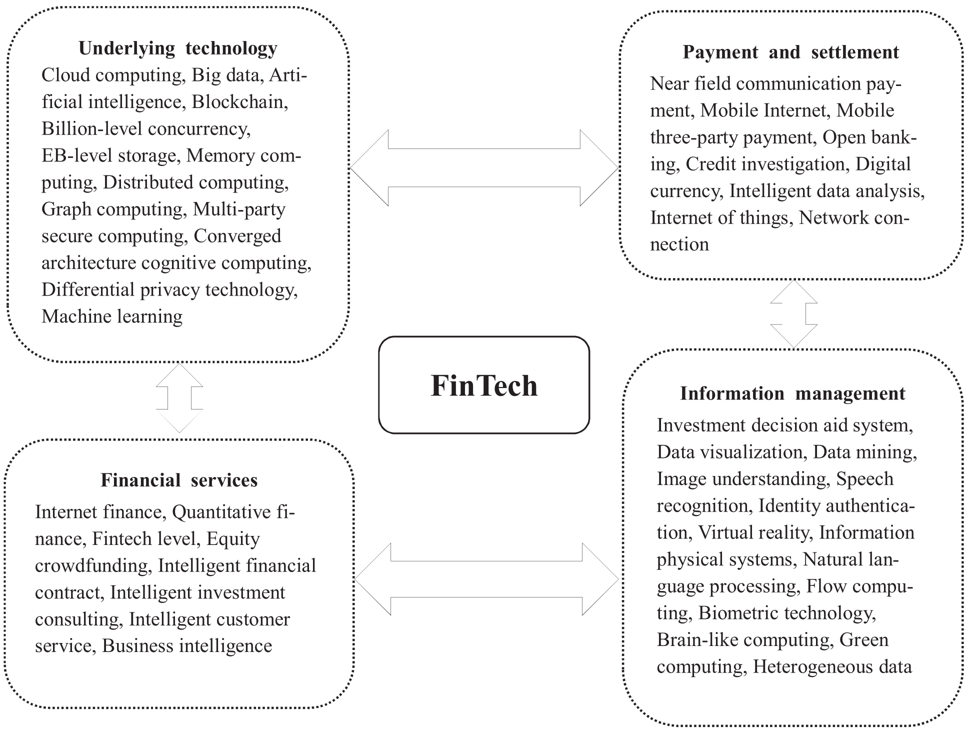

Figure A. The dictionary of keywords related to FinTech

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