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# Volume 18, 2 (2025)

China Journal of Accounting Research

Cross-owners and bond issue pricing: coordina	ation	Can independent directors effectively monitor	
or collusion?		controlling shareholders after reappointment?	
Shangkun Liang, Sichao Wang, Kaijuan Gao	100421	Rongjiang Bao, Yi Quan, Yuan Sun, Jingwen Zhang	100415
Fiscal expenditure responsibilities of			
public-private partnerships and corporate		Vertical interlock and corporate tax avoidance	
innovation investment—evidence from prefecture-level cities in China		Wen Wen, Fei Qiao, Jingli Feng	100418
Fang Wang, Xinci Chen, Guochao Yang	100416	Confucianism and corporate awareness	
		of climate change	
Does ex-ante disclosure of regulatory		Bin Li, Yunzhi Lin, Wendai Lv	100417
information really backfire?			
Huiyang Zhou, Jian Chu	100408	Refining employee treatment: Effects of	
		government arrears repayment in China	
Green underwriters and carbon information		Yanan Wang, Shuai Wang, Dongmin Kong,	
disclosure		Cheng Xue	100419
Yanan Tian, Yuhui Wu, Yun Zhang,			
Zhilun Zhang	100420		
Innovative or conservative? How clan culture			

100406

shapes bank digital transformation in China

Jinxuan Zhao, Meixu Ren



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#### 18 2

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# Cross-owners and bond issue pricing: coordination or collusion?



China Journal *oj* Accounting Research

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#### ABSTRACT

Using a sample of listed Chinese firms from 2007 to 2020, we investigate the governance implications of cross-ownership in corporate bond markets. We find that cross-ownership significantly reduces bond issuance spreads, suggesting that synergistic governance effects outweigh potential collusion risks. This effect operates through two channels: reducing information asymmetry between shareholders and creditors and lowering firm risk. The effect is stronger when cross-owners hold shares in more peer firms and retain shares longer but weaker for state-owned enterprises, long-term bonds and firms with robust information intermediaries. Our findings contribute to the corporate governance literature by demonstrating how cross-ownership enhances creditor protection, providing insights into optimizing ownership structures for debt financing, particularly in emerging markets with inadequate institutional monitoring.

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#### 1. Introduction

Cross-owners, defined as shareholders who simultaneously hold stakes in multiple companies, are common in the capital markets of many countries. In the United States, the proportion of companies with crossownership relationships involving institutional shareholders increased from 10% in 1980 to 60% in 2014 (He and Huang, 2017). This growth in cross-ownership has facilitated inter-firm information sharing while also raising concerns about potential collusive monopolies (Matvos and Ostrovsky, 2008; Harford et al., 2011). Despite their significant role in corporate governance and financial market development, the economic

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consequences of cross-ownership remain a subject of debate, with one perspective emphasizing collaborative benefits and the other highlighting risks of collusion.

The coordination effect perspective suggests that cross-ownership strengthens corporate governance (Kang et al., 2018; He et al., 2019), mitigates information asymmetry (Brooks et al., 2018; Park et al., 2019) and reduces earnings management (He et al., 2020). These effects positively influence firm development by increasing financing opportunities (Chen et al., 2021) and enhancing firm value (He and Huang 2017). Conversely, the collusion effect perspective argues that cross-owners engage in collusive agreements, increase the degree of monopoly and prioritize their own interests over those of the firm (Hansen and Lott, 1996; Azar et al., 2018; Pan et al., 2020). This incentive structure fosters information barriers, exacerbates information asymmetry (Maffett 2012) and leads to negative economic consequences.

The opposing viewpoints arise because, as shareholders, cross-owners have dual motives—both to promote the company's development and to advance their own interests, which may come at the company's expense. Studies mainly focus on the overall value of the company or shareholders, and less attention is paid to the impact of cross-owners on other stakeholders of the company.<sup>1</sup> Therefore, the full impact of cross-ownership on capital markets must be explored in depth.

The unique characteristics of shareholder structures and corporate governance mechanisms in China, compared with those in the United States, introduce significant uncertainty regarding the influence of cross-owners on corporate decision-making.<sup>2</sup> While cross-owners who hold larger stakes than small and medium shareholders and benefit from information spillovers have both the motivation and capacity to provide effective oversight, the widespread phenomenon of one-share dominance in Chinese companies may limit their ability to significantly influence corporate decisions. As of 2020, more than 30 % of listed Chinese companies were interconnected through the shareholding relationships of their top 10 shareholders.<sup>3</sup> Thus, understanding the role of cross-owners in China is essential for investors navigating the capital markets of developing economies and for policymakers striving to balance shareholder rights with overall corporate development.

The Chinese corporate bond market provides a unique setting in which to examine the influence of crossowners on corporate governance from the perspective of creditor interests. Despite significant growth with 2,802 bonds totaling RMB 2.38 trillion issued in 2021, a 13.9 % increase from the previous year, the market remains underdeveloped and heavily reliant on bank loans (Gu, 2015).<sup>4</sup> Information asymmetry, inadequate bond ratings and implicit guarantees continue to distort bond pricing and hinder market development (Fang et al., 2013). Unlike bank lenders, who rely on private information (Fama, 1985), corporate bond investors primarily depend on public information for pricing. Thus, signaling corporate health through effective internal governance is critical for ensuring reasonable bond pricing and reducing financing costs (Bhojraj and Sengupta, 2003).

Cross-owners may influence corporate bond issuance pricing through their role in corporate governance. We hypothesize that the coordinated governance effect of cross-owners can reduce information asymmetry and firms' operational risk, benefiting creditors. However, cross-owners may also prioritize the interests of shareholders over those of creditors or create information barriers through collusion, exacerbating information asymmetry. Using data on corporate bonds issued by companies listed on the Shanghai and Shenzhen

<sup>&</sup>lt;sup>1</sup> Cross-ownership in the United States has reached a relatively mature and stable state, whereas in China, it remains in a phase of rapid development. Given China's unique financial and market systems, examining cross-ownership within this context carries unique significance.

<sup>&</sup>lt;sup>2</sup> In terms of shareholding structure, cross-ownership in China is commonly associated with state-owned enterprises and family-owned firms, where shareholders often maintain close connections, complex relationships, and cross-shareholdings. In contrast, the U.S. shareholding structure is generally more decentralized, with institutional investors such as pension funds and insurance companies holding dominant positions. Corporate governance also differs significantly between the two countries. In China, shareholders, particularly in family-owned firms, directly influence managerial decisions, with founding families often retaining substantial control. In contrast, U.S. corporate governance emphasizes the independence of the board of directors, and shareholders primarily exercise influence through shareholder meetings and proxy voting, reflecting a more standardized governance framework. In addition, in China, large shareholders typically dominate corporate decision-making, whereas small and medium-sized shareholders have relatively weak rights. In the United States, although institutional investors may have greater influence, corporate governance mechanisms provide stronger protections for all shareholders, who collectively influence corporate decisions through voting at shareholder meetings.

<sup>&</sup>lt;sup>3</sup> Calculated based on data from the China Stock Market & Accounting Research (CSMAR) database.

<sup>&</sup>lt;sup>4</sup> Data source: Wind database.

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stock exchanges from 2007 to 2020, we find that cross-ownership significantly reduces corporate bond issuance spreads. Mechanism analysis indicates that cross-owners primarily influence pricing by reducing managerial earnings management and firm-level risk. A cross-sectional analysis shows that the impact of cross-owners on issuance pricing is more pronounced when they have stronger oversight capabilities, corporate bonds are riskier and information asymmetry is higher.

This study makes two primary contributions. First, it extends research on the economic consequences of cross-shareholding from the perspective of creditors. The literature examines the impact of cross-shareholding on firm value through various lenses, such as earnings management and investment efficiency; however, no consensus has yet been reached (He and Huang, 2017; He et al., 2020; Pan et al., 2020). Chen et al. (2021) find that cross-shareholding strengthens monitoring and reduces adverse selection, facilitating corporate financing. Using data on Chinese corporate bonds, this study finds that cross-shareholding lowers corporate bond costs by reducing information asymmetry and firm risk, further supporting Chen et al.'s (2021) findings. The present study, together with Chen et al.'s (2021) study, provides evidence from different perspectives on the positive role of cross-shareholdings in corporate financing, enhancing our understanding of the relationship between cross-shareholdings and corporate financing. These findings have important practical implications in determining whether to encourage or limit cross-shareholdings to maximize its positive effects.

Second, this study enriches the literature on the impact of equity markets on corporate bond markets by examining cross-shareholding. Previous studies examine the influence of equity structures and shareholder characteristics on bond pricing, including the roles of family shareholders (Anderson and Reeb, 2003), managerial shareholders (Bagnani et al., 1994), institutional investors (Cremers et al., 2007) and government shareholders (Borisova et al., 2015). These studies primarily focus on the equity structure and characteristics of individual firms. Conversely, the present study examines equity relationships created by cross-shareholders across multiple firms, extending the analysis of shareholder influence on corporate bond pricing from a single-firm perspective to a multi-firm network perspective. Building on Kang et al. (2018), this study further investigates the monitoring capacity of cross-shareholders using Chinese data. The findings indicate that the greater the number of peer firms in which a cross-shareholder holds stakes and the longer the average holding period of those shares, the more significant the effect of peer cross-shareholders in reducing corporate bond issuance pricing.

#### 2. Literature review and hypothesis development

#### 2.1. Literature review

#### 2.1.1. Economic consequences of cross-owners from two perspectives

Studies on cross-owners examine their influence on product markets, investment and financing behavior, information disclosure and earnings management, leading to two opposing perspectives: coordination and collusion.

The coordination perspective suggests that cross-owners mitigate information asymmetry and strengthen firm supervision using informational and supervision cost advantages gained through cross-shareholdings, ultimately enhancing firm value. Kacperczyk et al. (2005) and Park et al. (2019) find that common ownership promotes information disclosure. Brooks et al. (2018) argue that cross-owners reduce transaction costs and increase information transparency among firms, which, in turn, increases the likelihood of M&A. He et al. (2020) and Koch et al. (2021) find that cross-ownership helps curb earnings management. Kang et al. (2018) and He et al. (2019) show that cross-shareholdings encourage cross-owners to take on a more active monitoring role. Chen et al. (2021) verify that cross-owners exert a synergistic governance effect that facilitates corporate financing. He and Huang (2017) find that cross-owners enhance product market performance and increase firms' innovation productivity and profitability.

The collusion perspective argues that cross-shareholders engage in collusive behavior, using tactics such as increasing monopolistic power and creating information barriers to maximize their own interests instead of those of the firms in which they hold shares. Rubinstein and Yaari (1983) demonstrate that when two investors jointly establish two firms in an industry, they ultimately collude in the product market to form a monopoly. Hansen et al. (1996) find that when holding a diversified portfolio, cross-shareholders aim to maximize the

value of their portfolio. Azar et al. (2018) show that cross-shareholders may reduce incentives for inter-firm competition, reach a collusive consensus, raise product prices and reduce firm output. Pan et al. (2020) confirm the negative impact of collusive competition by cross-shareholders from the perspective of corporate investment activities and find that it reduces a firm's market value.

Overall, the literature on the economic consequences of cross-ownership examines various stakeholders, including shareholders, management and product markets, from both governance and collusion perspectives. However, no study explores the impact of cross-ownership on creditors who are also key stakeholders in a firm.

#### 2.1.2. Determinants of corporate bond pricing

The pricing of corporate bonds consists of two components: the risk-free rate of return and the risk rate of return. The risk-free rate of return is usually expressed as the risk-free interest rate of the bond, represented by the treasury bond yield, whereas the risk rate of return is represented by the risk compensation rate demanded by investors, also known as the bond spread. Factors affecting corporate bond pricing are classified into macro-, micro- and bond-level factors.

Macro-level factors such as the risk-free rate, economic cycle and political stability may affect bond pricing based on the overall risk environment. Longstaff and Schwartz (1995) find that lower risk-free bond yields lead to lower corporate bond pricing. Fama and French (1996) indicate that credit spreads widen during economic recessions. Jarrow and Turnbull (1995) argue that the default intensity of corporate bonds may depend on exogenous macroeconomic variables. Wang et al. (2015) find that lower policy volatility and a more favorable product market environment are associated with lower bond spreads.

Firm-level characteristics such as size, profitability and information environment affect information asymmetry and transmit signals about firm operations, thereby affecting a firm's risk level and thus bond prices. Merton (1974) argues that issuer size could affect credit spreads. Altman (1968) introduces the total asset to liability ratio into his model to demonstrate the impact of financial factors on bond credit spreads. Minnis (2011) empirically finds that corporate debt financing costs are inversely proportional to profitability. Wang and Shi (2014) report a significant negative relationship between operating capacity and corporate bond coupon rates. Higher information transparency (Sengupta, 1998; Yu, 2005) and higher-quality accounting information (Bharath et al., 2008; Baber et al., 2013) are associated with lower credit spread of corporate bonds, leading to lower bond issuance prices.

Corporate bond characteristics play a crucial role in bond pricing. Ziebart and Reiter (1992) find that bond ratings directly affect bond yields. He and Jin (2010) show that both bond and subject ratings influence issuance costs, but bond ratings have a stronger influence on issuance costs than subject ratings, and higher bond ratings can effectively reduce the issuance price of bonds. Chen and Li (2014) find that larger bond issuances are associated with lower financing costs. In addition, underwriters play a crucial role in the issuance of corporate bonds. The greater the number of top-ranked underwriters involved in a bond issuance, the more they can help reduce the spread of corporate bond issuances (Wang and Gao, 2017). Lin et al. (2019) find that underwriter ratings are negatively related to bond credit spreads, and this effect is more significant in firms with higher information asymmetry and credit risk.

#### 2.1.3. Shareholder characteristics and corporate bond issue pricing

Shareholder characteristics significantly influence corporate bond prices. Anderson and Reeb (2003) find that higher family ownership by firm founders lowers bond spreads, but excessive ownership increases agency conflicts between shareholders and debtholders, leading to higher spreads. Bagnani et al. (1994) and Ortiz-Molina (2007) show that managerial ownership is positively correlated with bond spreads because managers may engage in riskier activities to enhance firm value at the expense of debtholders. However, very high managerial ownership generally reduces bond financing costs (Bhojraj and Sengupta, 2003), but its impact on credit spreads depends on the takeover context (Cremers et al., 2007) and varies by type of institutional investors (Wang and Zhang, 2009). Government ownership can lower debt costs through implicit guarantees (Fang et al., 2013), but unless the implicit guarantee effect dominates, it is often associated with higher debt costs (Borisova et al., 2015).

#### 2.2. Hypothesis development

Cross-ownership influences corporate bond issuance prices by affecting firm operations and the information environment. First, cross-ownership exerts positive synergistic effects that help reduce bond issuance prices. Internally, cross-owners leverage information and governance experience from multiple holdings to enhance operational efficiency and monitor effectiveness. This reduces adverse selection and improves financing access (Kang et al., 2018; Chen et al., 2021). Moreover, cross-ownership can mitigate inefficiencies caused by governance externalities, increasing the performance sensitivity of CEO turnover (He et al., 2019). Externally, cross-owners use their informational advantages and accumulated knowledge to promote product market coordination, thereby improving innovation and profitability (He and Huang, 2017). Stronger profitability and firm value lead to lower debt financing costs (Minnis, 2011). Because good profitability enhances internal control quality, firms with higher profitability tend to have lower bond interest rates. Thus, cross-owners can reduce corporate bond issuance pricing by improving operational efficiency and firm value.

Second, cross-owners may reduce bond issuance pricing by alleviating information asymmetry. Crossowners strengthen the oversight of firm executives, improving earnings quality and reducing managerial earnings manipulation through product market and financial reporting monitoring (He et al., 2020; Koch et al., 2021; Ramalingegowda et al., 2021). Compared with general institutional investors and other shareholders, cross-owners enhance the efficiency of information transmission and use, reducing information asymmetry between investors and the company. Cross-owners generate economies of scale through information sharing (Kacperczyk et al., 2005), mitigate the proprietary costs of disclosure and promote information disclosure (Park et al., 2019). Brooks et al. (2018) show that cross-owners reduce transaction costs and increase intercompany information transparency, which are crucial for M&A. Higher-quality accounting information reduces information asymmetry between corporate bond issuers and investors, leading to higher credit ratings from rating agencies and lower required returns from bond investors, thereby reducing bond financing costs (Zhu, 2013). Thus, cross-owners can lower corporate bond financing costs by improving corporate information disclosure and mitigating information asymmetry.

Cross-owners may also generate negative collusive effects, leading to higher corporate bond issuance prices. First, collusive behavior among cross-owners is not conducive to firm value maximization. Cross-owners may reach a collusive consensus, increase their degree of monopoly and prioritize their own interests over those of the firm. Shareholders with diversified investment portfolios do not necessarily seek to maximize firm value as a corporate policy. Instead, they aim to maximize the value of their overall investment portfolio (Hansen and Lott, 1996). Cross-ownership reduces incentives for inter-company competition, facilitates collusive consensus, increases product prices and lowers company output (Azar et al., 2018). In addition, cross-ownership lowers investment efficiency and firm value (Pan et al., 2020). Therefore, cross-owners may reduce company value and profitability through collusion, ultimately increasing corporate bond financing costs.

Second, cross-owners create information barriers that increase information asymmetry. To preserve their information advantage and maximize benefits, cross-owners monopolize firms' proprietary information rather than disclosing it publicly. In countries with an underdeveloped disclosure infrastructure, where investors have strong incentives and opportunities to obtain private information, the correlation between firm-level opacity and informed trading is most evident (Maffett, 2012). Cross-owners are more likely to encourage firms to disclose low-quality accounting information to serve their interests. Therefore, to maintain their informational advantage and secure excess returns, cross-owners actively create information barriers. These barriers further increase information asymmetry, leading to an increase in corporate bond costs.

Third, even if cross-owners can exert synergistic effects, they may still choose to encroach on creditors' interests to secure high profits. The pursuit of high returns by shareholders often conflicts with creditors' preference for low risk, creating an incentive for shareholders to prioritize their own interests at the expense of creditors. This dynamic ultimately increases corporate bond issuance pricing (Shleifer and Vishny, 1997; Ashbaugh-Skaife et al., 2006). Sunder et al. (2014) also find that shareholder activism increases borrowing prices, indicating a conflict of interest between creditors and shareholders. Therefore, the synergistic effects of cross-owners may lead to higher corporate bond issuance pricing. Based on the aforementioned two opinions, this study proposes the following competing hypotheses<sup>5</sup>: H1a: Ceteris paribus, if the synergistic effect of cross-owners is stronger than the collusive effect, cross-owners

will reduce the issuance pricing of corporate bonds.

H1b: Ceteris paribus, if the collusive effect of cross-owners is stronger than the synergistic effect, cross-owners will increase the issuance pricing of corporate bonds.

#### 3. Research design

#### 3.1. Model construction and variable definition

Following Wang and Gao (2017), we use Model (1) to examine the impact of cross-ownership structures on corporate bond issuance pricing. If  $\beta_1$  is significantly less than 0, it suggests that cross-owners reduce corporate bond issuance prices, supporting H1a. Conversely, if  $\beta_1$  is significantly greater than 0, it indicates that cross-owners increase corporate bond issuance prices, supporting H1b.

$$SPREAD_{i,t} = \beta_0 + \beta_1 NUMCROSS_{i,t} + \sum BONDCONTROL_{i,t} + \sum FIRMCONTROL_{i,t} + \sum YEAR + \sum INDUSTRY + \varepsilon_{i,t}$$
(1)

#### 3.1.1. Dependent variable

Consistent with Fang et al. (2013), we calculate the bond issuance spread (*SPREAD*) as the percentage point difference between the coupon rate of corporate bonds and the yield to maturity of concurrent government bonds at the time of bond issuance.

#### 3.1.2. Independent variable

Following Chen et al. (2018), we define the number of cross-chain shareholders (*NUMCROSS*) as the number of major shareholders (holding 5% or more) with cross-shareholdings in the same industry during the quarter preceding a firm's corporate bond issuance. A major shareholder is classified as having cross-shareholdings if they hold shares in at least two firms within the same industry during the same quarter.

#### 3.1.3. Control variables

The corporate bond characteristic variables (BOND CONTROL) include the following. Bond rating (BON-DRATING) is measured as the natural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA–, 2 for AA, 3 for AA+ and 4 for AAA. Issuance size (BONDSIZE) is defined as the natural logarithm of the corporate bond issuance amount (in units of hundred million yuan). Issuance term (BONDTERM) refers to the term of the corporate bond. Guarantee situation (GUARANTOR) is an indicator variable equal to 1 if the corporate bond is guaranteed and 0 otherwise. Put option situation (PUT) is an indicator variable equal to 1 if the corporate bond has a put option and 0 otherwise. Call option situation (CALL) is an indicator variable equal to 1 if the corporate bond has a call option and 0 otherwise. Underwriter ranking (RANK) represents the ranking of the corporate bond's underwriter. In this study, the lead underwriter is ranked based on the total amount of bonds underwritten in the current year, with a higher ranking indicating stronger underwriting capability.

The firm-specific control variables (*FIRM CONTROL*) are as follows. Firm size (*SIZE*) is measured as the natural logarithm of market value. Leverage (*LEVERAGE*) represents the ratio of total liabilities to total assets. Return on equity (*ROE*) is calculated as the ratio of net profit to net assets. Total asset turnover

<sup>&</sup>lt;sup>5</sup> Cross-owners may act as creditors by purchasing corporate bonds. As bond investors, they have an incentive to increase bond issuance coupon rates to maximize bond income. However, cross-owners may also seek to reduce bond issuance prices to reduce financing costs. When both purchasing bonds for profit and issuing bonds for financing are viable strategies, cross-owners may prioritize their own financial interests. Specifically, the higher the number of firms in which cross-owners hold stakes, the greater their potential to reduce corporate bond issuance pricing. Thus, as the number of cross-owners in a firm increase, the likelihood of a decline in bond issuance pricing also rises. Conversely, when the incentive to increase corporate bond coupon rates for profit is stronger and more dominant, bond issuance pricing is more likely to increase.

ZH The ratio of the sum of the holdings of the second-to tenth-largest shareholders to the holdings of the largest shareholde	Variable definition Variable definition The percentage point difference between the coupon rate of corporate bonds and the yi government bonds at the time of bond issuance. The number of major shareholders (holding 5 % or more) with cross-shareholdings in the preceding a firm's corporate bond issuance. The natural logarithm of a categorical variable where corporate bond ratings are assigned AA+, and 4 for AAA. The natural logarithm of the corporate bond issuance amount (in units of hundred mill The term of the corporate bond issuance amount (in units of hundred mill The term of the corporate bond issuance amount (in units of hundred mill The term of the corporate bond issuance bond is guaranteed, and 0 otherwise. An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise. An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise. An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise. An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise. The ranking of the corporate bond's underwriter. The lead underwriter is ranked based underwriten in the current year, with a higher ranking indicating stronger underwriting The ratio of total liabilities to total assets. The ratio of total liabilities to total assets. The ratio of total assets to market value. An indicator variable equal to 1 if the CEO also serves as the chairman of the bond, a An indicator variable equal to 1 if the CEO also serves as the chairman of the bond. An indicator variable equal to 1 if the CEO also serves as the chairman of the bond, a An indicator variable equal to 1 if the CEO also serves as the chairman of the bond. An indicator variable equal to 1 if the CEO also serves as the chairman of the bond. An indicator variable equal to 1 if the CEO also serves as the chairman of the bond. An indicator variable equal to 1 if the CEO also serves as the chairman of the varich. The ratio of the s	Variable SPREAD NUMCROSS BONDRATING BONDRATING BONDTERM GUARANTOR PUT CALL RANK PUT CALL RANK SIZE LEVERAGE ROE AT BM ZSCORE SOE DUAL SEPARATION SEPARATION	tble 1 uriable definitions. uriable type ependent variable dependent variable ontrol variables
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old shares in two or more firms within the same industry during the same quarter.         orl variables       BONDRATING       The natural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA-, 2 for AA, 3         AA+, and 4 for AAA.       BONDSTZE       The natural logarithm of the corporate bond issuance amount (in units of hundred million yuan)         BONDSTRM       The natural logarithm of the corporate bond issuance amount (in units of hundred million yuan)         BONDTERM       The natural logarithm of the corporate bond is guaranteed, and 0 otherwise.         PUT       An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise.         PUT       An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise.         CALL       An indicator variable equal to 1 if the corporate bond has a rall option, and 0 otherwise.         RANK       An indicator variable equal to 1 if the corporate bond has a rall option, and 0 otherwise.         CALL       The natural logarithm of market value.         ISZE       The natural logarithm of market value.         ISZE       The natural logarithm of market value.         ISZE       The natural logarithm of market value.         ISTE       The natural logarithm of market value.         ISTE       The ratio of total assets.         ISTE       The ratio of notal assets.         ISTE	preceding a firm's corporate bond issuance. Specifically, a major shareholder is considere		
ol variables       BONDRATING       The natural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA-, 2 for AA, 3         AA+, and 4 for AAA.       AA+, and 4 for AAA.         BONDFRM       The natural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA-, 2 for AA, 3         BONDFRM       The natural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA-, 2 for AA, 3         BONDFRM       The natural logarithm of the corporate bond is guaranteed, and 0 otherwise.         BONDFRM       An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise.         CALL       An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise.         RANK       The natural logarithm of nater value.         SIZE       The natural logarithm of nater value.         BO       AT         The ratio of net profit to net assets.         BA       The ratio of net profit to net assets.         BA       The ratio of net profit net assets.	The number of major shareholders (holding 5 % or more) with cross-shareholdings in the	NUMCROSS	endent variable
wordent variable         NUMCROSS         The number of major shareholders (holding 5% or more) with cross-shareholdings if the game eindustry in the quarter.           hereding a firm's corporate bond issuance. Specifically, a major shareholder is considered to have cross-shareholdings if the base quarter.         BONDRATING         The natural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA-, 3 AA+, and 4 for AAA.           BONDSTER         The natural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA-, 2 for AA, 3 AA+, and 4 for AAA.           BONDSTER         The natural logarithm of the corporate bond issuance amount (in units of hundred million yuan)           BONDTERM         An indicator variable equal to 1 if the corporate bond is guaranteed, and 0 otherwise.           PUT         An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise.           PUT         An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise.           AUK         An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise.           AUK         An indicator variable equal to 1 if the corporate bond has a call ot therwise.           AUK         An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise.           AUK         An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise.           AUK         An indicator variable equal to 1 if the corporate	government bonds at the time of bond issuance.		
endent variable     NUMCROS     prevention onds at the time of bond issuance.       indent variable     NUMCROS     The number of major shareholders (holding 5% or more) with cross-shareholdings in the same industry in the quarter.       indent variable     BONDRATING     The number of major shareholders (holding 5% or more) with cross-shareholdings in the same industry during the same quarter.       indent variable     BONDRATING     The nutural logarithm of a categorical variable where corporate bond ratings are assigned values of 1 for AA-, 2 for AA, 3       AA+, and for AAA.     The natural logarithm of the corporate bond iss unstance amount (in units of hundred million yuan)       BONDTERM     The natural logarithm of the corporate bond iss guaranteed, and 0 otherwise.       PUT     An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise.       PUT     An indicator variable equal to 1 if the corporate bond has a put option, and 0 otherwise.       PUT     An indicator variable equal to 1 if the corporate bond has a rad option, and 0 otherwise.       PUT     An indicator variable equal to 1 if the corporate bond has a rad option, and 0 otherwise.       PUT     An indicator variable equal to 1 if the corporate bond is guaranteed, and 0 otherwise.       PUT     An indicator variable equal to 1 if the corporate bond has a rad option, and 0 otherwise.       PUT     An indicator variable equal to 1 if the corporate bond has a rad option, and 0 otherwise.       EVER     An indicator variable equal to 1 if the corporate bond i	The percentage point difference between the coupon rate of corporate bonds and the yi	SPREAD	ndent variable
Affect         The percentage point difference between the coupon rate of corporate bonds and the bised to maturity of concurrent government bonds at the time of bond issuance.           endent variable         NUMCROSS         The number of major shareholders (holding 5% or more) with cross-shareholdings if the anne industry during the same quarter.           ol variables         BONDRATTING         The number of major shareholders (holding 5% or more) with cross-shareholdings if the quarter.           ol variables         BONDRATTING         The number of major shareholder is considered to have cross-shareholdings if the dot have state to bond statuse. Specifically, a major shareholder is considered to have cross-shareholdings if the matural logarithm of the corporate bond issuance.           BONDSTZE         The natural logarithm of the corporate bond is guaranteed, and 0 otherwise.           BONDSTZE         The natural logarithm of the corporate bond is guaranteed, and 0 otherwise.           BONDSTZE         The natural logarithm of the corporate bond is guaranteed, and 0 otherwise.           BONDSTZE         The natural logarithm of the corporate bond has a call option, and 0 otherwise.           BONDSTERM         An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise.           CALL         An indicator variable equal to 1 if the corporate bond has a call option, and 0 otherwise.           BONE         The natural logarithm of matket white.           BONE         The natural logaritor variable equal to 1 if the corporate bond has a ca	Variable definition	Variable	ble type
Observation         Variable			ble definitions.
ble definition.         ble type         ble type       Variable       Va			1

(AT) is the ratio of annual operating revenue to total assets. The book-to-market ratio (BM) is the ratio of total assets to market value. The Z-score (ZSCORE) is a bankruptcy risk index calculated using the Altman model based on financial data. Ownership nature (SOE) is an indicator variable equal to 1 if the firm is stateowned and 0 otherwise. Duality (DUAL) is an indicator variable equal to 1 if the CEO also serves as the chairman of the board and 0 otherwise. Separation of powers (SEPARATION) is the difference between the control rights of the actual controller and ownership rights. Ownership restriction (ZH) is the ratio of the sum of the holdings of the second- to tenth-largest shareholders to the holdings of the largest shareholder. Big Four (BIG4) is an indicator variable equal to 1 if the firm is audited by one of the international Big Four accounting firms and 0 otherwise.

In the regression model, we also control for year fixed effects (*YEAR*) and industry fixed effects (*INDUS*-TRY). To mitigate the influence of extreme values, all continuous variables are winsorized at the 1st and 99th percentiles. See Table 1 for variable definitions.

#### 3.2. Sample selection and data sources

We select corporate bonds issued by listed companies on the Shanghai and Shenzhen stock exchanges from 2007 to 2020 as the initial sample and apply the following screening procedures. First, we exclude corporate bonds issued by firms in the financial industry. Second, we exclude private placement bonds issued by listed firms. Third, we exclude corporate bonds with incomplete data that prevent the calculation of the bond issuance spread. Fourth, we exclude corporate bonds with missing firm characteristic data. The final sample comprises 1,327 observations. Data on corporate bonds are sourced from the Wind database, whereas financial and original cross-shareholding data are sourced from the CSMAR database.

#### 4. Main results

#### 4.1. Descriptive statistics

Table 2 reports the descriptive statistics of the variables. For the sample, the mean *SPREAD* value is 2.302, with a standard deviation of 1.254. The minimum and maximum values are 0.350 and 5.296, respectively. The

Table 2	
Descriptive	statistics.

Variable	Mean	SD	Min	Median	Max
SPREAD	2.302	1.254	0.350	2.109	5.296
NUMCROSS	0.191	0.481	0.000	0.000	3.000
BONDRATING	1.346	0.220	0.693	1.386	1.609
BONDSIZE	2.198	0.816	0.000	2.303	4.094
BONDTERM	4.774	1.645	2.000	5.000	10.000
GUARANTOR	0.278	0.448	0.000	0.000	1.000
PUT	0.410	0.492	0.000	0.000	1.000
CALL	0.173	0.379	0.000	0.000	1.000
RANK	14.462	15.402	1.000	7.715	86.000
SIZE	23.978	1.464	21.526	23.751	28.191
LEVERAGE	0.585	0.172	0.138	0.604	0.870
ROE	0.093	0.056	-0.013	0.085	0.259
AT	0.543	0.427	0.031	0.424	2.215
BM	1.393	1.114	0.162	1.042	5.338
ZSCORE	1.451	0.974	0.088	1.223	6.030
SOE	0.585	0.493	0.000	1.000	1.000
DUAL	0.154	0.362	0.000	0.000	1.000
SEPARATION	5.414	8.402	0.000	0.000	31.459
ZH	0.774	0.708	0.030	0.556	3.400
BIG4	0.224	0.417	0.000	0.000	1.000

	(1)	(2)	(3)
DEPVAR=	SPREAD	SPREAD	SPREAD
NUMCROSS	-0.493***	-0.148***	-0.093**
	(-10.51)	(-3.21)	(-2.16)
BONDRATING		$-2.835^{***}$	$-2.272^{***}$
		(-18.26)	(-15.11)
BONDSIZE		-0.137***	-0.147***
DONDTEDM		(-3.82)	(-4.19)
BONDIERM		$-0.101^{+++}$	$-0.0/3^{***}$
GUARANTOR		(-0.03)	(-4.02)
00mmin on		(6 34)	(7.66)
PUT		0.100	0.058
		(1.52)	(1.01)
CALL		0.022	0.011
		(0.30)	(0.17)
RANK		0.003*	0.003**
		(1.90)	(2.53)
SIZE			0.060**
			(2.33)
LEVERAGE			0.942***
POF			(4.81) 2 224***
KUL			-2.224
AT			-0.267***
			(-4.04)
BM			0.138***
			(5.00)
ZSCORE			0.031
			(0.95)
SOE			-0.944***
			(-15.40)
DUAL			0.182***
SEDADATION			(2.76)
SEFARATION			(-1.10)
ZH			0.061*
			(1.78)
BIG4			-0.184***
			(-3.14)
CONSTANT	2.477***	7.020***	5.056***
	(5.41)	(16.05)	(7.44)
INDUSTRY FE	YES	YES	YES
YEAR FE	YES	YES	YES
Obs	1327	1327	1327
$AdI-R^{2}$	0.292	0.531	0.657

 Table 3

 Regression of cross-owners on corporate bond issuance spread.

Note: t-values adjusted for standard errors based on firm-level clustering are in parentheses; \*, \*\*, and \*\*\* indicate significance at the 1%, 5%, and 10% levels, respectively, the same below.

mean *NUMCROSS* value is 0.191, with a standard deviation of 0.481 and range from 0.000 to 3.000. The mean *BONDRATING* is 1.346, indicating relatively high credit quality. The mean *GUARANTOR* is 0.278, suggesting that approximately 28 % of bonds in the sample are guaranteed. The mean *LEVERAGE* is 0.585, indicating a relatively high level of leverage among bond-issuing firms. The mean *SOE* is 0.585, indicating that state-owned enterprises (SOEs) account for 58.5 % of the sample.

#### 4.2. Hypothesis testing results

Table 3 reports the results of the regression analysis for the main hypotheses. All regressions control for industry and year fixed effects, with *t* values reported in parentheses based on robust standard errors clustered at the bond level. Table 3 presents the results for the main effects. Column (1) includes only the key explanatory variable, *SPREAD*. The coefficient on *SPREAD* is negative and significant at the 1% level, suggesting that higher bond issuance spreads are associated with lower pricing. In Column (2), *BOND CONTROL* is added as an additional control. The coefficient on *SPREAD* remains negative and significant at the 1% level, indicating that the effect is robust to the inclusion of these controls. In Column (3), *FIRM CONTROL* is further included. The coefficient on *SPREAD* remains negative and significant at the 5% level, supporting Hypothesis 1a. This result indicates that a higher number of cross-owners is associated with lower corporate bond issuance pricing, i.e., the presence of cross-owners reduces the pricing of corporate bond issuance. The coefficients on *BONDRATING*, *BONDSIZE*, *ROE* and *SOE* are significantly negative, consistent with the findings of He and Jin (2010), Chen and Li (2014), Wang and Shi (2014) and Fang et al. (2013). The coefficient on *RANK* is significant and positive, supporting the conclusion of Wang and Gao (2017).

#### 4.3. Mechanism analysis

The hypothesis analysis and empirical results suggest that cross-ownership is associated with lower pricing of corporate bond issuances. What are the specific mechanisms through which cross-owners exert this influence? Theoretical analysis indicates that cross-owners may influence bond pricing through two primary channels: enhancing corporate operational efficiency and reducing information asymmetry. This leads to a reduction in the firm's operational risks, ultimately lowering the risk compensation rates demanded by investors and corporate bond issuance prices. Collectively, these actions reduce the risk premium investors demand, thereby lowering corporate bond issuance prices. To examine the potential pathways through which cross-owners affect the pricing of corporate bond issuances, we follow Jiang's (2022) approach and conduct the following tests on the mechanism of action.

First, we examine whether the effects of cross-owners on corporate bond issuance pricing operate by improving operational efficiency. We use the management expense ratio (ME) to measure firm operational efficiency, following Ang et al. (2000). Specifically, ME is calculated as the ratio of management expenses to operating revenue. Column (1) of Table 4 presents the test results. The coefficient on NUMCROSS is positive but not significant, indicating that the impact of cross-owners on the operational efficiency of bond-issuing firms is nonsignificant.

Second, we examine whether cross-ownership affects corporate bond issuance pricing by reducing information asymmetry. Following Bharath (2008), we measure the degree of information asymmetry using the abso-

Exploring efficiency, information and risk channels.						
	(1)	(2)	(3)			
DEPVAR=	ME	ABSDA	RISK			
NUMCROSS	0.001	-0.009***	-0.007**			
	(0.68)	(-2.99)	(-2.37)			
CONSTANT	0.235***	0.042	0.122***			
	(7.31)	(0.63)	(3.77)			
CONTROLS	YES	YES	YES			
INDUSTRY FE	YES	YES	YES			
YEAR FE	YES	YES	YES			
Obs	1327	1265	1327			
$Adj-R^2$	0.359	0.266	0.270			

Table 4					
Exploring efficiency,	information	and	risk	channels.	

lute value of discretionary accruals calculated using the modified Jones model (*ABSDA*). Column (2) of Table 4 presents the results. The coefficient on *NUMCROSS* is negative and significant at the 1 % level. This finding indicates that cross-ownership is associated with lower levels of earnings management, thereby alleviating information asymmetry between bond-issuing firms and investors.

Finally, we examine whether cross-owners affect corporate bond issuance pricing by reducing firm risk. Following John et al. (2008), we measure firm risk (*RISK*) using the standard deviation of the return on equity over 3 consecutive years. Column (3) of Table 4 presents the test results, which show that the coefficient on *NUMCROSS* is negative and significant at the 5 % level. This result indicates that cross-owners significantly reduce the risk level of bond-issuing firms.

In summary, cross-owners primarily reduce the issuance price of corporate bonds by mitigating earnings management and reducing *ROE* volatility. In other words, alleviating information asymmetry and reducing firm-level risk are the two crucial mechanisms through which cross-owners influence corporate bond pricing.

#### 4.4. Robustness tests

#### 4.4.1. Instrumental variable test

Cross-owners are more likely to invest in firms with higher profitability and more favorable growth prospects. Because investors typically prefer such firms, the risk premium they demand is lower, resulting in a decreased issuance spread for corporate bonds. In this case, the observed reduction in the issuance spread of corporate bonds is not due to cross-ownership itself but to the inherent characteristics of the firm. To address potential endogeneity concerns resulting from omitted variables and reverse causality in the relationship between cross-ownership and the issuance spread of corporate bonds, we use the inclusion and exclusion of stocks from the CSI 300 Index as instrumental variables, following the methodology of Pan et al. (2020).

Numerous large index funds operate in the market, typically allocating assets based on the composition and weight of specific stock indices. When a stock is added to or removed from an index, these funds adjust their investment portfolios accordingly. Crane et al. (2016) argue that after controlling for fundamental stock characteristics, changes in index composition can serve as a valid instrumental variable for investor shareholding variables. Because index funds generally hold shares in multiple listed firms, changes in their asset portfolios may influence the shareholder structure indicators of related firms but do not directly affect the bond issuance spread of these firms (Pan et al., 2020).

The constituent stocks of the CSI 300 Index represent the top 300 A-share stocks in the Shanghai and Shenzhen markets, characterized by substantial market capitalization and high liquidity, which are highly appealing to bond investors. When a firm's stock is added to the CSI 300 Index, its attractiveness to investors increases, potentially prompting investors to acquire shares. Conversely, when a firm's stock is removed from the CSI 300 Index, its attractiveness to investors decreases, which may lead investors to divest their holdings.

We define an instrumental variable, *IN300*, which equals 1 if a company is upgraded from non-CSI 300 to a constituent stock of the CSI 300 Index and 0 otherwise. We use *IN300* as the explanatory variable in the first-stage regression and *NUMCROSS* as the dependent variable. The predicted value of *NUMCROSS* from the first-stage regression is then used as the explanatory variable in the second-stage regression, and *SPREAD* is used as the dependent variable. Panel A of Table 5 presents the results. The first-stage regression results indicate that the coefficient on *IN300* is positive and significant at the 1 % level, suggesting that upgrading to the CSI 300 Index increases the number of cross-owners held by bond-issuing firms. The results of the second-stage regression indicate that the coefficient on *NUMCROSS* is negative and significant at the 10 % level, indicating that an increase in the number of cross-owners is associated with a reduction in the bond issuance spread. Thus, becoming a constituent stock of the CSI 300 Index leads to an increase in the number of cross-owners held by bond issuance spread.

Panel A: Instrumental van	riable test					
	(1)		(2)			
DEPVAR=	NUMO	CROSS	SPREAD			
IN300	0.	0.302***				
		(3.16)				
NUMCROSS			-0.540*			
CONSTANT	_1	659***	(-1.72) 4 289***			
constant	1.	(-4.33)	(5.00)			
CONTROLS	YES	· · ·	YES			
INDUSTRY FE	YES		YES			
YEAR FE	YES		YES			
Obs $Adi \mathbb{P}^2$		1327	1327			
Pageal D. Haalaman target		0.277	0.035			
Panel B: Heckman two-st	age method		(2)			
	(1)		(2)			
DEPVAR=	SPR	EAD	SPREAD			
NUMCROSS	-0.0	)90**	-0.073*			
IMD	(-	(-2.03)				
IMK	(	0.144				
CONSTANT	3.80	3.803***				
0011011111	(	(3.17)	(2.55)			
CONTROLS	YES		YES			
INDUSTRY FE	YES		YES			
YEAR FE	YES		YES			
Obs		1280	1246			
$Adj-R^2$		0.657	0.661			
Panel C: Altering the mea	surement of the dependent	nt variable				
	(1)	(2)	(3)			
DEPVAR=	ISSUERATE	ISSUERATE	ISSUERATE			
NUMCROSS	-0.438***	-0.255***	-0.087*			
	(-8.85)	(-4.88)	(-1.80)			
CONSTANT	6.822***	8.262***	9.895***			
	(16.56)	(16.12)	(13.08)			
BOND CONTROL	NO	YES	YES			
FIRM CONTROL	NO	NO	YES			
INDUSIKI FE VEAD FE	YES	I ES VES	I ES VES			
Obs	1327	1327	123			
$Adi-R^2$	0.384	0.469	0.626			
Panel D: Altering the mea	asurement of the independ	dent variable				
	(1)	(2)	(3)			
DEPVAR=	SPREAD	SPREAD	SPREAD			
NUMCROSS10	-0.821***	-0.278***	-0.167**			
	(-11.62)	(-3.96)	(-2.49)			
CONSTANT	2.482***	6.990***	5.021***			
	(5.40)	(15.98)	(7.37)			
BOND CONTROLS	NO	YES	YES			
FIRM CONTROLS	NO	NO	YES			
INDUSTRY FE	YES	YES	YES			
IEAR FE	Y ES	Y ES	YES			
$A di P^2$	1327	1527	1327			
nuj-N	0.295	0.332	0.057			

Table 5 Robustness tests.

# 4.4.2. Heckman two-stage method

(1) To address the potential self-selection bias resulting from cross-ownership in the same industry, we use the Heckman two-stage method, following the approach of Pan et al. (2020). Cross-owners are typically formed when investors hold shares in multiple firms in the same industry because of certain common characteristics of these firms. This may lead to selection bias, where observed results are driven by these common characteristics instead of cross-ownership itself.

In the first stage, we estimate the probability of a firm having a cross-owner (*DCROSS*), using lagged firm characteristics as predictors. These characteristics include lagged firm size (*LSIZE*), debt-to-asset ratio (*LLEV*), return on equity (*LROE*), growth capability (*LGROWTH*), fixed asset ratio (*LPPE*), cash ratio (*LCASH*) and the shareholding proportion of the largest shareholder (*LTOP1*). This allows us to construct an inverse Mills ratio (*IMR*) that captures selection bias. In the second stage, we incorporate *IMR* as an additional explanatory variable in our regression model. *NUMCROSS* and *SPREAD* serve as the primary explanatory and dependent variables in this model, respectively.

Panel B of Table 5 presents the results of the Heckman selection model. In Column (1), the coefficient on IMR is nonsignificant, indicating that selection bias is not a major concern. However, the coefficient on NUM-CROSS remains negative and significant at the 5% level.

(2) To control for the potential self-selection bias resulting from differences between firms that issue bonds and those that do not, we follow the approach of Wang and Gao (2017) and use the Heckman two-stage regression method. This method corrects for potential biases in the sample selection process that may affect our results.

In the first stage, we estimate the probability of a firm issuing bonds, using a set of lagged firm characteristics as predictors. These characteristics include *LSIZE*, *LLEV*, *LROE*, lagged sales growth (*LSALESG*), lagged natural logarithm of equity (*LEQUITY*), lagged short-term debt to total asset ratio (*LSHORTTERM*), lagged long-term debt to total asset ratio (*LLONGTERM*), *LTOP1*, lagged bankruptcy risk index (*LZSCORE*), lagged 3-year volatility of return on assets (*LRISK*) and lagged proportion of independent directors (*LINDEPENDENCE*). We use these variables to estimate the probability of a firm issuing bonds and construct *IMR* to capture potential selection bias. In the second stage, we incorporate *IMR* as an additional explanatory variable in our regression model. *NUMCROSS* and *SPREAD* are included as the primary explanatory and dependent variables in this model, respectively.

Panel B of Table 5 presents the results of the Heckman selection model. In Column (2), the coefficient on IMR is significant and positive at the 1 % level, indicating that selection bias is present in our sample. This finding suggests that accounting for this bias is necessary to obtain reliable estimates. The coefficient on NUM-CROSS remains negative and significant at the 10 % level.

#### 4.4.3. Altering the measurement of the dependent variable

Panel C of Table 5 presents the results of additional robustness tests using the coupon rate at the time of bond issuance (ISSUERATE) as an alternative measure for corporate bond issuance pricing. Columns (1)–(3) show that the coefficient on NUMCROSS remains significant and negative. This consistency with our main regression results indicates that cross-owners significantly reduce the issuance price of corporate bonds even when using a different measure of bond pricing.

#### 4.4.4. Altering the measurement of the independent variable

Panel D of Table 5 presents the results of additional robustness tests using an alternative measure of the independent variable. We redefine major shareholders by increasing the threshold from 5 % to 10 % and introduce a new variable, *NUMCROSS10*, which captures the number of major shareholders holding more than 10 % of shares with cross-ownership in the same industry in the quarter prior to the issuance of corporate bonds. In Column (1), we include only *NUMCROSS10* without the control variables. In Column (2), we add *BOND CONTROL*, and in Column (3), we include *FIRM CONTROL*. In Columns (1)–(3) of Panel D, the coefficients on *NUMCROSS10* remain significant and negative.

	(1)	(2)
DEPVAR=	SPREAD	SPREAD
NUMCROSS	0.168	-0.101*
	(1.45)	(-1.82)
NUMCROSS × NUMBER	-0.231**	
	(-2.30)	
NUMBER	0.061	
	(0.71)	
NUMCROSS × TIME		-0.293**
		(-2.23)
TIME		0.482***
		(2.78)
CONSTANT	5.146***	5.050***
	(7.57)	(7.40)
CONTROLS	YES	YES
INDUSTRY FE	YES	YES
YEAR FE	YES	YES
Obs	1327	1327
$Adj-R^2$	0.657	0.657

 Table 6

 Heterogeneous effects across cross-owners' supervisory ability.

#### 5. Cross-sectional analysis

#### 5.1. Heterogeneous effects of cross-owners' supervisory ability

#### 5.1.1. Number of firms hold by cross-owners

Kang et al. (2018) find that cross-owners with more equity holdings are more likely to play an active monitoring role, especially when they hold shares in multiple firms in the same industry. Thus, we hypothesize that the impact of cross-owners on reducing corporate bond issuance prices is stronger when they hold more firms in the same industry. To test this hypothesis, we introduce a new variable, *NUMBER*, which is defined as the logarithm of the weighted average number of same-industry firms held by cross-owners, and examine the interaction between *NUMCROSS* and *NUMBER*. Column (1) of Table 6 presents the results. The coefficient on the interaction term (*NUMCROSS* × *NUMBER*) is negative and significant at the 5 % level. This finding indicates that the more same-industry firms cross-owners hold, the more pronounced their effect on reducing corporate bond issuance prices.

#### 5.1.2. Time of cross-owner holding periods

Column (2) of Table 6 presents the results of the analysis of the impact of the cross-owner holding duration. We introduce an indicator variable, *TIME*, which equals 1 if the average number of quarters in which cross-owners hold shares in a firm exceeds the industry-year mean and 0 otherwise. We determine whether longer holding periods for cross-owners have different impacts on corporate bond issuance prices. The coefficient on the interaction term (*NUMCROSS* × *TIME*) is negative and significant at the 5 % level. This finding suggests that when cross-owners have longer average holding periods, their effect on corporate bond issuance price reductions is more pronounced.

#### 5.2. Heterogeneous effects across corporate bond risk

#### 5.2.1. Equity nature of the firm issuing corporate bond

As SOEs, implicit government guarantees reduce the risk premium required by investors and bond coupon rates, and increase bond issuance prices (Fang et al., 2013). This reduces the cross-owners' role in reducing corporate bond prices. SOE cross-owners are often the State-owned Assets Supervision and Administration

6		
	(1)	(2)
DEPVAR=	SPREAD	SPREAD
NUMCROSS	-0.413***	-0.172***
	(-4.82)	(-2.79)
NUMCROSS × SOE	0.378***	
	(4.09)	
SOE	-0.980***	
	(-15.57)	
NUMCROSS × DBONDTERM		0.133*
		(1.76)
DBONDTERM		-0.164***
		(-2.85)
CONSTANT	5.145***	5.096***
	(7.54)	(7.58)
CONTROLS	YES	YES
INDUSTRY FE	YES	YES
YEAR FE	YES	YES
Obs	1327	1327
$Adj-R^2$	0.657	0.659
*		

Table 7Heterogeneous effects across corporate bond risk.

Commission or other state-owned entities that bear significant social responsibilities and may not prioritize maximizing firm value. In addition, their compensation and career advancement are heavily influenced by political factors (Chen et al., 2018), weakening their incentive to influence bond pricing through governance improvements.

To capture the nature of the property rights of the firm, we introduce an indicator variable, SOE, which equals 1 if the firm is state-owned and 0 otherwise. Column (1) of Table 7 reports the results, showing that the coefficient on the interaction term (*NUMCROSS* × *SOE*) is positive and significant at the 1 % level. This finding indicates that the state-owned property rights of a firm attenuate the effectiveness of cross-owners in reducing corporate bond issuance prices. This result is consistent with our expectations, suggesting that state ownership mitigates the cross-owner's influence on bond issuance pricing.

#### 5.2.2. Bond term

Houwelingen et al. (2005) find that after controlling for interest rate and credit risk factors, bond maturity exerts a significant impact on bond yields. *Ceteris paribus*, the longer the bond term, the lower the bond issuance price. Conversely, the shorter the bond term, the higher the issuance price. Therefore, the lower pricing of long-term corporate bonds may be attributed to their longer maturities instead of the influence of cross-owners.

We define *DBONDTERM* as a measure of bond maturity. Specifically, *DBONDTERM* equals 1 if a firm issues bonds with a term exceeding the industry annual average and 0 otherwise. Column (2) of Table 7 presents the results. We find that the coefficient on the interaction term (*NUMCROSS*  $\times$  *DBONDTERM*) is positive and significant at the 10 % level. This finding suggests that bond maturity weakens the role of cross-owners in reducing corporate bond issuance prices.

#### 5.3. Heterogeneous effects across investors' information asymmetry

#### 5.3.1. Media coverage

Media coverage of firms reduces information asymmetry and the cost incurred by investors to gather information to some extent (Becker and Murphy, 1993), thereby playing a crucial role as an information intermediary. In China, media attention to the behavior of listed firms indicates significant supervisory and

Table 8					
Heterogeneous	effects	across	investors'	information	asymmetry.

	(1)	(2)	(3)	
DEPVAR=	SPREAD	SPREAD	SPREAD	
NUMCROSS	-0.208***	-0.214***	-0.104**	
	(-3.02)	(-3.31)	(-2.01)	
NUMCROSS × NEWS	0.058**			
	(2.32)			
NEWS	0.038			
	(1.05)			
NUMCROSS  imes CORRECT		0.184**		
		(2.46)		
CORRECT		-0.069		
		(-1.23)		
NUMCROSS × FOLLOW			0.175**	
			(2.42)	
FOLLOW			-0.188***	
			(-3.19)	
CONSTANT	5.508***	5.031***	4.903***	
	(7.65)	(7.42)	(7.09)	
CONTROLS	YES	YES	YES	
INDUSTRY FE	YES	YES	YES	
YEAR FE	YES	YES	YES	
Obs	1327	1327	1327	
$Adj-R^2$	0.658	0.657	0.658	

governance functions at various levels. Specifically, the more media report on a firm, the greater the level of media scrutiny it receives. Thus, the supervisory role of cross-owners may be weakened.

We define *NEWS* as an indicator of a firm's media attention, which is calculated as the natural logarithm of the number of media reports per quarter. Column (1) of Table 8 presents the results, showing that the coefficient on the interaction term (*NUMCROSS*  $\times$  *NEWS*) is positive and significant at the 5 % level. This finding suggests that greater media attention reduces the ability of cross-owners to reduce corporate bond issuance prices.

#### 5.3.2. Analyst forecasts

With the rapid development of China's capital market, analysts are playing an increasingly vital role in the bond market. Higher accuracy in analyst forecasts enhances investors' understanding of firms' financial information and operating conditions, leading to more reasonable bond issuance pricing and reducing the influence of cross-owners on corporate bond pricing. Likewise, a higher number of analysts tracking a firm may result in more comprehensive disclosures, further limiting the impact of cross-owners on bond pricing. Lin et al. (2013) find that analyst forecast bias is significantly correlated with bond credit spreads, whereas the number of analysts following a listed company is negatively correlated with bond credit spreads. Given these dynamics, we investigate how analysts influence the relationship between cross-ownership and corporate bond issuance prices.

We analyze analysts' forecast performance by measuring forecast bias and dispersion using the methods of Behn et al. (2008) and Cui et al. (2024). Specifically, we define *CORRECT* as an indicator variable that equals 1 if the accuracy of analysts' predictions for a firm is greater than the industry average and 0 otherwise. Column (2) of Table 8 presents the results, showing that the coefficient on the interaction term (*NUMCROSS* × *CORRECT*) is positive and significant at the 5 % level. This finding suggests that higher analyst prediction accuracy weakens the effect of cross-owners in reducing corporate bond issuance prices.

We measure the number of analysts tracking a firm using *FOLLOW*, an indicator variable that equals 1 if the number of analysts covering a firm is greater than the industry average and 0 otherwise. Column (3) of Table 8 presents the results, indicating that the coefficient on the interaction term (*NUMCROSS* × *FOLLOW*)

16

is positive and significant at the 5 % level. This finding suggests that as more analysts track a firm, the role of cross-owners in reducing corporate bond issuance prices decreases.

#### 6. Conclusion

This study examines the influence of cross-ownership on corporate bond issuance pricing. Although crossowners do not directly participate in the bond issuance process, they may indirectly affect pricing through their roles in corporate governance and risk management. Using a sample of listed companies that issued corporate bonds on the Shanghai and Shenzhen stock exchanges from 2007 to 2020, our analysis finds that cross-owners significantly reduce corporate bond issuance prices. This effect remains robust across various robustness tests, including instrumental variable method, Heckman two-stage regressions and alternative measurement approaches. Our findings are consistent with theoretical expectations, indicating that cross-owners lower bond issuance prices by mitigating earnings management and reducing firm-level risk. Moreover, cross-owners' impact on bond pricing is more pronounced when they have stronger supervisory capabilities, corporate bonds carry higher risk and information asymmetry is more severe. These results indicate the important role of cross-owners in shaping corporate bond issuance pricing.

The findings of this study have practical implications for firms, investors and policymakers. First, they provide a new perspective on the impact of cross-ownership on corporate governance and financing costs. By accumulating information and enhancing supervision, cross-owners help reduce firm risk and enhance corporate governance. Unlike collusive monopolies that prioritize their own interests, cross-owners should focus on the overall development of their firms and actively fulfill their supervisory and collaborative roles. Second, the ability of cross-owners to reduce corporate bond issuance prices indicates the importance of rational pricing of corporate bonds through market mechanisms. In an environment where bond market pricing remains imperfect, the presence of cross-owners serves as a valuable signal to investors, reinforcing confidence in the fair pricing of bonds. Finally, this study offers policy insights for regulators and policymakers. Policymakers should consider implementing measures to foster an environment in which cross-owners can contribute effectively to corporate governance. Specifically, regulatory frameworks should encourage cross-owners to adopt innovative approaches to information sharing and collaboration, strengthening corporate governance and improving the efficiency of both product and capital markets.

#### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# Fiscal expenditure responsibilities of public–private partnerships and corporate innovation investment evidence from prefecture-level cities in China



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#### ABSTRACT

Many public-private partnership (PPP) projects in China are facing increased fiscal expenditure responsibilities and weakened fiscal capacity, which may hinder investment in corporate innovation. Using data from Chinese prefecturelevel cities and listed firms from 2014 to 2020, we find that PPP fiscal expenditure responsibilities negatively affect firms' current and future innovation investment by reducing government subsidies and increasing corporate taxes. This negative effect is more pronounced when PPP fiscal expenditure responsibilities exceed a certain threshold. It is also stronger when local governments have higher levels of debt and lower central transfer payments. The effect is also stronger if the PPP project's return mechanism increases the government's future fiscal expenditure responsibilities, but weaker if the project's operating model revitalizes government assets. The effect on private firms, small firms, high-debt firms, and firms facing strong financing constraints is more pronounced. From the perspective of fiscal capacity, this paper explains the underlying reasons why the effectiveness of government support policies for corporate innovation varies. Additionally, it examines the negative impacts of the financing-oriented PPP model on corporate innovation investment, providing empirical evidence to support options for optimal PPP strategies.

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#### 1. Introduction

Innovation is the most enduring driver of economic growth (Rosenberg, 2006). However, due to the strong externality of research and development (R&D) activities, firms cannot fully capture the surplus generated by these activities and therefore lack sufficient incentives to increase their R&D investment (Arrow et al., 1962; Jones and Williams, 2000). To compensate for this positive externality loss and encourage R&D investment, governments must provide support for corporate innovation activities (Howell, 2017; Yang and Rui, 2020; Huang and Zhu, 2023). Government fiscal subsidies and tax incentives play a crucial role in fostering corporate innovation (Bronzini and Iachini, 2014; Czarnitzki et al., 2011; He et al., 2022). Literature examining the policy effects of local governments on corporate innovation often assumes that local governments have a strong fiscal capacity and can effectively provide fiscal support for corporate innovation activities. However, when fiscal capacity is weakened, the ability of local governments to offer effective policy support for corporate innovation becomes uncertain.

In recent years, many governments have applied the public-private partnership (PPP) model to public infrastructure and service provision, which has significantly affected local governments' fiscal capacity. Following the global financial crisis in 2008, numerous countries faced substantial fiscal deficits and turned to the PPP model to finance public infrastructure, aiming to avoid increasing explicit government debt (Engel et al., 2013). In the European Union, almost all local governments use the PPP model for public service provision, and their activities are not reflected in annual accounts (Torres and Pina, 2001). The government of the United Kingdom excludes PPP projects from its balance sheet, causing public debt figures to inadequately represent future payment obligations and allow governments to elude spending and debt caps (Engel et al., 2010). Similarly, the Portuguese government uses PPPs as off-budget operations to circumvent budget constraints (Sarmento, 2010), while local governments in the United States sometimes use PPPs to finance infrastructure without increasing the public debt (Engel et al., 2011). The complexity, lack of transparency, accounting rules, and hidden debt associated with the PPP mechanism make it difficult to evaluate the long-term fiscal impact of such projects on taxpayers. Consequently, there is a misconception that PPP project costs are lower than those of traditional investments (Cepparulo et al., 2019). Given the widespread adoption of the PPP model, it is essential to assess the resulting fiscal risks, particularly the debt sustainability challenges posed by future fiscal expenditure responsibilities under this model (Hemming, 2006). Although some studies explore PPP-related risks, most focus on specific cases or sectors and fail to generalize the common risk characteristics of PPP (Rybnicek et al., 2020). Furthermore, empirical evidence on the debt risks and future spending pressure imposed on local governments by financing-oriented PPP models remains scarce.

Since 2014, local governments in China have promoted the use of the PPP model to finance public infrastructure. During implementation, however, PPPs are being used as channels for local government debt financing, significantly increasing local governments' implicit debt (Wang et al., 2020). This situation provides a representative and suitable context for examining the impact of weakened local government fiscal capacity on corporate innovation. In 2014, the State Council issued the Opinions on Strengthening Local Government Debt Management (State Council Guofa [2014] No. 43), stipulating that local governments should no longer finance urban infrastructure construction through financing platform firms. Instead, this document vigorously promotes the PPP model, urging private sectors to actively participate in franchising urban infrastructure investments and operations to reduce reliance on local financing platform debt funds. Since then, China's PPP model has experienced explosive growth. From 2014 to 2015 and 2016, the ratio of the PPP financing scale to newly added infrastructure investment increased from 17.35 % to 87.99 % and 53.65 %, respectively (Wang et al., 2020). By the end of 2022, data from the China PPP Centre (CPPPC) included a total of 14,038 PPP projects with an investment amount of up to RMB 20.92 trillion. During implementation of the PPP projects, however, the lack of reasonable incentives for the private sector has effectively turned many PPP projects into "equity in form, debt in substance" projects, where governments bear the fiscal burden or guarantee returns (Zhang et al., 2019). Promotion pressure from local officials has distorted the purpose of PPP projects from a means to resolve local government debt into a tool for local governments to increase disguised debt (Wang et al., 2020), thereby increasing the government's expenditure responsibilities and fiscal risks (Liu and Zhang, 2020). As a result, for regulatory authorities, the role of PPP has shifted from being "a tool for resolving government debt risks" to "a method of raising debt in violation of laws and regulations"



Fig. 1. The proportion of PPP fiscal expenditure responsibility of each prefecture-level city in China from 2014 to 2020.

(Jia and Wu, 2020). Unlike government bond financing, which can delay expenditure responsibilities through debt replacement or refinancing,<sup>1</sup> PPP project contracts require fiscal expenditure responsibilities to be fulfilled on schedule, increasing the fiscal pressure on local governments. China's fiscal expenditure structure tends to prioritize productive spending over public service spending (Keen and Marchand, 1997; Qiao et al., 2005; Fu and Zhang, 2007; Yin and Zhu, 2011; Guo and Hu, 2012; Zhou et al. 2013). Consequently, when local governments face fiscal expenditure pressure, they are likely to maintain PPP project expenditure on infrastructure construction,<sup>2</sup> thus crowding out other fiscal expenditure.

Fig. 1 illustrates the proportion of PPP fiscal expenditure responsibility in the general public budget expenditure of each prefecture-level city in China from 2014 to 2020.<sup>3</sup> It reveals significant regional differences in PPP project-related fiscal expenditure responsibilities. Prefecture-level municipalities in eastern provinces such as Jiangsu and Zhejiang have the lowest average proportion of PPP fiscal expenditure responsibility, ranging from 1.6 % to 3.2 %. In northeastern provinces such as Jilin and Liaoning, this proportion is slightly higher, ranging from 3.2 % to 4.8 %. Central provinces such as Henan and Jiangxi have a relatively higher proportion, ranging from 4.8 % to 6.4 %, while western provinces such as Guizhou and Sichuan have the highest average proportion, ranging from 6.4 % to 8.0 %. These data indicate that local governments with weaker fiscal revenue capacities are more inclined to use PPP projects to finance infrastructure construction, leading to increased fiscal expenditure responsibilities and further erosion of fiscal capacity.<sup>4</sup> For instance, Tianshui city in Gansu province planned to invest and finance RMB 9 billion in a PPP project involving Phases I and II of the construction of a tramway project starting in 2018. During the operation of Phase I, the annual revenue

<sup>&</sup>lt;sup>1</sup> Local governments can issue local government bonds for replacement to repay local government debt, including Chengtou bonds. Local governments may also issue refinancing bonds to repay the principal of matured local government bonds.

 $<sup>^{2}</sup>$  According to the Audit office (2023), PPP project expenditure is mainly invested in transportation and municipal engineering. This paper also finds that from 2014 to 2020, the investment in transportation and municipal engineering in PPP projects totaled RMB 4,267,739,460,000, accounting for 76.5% of the total investment in all PPP projects.

<sup>&</sup>lt;sup>3</sup> In Fig. 1, PPP fiscal expenditure responsibility proportion equals expenditure responsibility of all PPP projects from the local government budget in the year divided by general public budget expenditure.

<sup>&</sup>lt;sup>4</sup> Between 2014 and 2020, the average annual general public budget revenue of eastern prefecture-level cities will be RMB 121.894 billion, the central prefecture-level cities will be RMB 49.37 billion, and the western prefecture-level cities will be RMB 47.966 billion.

was approximately RMB 1.6 million, while the annual operating cost was about RMB 40 million, with the operating deficit primarily subsidized by the government. During Phase II construction, insufficient government capital investment slowed progress by the private sector. After being notified by the central government and exposed by the media, Tianshui took steps to address the Phase II funding issues and promote the completion and operation of the tram project. In February 2024, Tianshui issued a Report on the Implementation of the 2023 Municipal Fiscal Budget and a draft of the 2024 Municipal and City-Level Fiscal Budget. The report highlights an increasingly severe fiscal situation in which revenues failed to cover expenditures and notes the lack of sufficient funds for rigid expenditures such as PPP project responsibilities. It emphasizes the need to improve fiscal and tax linkage mechanisms, strengthen fiscal revenue management, and prioritize fiscal expenditure responsibility increases, will it reduce government subsidies and intensify tax administration to alleviate fiscal pressure and address revenue-expenditure imbalances? Such actions could have adverse effects on corporate innovation.

Accordingly, this paper uses data from Chinese prefecture-level cities and listed firms from 2014 to 2020 as the sample and finds that the greater the PPP fiscal expenditure responsibilities of local governments, the lower the innovation investment of firms, indicating a "see-saw" effect. The fiscal expenditure responsibility arising from PPP projects dampens both current and future corporate innovation investment. When a local government's PPP fiscal expenditure responsibilities exceed a certain threshold, the see-saw effect becomes much more pronounced. Mechanism tests reveal that local governments' PPP fiscal expenditure responsibilities inhibit corporate innovation investment by reducing government subsidies and increasing corporate taxes. After a series of robustness tests, including the instrumental variable method, placebo tests, and analyzing the policy impact of the value-added tax (VAT) income-sharing reform, the core conclusions remain robust. Finally, heterogeneity tests reveal nuanced findings. From the perspective of government, the negative effects are more pronounced in local governments with higher debt levels and lower central transfer payments. From the perspective of PPP projects, if the return mechanism increases local governments' fiscal expenditure responsibilities, the crowding-out effect will be larger. Conversely, if the PPP operation method revitalizes government assets, the crowding-out effect will be smaller. From the perspective of firms, the effects are stronger on private firms, small firms, high-debt firms, and firms facing significant financing constraints than on other firms.

This paper makes several contributions. First, while many studies have examined the impacts of various government support policies on corporate innovation, limited attention has been paid to the prerequisite of these policies, namely whether the government's fiscal capacity can sustain such support. Croce et al. (2019) find that government debt expansion exacerbates fiscal policy instability and increases the risk premium for high-tech enterprises in the capital market. However, they do not open the "black box" to determine how government fiscal capacity influences corporate innovation investment. Our paper demonstrates that expanding PPP fiscal expenditure responsibilities weakens local governments' fiscal capacity and crowds out corporate innovation investment by reducing fiscal subsidies and increasing corporate taxes. We thus uncover the mechanisms and highlight the substantial impact of government fiscal capacity on corporate innovation. Our findings suggest that when government fiscal capacity is constrained, firms should avoid over-reliance on government financial support and instead adopt diversified financing strategies for R&D activities.

Second, this paper uses the proportion of PPP fiscal expenditure responsibility as an indicator to investigate the economic impact of government expenditure structural adjustments, thus providing micro-level evidence. Most studies in China focus on the impact of local government revenue and structural adjustments, such as transfer payments (Wang and Yu, 2018), land transfer fees (Zhao and Yang, 2015), and direct and indirect taxes and fees (Li and Wang, 2017), with relatively little attention given to changes in local governments' fiscal behavior driven by expenditure adjustments (Fan and Zhao, 2020). From an international perspective, there are significant differences in fiscal expenditure adjustment strategies and how they influence corporate innovation across countries. For instance, in the United States, adjustments in federal fiscal expenditures allocated to state governments often involve shifting resources for innovation activities from the private sector to the government sector (Kong, 2020). In contrast, China's fiscal expenditure structure tends to favor infrastructure investment (Keen and Marchand, 1997). This paper finds that the Chinese government's PPP fiscal expenditures have crowded out fiscal subsidies and tax incentives for firms. From a new perspective, we provide mech-

anisms and empirical evidence indicating that adjustments to the fiscal expenditure structure influence corporate innovation.

Third, our study provides empirical evidence to support ongoing research on the optimal strategic choice of PPP model. Studies suggest that when a country's government debt level is higher, the government is more inclined to adopt the PPP model to provide public infrastructure or public services as a means of concealing public debt (Maskin and Tirole, 2008; Wang et al., 2018), particularly in low- and middle-income countries (Nguyen-Thanh et al., 2024). An optimal PPP model should prioritize improving operational efficiency rather than serving as a tool for off-balance-sheet financing (Engel et al., 2013). However, this perspective is not yet supported by empirical studies. We find that expanding PPP fiscal expenditure responsibilities crowds out corporate innovation investment, providing evidence of the negative effects of financing-oriented PPP models. Our paper thus contributes to research on the optimal strategies for PPP implementation.

From a practical perspective, local governments transfer fiscal pressure to firms by reducing government subsidies and increasing corporate taxes when their fiscal expenditure responsibilities are increased by PPP projects. This underscores the crucial importance of controlling local government expenditures and assessing the government's fiscal capacity when implementing PPP projects. Beyond the PPP model, fiscal behaviors such as government procurement and government bond issuance may also generate debt risk and impact fiscal capacity. Therefore, before initiating major investment projects or implementing significant fiscal policies, local governments should assess their comprehensive fiscal capacity, which should be reflected and constrained by the budget process.

#### 2. Literature review

#### 2.1. Impact of government behavior on firms' investment in innovation

Governments can promote corporate innovation through policy support or inhibit it through fiscal pressure. They can encourage firms to innovate by providing policy support, such as fiscal subsidies and tax incentives. These subsidies help bridge the gap between corporate R&D investment and the socially optimal level of investment, alleviating financial pressure related to R&D and encouraging firms to increase their R&D expenditure (Almus and Czarnitzki, 2003). Government support plays a crucial role in enhancing corporate innovation capacity (Szczygielski et al., 2017). For example, government R&D subsidies stimulate firms' innovation activities in eastern Germany (Almus and Czarnitzki, 2003). In Canada, manufacturing firms that receive tax credits have higher innovative output than those lacking in such incentives (Czarnitzki et al., 2011). Similarly, in Italy, tax credits significantly boost R&D expenditure among manufacturing firms (Carboni, 2011). In Turkey and Poland, government support for R&D activities is improving corporate innovation performance (Szczygielski et al., 2017). Furthermore, policy support that combines linear corporate taxes with non-linear R&D subsidies also encourages firms to increase their R&D levels (Akcigit et al., 2022). Conversely, strengthening taxation administration can lead to declines in both the quantity and quality of firms' patents (Li et al., 2021; Dimitrova and Eswar, 2023).

In China, national science and technology programs have increased the probability of product and process innovation among small and medium-sized enterprises (SMEs) through funding channels (Qin et al., 2012). Industrial policies significantly boost the number of invention patents among enterprises in encouraged industries, with a pronounced effect on private enterprises (Yu et al., 2016). Government innovation subsidies effectively enhance corporate R&D investment and substantive innovation output through a signal transmission mechanism (Guo, 2018). A reduction in R&D tax credits decreases corporate R&D expenditure (Chen and Li, 2018), whereas an increase in government R&D spending spurs corporate technological innovation (Tang et al., 2022). Industrial policies such as the Identification of High-tech Enterprises enhance both the quantity and quality of innovation inputs and outputs (Yang and Rui, 2020). The introduction of foreign technologies can promote Chinese local enterprises' independent innovation activities (Zhang et al., 2020). Additionally, enterprises' R&D investment, patent output, and R&D efficiency have increased significantly since local governments introduced talent policies (Sun et al., 2021). Finally, manufacturing development strategies

enhance R&D intensity and patent output, with spillover effects on the R&D behavior of enterprises in related industrial chains (Zheng and Zhang, 2022).

Due to fiscal pressure, however, local governments may also act as a grabbing hand that inhibits corporate innovation. Since the 1994 reform of the tax system, which centralized fiscal powers while shifting expenditure responsibilities downward, local governments have faced considerable fiscal pressure (Jia et al., 2014; Xie et al., 2017). This reform, the elimination of agricultural taxes (Chen, 2016), income tax sharing reform (Xu et al., 2020), and value-added tax (VAT) reform (Peng et al., 2020; Zhang and Lin, 2022) have led to further increases in the fiscal pressure placed on local governments (Yang and Wang, 2021). As a result, fiscal pressure due to payment imbalance has transformed into a structural fiscal pressure, namely government debt default (Qi et al., 2023). Zhu et al. (2018) assert that local government debt places financing constraints on enterprises by crowding out financial resources, thereby suppressing corporate innovation. Liu et al. (2020) measure the scale of a local government's new debt as the difference between the amounts of municipal fixed asset investment and of the government's own available investment and demonstrate that expanding local government debt negatively affects corporate innovation by crowding out corporate debt financing and weakening corporate risk-taking ability.

#### 2.2. PPP model, local fiscal pressure, and fiscal expenditure restructuring

PPPs have attracted the attention of governments worldwide (Hodge and Greve, 2007). The PPP model refers to a long-term contract between a private party and a government entity to provide a public asset or service, in which the private party bears significant risk and management responsibility and remuneration is linked to performance (World Bank, 2019). Specifically, a PPP involves a competitive process wherein the government selects private sectors with investment, operation, and management capabilities. The private sectors provide public services and are compensated based on performance evaluations, ensuring reasonable returns (Iossa and Martimort, 2012; Hoppe and Schmitz, 2013). Governments adopt PPP for several reasons: transferring operational risks (Glaister, 1999), utilizing private sector technology and management experience to enhance project efficiency (Iossa and Martimort, 2012; Hoppe and Schmitz, 2013), alleviating fiscal pressure in public infrastructure construction (Zhang, 2014; Buso et al., 2017), and using off-balance sheet financing features to conceal government debt (Maskin and Tirole, 2008; Engel et al., 2013). The PPP model comprises two main categories: government payment and user fee (Smith and Love, 2011; Iossa and Martimort, 2012; Engel et al. 2013). Recent studies identify significant differences in PPP requirements and risks between developing and developed countries (Osei-Kyei and Chan, 2017; Urio, 2010; Rybnicek et al., 2020). For instance, Buso et al. (2017) analyze municipal PPP projects in France and show that financial constraints lead to a preference for PPP. These municipal governments do not aim to hide debt but rather to shift repayment burdens to future governments to gain short-term voter support. Nguyen-Thanh et al. (2024) argue that in low- and middle-income countries, governments with higher levels of short-term external debt are more likely to adopt the PPP model.

Local governments in China also have incentives to use PPP for debt financing, which increases the risk of implicit government debt (Audit Office, 2023). Local officials under promotion pressure are motivated to expand the scale of PPP financing in their jurisdictions and divert the funds to infrastructure to boost economic growth. However, under the guise of implementing PPP models, some local governments have introduced non-standard projects, such as excessive PPP and fake PPP, using methods such as government guarantees and "equity in form, debt in substance," leading to increases in both fiscal expenditure responsibilities and potential fiscal risks. Fiscal pressure can be defined from both the conceptual and structural perspectives. The conceptual definition focuses on the current budget balance, identifying fiscal pressure as the imbalance between revenue and expenditure. Under the structural definition, fiscal pressure can be categorized as pressure arising from a decline in revenue, increase in expenditure rigidity, or local debt default (Qi et al., 2023). A poorly designed tax system and inefficient management and use of funds can also be causes of fiscal pressure (Edgerton et al., 2004). Economics studies summarize the manifestations of fiscal pressure as budget imbalances, fiscal deficits, decreases in fiscal and land revenues, and increases in fiscal expenditure, debt service obligation, and fiscal risk (Zhu et al., 2019; BIS, 2022). A PPP model increases fiscal pressure on the local government through two main channels. First, a PPP project increases the local government's current fiscal expenditure.

diture responsibilities, leading to an imbalance between local fiscal revenues and expenditure. The main fiscal expenditure responsibilities include equity investment expenditure, operating subsidy expenditure, risk taking expenditure, and ancillary input expenditure (Ministry of Finance, 2015). Zhang et al. (2019) suggest that the fiscal expenditure pressure placed on local governments by fiscal expenditure responsibilities in the early stages of PPP projects is generally controllable. Liu and Zhang (2020), however, argue that the actual fiscal expenditure responsibilities are increasing due to the influence of PPP output structures and the expansion of PPP scales. Furthermore, the PPP model increases local governments' future fiscal expenditure responsibilities, increasing the risk of government debt. Ma and Li (2018) find that the PPP model generates risks associated with government contingent liabilities. Ma (2019) and Guo and Song (2020) categorize the fiscal expenditure responsibilities arising from illegal borrowing through PPP as implicit government debt. Jiang and Tang (2020) assert that while the concentration of PPP projects in recent years has alleviated fiscal pressure on local governments in the short term to a certain extent, it has increased local fiscal risks in the long term. Consequently, some studies and audit departments in certain regions regard all PPP fiscal expenditure responsibilities as part of the government's implicit debt (Jia and Wu, 2020).

For local governments, adjusting the fiscal expenditure structure is a crucial means of alleviating fiscal pressure. Local governments often adopt strategic behaviors in response to such pressure (Guo, 2019). However, increasing public demand leads to growth-oriented incentive targets and budget constraints, making it challenging to adjust the level of local fiscal expenditure effectively. In this context, researchers focus mainly on the structural adjustment of government expenditure under fiscal pressure, emphasizing the downward rigidity of fiscal expenditure (Xie et al., 2017; Yu et al., 2018; Sun and Zhang, 2019). Most studies discuss optimization of the government expenditure scale and structure under fiscal pressure from the perspective of decentralization (Xu et al., 2020). Fu (2007) suggests that fiscal decentralization and local government competition driven by performance appraisals have led to a fiscal expenditure structure bias, wherein local governments prioritize capital construction over human capital investment and public services. Gong and Lu (2009) demonstrate that due to fiscal decentralization, local governments tend to reduce expenditure on education, pensions, and social welfare relief while increasing administrative expenses and infrastructure investment. Zuo et al. (2011) and Que et al. (2019) argue that local governments under higher fiscal pressure are more likely to prioritize productive expenditure and neglect public service provision. Similarly, Yu et al. (2018) and Wu and Zhou (2020) assert that promotion incentives drive local officials to allocate more resources to visible expenditure, such as roads, bridges, and rail transportation, while limiting the allocation of funds to less visible expenditure, such as underground pipelines and flood control facilities. However, Ma and Qin (2022) contend that governments under fiscal pressure still prioritize safeguarding essential public services. Yang and Wang (2021) point out that prefecture-level governments under increasing fiscal pressure tend to stabilize growth and protect people's livelihoods at the cost of neglecting innovation and human capital investment. Similarly, Yu et al. (2020) demonstrate that cities with higher fiscal autonomy are more likely to increase the proportion of economic expenditure while engaging in a race to the bottom in terms of social expenditure.

To summarize, although studies extensively examine the role of various government policies in supporting corporate innovation, few explore in depth whether governments have sufficient financial resources to support such innovation. A mismatch between fiscal capacity and authority can place fiscal pressure on local governments (Qi et al., 2023). Current research primarily focuses on the impact of fiscal pressure on enterprise innovation from the perspective of local government debt but has yet to examine how fiscal pressure caused by increased expenditure rigidity affects corporate innovation. This paper focuses on the mechanism through which the structure of local government fiscal expenditure impacts corporate innovation. Specifically, in the context of fiscal expenditure structural bias in China's local governments, where capital construction is prioritized over human capital investment and public services, this paper investigates whether PPP expenditure on capital construction exhibits strong downward rigidity and whether it affects corporate tax burden. As Zhou et al. (2013) highlight, an in-depth analysis of the interaction mechanisms between various types of public expenditure by local governments is both interesting and meaningful. Furthermore, given the current national context, the recent misuse of the PPP model has led to a continuous rise in local debt risk. By studying the actual impacts of PPP fiscal expenditure responsibilities on corporate innovation and the underlying mechanisms,

this paper aims to provide insights into the regulation and implementation of new mechanisms for PPP projects. It also provides a valuable reference for policies focused on user fee projects.

#### 3. Institutional background and hypothesis development

#### 3.1. Institutional background

To broaden the financing channels for urbanization construction and accelerate the transformation of government functions, the Third Plenary Session of the 18th Central Committee of the Communist Party of China proposed allowing private sectors to participate in urban infrastructure investment and operation through franchising and other means. In 2014, the State Council issued the Opinions on Strengthening Local Government Debt Management, advocating the use of the PPP model and encouraging private sector involvement in urban infrastructure and public welfare projects with reasonable returns through franchising and other means. To prevent excessive PPP projects from increasing local fiscal pressure, the Ministry of Finance issued the Circular on Issues Related to Promoting the Use of PPP Models in 2014, requiring local finance departments to conduct fiscal capacity assessments based on medium- and long-term fiscal planning and the full lifecycle costs of projects. In 2016, the Ministry of Finance issued the Interim Measures for the Financial Management of PPP Projects, further strengthening the management of PPP expenditure responsibilities and debts. These measures stipulate that PPP expenditure responsibilities must be included in expenditure budgets according to the relevant government revenue and expenditure classification and budgetary expenditure standards and requirements. Local finance departments, in conjunction with industry authorities, are instructed to strengthen their monitoring of PPP project debts and ensure that project firm debts are not transferred to the government at the end of the project period.

To prevent and control local governments' risk of implicit debt, the Ministry of Finance issued the Implementing Opinions on Promoting the Standardized Development of PPP in 2019. The document emphasizes improving fiscal expenditure responsibility monitoring and early risk warning mechanisms to prevent excessive government expenditure responsibilities from overburdening local budgets and to curb implicit debts disguised as PPP projects. In 2022, to further regulate PPP projects and mitigate implicit debt risks, the Ministry of Finance issued the Notice on Further Promoting the Standardized Development and Transparent Operation of PPP, proposing to strengthen project contract audits, review project implementation details, and standardize budget management. The Notice also mandates that each year, the fiscal expenditure responsibility of all PPP projects shall not exceed 10 % of the annual general public budget expenditure. Furthermore, newly contracted projects shall not arrange for PPP project operating subsidy expenditure from government fund budgets and state-owned capital operating budgets.

Although the Ministry of Finance has issued numerous PPP-related documents in recent years and continuously enhanced regulatory standards while curbing irregular PPP practices, whether PPPs contribute to hidden debt risks remains uncertain. This uncertainty stems from the lack of a clear and detailed demarcation between the fiscal expenditure responsibilities of PPP projects and local government debt, which complicates practical implementation (Jia and Wu, 2020). To address these concerns, in November 2023, the General Office of the State Council forwarded the notice of the National Development and Reform Commission (NDRC) and the Ministry of Finance on the Guiding Opinions on Regulating the Implementation of the New Mechanism of PPP. This document replaces the PPP model with the New Mechanism. It requires that project operating revenues must cover construction investments and operating costs, provide a reasonable return on investment, and avoid creating new government debt or implicit debt. Furthermore, government payment return mechanism can only subsidize operations according to these regulations and cannot be used to cover construction costs. Local governments shall not use financial funds to supplement construction and operation costs through mechanisms such as viability gap funding, government-guaranteed minimum returns, or availability payments.

In addition, although the Ministry of Finance requires local governments to demonstrate their fiscal capacity when implementing PPP projects and prohibits new PPP projects in regions where fiscal expenditure responsibilities exceed the 10 % red line, in practice, local governments often artificially lower their PPP fiscal expenditure responsibility ratio to facilitate new projects. The Audit Office (2023) notes that local governments employ accounting firms to falsify their assessed fiscal capacity, thereby artificially reducing their proportion of PPP fiscal expenditure responsibility. This manipulation typically involves two main methods. The first involves inflating the denominator by, for example, increasing the base or growth rate of general public budget expenditure. For example, a local government may use the health insurance funds of the districts and counties under its jurisdiction to inflate its base of public budget expenditure by about 60 % and the growth rate by 3 %. The second method involves shrinking the numerator. The local government may inflate its project revenues. For example, a highway project may falsely increase the annual revenue per kilometer, thus significantly reducing the fiscal expenditure responsibility. The government may also falsely reduce its project expenditure. For example, a project's actual debt-based funds may account for 90 %, whereas the justification may be only 60 %, thereby reducing project interest expenses. Municipal-level projects may also shift fiscal expenditure responsibilities to the provincial level or to districts and counties. The manipulation of demonstrated fiscal capacity makes the red line of PPP fiscal expenditure responsibility a mere formality and increases local governments' fiscal pressure and debt risks.

The NDRC observes that, due to the issues of previous government payment PPP projects, it has increased the fiscal expenditure pressure on local governments. The latest implementation of the New Mechanism of PPP (which differs from previous PPP) in 2023 requires a focus on user fee projects to avoid new future expenditure responsibilities resulting from PPP projects. For this reason, we examine the period from 2014 to 2020, when PPP projects were implemented prior to the implementation of the New Mechanism, to investigate whether the expansion of PPP fiscal expenditure responsibilities affects corporate innovation investment.

#### 3.2. Hypothesis development

Knowledge and technology are public goods that are not entirely exclusive, and they are accompanied by significant uncertainty during exploration; these characteristics may discourage firms from engaging in R&D and innovation (Arrow et al., 1962). For this reason, most countries support firms' engagement in R&D activities through measures such as tax incentives and government subsidies (Bronzini and Iachini, 2014; Yang and Rui, 2020). However, local governments' ability to provide effective fiscal support for corporate innovation activities depends on their fiscal capacity. Local governments facing greater fiscal pressure are more likely to alleviate this pressure by reducing fiscal subsidies and increasing the tax burden on firms,<sup>5</sup> negatively affecting their investment in innovation.

The expansion of PPP fiscal expenditure responsibility may inhibit corporate innovation investment through the subsidy effect. Since China's tax system reform in 1994, financial power has been transferred mainly to the central government, while administrative power has been pushed mainly to local governments, creating spending pressure beyond the capacity of local finances (Gong et al., 2011). Meanwhile, under China's GDP-oriented promotion evaluation system, local officials compete for economic growth (Zhang and Zhou, 2008) with institutional incentives that favor infrastructure construction (Fu and Zhang, 2007). Local governments' massive investment in infrastructure has escalated the scale of local expenditure. The proportion of local fiscal expenditure has risen from 52.6 % in 1978 to more than 85 % in recent years (Lv and Wang, 2021). To address fiscal pressure, local governments can adjust the structure of their fiscal expenditure (Yang and Wang, 2021). In China, fiscal decentralization and local government competition based on performance appraisal cause a preference for productive spending (Guo and Hu, 2012). Investment bias enables local officials to influence social investment through the government's "visible hand," prioritizing production over innovation (Wu, 2017). Therefore, PPP, as a typical form of productive expenditure, exhibits rigidity in downward adjustment when fiscal responsibilities increase. Local governments are therefore likely to reduce their fiscal subsidies to firms to alleviate fiscal pressure and maintain a fiscal balance.

Government subsidies help stimulate corporate R&D investment enthusiasm (David et al., 2000; Hud and Hussinger, 2015), by alleviating corporate financing constraints and lowering corporate R&D costs (Guo, 2018; Zhang et al., 2018). These subsidies are a crucial policy tool in China's implementation of an

<sup>&</sup>lt;sup>5</sup> Most of the existing studies use the proportion of the general public budget revenue and expenditure gap in the general public budget revenue to measure fiscal pressure (Yang and Wang, 2021).

innovation-driven development strategy (Lai et al., 2021). Grounded in the resource-based view, government subsidies can supplement firms' lack of innovation resources (Tether, 2002), reduce the marginal cost of innovation efforts, and diversify innovation risks (Almus and Czarnitzki, 2003; González and Pazó, 2008; Hussinger, 2008), thereby promoting corporate innovation activities (Beugelsdijk and Cornet, 2002; Carboni, 2011; Kang and Park, 2012; Yang et al. 2015). When firms face strong financing constraints and cannot continue innovating due to insufficient funds, government subsidies can meet firms' urgent needs and thus accelerate innovation (Jaffe, 2002; Wallsten, 2000). Additionally, government subsidies for the purchase or upgrading of research equipment can lower the fixed or long-term costs of innovation activities, thereby encouraging R&D activities (Görg and Strobl, 2007). According to the signaling perspective, government subsidies act as a signal of good investment to private investors. This recognition helps firms obtain the required resources to enhance their innovation (Lerner, 1999; Feldman and Kelley, 2006; Kleer, 2010; Yang et al. 2015; Guo, 2018). Therefore, when local governments reduce fiscal subsidies due to weakened fiscal capacity, this will have a crowding-out effect on corporate innovation investment. Specifically, reduced subsidies directly increase firms' innovation costs and financial risk due to innovation failure. Furthermore, firms are forced to seek external financing for innovation activities, leading to increased financing costs that dampen their willing to innovate. Reduced subsidies also compel firms to allocate more funds to experimental equipment, further raising innovation costs. Therefore, if local governments reduce fiscal subsidies due to expanded PPP fiscal responsibilities, firms may lack sufficient funds and consequently reduce their innovation investment.

The expansion of PPP fiscal responsibility may also discourage investment in innovation through the tax effect. Local governments often increase revenue as a practical solution to negative fiscal shocks. Tax revenue is the most significant source of fiscal revenue for local governments (Zhang et al., 2022). Strengthening tax administration is a common strategy used to boost fiscal revenue (Li and Jia, 2020; Wen et al., 2023). Local governments under fiscal pressure are forced to raise taxes on firms to compensate for rigid public expenditure (Chen, 2016; Bayern et al., 2017). As the pressure on local fiscal spending grows, the government will also increase its precautionary reserve funds to ensure the sustainability of fiscal spending. As a result, local governments tend to increase preventive self-financing by enhancing their taxation efforts (Agénor and Aizenman, 2010; Wang and Yu, 2018), and the "grabbing hand" is an important means for increasing tax revenue. (Fang and Zhang, 2013; Chen et al., 2016). Central government revenues are susceptible to tough budgetary constraints, whereas local tax revenues are more easily dominated by local governments (Huang and Zhang, 2018). Therefore, when expenditure responsibilities expand, local governments tend to increase the corporate tax burden to alleviate fiscal pressure and maintain fiscal balance. This practice, however, crowds out investment in corporate innovation because innovation investment requires substantial capital (Hall, 2002). Corporate innovation activities are highly reliant on a large amount of financial support and sustained cash flow (Liu et al., 2017). Compared with other forms of investments, innovation investment is more sensitive to a firm's internal cash flow (Himmelberg and Petersen, 1994). Taxes are mandatory, gratuitous, and fixed by law. An increase in taxes reduces firms' internal cash flow and exacerbates financing constraints, leading to insufficient investment in R&D (Mukherjee et al., 2017). When local governments continuously increase the corporate tax burden in response to expanding PPP fiscal expenditure responsibilities, firms will be forced to allocate significant cash toward tax payments (Li et al., 2017), thus inhibiting corporate innovation investment. In addition, tax incentives can reduce the marginal cost of R&D and improve both input and output in innovation (Hall and Reenen, 2000). Conversely, when local governments increase the corporate tax burden in response to the expansion of PPP fiscal expenditure responsibilities, firms are likely to reduce their innovation investment due to reduced cash flow and increased R&D costs.

However, the expansion of PPP fiscal expenditure responsibilities may also compel firms to increase their innovation investment. Specifically, if local governments reduce fiscal subsidies or increase corporate taxes due to fiscal pressure caused by the expansion of PPP fiscal expenditure responsibilities, firms will lose the cost advantages provided by subsidies and raise their product prices to accommodate higher tax burdens. To enhance the competitiveness of their products and services, firms may increase their R&D investment and pursue innovation to mitigate the risk of market elimination. In summary, the expansion of local governments' PPP fiscal expenditure responsibilities may either reduce or increase corporate innovation investment. Therefore, we propose the following opposing hypotheses:

H1a. Expanded PPP fiscal expenditure responsibilities inhibit corporate innovation investment.

H1b. Expanded PPP fiscal expenditure responsibilities enhance corporate innovation investment.

#### 4. Research design

#### 4.1. Sample selection and data source

Since 2014, the National PPP Comprehensive Information Platform (hereafter, PPP Platform) on the website of the CPPPC of the Ministry of Finance has published information on the PPP projects initiated in each year by prefecture-level cities across China. As our sample, we manually collect the data of all prefecture-level cities carrying out PPP projects from 2014 to 2020 from the PPP Platform. Then, we match these prefecturelevel cities with A-share non-financial listed firms located in each prefecture-level city by city and year. We screen the initial sample and remove the following: (1) prefecture-level cities with missing data on city characteristics and (2) special treatment, irregularly listed, and insolvent firms. We obtain a final sample of 16,464 firm-year observations from 246 prefecture-level cities. To reduce the effect of potential outliers, we winsorize all firm and city variables at the 1st and 99th percentiles. Data on listed firms are sourced from the China Stock Market & Accounting Research database, while city-level characteristic variables are obtained from the China City Statistical Yearbook.

#### 4.2. Model construction and variable definition

To test the impact of PPP fiscal expenditure responsibility on corporate innovation investment, we construct the following baseline model:

$$RD = \beta_0 + \beta_1 PPP\_Duty + \beta_2 Controls + \sum Year + \sum Industry + \sum Province + \varepsilon$$
(1)

where  $PPP_Duty$  represents the proportion of a local government's PPP fiscal expenditure responsibility. It is calculated as follows: according to the Ministry of Finance's ratio of local governments' PPP fiscal expenditure responsibility, <sup>6</sup> i.e., the expenditure responsibility that must be arranged in the budget for all PPP projects in each year (i.e., equity investment expenditure, operating subsidy expenditure, risk taking expenditure, ancillary input expenditure) divided by the general public budget expenditure. *RD* is the corporate innovation investment. Following the literature (Yang et al. 2017; Yang and Rui, 2020; Zheng et al., 2021), we use the ratio of R&D expenditure to operating income to measure *RD*. *Controls* represents the control variables. Definitions of the variables are presented in Table 1.

We construct model (2) to further test whether the expansion of PPP fiscal expenditure responsibility affects corporate innovation investment through the subsidy effect and tax effect. *Subsidy* represents government subsidies received by firms, measured as the logarithm of government subsidies in the "Other Income" account; *Tax* represents the corporate tax burden, measured as the income tax rate (income tax expense divided by earnings before interest and taxes); and *Controls* represents the control variables, including *Size*, *Lev*, *Cash*, *Growth*, *ROA*, *Investment*, *Ownership*, *Blockholders*, *SA*, *Population*, *GDPgrowth*, *BudgetGap*, and *Student*.

$$Subsidy/Tax = \beta_0 + \beta_1 PPP\_Duty + \beta_2 Controls + \sum Year + \sum Industry + \sum Province + \varepsilon$$
(2)

<sup>&</sup>lt;sup>6</sup> The Guidelines for Demonstrating the Fiscal Capacity of Public-Private Partnership Projects stipulates the process for identifying and assessing PPP fiscal expenditure responsibilities. First, identify the full life-cycle expenditure liabilities, including the expenditure responsibilities' characteristics, scenarios, and probability of occurrence. Finally, after identifying and measuring the fiscal expenditure responsibility of individual projects, calculate fiscal expenditure responsibility ratio by aggregating the expenditure responsibility of all implemented PPP projects in a year, i.e. the proportion of the expenditure responsibility of all PPP projects in the general public budget expenditure annually.

Table 1	
Variable	definitions.

Туре	Name	Variable	Definition		
Explained variable	Corporate innovation investment	RD	Corporate R&D expenditure divided by operating income		
Explanatory variable	PPP fiscal expenditure responsibility proportion	PPP_Duty	Expenditure responsibility of all PPP projects from the local government budget in the year divided by general public budget expenditure		
Firm level	Firm size	Size	Natural logarithm of total assets		
control	Financial leverage	Lev	Total liabilities divided by total assets		
variable	Cash assets ratio	Cash	Cash and cash equivalents divided by total assets		
	Development capacity	Growth	Difference between current year's sales revenue and last year's sales revenue, scaled by last year's sales revenue		
	Profitability	ROA	Net income before extraordinary items divided by total assets		
	Investment intensity	Investment	Cash paid for acquisition of fixed assets, intangible assets, and other long- term assets divided by total assets		
	Governance structure	Ownership	Executive shareholding ratio		
		Blockholders	Sum of shareholdings of top five shareholders divided by 1000		
	SA index	SA	$ -0.737 \times \text{Size} + 0.043 \times \text{Size}^2 - 0.04 \times \text{Age} $		
Prefecture	City scale	Population	Natural logarithm of urban population, scaled to 10,000-person units		
level	City economic	GDP growth	Difference between current year's GDP and last year's GDP, scaled by		
control	development		last year's GDP		
variable	Local fiscal balance gap	Budget Gap	Difference between budgeted fiscal income and budgeted fiscal expenditure, scaled by GDP		
	Human capital stock	Student	Number of university students per 10,000 population		

#### 4.3. Descriptive statistics

Table 2 provides the descriptive statistics of the main variables. The minimum and maximum values of *PPP\_Duty* are 0 and 0.2021, respectively, highlighting significant differences in PPP fiscal expenditure responsibilities across prefecture-level cities. Similarly, *RD* has minimum and maximum values of 0 and 0.2197, respectively, and a standard deviation of 0.0397, indicating substantial variation in corporate innovation investment. For firm-level control variables, the *SA* ranges from 1.1839 to 3.9516, reflecting large differences in financing constraints among listed firms. *Size* varies between 19.9225 and 25.7746, indicating notable differences in firm size. For prefecture-level control variables, *GDPgrowth* ranges from -2.93% to 11.8%, with a

Table 2	
Descriptive	statistics.

Variable	Obs	Mean	SD	Median	Min	Max
PPP_Duty	16,464	0.0135	0.0212	0.0018	0.0000	0.2021
RD	16,464	0.0356	0.0397	0.0311	0.0000	0.2197
SA	16,464	2.9997	0.5156	3.0839	1.1839	3.9516
Size	16,464	22.1542	1.2317	22.0129	19.9225	25.7746
Lev	16,464	0.4100	0.1979	0.3988	0.0601	0.8754
Cash	16,464	0.1519	0.1160	0.1198	0.0114	0.5818
Growth	16,464	0.1641	0.3835	0.1021	-0.5395	2.3762
ROA	16,464	0.0456	0.0650	0.0422	-0.2289	0.2289
Investment	16,464	0.0476	0.0438	0.0347	0.0004	0.2108
Ownership	16,464	0.0828	0.1455	0.0040	0.0000	0.6150
Blockholders	16,464	1.5716	1.0982	1.2984	0.1604	5.4313
GDPgrowth	16,464	0.0690	0.0246	0.0750	-0.0293	0.1180
BudgetGap	16,464	-0.0704	0.1139	-0.0369	-0.7050	0.0167
Student	16,464	409.7373	345.1257	257.4970	20.7670	1244.4395
Population	16,464	6.3088	0.5627	6.3886	4.7005	7.5358

median of 7.5 %, suggesting diversity in economic development levels, with half of the cities having a growth rate close to 8 %. *BudgetGap* ranges from -0.705 to 0.0167, with a mean of -0.0704 and a median of -0.0369, indicating that most cities have a fiscal gap. *Student* ranges widely from 20.7670 to 1244.4395, reflecting disparities in education levels. *Population* ranges from 4.7005 to 7.5358, showing significant differences in population size and urban scale among cities.

#### 5. Empirical results and analysis

#### 5.1. PPP fiscal expenditure responsibility and corporate innovation investment

Table 3 reports the results of linear regressions of PPP fiscal expenditure responsibility on corporate innovation investment. Columns (1), (2), and (3) present the effects of PPP fiscal expenditure responsibility on current-period corporate innovation investment while controlling for year fixed effects, year and industry fixed effects, and year, industry, and province fixed effects, respectively. The regression coefficients of *PPP\_Duty* in

Table 3 PPP fiscal expenditure responsibility and corporate innovation investment.

	$RD_t$			$RD_{t+1}$	$RD_{t+2}$
	(1)	(2)	(3)	(4)	(5)
PPP_Duty	-0.0528***	-0.0486***	-0.0567***	-0.0683***	-0.0427*
	(-3.5146)	(-3.5914)	(-3.8649)	(-3.5525)	(-1.6456)
SA	$-2.0602^{***}$	$-1.1642^{***}$	$-1.2156^{***}$	$-1.0605^{***}$	$-0.9207^{***}$
	(-16.3551)	(-10.1713)	(-10.5678)	(-8.1101)	(-6.1927)
Size	$-1.0118^{***}$	$-0.4632^{***}$	$-0.4797^{***}$	$-0.4351^{***}$	$-0.3826^{***}$
	(-17.7350)	(-8.8577)	(-9.1288)	(-7.2751)	(-5.6409)
Lev	$-0.0417^{***}$	$-0.0373^{***}$	$-0.0369^{***}$	$-0.0338^{***}$	$-0.0296^{***}$
	(-22.1916)	(-21.0974)	(-20.9040)	(-16.9282)	(-13.2588)
Cash	$0.0374^{***}$	$0.0280^{***}$	$0.0272^{***}$	0.0281***	0.0281***
	(13.9422)	(11.4657)	(11.1228)	(10.1192)	(9.0474)
Growth	0.0008	-0.0013*	$-0.0016^{**}$	$-0.0018^{**}$	-0.0008
	(1.0996)	(-1.9126)	(-2.2905)	(-2.4548)	(-0.9516)
ROA	$-0.0442^{***}$	$-0.0350^{***}$	$-0.0350^{***}$	-0.0039	0.0212***
	(-8.6490)	(-7.5637)	(-7.5543)	(-0.7006)	(3.3189)
Investment	0.0485***	$0.0604^{***}$	$0.0557^{***}$	$0.0508^{***}$	$0.0458^{***}$
	(7.3833)	(9.9973)	(9.2102)	(7.4818)	(6.0502)
Ownership	0.0285***	$0.0180^{***}$	0.0159****	0.0139****	0.0126***
	(13.5922)	(9.5322)	(8.3686)	(6.5274)	(5.2665)
Blockholders	$-0.4566^{***}$	$-0.2250^{***}$	$-0.2156^{***}$	$-0.2246^{***}$	$-0.2472^{***}$
	(-17.4461)	(-9.3739)	(-8.9916)	(-8.3322)	(-8.2117)
GDPgrowth	0.0315*	0.0232	0.0209	0.0332*	0.0376*
	(1.9070)	(1.5656)	(1.2335)	(1.6747)	(1.7085)
BudgetGap	1.7716***	$0.6842^{***}$	0.3429	0.3465	0.5356*
	(6.4643)	(2.7540)	(1.2098)	(1.1545)	(1.6895)
Student	0.0005****	$0.0008^{***}$	$0.0009^{***}$	$0.0008^{***}$	$0.0008^{***}$
	(5.6756)	(10.1832)	(10.2488)	(8.6325)	(7.1772)
Population	0.2967***	0.2495***	0.1918***	0.3276***	0.3433***
	(5.6069)	(5.2142)	(3.4016)	(4.6642)	(4.3609)
_cons	31.1137***	14.3820***	14.6004	11.1009***	10.7912***
	(19.0742)	(9.5044)	(9.3936)	(6.2073)	(5.3944)
Year	Yes	Yes	Yes	Yes	Yes
Industry	No	Yes	Yes	Yes	Yes
Province	No	No	Yes	Yes	Yes
Ν	16,464	16,464	16,464	13,259	10,553
Adjusted $R^2$	0.1968	0.3566	0.3645	0.3602	0.3562
Columns (1), (2), and (3) are -0.0528, -0.0486, and -0.0567, respectively, and all are significant at the 1 % level. These results indicate a see-saw effect between local government fiscal expenditure and corporate innovation investment. Specifically, the expansion of local government fiscal expenditure responsibility crowds out corporate innovation investment. Columns (4) and (5) display the effect of PPP fiscal expenditure responsibility responsibility crowds are completed.

innovation investment.				
	RD			
	Dichotor (1)	nous method	Trichotomous method (2)	
PPP_Duty_112		-0.1539*		
PPP_Duty_212		(-1.9061) $-0.4339^{***}$		
PPP Duty 113		(-4.6861)	_0 1222	
111_Duty_115			(-1.4414)	
PPP_Duty_113			-0.3339***	
			(-3.5692)	
PPP_Duty_313			-0.4611***	
		***	(-4.5525)	
SA		-1.2134***	-1.2091***	
_		(-10.5518)	(-10.5126)	
Size		-0.4783	-0.4771	
		(-9.1055)	(-9.0813)	
Lev		-0.0370	-0.0370	
<i>a</i> 1		(-20.9672)	(-20.9726)	
Cash		0.0271	0.0272	
C d		(11.0/96)	(11.1209)	
Growth		-0.0016	-0.0016	
DO 4		(-2.3090)	(-2.2938)	
KOA		-0.0350	-0.0352	
Innestanont		(-7.5304)	(-7.0007)	
Investment		(0.2205)	(9.2646)	
Ownership		0.0150***	0.0150***	
Ownersnip		(8 3516)	(8 3504)	
Blackholders		$-0.2156^{***}$	(0.3304) $-0.2161^{***}$	
DIOCKHOIMEIS		(-8.9935)	(-9.0165)	
GDPgrowth		0.0239	0.0216	
GDI growin		(1 4173)	(1.2757)	
BudgetGan		0 2976	0 2946	
Dungeroup		(1.0483)	(1.0373)	
Student		0.0009***	0.0009***	
		(10.3398)	(10.4863)	
Population		0.2076***	0.1994***	
		(3.6814)	(3.5360)	
_cons		14.4375***	14.4402***	
		(9.2895)	(9.2908)	
Vaar	Vas		Vac	
Industry	Yes		Yes	
Province	Yes		Yes	
N	105	16 464	16 464	
Adjusted $R^2$		0 3649	0 3648	
Coefficient Difference		0.2800***	0.3389***	
JJ		(0.0001)	(0.0001)	

Table 4 Different levels of PPP fiscal expenditure responsibility on corporate innovation investment

ity on corporate innovation investment using one-period and two-period lags, respectively. The regression coefficients of  $PPP\_Duty$  are -0.0683 and -0.0427, and are significant at the 1% and 10% levels, respectively. These findings suggest that an expansion of PPP fiscal expenditure responsibility not only reduces current-period corporate innovation investment but also negatively affects future innovation investment. This occurs because PPP projects increase both the current and future fiscal expenditure responsibilities of local governments, exerting a sustained negative impact on corporate innovation investment.

In Table 4, we further examine whether the impact of PPP fiscal expenditure responsibility on corporate innovation investment varies across different levels of fiscal burden. In Columns (1) and (2), prefecture-level cities for which *PPP\_Duty* is equal to 0 are used as the benchmark group, while cities for which *PPP\_Duty* is greater than 0 are grouped using dichotomous and trichotomous methods, respectively. Column (1) shows that for prefecture-level cities in the first half, the coefficient of *PPP\_Duty* is -0.1539, which is significant at the 10% level. For cities in the second half, the coefficient increases in magnitude to -0.4339 and is significant at the 1% level. Column (2) reveals that for cities in the first third, the coefficient of *PPP\_Duty* is -0.1222, and this is not statistically significant. For cities in the middle third, the coefficient increases to -0.4611 and also is significant at the 1% level. According to these results, once *PPP\_Duty* exceeds a certain threshold, the negative impact on corporate innovation investment increases significantly. In other words, an excessive expansion of PPP fiscal expenditure responsibility accelerates the suppression of corporate innovation investment.

# 5.2. Mechanism analysis

## 5.2.1. Subsidy effect

As mentioned above, the expansion of PPP fiscal expenditure responsibility causes local governments to reduce their fiscal subsidies to firms, inhibiting innovation investment. Therefore, we examine whether the expansion of PPP fiscal expenditure responsibility produces a subsidy effect, as shown in column (1) of Table 5. *Subsidy* is defined as the logarithm of the amount of fiscal subsidies received by firms in prefecture-level cities. The coefficient of *PPP\_Duty* is -0.0301 and is significant at the 5 % level. This indicates a significant negative correlation between PPP fiscal expenditure responsibility and firm subsidies (*Subsidy*). In other words, the greater the PPP fiscal expenditure responsibility of local governments, the lower the fiscal subsidies provided to firms, verifying the subsidy effect.

## 5.2.2. Tax effect

As discussed earlier, the expansion of local governments' PPP fiscal responsibility may also increase firms' tax burden and thus reduce their innovation investment. We examine whether this expansion has a tax effect, as shown in column (2) of Table 5. Specifically, *Tax* is measured as the income tax expense divided by earnings before interest and taxes (EBIT). Following Li and Wu (2024), samples with effective tax rates of less than 0 or greater than 1 (1,592 observations) are excluded, resulting in a final sample size of 14,872. The results show that the coefficient of *PPP\_Duty* is 0.1100 and is significant at the 5 % level, indicating that the expansion of local governments' PPP fiscal expenditure responsibility increases the corporate tax burden in the region. This means that the larger the local government's PPP fiscal expenditure responsibility, the higher the corporate tax burden, thus confirming the tax effect.

# 5.3. Robustness test

# 5.3.1. Instrumental variable method

This paper selects the logarithmic value of losses related to natural disasters (*Disaster*) at the prefecture-city level as an instrumental variable to address potential endogeneity concerns. An increase in natural disaster losses in a region will lead to an increase in PPP project implementation by local governments for post-disaster reconstruction, resulting in increased PPP fiscal expenditure responsibilities. Economic losses related to natural disasters should thus increase the PPP fiscal expenditure responsibility but not directly affect corporate innovation investment. Natural disasters also exhibit strong exogeneity. Therefore, *Disaster* satisfies

	Subsidy	Tax
PPP_Duty	-0.0301**	0.1100**
	(-2.0842)	(2.0594)
SA	$-0.4994^{***}$	2.8470****
	(-4.4081)	(6.8863)
Size	0.4300****	1.5537***
	(8.3092)	(8.1812)
Lev	$-0.0047^{***}$	$0.0542^{***}$
	(-2.7286)	(8.2705)
Cash	-0.0016	0.0121
	(-0.6459)	(1.3781)
Growth	0.0013*	-0.0043*
	(1.9087)	(-1.7439)
ROA	-0.0038	$-0.1359^{***}$
	(-0.8243)	(-7.0692)
Investment	0.0093	$-0.1522^{***}$
	(1.5579)	(-7.0401)
Ownership	0.0034*	$-0.0187^{***}$
	(1.8231)	(-2.7684)
Blockholders	$-0.0946^{***}$	-0.1133
	(-4.0050)	(-1.3270)
GDPgrowth	0.0124	0.1072*
	(0.7441)	(1.7379)
BudgetGap	-0.2165	-0.6200
	(-0.7755)	(-0.6032)
Student	0.0002*	-0.0011****
	(1.8891)	(-3.4086)
Population	0.0015	-0.3894*
*	(0.0263)	(-1.9132)
_cons	$-7.1890^{***}$	-27.8039***
	(-4.6961)	(-4.9340)
Year	Yes	Yes
Industry	Yes Yes	
Province	Yes	Yes
N	16,464	14,872
Adjusted $R^2$	0.8541	0.1653

 Table 5

 The subsidy effect and tax effect of PPP fiscal expenditure responsibility.

the relevance and exogeneity requirements for an instrumental variable. This indicates that an increase in direct economic losses from natural disasters should lead to an increase in the share of PPP fiscal expenditure responsibilities. Table 6 presents the regression results when using instrumental variables. Column (1) shows the first-stage regression results, where the coefficient of *Disaster* is 0.0714 and significant at the 1 % level, indicating that the greater the direct economic loss caused by a natural disaster, the greater the share of PPP fiscal expenditure responsibility. Column (2) provides the second-stage regression results, where the coefficient of *PPP\_Duty* is -1.1794 and significant at the 1 % level, consistent with the main regression results. These findings demonstrate that after controlling for potential endogeneity using direct economic losses from natural disasters as an instrumental variable, the negative effect of expansion of a local government's PPP fiscal expenditure responsibilities on corporate innovation investment remains significant. This confirms the robustness of our conclusions.

# 5.3.2. Placebo test

In the previous section, we argue that the expansion of PPP fiscal expenditure responsibility reduces corporate innovation investment through the subsidy effect and the tax effect. However, it may also affect corpo-

	PPP_Duty	RD
	(1)	(2)
Disaster	0.0714***	
	(6.2768)	
PPP_Duty		-1.1794***
		(-3.1348)
SA	0.0908	$-1.0508^{***}$
	(1.2996)	(-6.2096)
Size	0.0574*	$-0.4284^{***}$
	(1.7992)	(-5.4431)
Lev	-0.0014	$-0.0355^{***}$
	(-1.3382)	(-14.0952)
Cash	-0.0004	0.0292***
	(-0.2823)	(8.3586)
Growth	-0.0000	$-0.0024^{***}$
	(-0.0783)	(-2.5650)
ROA	0.0017	$-0.0464^{***}$
	(0.6076)	(-6.9589)
Investment	-0.0012	0.0518***
	(-0.3351)	(6.0619)
Ownership	-0.0019	0.0192***
	(-1.6242)	(6.7132)
Blockholders	$-0.0391^{****}$	$-0.2520^{***}$
	(-2.7318)	(-6.8328)
GDPgrowth	-0.0199*	-0.0004
	(-1.9763)	(-0.0177)
BudgetGap	-0.2479	-0.2717
	(-1.6384)	(-0.7295)
Student	-0.0001	0.0007***
	(-1.2067)	(5.3888)
Population	0.3100***	0.8504***
	(8.0326)	(5.8442)
_cons	$-3.1010^{***}$	9.8976***
	(-3.2720)	(4.1344)
Year	Yes	Yes
Industry	Yes	Yes
Province	Yes	Yes
Ν	9790	9790
Adjusted $R^2$	0.3838	0.2547

Table 6Instrumental variables regression.

rate innovation investment through other mechanisms. To rule out competing hypotheses, we conduct a placebo test using data from the COVID-19 pandemic in 2020. During 2020, the government implemented over RMB 2.6 trillion in new tax cuts and fee reductions to mitigate the economic impact of the pandemic, facilitate the resumption of work and production, and ensure smooth economic operations. Additionally, in 2020, the fiscal deficit increased by RMB 1 trillion, and the central government issued anti-epidemic special treasury bonds worth RMB 1 trillion and allocated RMB 2 trillion in financial funds directly to grassroots governments through a special transfer payment mechanism. These measures aimed to guarantee residents' employment, basic living standards, and market entities. These large-scale tax cuts and fee reductions alleviated the tax effect associated with the expansion of PPP fiscal expenditure responsibilities. Moreover, the central transfer payments partially offset the subsidy effect caused by this expansion, thereby mitigating its negative impact on corporate innovation investment. If the expansion of local government PPP fiscal expenditure responsibilities continued to have a significant negative impact on corporate innovation investment during the COVID- 19 period, this would challenge the validity of our prior hypothesis. Therefore, we select data from local governments and firms during 2020 for our placebo test. Table 7 reports the regression results. Column (1), which covers the pre-COVID-19 period (2014–2019), shows that the coefficient of *PPP\_Duty* is -0.0986 and significant at the 1% level, confirming our research conclusion. Column (2), based on the COVID-19 period in 2020, reveals that the coefficient of *PPP\_Duty* is -0.0259 and not significant. This result indicates that the tax cuts and central transfer payments in 2020 weakened the negative impact of expanded PPP fiscal expenditure responsibility on corporate innovation investment.

We also conduct a placebo test using samples that are less affected by government subsidies and tax incentives. If the weakened fiscal capacity of local governments still has a significant negative impact on corporate innovation investment among firms in industries receiving fewer government subsidies and tax incentives, this would invalidate our research hypothesis. We adopt the industry classification methods of Guo (2018), Yang et al. (2023), and Dong et al. (2024). We categorize industries such as Agriculture, Forestry, Animal Husbandry, and Fishery; Manufacturing; Electricity, Heat, Gas, and Water Production and Supply; Information

Placebo test.				
	RD		RD	
	2014–2019	2020	High fiscal subsidies and tax incentives	Low fiscal subsidies and tax incentives
	(1)	(2)	(3)	(4)
PPP_Duty	-0.0986***	-0.0259	-0.0766***	-0.0014
	(-5.4380)	(-0.8685)	(-4.3658)	(-0.0526)
SA	$-1.3228^{***}$	-0.5570*	$-1.9831^{***}$	-0.2645
	(-10.6969)	(-1.9389)	(-14.2391)	(-1.4044)
Size	-0.5487***	-0.1281	-0.9629***	-0.0428
	(-9.7252)	(-0.9709)	(-15.5302)	(-0.4495)
Lev	$-0.0386^{***}$	$-0.0257^{***}$	-0.0389***	$-0.0216^{***}$
	(-20.6880)	(-5.3863)	(-18.6974)	(-8.2235)
Cash	0.0289***	0.0213***	0.0446***	$-0.0136^{***}$
	(11.0219)	(3.4513)	(15.3276)	(-3.2468)
Growth	$-0.0019^{***}$	0.0012	0.0006	$-0.0021^{**}$
	(-2.6378)	(0.5857)	(0.7185)	(-2.1364)
ROA	$-0.0461^{***}$	0.0158	$-0.0525^{***}$	-0.0004
	(-9.2089)	(1.3803)	(-9.5059)	(-0.0441)
Investment	0.0557***	0.0425***	0.0357***	$-0.0307^{**}$
	(8.6864)	(2.6342)	(5.1035)	(-2.4557)
Ownership	0.0175***	0.0056	0.0245***	$0.0097^{**}$
-	(8.6774)	(1.1171)	(10.9965)	(2.2354)
Blockholders	$-0.2227^{***}$	$-0.2132^{***}$	$-0.4417^{***}$	-0.2093****
	(-8.7257)	(-3.4297)	(-15.3556)	(-5.5872)
GDPgrowth	0.0270	0.0374	0.0400*	$-0.0601^{**}$
	(1.4494)	(0.5972)	(1.9418)	(-2.2426)
Budget Gap	0.1870	2.5092	1.3121***	0.4540
	(0.6643)	(1.1987)	(3.8631)	(0.8714)
Student	0.0008***	0.0010***	0.0010***	0.0000
	(8.5900)	(3.2246)	(9.0515)	(0.3232)
Population	$0.4070^{***}$	0.0086	0.2808****	-0.0233
*	(6.1643)	(0.0524)	(4.2195)	(-0.1904)
_cons	15.1459***	4.5762	29.2617***	4.2373
	(9.0626)	(1.1264)	(16.1031)	(1.5206)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes		
Province	Yes	Yes	Yes	Yes
N	13,632	2832	14,609	1855
Adjusted $R^2$	0.4111	0.1218	0.2087	0.1229

Table 7

	RD		
	VAT reform test	Parallel trend test	
	(1)	(2)	
Treat × Post	$-0.2893^{**}$		
	(-2.4288)		
Treat × Post <sub>-3</sub>		0.2871	
		(1.3591)	
Treat × Post_2		0.0948	
		(0.4588)	
$Treat \times Post_{-1}$		0.1310	
		(0.7028)	
$Treat  imes Post_1$		-0.3146*	
		(-1.7280)	
Treat × Post <sub>2</sub>		-0.0814	
		(-0.4601)	
Treat	0.3063***	0.1474	
	(3.0792)	(1.0657)	
SA	-1.3213***	$-1.3202^{***}$	
	(-10.6740)	(-10.6648)	
Size	$-0.5501^{***}$	$-0.5496^{***}$	
	(-9.7423)	(-9.7320)	
Lev	$-0.0384^{***}$	$-0.0384^{***}$	
	(-20.5886)	(-20.5865)	
Cash	$0.0289^{***}$	0.0289***	
	(11.0001)	(11.0070)	
Growth	$-0.0019^{***}$	$-0.0019^{***}$	
	(-2.7406)	(-2.7520)	
ROA	$-0.0464^{***}$	$-0.0464^{***}$	
	(-9.2615)	(-9.2603)	
Investment	0.0556***	0.0557***	
	(8.6710)	(8.6820)	
Ownership	$0.0177^{***}$	0.0177***	
	(8.7696)	(8.7732)	
Blockholders	$-0.2195^{***}$	$-0.2196^{***}$	
	(-8.5949)	(-8.6008)	
GDPgrowth	0.0277	0.0284	
	(1.4860)	(1.5190)	
BudgetGap	0.1058	0.0948	
	(0.3729)	(0.3332)	
Student	$0.0008^{***}$	$0.0008^{***}$	
	(8.3236)	(8.1842)	
Population	0.3784***	0.3750***	
	(5.7465)	(5.6913)	
_cons	15.1063***	15.0280***	
	(9.0203)	(8.9598)	
Voar	Ves	Ves	
Industry	Vas	Vas	
Province	Ves	Ves	
N	12 622	12 622	
Adjusted $R^2$	0.4102	0.4102	

Table 8VAT revenue division reform test.

Transmission, Software and Information Technology Services as industries receiving more government subsidies and tax incentives; other industries are classified as receiving less government subsidies and tax incentives. In Table 7, Column (3) presents the regression results for the sample with higher fiscal subsidies and tax incentives: the coefficient of  $PPP\_Duty$  is -0.0766 and significant at the 1 % level, thus validating our research con-

clusion. Column (4) reports the regression results for the sample with lower fiscal subsidies and tax incentives: the coefficient of  $PPP\_Duty$  is -0.0014 and not statistically significant. This suggests that the expansion of local governments' PPP fiscal expenditure responsibilities has a considerably smaller negative impact on the innovation investment of firms that are less influenced by tax incentives and government subsidies.

The results of our placebo test indicate that the impact of expansion of local governments' PPP fiscal expenditure responsibility on enterprises' innovation investment is transmitted via the subsidy effect and the tax effect, rather than through other mechanisms.

# 5.3.3. Value-added tax (VAT) revenue division reform as an exogenous shock

We use the exogenous policy shock of China's VAT Revenue Division reform (hereafter, "VAT reform"), implemented following the Business Tax to VAT Reform (BTR), to further examine the impact of local governments' fiscal capacity on corporate innovation investment and thereby address potential endogeneity concerns. Before the VAT reform in 2016, all business tax revenues were fully allocated to local governments,

Propensity score i	matching.			
	RD			
	Nearest-n (1)	eighbor matching	Radius m (2)	atching
PPP_Duty		-0.0494**	-0.	0552***
		(-2.2682)	(-	3.7578)
SA		-1.1575***	-1.	2225***
		(-6.9456)	(-1	0.6128)
Size		-0.3942***	-0.	4822***
		(-5.1911)	(-	9.1608)
Lev		-0.0363***	-0.	0369***
		(-14.2417)	(-2	0.8646)
Cash		0.0248***	0.	0273***
		(7.1137)	(1	1.1472)
Growth		-0.0011	-0	.0016**
		(-1.1331)	(-	2.3348)
ROA		-0.0289***	-0.	0348 <sup>***</sup>
		(-4.2805)	(-	7.5166)
Investment		0.0635***	0.	$0564^{***}$
		(7.2798)	(	9.3225)
Ownership		0.0171***	0.	0159 <sup>***</sup>
1		(6.1686)	(	8.3660)
Blockholders		-0.2565***	-0.	2157***
		(-7.4316)	(-	8.9943)
GDPgrowth		0.0251	Ì	0.0301 <sup>*</sup>
0		(0.9612)	(	1.7141)
BudgetGap		0.4147		0.3873
		(1.0032)	(	1.3638)
Student		0.0009***	0.	$0009^{**\acute{*}}$
		(7.6226)	(1	0.0859)
Population		0.2286***	0.	1953***
1		(2.8435)	(	3.4602)
cons		12.1575***	14.	5771***
		(5.3668)	(	9.3773)
Year	Yes		Yes	
Industry	Yes		Yes	
Province	Yes		Yes	
N		7934		16,392
Adjusted $R^2$		0.3553		0.3653

Table 10
Heterogeneity analysis at the governmental level.

	Grouped by local gov	ernment debt	Grouped by central tra	unsfer payment
	High local government debt	Low local government debt	High central transfer payment	Low central transfer payment
	(1)	(2)	(3)	(4)
PPP_Duty	-0.0509*	-0.0277	-0.0209	-0.0721****
	(-1.6702)	(-1.6109)	(-0.7685)	(-3.9702)
SA	-1.6308	-0.7241	-0.7551	-1.4071
_	(-9.0650)	(-5.0655)	(-4.2766)	(-9.4988)
Size	-0.5183	-0.4069	-0.4193	-0.4908
*	(-6.2864)	(-6.2712)	(-5.3175)	(-7.1826)
Lev	-0.0514	-0.0246	-0.0285	-0.0422
	(-18.2540)	(-11.4962)	(-11.2424)	(-1/.9/41)
Cash	0.0252	0.0258	0.0236	0.02/3
	(6.7/05)	(8.3050)	(6.4029)	(8.5/49)
Growth	-0.0010	-0.0022	-0.0024	-0.0011
DO 4	(-0.8437)	(-2.7910)	(-2.5305)	(-1.1939)
ROA	-0.0415	-0.0289	-0.035/	-0.0346
Torrest and	(-5.8227)	(-5.0090)	(-5.1346)	(-5.7697)
Investment	0.0595	0.0563	0.0540	0.0585
0 1:	(6.2221)	(7.6227)	(6.1/32)	(7.3059)
Ownersnip	0.0175	0.011/	0.0125	0.01/1
	(6.2384)	(4.6841)	(4.2413)	(7.0431)
BIOCKNOIAErs	-0.3303	-0.0937	-0.1029	-0.2442
CDD d	(-8.8927)	(-3.1860)	(-4.6842)	(-/.6932)
GDPgrowth	0.0975	0.0109	0.0130	0.0061
	(2.4949)	(0.6369)	(0.5374)	(0.2584)
BuagetGap	0.2867	-0.0919	-0.3326	0./468*
S. 1 .	(0.1334)	(-0.3259)	(-0.8931)	(1./233)
Student	0.0008	0.0012	0.0011	0.0009
	(3.2862)	(7.8024)	(6.0382)	(7.7488)
Population	-0.09//	0.2212	0.5001	-0.02//
	(-0.7583)	(3.1915)	(5.1/64)	(-0.3644)
_cons	18.98/3	10.0146	9.7096	17.2550
	(7.4998)	(5.2165)	(4.0985)	(8.4947)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes
N	8232	8232	5690	10,774
Adjusted $R^2$	0.3830	0.3408	0.3774	0.3647
Coefficient Difference		0.0232***		$0.0512^{***}$
		(0.0000)		(0.0000)

while VAT revenues were divided between the central and local governments in a 75:25 ratio.<sup>7</sup> On April 30, 2016, the State Council issued the Transitional Program for Adjusting the Division of Central and Local VAT Revenues after the Full Rollout of the BTR Pilot, stipulating that from May 1, 2016, all VAT paid by firms would be subject to a central–local sharing arrangement, with 50 % allocated each to the central government and local governments. As the business tax and VAT constitute key sources of tax revenue for local governments, this VAT reform significantly reduced the tax revenues of regions that had previously relied heavily on business tax, increasing their fiscal pressure (Zhang and Lin, 2022). Therefore, the policy shock of the VAT

<sup>&</sup>lt;sup>7</sup> Prior to the reform of VAT revenue division, during the period from January 1, 2012, when the pilot "Business Tax to VAT Reform" launched, to April 30, 2016, when it was fully completed, VAT revenues generated from the reform were still allocated exclusively to local governments.

reform following the full rollout of the BTR provides a suitable context for investigating the effects of local governments' PPP fiscal expenditure responsibilities on corporate innovation investment.

As discussed earlier, we select 2014 to 2019 as the sample period due to the unique circumstances of the COVID-19 pandemic in 2020. Considering the transitional nature of the VAT reform, we set *Post* as 1 for provinces and municipalities that implemented the reform in 2017 and subsequent years, and 0 for the years 2014, 2015, and 2016. Similarly, we set *Treat* as 1 for local governments where the proportion of VAT and business tax in fiscal revenue is higher than the median, and 0 for those below the median. The interaction term *Treat* × *Post* is then introduced into the regression model to capture the combined effect. Column (1) of Table 8 presents the regression results using the VAT reform as an exogenous shock. The regression coefficient of *Treat* × *Post* is -0.2893 and statistically significant at the 5% level. This finding indicates that the weakening of local governments' fiscal capacity resulting from the VAT reform leads to a significant decrease in corporate innovation investment. These results further validate our research hypothesis.

Column (2) of Table 8 shows the results of a parallel trend test based on the VAT reform. The regression coefficients of *Treat* × *Post* are statistically nonsignificant during the pre-reform period (*t*-3 to *t*-1), indicating no significant difference in the level of innovation investment between the experimental group (higher proportion of VAT and business tax in fiscal revenue) and the control group (lower proportion of VAT and business tax in fiscal revenue) and the control group (lower proportion holds. In contrast, during periods *t* and *t* + 1, the coefficient of *Treat* × *Post* becomes larger and statistically significant, suggesting that following the VAT reform, the innovation investment of firms in the experimental group decreased significantly compared with that of firms in the control group.

# 5.3.4. Propensity score matching (PSM)

We also use the PSM method to address the potential sample self-selection. First, following the requirements of logit model estimation using PSM, the treatment group (assigned a value of 1) and the control group (assigned a value of 0) are defined based on whether the local government's PPP fiscal expenditure responsibility exceeds the sample median. Second, the propensity scores (PS) for the treatment and control groups are estimated using the logit model, and matching is conducted to pair treatment group samples with control group counterparts. Third, the regression model is re-estimated using the matched samples. Columns (1) and (2) of Table 9 present the regression results obtained using PSM with nearest-neighbor matching and radius matching, respectively, while controlling for year, industry, and province fixed effects. The regression coefficients of *PPP\_Duty* are -0.0494 in Columns (1) and -0.0552 in Column (2) and are statistically significant at the 5% and 1% levels, respectively. These results align with the baseline regression, reaffirming that the effect of PPP fiscal expenditure responsibility on corporate innovation investment remains robust and significant.

# 6. Additional analysis

# 6.1. Heterogeneity analysis at the government level

## 6.1.1. Local government debt

We use the size of Chengtou bonds to measure the level of local government stock debt and further test whether this debt affects the relationship between local governments' PPP fiscal expenditure responsibility and corporate innovation investment. Larger Chengtou bonds indicate greater fiscal pressure resulting from debt servicing. Therefore, we divide the sample into two groups, high government debt and low government debt, based on the median size of issued Chengtou bonds. The analysis tests whether the impact of local government fiscal capacity on corporate innovation investment differs between the two groups. Data on Chengtou bonds are sourced from the Wind database. Columns (1) and (2) of Table 10 present the results of the grouped analysis based on the size of Chengtou bonds. In Column (1), the coefficient of *PPP\_Duty* is -0.0509 and significant at the 10 % level, indicating that when the bond size is large, the expansion of local government. In contrast, the coefficient of *PPP\_Duty* in Column (2) is -0.0277 and statistically nonsignificant, suggesting that when the bond size is small, the negative impact is not significant. The coefficient difference test confirms a

significant difference between the two groups. These findings indicate that large Chengtou bonds increase the fiscal pressure on local governments, thus amplifying the negative effects of expanding PPP fiscal expenditure responsibility on corporate innovation investment.

# 6.1.2. Central transfer payment

Transfer payments received by local governments from the central government can partially alleviate fiscal pressure, mitigating the negative impact of local government PPP fiscal expenditure responsibility on corporate innovation investment. We divide the sample into two groups, with and without central transfer payment, according to the median transfer payment obtained by local governments (median = 0). This classification allows further testing of the impact of PPP fiscal expenditure responsibility on corporate innovation investment

	Grouped by return n	nechanism	Grou	uped by operating mo	odel	
	High government payment (1)	Low government pay (2)	yment TOT (3)	and ROT model	Low TOT ar (4)	nd ROT model
PPP_Duty	-0.0863***	-0	0.0412	-0.0021		$-0.0800^{***}$
-	(-3.8243)	(-1.	5218)	(-0.0695)		(-3.8120)
SA	$-1.3407^{***}$	-0.84	441 <sup>***</sup>	$-1.0880^{***}$		$-1.0539^{***}$
	(-6.6820)	(-4.	0246)	(-4.1959)		(-5.9853)
Size	$-0.6198^{***}$	-0.2	2398**	$-0.3673^{***}$		$-0.4491^{***}$
	(-6.6941)	(-2.	5231)	(-3.0936)		(-5.5853)
Lev	$-0.0280^{***}$	-0.04	419***	$-0.0411^{***}$		$-0.0322^{***}$
	(-8.7781)	(-13.	0908)	(-10.3902)		(-11.6905)
Cash	0.0365	0.01	197	0.0242		0.0266
	(8.0935)	(4.	5542)	(4.3043)		(7.0538)
Growth	-0.0027	-0.0	0027	-0.0037		-0.0025
<b>D</b> O (	(-2.2766)	(-2.	1085)	(-2.2583)		(-2.4007)
ROA	-0.0450	-0.03	373	-0.0360		-0.0439
<b>T</b> , , ,	(-5.63/3)	(-4.	5353) 71.2***	(-3.5558)		(-6.2948)
Investment	0.032/	0.07	(12	0.0463		0.0550
O	(3.0045)	(0.	521/) 122***	(3.2/0/)		(5.9901)
Ownership	0.0205	0.01	[33 7222)	(4.5052)		0.0168
Dlo alsh al dana	(0.0/40)	(5.	7232) 520***	(4.3933)		(3.00/4)
Diocknoiders	-0.2038	-0.23	8541)	-0.20/4		-0.2130
GDPgrowth	(-4.0089)	(-5.	0036	(-3.0337)		(-3.8703)
GDI growin	(-0.7462)	(0	1113)	(-1.4111)		(0.8347)
RudgetGan	0 1682	(0. _0	0227	-0 7843		0.8193*
BuugerOup	(0.2714)	(-0	0368)	(-0.7552)		(1, 7019)
Student	0.0012***	0.00	)12***	0.0016***		0.0006***
Stutent	(6 7531)	(5	9952)	(6 2843)		(3 6221)
Population	0.3177***	0.3	3168 <sup>**</sup>	0.6004***		0.2637***
1	(2.9629)	(2.	5536)	(3.9114)		(3.0907)
_cons	18.3424***	7.3	3081 <sup>**</sup>	9.7942**		12.6586***
	(4.4303)	(2.	5162)	(2.5102)		(5.2126)
Year	Yes	Yes	Yes		Yes	
Industry	Yes	Yes	Yes		Yes	
Province	Yes	Yes	Yes		Yes	
N	5081		5691	3550		7222
Adjusted R <sup>2</sup>	0.3853	0	0.3207	0.3458		0.3541
Coefficient		0.04	451			$0.0779^{***}$
Difference		(0.	0000)			(0.0000)

Table 11 Heterogeneity analysis at the PPP level under different transfer payment levels. The transfer payment data are sourced from the Wind database and include general transfer payments, special transfer payments, and rebate income for prefecture-level cities. Columns (3) and (4) of Table 10 present the results with respect to central transfer payment. In Column (3), the coefficient of *PPP\_Duty* is -0.0209 and statistically nonsignificant, suggesting that the negative impact is not significant when local governments receive central transfer payments. In contrast, the coefficient of *PPP\_Duty* in Column (4) is -0.0721 and significant at the 1 % level, indicating that the negative impact is pronounced when local governments do not receive central transfer payments. The coefficient difference test further confirms a significant difference between the two groups. These findings suggest that for local governments that do not receive central transfer payments, an expansion of their PPP fiscal expenditure responsibility is likely to reduce fiscal subsidies and increase corporate taxes, ultimately leading to a decline in corporate innovation investment.

## 6.2. Heterogeneity analysis at the PPP level

## 6.2.1. Return mechanism of PPP project

We further examine the impact of the PPP project return mechanism on the relationship between local governments' PPP fiscal expenditure responsibility and corporate innovation investment. Expansion of the PPP scale increases local governments' fiscal expenditure responsibility (Liu and Zhang, 2020), with significant variation across return mechanisms. The government payment return mechanism involves direct government payments for public goods and services. The user fee return mechanism relies on end-users' direct payments for public goods and services. The viability gap funding return mechanism applies when user fee return mechanism is insufficient to meet the project company's cost recovery and reasonable return, necessitating government subsidies to bridge the gap. The government payment return mechanism imposes the highest fiscal expenditure responsibility on local governments. To address this, the Ministry of Finance has issued several regulations, including the Guidelines for Demonstrating the Fiscal Capacity of PPP Projects (Caijin [2015] No. 21) and the Notice on Further Promoting the Standardized Development and Transparent Operation of PPP (Caijin [2022] No. 119), which strictly limit the conditions for initiating government payment PPP projects to mitigate their impact on local fiscal capacity. In 2023, the State Council forwarded the Guiding Opinions on Regulating the Implementation of the New Mechanism of PPP, emphasizing that PPP projects should focus on user fee return mechanism and impose even stricter limitations on government payment return mechanism. Accordingly, we categorize the proportion of government payment PPP projects (the number of government payment PPP projects divided by the total PPP projects) across prefecture-level cities into two groups based on the median. We then examine whether there are differences in the impact of *PPP\_Duty* on corporate innovation investment. In Table 11, the coefficient of *PPP\_Duty* in Column (1) is -0.0863 and significant at the 1 % level. Therefore, when local governments prioritize the government payment return mechanism, the expansion of PPP fiscal expenditure responsibilities has a strong negative impact on corporate innovation investment. In contrast, the coefficient in Column (2) is -0.0412 and not statistically significant, suggesting that when local governments adopt other return mechanisms, such as user fee return mechanism, the expansion of PPP fiscal expenditure responsibilities does not significantly hinder corporate innovation investment. The coefficient difference test confirms that the results between these two groups are significantly different. These findings highlight that the fiscal burden associated with the government payment return mechanism amplifies the negative effect of PPP expenditure fiscal responsibilities on corporate innovation investment, whereas user fee return mechanism mitigate this effect.

# 6.2.2. Operating model of PPP project

We use the proportion of transfer–operate–transfer (TOT) and rehabilitate–operate–transfer (ROT) projects among all PPP projects to measure the degree of revitalization of stock assets when carrying out PPP projects.<sup>8</sup> We then examine whether revitalization affects the relationship between PPP fiscal expenditure responsibility and corporate innovation investment. The main PPP operation models are build–operate–trans

<sup>&</sup>lt;sup>8</sup> The firm-year observations in prefecture-level cities whose PPP projects does not equal 0 total 10,772.

Table 12 Heterogeneity analysis at the firm level.

	Grouped by ownership type		Grouped by firm size		
	SOEs (1)	Private enterprises (2)	Large firms (3)	Small firms (4)	
PPP_Duty	-0.0118	$-0.0787^{***}$	$-0.0471^{***}$	-0.0679***	
	(-0.5263)	(-4.1842)	(-2.7832)	(-2.7891)	
SA	$-1.0217^{***}$	$-1.5983^{***}$	$-0.1460^{**}$	-1.2664***	
	(-5.4367)	(-10.7901)	(-2.1073)	(-7.9546)	
Size	$-0.5737^{***}$	$-0.6126^{***}$			
	(-6.1745)	(-9.3604)			
Lev	$-0.0250^{***}$	$-0.0430^{***}$	$-0.0302^{***}$	$-0.0460^{***}$	
	(-9.3991)	(-18.7221)	(-13.8499)	(-17.0941)	
Cash	$0.0207^{***}$	0.0309***	0.0191***	0.0295***	
	(4.9114)	(10.2053)	(5.3519)	(8.6142)	
Growth	0.0001	$-0.0018^{**}$	$-0.0017^{**}$	-0.0012	
	(0.0618)	(-2.1625)	(-2.2234)	(-1.0586)	
ROA	$-0.0173^{**}$	$-0.0357^{***}$	-0.0226***	$-0.0455^{***}$	
	(-2.0160)	(-6.4481)	(-3, 6304)	(-6, 6998)	
Investment	0.0341***	0.0692***	0.0462***	0.0667***	
meesiment	(3.2586)	(9,3095)	(6 1611)	(7 1475)	
Ownership	(3.2300)	(5.5655)	0.0236***	0.0142***	
Ownership			(7.6253)	(5 7000)	
<b>D</b> lo alsh aldoug	0.2200***	0.1500***	(7.0233)	(3.7099)	
DIOCKNOIGErs	-0.2298	-0.1398	-0.1042	-0.2429	
CDD 1	(-0.0824)	(-4.8//6)	(-0.0734)	(-5.8224)	
GDPgrowth	-0.0305	0.0564	0.0044	0.0360	
	(-1.3181)	(2.4890)	(0.2265)	(1.2830)	
BudgetGap	0.7765*	0.3658	0.5917*	0.0132	
	(1.9512)	(0.9722)	(1.6857)	(0.0299)	
Student	0.0003	0.0012	0.0003	0.0015	
	(2.6461)	(10.0743)	(2.8238)	(10.2603)	
Population	0.2712***	0.2237***	0.4234***	0.0306	
	(3.0791)	(3.1251)	(6.1677)	(0.3445)	
_cons	15.8449***	19.4941***	-0.1243	4.8861***	
	(5.8653)	(9.9202)	(-0.1910)	(4.7535)	
Year	Yes	Yes	Yes	Yes	
Industry	Yes	Yes	Ves	Yes	
Province	Yes	Yes	Ves	Yes	
N	4934	11 320	8232	8232	
Adjusted $\mathbf{P}^2$	0 3800	0.3427	0.3486	0.3387	
Coefficient	0.3890	0.0427	0.5480	0.03087	
Differences		(0,0000)		(0.0000)	
Dijjerence	Grouped by del	(0.0000)	Grouped by financing constrain	(0.0000)	
	High debt	Low debt	Strong financing constraints	Weak financing constraints	
	(5)	(6)	(7)	(8)	
PPP Duty	-0.0566***	-0.0409*	-0.0639***	-0.0567***	
=	(-2.9189)	(-1.7791)	(-2.8832)	(-2.9507)	
SA.	-1 2798***	$-13020^{***}$	( 210002)	()	
511	(-8,5364)	(-7.0273)			
Size	-0.7595***	-0.7562***			
5120	(-11, 2180)	(0.7502)			
Lan	(-11.3169)	(-9.34/4)	0.0420***	0.0293***	
Lev			-0.0430	-0.0382	
Carl	0.0277***	A A27A***	(-10.91/3)	(-1/.3526)	
Cash	0.03//	0.03/9	0.0245	0.0367	
C d	(11.2082)	(10./504)	(/.26/1)	(10.1620)	
Growth	-0.0024	-0.0042	-0.0001	-0.0023	
	(-2.98/1)	(-3.2484)	(-0.0738)	(-2.7613)	

(continued on next page)

	Grouped by debt level		Grouped by debt level Grouped by financing constraints	
	High debt	Low debt	Strong financing constraints	Weak financing constraints
	(5)	(6)	(7)	(8)
ROA	-0.0016	-0.0009	$-0.0427^{***}$	$-0.0393^{***}$
	(-0.2544)	(-0.1379)	(-6.6182)	(-5.9012)
Investment	0.0388***	0.0663***	0.0732***	0.0407***
	(5.2314)	(5.9771)	(7.9156)	(5.2153)
Ownership	0.0114***	0.0242***	0.0196****	0.0189***
-	(4.6906)	(7.7790)	(7.8186)	(6.6566)
Blockholders	$-0.2183^{***}$	$-0.2187^{***}$	$-0.1721^{***}$	$-0.1993^{***}$
	(-7.0247)	(-5.6449)	(-4.2788)	(-6.8659)
GDPgrowth	0.0124	0.0325	0.0265	0.0151
	(0.5540)	(1.2229)	(0.9999)	(0.7073)
BudgetGap	0.5465	0.0428	-0.3094	0.9258***
	(1.4078)	(0.1000)	(-0.6916)	(2.5788)
Student	$0.0007^{***}$	0.0011****	0.0013****	0.0005***
	(5.6805)	(7.8963)	(9.8305)	(3.9121)
Population	$0.2689^{***}$	0.0967	0.0048	0.3867***
	(3.5747)	(1.1033)	(0.0563)	(5.2160)
_cons	17.9970***	20.8676***	0.5808	0.1499
	(8.8883)	(8.5321)	(0.6858)	(0.2252)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes
Ν	8902	7562	8232	8232
Adjusted $R^2$	0.3446	0.3539	0.3388	0.3912
Coefficient		0.0157***		0.0072***
Difference		(0.0010)		(0.0000)

Table 12	(continued
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fer (BOT), TOT and ROT.<sup>9</sup> The BOT model requires substantial financing for infrastructure construction, placing significant fiscal pressure on local governments. In contrast, under the TOT and ROT models, the private sector can use the governments' stock of assets for operation and services, thereby revitalizing local financial resources and reducing the fiscal revenue–expenditure gap. In 2015, the State Council issued the Guiding Opinions on Promoting PPP Models in the Field of Public Services, emphasizing that TOT and ROT modes should be actively used to transform public service projects managed by financing platforms into PPP projects, thus effectively converting governmental debt into nongovernmental debt. We group the proportions of TOT and ROT among all PPP projects according to the median to further test whether the impact of *PPP\_Duty* on corporate innovation investment differs across groups. Column (3) of Table 11 shows that the coefficient of *PPP\_Duty* is -0.0021, which is statistically nonsignificant, indicating when PPP projects are predominantly operated using the TOT and ROT modes, the negative impact of the main tested relationship is not significant. In contrast, the coefficient of *PPP\_Duty* in Column (4) is -0.0800 and significant at the 1 % level. This result suggests that for PPP projects with a lower proportion of TOT and ROT (i.e., those more reliant on the BOT model), the negative impact is significantly stronger. In summary, compared with the BOT model, the TOT and ROT model alleviate the negative impact of expansion of local governments' PPP fiscal expenditure

<sup>&</sup>lt;sup>9</sup> PPP project operation mode is divided into BOT (Build-Operate-Transfer), TOT (Transfer-Operate-Transfer), ROT (Rehabilitate-Operate-Transfer), etc. BOT refers to a model in which the private sector builds and operates new projects and transfers the project assets to the government at the end of the contract period. TOT refers to a model in which the government transfers the ownership of assets to the private sector for operation at a fee, and transfers assets to the government after the contract period expires. ROT refers to a model in which the assets need to be rehabilitated on the basis of TOT.

responsibilities on corporate innovation investment. Moreover, this negative effect can be mitigated by local governments' adoption of more effective approaches to revitalize stock assets for PPP project operations.

# 6.3. Heterogeneity analysis at the firm level

# 6.3.1. Ownership type

Compared with state-owned enterprises (SOEs), private enterprises have weaker financing capabilities and are more inclined to reduce their innovation investment to maintain their cash flow when facing the subsidy and tax effects triggered by the expansion of local governments' PPP fiscal expenditure responsibility. We divide the sample into SOEs and private enterprises to further examine potential differences in the impact of the expansion of local governments' PPP fiscal expenditure responsibility on corporate innovation investment under different property rights. Columns (1) and (2) in Table 12 present the varying effects of SOEs and private enterprises, respectively. Specifically, the coefficient of  $PPP_Duty$  in Column (1) is -0.0118 and not statistically significant, indicating no significant negative impact on SOEs. In contrast, the coefficient of  $PPP_Duty$  in Column (2) is -0.0787 and significant at the 1 % level, suggesting that there is a significant negative impact on private enterprises. The coefficient difference test confirms that the difference between the two groups is statistically significant. These findings indicate that the expansion of local government PPP fiscal expenditure responsibility has a greater negative impact on the innovation investment of private enterprises than on that of SOEs.

# 6.3.2. Firm size

Small firms are more susceptible to financing constraints than large firms (Zhang et al., 2017). As a result, the reduced fiscal subsidies and increased corporate taxes associated with the expansion of local government PPP fiscal expenditure responsibility exacerbate the financial constraints on small firms. Consequently, these firms' investment in innovation is more likely to be negatively affected than that of large firms. We divide the sample into large-scale and small-scale firms based on the median logarithm of total assets. Columns (3) and (4) in Table 12 show that the regression coefficients of *PPP\_Duty* are -0.0471 and -0.0679, respectively, and both are significant at the 1 % level. These coefficients differ significantly between the two groups. The results indicate that the expansion of local government PPP fiscal expenditure responsibility has a more significant negative impact on the innovation investment of small firms than that of large firms.

## 6.3.3. Debt level

Firms with higher debt levels are more likely to reduce their innovation investment to preserve cash flow when facing the subsidy and tax effects triggered by the expansion of the local government's PPP financial expenditure responsibility. Therefore, we also divide the sample into two groups, high debt and low debt, according to the median corporate debt ratio. The corporate debt ratio is the difference between the current year and previous year's total long- and short-term debt, scaled by total assets. Columns (5) and (6) in Table 12 show the results for the high and low debt groups, respectively. The coefficients of *PPP\_Duty* are -0.0566 in Column (5) and -0.0409 in Column (6), which are significant at the 1 % and 10 % levels, respectively. The coefficient difference test shows a significant difference between the two groups. These results suggest that the expansion of the local government's PPP fiscal expenditure responsibility has a greater negative impact on the innovation investment of high-debt firms than that of low-debt firms.

# 6.3.4. Finance constraints

Studies suggest that financing constraints significantly inhibit corporate innovation (Zhang et al., 2017). In the literature (Ju et al., 2013), an SA index is constructed to quantify the extent of corporate financing constraints. Therefore, we use the SA index as a measure of financing constraints and divide the sample into two groups: firms with strong financing constraints and those with weak financing constraints. We then examine the impact of PPP fiscal expenditure responsibility under varying degrees of financing constraints. Columns (7) and (8) of Table 12 present the regression results, with *PPP\_Duty* coefficients of -0.0639 and -0.0567, respectively, and both are significant at the 1 % level. Additionally, the coefficient difference test confirms significant differences between the two groups. These findings indicate that the negative impact of the expansion of a local

government's PPP fiscal expenditure responsibility on innovation investment is more pronounced for firms with high financing constraints than for those with low financing constraints.

# 7. Conclusion

In recent years, governments' PPP project expenditure responsibility has expanded, significantly weakening the fiscal capacity of local governments in China. In this paper, we identify a see-saw effect between PPP fiscal expenditure responsibility and corporate innovation investment. Our findings reveal that an increase in the local government's PPP fiscal expenditure responsibilities crowds out corporate innovation investment. The mechanism analysis demonstrates that reduced fiscal subsidies and increased corporate taxes are the main channels through which this effect is transmitted. Furthermore, the negative effects are weaker when the local government has a smaller Chengtou bond scale and receives larger central transfer payments. Compared with the user fee return mechanism, the government payment return mechanism exerts greater fiscal pressure on local governments, resulting in a more pronounced negative impact on corporate innovation investment. Similarly, compared with the BOT operation model, the TOT and ROT models alleviate local fiscal pressure by revitalizing stock assets, reducing the adverse effects of expanding PPP fiscal expenditure responsibilities on corporate innovation investment. Additionally, the negative effects are especially pronounced for private firms, small firms, high-debt firms, and firms facing strong financing constraints.

This paper provides several policy implications based on the above-described research. First, the expansion of local governments' PPP fiscal expenditure responsibilities inhibits corporate innovation investment through both the subsidy effect and the tax effect. To address this, local governments should adopt more prudent fiscal measures, such as optimizing their fiscal expenditure structures and enhancing their fiscal expenditure efficiency, which will promote fiscal balance. Meanwhile, local governments should avoid distorting resource allocation through, for example, reduced fiscal subsidies or increased corporate taxes to provide effective support for corporate innovation activities.

Second, under the New Mechanism, local governments should prioritize user fee projects and minimize the use of government payment projects. This approach will prevent additional fiscal expenditure burdens and ensure the sustainability of local public finances. Furthermore, local governments should apply cautious, proactive models for PPP project implementation. For instance, we find that compared with BOT projects, TOT and ROT projects have a lesser crowding-out effect on corporate innovation investment. By revitalizing governments' stock assets, TOT and ROT models can mitigate the adverse impact of expanded PPP fiscal expenditure responsibilities on corporate innovation. Thus, the use of standardized TOT and ROT models should be encouraged to alleviate fiscal pressure while promoting sustainable innovation.

Third, given the current challenges and pressures on local government finance, firms should broaden their financing channels to avoid over-reliance on local financial support. This can be achieved through methods such as public listing, bond issuance, scientific and technological credit products, and cross-border financing. These measures can help firms alleviate the negative impacts of expanded PPP fiscal expenditure responsibilities on their cash flow and provide sufficient funds for their innovation activities. Such strategies are particularly crucial for private firms, which face greater cash flow risks than SOEs and rely more on government support policies such as fiscal subsidies and tax incentives.

# Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# Does ex-ante disclosure of regulatory information really backfire?

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#### ABSTRACT

Regulatory information disclosure is an important measure to enhance government transparency and law enforcement credibility. Studies mainly focus on ex-post disclosure and affirm its positive effects. However, ex-ante disclosure of regulatory information, as a representative regulatory policy, not only receives little attention in research but also is highly controversial in practice. This paper leverages the differential timing of disclosure of on-site inspections by the China Securities Regulatory Commission as the research setting to examine the impact of ex-ante disclosure of regulatory information on the governance of regulated listed companies. We find that ex-ante disclosure of regulatory information does not weaken the regulatory effect as expected, but rather enhances the governance of listed companies, as evidenced by the improvement of internal control quality. Mechanism analysis shows that exante disclosure of regulatory information can stimulate shareholder activism and motivate investors to participate in corporate governance activities by exercising their rights and voicing their opinions, which in turn improves corporate governance. In addition, the heterogeneity test finds that regulatory capture induced by political connections weakens the governance effect of ex-ante disclosure of regulatory information. The economic consequence test shows that ex-ante disclosure of regulatory information reduces corporate violations and improves firm performance. Our findings suggest that ex-ante disclosure of regulatory information can mobilize investors, especially minority shareholders, to participate in corporate governance and promote the highquality development of listed companies in a market-oriented way. Meanwhile, the institutional cost of regulatory capture stemming from ex-ante disclosure must be watchfully monitored.

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# 1. Introduction

Regulatory information disclosure is an important measure to enhance government transparency and enforcement credibility, and it also directly affects the effectiveness of government regulation. The literature mainly focuses on ex-post disclosure of regulatory information and finds that such disclosure enhances regulatory effectiveness (Karpoff et al., 2005; Gong et al., 2021; Li et al., 2024), while fewer studies deal with exante disclosure.<sup>1</sup> In fact, ex-ante disclosure of regulatory information is common. For example, the Dutch Health Protection Agency usually provides advance notice before inspections of local nursing homes, and the regulatory policy implemented by the Minneapolis Food Safety Authority in the United States in 2002 also requires advance notice of inspection activities. Ex-ante disclosure, as a regulatory policy, aims to guide and urge regulated firms to conduct self-examination and rectification in various matters (Reske et al., 2007). However, it is controversial in practice, as this type of inspection may not enable the regulator to truly ascertain the status of inspected firms and achieve the purpose of inspection, i.e., solving existing problems. Kaskela et al. (2021) argue that ex-ante disclosure of inspection activities prompts firms to prepare themselves against inspections. Balthrop and Scott (2021) similarly insist that announcing inspections in advance may have the side effect of deliberate falsification by firms. In other words, ex-ante disclosure of inspection targets and inspection procedures may trigger speculative behavior by the inspection targets to reduce the probability of their being penalized by the regulator, which in turn results in regulatory failure. Accordingly, given these possible side effects, does ex-ante disclosure of regulatory information, a widely adopted regulatory policy, have any positive impact? If so, what is the mechanism?

The regulator has the power to take rigid measures to discipline the fulfillment of duties by regulated firms, but the process may be influenced by political factors (Stigler, 1971). Specifically, regulated subjects with political connections may intervene in the regulator's inspections by contacting government officials, and thus reduce the probability of being subject to regulatory measures or penalties—this is known as regulatory capture (Weingast, 1984; Yu and Yu, 2011; Correia, 2014). Therefore, in capital market regulation, ex-ante disclosure of regulatory information may lead to some firms avoiding regulatory measures through private communication channels, which in turn leads to regulatory failure. However, there is also evidence that regulatory information disclosure can trigger interaction between the public and the regulator, put more reputational pressure on the regulator, and thereby correct these adverse selection and moral hazard problems in the public sector (Coffee, 2006). In particular, ex-ante disclosure occurs before regulatory work is carried out, and to safeguard the government's image, the regulator has incentives to carry out more rigorous enforcement activities under widespread societal attention and scrutiny (Guo and Tian, 2024). To summarize, ex-ante disclosure of regulatory information operates through at least two public mechanisms: regulatory capture and regulatory reputation. However, these two mechanisms may not be applicable in emerging market countries, including China. For example, regulatory capture has gradually been weakened by China's ongoing anticorruption program since 2012. Meanwhile, the public, restrained by the traditional Chinese political culture and the level of awareness and exercise of citizens' rights, has insufficient motivation and ability to monitor the government (Li, 2005). Therefore, whether the above two public mechanisms are valid in emerging market countries, such as China, needs to be investigated.

Furthermore, in addition to those two mechanisms, ex-ante disclosure of regulatory information may conceivably trigger a third mechanism that has an impact on the quality of regulation. In addition to its mandatory governance role, the regulator has a macro-regulatory guidance role.<sup>2</sup> For instance, in the context of China's continued marketization, the establishment of the China Securities Investor Services Center, an investor protection institution with a government regulatory background, effectively guides the active participation

<sup>&</sup>lt;sup>1</sup> Ex-post disclosure means that the regulator publicly discloses the results of enforcement and anticipates societal supervision, while exante disclosure means that the regulator discloses information on the subject, personnel and procedures of administrative enforcement before enforcement activities are carried out.

<sup>&</sup>lt;sup>2</sup> Ministry of Finance of the People's Republic of China: https://qd.mof.gov.cn/dcyj/202005/t20200509\_3510511.htm.

3

of minority shareholders in corporate governance activities (He and Fang, 2021; Cao et al., 2024). A question that arises is whether ex-ante disclosure of regulatory information can play a similar role in triggering market mechanisms to improve governance of regulated firms. Government information disclosure can stimulate public participation (Bovens, 2007). Similarly, regulatory information disclosure can prompt market participants to exert a market surveillance effect (Goldstein and Sapra, 2014), which serves as a substitute or supplement to the regulator to some extent, achieving regularized supervision of firms. With the increasing development and maturity of the Chinese capital market, majority shareholders, represented by institutional investors, are increasingly able to use their professional ability and shareholding status to govern and supervise listed companies (Zhang et al., 2024), and minority shareholders are also able to use various types of platforms or social media to participate in corporate governance (Ding and Wang, 2023). Hence, almost all investor types in the market possess the ability and channels to exercise their rights or make their voice heard to varying degrees. Under such circumstances, when investors realize via regulatory information disclosure that listed companies are at risk of being exposed for violating the law (Teng et al., 2022), they may change their own decisionmaking patterns (Bordalo et al., 2012) out of a desire to avoid personal wealth losses, thus stimulating shareholder activism (Cziraki et al., 2010). Investors effectively improve corporate governance by exercising their rights or speaking out, enabling companies to respond to regulators' inspections in advance and reduce the probability of being subject to regulatory measures. In other words, ex-ante disclosure of regulatory information may stimulate shareholder activism to improve corporate governance in a more market-oriented manner. Therefore, it is essential to take this market mechanism into account.

We use the differential timing of the disclosure of on-site inspections by the China Securities Regulatory Commission (CSRC) to examine the impact and mechanism of ex-ante disclosure of regulatory information. Specifically, while the local bureaus of the CSRC usually disclose the list of inspected subjects before conducting their on-site inspections, some instead disclose the list after finishing the inspections. Exploiting this, we take listed firms inspected on-site by the local bureaus of the CSRC from 2016 to 2021 as a research sample, and select internal control quality as a proxy for corporate governance, to examine the impact of ex-ante disclosure of regulatory information on regulatory quality and corporate governance. The results show that exante disclosure of regulatory information improves the governance of listed companies, which is evidenced by the improvement of their internal control quality. Our mechanism analysis shows that the ex-ante disclosure of regulatory information can stimulate shareholder activism, inducing investors to take part in corporate governance. However, regulatory capture and regulatory reputation do not play a dominant role. In addition, the heterogeneity analysis indicates that regulatory capture due to political connections weakens the above governance effect of ex-ante disclosure of regulatory information information and improve firm performance.

The contributions of this paper are as follows. First, government transparency is the basis for positive interaction between the government and the public, while regulatory information disclosure is a crucial bridge between the regulator and market participants. Most studies on regulatory information disclosure focus on the impact of disclosure of regulatory outcomes (Karpoff et al., 2005; Gu et al., 2016; Wang et al., 2020; Gong et al., 2021) and are mainly conducted with undisclosed information as the benchmark (Blackburne et al., 2020; Hu et al., 2020; Li et al., 2024). However, we focus solely on disclosed information and discuss the phenomenon of differential disclosure timing (i.e., ex-ante or ex-post), finding that ex-ante disclosure of regulatory information helps improve regulatory quality and has practical significance in standardizing the behavior of regulatory targets.

Second, government regulatory transparency is an important manifestation of the modernization of governance systems and governance capacity. The literature suggests that increased transparency of regulatory information leads to regulatory capture or triggers regulatory reputational concerns, and thereby has an impact on regulatory quality (Duro et al., 2019; Hutton et al., 2022; Guo and Tian, 2024). However, both mechanisms may be invalid in China's political and cultural context. Thus, we turn our attention to the influence of increased regulatory information transparency on market participants (mainly investors). Studies find that increased transparency of regulatory information may induce investors to express their views or emotions through "voting with their feet" (Chen et al., 2018). However, this paper focuses on the impact of regulatory information transparency on mobilization and stimulation of investor activism, such as investors exercising their rights or speaking out. In other words, the regulator can guide and use market forces rather than rigid regulatory measures to promote the quality of listed companies.

Third, shareholder activism is a significant mechanism for realizing corporate governance (Smith, 1996; Zhang et al., 2024). Studies show that improvements in the corporate information environment, such as the existence of social media comments, trigger shareholder activism, which in turn positively enhances the governance of listed companies (Ganguly, 2018; Ang et al., 2021). In contrast to the above studies, we take a government regulatory perspective and find that regulatory information disclosure (ex-ante) is another way to induce shareholders to actively participate in corporate monitoring and governance.

# 2. Literature review, institutional background and research question

# 2.1. Literature review

To improve the effectiveness of market supervision, the regulator must be granted sufficient power and space for enforcement. The regulator can take rational and proportionate rigid regulatory measures to manage the capital market and to exert a deterrent effect on listed companies, reducing illegal behaviors in the capital market and improving the quality of listed companies. However, various kinds of violations by listed companies still occur, and have adverse effects on the capital market (Chen et al., 2005; Karpoff et al., 2008). Some scholars identify regulatory capture as one of the causes of regulatory failure (Stigler, 1971). According to the theory of regulatory capture, firms with political connections can induce government officials to intervene in regulatory inspections, reducing the likelihood that these firms will be subject to regulatory penalties (Yu and Yu, 2011; Correia, 2014), and political connections decrease the efficiency of regulatory enforcement (Xu et al., 2013). Under China's government-led economic development system, local governments are major holders of scarce resources and possess the power to allocate them. To obtain these crucial resources, firms have strong incentives to establish and maintain political connections with local governments. Accordingly, political connections are prevalent in the Chinese capital market (Yu and Pan, 2008), which increases the possibility of regulatory capture.

Although political pressure has the potential to lead to regulatory failure, disclosure can weaken the influence of regulatory capture (Hutton et al., 2022). This is principally because regulatory disclosure puts the regulator under third-party scrutiny, thereby inducing stronger reputational and regulatory pressures. Guo and Tian (2024) hold that if regulators know that regulatory information is going to be disclosed, they devote more effort to the implementation of regulatory work-thereby improving the efficiency of supervision-to maintain their reputation and establish a positive public image. Kleymenova and Tomy (2022) find that when regulators receive greater societal attention, their enforcement efforts and efficiency are enhanced. In recent years, China has attached great importance to the disclosure of government information and has focused on building a positive and transparent government, requiring administrative agencies to disclose government information in a timely and accurate manner. Additionally, regulators are required to disclose all aspects of regulatory information to clarify the boundaries between themselves and the market, and to enhance their supervision of market participants. This initiative places higher normative requirements on enforcement authorities and personnel. The enforcement actions of regulatory authorities and personnel are disclosed to the public, and thus subject to public scrutiny. Furthermore, the quality of regulators' work is a proxy for the credibility of the government. The public disclosure of regulatory behaviors and processes increases the reputational pressure on the regulator, further lowering the likelihood of regulatory capture and improving the quality of regulation.

In addition to external regulation, internal governance is another key factor in improving the quality of listed companies. Shareholders are a vital subject in internal corporate governance. As their personal wealth is directly linked to the company's business performance, shareholders have considerable incentives to monitor and improve the internal governance of the company by exercising their rights, with a positive effect on firm performance (Westphal and Bednar, 2008; Mishra, 2011). "Shareholder activism" is generally regarded as the measures taken by shareholders to improve firm performance. Studies find that firms with a larger scale, poorer performance and higher stock liquidity attract more attention from activist shareholders (Del Guercio

and Hawkins, 1999; Ertimur et al., 2011; Norli et al., 2015). In addition, shareholder activism reduces firms' accrual-based earnings management (Ng et al., 2021), increases voluntary disclosure (Flammer et al., 2021) and enhances board diversity (Marguardt and Wiedman, 2016). The two main ways in which shareholder activism is implemented (Chung and Talaulicar, 2010; Stathopoulos and Voulgaris, 2016) comprise shareholders "voting with their feet," i.e., defending their interests by selling their holdings, and using their "voice," that is, not withdrawing from the company but rather exercising their rights to pressure management into improving corporate governance and operation. Shareholders can exercise their rights through, for example, negotiating with management, submitting shareholder proposals and forming shareholder coalitions (Chung and Talaulicar, 2010). The shareholder proposal is one way of exercising shareholder rights that has a significant influence on corporate decision-making and governance (Ng et al., 2021). In the Chinese capital market, minority shareholders account for the largest number of shareholders. However, because they hold few shares and thus have a weak voice, as well as facing higher costs for exercising their rights, it is difficult for minority shareholders to play a direct role in the governance of listed companies, and most instead protect their interests by voting with their feet (He and Fang, 2021). Nonetheless, with the gradual strengthening of investor protection mechanisms and the rise of various communication platforms and social media, increasing numbers of investors (especially minority shareholders) are able to participate in corporate governance through the Internet (Zhao and Lv, 2022). The active participation of minority shareholders has gradually become one of the most important forces for improving corporate governance (Huang et al., 2022; Ma and Chen, 2024).

# 2.2. Institutional background

To deepen the reform of the administrative system and regulate market enforcement behaviors, China's State Council released the "Announcement on Promoting Random Inspection to Standardize Interim and Post-event Supervision" in 2015, which established the random inspection policy. Following this announcement, the CSRC issued the "List of Random Inspection Matters of the CSRC," which requires local CSRC bureaus to conduct annual, random on-site inspections of local listed companies, the procedures of which must be disclosed to the public.

According to the random inspection policy, the local bureaus of the CSRC are first required to establish a directory of on-site inspection targets each year. The directory must be comprehensive in coverage, encompassing all listed companies within the jurisdiction of the bureau, although excluding specific targets. The scope of excluded targets may include companies that are under investigation or audit in accordance with the law, have been subject to an on-site inspection by the CSRC in the last 3 years or have been included in the scope of special inspections. However, the exact definition of these specific targets may vary between bureaus. Based on the directory of potential inspection targets, the bureaus determine the actual subjects of inspection by random sampling of 5 % of firms in the directory, by means of a lottery or machine selection. To guarantee the fairness of the selection process, the bureaus invite the disciplinary department of the CSRC and representatives of listed companies under their jurisdiction to witness the process and results of the random selection. The results cannot be changed once selected. After determining the list of inspection targets, the bureaus first notify the inspected listed companies in the form of an on-site inspection. If violations are found during the on-site inspection, the bureaus will take regulatory measures in accordance with the law.

As far as regulatory information disclosure is concerned, in the course of conducting random inspections, the local bureaus of the CSRC are required to publicly disclose the list of on-site inspection targets. Currently, most bureaus implement the random selection of inspection targets in March, April, May or June. For example, 81.02% of the companies in this paper's research sample were selected as inspection targets between March and June. After determining the list of on-site inspections, some bureaus publicly disclose the list of inspection targets on their official websites within 5–10 days, and then carry out the on-site inspections within 2-6 months and complete the inspections within the same year. On-site inspection itself may last 1–2 months, while the on-site inspection notice is issued to the inspected companies 1 week in advance. However, some bureaus disclose the list of inspected companies after the completion of on-site inspection, referred to as ex-post disclosure in this paper. In summary, the on-site inspection process for ex-ante disclosed companies comprises *drawing up the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *carrying out the on-site inspection disclosing the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection list*  $\rightarrow$  *disclosing the on-site inspection lis* 

site inspection, while that for ex-post disclosed companies comprises drawing up the on-site inspection list  $\rightarrow$  carrying out the on-site inspection  $\rightarrow$  disclosing the on-site inspection list. This systematic difference between ex-ante and ex-post disclosure of inspection target lists may induce different behavioral responses by investors, which in turn would affect the regulatory effects on listed companies. Accordingly, this phenomenon provides the setting for the current study's research.

# 2.3. Research question

We use the differential timing of disclosure of on-site inspections by the CSRC to examine the impact of exante disclosure of regulatory information on regulatory quality and corporate governance. Theoretically, exante disclosure of regulatory information by the CSRC may induce regulatory capture, resulting in regulatory failure, which is detrimental to corporate governance. Ex-ante disclosure of regulatory information mainly involves the public disclosure of process information, such as regulatory targets and regulatory procedures. Prat (2005) holds that the public disclosure of administrative work processes may be regarded by opportunists as a way to obtain bribes. Therefore, ex-ante disclosure of regulatory information may provide the conditions for regulatory capture by firms via speculative behaviors. When listed companies know in advance that they are about to be inspected by the CSRC, they may seek protection from government officials to reduce the probability of being penalized and to mitigate the negative impact of being subjected to random inspections. When considering local regional economic development, tax revenue, employment and other aspects of political performance, government officials may have incentives to cover up problems with non-compliant firms (Gong et al., 2015). They may intervene politically in the work of the regulator, treating otherwise punishable conduct as acceptable conduct or enforcing less severe penalties for infractions (He, 2023), which ultimately results in regulatory capture (Weingast, 1984; Yu and Yu, 2011; Correia, 2014) and a decline in regulatory quality (Oliva, 2015). Especially, some bureaus of the CSRC disclose in advance the list of companies to be selected and the list of inspection team members assigned to each company. The disclosure of this information gives opportunists a clear target of capture, increasing the possibility of regulatory capture, which has a negative effect on the regulatory work and listed companies' quality.

However, ex-ante disclosure of regulatory information is also likely to increase the reputational pressure on the regulator, prompting them to improve the quality of regulation. According to the theory of public fiduciary duty, the government is entrusted by the public with the power to manage public affairs (Lu and Li, 2006); however, the existence of information asymmetry may trigger moral hazard and adverse selection problems for administrators (Chen, 2003). A regulator facing less competitive pressure and exit risk may be unmotivated to fulfill their duties (Guo and Tian, 2024), and this phenomenon will be more serious in the presence of information asymmetry. However, regulatory information disclosure can reduce information asymmetry while exerting reputational pressure on the regulatory agencies (Coffee, 2006). Being motivated to maintain their reputation, the regulator may modify any regulatory behaviors and attitudes that do not constitute due diligence (Kleymenova and Tomy, 2022) and choose to put more effort into their work (Guo and Tian, 2024), thereby improving regulatory effectiveness. Managers also tend to change their behavior as a result of stricter regulation (Blackburne et al., 2021), which improves corporate governance. Specifically in the context of this paper, ex-ante disclosure means disclosing information before on-site inspection is carried out, meaning that the regulator's subsequent inspection work will be subject to public attention and supervision after the information is disclosed. Hence, the regulator faces heavier reputational and enforcement pressure. To avoid negative evaluation of local government agencies by the public, the regulator has stronger incentives to implement stricter inspections, discouraging regulatory capture behaviors and enhancing the supervision of the inspected companies, which improves corporate governance. In contrast, in the case of ex-post disclosure, the public does not know beforehand when the regulator intends to carry out inspections and which companies are to be inspected. Under such circumstances, the regulator does not face direct public scrutiny or excessive reputational pressure when carrying out its regulatory work, leading to a downward trend in regulatory efficiency and corporate governance.

In addition, ex-ante disclosure of regulatory information can guide investors to play a direct or indirect role in corporate governance. According to salience theory, investors are attracted to salient information and change their decisions accordingly (Bordalo et al., 2012). Ex-ante disclosed regulatory information includes the identity of listed companies that are about to be inspected, and in general, inspected companies face a higher risk of penalties in the future, which will cause a negative reaction in the market (Teng et al., 2022). Therefore, some shareholders are likely to take action to realize their own claims in response to possible future negative impacts and personal wealth losses when they learn of a listed company's upcoming inspection. Investors may choose to implement governance indirectly in a negative way by voting with their feet. As the phenomenon of single-shareholder dominance is particularly prevalent in the Chinese capital market (Liu and Gao, 2021), even institutional investors are relatively unlikely to intervene directly in a company's management. They instead choose to use the threat of exit to improve corporate governance (Wu et al., 2019). Minority shareholders are particularly likely to exercise their rights by voting with their feet, both because they have few shares and a weak voice and because of the extremely asymmetric costs and benefits of exercising their rights (Kong et al., 2013). Therefore, voting with their feet is a feasible way for investors to put pressure on the management team and promote corporate governance when they become aware of ex-ante disclosure of regulatory information. Alternatively, investors may also take active measures to correct problems with corporate governance. Participating in general meetings is one of the most important ways in which shareholders can exercise their rights (Ng et al., 2021). Shareholders have the ability to improve the corporate governance situation by initiating general meetings and submitting shareholder proposals (Zhao and Lv, 2022). However, for minority shareholders, the costs of taking part in corporate governance through formal mechanisms such as shareholders' meetings are not commensurate with the benefits. They may prefer to use online platforms to make their voices heard and pressure the management team, thus playing a supervisory role (Dou and Luo, 2020) to influence managers' decisions (Ang et al., 2021). Moreover, with the continuing improvement of investor protection systems and the widening of the channels of participation in governance, the cost of "voting by hand" has fallen. Minority shareholders increasingly choose to participate through online platforms to improve corporate governance (Huang et al., 2022). To summarize, investors' access to the information disclosed by the government may prompt them to react to regulatory information that concerns their own interests. Especially when the regulatory information is disclosed in advance of the inspection activities starting, investors have considerable incentives to improve corporate governance via exercising their right to make their voices heard or via voting with their feet to reduce potential losses. In contrast, in the case of ex-post disclosure of the inspection targets after the completion of on-site inspection by the CSRC, the timing of information disclosure is delayed. Even if the disclosed information attracts the attention of various actors in the market, it may not be able to motivate investors (especially minority shareholders) to enact supervisory and governance functions because the regulatory work has already been completed by the time of disclosure. This is ultimately detrimental to corporate governance.

According to the above analysis, compared with ex-post disclosure, ex-ante disclosure of regulatory information puts more reputational pressure on the regulator and attracts more attention from investors, leading to better regulatory effects and improving corporate governance. However, there are also hidden risks of regulatory capture, leading to regulatory failure. Therefore, the ultimate regulatory effect of ex-ante disclosure of regulatory information remains an empirical matter, which forms the research question of this paper.

# 3. Research design

# 3.1. Model specification and variable definitions

We construct the following difference-in-differences (DID) model to examine the impact of ex-ante disclosure of regulatory information on corporate governance:

$$IC_{it} = \alpha_0 + \alpha_1 Treat_i + \alpha_2 Post_{it} + \alpha_3 Treat \times Post_{it} + \alpha_4 Controls_{it} + \sum Industry + \sum Year + \sum Bureau + \varepsilon_{it}$$
(1)

We use the CSRC's on-site inspection of listed companies as our research setting to examine the impact of ex-ante disclosure of regulatory information. Corporate governance is a critical aspect of the CSRC's on-site inspection (Teng et al., 2022). Considering that internal control is an effective proxy for firms' corporate governance (Ma and Chen, 2024), the dependent variable in Model (1) is the quality of internal control (*IC*). Fol-

lowing Cao and Sun (2021), we measure *IC* as the value of the internal control index published by the Shenzhen DIB database, divided by 100. The local bureaus of the CSRC disclose the list of inspected companies either before or after the on-site inspection. Therefore, *Treat* is a dummy variable that equals 1 if the inspected firm is publicly disclosed by the CSRC bureaus before the on-site inspections, and 0 if it is disclosed afterward. *Post* is a time dummy variable. For ex-ante disclosed firms, *Post* takes a value of 1 for the year of disclosure and subsequent years, and 0 before the year of disclosure. For ex-post disclosed firms, *Post* takes a value of 1 from the year of inspection to the year before disclosure, and 0 before the year of inspection.<sup>3</sup> The independent variable is *Treat* × *Post*, and its coefficient  $\alpha_3$  reflects the double difference in the impact of ex-ante disclosure of regulatory information on the quality of firms' internal controls given the randomness of inspected firms.

Following Doyle et al. (2007) and Chu and Fang (2018), we select the following variables as control variables. *Size* is the natural logarithm of a firm's total assets at the end of the year. *Roa* is the net income divided by total assets at the end of the year. *Growth* is the sales revenue growth rate. *Lev* is total liabilities divided by total assets at the end of the year. *InBoard* is the natural logarithm of 1 plus the number of directors on the board. *Indep* is the number of independent directors divided by the number of directors on the board. *Indep* is the chairman of the board also holds the position of CEO, and 0 otherwise. *Top1* is the percentage of ownership held by the largest shareholder. *Mshare* is the number of shares held by the board of directors divided by the total number of shares. *Age* is the natural logarithm of 1 plus the number of years for which a firm has been established. All continuous variables are winsorized at the 1st and 99th percentiles. In addition, we control for industry, year and bureau fixed effects and adjust for clustering of standard errors at the firm level.

# 3.2. Sample selection and data sources

Because we intend to examine the impact of ex-ante disclosure of regulatory information regarding on-site inspection, firms randomly selected for on-site inspections by the CSRC in 2016–2021 are chosen as our research sample. The local bureaus of the CSRC announce the results of random selection on their websites. After applying for disclosure of the results from bureaus that had not already disclosed them or had disclosed incomplete results, we collect data on 1,008 firms that had experienced on-site inspections.<sup>4</sup> Among these firms, 915 were disclosed before the on-site inspection, while the remaining 93 were disclosed afterward.<sup>5</sup>

Due to the large difference between the numbers of firms with ex-ante disclosure and ex-post disclosure, we employ propensity score matching (PSM) to ensure a balance between the treatment and control groups. The covariates are the same as the control variables in Model (1). Table 1 shows the differences between the treatment and control groups regarding each covariate before and after matching. It can be seen that there are significant differences between the treatment and control groups in terms of *IC*, *Roa*, *Top1* and *Age*. This suggests that firms with good governance or operation, with relatively concentrated shareholdings and with shorter histories of existence are more likely to be subject to delayed disclosure of inspection by the CSRC bureaus. After PSM, there is no significant difference between the treatment and control groups in any covariate. The matching process is as follows. First, we exclude B-share listed firms, firms in the financial sector and firms missing data for the year prior to the inspection. Second, based on the data from the year before listed firms are inspected, one-to-one nearest neighbor matching is carried out to match ex-ante disclosed and ex-post disclosed firms. After PSM, 153 inspected firms are retained in our sample. Then, we expand the sample of ex-ante disclosed firms such that it spans from 3 years before to 3 years after disclosure, and that for ex-post disclosure firms such that it spans from 3 years before inspection to 1 year before disclosure (but

<sup>&</sup>lt;sup>3</sup> According to the "Notice on the Issuance of the Implementation Plan for CSRC's Promotion of Random Inspection," for ex-ante disclosed firms, the disclosure year and the inspection year are often the same year. Similarly, for ex-post disclosed firms, we take the inspection year as the pseudo-disclosure year.

<sup>&</sup>lt;sup>4</sup> There are 51 firms inspected multiple times.

 $<sup>^{5}</sup>$  In general, the local bureaus of the CSRC should carry out random inspection in the first half of the year, and should disclose the results in a timely manner after randomly selecting target firms. However, some bureaus delay or withhold disclosure, i.e., disclose the selection results after the completion of the inspection. To capture the impact of ex-ante and ex-post disclosure of regulatory information, we treat both delayed disclosure and disclosure withheld beyond the selection year as ex-post disclosure.

Table	: 1	
PSM	balance	test.

	Unmatched (U)/	Mean		%reduct		<i>t</i> -test	
Variable	Matched (M)	Treated	Control	%bias	bias	t	p >  t
IC	U	5.091	5.996	-42.3		-4.37	0.000
	Μ	5.081	5.409	-15.3	63.7	-0.89	0.376
Size	U	22.118	22.194	-6.4		-0.55	0.583
	Μ	22.163	22.053	9.3	-44.8	0.64	0.522
Roa	U	-0.258	0.185	-30.7		-3.61	0.000
	М	-0.161	-0.177	1.1	96.4	0.07	0.942
Lev	U	0.467	0.430	17.0		1.63	0.103
	Μ	0.474	0.474	-0.2	98.5	-0.02	0.987
Growth	U	0.399	0.315	-16.8		-1.16	0.246
	М	0.484	0.046	0.2	99.1	0.03	0.976
lnBoard	U	2.222	2.227	-2.7		-0.25	0.804
	М	2.223	2.201	12.7	-372.8	0.79	0.432
Indep	U	0.370	0.377	-14.6		-1.23	0.218
	М	0.369	0.367	4.6	68.9	0.31	0.759
Dual	U	0.375	0.310	13.7		1.25	0.212
	Μ	0.366	0.341	5.1	62.5	0.32	0.746
Top1	U	0.288	0.325	-25.6		-2.28	0.023
	Μ	0.287	0.311	-17.4	32.1	-1.12	0.262
Mshare	U	0.108	0.141	-18.7		-1.54	0.123
	М	0.099	0.081	10.0	46.9	0.77	0.443
Age	U	3.002	2.929	23.8		2.19	0.029
	М	3.021	3.007	4.4	81.6	0.29	0.771

definitively after inspection). Now, we have an unbalanced panel of 821 observations from 2013 to 2022. After excluding firms that are inspected more than twice and those with missing data, the total number of observations is 710.

The data on securities regulatory information used in this paper are obtained from the websites of the local bureaus of the CSRC and from the applications to the bureaus for public access. The data on web search indexes and media reports are obtained from the Chinese Research Data Services Platform (CNRDS). The financial data, governance data and regulatory penalties for the listed firms are obtained from the China Stock Market & Accounting Research database (CSMAR).

# 4. Empirical results

# 4.1. Descriptive statistics

Table 2 shows the descriptive statistics of our sample. The mean value of *IC* is 5.655, with a minimum of 0 and a maximum of 7.602, which indicates that there is some variance in the quality of internal control among the firms. The mean value of *Treat* is 0.583, which indicates that 58.3 % of the sample belongs to the ex-ante disclosed group. The descriptive statistics of the other variables are consistent with the literature (Yang et al., 2023).

# 4.2. Baseline regression

Table 3 presents the regression results for Model (1). Column (1) shows that the coefficient of *Treat*  $\times$  *Post* is positive and significant when controlling for *Industry*, *Year* and *Bureau* fixed effects but without control variables, indicating that ex-ante disclosure has greater regulatory effects than ex-post disclosure of regulatory information. Column (2) shows that ex-ante disclosure of regulatory information remains significantly and positively related to internal control quality after the control variables are included. In economic terms, firms with ex-ante disclosure have a 1.021 higher internal control quality than those with ex-post disclosure,

1 4010 2	
Descriptive statistics.	

Variable	N	Mean	S.D.	Min	Median	Max
IC	710	5.655	2.047	0	6.356	7.602
Treat	710	0.583	0.493	0	1	1
Post	710	0.451	0.498	0	0	1
Size	710	22.027	1.089	19.446	21.869	25.081
Roa	710	0.001	0.114	-0.703	0.020	0.216
Growth	710	0.174	0.642	-0.709	0.074	4.370
Lev	710	0.469	0.206	0.061	0.465	1.024
lnBoard	710	2.200	0.182	1.792	2.303	2.639
Indep	710	0.376	0.052	0.333	0.333	0.556
Dual	710	0.346	0.475	0	0	1
Top1	710	0.295	0.139	0.091	0.278	0.642
Mshare	710	0.083	0.139	0	0.004	0.544
Age	710	3.034	0.289	2.197	3.091	3.611

Table 3

Ex-ante disclosure of regulatory information and the quality of internal control.

	(1)	(2)
	IC	IC
Treat	$-0.780^{**}$	-0.545*
	(-2.470)	(-1.723)
Post	$-0.705^{**}$	-0.797***
	(-2.486)	(-2.851)
Treat  imes Post	$0.952^{**}$	1.021***
	(2.549)	(2.697)
Size		0.506***
		(3.810)
Roa		2.465
		(2.199)
Growth		-0.015
		(-0.108)
Lev		-1.435*
		(-1.855)
InBoara		0.286
Indon		(0.409)
Indep		0.749
Dual		(0.433)
Duui		(1.037)
Tonl		-1.047
1001		(-1 464)
Mshare		1.369*
		(1.696)
Age		$-1.308^{***}$
5		(-2.766)
_cons	6.052***	-0.621
	(6.238)	(-0.170)
Industry	Yes	Yes
Bureau	Yes	Yes
Year	Yes	Yes
N	710	710
adj. $R^2$	0.288	0.403

Note: The t-statistics adjusted for standard errors based on firm-level clustering are in parentheses. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, as below.

11

translating to a 18.1 % increase relative to the sample mean. This result suggests that ex-ante disclosure of regulatory information can significantly improve regulatory quality and enhance corporate governance. It also suggests that the regulatory capture mechanism does not hold for the sample studied in this paper. According to our theoretical analysis, if there is regulatory capture, ex-ante disclosure of regulatory information may lead to regulatory failure and thus fail to improve corporate governance; however, this is not borne out by our empirical results.<sup>6</sup> It remains to distinguish between the regulatory reputation mechanism and the market mechanism.

# 4.3. Mechanism test

The above empirical result that ex-ante disclosure of regulatory information significantly enhances the level of corporate governance has two implications. First, ex-ante disclosure of regulatory information is likely to increase the reputational cost and regulatory pressure on the regulator, increasing the rigorousness of their regulatory work. Second, investor attention may be directed to corporate governance. However, according to our theoretical analysis, due to the political and cultural background of China, the ability of the public to conduct bottom-up supervision of the government still needs to be strengthened (Li, 2005). Therefore, it needs to be tested whether the regulatory reputation mechanism actually exists.

Guo and Tian (2024) find that when regulators face reputational pressure, they will choose to devote more efforts to enforcement. Duro et al. (2019) and Axbard and Deng (2024) find that when regulation is stricter, firms are subject to more regulatory measures as a result. Therefore, we replace the dependent variable with *Punish*, which equals 1 if the firm is subject to regulatory actions by the local bureaus of the CSRC in the current year, and 0 otherwise. If the regulatory reputation mechanism is valid, the coefficient of  $Treat \times Post$ should be positive and significant. Column (1) of Table 4 shows that  $Treat \times Post$  is not significantly correlated with *Punish*, indicating that the regulatory reputation mechanism does not play a major role in the impact of ex-ante disclosure of regulatory information on corporate governance. To further rule out the regulatory reputation mechanism, we construct the variable *Reg\_member* to capture the degree of regulatory input. Reg\_member is the natural logarithm of 1 plus the number of staff assigned to conduct on-site inspection of the listed company. If ex-ante disclosure of regulatory information brings greater reputational pressure to bear on the CSRC bureaus, the bureaus may choose to assign more inspectors to ensure the effective implementation of regulation, and the coefficient of *Treat* should be positive and significant. However, as seen in Column (2) of Table 4,<sup>7</sup> ex-ante disclosure of regulatory information does not prompt the bureaus to assign more inspectors, implying that the regulatory reputation mechanism does not hold in the sample studied in this paper.

The above results indicate that the regulatory capture and regulatory reputation mechanisms do not play a dominant role. Therefore, we argue that ex-ante disclosure of regulatory information mainly triggers the market mechanism, causing the market to play a supervisory and governance role in relation to the inspected listed companies. From a salience theory perspective, the local bureaus of the CSRC attract investors' attention by disclosing the list of inspected companies. The degree of attention will be even higher for ex-ante disclosed companies. Investors' attention to a company can be reflected by a web search index (Guan et al., 2023). Here, we take the date when listed companies disclose that they have been selected for inspection as the benchmark date, calculate the average value of the web search index of each listed company 2 months prior to the disclosure ([-60, -30]), and use it as the standard value for each company not affected by the event. Then, we subtract the standardized value from the web search index of each listed company in the time windows before and after disclosure, yielding the change in the web search index around the disclosure date. Taking the [-3, +3]

<sup>&</sup>lt;sup>6</sup> In addition, we replace the dependent variable with variables indicating whether the bureaus of the CSRC have taken regulatory measures (Punish) and firms have violations in the current year (Violation), and conduct group tests for firms with and without political connections. The untabulated results show that ex-ante disclosure of regulatory information is negatively and significantly related to Punish and Violation among firms without political connections, while it is not significant among firms with political connections. This suggests that politically connected firms are subject to more regulatory actions and detected more often for corporate violations than nonpolitically connected firms, which contradicts the regulatory capture hypothesis and further rules out the regulatory capture mechanism.

	(1)	(2)
	Punish	Reg_member
Treat	-0.017	-0.358
	(-0.353)	(-1.401)
Post	0.189***	
	(3.181)	
$Treat \times Post$	-0.093	
	(-1.543)	
Size	-0.014	-0.029
	(-1.166)	(-0.909)
Roa	-0.042	-0.177
	(-0.303)	(-1.239)
Growth	-0.015	-0.025
	(-0.986)	(-0.372)
Lev	0.190**	-0.046
	(2.220)	(-0.309)
lnBoard	-0.017	-0.088
	(-0.156)	(-0.606)
Indep	0.245	-1.245*
1 I	(0.797)	(-1.956)
Dual	-0.053**	-0.044
	(-2.027)	(-0.471)
Top1	-0.073	-0.001
	(-0.792)	(-0.532)
Mshare	0.039	0.107
	(0.313)	(0.389)
Age	0.019	0.013*
0	(0.303)	(1.929)
cons	0.298	2.880***
_	(0.674)	(2.779)
Industry	Yes	Yes
Bureau	Yes	Yes
Year	Yes	Yes
Ν	710	90
adj. <i>R</i> <sup>2</sup>	0.104	0.547

Table 4Mechanism test: Regulatory reputation.



Fig. 1. Web search index around the disclosure date of the inspection list.

Table 5Mean difference test for the web search index.

Window period	Ex-ante disclosure	Ex-post disclosure	t-value
[-1, +1]	108.999	-11.716	1.472
[-3, +3]	18.703	-100.304	2.235**
[-5, +5]	4.199	-121.526	2.760***

window as an example, as shown in Fig. 1, the web search index is higher than the standard value, regardless of whether the disclosure is ex-ante or ex-post, which suggests that regulatory information disclosure attracts market attention. However, in terms of the level and duration of attention, ex-ante disclosure triggers broader and longer investor attention than ex-post disclosure. Table 5 shows the significance of the differences between the mean values of the web search index around ex-ante and ex-post disclosure for different windows, i.e., [-1, +1], [-3, +3] and [-5, +5], showing that the differences are significant for [-3, +3] and [-5, +5].

The above results suggest that ex-ante disclosure of regulatory information attracts more investor attention than ex-post disclosure. After shareholders become aware of ex-ante disclosure of regulatory information, they may take measures to improve corporate governance to reduce potential future losses. The shareholder proposal is one important way for shareholders to participate in corporate governance and exercise their rights (Ng et al., 2021; Zhao and Lv, 2022). If ex-ante disclosure of regulatory information stimulates shareholder activism, shareholders should initiate shareholders' meetings and propose relevant motions to improve corporate governance. Therefore, we collect the contents of the resolutions of shareholders' meetings by the sample companies, and manually read them to determine whether the meetings involve motions related to corporate governance. If companies that are ex-ante disclosed for inspection hold more shareholders' meetings to discuss corporate governance, this implies that ex-ante disclosure of regulatory information stimulates shareholder activism to improve the governance of listed companies by convening shareholders' meetings and proposing motions. Based on this, we conduct regression analysis by replacing the dependent variable with IC Meeting, which is the number of shareholders' meetings held involving motions on corporate governance. As shown in Column (1) of Table 6, the coefficient of  $Treat \times Post$  is positive and significant, which verifies that shareholder activism can be triggered by ex-ante disclosure of regulatory information. In addition, as annual shareholders' meetings are usually held regularly every year, whereas the timing of local CSRC bureaus' launch of on-site inspection and disclosure of the list of inspected firms is not fixed, shareholders should be more likely to convene an interim shareholders' meeting to discuss corporate governance issues if they are concerned about the inspection and interested in improving the corporate governance situation. Therefore, we calculate the number of interim shareholders' meetings held involving corporate governance motions (IC\_Meeting2). As shown in Column (2) of Table 6, the coefficient of  $Treat \times Post$  is positive and significant, which indicates that companies that have been ex-ante disclosed as inspection targets hold more (interim) shareholders' meetings to discuss corporate governance.

We further study the behavior and reaction of minority shareholders after ex-ante disclosure of regulatory information. Due to the high cost of exercising rights (He and Fang, 2021), minority shareholders often find it difficult to directly participate in the company's operation and management activities, and they are more likely to express their voice through online platforms to fulfill their monitoring function. Therefore, we examine whether minority shareholders use online platforms to express their concerns about inspected companies. We obtain the content of questions posed by investors on the Shenzhen Stock Exchange's platform "Hu Dong Yi" and the Shanghai Stock Exchange's platform "E Hu Dong" to the inspected companies in each year, and use keywords to determine whether the questions are related to corporate governance.<sup>8</sup> We construct the variable *Pro\_ic\_que* by dividing the number of questions related to corporate governance by the total number of questions asked to measure the extent to which minority shareholders are attentive to corporate governance. As shown in Column (3) of Table 6, the results suggest that ex-ante disclosure does not cause minority shareholders.

<sup>&</sup>lt;sup>8</sup> Keywords: "内部控制," "内控," "公司治理," "内部治理," "内部管理," "内部监督," "内部监管," "内部审计," "治理结构," "治理架构," "组织架构," "内部交易," "内幕交易," "内幕消息," "管理制度," "管理模式," "决策机制," "决策程序," "信息披露," "内部架构," "风险管理," "风险控制," "约束机制," "监督制约," "组织结构," "管理质量," "问责机制," "管理方式" and "综合管理.".

Table 6					
Mechanism	test:	Investors'	exercise	and	voice.

	(1)	(2)	(3)	(4)
	IC_Meeting	IC_Meeting2	Pro_ic_que	Pro_neg_ic_que
Treat	-0.231**	-0.222**	$0.004^{**}$	-0.072
	(-2.171)	(-2.229)	(2.197)	(-0.569)
Post	-0.048	-0.080	0.004	-0.184
	(-0.412)	(-0.728)	(1.397)	(-1.122)
$Treat \times Post$	0.255**	0.231**	-0.004	0.316*
	(2.035)	(2.177)	(-1.410)	(1.853)
Size	0.112***	0.072**	0.001	0.005
	(3.336)	(2.248)	(1.566)	(0.172)
Roa	0.200	0.524*	$-0.019^{***}$	-0.293
	(0.556)	(1.765)	(-3.027)	(-0.901)
Growth	-0.031	-0.006	0.000	-0.028
	(-0.636)	(-0.152)	(0.308)	(-0.360)
Lev	-0.121	0.284	-0.005	0.114
	(-0.537)	(1.308)	(-1.447)	(0.502)
lnBoard	-0.319	-0.461**	0.007*	0.160
	(-1.455)	(-2.113)	(1.950)	(0.531)
Indep	0.501	0.214	0.017	0.534
•	(0.736)	(0.356)	(1.323)	(0.619)
Dual	-0.043	-0.115***	0.000	-0.051
	(-0.645)	(-2.051)	(0.375)	(-0.613)
Top1	0.438*	-0.031	-0.008*	0.070
*	(1.663)	(-0.111)	(-1.777)	(0.203)
Mshare	-0.203	-0.285	0.000	0.881***
	(-0.790)	(-1.270)	(0.086)	(2.672)
Age	-0.180	$-0.254^{**}$	0.000	0.038
	(-1.363)	(-2.170)	(0.085)	(0.252)
_cons	-0.892	0.369	-0.018	-0.059
	(-0.889)	(0.471)	(-1.033)	(-0.053)
Industry	Yes	Yes	Yes	Yes
Bureau	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	710	710	684	249
adj. $R^2$	0.070	0.062	0.063	0.013

holders to pay more attention to the corporate governance of the inspected companies. Next, we determine the tone of investor questions, based on the dictionary of positive and negative meanings in Chinese published by Tsinghua University's Li Jun, and focus on investor questions with a negative tone. We argue that a negative tone of investor questions can reflect the degree of investors' concerns about the company. Therefore, we construct the variable *Pro\_neg\_ic\_que* as the number of negative questions related to corporate governance divided by the total number of questions related to corporate governance to measure the extent to which minority shareholders are concerned about the inspected companies in terms of corporate governance. As shown in Column (4) of Table 6, the coefficient of  $Treat \times Post$  is positive and significant, which suggests that ex-ante disclosure of regulatory information causes minority shareholders to care more about the corporate governance of the inspected companies. Combined with the previous empirical results, ex-ante disclosure of regulatory information attracts greater investor attention, based on which activist shareholders improve the company's governance by initiating shareholders' meetings. At the same time, minority shareholders express their voice through online platforms after becoming aware of regulatory information, demonstrating their concerns about the company. This in turn puts pressure on the managers and prompts them to improve corporate governance. Therefore, ex-ante disclosure of regulatory information can trigger shareholder activism to realize the improvement of corporate governance.

The above results suggest that ex-ante disclosure of regulatory information can induce shareholders to participate in corporate governance activities through shareholders' meetings and online platforms. However, in addition to voice, investors may threaten to withdraw their shares and exert pressure on the managers to improve corporate governance (Chung and Talaulicar, 2010; Stathopoulos and Voulgaris, 2016). We examine whether investors implement the threat of exit through voting with their feet and thus realize improvements in corporate governance. Following Hu et al. (2018), we use the following variables. The first is *Minor Sell*, which equals 1 minus *Ltonva*, where *Ltonva* refers to the average of the cumulative volume of selling on large trading days as a proportion of the total volume of selling. Thus, Minor\_Sell reflects the impact of selling by minority shareholders. The result is shown in Column (1) of Table 7. The coefficient of  $Treat \times Post$  is negative but not significant, indicating that minority shareholders do not use the threat of exit to put pressure on managers when learning of ex-ante disclosure of regulatory information. In addition, we examine the impact of ex-ante disclosure of regulatory information on the turnover rate (Turnover), as well as the proportion of institutional investors' shareholding (Inst\_share), as shown in Columns (2)-(3) of Table 7. The results show that ex-ante disclosure of regulatory information does not have a statistically significant impact on the turnover rate of a company's stock or the percentage of institutional investors' shareholding, which indicates that ex-ante disclosure of regulatory information does not cause shareholders to vote with their feet.

	(1)	(2)	(3)
	Minor_Sell	Turnover	Inst_share
Treat	0.010	1.155*	$-0.075^{**}$
	(1.504)	(1.776)	(-2.544)
Post	0.004	-0.965	0.022
	(0.495)	(-1.193)	(0.981)
$Treat \times Post$	-0.009	-0.362	-0.017
	(-1.187)	(-0.377)	(-0.768)
Size	0.010****	$-0.698^{***}$	$0.047^{***}$
	(4.952)	(-3.116)	(4.641)
Roa	-0.005	-0.393	0.071
	(-0.233)	(-0.257)	(1.264)
Growth	-0.000	0.238	0.029***
	(-0.164)	(1.234)	(3.595)
Lev	$-0.028^{**}$	1.537	$-0.112^{**}$
	(-2.600)	(1.409)	(-1.983)
lnBoard	-0.008	-1.688	0.039
	(-0.575)	(-1.024)	(0.563)
Indep	-0.043	-2.230	-0.405*
	(-1.124)	(-0.511)	(-1.854)
Dual	0.006*	0.320	-0.005
	(1.736)	(0.784)	(-0.266)
Top1	$-0.081^{***}$	$-3.805^{***}$	0.733****
*	(-3.934)	(-2.673)	(9.292)
Mshare	0.000	5.732***	$-0.603^{***}$
	(0.022)	(3.026)	(-6.207)
Age	$-0.033^{***}$	$-2.250^{***}$	0.035
	(-3.735)	(-2.647)	(0.642)
_cons	0.824***	30.281***	$-0.647^{**}$
	(12.590)	(4.474)	(-1.984)
Industry	Yes	Yes	Yes
Bureau	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	710	710	710
adj. R <sup>2</sup>	0.234	0.260	0.603

Table 7Mechanism test: Investors' "voting with their feet".

# 4.4. Robustness tests

# 4.4.1. Parallel trend test

A key assumption of the DID approach is that the dependent variable shows parallel trends for the treatment and control groups before the shock. Thus, we construct seven dummy variables—the third year before inspection (t-3), second year before inspection (t-2), year before inspection (t-1), year of inspection (t), year after inspection (t + 1), second year after inspection (t + 2) and third year after inspection (t + 3)—and conduct a parallel trend test using t-1 as the benchmark period. The results are reported in Fig. 2. The coefficients for t-2 and t-3 are near 0 and the 90 % confidence intervals also contain 0, indicating that the parallel trend assumption is satisfied.

## 4.4.2. Self-selection bias

The choice between ex-ante and ex-post disclosure of regulatory information may be influenced by the government itself. For example, governments located in more market-oriented regions are more standardized in their information disclosure, and therefore strictly follow the requirement to disclose regulatory information ex-ante. Meanwhile, the public's demand for government information is stronger in areas with higher levels of marketization, and local governments have stronger incentives to disclose information in a timely manner. This would cause the choice between ex-ante and ex-post disclosure of regulatory information to be endogenous. To address self-selection bias, we conduct a Heckman two-stage estimation. Following Li and Shao (2022), we use the percentage of the urban population in each region in the previous year (Urbanization) as the instrumental variable. In general, regions with higher levels of urbanization have higher levels of marketization and urban populations pay more attention to government information. Therefore, we predict that urbanization is related to the decision of ex-ante vs. ex-post regulatory information disclosure, but not directly related to the quality of firms' internal control. In the first stage, we run a probit model in which the dependent variable is  $Treat \times Post$  and the independent variable is Urbanization. The results in Column (1) of Table 8 suggest that the higher the rate of urbanization in the previous year, the more likely the disclosure of regulatory information is to be ex-ante. In the second stage, we re-estimate Model (1) by including the inverse Mills ratio (IMR), as calculated from the first stage, as a control variable. The results remain constant, as shown in Column (2) of Table 8, which indicates that our findings do not suffer from obvious self-selection bias, and exante disclosure of regulatory information does significantly improve firms' internal control.



Fig. 2. Parallel trend test.

# 4.4.3. Alternative sample

The number of times a firm is randomly inspected may affect the quality of corporate governance. The more frequently a firm is randomly inspected, the more likely it is to make improvements in corporate governance under regulatory pressure. Therefore, to ensure the regulatory consistency of the sample firms, the analyses in the previous section exclude firms that have been randomly inspected more than twice. Column (1) of Table 9 shows that the result remains robust after adding the sample firms that have been randomly inspected more than twice.

# 4.4.4. Alternative measures of the dependent variable

In the above analyses, IC is taken as the internal control index divided by 100. Here, we use the natural logarithm of the internal control index (IC2) as an alternative measure of internal control quality. It can be seen in Column (2) of Table 9 that the result is consistent with the previous tests.

Table 8 Addressing solf selection bios		
Addressing sen-selection bias	(1)	(2)
	(1) Treat $\times$ Post	(2) IC
Urbanization	23 334**	
crounization	(2.340)	
Treat	(21010)	-0.433
1.000		(-1.341)
Post		-0.872***
1000		(-2.665)
Treat  imes Post		2.413**
1.000 / 1.000		(2.215)
Size	0.006	0 522***
	(0.052)	(3.528)
Roa	0.778	2.650**
1.04	$(1 \ 131)$	(2.094)
Growth	-0.013	-0.118
Glowin	(-0,114)	(-0.984)
Lev	-0.470	-1.289
200	(-0.747)	(-1.450)
InBoard	0 446	0 355
in Dour a	(0.654)	(0.528)
Inden	1.051	1.003
Interp	(0,507)	(0.545)
Dual	-0 462**	0.385*
2	(-2, 385)	(1.791)
Tonl	1 226	-1 894**
- op 1	(1 263)	(-2.084)
Mshare	-3.027***	2.024**
	(-2, 897)	(2.134)
Age	0.286	-1.767***
	(0.571)	(-3, 494)
IMR	(0.071)	-0.869
		(-1.462)
cons	-22.189**	-0.199
	(-2.263)	(-0.048)
Industry	Yes	Yes
Bureau	Yes	Yes
Year	Yes	Yes
Ν	574	574
adj. $R^2$		0.393
pseudo $R^2$	0.265	

	(1)	(2)	(3)
	IC	IC2	IC
Treat	-0.188	-0.403	
	(-0.570)	(-1.365)	
Post	-0.926***	$-0.667^{**}$	$-0.824^{***}$
	(-3.393)	(-2.541)	(-3.006)
Treat  imes Post	1.113***	0.819**	1.131***
	(3.002)	(2.398)	(2.962)
Size	0.384***	0.445***	0.720**
	(2.824)	(3.019)	(2.465)
Roa	2.634**	1.617	2.276**
	(2.413)	(1.389)	(2.084)
Growth	-0.053	-0.135	0.038
	(-0.397)	(-1.036)	(0.351)
Lev	-1.191	-1.439*	-2.197**
	(-1.489)	(-1.847)	(-2.020)
lnBoard	0.250	0.347	-0.679
	(0.390)	(0.559)	(-1.124)
Indep	1.685	1.411	-0.264
1	(0.992)	(0.862)	(-0.161)
Dual	0.191	0.050	-0.152
	(1.001)	(0.316)	(-0.595)
Top1	-0.813	-0.849	1.061
	(-1.078)	(-1.200)	(0.752)
Mshare	2.333****	1.392*	-1.582
	(2.819)	(1.939)	(-1.376)
Age	-1.256**	-1.266***	5.596**
0	(-2.533)	(-2.677)	(2.160)
_cons	0.870	0.515	-22.016**
	(0.233)	(0.137)	(-2.592)
Firm	No	No	Yes
Industry	Yes	Yes	No
Bureau	Yes	Yes	No
Year	Yes	Yes	Yes
Ν	769	710	710
adj. R <sup>2</sup>	0.357	0.396	0.583

Table )	
Robustness	s tests.

Table 9

## 4.4.5. Alternative regression model

The following DID model is used as a robustness test:

$$IC_{it} = \alpha_0 + \alpha_1 Post_{it} + \alpha_2 Treat \times Post_{it} + \alpha_3 Controls_{it} + \sum Firm + \sum Year + \varepsilon_{it}$$
(2)

In Model (2), we use firm fixed effects to control for *Treat* and all other factors that do not change over time, while the control variables are the same as in Model (1). The result remains robust, as shown in Column (3) of Table 9.

# 5. Further analysis

# 5.1. Heterogeneity analysis

The above empirical evidence suggests that ex-ante disclosure of regulatory information improves the governance of listed companies, implying that the regulatory capture mechanism does not hold in the sample studied in this paper. In theory, regulatory capture could still weaken the effectiveness of regulation. Following Yu and Pan (2008), we divide the full sample into two sub-samples according to whether the chairman and/or
Heterogeneity	analysis:	Political	connections.
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Table 10

	PC = 1	PC = 0	SOE = 1	SOE = 0
	(1)	(2)	(3)	(4)
	IC	IC	IC	IC
Treat	-0.452	-0.771*	-0.017	-0.633*
	(-1.069)	(-1.738)	(-0.036)	(-1.740)
Post	-0.051	$-1.078^{***}$	-0.556	$-0.765^{**}$
	(-0.131)	(-2.913)	(-0.866)	(-2.337)
$Treat \times Post$	0.162	1.430****	0.661	1.175**
	(0.357)	(2.683)	(0.956)	(2.492)
Size	0.530****	$0.464^{***}$	1.474****	0.122
	(3.783)	(2.762)	(10.120)	(0.849)
Roa	4.820*	2.741**	5.354*	2.463**
	(1.855)	(2.194)	$\begin{array}{ccccc} -0.017 & -0.633^* \\ (-0.036) & (-1.740) \\ -0.556 & -0.765^{**} \\ (-0.866) & (-2.337) \\ 0.661 & 1.175^{**} \\ (0.956) & (2.492) \\ 1.474^{***} & 0.122 \\ (10.120) & (0.849) \\ 5.354^* & 2.463^{**} \\ (1.841) & (2.147) \\ -0.236 & -0.027 \\ (-1.105) & (-0.174) \\ -0.496 & -1.472^* \\ (-0.291) & (-1.801) \\ -1.772 & -0.253 \\ (-1.176) & (-0.349) \\ -2.900 & -0.547 \\ (-1.030) & (-0.305) \\ -0.511 & 0.262 \\ (-1.366) & (1.159) \\ -6.928^{***} & -1.093 \\ (-3.117) & (-1.124) \\ -4.871 & 1.426^* \\ (-0.371) & (1.665) \\ 2.444 & -1.529^{***} \\ (1.463) & (-2.937) \\ -25.280^{***} & 9.112^{**} \end{array}$	
Growth	0.111	-0.035	-0.236	-0.027
	(0.689)	(-0.241)	(-1.105)	(-0.174)
Lev	-0.013	-1.407	-0.496	-1.472*
	(-0.009)	(-1.542)	(-0.291)	(-1.801)
lnBoard	0.355	-0.008	-1.772	-0.253
	(0.467) (-0.010)	(-1.176)	(-0.349)	
Indep	0.226	0.136	-2.900	-0.547
-	(0.066)	(0.069)	(-1.030)	(-0.305)
Dual	0.913****	0.221	-0.511	0.262
	(3.441)	(0.934)	(-1.366)	(1.159)
Top1	-5.806*	-0.592	$-6.928^{***}$	-1.093
-	(-1.871)	(-0.691)	(-3.117)	(-1.124)
Mshare	2.580***	0.441	-4.871	1.426*
	(3.415)	(0.427)	(-0.371)	(1.665)
Age	-0.736	$-1.552^{***}$	2.444	$-1.529^{***}$
	(-1.117)	(-2.773)	(1.463)	(-2.937)
_cons	-1.792	2.168	$-25.280^{***}$	9.112**
	(-0.478)	(0.480)	(-3.135)	(2.168)
P-value		0.010**		0.017**
Industry	Yes	Yes	Yes	Yes
Bureau	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Ν	177	533	216	494
adj. $R^2$	0.658	0.388	0.601	0.440

CEO has political connections (PC). The results are shown in Columns (1) and (2) of Table 10. It can be seen that the corporate governance effect of ex-ante disclosure is only significant in firms without political connections and not in firms with political connections, which suggests that regulatory capture does weaken the regulatory quality to some extent.

The nature of property rights is also likely to affect the governance role of ex-ante disclosure of regulatory information. For state-owned enterprises (SOEs), the existence of political connections may affect the deterrent effect of regulatory actions (Wang et al., 2023). Furthermore, due to the disadvantage faced by private firms in accessing resources compared with SOEs, private firms tend to show higher law-abiding conscientiousness after being randomly inspected by the CSRC. Therefore, the effect of ex-ante disclosure of regulatory information on corporate governance may be more significant among private firms. To test this conjecture, we divide the full sample into two sub-samples, i.e., SOEs and non-SOEs, according to their property rights. Columns (3) and (4) of Table 10 show that the corporate governance effect of ex-ante disclosure of regulatory information is only significant in private firms and not in SOEs, which is evidence that regulatory capture may weaken the regulatory effect.

Based on the above analysis, we argue that if the regulator provides regulatory information to the market in advance, this triggers shareholder activism to achieve effective governance of listed companies. If this market mechanism is valid, other information sources in the market may also trigger shareholder activism and realize governance effects. Some research shows that media can stimulate shareholder activism through their function of information dissemination (Ganguly, 2018). Therefore, the relationship between ex-ante disclosure of regulatory information and corporate governance may be affected by a company's external information environment. Specifically, when the external information environment is poorer, investors rely more on information disclosed by the regulator due to the lack of other sources of information. When the external information environment is better, investors may be motivated by information from other sources, even if the regulator does not disclose information. Thus, regulatory information and information disclosed by market intermediaries, such as the media, may substitute for each other. Therefore, we predict that ex-ante disclosure of regulatory information has a limited governance effect when a company has a good external information environment but becomes more important when the external information environment is poor. Both analysts and social media, as important market intermediaries, can provide effective information to reduce the information asymmetry between investors and firms (Zhang and Yang, 2016; Song et al., 2024). Therefore, we use online news in

	Media = 1	Media = 0	Analyst = 1	Analyst = 0
	(1)	(2)	(3)	(4)
	IC	IC	IC	IC
Treat	-0.160	-0.867*	-0.936***	-0.331
	(-0.458)	(-1.774)	(-3.228)	(-0.660)
Post	$-0.888^{**}$	-0.928*	-0.550*	$-1.307^{***}$
	(-2.439)	(-1.731)	(-1.825)	(-2.892)
$Treat \times Post$	0.363	1.633**	0.760*	1.389**
	(0.775)	(2.409)	(1.796)	(2.209)
Size	0.372**	0.582***	0.203**	0.717***
	(2.352)	(3.535)	(2.163)	(4.058)
Roa	4.109****	1.425	4.716***	0.893
	(2.867)	(0.911)	(3.595)	(0.683)
Growth	-0.106	-0.031	-0.046	-0.001
	(-0.510)	(-0.178)	(-0.248)	(-0.008)
Lev	0.184	-2.124**	0.181	$-2.267^{**}$
	(0.211)	(-2.274)	(0.338)	(-2.132)
lnBoard	-0.420	-0.032	0.494	$2.478^{**}$
	(-0.710)	(-0.036)	(0.892)	(2.249)
Indep	-2.257	0.128	-1.611	6.075**
	(-1.041)	(0.056)	(-0.812)	(2.046)
Dual	-0.055	0.397	0.184	0.284
	(-0.240)	(1.539)	(1.431)	(0.925)
Top1	-1.587	-0.216	0.061	-2.308*
	(-1.524)	(-0.193)	(0.091)	(-1.700)
Mshare	1.193*	0.364	-0.507	1.415
	(1.686)	(0.358)	(-0.723)	(1.126)
Age	$-1.095^{**}$	$-1.853^{***}$	-0.321	$-3.078^{***}$
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	(-0.869)	(-4.600)		
_cons	5.697	-0.016	2.985	-5.806
	(1.435)	(-0.004)	(0.875)	(-1.146)
P-value		0.018**		0.029**
Industry	Yes	Yes	Yes	Yes
Bureau	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Ν	316	394	342	368
adj. $R^2$	0.447	0.424	0.310	0.505

Table 11 Heterogeneity analysis: External information environment.

the CNRDS database as a proxy for media coverage (*Media*). If the number of times the focal company appears in online news headlines is higher than the annual average for the industry, *Media* is taken as 1, and 0 otherwise. In addition, we construct a dummy variable for the presence or absence of analyst following (*Analyst*), which is taken as 1 if there is an analyst following, and 0 otherwise. The results are shown in Table 11. In the samples with low media coverage or low analyst following, the effect of ex-ante disclosure of regulatory information on corporate governance is more significant, indicating that regulatory information is in a substitutive relationship with information provided by market intermediaries, which further verifies the existence of the market mechanism.

# 5.2. Analysis of economic consequences

Table 12

Effective regulatory enforcement helps improve firms' operating performance (Ke and Zhang, 2021). Blackburne et al. (2020) find that undisclosed government investigations predict economically material declines in future firm performance. Therefore, we predict that firms disclosed for inspection ex-ante will have better operating outcomes after the on-site inspection. We use economic value added (EVA) as the measurement of firms' operating performance. Specifically,  $EVA_OE$  is EVA divided by average net assets at the beginning and end of the year. In Column (1) of Table 12, the coefficient of  $Treat \times Post$  is positive and significant, sug-

Economic consequence test.			
	(1) EVA_OE	(2) Violation	
Treat	0.019	-0.044	
	(0.675)	(-0.550)	
Post	-0.031	0.185**	
	(-1.140)	(2.288)	
Treat  imes Post	0.076**	-0.252***	
	(2.022)	(-2.972)	
Size	0.021	-0.017	
	(1.375)	(-0.797)	
Roa	1.657***	-0.207	
	(9.289)	(-0.974)	
Growth	0.023**	-0.039**	
	(2.087)	(-2.029)	
Lev	-0.339***	0.374***	
	(-2.970)	(3.025)	
lnBoard	-0.088	-0.495***	
	(-1.498)	(-3.711)	
Indep	-0.100	-0.774	
*	(-0.652)	(-1.650)	
Dual	-0.001	-0.035	
	(-0.051)	(-0.756)	
Top1	0.089	-0.152	
x	(1.338)	(-0.830)	
Mshare	0.057	0.268	
	(0.961)	(1.247)	
Age	-0.039	0.007	
	(-1.015)	(0.056)	
_cons	-0.090	1.831**	
	(-0.261)	(2.428)	
Industry	Yes	Yes	
Bureau	Yes	Yes	
Year	Yes	Yes	
N	710	710	
adj. $R^2$	0.631	0.222	

gesting that ex-ante disclosure of regulatory information can improve firms' operating performance. Additionally, we examine whether the high-quality regulation resulting from ex-ante disclosure of regulatory information can reduce corporate violations. We construct the variable *Violation*, which equals 1 if the firm has incurred a violation in that year, and 0 otherwise. As shown in Column (2) of Table 12, the coefficient of *Treat*  $\times$  *Post* is negative and significant, indicating that the market mechanism induced by ex-ante disclosure of regulatory information provides more effective governance of the inspected firms and reduces their probability of violations.

# 6. Conclusion

Government regulation is the cornerstone of the healthy development of the capital market, especially for the relatively late-starting Chinese capital market. Strong government regulation is an important mechanism for solving various problems in the capital market. Although there is evidence that disclosure of regulatory results or regulatory penalties can play a certain deterrent role in standardizing the governance of listed companies, differences in the regulatory enforcement process may bring about different regulatory effects. In this paper, we use the on-site inspection system of the CSRC as a research setting to explore the governance effect of ex-ante disclosure of regulatory information. We find that ex-ante disclosure of regulatory information does not weaken the regulatory effect as expected, but rather improves the governance of listed companies, as evidenced by the improvement of their internal control quality. Mechanism analysis shows that ex-ante disclosure of regulatory information can stimulate shareholder activism and induce investors to participate in corporate governance activities by exercising their rights and voicing their opinions, which in turn improves corporate governance. In addition, the heterogeneity test shows that regulatory capture induced by political connections weakens the above corporate governance effects of ex-ante disclosure of regulatory information. The economic consequence test shows that ex-ante disclosure of regulatory information.

The findings of this paper have important policy implications. First, ex-ante disclosure of regulatory information contributes to the enhancement of regulatory quality and can have a positive impact on the inspection targets. Specifically, we show that ex-ante disclosure of regulatory information can stimulate shareholder activism, mobilize investor initiative and improve the quality of listed companies. Therefore, it is vital to further strengthen the implementation of the policy of ex-ante disclosure of regulatory information to clarify the responsibilities of regulatory agencies and standardize the operational behaviors of firms. Second, investors are the foundation of the market. The structure of the Chinese investment market is relatively decentralized. Given this, promoting investor participation in the capital market, safeguarding the legitimate rights and interests of investors and encouraging investors to actively exercise their rights and form a synergy with the regulatory authorities are all important measures to realize the high-quality development of the capital market. The findings of this paper show that the effective use of ex-ante disclosure of regulatory information can leverage market power, prompting a wide range of investors to exercise their rights, voice their opinions and actively participate in corporate governance. Third, the regulatory utility of the regulator is closely related to its independence. Government intervention should be minimized to reduce the systemic costs brought about by regulatory capture, thus promoting the healthy development of the capital market with strict and fair enforcement.

# **Conflict of interest**

We have no conflict of interest.

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# Green underwriters and carbon information disclosure

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#### ABSTRACT

Carbon information disclosure is crucial for combating climate change, but firms often face cost and market constraints that limit their willingness to disclose. We focus on green underwriters as financial intermediaries to examine their influence on corporate carbon information disclosure. We find that green underwriters significantly improve disclosure levels through information and monitoring effects. Cross-sectional analyses reveal that this positive association is more pronounced among firms with close underwriting relationships, highcarbon firms and environmentally friendly firms. Furthermore, we rule out collusion between underwriters and issuers, showing that green underwriters reduce proprietary costs while increasing market share and recognition from green funds. Our research highlights the monitor role of green financial intermediaries in promoting carbon disclosure and introduces new applications for textual analysis in this area.

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# 1. Introduction

The increasing focus on corporate carbon information and climate-related risks in capital markets has underscored the importance of carbon information disclosure (Bolton and Kacperczyk, 2021). However, firms often face significant cost and market constraints that hinder their willingness to disclose such information, creating a pressing need to explore effective external monitoring mechanisms. Underwriters, as key intermediaries in bond financing, act as general managers throughout the bond issuance process (Zhu and Zhang, 2021). While the literature has examined underwriter characteristics such as ratings, relationship capital,

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reputation and social networks (Wang and Gao, 2017; Lin et al., 2019; Dick-Nielsen et al., 2021; Nagler and Ottonello, 2022), the role of the green attributes of underwriters remains underexplored. To address this gap, we investigate whether green underwriters influence the carbon information disclosure of bond issuers.

Underwriters play a pivotal role in the preparation, review and submission of key disclosure documents, such as bond prospectuses. Green underwriters contribute to enhanced carbon information disclosure by performing two essential functions. First, they act as information intermediaries, facilitating the disclosure of carbon-related information to reduce information asymmetry between issuers and investors while addressing investor demands (Chen et al., 2020). Second, they serve as monitors, encouraging issuers to disclose carbon information and conducting due diligence to ensure its accuracy and reliability (Ma et al., 2019). While green underwriters often gain access to accurate carbon information through their investigations, issuers may hesitate to share such information prior to bond issuance. From a rational perspective, issuers are more likely to disclose carbon information if the perceived benefits exceed the associated costs (Kleimeier and Viehs, 2018; Lemma et al., 2019).

However, there is a potential risk of collusion, where green underwriters could exploit their expertise to assist issuers in concealing or misrepresenting carbon-related risks (Liu and Wang, 2015). Prior research documents instances of collusion between underwriters and issuers, particularly in environments lacking robust punitive mechanisms, where underwriters face greater incentives to prioritize profits over transparency (Guo et al., 2011; Chen and Song, 2018). Such behavior could manifest in the production of noisy or misleading information, which is then disseminated to investors during the bond issuance process (Bajo et al., 2016).

The identification of green underwriters is a key focus of this study. Underwriters participate in a broad spectrum of green financial activities, including bond underwriting, asset management, equity financing and fund management.<sup>1</sup> Due to data availability, we primarily measure green underwriters based on their involvement in underwriting and issuing green bonds, which account for over 60 % of their green financial activities. Green bonds are subject to regulatory requirements that mandate the disclosure of information on the use of proceeds, progress on green projects and associated environmental benefits, often encompassing detailed carbon-related information. To avoid self-selection bias, we focus on voluntary carbon information disclosure in bond prospectuses for general-purpose bonds.

Carbon disclosure policies in China currently lack robust incentives and enforcement mechanisms, leaving most issuers unmotivated to disclose such information. Using a sample of Chinese bond issuers from 2009 to 2019, we employ machine learning techniques (King et al., 2017; Sautner et al., 2023a) to measure carbon information disclosure based on bond prospectuses. Specifically, we develop a comprehensive carbon information keyword library and quantify disclosure by calculating the frequency of these keywords in bond prospectuses. This approach addresses the limitations of existing methods, such as reliance on Carbon Disclosure Project (CDP) reports, which suffer from low participation rates and limited reliability in the Chinese context (Li et al., 2019).

Our findings reveal that green underwriters significantly promote carbon information disclosure among bond issuers, particularly in the disclosure of opportunity-related carbon information. Mechanism analyses indicate that this effect is primarily driven by information and monitoring roles. Green underwriters mitigate information asymmetry, enabling issuers to proactively disclose carbon information in response to increased environmental, social and governance (ESG) demand and favorable green policies. Additionally, they encourage timely disclosure even under high uncertainty. Heterogeneity analyses suggest that the effect is more pronounced for issuers with close underwriting relationships, high-carbon firms and environmentally friendly firms. Furthermore, we rule out collusion between underwriters and issuers, showing that green underwriters tend to promote risk information disclosure and green practices. Finally, we find that green underwriters can alleviate the proprietary costs of carbon disclosure while enhancing their market share and attracting green fund investments.

This study makes several key contributions to the literature. First, we enrich research on the determinants of corporate carbon information disclosure and non-financial information disclosure (Prado-Lorenzo and Garcia-Sanchez, 2010; Tang and Luo, 2016; Hollindale et al., 2019). Studies primarily focus on factors such

<sup>&</sup>lt;sup>1</sup> See Table A1.

as firm characteristics, internal governance and institutional features (Downar et al., 2021; Flammer et al., 2021). For example, larger and more profitable firms are more motivated to disclose carbon information to communicate their product characteristics and emissions reduction targets (Stanny and Ely, 2008). Governance mechanisms, such as shareholder activism and board oversight, can enhance carbon disclosure when its quality is low (Liao et al., 2015; Flammer et al., 2021; Nagar and Schoenfeld, 2021). Firms may also voluntarily disclose carbon information as a strategic response to avoid stringent regulatory legislation (Matisoff et al., 2013; Grauel and Gotthardt, 2016). Furthermore, strict carbon policies have been shown to improve the credibility of disclosure (Luo, 2019). We extend the literature by clarifying the role of green underwriters as external monitors in promoting carbon information disclosure by bond issuers.

Second, we advance the literature on carbon information disclosure in the bond market. With the rapid growth of bond markets-particularly the green bond market-the diversity of bond types has significantly expanded. Since 2016, widely regarded as the inception of China's green bond market, the country has emerged as the largest green bond market globally, offering a valuable context for studying carbon information disclosure (Flammer, 2021). While most studies focus on equity markets, the significant differences between bond and equity markets-including regulatory frameworks, investor composition and risk preferences—can lead to distinct disclosure practices and investor responses. Specifically, these differences are as follows. (1) Regulatory frameworks differ. The equity market is vertically regulated by the China Securities Regulatory Commission (CSRC), which mandates governance structures such as independent directors. In contrast, the bond market operates under a multi-agency regulatory framework with no such requirements, potentially affecting the quality and consistency of disclosure practices. (2) Investor composition differs. Equity markets are predominantly driven by retail investors, whereas bond markets are dominated by institutional investors, who tend to prioritize carbon information in their investment decisions. These differences result in varying market responses to disclosures, such as stock price volatility in equity markets versus bond yield adjustments in bond markets. (3) Risk preferences differ. Compared with equities, bonds offer limited upside potential but carry higher downside risks (Ilhan et al., 2021). Bond investors, being more riskaverse, are likely to demand opportunity-oriented carbon information that aligns with their cautious investment strategies. By focusing on the bond market, we identify the factors influencing voluntary carbon information disclosure in this unique context, offering new insights into disclosure dynamics and investor behavior.

Third, we introduce an innovative methodology for measuring carbon information disclosure by applying machine learning to bond prospectuses, thereby expanding the scope of textual analysis in carbon information research. Carbon information disclosure is a critical indicator of corporate efforts toward carbon reduction, yet current measurement methods lack a unified definition or framework. Existing approaches include the use of indices based on CDP reports (Jung et al., 2018; Kleimeier and Viehs, 2018), greenhouse gas (GHG) reports (Tauringana and Chithambo, 2015), textual analysis of annual reports (Karim et al., 2021) and carbon emission levels as proxies (Matsumura et al., 2014). We refine these measures by employing machine learning techniques to analyze carbon-related information in bond prospectuses (King et al., 2017; Sautner et al., 2023a).

Additionally, we expand the application of textual analysis to bond prospectuses, an area that has been underexplored in prior research. While listed firms typically disclose carbon information through annual or sustainability reports, bond issuers—many of which are unlisted firms with lower visibility and higher information asymmetry—are required to disclose prospectuses. These documents not only provide structured financial and bond-related data but also include unstructured textual information, such as risk factors, future projections, use of proceeds and climate-related risks and opportunities. Despite this, academic research on bond prospectuses largely focuses on financial and risk disclosures, with limited attention paid to carbon-related information, especially in emerging markets like China. By analyzing carbon disclosures in bond prospectuses, we complement and extend research on the role of textual information in bond markets.

The remainder of this paper is organized as follows. Section 2 provides an overview of the literature and develops the hypothesis. Section 3 introduces the sample, variables and model settings. Section 4 reports the research results. Section 5 presents the results of further analysis. Section 6 provides an overall conclusion of the study.

#### 2. Literature review and hypothesis development

#### 2.1. Literature review

# 2.1.1. Underwriter characteristics and their economic consequences

Underwriters play a critical role in capital markets by providing both informational and certification effects (Lin et al., 2019). Through professional information discovery and validation, underwriters convey private information about issuers to investors, thereby mitigating information asymmetry between the two parties (Booth and Smith, 1986). High-reputation underwriters are more likely to devote significant effort to uncovering issuers' private information and apply stricter evaluation standards to newly issued firms (Erhemjamts and Raman, 2012). The informational and certification functions of underwriters have been well documented in the context of IPO premiums (Guo and Zhao, 2006).

Similarly, underwriters serve as crucial intermediaries between bond issuers and investors, performing analogous roles in the bond market (Wang and Gao, 2017). First, high-reputation underwriters possess stronger risk management capabilities, enabling them to identify potential risks associated with bond issuers. By carefully assessing these risks, they help enhance the credibility of bond issuances. Second, experienced underwriters have a proven ability to uncover detailed information about issuers. They often require issuers to adhere to particularly strict disclosure standards, thereby further reducing information asymmetry in the bond market. Finally, high-reputation underwriters are motivated to safeguard their reputation, which incentivizes them to select high-quality issuers and ensure the overall quality of the bonds they underwrite (Liang and Yu, 2014).

#### 2.1.2. Measuring carbon information disclosure

Carbon information disclosure plays a critical role in improving firms' carbon management practices. Such disclosure can be either mandatory or voluntary. In most countries, carbon information disclosure is voluntary and lacks specific, standardized guidelines (Wang, 2023), leading to heterogeneity in its measurement. Existing methods for measuring carbon information disclosure include indices derived from CDP reports (Jung et al., 2018; Kleimeier and Viehs, 2018) and GHG emission reports (Tauringana and Chithambo, 2015; Li et al., 2019), textual analyses of annual reports (Karim et al., 2021) and proxies such as carbon emission levels (Matsumura et al., 2014). Among these, disclosure indices are the most used metrics in empirical studies. Tauringana and Chithambo (2015) employ content analysis to measure carbon disclosure levels based on information from annual and GHG emission reports. They develop a disclosure index comprising 60 indicators, including 34 qualitative items such as explanations for changes in Scope 1, 2 and 3 emissions, statements ensuring disclosure reliability and corporate governance related to climate change.

Similarly, the CDP carbon disclosure index is one of the most comprehensive measures of carbon-related actions. CDP, an independent non-profit organization, annually solicits carbon data from global publicly listed companies through questionnaires covering areas such as governance, risks and opportunities, strategy, carbon emissions and stakeholder engagement (Jung et al., 2018; Kleimeier and Viehs, 2018). However, CDP reports are inherently voluntary and lack enforceable standards, raising concerns about data reliability (Li et al., 2019). The adoption of CDP reporting in China has been relatively limited, with participation rates falling below 50 %.

# 2.1.3. Determinants of carbon information disclosure

The decision of firms on whether to disclose carbon information is influenced by various factors, including firm characteristics, corporate governance and institutional frameworks. First, firm-specific attributes such as profitability, firm size, leverage and stage of development play an important role in determining carbon disclosure. Higher profitability often leads to better carbon disclosure, as financially robust firms possess the resources to invest in emissions reduction and disclosure initiatives. For instance, Stanny and Ely (2008) find a positive correlation between firm performance and environmental information disclosure, as profitable firms are motivated to convey the quality of their products to investors. Larger firms are also more likely to disclose carbon information due to lower information dissemination costs and greater scrutiny from the media and

5

regulators (Prado-Lorenzo and Garcia-Sanchez, 2010). Furthermore, creditors, in their assessment of financial security, consider not only a firm's financial performance but also its operational risks. In the context of carbon peaking and carbon neutrality, creditors increasingly focus on a firm's long-term sustainability. As a result, highly leveraged firms tend to disclose more carbon information to gain creditor support (Tang and Luo, 2016).

Second, corporate governance mechanisms, such as shareholder activism and board oversight, play a crucial role in encouraging firms to disclose carbon information. Flammer et al. (2021) show that shareholder activism enhances firms' voluntary disclosure of climate-related risks by prompting firms to reassess these risks and raising management awareness of climate issues. Similarly, Bose et al. (2018) find a significant positive relationship between governance quality and green information disclosure. For example, larger boards often have more resources to implement environmental initiatives, while board diversity enhances the management of climate-related risks. Hollindale et al. (2019) find that having more female directors improves both the quantity and quality of carbon disclosure, as female directors often prioritize addressing strategic issues like climate change and communicating them to stakeholders. Independent directors and the establishment of environmental committees further enhance ecological transparency and the quality of carbon disclosure (Liao et al., 2015). Boards also act as monitors to prevent greenwashing by management. For instance, Bui et al. (2020) demonstrate that increasing the frequency of board reporting on carbon emissions significantly improves carbon disclosure. In addition, stakeholders exert considerable influence on firms. Institutional investors often demand disclosure of environmental risks and opportunities (Cotter and Najah, 2012), and firms are motivated to meet these expectations to maintain stakeholder support.

Third, institutional environments and regulatory frameworks are critical drivers of carbon information disclosure. Firms adapt to regulatory environments by utilizing voluntary environmental reporting frameworks to disclose carbon information prior to the enactment of formal legislation. For example, Grauel and Gotthardt (2016) find significant differences in the response rates to CDP climate change projects across countries, with stricter environmental regulations promoting carbon disclosure. Similarly, Matisoff et al. (2013) show that regulatory stringency and environmentalism within a country drive Scope 2 carbon disclosure. Luo (2019) finds that stringent carbon regulations enhance the credibility of carbon disclosures and weaken the negative correlation between carbon disclosure and carbon performance. Mandatory disclosure requirements also play a significant role. Downar et al. (2021) observe that when UK regulators mandated listed firms to disclose their carbon emissions in annual reports, firms not only improved the transparency of carbon disclosure but also significantly reduced direct emissions.

In summary, studies on the determinants of carbon information disclosure primarily focus on firm characteristics, corporate governance and external regulatory environments. However, limited research explores how third-party intermediaries influence carbon disclosure, particularly in China's bond market. As key intermediaries, underwriters have been studied for their reputation (Wang and Gao, 2017), underwriting experience, relationships (Dick-Nielsen et al., 2021), social networks (Bajo et al., 2016; Nagler and Ottonello, 2022) and independence (Liang and Yu, 2014). However, the role of green underwriters in promoting information disclosure—especially carbon disclosure—remains largely unexplored. This gap presents an opportunity to investigate how green underwriters influence carbon information disclosure by bond issuers.

### 2.2. Hypothesis development

Underwriters play a crucial role in bond issuance and subsequent oversight. First, underwriters act as information intermediaries (Bajo et al., 2016). Before issuance, underwriters actively collect information and encourage bond issuers to disclose more details, thereby mitigating information asymmetry with investors (Dong et al., 2011; Erhemjamts and Raman, 2012). Through their research on issuers and extensive network resources, underwriters compile and publicize information in prospectuses, which serve as essential documents for investors to access carbon-related information (Lin et al., 2019). Prospectuses contain rich details about issuers, making them a valuable tool for communicating carbon-related information (Li et al., 2023). Given the increasing importance of carbon information in investment decision-making, underwriters are likely to encourage issuers to disclose more carbon-related information to meet investor demand. To ensure the quality and credibility of bonds, underwriters conduct ESG due diligence on issuers prior to issuance. During the bond's duration, underwriters guide and encourage issuers to disclose ESG information, enhancing transparency and traceability. For instance, the Agricultural Bank of China (ABC) supports high-quality firms in issuing green bonds and continually improves its underwriting services. By fulfilling its due diligence and providing ongoing guidance, the bank evaluates issuers' governance, social responsibility and environmental practices, thereby encouraging carbon information disclosure.<sup>2</sup> This suggests that underwriters leverage their experience in green finance, such as green bond underwriting, to guide issuers in disclosing more carbon-related information.

In addition, Houston and Shan (2022) find that banks are more inclined to lend to firms with ESG practices like their own. Similarly, underwriters may use their expertise in green finance to encourage issuers to disclose carbon information in prospectuses. As members of green bond standard-setting committees, underwriters actively promote the development of green bond disclosure practices. For example, the China Construction Bank has used its extensive experience in underwriting and issuing green bonds to participate in drafting the *China Green Bond Principles*, conducting related research and fostering industry exchanges.<sup>3</sup> Additionally, green underwriters' professional responsibilities drive them to stay informed about external policy changes in low-carbon finance. Their sensitivity to and understanding of regulatory changes allow them to guide issuers in overcoming cognitive biases about low-carbon policies and providing high-quality carbon disclosures based on scientific evidence.

Second, green underwriters also act as monitors. They can access private information from issuers to monitor their activities. For example, Frankel et al. (2020) show that bank underwriters improve firms' financial reporting quality by requiring the disclosure of accounts receivable aging reports, thereby fulfilling their monitoring role. Similarly, underwriters can regulate their analysts' behavior to ensure alignment with client interests. Altınkılıç et al. (2019) find that banks penalize biased reports, prompting analysts to issue fewer overly optimistic and bold forecasts. In the bond market, underwriters play a similar monitor role, reducing default risks among issuers (Lin et al., 2019). Green underwriters can extend this monitoring function by encouraging issuers to disclose more carbon-related information.

Lastly, there is a potential risk that green underwriters may act as colluders. Leveraging their green expertise, underwriters might encourage issuers to obscure or minimize the disclosure of risk-related information. Prior studies document collusion between underwriters and issuers (Guo et al., 2011), especially in the absence of punitive mechanisms, where underwriters have greater incentives to exploit their position for profit (Chen and Song, 2018). Underwriters may even produce noisy information and pass it on to investors during the issuance process (Bajo et al., 2016). However, issuers engaging in greenwashing through prospectuses could harm underwriters' reputations and negatively affect future underwriting business. If green underwriters fail to monitor issuers' disclosures of carbon opportunities and regulatory risks during post-issuance management, investors may hold them accountable. To protect their reputation, green underwriters are likely to monitor the authenticity of issuers' carbon disclosures, rigorously evaluate the quality of prospectuses and ensure that carbon information disclosure meets high standards. Moreover, as regulatory oversight and penalty mechanisms for underwriters become more robust, the reputational effects of green underwriters are further reinforced (Lin et al., 2019). Based on this analysis, we propose the following hypothesis:

H1: Green underwriters promote carbon information disclosure by bond issuers.

<sup>&</sup>lt;sup>2</sup> In July 2021, ABC, acting as the lead underwriter, successfully underwrote the first green medium-term note issuance of the year (21 Shenzhen Energy MTN001) for Shenzhen Energy Group Co. During this process, ABC guided the issuer to disclose not only the allocation of proceeds but also detailed carbon-related information, including expected and actual environmental benefits. For instance, the offering prospectus indicated that the funded project was expected to achieve annual savings of 978,000 tonnes of standard coal and reductions of 2,596,300 tonnes of carbon dioxide equivalents, 513.24 tonnes of sulfur dioxide, 574.19 tonnes of nitrogen oxides and 102.65 tonnes of soot, thereby generating significant environmental benefits. Moreover, the periodic report on the use of proceeds during the bond's lifecycle detailed the allocation of funds, the progress of green and low-carbon projects and the associated carbon emission reductions.

<sup>&</sup>lt;sup>3</sup> https://sinfo2.ccb.com/cn/group/finance/20220810\_1660117296.html.

#### 3. Research design

#### 3.1. Sample selection and data sources

We analyze corporate bonds, enterprise bonds and medium-term notes issued in China from 2009 to 2019.<sup>4</sup> Given that green bonds are subject to regulatory requirements mandating the disclosure of information such as the use of proceeds, progress on green projects and environmental benefits, their prospectuses typically include abundant carbon-related information. To ensure consistency and focus on voluntary carbon disclosure, green bonds are excluded from the sample. Thus, our sample consists entirely of general credit bonds. Data on the financial characteristics of bond issuers and bond-specific features are obtained from the Wind and CSMAR databases. The sample excludes financial firms, firms under special treatment and bonds rated by foreign credit rating agencies. Observations with incomplete financial or industry data are also removed. After data cleaning, the final sample comprises 3,074 issuers and 11,322 observations of credit bonds. To mitigate the influence of outliers, continuous financial variables are winsorized at the 1st and 99th percentiles.

# 3.2. Variable measurement and empirical models

To examine the impact of green underwriters on carbon information disclosure, we construct Model (1) based on the methodologies proposed by Sautner et al. (2023a) and Wu et al. (2022). In the model, *i* denotes bonds, *t* represents time and  $\varepsilon_{it}$  is the random disturbance term.

$$CIE_{it} = \alpha_0 + \alpha_1 GUW_{it} + \alpha_i Controls_{it} + \varepsilon_{it}$$

$$\tag{1}$$

The dependent variable, *CIE*, measures the level of carbon information disclosure by bond issuers. Some bond issuers with a strong sense of social responsibility and a high awareness of information disclosure have started to disclose relevant carbon information in their offering prospectuses. Hence, we adopt a methodology inspired by Sautner et al. (2023a) to assess whether the offering prospectuses disclose carbon information. This identification approach prioritizes substance over form, aligning with the practical context in China. Subsequently, we employ a machine learning keyword algorithm proposed by Sautner et al. (2023a) and King et al. (2017) to measure the level of carbon information disclosure.

The process involves the following steps. First, an initial set of carbon-related keywords is manually compiled based on the Green Bond Endorsed Projects Catalogue (2021 Edition), China's Second Biennial Update Report on Climate Change, research reports on the use of proceeds, the Carbon Emissions Trading Network, bond prospectuses and proceedings from the first Carbon Neutrality Conference. Additional carbon-related terms are collected from relevant studies on carbon disclosure (e.g., Sautner et al., 2023a; Li et al., 2019). Keywords are categorized into opportunity carbon information, regulatory carbon information, and physical carbon information, following Sautner et al. (2023a). After several rounds of manual review, the initial keyword set (C) includes 140 terms. Secondly, the initial keyword set is used to expand and generate new keywords. Financial news and *People's Daily* are used as training corpora for expansion purposes, and the 100 highest-frequency words are extracted as new keywords.<sup>5</sup> Third, we select keywords from the expanded set that exhibit high similarity with the seed keywords (similarity score > 0.5) and appear at least 10 times. These selected keywords are then added to the initial set of carbon information keywords, resulting in a total of 321 keywords.<sup>6</sup> Finally, we apply this carbon information keyword set to the offering prospectuses of the bonds and calculate the frequency of occurrence of these keywords as a measure of carbon information disclosure (*CIE*).

<sup>&</sup>lt;sup>4</sup> Given the implementation of the *Pilot Measures for the Issuance of Corporate Bonds* in August 2007 and the introduction of medium-term notes in April 2008, we select 2009 as our start date.

<sup>&</sup>lt;sup>5</sup> The financial news training corpus expands the initial keyword set by 5,105 keywords, and after the screening process, a total of 89 keywords are selected. Similarly, the *People's Daily* training corpus expands the initial keyword set by 4,483 keywords, and after screening, a total of 99 keywords are obtained.

<sup>&</sup>lt;sup>6</sup> Table A2 presents a glossary of carbon-related terms.

Variable	Label	Definition
Dependent variable	CIE	(Frequency of carbon information keywords/total number of words in the offering prospectus) $\times 100$
Independent variable	GUW	Indicator variable that equals 1 if the underwriter underwrites or issues green bonds in period $t$ and 0 otherwise
Issuer-level control variables	Size	Natural logarithm of total assets
	Lev	Total debt/total assets
	ROA	Earnings/total assets
	Growth	(Operating income – prior period operating income)/prior period operating income
	Asset	Operating income/total assets
	Turnover	
	Cash	(Monetary cash + financial assets held for trading)/total assets
	Property	Net value of fixed assets/total assets
	SOE	Indicator variable that equals 1 if the issuer is a state-owned firm and 0 otherwise
	Opinion	Indicator variable that equals 1 if the issuer receives a standard unqualified opinion and 0 otherwise
	Listed	Indicator variable that equals 1 if the issuer is a listed firm and 0 otherwise
Bond-level control variables	Credit	Issuer bond ratings from CCC to AAA, with "+" and "-" for fine tuning, and
	Rating	assignments 1–12
	Maturity	Natural logarithm of the bond issue term
	Proceeds	Natural logarithm of the bond issue amount
	Guarantee	Indicator variable that equals 1 if the bonds are pledged, secured or guaranteed and 0 otherwise
Fixed effects	Year	Year fixed effects
	Industry	Industry fixed effects
	Agency	Agency fixed effects
	Underwriting	Underwriting fixed effects

The key independent variable, GUW, represents the green level of underwriters. As critical intermediaries in the bond market, underwriters engage in diverse activities, including supporting the real economy and promoting ESG principles. The underwriting of green bonds serves as an important indicator of an underwriter's ESG performance.<sup>7</sup> During the underwriting process, underwriters conduct due diligence on issuers' environmental and social risks, encouraging and guiding issuers to disclose carbon-related information.<sup>8</sup> Furthermore, underwriters contribute to the financial sector's decarbonization by issuing green bonds, thereby aiding issuers' transitions. Bedendo et al. (2023) find that banks publicly supporting green transitions reduce emissions through green bond issuance. We measure GUW based on whether the underwriter engaged in underwriting or issuing green bonds during period t.

The model includes a range of control variables (*Controls*) to account for issuer- and bond-specific characteristics, as defined in Table 1. Issuer characteristic variables comprise firm size, leverage, profitability, revenue growth, ownership type, audit opinion and listing status. Bond characteristic variables include credit ratings, issuance volume, maturity and whether the bond is secured. Fixed effects are included for year, industry, credit rating agency and underwriter, following Wu et al. (2022). To ensure robust results, heteroskedasticityconsistent standard errors are employed, and clustering is performed at the industry level.

<sup>&</sup>lt;sup>7</sup> For instance, Huatai Securities has actively advanced the development of green finance, underwriting green bonds with a total financing scale exceeding 150 billion yuan over the past five years and supporting numerous innovative projects focused on energy conservation and carbon reduction.

<sup>&</sup>lt;sup>8</sup> For example, in its 2021 *Green Finance Development Report*, ABC highlighted that its bond underwriting business actively encourages and guides issuers to disclose ESG information while providing relevant advisory support throughout the bond's lifecycle.

#### 4. Empirical results

#### 4.1. Descriptive statistics

Table 2 provides the descriptive statistics for the key variables used in this study. The mean value of *CIE* is 0.2142 %, with a maximum of 4.2342 %. This indicates that while some issuers include carbon-related information in their prospectuses, the overall level of disclosure remains low, with the highest disclosure rate only reaching 4.2342 %. The mean value of *GUW* is 0.1751, suggesting that approximately 18 % of the issuers in the sample selected green underwriters for their bond issuance. For the control variables, the mean credit rating of the bonds (*Credit Rating*) is 11.1272, indicating that most issuers have relatively high credit ratings, primarily concentrated in the AA and AA + categories. The mean financial leverage (*Lev*) is 58.39 %, reflecting that most bond issuers carry debt levels exceeding half of their total assets. The highest leverage ratio reaches 86.77 %, indicating significant financial risk for some issuers. The mean return on assets (*ROA*) is 3.03 %, suggesting that most issuers exhibit modest profitability. The mean value for company ownership (*SOE*) is 0.8928, indicating that most bond issuers are state-owned enterprises (SOEs), with non-SOEs accounting for only about 10 % of the sample. Additionally, the mean value of firm size (*Size*) is 24.6496, the mean turnover rate (*Turnover*) is 25.39 % and the mean revenue growth rate (*Growth*) is 16.69 %.

#### 4.2. Baseline regression

. . . .

Table 2

Table 3 examines the impact of green underwriters on carbon information disclosure by bond issuers. Panel A reports the regression results based on Model (1). Column (1) presents the results without including any control variables, where the coefficient of GUW is 0.1015 and is statistically significant at the 5 % level. In Column (2), firm-specific and bond-specific characteristics are added as control variables, along with fixed effects for year, industry, rating agency and underwriter. The results show that the coefficient of GUW remains positive and significant at the 5 % level. Specifically, a one standard deviation increase in GUW is associated with a 15.5761 % increase in carbon information disclosure by bond issuers.

Table 3, Panel B, further explores the influence of green underwriters on carbon information disclosure by categorizing disclosure into opportunity-related carbon information (Opp), regulatory carbon information (Reg) and physical carbon information (Phy). Sauther et al. (2023b) find that the pricing of climate risk premiums is primarily driven by climate-related opportunity shocks rather than regulatory or physical shocks. Thus,

Summary statistics.							
Variable	Obs.	Mean	Median	Std.	Min	Max	
CIE	11,322	0.2142	0.1012	0.3161	0.0000	4.2342	
GUW	11,322	0.1751	0.0000	0.3800	0.0000	1.0000	
Credit Rating	11,322	11.1272	11.0000	0.8471	0.0000	12.0000	
Size	11,322	24.6496	24.4154	1.3893	22.2299	28.7648	
Lev	11,322	0.5839	0.5994	0.1441	0.1260	0.8677	
ROA	11,322	0.0303	0.0243	0.0232	-0.0061	0.1165	
Growth	11,322	0.1669	0.0916	0.4039	-0.6237	2.4393	
Asset Turnover	11,322	0.2539	0.1063	0.3249	0.0071	1.6123	
Cash	11,322	0.1073	0.0967	0.0647	0.0052	0.3319	
Property	11,322	0.1316	0.0479	0.1788	0.0000	0.7476	
SOE	11,322	0.8928	1.0000	0.3094	0.0000	1.0000	
Opinion	11,322	0.9869	1.0000	0.1136	0.0000	1.0000	
Listed	11,322	0.1203	0.0000	0.3253	0.0000	1.0000	
Maturity	11,322	1.6602	1.6094	0.3728	1.0986	2.7081	
Proceeds	11,322	6.8570	6.9078	0.6572	5.2983	8.8537	
Guarantee	11.322	0.4065	0.0000	0.4912	0.0000	1.0000	

Notes: This table presents the descriptive statistics for the variables in the main tests. The variable definitions are provided in Table 1.

Table 3

Green underwriters and carbon information disclosure.

Panel A Baseline regression				
Variable				
		(1)	(2)	
GUW		0.1015**	0.0878**	
		(2.33)	(2.24)	
Credit Rating			0.0193	
c.			(2.28)	
Size			0.0135	
T			(1.99)	
Lev			0.0763*	
PO 4			(1.//)	
KOA			0.9743	
Growth			(5.55)	
Growin			-0.0034	
Asset Turnover			0.0634**	
Asset Turnover			(2.57)	
Cash			0.1387*	
Cush			(1.86)	
Property			0 2241***	
1.0penty			(3.25)	
SOE			-0.0120	
			(-0.59)	
Opinion			0.0440*	
1			(1.78)	
Listed			0.0128	
			(0.74)	
Maturity			-0.0317*	
			(-1.69)	
Proceeds			-0.0083	
			(-1.17)	
Guarantee			$-0.0317^{**}$	
			(-2.56)	
_cons		0.1965****	-0.3956**	
		(16.69)	(-2.30)	
Year		Yes	Yes	
Industry		Yes	Yes	
Agency		Yes	Yes	
Underwriting		Yes	Yes	
2				
adj. $R^2$		0.3940	0.4298	
N		11,322	11,322	
Panel B Different dimensions o	t carbon information disclosure			
Variable	Орр	Reg	Phy	
	(1)	(2)	(3)	
GUW	$0.0680^{**}$	0.0196	0.0042	
	(2.44)	(1.40)	(1.33)	
Controls	Yes	Yes	Yes	
Year	Yes	Yes	Yes	
Industry	Yes	Yes	Yes	
Agency	Yes	Yes	Yes	
Underwriting	Yes	Yes	Yes	
$a d; D^2$	0.2250	0.4021	0.1044	
auj. K N	0.5250	0.4951	0.1044	
1.1	11,322	11,322	11,322	

Notes: This table provides the results for the effect of green underwriters on carbon information disclosure. Panel A presents the baseline regression results, while Panel B examines different dimensions of carbon information disclosure. The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

green underwriters may leverage their green expertise to strategically guide issuers in disclosing more opportunity-related carbon information. In Panel B of Table 3, Columns (1) to (3) replace the dependent variable *CIE* with *Opp*, *Reg* and *Phy*, respectively. The coefficient of *GUW* in Column (1) is positive and significant at the 1 % level, indicating that green underwriters significantly promote the disclosure of opportunity-related carbon information. In contrast, the coefficients of *GUW* in Columns (2) and (3) are nonsignificant, suggesting that green underwriters have little impact on regulatory or physical carbon information disclosure.

# 4.3. Robustness tests

First, we employ alternative measures of green underwriters and re-estimate their impact on carbon information disclosure. In the main analysis, the green level of underwriters is measured based on their involvement in underwriting and issuing green bonds. However, underwriters can also promote green and low-carbon transitions in the real economy through other activities, such as providing green loans and implementing green operational practices.<sup>9</sup> Research shows that green banks are more likely to make green investments and offer green loans to eco-friendly firms at lower interest rates (Malandrakis and Drakos, 2020; Gunawan et al., 2022; Degryse et al., 2023). Moreover, underwriters actively manage their carbon footprint by adopting green practices, such as paperless operations and promoting green transportation<sup>10</sup> (Al Mulla and Nobanee, 2020). Environmental performance is also a critical criterion for determining green-oriented bonds (Yip and Bocken, 2018; Gunawan et al., 2022).

In this robustness check, the proportion of green underwriters (GUW) is redefined based on five dimensions in Table 4: green bond underwriting, green bond issuance, green loans, green operations and environmental performance. Specifically, in Table 4, GUW is coded as 1 if an underwriter satisfies any of the five dimensions during year t and 0 otherwise.  $GUW_{half}$  is coded as 1 if an underwriter satisfies at least 8 indicators across the five dimensions and 0 otherwise. Green Bank is coded as 1 if an underwriter's score on any continuous variable in the five dimensions exceeds the median and 0 otherwise.<sup>11</sup> Green  $Bank_{half}$  is coded as 1 if an underwriter satisfies at least 8 indicators above the median and 0 otherwise. Panel A of Table 5 presents the regression results using these alternative measures of green underwriters. The coefficients of GUW, Green Bank,  $GUW_{half}$ and Green  $Bank_{half}$  are all positive and statistically significant at the 10 % level or better, indicating that green underwriters, measured through multiple dimensions, consistently promote higher carbon information disclosure by bond issuers. These findings confirm the robustness of our main conclusions.

To further explore the role of each dimension, we conduct separate regressions for each measure. Panel B of Table 5 presents the results: Column (1) examines whether green bond issuance (*Greenbond-iu*) influences carbon disclosure. The coefficient of *Greenbond-iu* is positive and significant at the 1% level. Columns (2) to (4) investigate the impact of green bond underwriting. The dummy variable *Greenbond-uw* (indicating whether the underwriter has underwritten green bonds), the natural logarithm of the number of green bonds underwritten (*GB-Number*) and the natural logarithm of the value of green bonds underwritten (*GB-Amount*) all exhibit positive and statistically significant coefficients at the 1% level. Column (5) examines the effect of green loans (*Green Loan*, log-transformed) on carbon disclosure, with the coefficient also significant at the 1% level. Column (6) analyzes underwriters' green operational practices using the green operations index, constructed through principal component analysis of metrics such as per capita water and energy consumption, paper use, fuel use and gas consumption. The coefficient of *Green Operations* is positive and significant at the 1% level.

Panel C explores the relationship between underwriters' environmental performance and carbon information disclosure. Environmental performance is measured using several indicators<sup>12</sup>: savings in standard coal

<sup>&</sup>lt;sup>9</sup> For example, Industrial Bank has been engaged in green credit initiatives since 2006. By 2019, it had extended green financing totaling 2.2 trillion yuan to 19,454 enterprises.

<sup>&</sup>lt;sup>10</sup> For example, Hang Seng Bank launched a paperless office initiative in 2019, leading to an 80% reduction in paper document storage by 2020 compared with pre-project levels.

<sup>&</sup>lt;sup>11</sup> The primary types of bond underwriters are securities firms and banks. When measured by the median, green underwriters are predominantly concentrated among bank underwriters (*Green Banks*).

<sup>&</sup>lt;sup>12</sup> Standard Coal, Saving Water, CO<sub>2</sub>, COD, NH<sub>3</sub>, SO<sub>2</sub> and  $O_{xy}$  are all transformed into their logarithmic values.

Table 4					
Different	dimensional	measures	of	green	underwriters

Dimension	Label	Definition
Green Bond Underwriting	Greenbond-uw	Equal to 1 if the underwriter participates in underwriting green bonds during period $t$ and 0 otherwise
	GB-Number	Logarithm of 1 plus the number of green bonds underwritten by the underwritter in period $t$ (count)
	GB-Amount	Logarithm of 1 plus the size of green bonds underwritten by the underwriter in period $t$ (in billions of RMB)
Green Bond Issuance	Greenbond-iu	Equal to 1 if the underwriter issues green bonds in period $t$ and 0 otherwise
Green Loan	Green Loan	Logarithm of 1 plus the size of green loans originated by bank underwriters (in billions of RMB)
Green Operations	Water Consumption Per	Underwriter office per capita water consumption (tonnes/person)
	Power Consumption Per	Underwriter office per capita electricity consumption (kWh/person)
	Paper Consumption Per	Underwriter office per capita paper consumption (10,000 sheets/person)
	Gas Consumption Per	Underwriter office per capita gas consumption (cubic meters/person)
	Vehicles Fuel Per	Underwriter office per capita vehicle fuel consumption (liters/person)
Environmental Performance	Standard Coal	Logarithm of 1 plus standard coal saved by the underwriters' issuance of green loans or bonds (10,000 tonnes)
	Saving Water	Logarithm of 1 plus the water saved by underwriters' issuance of green loans or green bonds (10,000 tonnes)
	<i>CO</i> <sub>2</sub>	Logarithm of 1 plus the carbon dioxide-equivalent emission reduction due to underwriters' issuance of green loans or green bonds (10,000 tonnes)
	COD	Logarithm of 1 plus the reduction of chemical oxygen demand due to underwriters' issuance of green loans or green bonds (in tonnes)
	NH <sub>3</sub>	Logarithm of 1 plus the emission reduction of ammonia nitrogen (in tonnes) due to the underwriters' issuance of green loans or bonds
	$SO_2$	Logarithm of 1 plus the emission reduction of sulfur dioxide (in tonnes) due to the underwriters' issuance of green loans or green house.
	$O_{xy}$	Logarithm of 1 plus the emission reduction of nitrogen oxides due to underwriters' issuance of green loans or green bonds (10,000 tonnes)
	Exposure	Environmental benefits per unit of capital due to underwriters' issuance of green loans or green bonds

(*Standard Coal*) and water (*Saving Water*), reductions in CO<sub>2</sub> emissions (*CO*<sub>2</sub>), chemical oxygen demand (*COD*), ammonia nitrogen (*NH*<sub>3</sub>), sulfur dioxide (*SO*<sub>2</sub>) and nitrogen oxides ( $O_{xy}$ ), and environmental benefits per unit of funding (*Exposure*). The regression results indicate that the coefficients of *Standard Coal*, *Saving Water*, *CO*<sub>2</sub>, *COD*, *NH*<sub>3</sub>, *SO*<sub>2</sub> and *O*<sub>xy</sub> are all positive and significant at the 1 % level, while *Exposure* is significant at the 10 % level. These findings suggest that underwriters with better environmental performance are more likely to promote carbon disclosure by bond issuers.

Second, we use four alternative measures of carbon information disclosure. (1) We use *People's Daily* as a training library to construct the target set and recalculate the degree of carbon disclosure ( $CIE_{paper}$ ). (2) We use financial news as a training library to construct the target set and recalculate the degree of carbon disclosure ( $CIE_{news}$ ). (3) We use Baidu Encyclopedia as a training library to construct the target set and recalculate the degree of carbon disclosure ( $CIE_{news}$ ). (3) We use Baidu Encyclopedia as a training library to construct the target set and recalculate the degree of carbon disclosure ( $CIE_{baidu}$ ). (4) To mitigate the noise inherent in unsupervised learning, we adopt the approach proposed by Li et al. (2024) to construct a carbon information dictionary. Specifically, we compile a list of 100 vocabulary terms related to carbon information (e.g., carbon emissions, carbon trading, carbon dioxide, methane, renewable energy) from sources such as the "Green Bond Support Project Catalog (2021 Edition)," the "Second Biennial Update Report on Climate Change in the People's Republic of China" research reports on capital usage, carbon emission trading platforms, bond prospectuses and conference proceedings from the first Carbon Neutrality Conference. Finally, we calculate the ratio of the frequency of carbon information vocabulary to the total number of characters in bond prospectuses, multiplied by 100, resulting in a measure called  $CIE_{dic}$ . The results in Panel D indicate that the coefficient of *GUW* remains consistently positive and statistically significant at the 1% level, regardless of the method of measuring carbon disclosure. These findings support the robustness of the conclusions of this study.

# Table 5 Robustness tests.

Panel A Alternatio	ve measures for	green underw	riters: in general	1				
Variable	ve measures for	CIE	inters. in general					
, una che		(1)		(2)		(3)		(4)
GUW		0.0476**						
Cucou hauk		(2.77)		0.0920***				
Green bank				(2.73)				
$GUW_{half}$						0.0161* (1.83)		
Green bank <sub>half</sub>								0.0734 <sup>***</sup> (3.19)
Controls		Yes		Yes		Yes		Yes
Year		Yes		Yes		Yes		Yes
Industry		Yes		Yes		Yes		Yes
Agency		Yes		Yes		Yes		Yes
Underwriting		Yes		Yes		No		Yes
adj. $R^2$		0.4270		0.4274		0.4153		0.4277
N		11,322		11,322		11,322		11,322
Panel B Alternativ	ve measures for	green underwr	iters: by divisio	n				
Variable	CIE							
	(1) Green Bo	nd Issuance	(2) Green Bond	(3) Underwriting	(4)	(5) Green Loan	(6) Gree	n Operations
Greenbond-iu		0.0158**** (4.80)						
Greenbond-uw		()	0.1295 <sup>***</sup> (5.90)					
GB-Number				0.0336**** (7.78)				
GB-Amount					0.0213 <sup>***</sup> (8.48)			
Green Loan					· · ·	0.0030****		
Green Operations						(5.10)		0.0029***
Controls	Ves		Ves	Ves	Ves	Ves	Ves	(3.55)
Year	Ves		Ves	Ves	Ves	Ves	Ves	
Industry	Yes		Yes	Yes	Yes	Yes	Yes	
Agency	Yes		Yes	Yes	Yes	Yes	Yes	
Underwriting	No		Yes	Yes	Yes	No	No	
Issuer	Yes		No	No	No	Yes	No	
adi. $R^2$		0.9623	0.4325	0 4317	0 4321	0 9629		0 4152
N		11,193	11,322	11,322	11,322	11,322		11,322
Panel C Environm	nental benefits a	and carbon info	ormation disclos	sure				
Variable	CIE							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Standard Coal	0.0032***							

Sianaara Coai	0.0032		
	(3.87)		
Saving Water	× /	0.0023***	
		(3.60)	
$CO_2$			$0.0028^{***}$
			(3.85)

(continued on next page)

Table 5 (continued)

Panel C Enviror	nmental benefits	and carbon info	ormation disclo	sure				
Variable COD NH <sub>3</sub>	CIE							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
COD				$0.0034^{***}$				
NH <sub>3</sub>				(3.41)	0.0071***			
$SO_2$					(2.74)	0.0029***		
$O_{xy}$						(2.00)	$0.0024^{**}$	
Exposure							(2.10)	0.0026*
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Agency	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
adj. R <sup>2</sup>	0.9628	0.9627	0.9628	0.9626	0.9626	0.9626	0.9625	0.9626
N	11,328	11,328	11,328	11,328	11,328	11,328	11,328	11,322
Panel D Alterna	tive measures fo	or carbon inform	nation disclosur	re				
Variable		CIE <sub>paper</sub>		CIE <sub>news</sub>		CIEbaidu		$CIE_{dic}$
		(1)		(2)		(3)		(4)
GUW		0.0621***		$0.0600^{***}$		0.0203**		0.0302***
		(4.14)		(4.04)		(2.79)		(3.75)
Controls		Yes		Yes		Yes		Yes
Year		Yes		Yes		Yes		Yes
Industry		Yes		Yes		Y es		Yes
Agency Underwriting		Yes		Yes		Yes		Yes
2								
adj. $R^2$		0.4730		0.4711		0.4503		0.4199
N		11,322		11,322		11,322		11,322
Panel E Exogen	ous shocks and	IV method						
Variable			CIE					
			(1)		(2)			(3)
$GUW_{fl}$			0.0381	**				
GUW			(2.46	5)	0.01	60**		
00111					(2	.09)		
GUW						,		0.5781***
								(2.93)
Controls			Yes		Yes			Yes
Year			Yes		Yes			Yes
Industry			Yes		Yes			Yes
Agency			Yes		Yes			Yes
Underwriting			Yes		Yes			Yes
Kleibergen–Paaj	prk LM		-		-			80.898
Kleibergen-Paaj	prk Wald F		-		_			88.006
Stock-Yogo bia	s critical value		_		_			16.38 (10%)
adj. <i>R</i> <sup>2</sup>			0.415	59	0.4	153		0.1398
N			11,32	22	11.	,322		6,997

Table 5 (continued)

Panel F Sample matching					
Variable	CIE	CIE			
	(1) PSM	(2) CEM			
GUW	0.0620* (2.14)	0.1213 <sup>***</sup> (2.60)			
Controls	Yes	Yes			
Year	Yes	Yes			
Industry	Yes	Yes			
Agency	Yes	Yes			
Underwriting	Yes	Yes			
adj. $R^2$	0.4828	0.5088			
N	3,366	4,794			

Panel G Other robustness tests

Variable	CIE				
-	(1)	(2)	(3)	(4)	(5)
	Heckman	Different fixed effects	Excluding other sources of information	Placebo test	
GUW	$0.0886^{**}$	$0.0447^{**}$	0.0119*	0.0307**	
	(2.26)	(2.51)	(1.68)	(2.35)	
G-Random					-0.0048
					(-0.85)
IMR	-0.0679				
	(-0.26)				
Controls	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	No	No	Yes
Agency	Yes	Yes	No	No	Yes
Underwriting	Yes	Yes	Yes	Yes	Yes
Province	No	Yes	No	No	No
Issuer	No	No	Yes	Yes	No
Year×Issuer	No	No	No	Yes	No
adj. $R^2$	0.4298	0.4464	0.9658	0.9801	0.4265
Ň	11 322	11 322	9.854	9 8 5 4	11 322

Notes: This table presents several robustness tests, including alternative measures of green underwriters, alternative measures of carbon information disclosure, a difference-in-differences analysis, an instrumental variable method, sample matching, the Heckman two-step model, different fixed effects, the exclusion of other information sources and a placebo test. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee*. The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Third, we address potential endogeneity concerns by considering the possibility that unobservable firm characteristics may simultaneously influence both underwriters' green characteristics and issuers' carbon disclosure practices, leading to omitted variable bias. To address this, first, we exploit an exogenous shock—when an underwriter is classified as a green underwriter for the first time—to alleviate endogeneity. This classification provides an external event that may influence the carbon information disclosure of general bond issuers. For instance, the increased market attention on green underwriters may enhance the credibility and attractiveness of their general bond issuances. Specifically, we define two indicators:  $GUW_{fl}$  equals 1 if an underwriter issues its first green bond in year t and 0 otherwise, while  $GUW_{f2}$  equals 1 if an underwriter underwrites its first green bond in year t and 0 otherwise. Panel E of Table 5 reports the results. In Columns (1) and (2), the coefficients of  $GUW_{f1}$  and  $GUW_{f2}$  are both negative and statistically significant at the 5 % level, indicating that the first-time classification as a green underwriter prompts issuers to disclose more carbon information.

Next, we employ an instrumental variable (IV) approach to identify the causal effect of green underwriters on carbon disclosure. Specifically, we leverage the release of the *Notice on Strengthening the Supervision of Green Financial Bonds During Their Duration* ("the Notice") by the People's Bank of China in 2018.<sup>13</sup> The Notice provides clear guidelines for financial institutions regarding the authenticity of green project funding, compliance with decision-making procedures and the achievement of environmental benefits. This policy increases the issuance and underwriting of green bonds but is unrelated to the issuance or disclosure practices of general bonds, making it a valid instrument. We construct the IV by identifying whether underwriters issued or underwrote green financial bonds after 2018 and limit the sample to one year before and after the policy implementation. Panel E of Table 5, Column (3), presents the second-stage IV regression results. The coefficient of *GUW* is 0.5781 and is statistically significant at the 1 % level, exceeding the OLS estimate of 0.0878 in Table 3, Column (2). This result reinforces the causal relationship between green underwriters and carbon information disclosure.

To further mitigate noise in carbon disclosure and ensure comparability between the treatment and control groups, we apply matching methods to construct a balanced sample. We use propensity score matching (PSM) to match issuers with green underwriters to a control group using a 1:1 nearest neighbor matching algorithm. Covariates include firm size (*Size*), capital structure (*Lev*) and return on equity (*ROE*). Panel F of Table 5, Column (1), shows the regression results for the matched sample. The coefficient of *GUW* remains positive and significant, indicating that green underwriters continue to promote carbon disclosure, supporting H1.

Recognizing the limitations of PSM, where covariate balance may be incomplete, we also use the coarsened exact matching (CEM) method, which does not require balance checks and is less model-dependent (Connelly et al., 2017). Using criteria such as size, leverage and profitability, we construct a matched control group. Panel F, Column (2), reports the results for the CEM-matched sample. The findings are consistent with those in Table 3, suggesting that differences in bond and firm characteristics between the treatment and control groups do not drive the main results, further confirming their robustness.

Four, firms with higher environmental performance, profitability or specific capital structures may be more likely to select green underwriters. For instance, issuers with higher ESG ratings may prefer green underwriters due to their alignment with sustainability objectives. To address this self-selection issue, we employ the Heckman two-step model. Panel G, Column (1), presents the results from the second stage of the Heckman model. The coefficient of GUW is positive and significant at the 1 % level, indicating that after accounting for potential self-selection bias, the results remain robust. This finding confirms the positive role of green underwriters in promoting carbon information disclosure.

Five, regional factors may also influence issuers' carbon disclosure levels, as provincial differences in regulations, economic development and environmental priorities can vary significantly. To account for this, we include provincial fixed effects in the model to mitigate potential regional bias. Panel G, Column (2), reports the results with provincial fixed effects. The coefficient of GUW remains positive and statistically significant, indicating that the impact of green underwriters on carbon disclosure is robust to the inclusion of regional controls.

Six, carbon information disclosed in bond prospectuses may overlap with disclosures in other corporate reports, such as annual or sustainability reports, potentially diminishing the unique informational value of the prospectus. To address this issue, we restrict the sample to bonds issued by the same firm within the same year, ensuring consistency in alternative information sources across bonds. Furthermore, we incorporate firm fixed effects and firm year interaction fixed effects into the model to account for unobservable factors that may influence carbon disclosure at the firm level. Panel G, Columns (3) and (4), presents the results. The coefficient of GUW remains positive and statistically significant, indicating that green underwriters actively promote carbon information disclosure in bond prospectuses, even after controlling for other potential sources of carbon information.

<sup>&</sup>lt;sup>13</sup> https://www.pbc.gov.cn/zhengwugongkai/4081330/4406346/4693545/4085514/index.html.

Finally, to further ensure that the findings are not driven by unobservable time-varying factors, we conduct a placebo test by randomly assigning green underwriters to bond issuers. Panel G, Column (5), reports the results of the placebo test. The coefficient of *G*-*Random* is -0.0048 and statistically nonsignificant, indicating that the impact of green underwriters is not driven by random assignment. This confirms that the observed impact of green underwriters on carbon disclosure is genuine and not attributable to chance.

# 4.4. Channel tests

# 4.4.1. Information effect

#### (1) Information transmission

Bajo et al. (2016) demonstrate that underwriters act as informational intermediaries during IPOs, facilitating the dissemination of information about the issuing firm to investors while extracting valuable feedback from institutional investors. Similarly, green underwriters in the bond market fulfill dual roles of information dissemination and information extraction.

Green underwriters can attract greater investor attention to the bonds they underwrite, thereby effectively disseminating carbon information disclosed by bond issuers. This process helps mitigate information asymmetry between issuers and investors. To test this channel, we measure information asymmetry using information transparency (*Transparency*), which is based on the ChinaBond ESG evaluation methodology. This metric assesses the timeliness, reliability and completeness of information disclosure. Column (1) of Table 6 presents the results. The coefficient of GUW is positive and significant at the 5 % level, indicating that green underwriters improve the transparency of bond issuers' information disclosures. This finding supports the hypothesis that green underwriters enhance information dissemination, reducing information asymmetry between bond issuers and investors.

Simultaneously, green underwriters also can extract meaningful insights from institutional investors, such as incorporating private information about how disclosed carbon information affects bond valuation. For example, Chen et al. (2020) find that during periods of stronger ESG demand, fund managers are more likely to hold stocks with high ESG performance to cater to investor preferences. Similarly, green underwriters can leverage their knowledge of investors' green investment preferences to encourage issuers to disclose more carbon information, aligning with investor demand. To test this hypothesis, we estimate periods of high ESG demand following the methods of Naughton et al. (2019) and Chen et al. (2020). First, we use ESG as the dependent variable in a regression with firm characteristics (e.g., asset size, leverage, profitability, revenue growth, turnover, cash holdings, fixed assets and ownership type) as explanatory variables, controlling for time trends and industry fixed effects. Second, we compute the residuals from the regression as abnormal ESG. Third, we rank all bonds annually by abnormal ESG and calculate the difference in secondary bond credit spreads between the top and bottom quintiles, defining this spread as the market-level ESG premium. Finally, we split the sample at the median into periods of high ESG demand (ESG demand) and low ESG demand. Column (2) of Table 6 presents the results of the interaction term  $GUW \times ESG$  demand. The coefficient is positive and significant at the 5% level, indicating that during periods of high ESG demand, green underwriters encourage issuers to disclose more carbon information. This finding highlights the information extraction role of green underwriters, whereby they respond to investor preferences by promoting greater carbon disclosure.

# (2) Policy perception

As a critical bridge between bond issuers and investors, green underwriters can effectively transmit the latest low-carbon policy updates from government departments to bond issuers. This policy sensitivity enables issuers to better understand and adapt to the evolving low-carbon regulatory environment. Moreover, green underwriters can guide issuers to disclose carbon information strategically, boosting investor confidence. For instance, when underwriters perceive favorable low-carbon policies, they may encourage issuers to disclose more carbon-related information to gain market recognition.

Variable	Transparency	CIE
	Information dissemination (1)	Information extraction (2)
GUW	0.2028**	0.0839**
	(2.14)	(2.10)
ESG demand		0.0011
		(0.21)
GUW  imes ESG demand		$0.0904^{**}$
		(2.32)
Controls	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
Agency	Yes	Yes
Underwriting	Yes	Yes
adj. $R^2$	0.2733	0.4297
N	11,322	11,322

10010 0			
Information	effects	of green	underwriters.

Table 6

Notes: This table reports the information effects of green underwriters, including information dissemination and information extraction. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee.* The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

To examine this channel, we introduce an interaction term between GUW and local government green policy intensity (*Policy*) into Model (1). *Policy* is measured as the natural logarithm of the number of green finance policies issued by municipal governments, with a higher value indicating more comprehensive green infrastructure and stronger support for green development. Table 7 presents the regression results. Column (1) shows that the coefficient of  $GUW \times Policy$  is positive and significant at the 5% level. This finding indicates that green underwriters enhance issuers' understanding of low-carbon policies, enabling issuers to align their carbon disclosure with the current policy environment.

Green underwriters also assist issuers in interpreting key low-carbon policies, helping them understand regional low-carbon priorities and market dynamics. Drawing on the approach used by SynTao Green Finance, we classify low-carbon policies into four categories based on their incentive mechanisms. Convenience policies ( $Policy_1$ ) offer operational facilitation, such as establishing green channels. Policy signals (Pol $icy_2$ ) provide general guidelines or signaling support for green finance. Administrative details (*Policy*<sub>3</sub>) specify implementation departments or detailed execution methods. Financial incentives ( $Policy_4$ ) offer subsidies or financial rewards to enterprises or individuals. Columns (2)–(5) of Table 7 report the results for each policy type. The coefficient of  $GUW \times Policy_I$  in Column (2) is positive and significant at the 1 % level, suggesting that green underwriters are particularly responsive to facilitative policies, encouraging issuers to disclose more carbon information. The coefficient of  $GUW \times Policy_2$  in Column (3) is positive and significant at the 10 % level, indicating that policy signals from the government also motivate issuers to enhance their carbon disclosure. The coefficient of  $GUW \times Policy_3$  in Column (4) is positive and significant at the 10 % level, demonstrating the importance of administrative detail policies in driving issuers' carbon disclosure through green underwriters. However, the coefficient of  $GUW \times Policy_4$  in Column (5) is negative (-0.0244) and statistically nonsignificant, suggesting that green underwriters' sensitivity to financial incentive policies has a limited effect on carbon information disclosure.

Variable	CIE				
	(1)	(2)	(3)	(4)	(5)
GUW	0.0797	0.0818	0.0703	0.0709	0.0919**
	(1.50)	(1.49)	(1.35)	(1.36)	(2.30)
Policy	0.0025				
	(0.11)				
$GUW \times Policy$	0.0970**				
	(2.33)				
Policy <sub>1</sub>	. ,	0.0932			
		(1.62)			
$GUW \times Policy_1$		$0.1907^{***}$			
		(2.78)			
Policy <sub>2</sub>			-0.0220		
			(-1.44)		
$GUW \times Policy_2$			0.0737*		
, 2			(1.83)		
Policy <sub>3</sub>				-0.0210	
				(-1.40)	
$GUW \times Policy_3$				0.0741*	
22				(1.83)	
<i>Policv</i> ₄					0.2475
24					(1.62)
$GUW \times Policy_4$					-0.0244
					(-1.12)
Controls		Yes	Yes	Yes	Yes
Year		Yes	Yes	Yes	Yes
Industry		Yes	Yes	Yes	Yes
Agency		Yes	Yes	Yes	Yes
Underwriting		Yes	Yes	Yes	Yes
adj. <i>R</i> <sup>2</sup>		0.4306	0.4297	0.4296	0.4302
N		11,322	11,322	11,322	11,322

Table	7			
Policy	perceptions	of	green	underwriters.

Notes: This table reports the policy sensitivity effects of green underwriters. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee.* The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

#### 4.4.2. Monitoring effect

As outlined in the theoretical framework, green underwriters play a critical monitoring role by encouraging bond issuers to disclose more carbon information. Carrizosa and Ryan (2017) find that when borrowers face higher credit risk or uncertainty, loan contracts are more likely to include clauses allowing banks to access private information. Similarly, in uncertain environments, green underwriters are more likely to monitor issuers and promote greater carbon disclosure. We examine three scenarios of uncertainty to test the supervisory role of green underwriters. Policy uncertainty is measured using the China Policy Uncertainty Index developed by Davis et al. (2019), based on newspaper articles from *People's Daily* and *Guangming Daily*. Values above the median are used as a proxy for high policy uncertainty (*EPU*). Credit risk is proxied by the Altman Z-score, with firms below the median Z-score categorized as high-risk issuers (*Z-high*). Environmental risk is proxied by whether an issuer faced environmental penalties (*E-penalty*) before the bond issuance.

Variable	CIE				
	(1)	(2)	(3)		
GUW	0.0856**	0.0251	0.0630***		
	(2.44)	(1.11)	(3.28)		
EPU	-0.0017		()		
	(-0.16)				
$GUW \times EPU$	0.0868**				
	(2.09)				
7-high	(2.0))	0.0242***			
Z-mgn		(3.42)			
$GUW \times \mathbf{Z}$ high		(3.+2) 0.1245***			
$GOW \times Z$ -nign		(3.56)			
Enoughty		(3.30)	0.0100		
E-penaliy <sub>t-1</sub>			-0.0100		
CUW X E nonaltu			(-0.07)		
$GUW \times E$ -penalty <sub>t-1</sub>			(1.02)		
$C \rightarrow 1$	X7	X	(1.93)		
Controls	Yes	Yes	Yes		
Year	Yes	Yes	Yes		
Industry	Yes	Yes	Yes		
Agency	Yes	Yes	Yes		
Underwriting	Yes	Yes	Yes		
adj. <i>R</i> <sup>2</sup>	0.4297	0.4387	0.4183		
N	11,322	11,322	8,439		

Table 8				
Monitoring	effects	of	green	underwriters.

Notes: This table reports the monitoring effects of green underwriters. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee*. The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 8 reports the regression results for these three uncertainty scenarios. In Column (1), the coefficient of  $GUW \times EPU$  is positive and significant, indicating that green underwriters enhance carbon information disclosure in periods of high macroeconomic policy uncertainty. In Column (2), the coefficient of  $GUW \times Z$ -high is positive and significant, suggesting that green underwriters promote greater carbon disclosure for issuers with higher credit risk. In Column (3), the coefficient of  $GUW \times E$ -penalty is positive and significant, demonstrating that green underwriters play a critical role in encouraging carbon disclosure for issuers with prior environmental violations.

### 4.5. Cross-sectional analyses

### 4.5.1. Underwriter relationships

Research suggests that firms leverage relationships with banks to navigate financial difficulties while maintaining high levels of investment and employment (Banerjee et al., 2021; Murro and Peruzzi, 2022). Similarly, Dick-Nielsen et al. (2021) find that bond issuers can reduce issuance costs by using existing relationships with underwriters. Houston and Shan (2022) demonstrate that banking relationships facilitate the implementation of ESG policies. Banks are more likely to lend to firms with ESG practices like their own, and this alignment generates long-term positive impacts on borrowers' ESG performance. Banks, concerned about reputational risks, often pressure firms with poor ESG performance to improve, as such firms may face higher risks that could harm the bank's social capital. In the bond market, underwriters serve as both monitors and promoters (Ma et al., 2019). Building on this literature, we hypothesize that closer relationships with green underwriters result in issuers disclosing more carbon information.

21
21

Variable	CIE				
	(1)	(2)	(3)		
GUW	0.0563	-0.0166	0.0964***		
	(1.38)	(-0.66)	(2.62)		
Relation	0.0109				
	(1.30)				
$GUW \times Relation$	0.1112****				
	(2.89)				
Pollution		0.1348*			
		(1.91)			
$GUW \times Pollution$		0.0946**			
		(1.98)			
Environmentally			0.1685***		
			(6.08)		
$GUW \times Environmentally$			0.2259***		
			(2.77)		
Controls	Yes	Yes	Yes		
Year	Yes	Yes	Yes		
Industry	Yes	Yes	Yes		
Agency	Yes	Yes	Yes		
Underwriting	Yes	Yes	Yes		
adj. $R^2$	0.4309	0.4360	0.4533		
N	11,322	11,322	11,322		

Notes: This table presents regression results examining how the effect of green underwriters on carbon information disclosure varies with underwriter relationships, high-carbon firms and environmentally friendly firms. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee.* The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

To test this hypothesis, we introduce an interaction term between GUW and the strength of the relationship between the issuer and the underwriter (*Relation*) into Model (1). Following Dick-Nielsen et al. (2021), we define the relationship variable, *Relation*, as a dummy variable that takes a value of 1 if the underwriter for a newly issued bond has also underwritten other outstanding bonds from the same issuer and 0 otherwise. Table 9, Column (1), reports the regression results. The coefficient of  $GUW \times Relation$  is positive and statistically significant at the 1 % level, indicating that the positive impact of green underwriters on issuers' carbon information disclosure is more pronounced when the relationship between the issuer and the underwriter is stronger.

#### 4.5.2. Environmental performance

Studies indicate that carbon information disclosure varies across firms with different environmental profiles (Wu et al., 2022). According to legitimacy theory, high-carbon issuers disclose more carbon information to enhance their legitimacy and demonstrate social responsibility to investors. Given the information asymmetry between issuers and investors, green underwriters can encourage high-carbon issuers to disclose additional carbon information to improve their legitimacy, thereby influencing investors' decisions (Cho and Patten, 2007).

For environmentally friendly issuers, carbon disclosure serves different purposes. These firms disclose more carbon information to build a positive corporate image, creating intangible assets that enhance their competitiveness. Moreover, to mitigate adverse selection among stakeholders, environmentally friendly firms voluntarily disclose more carbon information. Green underwriters can assist these firms by encouraging disclosures that differentiate them from less environmentally responsible firms, thereby increasing transparency and attracting investor interest (Clarkson et al., 2008). To examine whether green underwriters tailor their recommendations based on firms' environmental performance, we follow the approach of Wu et al. (2022) to classify firms into two categories based on their environmental profiles. High-carbon firm (*Pollution*) is defined as a dummy variable equal to 1 if the issuer operates in one of the 16 highly polluting industries (e.g., thermal power, pulp and paper manufacturing, fermentation), as specified in the Directory of Environmental Verification and Management by Industry for Listed Companies. Environmentally friendly firm (*Environmentally*) is defined as a dummy variable equal to 1 if the issuer's primary business aligns with one of the six key sectors outlined in the Green Industry Guiding Catalogue (2019 Edition), such as energy conservation, clean energy and ecological environment industries. Table 9 presents the results of the cross-sectional analyses based on firms' environmental characteristics. In Column (2), the coefficient of *GUW* × *Pollution* is positive and significant at the 5 % level. This suggests that green underwriters actively encourage high-carbon firms to disclose more carbon information, addressing information asymmetry and enhancing legitimacy. In Column (3), the coefficient of *GUW* × *Environmentally* friendly firms disclose more carbon information to attract investor interest and build a positive corporate image.

#### 5. Additional analyses

#### 5.1. Discussion of collusion

#### 5.1.1. Risk information disclosure

The literature on the independence of underwriters presents mixed findings. Early empirical studies focusing on China's capital markets reveal a lack of underwriter independence, with evidence of collusion between underwriters and issuers (Guo et al., 2011; Liu and Wang, 2015). However, as the CSRC has strengthened its oversight and penalties for underwriters, reputational effects have gradually emerged (Lin et al., 2019). For instance, Chen and Song (2018) use exogenous penalty events to demonstrate the existence of reputation concerns among underwriters. In general, high-reputation underwriters are incentivized to safeguard their reputation and avoid potential penalties by conducting stricter monitoring of issuers and improving the quality of information disclosure (Chang et al., 2010; Erhemjamts and Raman, 2012). As bond prospectuses are primarily drafted by underwriters, issuers working with high-reputation underwriters tend to have more accurate risk information disclosures that better predict bond default risk (Wu and Tang, 2021). However, risk information disclosure inherently carries negative connotations and uncertainties, potentially creating opportunities for collusion. Underwriters may assist issuers in concealing risk information to protect the issuer's market perception. Thus, the behavior of green underwriters prioritize their reputation or engage in collusion with issuers.

To test this hypothesis, we follow the approach of Hope et al. (2016) and use Named Entity Recognition (NER) to measure risk information disclosure (*Disclosure*). Specifically, we calculate the proportion of seven NER categories—person names, organization names, location names, time, dates, currencies and percentages—relative to the total word count in the risk section of the bond prospectus. Table 10, Column (1), reports the results of the regression analysis. The coefficient of *GUW* is positive and statistically significant at the 1 % level, indicating that green underwriters emphasize their reputation by encouraging issuers to disclose more risk-related information. This finding suggests that green underwriters are not driven by motives of collusion but rather aim to enhance the transparency and credibility of the bond issuance process.

#### 5.1.2. Green behavior

While studies suggest that carbon disclosure can lead to behavioral changes, the motivations and outcomes of such disclosures remain debated. For instance, Downar et al. (2021) find that firms disclosing carbon information often alter their production models and adopt more carbon-reduction measures. However, Briscoe-Tran (2021) argues that some firms disclose ESG policies primarily to enhance their public image without taking meaningful actions to improve their ESG practices. Nevertheless, financial intermediaries, such as banks,

Variable	Disclosure	<i>Env</i> - <i>Products</i> <sub><math>t+1</math></sub>	Re-wastes <sub>t+1</sub>	G-invention <sub>t+1</sub>	G-patent <sub>t+1</sub>
	(1)	(2)	(3)	(4)	(5)
GUW	0.0052**	0.1475***	0.1135**	0.0782	0.3132**
	(2.36)	(3.46)	(2.41)	(0.35)	(2.95)
Controls	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Agency	Yes	Yes	Yes	Yes	Yes
Underwriting	Yes	Yes	Yes	Yes	Yes
adj. R <sup>2</sup>	0.4864	0.3290	0.3037	0.3232	0.3316
N	11,285	8,718	8,718	8,718	8,718

Table 10 Exclusion of collusion.

Notes: This table reports results that rule out the possibility of collusion between green underwriters and bond issuers. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee*. The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\* \*\*, and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

can pressure firms to improve their ESG performance to mitigate reputational risks associated with lending to ESG laggards. Houston and Shan (2022) find that banks lending to firms with similar ESG values have a long-term positive impact on borrowers' ESG performance. By analogy, green underwriters may not only encourage issuers to disclose more carbon information but also monitor and influence their subsequent environmental practices.

To test this hypothesis, we examine the influence of green underwriters on issuers' green behaviors from two dimensions: environmental behaviors and green innovation. Following Wu et al. (2022), we measure issuers' environmental behaviors using two indicators. Environmentally beneficial products (*Env-Products*<sub>t+1</sub>) refer to whether the issuer develops or adopts environmentally beneficial innovative products, equipment or technologies in the following period. Waste reduction measures (*Re-wastes*<sub>t+1</sub>) refer to whether the issuer implements policies, measures or technologies to reduce emissions of waste gas, wastewater, solid waste or GHGs in the following period. Table 10, Columns (2) and (3), presents the results. In Column (2), the coefficient of *GUW* is positive and statistically significant at the 1 % level, indicating that green underwriters significantly promote the adoption of environmentally beneficial products. In Column (3), the coefficient of *GUW* is positive and statistically significant at the 5 % level, suggesting that green underwriters encourage issuers to implement waste reduction measures. These findings highlight the monitoring role of green underwriters in fostering issuers' environmental behaviors, further refuting the possibility of collusion between green underwriters and issuers.

To measure green innovation, we follow Zhang et al. (2019). The variable for green invention patents (G-invention<sub>t+1</sub>) relates to the number of green invention patent applications filed by the issuer in the subsequent period. The variable for green patent grants (G-patent<sub>t+1</sub>) relates to the number of green patents granted to the issuer in the subsequent period. Table 10, Columns (4) and (5), reports the results. In Column (4), the coefficient of GUW is positive (0.0782) but not statistically significant, indicating that green underwriters have a limited impact on issuers' green invention patent applications. In Column (5), the coefficient of GUW is positive and statistically significant at the 5% level, suggesting that green underwriters positively influence the number of green patents granted to issuers.

#### 5.2. Cost of bond financing

The voluntary disclosure of carbon information by bond issuers remains an intriguing question. Studies suggest that underwriters can mitigate information asymmetry between issuers and bond investors by leverag-

ing their information-gathering capabilities, thereby reducing bond financing costs (Bajo et al., 2016; Wang and Gao, 2017). Notably, socially responsible underwriters have a stronger negative impact on bond costs (Zhu and Zhang, 2021). Similarly, if the reputation of green underwriters is recognized by the market, they can further reduce bond financing costs. Investors increasingly incorporate green information into their portfolios, but given that bond investors do not directly participate in the production or operations of issuers, accessing carbon information often involves proprietary costs. Green underwriters, with their expertise in green finance, encourage issuers to disclose carbon information, alleviating information asymmetry with investors and thereby lowering financing costs.

To explore this hypothesis, we examine three aspects: bond credit spreads, investor subscription multiples and issuance fees. Bond credit spreads are used as a proxy for financing costs, measured as the difference between bond coupon rates and yields on government bonds with equivalent maturities, following Wu et al. (2022). The sample is divided based on the median of carbon information disclosure, with *CIE-M* coded as 1 for bonds with above-median carbon disclosure and 0 otherwise. Table 11, Column (1), presents the results, showing that the coefficient of  $GUW \times CIE-M$  is negative and statistically significant at the 1 % level, indicating that green underwriters alleviate investor concerns about carbon disclosure and reduce bond financing costs. Investor preferences for bonds underwritten by green underwriters are also examined. If investors value the efforts of green underwriters in promoting carbon disclosure, they are likely to subscribe to a higher proportion of the bonds they underwrite (*Buy*). Column (2) of Table 11 shows that the coefficient of *GUW*  $\times$ *CIE-M* is positive and significant at the 1 % level, suggesting that investors are more willing to purchase bonds underwritten by green underwriters. Finally, we investigate the impact of green underwriters on bond issuance fees (*Issuance-fee*). Column (3) of Table 11 reveals that the coefficient of *GUW*  $\times$  *CIE-M* is negative and significant at the 1 % level, demonstrating that green underwriters, leveraging their reputation, help issuers reduce overall issuance fees.

Variable	CS	Buy	Issuance-fee
	(1)	(2)	(3)
GUW	0.1550*	0.1277*	-0.0529***
CIE-M	(1.93) $0.0635^{***}$	(1.90) $0.0369^{**}$	(-3.31) 0.0177 <sup>***</sup>
$GUW \times CIE-M$	(2.70) $-0.2572^{***}$	(2.00) 0.2053***	$(4.32) \\ -0.0415^{***}$
<i>a</i>	(-3.30)	(3.15)	(-3.30)
Controls	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Agency	Yes	Yes	Yes
Underwriting	Yes	Yes	Yes
adj. $R^2$	0.4049	0.1725	0.4122
N	11,322	11,322	11,322

Table 11					
Green underwriters,	carbon infor	mation disclo	osure and th	ne cost of	bond financing.

Notes: This table reports the effects of green underwriters' promotion of carbon information disclosure on the cost of bond financing, including bond credit spreads, investor subscription multiples and issuance fees. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee*. The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

 Table 12

 Green underwriters, carbon information disclosure and self-interest.

Variable	Rating	Share	ESG Fund	Hold Quantity
	(1)	(2)	(3)	(4)
GUW	0.5692***	0.0021***	0.0634***	0.4472***
	(6.86)	(5.74)	(3.92)	(3.02)
CIE	-0.0609	0.0002	0.0100*	0.0713*
GUW  imes CIE	(-1.38) $0.4790^{***}$	(0.92) $0.0022^{***}$	(1.88) $0.0579^{***}$	(1.83) 0.4295***
	(6.26)	(6.16)	(4.02)	(3.59)
Controls	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Agency	Yes	Yes	Yes	Yes
Underwriting	Yes	Yes	Yes	Yes
adj. $R^2$	0.7277	0.9233	0.8560	0.9240
N	9987	9668	11,322	11,322

Notes: This table reports the effects of green underwriters' promotion of carbon information disclosure on self-interest outcomes, including the underwriter's regulatory rating, market share, whether the green underwriter's stock is held by a green fund and the number of shares held by green funds. The regressions include control variables where specified, namely *Credit Rating, Size, Lev, ROA, Growth, Asset Turnover, Cash, Property, SOE, Opinion, Listed, Maturity, Proceeds* and *Guarantee.* The t-statistics, shown in brackets, are computed using standard errors clustered at the industry level. Definitions of all variables are provided in Table 1. \*\*\*, \*\* and \* indicate statistical significance at the 1%, 5% and 10% levels, respectively.

# 5.3. Based on underwriters' self-interest

Green underwriters may encourage bond issuers to disclose carbon information as a strategy to enhance their reputation and increase their market share. To investigate this hypothesis, we use the underwriter's regulatory rating (*Rating*) and market share (*Share*) as dependent variables. Following Lin et al. (2019), *Rating* is assigned a value of 1 for a C rating and increments upward to 8 for an AA rating. *Share* is calculated as the proportion of total underwriting amounts attributed to the underwriter within the total market underwriting amounts during a specific period (Wu et al., 2022). Table 12, Column (1), presents the regression results with *Rating* as the dependent variable. The coefficient of  $GUW \times CIE$  is positive and significant at the 1 % level, indicating that promoting carbon disclosure positively impacts the regulatory ratings of green underwriters. Column (2) reports the results with *Share* as the dependent variable. The coefficient of  $GUW \times CIE$  is also positive and significant at the 1 % level, suggesting that green underwriters improve their market share by promoting issuers' carbon disclosure. These findings imply that enhancing reputation and expanding market presence may be key motivations for green underwriters to encourage carbon information disclosure.

Furthermore, studies show that ESG-focused institutional investors tend to divest from firms with high ESG risks (Gantchev et al., 2022) and invest in those with high ESG scores (Chen et al., 2022). Similarly, Raghunandan and Rajgopal (2022) find that ESG funds favor firms with high ESG scores and voluntary carbon disclosures. Being held by green funds can generate positive reputational effects, which may motivate green underwriters to attract green fund investments to boost their valuation. To examine the impact of green funds on the holdings of green underwriters, we first identify green funds based on Wind's classification, including ESG-themed funds and carbon–neutral funds. We then use two dependent variables: whether the green underwriter's stock is held by a green fund (*ESG Fund*) and the log-transformed number of shares held by green funds (*Hold Quantity*). Table 12, Column (3), shows the results with *ESG Fund* as the dependent variable. The coefficient of  $GUW \times CIE$  is positive and significant at the 1 % level, indicating that green underwriters promoting carbon disclosure are more likely to have their stocks held by green funds. Column (4),

using *Hold Quantity* as the dependent variable, reveals a similarly positive and significant relationship at the 1 % level, suggesting that green funds increase their holdings of green underwriters' stocks.

# 6. Conclusion

We examine whether green underwriters influence carbon information disclosure by bond issuers, using a sample of Chinese bond issuers from 2009 to 2019. First, we find that green underwriters significantly enhance the level of carbon information disclosure by bond issuers. Economically, a one standard deviation increase in green underwriter activity is associated with a 15.5761 % increase in carbon disclosure. This result remains robust across a series of sensitivity analyses, including alternative variable measurements, a difference-in-differences model and variations in fixed effects. Second, we identify two primary channels through which green underwriters promote carbon disclosure: the information effect and the monitoring effect. Specifically, (1) green underwriters serve as information intermediaries, enhancing transparency and guiding issuers to disclose carbon information in response to rising ESG demands. Moreover, green underwriters demonstrate acute policy sensitivity, encouraging issuers to increase disclosure under facilitative, signaling and regulatory-specific policies. (2) Green underwriters act as monitors, ensuring that issuers disclose carbon information of uncertainty.

Third, cross-sectional analyses indicate that the relationship between green underwriters and issuers, as well as the issuers' environmental performance, strengthens the positive impact of green underwriters on carbon disclosure. Additional tests rule out the possibility of collusion between green underwriters and issuers and show that green underwriters facilitate greater disclosure of risk information. Furthermore, green underwriters motivate issuers to adopt carbon reduction measures, develop environmentally friendly products, implement waste-reduction initiatives and engage in green innovation. Finally, we explore the motivations behind voluntary carbon disclosure by issuers and the role of green underwriters in driving this behavior. The findings suggest that issuers following the recommendations of green underwriters achieve significant reductions in bond financing costs. Meanwhile, green underwriters benefit from increased market share and enhanced recognition by green funds.

Based on the research described above, we propose the following policy recommendations. First, building a high-quality bond market necessitates not only educating and monitoring issuers but also guiding and monitoring intermediaries to ensure service quality and accountability. In particular, the general manager role of underwriters should be reinforced to bridge information gaps, enabling investors to track issuers' progress in green transitions. Second, regulatory authorities can diversify the use of disclosed environmental information to incentivize issuers. Policymakers could explore integrating environmental information into issuer credit evaluation systems and developing verifiable carbon emission data frameworks. For example, linking environmental disclosures with rewards for proactive carbon reduction could encourage greater transparency and sustainability efforts among issuers.

#### **Declaration of competing interests**

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Table A1						
Distribution of underwriters' gre	en finance business	in 2022.				
	China Mercha	ants Securities	Industrial So	ecurities	Industrial and Bank of Chin	Commercial a
Financing business (RMB billion)/ratio	1,456.66	99.07 <i>%</i>	600.00	74.29 %	1,557.13	66.17 %
Asset management business (RMB billion)/ratio	4.01	0.27~%	17.60	2.18 %	3.00	
Equity business (RMB billion)/ratio	3.00	0.19%	60.00	7.43 %		
Fund business (RMB billion)/ratio	6.67	0.45 %	130.00	16.10%	800.00	33.83 %

Tab Car	ole A2 bon inforu	mation glossary.						
Panel	l A Original vo	cabulary						
Sort	Specific voca	bulary						
Opp	新能源 风能	new energy wind energy	可再生能源 太阳能	renewable energy solar energy	新能源汽车 太阳能发电 站	new energy vehicles solar power station	猜狤能源 可持续能源	clean energy sustainable energy
	服中和	carbon neutral	礙达峰	carbon peak	生态工业园	eco-industrial park	太阳能电池	solar battery
	に変遣	carbon assets	嚴捕获	carbon capture	绿色建筑	green building	绿色改造	green transformation
	循环	cycle	ESG	ESG	CSR	ČSR Č	节能环保	energy saving and environmental
					i I		1	protection
	请活生产	clean manufacturing	生态が保	eco-friendly	绿色升级	green upgrade	绿巴服务	green service
	请洁交通 水利茨电设	clean transportation hydropower generation	绿色交通 绿色消费	green transportation green consumption	贴标 转型升级	labeling upgrade	绿色认证 生态保护	green certification ecological protection
	随	facilities		•		)		•
	节能	energy saving	电动汽车	electric car	碳汇	carbon sink	水电站	hydropower station
	风力发电	wind power	工业园区	industrial park	循环经济	circular economy	可再生	renewable
	清洁	clean	能源	energy	可持续	sustainable	生态	ecology
	工业园 绿色生态	industrial area green ecology	环保 变质为宝	environmentally friendly turning waste into treasure	风电	wind power	光伏	photovoltaic
Reg	温室气休	greenhouse gas	@ 个瑞	carbon dioxide	u提/成4非	carbon reduction	品は非内	carbon emissions
0	能源比管	energy regulation	時代	carbon tax	瑞介	carbon price	王不上章林示가住	environmental standards
	二氧化碳排	carbon dioxide emissions	碳排放权交易	carbon emissions trading	生态环境部	Ministry of Ecology and	零排放	zero emissions
	放		市场	market		Environment		
	二氧化硫	sulfur dioxide	绿水青山 537 51	green water and green hills	職 足 逆	carbon footprint	●図	power grid
	京都以定书	Kyoto Protocol	汚染物	pollutants	洗绿	greenwashing	煤炭	coal
	行来仍治	pollution prevention	化石配源	tossil energy	污水処理	sewage treatment	垃圾处理 CTA	waste treatment
	(反動反義) 医血管炎 化	carbon reduction	岐(世路 十 人	carbon leakage	如灰 3 并 刀 X 臼 C 名 M 4 田 イトトキャー ヨー	carbon emission allowances	СЕА 13 <i>4</i> , 13 44 — 14 тя С	CEA
	地议员厂	stranded assets	ЩШ	electricity prices	四半排以重	soot emissions	琢巴喷茶文拜坝日 日泰	catalogue of green bond supported projects
	氮氧化物	NOX	环保政策	environmental policies	玉 王 二	three wastes	「二千日	chemicals
	煤炭价格	coal prices	环保投入	environmental inputs	排污权交易	emissions trading	排放	emissions
	酉己客页	quotas	变暖	warming	温室效应	greenhouse effect	极端	extreme
	减排	emissions reduction	环境税	environmental taxes	燃油税	fuel taxes	魚祿允	low carbonization
Phy	全球变暖	global warming	暴雨	heavy rainfall	大事	heavy snowfall	自然灾害	natural disasters
	林地	woodlands	<b>(海1)肃</b>	tsunamis	∎ H	droughts	旱灾	drought
	洪水	floods	极端天气	extreme weather	极端温度	extreme temperatures	沿海地区	coastal zones
	非常规水资	unconventional water	生态系统	ecosystems	台风	typhoons	森林火灾	forest fires
	刘原	resources						
	MEJA	hurricanes	自然保护地	nature reserves	植液	vegetation	山洋	flash floods
	塌方	landslides	泥石流	mudslides	水资源	water resources	事故灾难	accidental catastrophes
	売 憲	earthquakes	强对流	strong convection	実通	cold tides	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	low temperatures
	ХХ ₩	high winds	参業	sandstorms	7百/万 **#**^	frosts	洋雪	hailstorms
	<b>光街风</b> 戸船定金	olimotic becoude	元渓工品によ	deserts	活法	mudnows	年 王 王	grassiands Acoding
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Table	A2 (continued,							
Panel	B Financial ne	ews expansion words						
Sort	Specific voc	abulary						
Opp	涵养林	Culver forests	风能	wind energy				
Reg	EUETS	EUETS						
Phy	强降雨	heavy rainfall	强降水	heavy precipitation	大到暴雨	heavy to heavy rainfall	洪涝灾害	flooding
	雷雨大风	thunderstorms and gales	风暴潮	storm surges	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Sonca	豪雨	heavy rain
	雷暴雨	thunderstorms	洪済	flooding	渍滼	flooding	抹沃	freezing
	倾盆	dumping	风雹	wind and hail	雨夹雪	rain and snow	降水强度	precipitation intensity
	小到中雨	light to moderate rainfall	伏旱	drought	山洪暴茨	flash floods	甘白	seedling cypresses
	個穴	hailstorms	低洼地区	low-lying areas	汉害	disasters	入梅	entry into the plum blossoms
	訳漢	accumulated floods	普降大雨	heavy rainfall	暴洪	flash floods	秋旱	autumn droughts
	干热风	dry and hot winds	<b>涝情</b>	flooding	困難	fog	小到中雪	light to moderate snow
	水旱灾害	drought and flooding	雨帯	rain bands	號雨	sudden rains	冷暖空气	cold and warm air
	雷雨和	thunderstorms	受淹	flooded	热天气	hot weather	天公不作美	weather
	外河	outer river	凝冻	freezing	强风暴	strong storms	扬沙	sandy
	阴雨连绵	rainy	重旱	heavy drought	春旱	spring drought	初伏	early flooding
	山地气候	mountainous climate	事 次	snowstorms	冻雨	freezing rain	来水多	more water
	气候异常	climate anomalies	灾害性	catastrophic	蝗汉	locusts	厄尔尼诺现象	El Niño phenomenon
	<b></b> 书	pests	地裂	cracks in the ground	热害	heat damage	受灾面积	affected area
	盐碱化	salinization	前震	foreshock	坍方	collapsing	火山地震	volcanic earthquakes
	大洪水	heavy floods	中霜	early frosts	气候干旱	climatic droughts	渍害	impregnation
	阴雨寡照	overcast rain and low sunshine	南诱北旱	flooding in the south and drought in the north	土壤湿度	soil moisture	秋播作物	autumn sowing crops
	于旱区	arid areas	强冷空气	strong cold air	洪水泛滥	flooding	黄河防总	Yellow River defense
	渭河流域	Weihe River Basin	爱灾人口	affected population	溶岩	dissolved rocks	沟壑区	gully areas
	贫瘠化	barrenness	冰川退缩	glacial retreat	清沟	clearing ditches	雨区	rainy areas
	通渠	through ditches	环境灾害	environmental hazards				

Table A2	(continued)							
Panel C 1	People's Daily expan	ision words						
Sort	Specific vocabult	ary						
Opp	氢能 高载能	hydrogen energy high load energy	请狤煤 斓汐能	clean coal tidal energy	再生能源 洁浄媒	renewable energy clean coal	生物质能 地热能	biomass energy geothermal energy
	高能效 ####C	high energy efficiency	海洋能	ocean energy	绿色建材 可声止%%	green building materials	CDM Strong AK	CDM
	殊制气 地热能源	coal-to-gas geothermal energy	吃?5.米 波浪发电	low pollution wave power generation	し 中 一 中 二 次 源 二 二 二 二 二 二 二 二 二 二 二 二 二	renewable resources source heat pump	讽讽睍 电采暖	wave energy electric heating
	二次能源	secondary energy	CCS	ccs	采暖系统	heating system	可再生性	renewable
	燃气炉	gas furnace	晶哇	crystalline silicon	利用装置	utilization device	电锅炉	electric boiler
	IGCC 生物转化	IGCC biology converts	循环性	circulation	循环型	circulation type	清洁化	cleanliness
Bea	日 午午	martansita	点車な	reduction	<b>玄</b> /右住化	sustem ontimization	研治与	אנה מינה
NCS			(原里 I-C	ICUUCIO	775 J.L.I.L.I.L.			ILUC BAS
	环境效应	environmental effects	ODS	ODS	防治亏型	antifouling	POPs	POPs
	水效	water efficiency	产生量	generation	低硫煤	low-sulfur coal	排放物	emissions
	水耗	water consumption	噪声控制	noise control	絮凝剂	flocculants	节省能源	energy savings
	脱硝	denitrification	双控	dual control	曝音控制	noise control	可更新资源	renewable resources
	氮氧化合物	nitrogen oxides	氧化亚氮	nitrous oxides	酸性气体	acidic gases	烟粉尘	soot and dust
	心刻	hydrogen-containing	少排	less emission	NOX	NOX	利用量	utilization
	限到	hydrocarbons	BOD	BOD	合土量	dust content	POPs	POPs
	REDD	REDD	等量置换	equivalent replacement	环境自浄	environmental self-purification	热污染	thermal pollution
	营养盐	nutrient salts	无毒害	non-toxicity	净化率	purification rate	两控区	two-control area
	<b>康</b> 元 大	wastewater	水污染源	water pollution sources	城市污染	urban pollution	淡冗永	desalinated water
	洗车业	car wash industry	耗水率	water consumption rate	变湿	wetting	谷电	valley power
	弃风	wind abandonment	弃光	light abandonment	风弃光	wind abandonment		
Phy	强降水	heavy precipitation	风雹	wind and hail	风暴潮	storm surges	霍雨和	thunderstorms
	暴洪	flash floods	降水强度	precipitation intensity	韦森特	Vicente	洪泛	flooding
	渍饼 2. 1 1	impregnation	夏伏旱	summer drought	土壤退代 法111年	soil degradation	可利用量	availability
	化合风应	chemosynthesis	凶搏气候	regional climate	埃尔尼诺	El Niño		

30
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# Innovative or conservative? How clan culture shapes bank digital transformation in China



China Journal *oj* Accounting Research

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#### ABSTRACT

How culture affects banks' digital transformation (BDT) is understudied. We discover that clan culture inhibits BDT in China. Clan culture's short-radius trust requires banks to have more physical branches and employees to establish trust, and its risk aversion reduces banks' willingness to bear risks, inhibiting BDT. Resource pooling within clans attenuates the financing constraints and reduces the credit demand of enterprises; households seek more credit through informal channels, limiting their reliance on bank loans and inhibiting BDT from the demand side. Developing the institutional environment and generalized trust as well as demographic change can attenuate these negative effects. Overall, we clarify how informal institutional factors inhibit BDT, enriching research on clan culture and modern financial development.

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# 1. Introduction

The field of financial economics is undergoing a cultural revolution (Zingales, 2015), and interpreting the development of modern finance in China from a cultural perspective has become a major research hotspot. As one of the four ancient civilizations, China has a rich culture, and the role of traditional clan culture as an informal system in the development of modern finance is widely discussed (Greif and Tabellini, 2017; Zhang, 2019; Cao et al., 2022; Chen et al., 2022; Fan et al., 2023; Liu et al., 2023b). Clan culture, as a social organizational structure based on blood ties and cultural carriers such as genealogy, rules and ancestral temples, shapes people's values, beliefs and behavioral patterns. It also influences people's thought patterns and

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decision-making processes in the long term (Fei and Liu, 1982; Fukuyama, 1996). However, research on clan culture primarily investigates its impact on household and enterprise development (Zhang, 2019, 2020; Cao et al., 2022), while research on the role of modern banking development remains in its infancy. As the core institutions of China's financial system, banks have more important social and economic impacts than do non-financial enterprises. Thus, understanding the impact of traditional culture on the development of China's banking industry holds significant theoretical and practical implications. In this paper, we explore the long-term impact of clan culture on the development of the banking industry from the perspective of banks' digital transformation (BDT).

As an informal institutional factor, clan culture influences the trajectory of the innovation and development of China's banks. Clan culture in China emphasizes resource sharing and mutual benefits among members, creating a short-radius trust effect based on shared blood ties while suppressing generalized trust (Fukuyama, 1996; Peng, 2004). Nevertheless, financial contracts are typically trust-intensive (Guiso et al., 2004), highlighting that enhancing generalized trust is crucial for advancing modern financial markets (Zak and Knack, 2001). Chen et al. (2022) demonstrate that the internal financial market fostered by clan-based short-radius trust limits the demand of households and enterprises for formal bank credit, thereby impeding the evolution of modern banking in China.

Digital transformation, as a revolutionary new development trend in the banking industry, considerably improves bank risk management and the quality and efficiency of financial services rendered in the real economy (Borges et al., 2020; Xie and Wang, 2023; Porfírio et al., 2024). Consequently, understanding how clan culture influences BDT is important for revealing the institutional barriers to banks' technological innovation. Researchers argue that the acquaintance networks and short-radius trust formed by clan culture are contrary to the emphases of the digital age on boundary breaking and interconnected sharing, thus inhibiting the digital transformation of nonfinancial enterprises (Liu et al., 2024). However, as the foundation for the development of modern finance, generalized trust has a more profound impact on the financial industry, especially banking. In addition, the complexity of banking requires exploration of the underlying mechanism of clan culture's influence on BDT from both the bank side and the demand (for financial services) side. The characteristics of clan culture that emphasize interdependence, teamwork (Fei and Liu, 1982; Cheng et al., 2021), and risk or benefit sharing in long-term cooperative relationships among clan members (Zhang, 2019; Liu et al., 2023a) may provide a stable foundation for BDT. However, the short-radius trust and conservative risk preferences of clan culture are contrary to the development of the modern banking industry, which has generalized trust as its core. In addition, the mutually beneficial financial attributes of clan culture may further inhibit BDT from the demand side. Therefore, does clan culture promote or inhibit BDT in China, and do banks in regions with stronger clan culture exhibit stronger innovation or more conservatism? Answering these questions will shed important new light on the impact of traditional culture on the development of modern finance.

In this paper, we refer to the literature and measure clan culture as the number of genealogies in prefecturelevel cities and use the digital transformation index for Chinese commercial banks constructed by Xie and Wang (2023) to empirically analyze how clan culture shapes BDT and the underlying mechanisms. We find that clan culture inhibits BDT. Mechanism analysis yields the following results. (1) Banks in regions with a stronger clan culture have more branches and employees, and these employees have lower educational levels, indicating that the acquaintance society of clan culture reduces banks' inclination to replace traditional labor with digital technologies. (2) Clan culture's risk aversion inhibits BDT, and increasing bank risk taking can mitigate this negative impact. (3) The financing characteristics associated with clan culture limit the demand of enterprises and households for formal bank credit, thereby inhibiting BDT from the demand side. Furthermore, we explore the impact of changes in the institutional environment and demographic structure on clan culture's inhibitory effect. Our findings reveal that enhancing marketization, improving the legal environment and increasing generalized trust can attenuate the negative impact of clan culture, and that this inhibitory effect weakens with demographic structural change.

Our research makes three contributions to the literature. First, we expand research on how traditional Chinese culture sharpens modern financial development. Recent research on the impact of clan culture on enterprises is abundant (Greif and Tabellini, 2017; Zhang, 2019; Cheng et al., 2021; Cao et al., 2022; Fan et al., 2023; Tang and Zhao, 2023), but few studies focus on the banking industry. As the core of China's financial system, banks hold significant economic and social influence. Therefore, understanding how clan culture impacts BDT is of great importance for enhancing financial innovation within the banking industry and improving the efficiency of banks' support for the real economy. Our research helps to explain why some regional banks perform poorly in digital transformation and sheds light on the long-term impact of traditional culture on modern financial development in China.

Second, we clarify multiple mechanisms by which clan culture inhibits BDT, providing a reference for removing the institutional obstacles that inhibit BDT. Although Liu et al. (2024) find that clan culture can inhibit digital transformation, the mechanism underlying the effect of clan culture on BDT may differs significantly because of the unique characteristics of the banking industry. We find that clan culture's short-radius trust and low risk preference inhibit BDT. Moreover, clan culture alleviates corporate financing constraints and reduces households' demand for bank credit, suppressing banks' innovation of financial services from the demand side. Our research provides a reference for enhancing BDT by increasing bank risk taking, strengthening generalized trust and improving banks' provision of financial services to households and enterprises.

Finally, we emphasize the importance of strengthening institutions and promoting the organic integration of traditional culture and modern institutions for financial development. We find that while clan culture exerts a long-term negative impact on BDT, the development of formal institutions and improvement of generalized trust can help attenuate clan culture's negative impact and promote BDT. Our research reveals that strengthening the regional institutional environment can reduce the negative effect of traditional culture on modern financial development.

This paper is structured as follows. Section 2 reviews relevant literature and outlines the research hypotheses. Section 3 describes the data and modeling approach. Section 4 presents and examines the empirical findings. Section 5 explores the mechanisms underlying the results, and Section 6 provides additional analyses. Finally, the paper concludes with a summary and policy recommendations.

# 2. Literature review and hypothesis development

# 2.1. Clans and clan culture in China

Chinese clans are social organizations connected by common blood relationships or ancestors. They are guided by family rules, traditions and values and feature genealogies, clan rules and ancestral halls. Clans are among the most important and stable social organizations in China, with profound historical and cultural traditions (Fei, 1946; Fei and Liu, 1982; Fukuyama, 1996; Chen et al., 2022). Clan culture comprises the traditions, values and code of conduct of a clan, which emphasize family unity and kinship and encourage clan members to support each other and develop together (Chen et al., 2022). Chinese clan culture has a long and complex history that began thousands of years ago and developed extensively in feudal societies.

Although facing challenges in the modern age, clan culture remains an essential part of Chinese society and has a profound impact on Chinese cultural inheritance and social order. Research finds that clan culture can promote rural enterprise development, industrial agglomeration (Zhang, 2020; Fan et al., 2023), household financing and elderly care (Zhang, 2019; Liu et al., 2021); help enterprises and households withstand extreme adverse shocks (Zhang, 2019); strengthen labor mobility and entrepreneurship (Chen and Chen, 2018; Zhang, 2020); and ease corporate financing constraints (Mertzanis, 2019; Pan et al., 2019). However, the emphasis on inheritance and risk aversion of clan culture exacerbate China's gender imbalance (Zhang and Ma, 2017) and hinder corporate innovation (Huang et al., 2022). Research emphasizes the impact of clan culture on enterprises and families, but little research investigates how clan culture affects the development of the banking industry, especially BDT.

#### 2.2. Clan culture and modern financial development

Institutions shape modern financial development. Research explores the impact of formal institutions, such as written laws, regulations and contracts, on the evolution of modern finance (La Porta et al., 1997, 1998; Beck et al., 2003; Kim et al., 2012); however, insufficient attention is paid to the role of informal institutions, including traditional culture, morality, ethics and social norms, in this process. Cultural factors, particularly

clan culture, have a critical influence on informal institutions, shaping the development of China's modern financial system. Under the long-term influence of Confucian culture, Chinese clans have formed short-radius trust based on common ancestral or blood relationships (Fukuyama, 1996; Lin and Si, 2010; Ruan and Zheng, 2013; Cheng et al., 2021), as reflected by a high level of trust within the clan and the rejection of individuals outside the clan. Consequently, the prevalence of short-radius trust limits the development of generalized trust in society (Huang et al., 2022). In addition, clans emphasize cooperation among members but competition with outsiders; therefore, they often require strong trust among members to promote group cohesion, limiting general social trust. Fukuyama (1996) argues that certain trust boundaries exist between cultures and societies and that those on the same side of the boundaries tend to receive more trust, whereas intraorganizational solidarity tends to slow extra-organizational trust development (Fukuyama, 1996; Redding, 2013; Greif and Tabellini, 2017). Research also points out that short-radius trust based on blood ties is typical in Chinese society, while generalized trust is relatively lacking (Zhang and Ke, 2003).

Financial contracts are typically trust-intensive (Guiso et al., 2004), and generalized trust lays a solid foundation for the development of modern financial markets (Knack and Keefer, 1997; Pevzner et al., 2015). Arrow (1972) argues that every commercial transaction has an inherent element of trust, and the absence of trust is often cited as a primary factor contributing to the economic underdevelopment of many nations. Guiso et al. (2004) find that in areas with higher social trust, households use less informal credit and have more financial assets and bank credit and local enterprises have more bank loans and equity capital, demonstrating the pivotal role of social trust in financial development. Conversely, the short-radius trust confined within familial circles impedes residents' engagement in the stock market and the diversification of asset portfolios (Guiso et al., 2008). Chen et al. (2016) demonstrate that an enhanced trust environment within a region decreases the likelihood of corporate default and elevates the quality of financial reporting, facilitating private enterprises' access to bank credit. Scholars further note that lack of generalized trust inhibits the development of the modern banking industry (D'Acunto et al., 2019). Clan culture also had a negative impact on the development of early modern banking in China. Chen et al. (2022) find that from 1897 to 1936, the internal financial market formed by traditional clan culture satisfied the financial needs of clan members and inhibited the development of modern banking in China.

In addition to trust, risk aversion and other social norms shaped by clan culture influence the development of modern finance. Clans tend to focus on maintaining the security and stability of the family and thus make conservative financial decisions. Huang et al. (2022) observe that in regions with a stronger clan culture, corporate executives, driven by a duty to protect clan interests and their reputation within the clan, tend to make more cautious decisions; thus, a strong clan culture curbs corporate risk taking and innovation. Kanagaretnam et al. (2014) note that banks in countries with strong risk aversion exhibit more conservative financial reporting and make more timely loan loss provisions and write-offs, whereas banks in less risk-averse environments face higher risks of financial distress and bankruptcy. Moreover, social norms stemming from clan ethics and morality can constrain clan members, potentially impeding financial development if these norms circumscribe behaviors related to financial transactions (Alesina and Giuliano, 2015).

#### 2.3. Hypothesis development

Culture forms the basic norms and moral ethics of society. It shapes people's values, belief systems and behavioral habits and affects their ways of thinking and decision-making processes in the long term (Fei, 1946; Fei and Liu, 1982; Fukuyama, 1996; Chen et al., 2022). Over the long term, the characteristics of clan culture that emphasize interdependence among clan members, teamwork (Fei and Liu, 1982; Cheng et al., 2021) and risk or benefit sharing in cooperative relationships (Zhang, 2019; Liu et al., 2023a) may provide a stable foundation for BDT and thus promote BDT. The specific reasons are as detailed below.

Clan culture emphasizes teamwork and mutual assistance among members, and this cooperative spirit can enhance coordination and execution efficiency among bank employees and stakeholders, thereby promoting BDT. Digital transformation is a complex and long-term process that requires the close cooperation of various internal teams, as well as the sharing of information, technology and resources. In banks, the "collective supremacy" philosophy of clan culture helps reduce friction between departments, minimize information barriers and strengthen the sense of teamwork (Fei and Liu, 1982; Fukuyama, 1996), thereby improving

the efficiency of innovation. However, digital transformation often requires long-term investment and continuous innovation. Clan culture typically prioritizes the long-term interests of a family or group, and this longterm orientation can play a crucial role in BDT.

Clan culture emphasizes long-term cooperative relationships, fostering a strong sense that risk is shared among members, which provides a stable foundation for BDT. Significant innovation investment and trialand-error processes often accompany BDT. The high level of trust established through long-term cooperation among clan members facilitates risk and reward sharing during technological innovation (Li et al., 2024). Moreover, the strong risk-sharing awareness inherent in clan culture helps reduce the costs of failure associated with digital transformation, making banks more willing to bear the risks of digital transformation. Based on the above analysis, we propose hypothesis Ha:

#### Ha. Clan culture promotes BDT.

However, the short-radius trust fostered by clan culture counteracts the generalized trust required for the development of a modern financial industry. Additionally, the risk aversion and financial attributes associated with clan culture may inhibit BDT, both from the perspective of the banks themselves and through the low demand for financial services from enterprises and individuals. The specific explanation is as follows.

Clan culture's short-radius trust requires banks to invest more human and material resources to gain trust and provide services; such investment is a substitute for BDT, which is centered on technological innovation. Clan networks based on blood relationships build close and trusting relationships among family members, making the formation of generalized trust in society challenging (Fukuyama, 1996; Lin and Si, 2010; Ruan and Zheng, 2013; Cheng et al., 2021). Outsiders seeking entry into clan networks undergo a period of bonding and interaction to cultivate trust and familiarity. In addition, the absence of generalized trust limits the development of modern contract-based finance (Knack and Keefer, 1997; Pevzner et al., 2015) and inhibits digital transformation based on new products, technologies and services. Consequently, banks aiming to infiltrate tight-knit networks must depend more on physical branches and employees and increase contact with residents to gain trust, inhibiting BDT, which is based on information, intelligence and technology.

The risk aversion of clan culture may also inhibit BDT. BDT relies on banks' continuous investment in innovation in technologies, products, services and management techniques (Xie and Wang, 2023; Porfírio et al., 2024). However, innovation entails uncertainty and high risks, demanding sustained financial and labor support. The risk-averse tendency of clan culture often compels banks to adhere rigidly to traditional business models and processes, making them reluctant to explore novel methodologies or technologies or to implement strict approval processes for existing financial services to ensure product compliance and risk control. Furthermore, constrained by limited resources, risk-averse banks may prioritize allocating resources to safer ventures over taking on the risks associated with supporting innovative projects. Research also finds that the risk aversion of clan culture inhibits corporate innovation, mergers and acquisitions and other corporate activities (Tian et al., 2018; Huang et al., 2022). However, increased bank risk taking incentivizes the exploration of new financial products and services, enhances fintech investment and promotes digital transformation.

The financing attributes of clan culture can limit enterprise and household demand for bank credit and prevent BDT from the demand side. The fundamental purpose of BDT is to develop innovative business models and financial products and services to improve the customer experience and operational efficiency (Naimi-Sadigh et al., 2021; Xie and Wang, 2023), and serving customers' needs is the primary motivation for BDT. In China, however, in addition to formal financial institutions such as banks, enterprises and households have the option to meet their financing demands within their clans. Clans operate an internal financial market, where resource pooling is based on implicit contracts enforced by clan culture. Mutually beneficial cooperation and resource and information sharing within clans can help to decrease the costs of transactions and information collection for enterprises (households), and strict moral norms within clans reduce the possibility that enterprises (households) will default (Pan et al., 2019; Chen et al., 2022). Consequently, in regions with a strong clan culture, the internal financial market fostered by clans is an effective substitute for formal banking services, thereby inhibiting BDT from the demand side. Based on the above analysis, we propose the alternative hypothesis Hb:

# Hb. Clan culture inhibits BDT.

# 3. Data and variables

#### 3.1. Data source

We use data from the Chinese banking industry from 2010 to 2021 to study the impact of clan culture on BDT. We measure the strength of clan culture using prefecture-level genealogy data from the *General Catalogue of Chinese Genealogy* published by Shanghai Ancient Books Publishing House. BDT data are obtained from the 2010–2021 Peking University digital transformation index of Chinese commercial banks constructed by Xie and Wang (2023). We obtain bank financial data from the Wind database and China Stock Market & Accounting Research (CSMAR) databases and prefecture-level city economic development data from the CEIC database. Because China's state-owned banks and joint-stock commercial banks that have branches throughout the country are less affected by the clan culture of prefecture-level cities, we focus on urban and rural commercial banks. Our final sample comprises observations of 143 banks, namely 100 urban and 43 rural commercial banks, from 2010 to 2021, for a total of 1215 observations.

## 3.2. Variable construction

# 3.2.1. Clan culture

Referring to the literature (Chen et al., 2022; Fan et al., 2023), we measure clan culture as the number of genealogies per million population in prefecture-level cities. A Chinese genealogy is an important document that records family lineage, history and culture and assists families in carrying forward their heritage and cultural traditions. We manually collect genealogical data from the Ming dynasty to 1990 from the *General Catalogue of Chinese Genealogy* and calculate the number of genealogies in each prefecture-level city. We next divide this number by the population of the city in 1990. We construct the clan culture variable (*Clan*) as the natural log of 1 plus the number of genealogies per million population in a prefecture-level city.

# 3.2.2. Bank digital transformation

The data on BDT are derived from the 2010–2021 Peking University digital transformation index of Chinese commercial banks. Xie and Wang (2023) construct a BDT index for each Chinese bank from three dimensions of digitization, namely strategic, operational and managerial, based on the text of each commercial bank's annual financial report and patent and governance information. We take the natural log of 1 plus the BDT index to measure the degree of digital transformation.

Fig. 1 shows the average degree of digital transformation of the sample banks from 2010 to 2021. The curves *Digital\_Urban* and *Digital\_Rural* indicate the digital transformation index of urban and rural





commercial banks, respectively. The degree of BDT exhibits an increasing trend yearly from 2013 to 2015, which is closely related to the rapid development of Internet finance in China. From 2015 to 2018, the degree of BDT of rural commercial banks stagnates, while that of urban commercial banks increases slightly. In 2018, China's banking industry announced strategic objectives to be technology led and innovation driven, which promoted BDT. Fig. 1 demonstrates that the digital transformation index used in this study is reasonable.

# 3.3. Empirical model

We construct model (1) to study the impact of clan culture on BDT.

$$Digital_{i,c,t} = \beta_0 + \beta_1 Clan_c + \lambda Ctrl_{i,c,t} + \mu_{pt} + \varepsilon_{i,t}$$

$$\tag{1}$$

In model (1), *i*, *c* and *t* represent the bank, prefecture-level city and year, respectively. We control for bank and prefecture-level city indicators that may affect BDT. The bank-level control variables are asset size (*Size*), bank loan share (*Loan*), nonperforming loan ratio (*NPL*), capital adequacy ratio (*CapRatio*), net profit margin (*ROE*), the proportion of noninterest income (*FeeInc*), state shares (*StatShare*) and foreign shares (*ForeShare*). The prefecture-level city control variables are economic growth rate (*GDPg*), per capita GDP (*Avegdp*) and financial development depth (*Findeep*). In addition, we include province and time interaction fixed effects ( $\mu_{pt}$ ) to control for the impact of time-varying economic factors and policy shocks in each province. The main variables and their descriptions are listed in Appendix 1.

# 3.4. Descriptive statistics of variables

Table 1 lists the descriptive statistics of the main variables; the Pearson correlations are listed in Appendix 2. All continuous variables are winsorized at the 1 % and 99 % levels to avoid the influence of extreme values. As shown in Table 1, the mean BDT index is 3.605, with a minimum of 0 and maximum of 5.289, indicating that the differences among banks in digital transformation are pronounced during the sample period. The mean value of clan culture (*Clan*) is 3.199 and the maximum value is 7.691, suggesting significant regional differences in the strength of clan culture. The average nonperforming loan ratio (*NPL*) is 1.46 % and the maximum is 4.78 %, indicating that the overall risk in China's banking industry during the sample period is low but that individual banks' risks are significant. The proportion of shares held by the top three shareholders that are state-owned is 27.4 %, while the proportion of such shares that are foreign-owned is only 3 %, indicating that the overally influences Chinese banks. The values of the local economic development

Table 1	
Descriptive	statistics.

variable	Mean	sd	min	p50	max	Ν
Digital	3.6050	1.0960	0.0000	3.9310	5.2890	1215
Clan	3.1990	1.5490	0.2230	3.0120	7.6910	1215
Size	7.2190	1.0710	4.9310	7.1660	9.9170	1215
Loan	0.4610	0.1020	0.2090	0.4670	0.6640	1215
Loang	0.1990	0.1150	-0.0439	0.1800	0.6970	1215
InteBank	0.0457	0.0501	0.0010	0.0266	0.2500	1215
NPL	0.0146	0.0079	0.0005	0.0134	0.0478	1215
Cap Ratio	0.1330	0.0181	0.0969	0.1310	0.1960	1215
RÔE	0.1480	0.0716	0.0122	0.1360	0.3570	1215
FeeInc	0.1270	0.1360	-0.1270	0.0903	0.6950	1215
StatShare	0.2740	0.1640	0.0000	0.2350	0.9190	1215
ForeShare	0.0300	0.0706	0.0000	0.0000	0.2860	1215
GDPg	0.0813	0.0306	-0.0300	0.0810	0.1530	1215
Avegdp	4.2960	0.4780	3.2050	4.3500	5.1680	1215
FinDeep	1.5670	0.6570	0.5060	1.5020	3.6570	1215
Firstind	0.0550	0.0465	0.0029	0.0403	0.1990	1215
Thirdind	0.5040	0.1030	0.2890	0.4980	0.8160	1215

variables are consistent with the economic characteristics of prefecture-level cities in China during the sample period.

# 4. Empirical results and analysis

# 4.1. Clan culture and BDT

Table 2 presents the results of model (1). Column (1) presents the results of a regression with controls for only year and province effects. The regression for column (2) adds bank-level control variables, while that for column (3) incorporates prefecture-level controls. In the regression for column (4), additional province and

Table 2 Clan culture and BDT.

Digital         Digital         Digital         Digital         Digital           Clan $-0.0794^{***}$ $-0.0884^{***}$ $-0.101^{***}$ $-0.1102^{***}$ Size $(-3.40)$ $(-3.33)$ $(-4.24)$ $(-3.9)$ Size $0.2708^{***}$ $0.2749^{***}$ $0.2586^{***}$ Loan $0.2522$ $0.2351$ $-0.1367$ Loan $0.074$ $(0.77)$ $(-0.37)$ Loang $-0.2470$ $-0.4246^{***}$ Loang $(-1.19)$ $(-1.39)$ $(-2.17)$ InteBank $0.0622$ $-0.0824$ $-0.1039$ NPL $2.4332$ $2.5530$ $7.2865$ (0.61) $(-0.60)$ $(0.64)$ $(0.86)$ QPRatio $0.9238$ $1.2457$ $1.3575$ ROE $-1.1325^{**}$ $-1.0244^{**}$ $-0.484^{**}$ StatShare $0.0375$ $0.1853$ $0.2217$ GDPg $(-3.32)$ $(-1.38)$ $(-2.35)$ $(-1.38)$ ForeShare $1.663^{***}$ $1.6$		(1)	(2)	(3)	(4)
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		Digital	Digital	Digital	Digital
(-3.40) $(-3.38)$ $(-4.24)$ $(-3.91)$ Size         0.2708****         0.2749***         0.2586***           Loan         0.2522         0.2351         -0.1367           Loan         0.2522         0.2351         -0.1377           Loang         -0.2115         -0.2470         -0.4246*           (-1.19)         (-1.39)         (-2.17)           InteBank         0.0622         -0.0824         -0.0139           NPL         2.4332         2.5630         7.2865           CapRatio         0.9238         1.2457         1.3573           (0.60)         0.0641         (0.59)         0.257           CapRatio         0.2247         0.1957         0.1913           ROE         -1.1325**         -1.0244*         -0.8475           StatShare         0.1375         0.1853         0.2317           StatShare         0.1375         0.1853         0.2317           GDPg         -0.0465***         1.6667***         1.6667***           GDPg         -0.3897***         -0.0462         -3.392           Fristind         -3.3829***         0.3194         0.0748           GDPg         -0.0627	Clan	-0.0794***	$-0.0884^{***}$	-0.1081***	-0.1102***
Size $0.276^{***}$ $0.274^{9***}$ $0.286^{***}$ Loan $0.2252$ $0.3351$ $-0.1367$ Loan $0.741$ $(0.77)$ $(-0.37)$ Loang $-0.2115$ $-0.2470$ $-0.4246^{**}$ Loang $-0.2115$ $-0.2470$ $-0.4246^{**}$ Loang $-0.2115$ $-0.2470$ $-0.4246^{**}$ Loang $-0.2115$ $-0.2470$ $-0.4246^{**}$ Loang $-0.2119$ $(-1.39)$ $(-2.17)$ InteBank $0.0622$ $-0.0824$ $-0.019$ NPL       2.4332       2.5630       7.2853         CapRatio $0.29238$ $1.2457$ $1.573$ CapRatio $0.2247$ $0.1851$ $(0.86)$ $(0.86)$ ROE $-1.1325^{**}$ $-1.0244^{*}$ $-0.8475$ $1.6667^{**}$ StatShare $0.1375$ $0.1853$ $0.2315$ $0.331$ ForeShare $1.6463^{**}$ $1.6453^{**}$ $1.6453^{**}$ $1.6667^{**}$ GDPg $-0.3897^{**}$ $-0.3897^{**}$ $0.2807^{**}$ $-0.3807^{**}$ $-0.38$		(-3.40)	(-3.38)	(-4.24)	(-3.91)
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Size		0.2708***	0.2749***	0.2586***
Loan $0.2252$ $0.3351$ $-0.1367$ Loang $0.74$ $0.77$ $(-0.37)$ Loang $-0.2115$ $0.02470$ $-0.4246^*$ $(-1.19)$ $(-1.39)$ $(-2.17)$ InteBank $0.0622$ $-0.0824$ $-0.1039$ $NPL$ $2.4332$ $2.6530$ $7.2865$ $(0.60)$ $0.644$ $(0.56)$ $(1.59)$ $CapRatio$ $0.9238$ $1.2457$ $1.3573$ $CapRatio$ $0.2247$ $0.1957$ $0.1913$ $Feelnc$ $0.2247$ $0.1957$ $0.1913$ $freShare$ $0.1375$ $0.1833$ $0.231$ $foreShare$ $0.1375$ $0.1833$ $0.231$ $foreShare$ $0.643^{***}$ $1.6463^{***}$ $1.6667^{***}$ $forShare$ $0.397^{***}$ $-0.3897^{***}$ $0.4282^{***}$ $forShare$ $(-0.677)$ $(-1.21)$ $(-5.15)$ $(-3.38)$ $forShare$ $0.667^{**}$ $-0.3897^{***}$ $-0.4282^{***}$ <tr< td=""><td></td><td></td><td>(10.47)</td><td>(8.84)</td><td>(7.52)</td></tr<>			(10.47)	(8.84)	(7.52)
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Loan		0.2252	0.2351	-0.1367
Loang $-0.2115$ $-0.2470$ $-0.4246^{**}$ $(-1.19)$ $(-1.3)$ $(-2.17)$ InteBank $0.0622$ $-0.0824$ $-0.103$ NPL $2.4332$ $2.5630$ $7.2865$ $0.600$ $0.644$ $(0.66)$ $(0.64)$ $(1.57)$ CapRatio $0.9238$ $1.2457$ $1.3573$ $0.641$ $0.86$ $0.861$ ROE $-1.1325^{**}$ $-1.0244^{**}$ $-0.847$ FeeInc $0.2247$ $0.1957$ $0.1913$ StatShare $0.1375$ $0.1853$ $0.2315$ ForeShare $1.6463^{**}$ $1.6453^{**}$ $1.6463^{**}$ GDPg $-0.7460$ $-2.8671$ $(-0.57)$ $(-1.28)$ $(-3.82)$ $(-3.69)$ FinDeep $-0.0463^{**}$ $1.6453^{**}$ $-0.4282^{**}$ $(1.32)$ $(1.14)$ $(0.57)$ $(-1.28)$ findind $(-0.57)$ $(-1.28)$ $(-5.15)$ $(4.38)$ $(-0.52)$ $(-5.15)$ <td></td> <td></td> <td>(0.74)</td> <td>(0.77)</td> <td>(-0.37)</td>			(0.74)	(0.77)	(-0.37)
$(-1.19)$ $(-1.39)$ $(-2.17)$ InteBank         0.0622         -0.0824         -0.103           NPL         2.4332         2.5630         7.2865 $(0.60)$ $(0.64)$ $(0.57)$ 7.2865 $(0.60)$ $(0.64)$ $(0.86)$ $(0.86)$ $ROE$ $-1.1325^{**}$ $-1.0244^{*}$ $-0.8475$ $Feelnc$ $0.2247$ $0.1957$ $0.1913$ $feelnc$ $0.1375$ $0.1853$ $0.2217$ $forsShare$ $0.1375$ $0.1853$ $0.2317$ $forsShare$ $0.1375$ $0.1853$ $0.2317$ $forsShare$ $1.6463^{***}$ $1.6453^{***}$ $1.6667^{***}$ $GDPg$ $-0.7460$ $-2.8671$ $(-3.52)$ $finDeep$ $-0.7860$ $-2.3862^{***}$ $-0.4828^{***}$ $finDeep$ $-0.6627$ $-0.0435$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ $findind$ $0.3194$ $0.0742$ $(0.67)$ $(0.72)$ $(-0.57)$	Loang		-0.2115	-0.2470	-0.4246**
InteBank         0.0622         -0.0824         -0.039           (0.11)         (-0.14)         (-0.15)           NPL         2.4332         2.5530         7.2865           (0.60)         (0.64)         (1.59)           CapRatio         0.9238         1.2457         1.3573           0.644         (0.86)         (0.86)         (0.86)           ROE         -1.1325**         -1.0244*         -0.8475           (-2.05)         (-1.86)         (-1.28)           Feelnc         0.2347         0.1957         0.1913           StatShare         0.1375         0.1853         0.2315           ForeShare         1.6463***         1.6463***         1.6667**           (1.52)         (1.31)         (1.41)         (1.03)           GDPg         -0.057         (-0.4282           (-0.57)         (-1.12)         (-0.57)         (-1.12)           Avegdp         -0.0627         -0.0627         -0.0432           (-0.89)         (-0.52)         (-0.329)         (-0.52)           Firstind         -3.3293***         0.8576**         2.5715**         3.7350**           (18.39)         (2.07)         (4.26)         (4445) <td>0</td> <td></td> <td>(-1.19)</td> <td>(-1.39)</td> <td>(-2.17)</td>	0		(-1.19)	(-1.39)	(-2.17)
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Inte Bank		0.0622	-0.0824	-0.1039
NPL $2.4332$ $2.5630$ $7.2865$ $(0.60)$ $(0.64)$ $(1.59)$ $(0.64)$ $(0.86)$ $(0.86)$ $ROE$ $-1.1325^{**}$ $-1.0244^*$ $-0.8475$ $(-2.05)$ $(-1.86)$ $(-1.28)$ $FeeInc$ $0.2247$ $0.1957$ $0.1913$ $StatShare$ $0.1375$ $0.1853$ $0.2315$ $foreShare$ $1.6463^{***}$ $1.6453^{***}$ $1.6667^{***}$ $GDPg$ $-0.7460$ $-2.8671$ $foreShare$ $(-0.57)$ $(-1.12)$ $foreShare$ $(-0.57)$ $(-1.12)$ $foreShare$ $(-0.57)$ $(-1.28)$ $foreShare$ $(-0.67)$ $(-1.21)$ $foreShare$ $(-0.87)^{**}$ $-0.4820^{**}$ $(-0.57)$ $(-1.22)$ $(-0.57)$ $(-1.22)$ $finDeep$ $-0.627$ $-0.0403$ $(-0.52)$ $firstind$ $(-3.32)^{***}$ $(-3.82)^{***}$ $(-3.82)^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.38)^{***}$ $(18.39)$ $(2.07)^{**}$ $(4.2$			(0.11)	(-0.14)	(-0.15)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	NPL		2.4332	2.5630	7.2865
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(0.60)	(0.64)	(1.59)
$(0.64)$ $(0.86)$ $(0.86)$ $ROE$ $-1.1325^{**}$ $-1.0244^*$ $-0.8475$ $(-2.05)$ $(-1.86)$ $(-1.28)$ Feelnc $0.2247$ $0.1957$ $0.1913$ $(1.32)$ $(1.14)$ $(1.03)$ StatShare $0.1375$ $0.1853$ $0.2315$ $(0.95)$ $(1.25)$ $(1.33)$ ForeShare $1.6463^{***}$ $1.6453^{***}$ $1.6667^{***}$ $(5.12)$ $(5.15)$ $(4.43)$ $GDPg$ $-0.7460$ $-2.8671$ $(-0.57)$ $(-1.12)$ $(-3.82)$ $finDeep$ $-0.0627$ $-0.0463$ $(-3.82)$ $(-3.69)$ $(-3.52)$ $finIdid$ $0.3194$ $0.0748$ $(-3.52)$ $(0.67)$ $(0.12)$ $_{cons}$ $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ $Year$ YesYesYesYes $Provt Yea$ YesYesYesYes $Provt Year$ NoNoNoYes $Mi R2$ $0.56$ $0.63$ $0.64$ $0.62$ $No$ NoNoYesYes $Mi R2$ $0.56$ $0.63$ $0.64$ $0.62$ $No$ NoNoYesYes $No$ NoNoYesYes $No$ NoNoYes $No$ NoNoYes $No$ NoNoYes $No$ NoNo $No$ NoNo <tr< td=""><td>CapRatio</td><td></td><td>0.9238</td><td>1.2457</td><td>1.3573</td></tr<>	CapRatio		0.9238	1.2457	1.3573
ROE $-1.1325^{**}$ $-1.0244^*$ $-0.8475$ Feelnc       0.2247       0.1957       0.1913         StafShare       0.1375       0.1853       0.2315 $(1.32)$ $(1.14)$ $(1.03)$ StafShare       0.1375       0.1853       0.2315 $(0.95)$ $(1.25)$ $(1.33)$ ForeShare       1.6463^{***}       1.6453^{***}       1.6667^{***} $(5.12)$ $(5.15)$ $(4.43)$ $(-2.8671)$ $(-0.57)$ $(-1.12)$ $(-0.57)$ $(-1.12)$ Avegdp $-0.7460$ $-2.8671$ $(-3.69)$ FinDeep $(-0.627)$ $-0.0428$ $(-3.69)$ Firstind $(-3.82)$ $(-3.52)$ $(-3.52)$ Thirdind $(0.67)$ $(0.12)$ $(-0.57)$ $(-1.2)$ $_2cons$ $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $3.7350^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ Year       Yes       Yes       Yes       Yes         Prov       Yes       Yes       Yes       Yes         Provt <td< td=""><td></td><td></td><td>(0.64)</td><td>(0.86)</td><td>(0.86)</td></td<>			(0.64)	(0.86)	(0.86)
$(-2.05)$ $(-1.86)$ $(-1.28)$ FeeInc $0.2247$ $0.1957$ $0.1913$ $(1.32)$ $(1.14)$ $(1.03)$ StatShare $0.1375$ $0.1853$ $0.2315$ $(0.95)$ $(1.25)$ $(1.33)$ ForeShare $1.6463^{***}$ $1.6453^{***}$ $1.6667^{***}$ $(5.12)$ $(5.15)$ $(4.43)$ $GDPg$ $-0.7460$ $-2.8671$ $(-0.57)$ $(-1.7)$ $(-1.7)$ Avegdp $-0.3897^{***}$ $-0.4282^{***}$ $(-0.57)$ $(-1.7)$ $(-1.7)$ $FinDeep$ $-0.0627$ $-0.0463$ $(-3.82)$ $(-3.69)$ $(-3.52)$ $Firstind$ $0.3194$ $0.0748$ $(-4.38)$ $(-3.52)$ $(-3.52)$ $Thirdind$ $0.8576^{**}$ $2.5715^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ YearYesYesYesYesProvYesYesYesYesProvt YearNoNoNoYes $Adj.R2$ $0.56$ $0.63$ $0.64$ $0.62$ N $1439$ $1215$ $1215$ $1215$	ROE		-1.1325**	-1.0244*	-0.8475
Feelnc $0.2247$ $0.1957$ $0.1913$ $(1.32)$ $(1.14)$ $(1.03)$ StatShare $0.1375$ $0.1853$ $0.2315$ $(0.95)$ $(1.25)$ $(1.33)$ ForeShare $1.6463^{***}$ $1.6453^{***}$ $1.6667^{**}$ $(5.12)$ $(5.15)$ $(4.43)$ $GDPg$ $-0.7460$ $-2.8671$ $(-0.57)$ $(-1.12)$ $Avegdp$ $-0.3897^{***}$ $-0.4282^{**}$ $(-0.57)$ $(-1.12)$ $(-3.62)$ $(-3.62)$ FinDeep $-0.06677$ $-0.0463$ $(-0.59)$ $(-3.52)$ Firstind $-3.8629^{***}$ $-3.3923^{***}$ $(-3.52)$ $(-0.57)$ $(-1.52)$ $(-3.52)$ $(-3.52)$ $firdind$ $0.3194$ $0.0748$ $(0.67)$ $(0.12)$ $\_cons$ $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $3.7350^{***}$ $[18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ $(4.25)$ $(4.45)$ Year       Yes       Yes       Yes       Yes       Yes       Yes       Yes </td <td></td> <td></td> <td>(-2.05)</td> <td>(-1.86)</td> <td>(-1.28)</td>			(-2.05)	(-1.86)	(-1.28)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	FeeInc		0.2247	0.1957	0.1913
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(1.32)	(1.14)	(1.03)
ForeShare $(0.95)$ $(1.25)$ $(1.33)$ ForeShare $1.6463^{***}$ $1.6453^{***}$ $1.6667^{***}$ $(5.12)$ $(5.15)$ $(4.43)$ $GDPg$ $-0.7460$ $-2.8671$ $(-0.57)$ $(-1.12)$ $Avegdp$ $-0.3897^{***}$ $-0.4282^{***}$ $(-3.82)$ $(-3.69)$ $(-3.69)$ $FinDeep$ $-0.0627$ $-0.0463$ $(-0.89)$ $(-0.52)$ $Firstind$ $-3.8629^{***}$ $-3.3923^{***}$ $(-4.38)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.52)$ $(-3.53)$ $(-3.52)$ $(-3.53)$ $(-3.52)$ $(-3.53)$ $(-3.52)$ $(-3.53)$ $(-3.52)$ $(-3.53)$ $(-3.52)$ $(-3.53)$ $(-3.52)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$ $(-3.53)$ $(-5.52)$	StatShare		0.1375	0.1853	0.2315
ForeShare $1.6463^{***}$ $1.6453^{***}$ $1.667^{***}$ $GDPg$ $(5.12)$ $(5.15)$ $(4.43)$ $GDPg$ $-0.7460$ $-2.8671$ $(-0.57)$ $(-1.12)$ $Avegdp$ $-0.3897^{***}$ $-0.4282^{***}$ $(-3.82)$ $(-3.69)$ $FinDeep$ $-0.0627$ $-0.0463$ $(-8.9)$ $(-0.59)$ $(-0.52)$ $Firstind$ $-3.8629^{***}$ $-3.3923^{***}$ $(-4.38)$ $(-3.52)$ $(-3.52)$ $Thirdind$ $0.3194$ $0.0748$ $(0.67)$ $(0.12)$ $_ccons$ $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ YearYesYesYesYesProvYesYesYesYesProvYesYesYesYes $Adj.R2$ $0.56$ $0.63$ $0.64$ $0.62$ NoNoNoYes $Adj.R2$ $0.56$ $0.63$ $0.64$			(0.95)	(1.25)	(1.33)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	ForeShare		1.6463***	1.6453***	1.6667***
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			(5.12)	(5.15)	(4.43)
$Avegdp$ $(-0.57)$ $(-1.12)$ $Avegdp$ $-0.3897^{***}$ $-0.4282^{***}$ $FinDeep$ $(-3.82)$ $(-3.69)$ $Firstind$ $-0.0627$ $-0.0463$ $(-0.89)$ $(-0.52)$ $Firstind$ $-3.8629^{***}$ $-3.3923^{***}$ $(-4.38)$ $(-3.52)$ $Thirdind$ $0.3194$ $0.0748$ $(-0.67)$ $(0.12)$ $\_cons$ $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ YearYesYesYesYes $Prov$ YesYesYesYes $Prov$ YesYesYesYes $Prov Yes$ NoNoYes $Adj.R2$ $0.56$ $0.63$ $0.64$ $0.62$ $N$ $1439$ $1215$ $1215$ $1215$	GDPg			-0.7460	-2.8671
Avegdp $-0.3897^{***}$ $-0.4282^{***}$ FinDeep $(-3.82)$ $(-3.69)$ Firstind $-0.0627$ $-0.0463$ $(-0.89)$ $(-0.52)$ Firstind $-3.8629^{***}$ $-3.3923^{***}$ $(-4.38)$ $(-3.52)$ Thirdind $0.3194$ $0.0748$ $(-0.67)$ $(0.12)$ $\_cons$ $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ YearYesYesYesYesProvYesYesYesYesProv#YearNoNoNoYesAdj.R2 $0.56$ $0.63$ $0.64$ $0.62$ N1439121512151215	8			(-0.57)	(-1.12)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Avegdn			-0.3897***	-0.4282***
FinDeep $-0.0627$ $-0.0463$ Firstind $(-0.89)$ $(-0.52)$ Firstind $-3.8629^{***}$ $-3.3923^{***}$ Thirdind $(-4.38)$ $(-3.52)$ $(-4.38)$ $(-3.52)$ $(-4.38)$ $(-3.52)$ $(-6,7)$ $(0.074)$ $(-6,7)$ $(0.12)$ $\_cons$ $3.3329^{***}$ $0.8576^{**}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ YearYearYesYesProvYesYesYesYesYesYesYesYesProv#YearNoNoNoNoYesAdj.R2 $0.56$ $0.63$ $0.64$ No143912151215	8-T			(-3.82)	(-3.69)
Firstind $(-0.8)$ $(-0.52)$ Firstind $-3.8629^{***}$ $-3.3923^{***}$ Thirdind $(-4.38)$ $(-3.52)$ $(-4.38)$ $(-3.52)$ $(-4.38)$ $(-3.52)$ $(-4.38)$ $(-3.52)$ $(-6.67)$ $(0.12)$ $\_cons$ $3.3329^{***}$ $0.8576^{**}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ $(4.45)$ YearYesYesProvYesYesYearNoNoYearNoNoYesYesYesYesYesYesAdj.R2 $0.56$ $0.63$ $0.64$ No143912151215	FinDeen			-0.0627	-0.0463
Firstind $-3.8629^{***}$ $-3.3923^{***}$ Thirdind $(-4.38)$ $(-3.52)$ Thirdind $0.3194$ $0.0748$ _cons $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $3.7350^{***}$ _cons $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $3.7350^{***}$ _cons $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ Year       Yes       Yes       Yes       Yes         Prov       Yes       Yes       Yes       Yes         Prov#Year       No       No       No       Yes         Adj.R2 $0.56$ $0.63$ $0.64$ $0.62$ N       1439       1215       1215       1215				(-0.89)	(-0.52)
Thirdind $(-4.38)$ $(-3.52)$ Thirdind $0.3194$ $0.0748$ _cons $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ (18.39)(2.07)(4.26)(4.45)YearYesYesYesProvYesYesYesProvYesYesYesProv#YearNoNoYesAdj.R20.560.630.640.62N1439121512151215	Firstind			-3.8629***	-3.3923****
Thirdind $(0.3194)$ $(0.074)$ _cons $3.3329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $3.7350^{***}$ (18.39)       (2.07)       (4.26)       (4.45)         Year       Yes       Yes       Yes       Yes         Prov       Yes       Yes       Yes       Yes         Prov#Year       No       No       No       Yes         Adj.R2       0.56       0.63       0.64       0.62         N       1439       1215       1215       1215				(-4.38)	(-3.52)
cons         3.3329***         0.8576**         2.5715***         3.7350***           (18.39)         (2.07)         (4.26)         (4.45)           Year         Yes         Yes         Yes         Yes         Yes           Prov         Yes         Yes         Yes         Yes         Yes           Prov#Year         No         No         No         Yes           Adj.R2         0.56         0.63         0.64         0.62           N         1439         1215         1215         1215	Thirdind			0.3194	0.0748
$\_cons$ $3.329^{***}$ $0.8576^{**}$ $2.5715^{***}$ $3.7350^{***}$ $(18.39)$ $(2.07)$ $(4.26)$ $(4.45)$ YearYesYesYesYesProvYesYesYesYesProv#YearNoNoNoYesAdj.R2 $0.56$ $0.63$ $0.64$ $0.62$ N1439121512151215				(0.67)	(0.12)
YearYesYesYesYes $Prov$ YesYesYesYes $Prov \# Year$ NoNoNoYes $Adj.R2$ 0.560.630.640.62N1439121512151215	cons	3.3329***	0.8576**	2.5715***	3.7350***
Year         Yes         Yes         Yes         Yes           Prov         Yes         Yes         Yes         Yes         Yes           Prov#Year         No         No         No         Yes         Yes           Adj.R2         0.56         0.63         0.64         0.62           N         1439         1215         1215         1215		(18 39)	(2.07)	(4.26)	(4.45)
Prov         Yes         Yes <td>Year</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>Yes</td>	Year	Yes	Yes	Yes	Yes
Prov#Year         No         No         Yes           Adj.R2         0.56         0.63         0.64         0.62           N         1439         1215         1215         1215	Prov	Yes	Yes	Yes	Yes
Adj. R2         0.56         0.63         0.64         0.62           N         1439         1215         1215         1215	Prov#Year	No	No	No	Yes
N 1439 1215 1215 1215	Adi.R2	0.56	0.63	0.64	0.62
	N	1439	1215	1215	1215

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. *Prov#Year* represents province and time interaction fixed effects.

year interaction fixed effects are included. Across columns (1)–(4), the coefficients of clan culture (*Clan*) are consistently negative and significant, indicating that stronger clan culture inhibits BDT, supporting Hb.

According to the results for the bank-level control variables in column (4), banks with a larger asset scale (*Size*) are more inclined to undertake digital transformation, while a higher loan growth rate inhibits BDT. Both nonperforming loan ratio (*NPL*) and capital adequacy ratio (*CapRatio*) positively but nonsignificantly affect digital transformation. However, foreign shares (*ForeShare*) significantly improve BDT. Among the prefecture-level city control variables, both GDP per capita (*Avegdp*) and the primary industry share (*FirstInd*) significantly inhibit BDT.

# 4.2. Omitted variable analysis

#### 4.2.1. Considering the potential impact of omitted variables

Our main results in Table 2 indicate that clan culture inhibits BDT. However, unobserved variables may influence these results. We control potentially influential omitted variables as follows.

In addition to clan culture, Buddhism and Taoism are essential components of traditional Chinese culture. Buddhism advocates introspection and spiritual enlightenment, and Taoism emphasizes alignment with natural principles and a philosophy of noninterference. These ideological stances may reduce the impetus for innovation and transformative change, thereby hindering BDT endeavors. To exclude the influence of Buddhism and Taoism, we collect data on religious sites from the State Administration of Religious Affairs of China and count the Buddhist and Taoist temples in each prefecture-level city. We add the natural log of 1 plus the number of Buddhist and Taoist temples to model (1) as *Buddhism* and *Taoism*, respectively; we present the results in columns (1) and (2) of Table 3. Buddhist culture (*Buddhism*) significantly inhibits BDT, and the effect of Taoist culture (*Taoism*) is negative but nonsignificant. The coefficient of clan culture (*Clan*) remains negative and significant in columns (1) and (2), indicating that our conclusion is stable.

Opening up to the outside world is an important means of promoting economic and technological development, and the spillover effects of foreign direct investment (FDI) are conducive to innovation and development by local enterprises (Cheung and Ping, 2004; Zhang, 2017). However, the moral norms and cultural values introduced by FDI inflows may challenge traditional clan culture, thus weakening its influence. To mitigate the confounding effects of FDI inflows, we add the share of prefecture-level city GDP accounted for by FDI (*FDI*) to model (1). The results are shown in column (3) of Table 3. Even after we control for the impact of FDI inflows, the main regression results remain robust.

	(1)	(2)	(3)	(4)	(5)	
	Digital	Digital	Digital	Digital	Digital	
Clan	-0.1028***	-0.1093***	$-0.1144^{***}$	-0.1122***	-0.1103***	
	(-3.63)	(-3.88)	(-3.96)	(-3.98)	(-3.76)	
Buddhism	$-0.0875^{***}$				-0.0537	
	(-2.81)				(-1.45)	
Taoism		-0.0152			0.0115	
		(-0.77)			(0.52)	
FDI			3.7228**		3.3688*	
			(1.98)		(1.74)	
UrbanRate				1.9735***	1.6386**	
				(3.21)	(2.44)	
Ctrlvar	Yes	Yes	Yes	Yes	Yes	
Prov#Year	Yes	Yes	Yes	Yes	Yes	
Adj. R2	0.62	0.62	0.62	0.62	0.62	
Ν	1215	1215	1193	1215	1193	

Table 3 Robustness tests: Omitted variables.

Notes: \*, \*\*, and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. Control variables are denoted as *Ctrlvar*. *Prov*#*Year* represents province and time interaction fixed effects.



Fig. 2. Sensitivity analysis: estimated coefficient of Clan (left) and its t value (right).

Urbanization rate reflects a region's level of urbanization, and regions with higher urbanization exhibit richer concentrations of talent, knowledge and expertise and thus greater enterprise productivity and innovation culture. However, urbanization often precipitates shifts in lifestyle patterns and value systems, potentially altering the structural composition and social dynamics of traditional clan-based societies and weakening the influence of clan culture. We incorporate the prefecture-level city urbanization rate (*UrbanRate*) into the base model, and the results are listed in column (4) of Table 3. Urbanization appears to promote local BDT, yet the coefficient of clan culture (*Clan*) remains significant and negative. Column (5) of Table 3 presents the results after adding the above four omitted variables to the base model. Despite these adjustments, our main results remain robust, indicating that these omitted variables do not significantly influence our findings.

# 4.2.2. Sensitivity analysis

To further consider the potential impact of omitted variables on the results, we perform a sensitivity analysis. Specifically, we include bank asset size (*Size*) among the control variables as a comparison variable for potentially omitted variables<sup>1</sup>; the estimation results are shown in Fig. 2. The left panel shows the contour plots of the estimated coefficients of the core explanatory variables, and the right panel shows the contour plots of the *t* statistics corresponding to the estimated coefficients. Even when the omitted variable intensity is three times greater, the estimated coefficient of *Clan* remains negative (left panel of Fig. 2); therefore, the omitted variable does not change the sign of the coefficient estimated in the baseline regression. In terms of statistical significance, when the omitted variable intensity is 2 times the size, the *t* value of the estimated coefficient remains less than -1.96, indicating significance at the 5 % confidence level. This finding suggests that omitted variables are unlikely to strongly affect our main results.

# 4.3. Instrumental variable analysis

We use instrumental variables to address endogeneity concerns. Referring to Xiong et al. (2021) and Liu et al. (2023a), we use prefecture-level city terrain slope (*Slop*) as an instrumental variable for clan culture. Terrain slope reflects the complexity of a region's terrain and is highly correlated with clan activity. Large terrain undulations (e.g., mountainous and hills) often make transportation inconvenient and create geographical isolation, limiting contact between residents and the outside world. Such geographic features promote clan cohesion and cultural inheritance. Moreover, since the Song dynasty, people from the north have repeatedly moved southward into mountainous areas to escape war, and historical conditions have also made it more likely for clan culture to form in mountainous than other areas (Zhang, 2020). However, terrain slope is mostly natural

<sup>&</sup>lt;sup>1</sup> We believe that bank size is an important factor affecting BDT. The main results in Table 2 show that the larger the bank, the higher the degree of its digital transformation. We also replace the comparison variable with other variables, but doing so does not change the results of the sensitivity analysis.

and relatively constant over the long term and does not affect BDT. Therefore, this instrumental variable satisfies the correlation and exclusivity assumptions.

We obtain the prefecture-level city terrain slope data from the Resources and Environmental Science Data Center of the Chinese Academy of Sciences; the larger the indicator, the steeper the terrain slope. Column (1) of Table 4 presents the first-stage results, while column (2) presents the second-stage results. Table 4 shows that the instrumental variables satisfy the correlation assumption (*1st-Fvalue*) and pass the underidentification test (Under-Chi(1)) and weak instrumental variable test (CDF-test), indicating their appropriateness as instrumental variables. The result in column (2) suggests that our main conclusion is robust to potential endogeneity issues.

#### 4.4. Additional robustness tests

#### 4.4.1. Robustness tests replacing key variables

First, we refer to (Ruan and Zheng, 2013; Chen and Chen, 2018) and employ surname shares within prefecture-level cities as a proxy variable for clan culture. A surname is a symbol of a clan, representing family identity and belonging. Clan members pass on their bloodline and traditional values from generation to generation through their surname, thereby strengthening family cohesion. Therefore, the larger the share of top surnames in a region, the closer the clan relations and the stronger the clan culture in the region (Chen and Chen, 2018). Based on the above analysis, we extract surname data from the 2005 China 1 % Population Sampling Survey and calculate the proportions of the populations of prefecture-level cities with the most common surname (Top1Share), one of the three most common surnames (Top3Share) and one of the five most common surnames (Top5Share). We use these three variables as proxies for clan culture; the results are listed in columns (1)–(3) of Table 5. The greater the share accounted for by top surnames, the lower the degree of BDT, demonstrating that replacing the identification index does not affect the conclusion.

Second, we replace the BDT indicator with a measure based on the frequency of digitalization-related words and sentences in the compiled texts of banks' annual reports. Annual reports are an essential means through which enterprises provide information to investors. The frequency of digitalization-related words or sentences can reflect an enterprise's investment in digital transformation and BDT performance. We use the natural log of 1 plus the frequency of digitalization terms (*Digit\_Word*) and number of digitalization sentences (*Digit\_Sen*) as proxy variables for BDT; the results are listed in columns (4) and (5) of Table 5. The coefficients of clan culture (*Clan*) in both columns are negative and significant, indicating that the conclusion does not change with the BDT indicator.

Robustness tests: Instrumental variable.				
	(1)	(2)		
	Clan	Digital		
Slop	0.3271***			
	(3.68)			
Clan		$-0.5778^{**}$		
		(-2.23)		
CtrlVar	Yes	Yes		
Prov#Year	Yes	Yes		
Adj.R2	0.76	0.56		
1st-Fvalue		98.23		
Under-Chi(1)		80.45		
CDF-test		61.89		
Ν	1215	1215		

D - 1-

Table 4

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. Control variables are denoted as Ctrlvar. Prov#Year represents province and time interaction fixed effects.

	(1) (2)		(3)	(4)	(5)
	Digital	Digital	Digital	Digit_Word	Digit_Sen
Top1Share	-3.9611***				
	(-3.88)				
Top3Share		$-1.8768^{***}$			
*		(-3.56)			
Top5Share			-1.5429***		
*			(-3.42)		
Clan			· · · · ·	-0.0920*	-0.0851*
				(-1.85)	(-1.88)
Ctrlvar	Yes	Yes	Yes	Yes	Yes
Prov#Year	Yes	Yes	Yes	Yes	Yes
Adj.R2	0.60	0.60	0.60	0.31	0.35
Ň	1135	1135	1135	1215	1215

Table 5 Robustness tests: Replacing key variables.

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. Control variables are denoted as *Ctrlvar*. *Prov*#*Year* represents province and time interaction fixed effects.

# 4.4.2. Robustness test without observations from regions with weak clan culture

China's clan culture has strong regional characteristics, which are reflected in the fact that clan power is stronger in the eastern, southern and central regions and weaker in the western and northeastern regions; the economies of these weaker clan regions also lag behind. To reduce the influence of these factors, we exclude observations from the western (Gansu, Shaanxi, Ningxia, Qinghai, Yunnan, Chongqing and Inner Mongolia) and northeastern (Heilongjiang, Jilin and Liaoning) regions; the results are presented in column (1) of Table 6. The coefficient of clan culture remains negative and significant.

# 4.4.3. Robustness test without observations from the initial stage of digitalization

BDT in China was slow before 2013. In 2013, Chinese Internet financial enterprises represented by Alipay started the "Year of the Internet." In 2014, the Chinese government included "Internet finance" in the annual government work report for the first time, which promoted the rapid development of BDT. Therefore, the negative impact of clan culture on BDT may be influenced by banks paying insufficient attention to digital transformation before 2013. For column (2) of Table 6, we delete observations from 2010 to 2012. The conclusions remain robust to the exclusion of observations from the initial stage of digitalization.

#### 4.4.4. Robustness tests with different bank sizes

Table 6

A bank's size may influence its digital transformation. Larger banks usually have stronger technical capabilities and are more likely to choose to bear the high costs of digital transformation, while small banks face technological, human capital and financial constraints in digital transformation. Therefore, does the inhibitory

Other robustness tests.						
	(1)	(2)	(3)	(4)		
	Digital	Digital	Digital	Digital		
Clan	$-0.1058^{***}$ (-3.38)	$-0.0719^{***}$ (-2.79)	$-0.1003^{**}$ (-2.45)	-0.1375* (-1.86)		
Ctrlvar	Yes	Yes	Yes	Yes		
Prov#Year	Yes	Yes	Yes	Yes		
Adj.R2	0.62	0.52	0.56	0.70		
N	903	985	610	605		

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. Control variables are denoted as *Ctrlvar*. *Prov*#*Year* represents province and time interaction fixed effects.

effect of clan culture only exist for small banks? For columns (3) and (4) of Table 6, we divide banks into small banks and big banks based on the median size in each year. The effect of clan culture is consistent for differently sized banks, implying that the conclusion does not change with bank size.

# 5. Mechanism analysis

The above analyses demonstrate that clan culture inhibits BDT and that this conclusion remains robust to considering omitted variables, using instrumental variables (to address endogeneity), replacing key indicators and using subsamples based on bank size. In the following analysis, we examine the underlying mechanisms by which clan culture inhibits BDT, specifically investigating the number of bank branches and employees, bank risk taking and enterprise and household credit demand.

## 5.1. Mechanism analysis at the bank level

#### 5.1.1. Clan culture and bank branches and employees

In the theoretical analysis section, we argue that short-radius trust requires banks to invest more human and material resources to build trust in areas with a strong clan culture. Specifically, if banks want to establish relationships and credibility in the region, they need more physical branches and employees, which are a substitute for modern fintech services, such as e-banking and Internet financial products. If this logic is sound, we expect banks to have more branches and more employees in areas with strong clan culture.

We first calculate each bank's number of branches from the financial license information published by the State Administration of Financial Supervision and Administration of China and use the natural log of 1 plus this number (*BankBranch*) as the explained variable. The results are listed in column (1) of Table 7, indicating that banks have more branches in areas with a strong clan culture. Columns (2) and (3) present the impact of clan culture on the number of bank employees; the explained variables are the natural log of 1 plus the number of bank employees (*BankEmp1*) and the number of employees standardized by bank operating income (*BankEmp2*). The results in columns (1)–(3) of Table 7 support the above logic, namely that clan culture, which relies on short-radius trust, makes banks more dependent on traditional branches and employees to provide financial services and reduces investment in digital transformation.

We extend our analysis to explore the influence of clan culture on the educational levels of bank employees, with the explanatory variables being the proportion of employees with graduate degrees or higher (*HighEdu\_Gra*) and the proportion of employees with undergraduate degrees or lower (*UdCollegeRt*); the results are presented in columns (4) and (5) of Table 7, respectively. Our findings indicate that in regions with a stronger clan culture, banks exhibit a weaker preference for highly educated personnel while demonstrating a greater reliance on individuals with low educational levels, further inhibiting BDT.

-		1 2			
	(1)	(2)	(3)	(4)	(5)
	BankBranch	BankEmp1	BankEmp2	HighEdu_Gra	UdCollege Rt
Clan	0.0388 <sup>**</sup> (2.20)	0.0380 <sup>***</sup> (3.43)	0.3660 <sup>***</sup> (3.82)	-0.0033* (-1.66)	0.0206 <sup>***</sup> (3.72)
Ctrlvar	Yes	Yes	Yes	Yes	Yes
Prov#Year	Yes	Yes	Yes	Yes	Yes
Adj. R2	0.77	0.91	0.54	0.64	0.70
N	1027	1107	1107	681	554

Table 7 Mechanism analysis: Clan culture and bank branches and employees.

Notes: \*, \*\*, and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. Control variables are denoted as *Ctrlvar*. *Prov*#*Year* represents province and time interaction fixed effects.

Table 8

	(1) (2)		(3)	(4)	
	Digital	Digital	Digital	Digital	
Clan	$-0.5298^{***}$	-0.1083***	-0.1282***	-0.3741***	
	(-4.29)	(-3.76)	(-4.43)	(-2.64)	
Clan RWA	0.6376***			· · · · ·	
_	(3.60)				
RWA	-2.1180***				
	(-3.03)				
Clan NPL	()	0.0160*			
		(1.75)			
NPL.		-0.0503			
		(-1.49)			
Clan NPLCover			$0.0061^{***}$		
			(3.33)		
NPLCover			-0.0321***		
			(-3.17)		
Clan Cap			()	1 9845**	
				(1.96)	
CanRatio	1 3557	1 0896	1 0554	-5 4842	
cupitane	(0.78)	(0.67)	(0.66)	(-1.55)	
Ctrlvar	Yes	Yes	Yes	Yes	
Prov#Year	Yes	Yes	Yes	Yes	
Adi.R2	0.61	0.61	0.62	0.62	
N	1135	1181	1202	1215	

Mechanism	analycie	Clan	cultura	hank	rick	taking	and	digital	transformation
witcenamism	analysis.	Cian	culture,	Uank	1121	laning	anu	uigitai	transformation.

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. Control variables are denoted as *Ctrlvar*. *Prov*#*Year* represents province and time interaction fixed effects.

# 5.1.2. Clan culture and bank risk taking

The risk-averse nature of clan culture may also inhibit BDT, as clan culture's conservative characteristics and associated preference for long-term stability may reduce bank risk taking. If this logic is sound, then increasing bank risk taking may attenuate clan culture's inhibitory impact and promote BDT. To tests this hypothesis, we refer to Ren et al. (2023a) and analyze the moderating effects of bank risk taking and bank risk resistance on the relationship between clan culture and BDT (Table 8). We add the interaction terms of weighted risk asset ratio (RWA) and nonperforming loan ratio (NPL) with clan culture (Clan\_RWA and *Clan\_NPL*, respectively); the results are presented in columns (1) and (2), respectively. The coefficients of the interaction terms (*Clan\_RWA* and *Clan\_NPL*) are both positive and significant, indicating that bank risk taking attenuates the negative impact of clan culture and thereby promotes BDT. We further analyze the moderating effect of bank risk taking from the perspective of risk resistance; the results are shown in columns (3) and (4) of Table 8. We add the interaction terms of nonperforming loan provision coverage ratio (NPLCover) and capital adequacy ratio (*CapRatio*) with clan culture (*Clan\_NPLCover* and *Clan\_Cap*, respectively); the results are presented in columns (3) and (4), respectively. The coefficients of the interaction terms are both positive, suggesting that increasing bank risk resistance can weaken the risk aversion of clan culture and thereby promote BDT. Overall, the moderation results in Table 8 indicate that clan culture reduces banks' risk taking and increases their risk aversion, thus inhibiting BDT, while increasing bank risk taking weakens the inhibitory effect of clan culture.

# 5.2. Mechanism analysis from credit demand side

In the above bank-level analysis, we analyze two mechanisms of clan culture's BDT inhibitory effect: shortradius trust and risk aversion. We further analyze a mechanism from the credit demand side. Meeting customer needs and providing them with diversified financial products and services are important factors driving BDT. However, the financing attributes of clan culture help to ease corporate financing constraints and reduce the dependence of enterprises and families on bank credit, potentially inhibiting BDT from the demand side. In the subsequent analysis, we start by assessing the credit needs of enterprises and households and clarify the factors that inhibit BDT from the demand side.

# 5.2.1. Clan culture and private enterprise financing

We first focus on the influence of clan culture on the financing constraints faced by private enterprises and their access to bank loans. As state-owned enterprises often benefit from implicit government backing, accruing political and resource advantages, private enterprises encounter greater financing challenges (Zhang, 2020). Therefore, we focus on clan culture and private enterprises' financing constraints. We collect financial data on listed private enterprises from the CSMAR database, and the sampling range is 2010–2021. Referring to Pan et al. (2019), we utilize model (2) to analyze how clan culture influences private enterprises' financing constraints on private enterprises and bank lending.

$$KZindex/Loan_{i,j,c,t} = \beta_0 + \beta_1 Clan_c + \gamma Compctrl_{i,j,c,t} + \lambda Cityctrl_{c,t} + \mu_i + \eta_t + \varepsilon_{i,j,c,t}$$

$$(2)$$

Here, *i*, *j*, *c* and *t* represent the enterprise, industry, city and time, respectively. The explained variables are the financing constraint index (*KZindex*) and the ratio of bank loans to liabilities (*Loan*).<sup>2</sup> Columns (1) and (2) of Table 9 reveal the impact of clan culture on private enterprises' financing constraints; the column (2) regression controls for year and industry interaction fixed effects. The results indicate that clan culture can alleviate private enterprises' financing constraints, consistent with Pan et al. (2019). The explained variable for columns (3) and (4) is the proportion of bank loans. The results indicate that in areas with a stronger clan culture, private enterprises obtain fewer loans from banks. Table 9 demonstrates that the financing attributes of clan culture can alleviate enterprises' financing constraints and reduce their demand for bank credit, thereby inhibiting BDT from the demand side.

# 5.2.2. Clan culture and household credit financing

We next analyze the impact of clan culture on household credit demand (Table 10). Household-level data from 2014 to 2020 are derived from Peking University's China Family Panel Survey. From household debt composition, we calculate the amount borrowed by each household from banks and relatives and use the natural log of 1 plus this value as the explained variable (*Bankamount* and *Reaamount*). In addition, we construct a dummy variable for relative preference (*RelaPrefer*) based on the household's preferred borrower, as indicated in the survey's questionnaire; this variable equals 1 when households prefer informal borrowing from clan relatives. We construct model (3) to study the effect of clan culture on household credit financing.

$$House fin_{i.c.t} = \beta_0 + \beta_1 Clan_c + \beta_h House ctrl_{i.c.t} + \lambda_p + \gamma_t + \varepsilon_{i.c.t}$$
(3)

Here, *i*, *c* and *t* represent the household, city and year, respectively. *Housectrl* represents household-level control variables. We also control for province fixed effects ( $\lambda$ ) and year fixed effects ( $\gamma$ ). The explained variables in columns (1)–(3) of Table 10 are the amount of household borrowing from banks (*Bankamount*), amount of household borrowing from relatives (*Reaamount*) and household borrowing preference (*RelaPrefer*). Clan culture does not have a significant effect on household bank borrowing, but it significantly increases borrowing from relatives and borrowing preferences, suggesting that clan culture promotes informal household deposit demand may spur bank product innovation. We further analyze the impact of clan culture on deposits, with the explained variable for column (4) of Table 10 being the ratio of deposits to net assets (*Deposit*). Clan culture does not have a significant effect on household deposits. The results in Table 10 indicate that the informal financing enabled by clan culture can meet household's financing needs and weaken their demand for formal bank credit, thus reducing banks' motivation for digital transformation from the demand side.

<sup>&</sup>lt;sup>2</sup> The formula for *KZindex* is *KZindex* = -9.88\* *Cashflow* - 30.76\* *Dividend* - 5.26\* *Cash* + 4.77\* *Lev* + 0.46\* *TBQ. Cashflow* represents net operating cash flow divided by total assets, *Dividend* represents cash dividends divided by total assets, *Cash* represents corporate cash holdings divided by total assets, *Lev* represents liabilities divided by total assets, and *TBQ* represents market value divided by book value.

	(1)	(2)	(3)	(4)	
	KZindex	KZindex	Loan	Loan	
Clan	$-0.0470^{***}$	$-0.0477^{***}$	$-0.0104^{**}$	$-0.0103^{**}$	
	(-3.42)	(-3.46)	(-2.48)	(-2.47)	
Size	-0.423***	-0.422***	0.0403***	0.0396***	
	(-18.11)	(-17.81)	(7.27)	(7.10)	
Lev	6.484***	6.492***	0.301****	0.302***	
	(58.79)	(57.69)	(8.75)	(8.75)	
ROA	-4.431****	-4.524***	0.673****	$0.704^{***}$	
	(-12.49)	(-12.53)	(5.93)	(6.12)	
Growth	-0.0204	-0.0221	-0.00232	-0.00222	
	(-0.88)	(-0.96)	(-0.44)	(-0.41)	
Fixasset	$-0.896^{***}$	$-0.898^{***}$	$-0.244^{***}$	$-0.255^{***}$	
	(-5.35)	(-5.28)	(-4.33)	(-4.52)	
Liquid	$-1.982^{***}$	$-1.991^{***}$	$-0.374^{***}$	-0.383***	
1	(-14.79)	(-14.61)	(-9.57)	(-9.80)	
Solvency	$-1.012^{***}$	$-0.989^{***}$	$-0.294^{***}$	-0.301***	
	(-11.07)	(-10.74)	(-8.60)	(-8.83)	
GDPg	-0.727	-0.672	0.914**	$0.946^{**}$	
	(-0.66)	(-0.60)	(2.16)	(2.23)	
Avegdp	0.165**	0.160**	-0.0394	-0.0356	
	(2.08)	(2.01)	(-1.61)	(-1.46)	
Firstind	3.708****	3.592****	0.273	0.325	
	(4.03)	(3.88)	(1.08)	(1.28)	
Findeep	0.00484	0.00272	0.0142***	0.0137***	
	(0.32)	(0.18)	(3.09)	(3.00)	
_cons	7.363***	7.425***	$-0.774^{**}$	$-1.061^{***}$	
	(6.89)	(6.89)	(-2.49)	(-2.89)	
Year	Yes	Yes	Yes	Yes	
Indu	Yes	Yes	Yes	Yes	
Year#Indu	No	Yes	No	Yes	
Adj.R2	0.59	0.59	0.07	0.08	
Ν	17,011	17,001	20,124	20,124	

Table 9Clan culture and enterprise credit needs

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. *Prov#Year* represents province and time interaction fixed effects.

# 6. Further analysis

The above analyses support our main hypothesis, namely that clan culture inhibits BDT, and reveal the underlying mechanism from the bank and demand sides. Does improving China's institutional environment mitigate the inhibitory effect of clan culture, as an informal institution, on BDT? Additionally, how does clan culture's influence change with demographics? In the following sections, we analyze the moderating effects of the institutional environment and demographic change on the influence of clan culture.

# 6.1. Market-oriented environment, clan culture and BDT

The development of a market-oriented environment entails a series of reforms and evolution of the social, economic, legal and other institutional environments and plays an important role in improving resource allocation efficiency, stimulating innovation and technological progress, improving living standards and promoting economic growth (Fan et al., 2011; Fan et al., 2019). Improving the market orientation of the environment can stimulate innovation by local enterprises, increase bank competitiveness and risk taking and promote BDT. In addition, a well-developed market-oriented environment can significantly stimulate the market and residents and increase the demand of enterprises and residents for formal credit. Therefore, market-oriented development can weaken the negative impact of clan culture and promote BDT. To test this

Table 10				
Clan culture and	family	credit	financing	needs.

	(1)	(2)	(3)	(4)
	Bankamount	Reaamount	ReaPrefer	Deposit
Clan	0.0161	0.0446***	0.0273***	0.0035
	(1.41)	(2.84)	(3.58)	(1.14)
Size	-0.0341***	0.0253***	-0.0061**	0.0043
	(-6.31)	(3.93)	(-2.08)	(1.19)
Lev	0.0231	0.1481***	-0.0079*	0.0821
	(1.63)	(8.59)	(-1.66)	(1.40)
Finasset	$-0.4536^{***}$	$-1.4146^{***}$	0.0387	1.0923***
	(-4.37)	(-11.94)	(0.89)	(5.85)
Transfer	-0.1194**	$-0.4839^{***}$	-0.0033	0.0041
	(-2.53)	(-6.91)	(-0.08)	(1.17)
Age	6.4687****	13.6525***	$-16.1857^{***}$	-1.3433
	(6.33)	(9.21)	(-24.71)	(-1.36)
Age2	$-0.9440^{***}$	$-2.0078^{***}$	2.1450****	0.1760
	(-7.07)	(-10.36)	(24.81)	(1.37)
Edu	0.0648****	0.2224***	0.0133**	$-0.0037^{***}$
	(5.78)	(13.68)	(2.11)	(-2.65)
Male	0.1417****	0.2085***	$-0.1585^{***}$	-0.0109
	(4.81)	(4.81)	(-8.03)	(-1.22)
Marry	-0.0684*	-0.0603	$0.2120^{***}$	-0.0113
	(-1.83)	(-1.13)	(7.62)	(-0.73)
Famsize	$0.0664^{***}$	$0.1068^{***}$	$-0.0935^{***}$	0.0064
	(7.43)	(8.31)	(-14.11)	(0.93)
Rural	-0.0381	0.2977***	0.0233	-0.0003
	(-1.22)	(6.57)	(1.10)	(-0.05)
Health	$-0.0741^{**}$	-0.0322	-0.0014	-0.0145
	(-2.42)	(-0.74)	(-0.07)	(-0.88)
Insurance	-0.0084	0.0355	0.0065	-0.0081
	(-0.24)	(0.66)	(0.26)	(-0.93)
_cons	$-10.0360^{***}$	$-22.4926^{***}$	29.1850***	2.4476
	(-5.15)	(-7.94)	(23.65)	(1.35)
Year	Yes	Yes	Yes	Yes
Prov	Yes	Yes	Yes	Yes
$Adj. R^2/Pse. R^2$	0.26	0.18	0.08	0.12
N	33,607	33,607	28,913	39,229

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% level, respectively. Standard errors are clustered at the bank level. Control variables are denoted as *Ctrlvar*.

conjecture, we add the interaction term (*Clan\_MI*) between market environment (*MarketIndex*) and clan culture (*Clan*) to the base model. We employ an environment marketization indicator derived from Wang et al. (2017). This marketization indicator may be endogenous and thus may promote BDT while also weakening clan culture's influence. Therefore, we refer to Ren et al. (2023b) and use the initial value (i.e., in 2008) of this indicator as a proxy variable for environment marketization. The results are listed in column (1) of Table 11. The coefficient of the interaction term (*Clan\_MI*) is positive and significant at the 5 % level, indicating that the development of the market environment can attenuate clan culture's negative impact, thereby promoting BDT.

# 6.2. Legal system development, clan culture and BDT

Developing the legal system provides guarantees for the formulation and enforcement of contracts, improves the protection of intellectual property rights and incentivizes corporate innovation (Chen and Puttitanun, 2005). Unlike the acquaintance guarantees of traditional clan societies, an effective legal system can ensure the upholding of contracts between borrowers and lenders and encourage banks to take risks

	(1) Digital	(2)	(3)	(4)
		Digital	Digital	Digital
Clan	$-0.4919^{***}$	-0.1688***	-0.1918***	-0.1425***
	(-2.74)	(-3.96)	(-3.82)	(-3.47)
Clan_MI	0.0564**			
	(2.21)			
Clan_IPR		$0.0150^{**}$		
		(2.18)		
Clan_Trust			0.0013**	
			(2.21)	
Clan_Popu_Shock				0.0498*
*				(1.75)
Popu_Shock				-0.2564**
*				(-2.00)
Ctrlvar	Yes	Yes	Yes	Yes
Prov#Year	Yes	Yes	Yes	Yes
Adj. R2	0.62	0.62	0.62	0.62
N	1215	1168	1215	1215

Table 11 Further research: Institutional environment, clan culture and BDT.

Notes: \*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. Standard errors are clustered at the bank level. Control variables are denoted as *Ctrlvar*. *Prov*#*Year* represents the interaction of province and time fixed effects.

(Ge et al., 2012). Therefore, developing the legal environment can also attenuate the inhibitory effect of clan culture on BDT. We obtain the legal development index from among the subindicators of Chinese provinciallevel marketization process indicators measured by Wang et al. (2017). We use the intellectual property protection index (*IPR*) at the beginning of the sample period as a proxy variable for indicating the legal environment. The empirical results are listed in column (2) of Table 11. The coefficient of the interaction term (*Clan\_IPR*) between the legal environment and clan culture is positive and significant at the 5 % level, indicating that developing the legal environment can attenuate the negative impact of clan culture and promote BDT.

# 6.3. Generalized trust, clan culture and BDT

Clan culture based on common ancestry and blood ties emphasizes trust among acquaintances, and such short-radius trust facilitates intraclan financing, weakening the demand for formal finance and thus hindering the development of modern banking (Chen et al., 2022). Therefore, can increasing generalized social trust reduce the negative impact of clan culture and promote BDT? In column (3) of Table 11, we add the interaction of generalized trust index (*Trust*) and clan culture (*Clan\_Trust*) to the base model. Data on generalized trust are derived from Zhang and Ke (2003), who measure the degree of trust that other provinces have in a given province. This indicator is often regarded as a proxy variable for generalized trust in societal members other than acquaintances (Ren et al., 2023b). The coefficient of the interaction term (*Clan\_Trust*) is positive and significant at the 10 % level, indicating that improving generalized trust can attenuate clan culture's inhibitory effect and promote BDT.

# 6.4. Demographic change, clan culture and BDT

Since 1990, the demographic structure of China's prefecture-level cities has significantly changed, with an influx of immigrants challenging the inheritance and continuation of traditional local culture. Does such demographic change affect the inhibitory effects of clan culture? We refer to Pan et al. (2019) to construct a population mobility shock indicator for prefecture-level cities to explore the impact of demographic change. Specifically, we estimate the expected population of each prefecture-level city during the sample period based on the 1990 population data provided by the China Urban Statistical Yearbook and national population growth rate (*Popu\_Rate*) in each

prefecture-level city by dividing the yearly resident population by the estimated population. Finally, we divide the annual population growth multiple into tertiles and define the population mobility shock variable, *Popu\_Shock. Popu\_Shock* equals 2 when the population growth multiple (*Popu\_Rate*) is the largest tertile, 1 when it is in the middle tertile and 0 when it is the lowest tertile. We add the interaction term (*Clan\_Popu\_Shock*) between clan culture and population shock to the base model; the result is listed in column (4) of Table 11. The coefficient of the interaction term is positive and significant, indicating that the inhibitory effect of clan culture weakens as the population structure changes.

# 7. Conclusion

This paper analyzes the impact of traditional Chinese clan culture on BDT. We find that clan culture inhibits BDT, and this result remains robust to considering multiple omitted variables, using the instrumental variable method to address endogeneity and replacing key variables. Mechanism analysis from the bank perspective reveals that banks in regions with stronger clan culture have more branches and employees and that the educational level of bank employees in those regions is lower. This suggests that the acquaintance society formed by clan culture inhibits the substitution of banking technology for labor. In addition, the risk aversion characteristic of clan culture further reduces risk taking, thereby inhibiting BDT. Mechanism analysis from the credit demand side indicates that clan culture can ease local private enterprises' financing constraints and reduce their demand for credit from banks. Moreover, households in regions with stronger clan culture tend to obtain more credit support through informal financial channels and borrow less from banks. The low demand of enterprises and households for bank credit further inhibits BDT from the demand side. Our further research indicates that improving the market orientation of the environment, developing the legal system and increasing generalized trust reduce clan culture's negative impact. Moreover, demographic change weakens the influence of traditional clan culture. Our research deepens understanding of the negative impact of clan culture and provides a reference for strengthening the institutional environment and promoting the technological innovation of modern banks. Our research has the following policy implications.

First, it is vital to take a dialectical view of the influence of traditional Chinese culture on modern financial development. Chinese culture has a long history, and strong traditional culture is China's spiritual lifeline and most profound form of cultural soft power. We find that clan culture inhibits BDT yet informally satisfies the financing requirements of enterprises and households. In practice, it is crucial to find a balance between traditional culture and modern financial development to ensure that the financial system can not only benefit from traditional values but also adapt to the rapidly changing market, achieve financial innovation and improve financial services.

Second, the government should strengthen the institutional environment, promote the organic integration of traditional culture and modern systems and encourage BDT. We find that improving the institutional environment and increasing generalized trust can attenuate the negative effect of clan culture. Accomplishing these goals requires the government to strengthen the regional institutional environment, establish a sound legal system, enhance social trust and build a robust institutional foundation for BDT. In addition, it is necessary to strengthen the organic integration of the institutional environment and China's invaluable traditional culture; combine the inheritance of traditional culture with the development of modern finance to achieve a win–win outcome; and promote the transformation of Chinese culture from tradition to modernity.

# **Competing interests**

The authors confirm that there are no relevant financial or nonfinancial competing interests to report.

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# Appendix 1.

Table A1 Variable definitions.

Variable	Definition
Digital	Degree of BDT, obtained from the 2010–2021 Peking University digital transformation index of Chinese commercial banks constructed by Xie and Wang (2023)
Clan	Clan culture, equal to the natural log of 1 plus the number of genealogies per million population in a prefecture-level city
Size	Bank size scale, equal to the natural log of 1 plus bank asset scale
Loan	Bank loan share, equal to bank loans divided by total assets
Loang	Bank loan growth rate, calculated as the change in bank loans divided by total assets at the beginning of the period
Inte Bank	Interbank asset share, equal to interbank assets divided by total assets
NPL	Bank nonperforming loan ratio, equal to nonperforming loans divided by total loans
CapRatio	Bank capital adequacy ratio, equal to total capital divided by weighted risk assets
ROE	Return on equity, calculated as net profit divided by bank equity
FeeInc	Net noninterest income share calculated as net intermediate business income divided by operating income
StatShare	State-owned equity share, the proportion of state-owned shares among those held by the top three shareholders
ForeShare	Foreign-owned equity shares, the proportion of foreign-owned shares among those held by the top three shareholders
GDPg	GDP growth rate of prefecture-level cities
Avegdp	The per capita GDP of a prefecture-level city, calculated as the natural log of 1 plus GDP per capita
FinDeep	Degree of financial deepening, calculated as total loans as a share of the GDP of the prefecture- level city
Firstind	Ratio of the output value of primary industry to the GDP of a prefecture-level city
Thirdind	Ratio of the output value of tertiary industry to the GDP of a prefecture-level city

# Appendix 2.

Table A2 Pearson correlation results.

	Digital	Clan	Size	Loan	Loang	Inte Bank	NPL
Digital	1						
Clan	-0.0130**	1					
Size	0.523***	-0.0370	1				
Loan	-0.0130	0.242***	-0.217***	1			
Loang	-0.154***	-0.093***	-0.075***	-0.271***	1		
InteBank	-0.310***	-0.094***	-0.185***	-0.252***	0.111***	1	
NPL	0.217***	-0.101***	-0.067**	0.249***	-0.287***	-0.193***	1
CapRatio	-0.00400	0.119***	-0.170***	0.073**	0.0400	0.077***	-0.136***
RÔE	-0.464***	-0.092***	-0.118***	-0.224***	0.168***	0.386***	-0.519***

	Digital	Clan	Size	Loan	Loang	InteBank	NPL
FeeInc	0.185***	-0.0230	0.370***	-0.327***	0.0220	-0.0260	0.0410
Stat Own	0.065**	-0.167***	0.0210	-0.072**	0.055*	-0.053*	0.090***
ForOwn	0.118***	-0.064**	0.303***	-0.129***	0.0220	-0.0280	-0.106***
GDPg	$-0.486^{***}$	0.0460	-0.227***	-0.091***	0.165***	0.296***	-0.304***
Avegdp	0.372***	0.375***	0.427***	0.235***	-0.277***	$-0.185^{***}$	0.049*
FinDeep	0.293***	-0.0190	0.486***	0.0380	-0.0460	-0.093***	0.059**
Firstind	-0.173***	-0.380***	-0.351***	-0.151***	0.172***	0.0400	0.085***
Thirdind	0.434***	-0.059**	0.628***	0.00200	-0.168***	$-0.116^{***}$	0.147***
	<b>CapRatio</b>	ROE	FeeInc	<b>StatOwn</b>	ForOwn	GDPg	Avegdp
CapRatio	1						
ROE	0.00500	1					
FeeInc	-0.181***	-0.098***	1				
Stat Own	-0.063**	-0.135***	0.023	1			
ForOwn	0.0080	0.012	0.174***	-0.200***	1		
GDPg	0.0410	0.497***	0.0160	0.0240	0.0450	1	
Avegdp	0.141***	-0.307***	0.109***	0.0330	0.121***	-0.216***	1
FinDeep	-0.012	-0.151***	0.119***	0.0310	0.149***	-0.144***	0.306***
Firstind	-0.125***	0.071**	-0.164***	0.0260	-0.173***	-0.059**	-0.340***
Thirdind	-0.0410	-0.267***	0.202***	0.158***	0.209***	$-0.255^{***}$	0.442***
	FinDeep	Firstind	Thirdind				
FinDeep	1						
Firstind	-0.421***	1					
Thirdind	0.240***	-0.421***	1				

Table A2 (continued)

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# Can independent directors effectively monitor controlling shareholders after reappointment?



China Journal *oj* Accounting Research

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#### ABSTRACT

The mandatory rotation of independent directors upon the expiration of their term is a key institutional design in China, aimed at safeguarding their independence and enhancing the effectiveness of their supervision. However, whether reappointing these directors after a "cooling-off period" following mandatory rotation undermines the effectiveness of supervision remains an open question. We investigate whether independent directors can effectively monitor tunneling activities after their reappointment. We find that their monitoring is less effective during their reappointment term than in their first term, reflected in a significant increase in related-party transactions with controlling shareholders. A mechanism test reveals that independent directors' monitoring behavior is more passive during the reappointment term, as evidenced by less dissent and a lower likelihood of challenging proposals related to controlling shareholders. These effects are more pronounced when reappointed independent directors are less willing or able to supervise, or when the company's internal and external governance environment is poor. Supervision also appears to be more effective if they are reappointed after a cooling-off period of more than three years. This paper extends research on the governance impact of reappointed independent directors and provides empirical evidence that can help to improve their post-term management practices.

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# 1. Introduction

Independent directors play a crucial role in corporate governance, particularly in mitigating agency problems (Fama and Jensen, 1983). Ownership structures in China are highly concentrated, and one of the main responsibilities of independent directors is to supervise controlling shareholders' expropriation, thus protecting the interests of minority shareholders. To avoid the loss of independence or reduced willingness to perform their duties due to prolonged service, the "Guidelines for Establishing Independent Director System in Listed Firms" stipulate that "independent directors can be re-elected after their term ends, but their continuous tenure should not exceed six years."<sup>1</sup> However, in practice, many listed companies circumvent the consecutive tenure limit by reappointing independent directors after they undergo mandatory rotation and a cooling-off period. By the end of 2020, 257 companies on the Shanghai and Shenzhen A-share main boards had reappointed 314 independent directors following mandatory rotation, with multiple instances of the same independent director being reappointed several times and some companies reappointing multiple independent directors simultaneously. Although such reappointments do not formally violate the regulations, they essentially extend the directors' terms, potentially compromising their independence in fulfilling their duties (Zheng, 2016). Whether this practice deviates from the original intent and whether it undermines the effectiveness of independent directors in monitoring controlling shareholders remain unclear. Given the ongoing reforms in China's capital markets and the emphasis on enhancing the governance functions of independent directors, it is crucial to investigate whether this practice affects the ability of reappointed independent directors to monitor controlling shareholders.

Most studies examine the effectiveness of independent directors in monitoring controlling shareholders in terms of the static factors that influence their willingness or ability to perform their duties, but the conclusions drawn from these studies diverge considerably. Some studies suggest that geographic barriers, social ties and high salaries may reduce their independence, thereby weakening their monitoring of controlling shareholders' expropriation activities (Lu and Ma, 2021; Sun and Liu, 2014; Li et al., 2023). Other studies argue that more practical experience, stronger social networks, greater proactiveness in performing duties and more stringent external regulation enhance independent directors' monitoring abilities or willingness, thus reducing tunneling by controlling shareholders (Chen et al., 2014; Liu et al., 2016; Chen and Keefe, 2020; He et al., 2023). This study focuses on the reappointment of independent directors and investigates how dynamic changes in their willingness and ability to perform their duties, due to the extension of their terms, can influence the effectiveness of their supervision over controlling shareholders. This offers a novel perspective on the governance role of independent directors.

We theorize that the monitoring effectiveness of reappointed independent directors is influenced by their willingness and ability to monitor. Reappointment serves as positive feedback regarding their previous tenure, as it enhances their sense of self-efficacy and motivates them to actively engage in supervision after reappointment. The experience gained during the first term not only enables them to gather more information about the company but also increases their familiarity with internal personnel, thus reducing problems with information acquisition. Reappointment can thus enhance their ability to monitor tunneling activities by controlling shareholders. However, the personal relationships that reappointed independent directors develop with controlling shareholders during their first term may increase mutual trust and reduce professional skepticism regarding tunneling. They may also experience cognitive inertia and overconfidence in decision-making due to longer cumulative tenure, thereby diminishing their monitoring effectiveness. Therefore, whether independent directors can effectively perform their monitoring roles and reduce tunneling during their reappointment term is an empirical issue that warrants further examination.

We consider firms with reappointed independent directors on the Shanghai and Shenzhen A-share main boards from 2004 to 2020 and investigate the monitoring effectiveness of reappointed independent directors in addressing tunneling activities before and after reappointment. We find that compared with their first term,

<sup>&</sup>lt;sup>1</sup> Source: The China Securities Regulatory Commission issued the "Guidelines for Establishing Independent Director System in Listed Firms" in 2001. See https://www.cq.gov.cn/ykbzt/yhyshj/zcjj/bhzxtzz/200108/t20010816\_8740798.html for more information. In addition, it issued the "Measures for the Administration of Independent Directors of Listed Companies" in 2023. See https://www.gov.cn/gongbao/2023/issue\_10746/202310/content\_6907746.html for more information.

in their reappointment term these directors tend to exhibit more favorable governance behavior, reflected in less public objection to controlling shareholders. Their effectiveness in monitoring tunneling is weakened as a result, thus exacerbating the type II agency problem.<sup>2</sup> This conclusion remains robust after addressing endogeneity concerns. Our heterogeneity analysis reveals that this effect is influenced by the directors' levels of willingness and ability, in addition to the company's internal and external governance environment. Specifically, the effectiveness of reappointed independent directors' monitoring is further weakened when their willingness or professional ability is lower, while a good internal and external governance environment helps to mitigating this weakening effect, thus curbing tunneling behavior. In addition, we find that reappointment after a coolingoff period of more than three years can restore independent directors' effectiveness in monitoring tunneling.

Our study makes three main contributions. First, it contributes to the literature on the impact of reappointment on independent directors from the perspective of the type II agency problem. Previous research examines the governance effectiveness of reappointed independent directors from various perspectives, such as corporate violations (Du and Zhang, 2021) and operating performance (Zheng, 2016), but its results are mixed. Our study focuses on the type II agency problem of listed companies in China and investigates the impact of reappointed independent directors on tunneling by controlling shareholders. It therefore enriches research on the economic consequences of reappointing independent directors from the perspective of monitoring shareholders. We also effectively control for the potential confounding effects of tenure differences during their first term by selecting independent directors reappointed after the mandatory rotation at the end of their tenure.

Second, our study is the first to test the differential impact of the length of a cooling-off period on the monitoring effectiveness of reappointed independent directors. The findings show that a reappointment after a gap of more than three years helps to restore independent directors' effectiveness in supervision. This supports the new regulations imposed by the Shanghai and Shenzhen stock exchanges, which require a cooling-off period of 36 months for independent directors.<sup>3</sup> Thus, our study provides empirical evidence that can inform the regulation of independent directors' behavior by regulatory authorities.

Third, our study can help investors and regulators identify variations in the governance effects of independent directors. Factors such as their willingness and ability to monitor, the internal and external governance environment of the company and the length of the cooling-off period have different effects on the monitoring effectiveness of reappointed independent directors. This can help stakeholders assess the governance effectiveness of companies and enable regulatory authorities to implement more targeted supervision.

#### 2. Institutional background and literature review

#### 2.1. Institutional background

The independent director system originated in the 1930 s, with the aim of establishing checks and balances within the board and preventing the erosion of company interests by the controlling shareholders and management. It also addressed the increasingly severe agency problems within companies. To improve the governance structure of listed companies, the China Securities Regulatory Commission (CSRC) issued its "Guidelines for Introducing Independent Directors to the Board of Directors of Listed Companies" (*Guidelines*) in 2001, which marked the formal introduction of the independent director governance mechanism in China. The system considered the adverse effects of ownership concentration from its inception, and the protection of minority shareholders' interests from expropriation by controlling shareholders was deemed one of the core responsibilities of independent directors. The *Guidelines* clearly stipulate that

<sup>&</sup>lt;sup>2</sup> "Type II agency problem" refers to the conflicts of interest between controlling shareholders and minority shareholders.

<sup>&</sup>lt;sup>3</sup> The Shanghai Stock Exchange issued the "Self-regulation Supervision Guidelines for Listed Companies No. 1: Standard Operations (Revised in December 2023)," which stipulate that "an independent director who has served continuously for six year in the same listed company cannot be nominated as an independent director for that company within 36 months." Source: https://www.sse.com.cn/lawandrules/sselawsrules/stocks/mainipo/c/c\_20231215\_5733508.shtml. Similarly, the Shenzhen Stock Exchange's "Self-regulation Supervision Guidelines for Listed Companies No. 1: Standard Operations for Main Board Listed Companies (Revised in December 2023)" include the same 36-month "cooling-off period" provision. Source: https://www.szse.cn/lawrules/rule/stock/supervision/mb/t20231215\_605013.html.

"independent directors should diligently perform their duties, safeguard the overall interests of the company and particularly ensure that the legal rights and interests of minority shareholders are not harmed." To realize these objectives, the *Guidelines* require independent directors to be fully independent. Therefore, the provisions regarding their qualifications are strict, requiring them to issue independent opinions on matters that may harm the interests of minority shareholders and limiting their consecutive service to a maximum of six years. In 2004, the CSRC issued its "Standards Concerning the Contents and Formats of Information Disclosure by Companies Offering Securities to the Public No. 2-Contents and Formats of Annual Reports." These further required listed companies to disclose the performance of independent directors, including their attendance at board meetings and any objections they raised. In 2023, the CSRC introduced the "Measures for the Administration of Independent Directors of Listed Companies" (Measures), marking the first significant revision of the independent director system in more than 20 years. The Measures clearly define the role, scope of responsibilities and approaches of independent directors. They state that "independent directors owe loyalty and diligence to the listed company and all shareholders, play a role in decision-making, checks and balances and professional consulting in the board, safeguard the overall interests of the listed company and protect the legitimate rights and interests of minority shareholders." These directors must oversee any activities related to potential major conflicts of interest between a listed company and its controlling shareholders or actual controllers.

# 2.2. Literature review

# 2.2.1. Supervision of controlling shareholders by independent directors

In emerging markets such as China, the agency problem in companies mainly arises from conflicts of interest between controlling and minority shareholders (La Porta et al., 1998). In this context, independent directors, who are regarded as possessing independence and industry expertise, play a crucial role in alleviating the type II agency problem, and they are thus often the focus of research. Some studies take the perspective of independence and explore how factors such as tenure (Zhang and Huang, 2022), compensation (Lu and Ma, 2021) and social connections (Li et al., 2023) influence the independence of such directors and consequently the effectiveness of their monitoring of controlling shareholders' tunneling. Other studies examine how factors such as professional knowledge (Wang et al., 2016), tenure experience (Chen and Keefe, 2020), social networks (Chen et al., 2014), geographical distance (Sun and Liu, 2014; Luo et al., 2017; Quan and Zhang, 2021) and diligence (Liu et al., 2016) affect the information acquisition of independent directors, thus influencing their ability to monitor tunneling. In addition, some studies investigate the impact of external regulation on the effectiveness of independent directors' supervision of tunneling. For example, He et al. (2023) find that the Comment Letters issued by stock exchanges can serve as a warning to independent directors, motivating them to diligently monitor related-party transactions in other companies in which they hold positions.

# 2.2.2. Reappointed independent directors

Previous literature finds that reappointment can have contrasting effects on independent directors' information acquisition and independence. Reappointed independent directors have more contact with the supervised entities, making it easier for them to obtain information and improving their performance. They can also provide more targeted advice regarding company decisions, thereby improving the quality of corporate governance. Chen and Xiang (2017) define reappointment as involving an initial tenure of three years or more and a cooling-off period of less than three years. After matching reappointed and non-reappointed samples, they find that compared with non-reappointed independent directors, reappointed independent directors significantly reduce related-party transactions, related-party guarantees and earnings management in their first year. Du and Zhang (2021) focus on corporate violations and compare the governance effects of the reappointment term and cooling-off period, and find that during the former, companies have significantly fewer violations than during the latter. However, due to the experience gained in their initial terms, reappointed independent directors may form "acquaintance *guanxi*" with the supervised entities, which may reduce their independence and undermine the company's development (Zheng, 2016). Auditors, whose professional and independence requirements are similar to those of independent directors, may also experience reappointment.

5

Some studies find that auditors' independence when performing audit tasks declines after reappointment, leading to a reduction in audit quality (Zhang et al., 2011; Firth et al., 2012) and an increase in audit fees (Jiang and Tao, 2016).

Our paper makes two main contributions to the literature. First, studies of independent directors' governance of controlling shareholders' tunneling mainly focus on static characteristics such as social ties, professional background, social networks and geographical distance, which typically influence only one aspect of independent directors' willingness or ability to perform their duties. Research on the dynamic characteristics that may have an effect is therefore lacking. We address this gap by focusing on reappointment behavior, which extends the tenure of independent directors and may result in dynamic changes in both their monitoring willingness and ability. Second, the literature on the governance effectiveness of reappointed independent directors presents considerable discrepancies. This is probably due to the failure to control for tenure differences in their first term, which may interfere with their willingness and ability to perform their duties after reappointment. In addition, the length of the cooling-off period may affect the independence and timeliness of information acquisition, which is not sufficiently explored in previous studies. By focusing on independent directors reappointed after a mandatory six-year term rotation, this paper examines the differential effectiveness of monitoring of tunneling before and after reappointment and considers the impact of the cooling-off period.

# 3. Theoretical analysis and hypothesis development

The "single-shareholder dominance" structure is a prevalent and stable governance model for listed companies in China (Liu and Ma, 2016). Although the controlling shareholders of a company directly control the nomination and election of independent directors, drawing on their extensive influence (Zhi and Tong, 2005), the effectiveness of independent directors' monitoring primarily depends on their own motivation and ability (Zhou et al., 2016). Therefore, whether reappointed independent directors can more effectively monitor controlling shareholders and curb tunneling is determined by their willingness and ability after reappointment. Fig. 1 illustrates the theoretical framework of this study.

# 3.1. Monitoring willingness of reappointed independent directors: More proactive or more passive?

Reappointed independent directors' willingness to supervise may change in two distinct ways. Many individuals have a strong need for self-actualization, and independent directors may have higher expectations than others in terms of personal fulfillment, due to their relatively high levels of education and social status. They can contribute to the governance of listed companies through their knowledge, experience and expertise in monitoring and consulting, thereby creating social value. Reappointment indicates to them that their governance abilities are recognized and affirmed by the company's shareholders. Like most individuals, directors



Fig. 1. Theoretical framework.

with higher self-efficacy tend to be more committed to their work, set higher goals and maintain stronger commitments (Bandura, 1977). Reappointed independent directors may undergo a psychological shift from their previous negative perceptions of "part-time roles" or "outsider status" to a more proactive stance, resulting in the more effective fulfillment of their responsibilities in monitoring controlling shareholders, such as identifying and curbing tunneling. Serving as an independent director also provides reputational benefits (Huang et al., 2016). This increased self-efficacy following reappointment may strengthen a director's motivation to protect their reputation by actively monitoring high-risk behaviors that harm minority shareholders, thus avoiding negative and damaging events.

The personal relationships established between independent directors and controlling shareholders during their first term may also increase mutual trust, thereby reducing the independent directors' willingness to monitor controlling shareholders during their reappointment term. "Social capital" refers to the resources invested in social relationships with the expectation of returns (Lin, 1999). To facilitate greater control over the board, controlling shareholders tend to appoint familiar individuals with close personal ties as independent directors (Ning and Zhang, 2012). The initial term of service allows for the further development of friendly personal relationships between both parties. Reappointment can therefore be viewed by controlling shareholders as a reinvestment in these relationships, with the aim of consolidating their social capital. To maintain friendly relations with internal nominators, reappointed independent directors' supervision of controlling shareholders may be only symbolic, thus ensuring that their own interests are not harmed but failing to effectively fulfill their governance responsibilities. Furthermore, within China's distinct guanxi culture, social networks display a hierarchical structure characterized by varying degrees of proximity and distance, along with clear distinctions between insiders and outsiders. When interacting within different "circles," the norms and principles that individuals follow are likely to differ (Fei, 1998). Personal connections may then gradually evolve into a form of social rent. To maintain friendly relations and preserve social face, reappointed independent directors may therefore be less willing to monitor controlling shareholders.

# 3.2. Monitoring ability of reappointed independent directors: Stronger or weaker?

Reappointed independent directors may experience improvements in decision-making power, information access and organizational status, thus enhancing their ability to monitor controlling shareholders. First, independent directors accumulate more experience and company-related information during their first term, which helps them better identify abnormal and often covert behaviors of controlling shareholders, such as tunneling (Li et al., 2005). Most independent directors in China come from academia (Quan and Li, 2017) and generally lack practical experience. Thus, they need more time to understand and adapt to their responsibilities. By the end of their first term, many independent directors may still be in the early or middle stages of their careers, which means that the "learning effect" of reappointment can further enhance their monitoring abilities. Second, they need adequate access to information if they are to effectively perform their duties (Du and Zhang, 2021). In the initial stages of their tenure, independent directors have limited access to company information, which restricts their ability to monitor and provide advice. Managers may be motivated to conceal information from newly appointed independent directors to avoid being supervised, thereby increasing the cost of information acquisition for these directors (Chen and Xiang, 2017). They will then be less likely to effectively perform their monitoring roles (Armstrong et al., 2014). However, reappointed independent directors benefit from the experience and networks they have built during their first terms, thus enabling them to better obtain information and allowing them to supervise more effectively. Finally, long tenures often enable independent directors to become "independent director leaders" and thus gain higher status within the board (Bonini et al., 2022). Longer cumulative tenures better equip reappointed independent directors with the ability and social capital to influence board decision-making and thus monitor tunneling more effectively.

However, the extended terms resulting from reappointment may lead to cognitive rigidity. Reappointed independent directors' curiosity and initiative may gradually decrease, limiting their monitoring effectiveness. Research based on pressure-emotion theory and activation theory suggests that challenging stressors in organizations can motivate individuals to respond proactively (Wang et al., 2019). Independent directors typically face a relatively unfamiliar work environment during their first term. Motivated by the desire to perform their duties effectively, they will more diligently attend meetings and a "learning effect" can occur. However, their

tenure will be indirectly extended through reappointment, which not only leads to a saturation of the learning effect but can reduce the challenges in their roles, potentially leading directors to become complacent and less innovative (Golden and Zajac, 2001). They will then rely more on previous experience in the decision-making process, resulting in a decline in their ability and the effectiveness of their rational decision-making. The extended tenure resulting from reappointment can also strengthen independent directors' sense of identification with their company (Shore et al., 1995), fostering in-group preferences and leading to greater alignment with other board members in collective decision-making. This leads to cognitive entrenchment, making independent directors less sensitive to the issues within the company and thus weakening their ability to monitor tunneling by controlling shareholders. Based on these potential changes in reappointed independent directors' willingness and ability to monitor, we posit the following competing hypotheses:

 $H_{Ia}$ : Compared with their first term, independent directors are more effective in monitoring controlling shareholders during their reappointment term.

 $H_{1b}$ : Compared with their first term, independent directors are less effective in monitoring controlling shareholders during their reappointment term.

# 4. Research design

# 4.1. Sample and data

This study focuses on independent directors on the Shanghai and Shenzhen A-share main boards from 2004 to 2020, who experienced a mandatory six-year rotation during their initial term and were reappointed after a cooling-off period.<sup>4</sup> The sample includes only the years of their first term and reappointment term. Data on the independent directors' personal information, tenure and board voting are manually collected, while other data are sourced from the CSMAR database. The sample excludes (1) companies in the financial and insurance industries; (2) companies with liabilities exceeding the assets; and (3) samples with missing data. Our final sample then consists of 2,519 valid firm-year observations. We winsorize all continuous variables at the 1st and 99th percentiles to minimize the effects of outliers.

#### 4.2. Model and variables

Following previous literature (Chen and Xiang, 2017; Jian and Wong, 2010), we construct Model (1) to examine the difference in the effectiveness of reappointed independent directors' monitoring of tunneling by controlling shareholders before and after reappointment.

$$Tunneling_{f,t} = c_0 + c_1 Back_dummy_{f,t} + \varphi \Sigma Controls + e_{f,t}$$
(1)

In the model, f and t denote firm and year, respectively. The variables are defined as follows:

1. Dependent variable: This study measures tunneling by controlling shareholders using related-party transactions.<sup>5</sup> The specific measurement methods are as follows. (1) Related-party transactions (*RPT*): following Zheng (2009), this is calculated as the ratio of the total annual value of purchases (sales) of goods and provision (receipt) of services between the listed firm and its parent firm along with other firms controlled by the parent firm, scaled by total assets at the end of the year. (2) Significant related-party transactions (*RPT1*): the independent director system stipulates that "significant related-party transactions (transactions

 $<sup>^{4}</sup>$  Considering that board changes may occur earlier or later than scheduled, this paper treats independent directors with tenures between 66 months and 78 months as having served a full 6-year term.

<sup>&</sup>lt;sup>5</sup> The use of controlling shareholder capital occupation and cash dividends to measure tunneling may involve some noise. For example, the "Notice on Further Enhancing the Work of Clearing Controlling Shareholder Capital Occupation in Listed Companies" issued by the CSRC in 2006 explicitly required listed companies to resolve the issue of controlling shareholder capital occupation. The tunneling effect through cash dividends may also be influenced by the split-share structure reform. Before the reform, most shares held by controlling shareholders were non-tradable, so the stock price decline caused by cash dividends had little impact on their interests. However, after the split-share structure reform, controlling shareholders' shares became tradable, thus reducing their motivation to tunnel through cash dividend payouts.

where the total amount between the listed firm and related parties exceeds 3 million yuan or 5 % of the latest audited net assets of the listed firm) must be pre-approved by independent directors." Therefore, we calculate the ratio of the annual value of significant related-party transactions involving goods and services between the listed firm and its parent firm or other firms controlled by the parent firm, scaled by total assets at the end of the year; and (3) abnormal related-party purchases and sales (*RPT2*). However, related-party transactions may include normal business transactions, so following Jian and Wong (2010), we perform cross-sectional regressions for each industry and year of the related-party transactions using the listed firm's total assets, financial leverage and market-to-book ratio at the end of the year, with the residuals serving as a measure of abnormal related-party purchases and sales.

- 2. Independent variable: This is the reappointment of independent directors (*Back\_dummy*), which equals 1 if the company has reappointed independent directors in their reappointment term in year t, and 0 otherwise
- 3. Control variables: Following the literature (Chen and Xiang, 2017; Zheng, 2009), our control variables are firm size (Size), concentration of ownership (Top1), board size (Boardsize), proportion of independent directors (Rindirector), Tobin's Q (Tobin's Q), financial leverage (Lev), firm age (Firm\_Age), institutional investor ownership ratio (InsInvestor), cash holdings (Cash), return on equity (ROE), the nature of property rights (SOE), whether the firm is audited by a Big4 firm (Big4), duality (Dual) and the presence of a loss (Loss). To better control for potential endogeneity due to omitted variables, the regressions control for year and firm fixed effects. The definitions of the variables are provided in Table 1.

# 5. Empirical analysis

# 5.1. Descriptive statistics

Table 2 reports the descriptive statistics for the main variables. The data show that the mean of *RPT1* is 0.051, indicating that the majority of related-party transactions between listed firms and controlling shareholders are significant. The mean of *Back\_dummy* is 0.442, suggesting that 44.2 % of the sample observations are within the reappointment term; this proportion is slightly smaller than that of observations in the first term. During the sample period, the average ownership stake of the largest shareholder is 36.3 %, indicating that, on average, the controlling shareholders can exert a significant influence on the company. The average size of the board is 9.415 members. In addition, 61.7 % of the companies are state-owned and the average proportion of firms where the chairman and CEO are the same person is 15.9 %.

# 5.2. Multivariate regression analysis

Table 3 presents the baseline regression results for related-party transactions between listed firms and controlling shareholders in the periods before and after the reappointment of independent directors. Columns (1) to (3) show that the coefficients of *Back\_dummy* are positive at a high significance level of 5 %. These results indicate that compared with the first term, the effectiveness of independent directors' supervision of controlling shareholders declines after reappointment, as evidenced by a notable increase in tunneling through relatedparty transactions. The results support H<sub>1b</sub>, which states that independent directors are less effective in monitoring controlling shareholders during their reappointment terms than in their first terms.

# 5.3. Robustness tests

# 5.3.1. Test for omitted variables at the independent director level

Changes in independent directors' personal characteristics over time may influence their monitoring effectiveness (Masulis and Zhang, 2019). To address any potential endogeneity issues arising from omitted variables at the independent director level, we further compare the differences in the monitoring effectiveness of independent directors during their first term at one firm and of those during their reappointment term at another firm concurrently. The variable *Match* is a dummy variable that equals 1 if the firm is appointing an independent director for the first time and 0 if it is reappointing the independent director during the same

Table 1 Variable definitions.

Variable type	Variable	Definition
Dependent variable		
Firm level	RPT	The ratio of the total annual value of purchases (sales) of goods and provision (receipt) of services between the listed firm and its parent firm along with other firms controlled by the parent firm scaled by total assets at the end of the year.
	RPT1	The ratio of the annual value of significant related-party transactions involving goods and services between the listed firm and its parent firm or other firms controlled by the parent firm scaled by total assets at the end of the year
	RPT2	The residuals from the cross-sectional regressions for each industry and year of the related-party transactions using the listed firm's total assets, financial leverage and market to book ratio at the end of the year.
	C_medRPT	Industry-adjusted <i>RPT</i> is equal to <i>RPT</i> minus the median of <i>RPT</i> in the same industry for the current year.
	C_medRPT1	Industry-adjusted <i>RPT1</i> is equal to <i>RPT1</i> minus the median of <i>RPT1</i> in the same industry for the current year.
	C_medRPT2	Industry-adjusted <i>RPT2</i> is equal to <i>RPT2</i> minus the median of <i>RPT2</i> in the same industry for the current year.
	RPT_Good	The ratio of the monetary value of supportive-related transactions scaled by total assets at the end of the year.
	RPT_Bad	The ratio of the monetary value of tunneling-related transactions scaled by total assets at the end of the year.
Director level	Attend_Meeting	The ratio of meetings personally attended by an independent director scaled by the total number of meetings the independent director is required to attend during the year.
	Dissent	A dummy variable that equals 1 if an independent director issues any opinion other than "Agreement" during the year and 0 otherwise.
Te day and and a multiple	Dissent1	A dummy variable that equals 1 if an independent director dissents to proposals related to controlling shareholders and 0 otherwise.
Independent variable Firm level	Back_dummy	A dummy variable that equals 1 if the firm has reappointed independent directors in their reappointment term in year t and 0 otherwise.
	Back_dummy_6 + 6	A dummy variable that equals 1 if the firm has reappointed independent directors in their reappointment term who served full six-year terms in both their first term and reappointed term and 0 otherwise.
	Back_dummy_Non6 + 6	A dummy variable that equals 1 if the firm has reappointed independent directors in their reappointment term who served only a full six-year first term and 0 otherwise.
	Back_dummy_NonExceed	A dummy variable that equals 1 if the firm has reappointed independent directors in their reappointment term whose reappointments with an average cooling-off period of
	Back_dummy_Exceed	A dummy variable that equals 1 if the firm has reappointed independent directors in their reappointment term whose reappointments with an average cooling-off period of
	Match	A dummy variable that equals 1 if the firm is appointing an independent director for the first time and 0 if it is reappointing the independent director during the same
	Back	A dummy variable that equals 1 if a firm has ever reappointed independent directors (treatment group) and 0 if a matched firm has never reappointed independent directors
	Post	(control group). A dummy variable for the period during which independent directors are reappointed. The dummy variable equals 1 for both treatment and control groups if the year is during the reappointment term, while it equals 0 for both groups if the year is during the first term.
Director level	Sameperiod	A dummy variable that equals 1 for reappointed independent directors during their first term and 0 for other independent directors serving concurrently in the same
	Back_ID	A dummy variable for reappointment that equals 1 if the independent director is within the reappointment term or 0 if within the first term.

(continued on next page)

Table 1	(continued	)
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Variable type	Variable	Definition
Control variables		
Firm level	Size	The natural logarithm of total assets at the end of the year.
	Top1	The ratio of shares held by the largest shareholder scaled by the total number of shares at the end of the year
	Roardsize	The number of directors on the board for the current year
	Rindirector	The proportion of independent directors on the board for the current year.
	Tobin's Q	The market value of total assets scaled by the book value of total assets at the end of the year.
	Lev	Interest-bearing debt scaled by total assets at the end of the year.
	Firm_Age	The natural logarithm of one plus firm age.
	InsInvestor	The ratio of shares held by institutional investors scaled by the total number of shares at the end of the year.
	Cash	Cash holdings scaled by total assets at the end of the year.
	ROE	Net income scaled by equity at the end of the year.
	SOE	A dummy variable that equals 1 if the firm is state-owned and 0 otherwise.
	Big4	A dummy variable that equals 1 if the firm is audited by Big4 and 0 otherwise.
	Dual	A dummy variable that equals 1 if the board chairman and $\tilde{CEO}$ are the same person and 0 otherwise.
	Loss	A dummy variable that equals 1 if the firm experiences a loss in year t and 0 otherwise.
Director level	Meeting	The total number of meetings that an independent director should attend that year.
	Indir_Age	The natural logarithm of an independent director's age at the end of the year.
	Indir_Pay	The total compensation of an independent director for the current year (in ten thousand yuan).
	Education	Education level of independent directors: 5 for a doctoral degree, 4 for a master's degree, 3 for a bachelor's degree, 2 for an associate degree and 1 otherwise.
	Indir_Acc	A dummy variable that equals 1 if an independent director with an accounting or financial background and 0 otherwise.
	Busy	A dummy variable that equals 1 if an independent director has more than two directorships in year t and 0 otherwise.
	Interval_time	The years of the cooling-off period. The number of years between the mandatory rotation of a reappointed independent director (the expiration of first term) and their reappointment to the company (reappointment term).
	Gender	A dummy variable that equals 1 if an independent director is female and 0 otherwise.

period. The statistics show that in approximately 37.63 % of the sample, *Match* equals 1. The results in Table 4 show that the coefficients of *Match* are significant and negative.<sup>6</sup> This indicates that within the same period, independent directors' monitoring during their first term is significantly more effective than in the reappointment term, thus ruling out any potential interference of omitted variables at the independent director level.

#### 5.3.2. Test for omitted variables at the firm level

Our results may also be influenced by other time-varying unobservable factors at the firm level. For example, changes in the business operations of listed firms can influence tunneling. To reduce the potential endogeneity, we construct a matched sample and perform a staggered difference-in-differences (DID) test. Following Wu and Ye (2020), we use propensity score matching to calculate the propensity scores (Pscores) for both reappointed and non-reappointed firms for each year. Firms that have P-scores closest to

 $<sup>^{6}</sup>$  In the tests presented in Table 4, the value of *Match* remains constant across the years for the same company. The regression coefficients of *Match* are dropped when using firm fixed effects. Therefore, we control for industry and year fixed effects instead in Table 4.

11

Table 2	
Descriptive	statistics.

Variable	Obs.	Mean	STD	Min	P25	P50	P75	Max
RPT	2519	0.052	0.144	0.000	0.000	0.002	0.034	0.959
RPT1	2519	0.051	0.143	0.000	0.000	0.001	0.033	0.953
RPT2	2519	0.002	0.112	-0.154	-0.042	-0.017	0.001	0.589
Back_dummy	2519	0.442	0.497	0.000	0.000	0.000	1.000	1.000
Size	2519	22.392	1.339	19.189	21.418	22.283	23.161	26.477
Top1	2519	0.363	0.158	0.090	0.236	0.347	0.497	0.770
Boardsize	2519	9.415	2.090	4.000	9.000	9.000	11.000	18.000
Rindirector	2519	0.369	0.054	0.273	0.333	0.333	0.400	0.571
Tobin's Q	2519	1.754	1.165	0.843	1.114	1.360	1.943	10.192
Lev	2519	0.235	0.166	0.000	0.091	0.230	0.360	0.649
Firm_Age	2519	2.810	0.378	1.792	2.565	2.890	3.091	3.497
InsInvestor	2519	0.540	0.186	0.028	0.414	0.554	0.671	0.930
Cash	2519	0.159	0.105	0.007	0.087	0.131	0.205	0.574
ROE	2519	0.063	0.161	-1.357	0.031	0.070	0.125	0.378
SOE	2519	0.617	0.486	0.000	0.000	1.000	1.000	1.000
Big4	2519	0.081	0.272	0.000	0.000	0.000	0.000	1.000
Dual	2519	0.159	0.366	0.000	0.000	0.000	0.000	1.000
Loss	2519	0.089	0.284	0.000	0.000	0.000	0.000	1.000

the reappointing firms in the same region, industry and year are selected as the control group, while the reappointing firms form the treatment group.<sup>7</sup> We then conduct a staggered DID test using the matched control and treatment groups. *Back* is a dummy variable that equals 1 if a firm has ever reappointed independent directors (treatment group) and 0 if a matched firm has never reappointed independent directors (control group). *Post* is a dummy variable for the period during which independent directors are reappointed. The dummy variable equals 1 for both treatment and control groups if the year is during the reappointment term, while it equals 0 for both groups if the year is during the first term. Table 5 presents the results, showing that the coefficients of *Back\*Post* are significant and positive. This suggests that compared with non-reappointing firms, the related-party transactions in reappointing firms significantly increase after reappointment. This indicates that our findings remain robust after controlling for any endogeneity arising from omitted firm-level variables. Additionally, this test mitigates potential sample selection bias due to systematic differences between reappointing and non-reappointing firms.

# 5.3.3. Test for reappointed independent directors as weak monitors

Our conclusions may also be affected by reverse causality. For instance, controlling shareholders may be more inclined to reappoint weaker independent directors if they are motivated to expropriate the interests of minority shareholders. To further mitigate endogeneity concerns, we compare the monitoring behavior of reappointed independent directors during their first term with that of other independent directors at the same firm during the same period. If reappointed independent directors attend fewer board meetings or cast fewer dissenting votes compared with other independent directors, this suggests that they are weaker monitors.

In Table 6, the *Sameperiod* variable equals 1 for reappointed independent directors during their first term and 0 for other independent directors serving concurrently in the same company. In addition to some of the firm-level control variables that are used in Model (1), we control for the personal characteristics of independent directors, including the total number of meetings required (*Meeting*), their age (*Indir\_Age*), their compensation (*Indir\_Pay*), their educational background (*Education*), their accounting and finance expertise (*Indir\_Acc*) and whether they are considered to be busy (*Busy*). The results shown in Table 6 indicate that

<sup>&</sup>lt;sup>7</sup> To ensure that all observations before and after reappointment in the treatment group have matched samples and to eliminate the influence of time trends, we require that during the matching process, reappointing companies (treatment group) and their matched non-reappointing companies (control group) have observations in the same years before and after reappointment.

Variable	(1)	(2)	(3)
	RPT	RPT1	RPT2
Back_dummy	0.018**	0.018**	0.017**
	(2.312)	(2.307)	(2.532)
Size	-0.024***	-0.023***	-0.026***
	(-4.183)	(-4.123)	(-5.590)
Top1	0.131***	0.129***	0.136***
	(3.092)	(3.069)	(3.839)
Boardsize	0.001	0.001	0.000
	(0.673)	(0.690)	(0.161)
Rindirector	-0.079	-0.077	-0.083*
	(-1.336)	(-1.317)	(-1.727)
Tobin's Q	-0.000	-0.000	-0.003
	(-0.132)	(-0.130)	(-1.185)
Lev	-0.006	-0.006	0.016
	(-0.281)	(-0.301)	(0.986)
Firm_Age	-0.111***	-0.109***	-0.074***
	(-3.513)	(-3.467)	(-2.887)
InsInvestor	-0.009	-0.008	-0.029*
	(-0.450)	(-0.428)	(-1.752)
Cash	0.062**	0.062**	0.041*
	(2.086)	(2.095)	(1.839)
ROE	0.001	0.001	0.010
	(0.056)	(0.059)	(0.719)
SOE	0.022	0.021	0.013
	(1.368)	(1.341)	(0.966)
Big4	0.027*	0.027*	0.013
	(1.779)	(1.809)	(1.111)
Dual	0.011**	0.011**	0.009**
	(2.378)	(2.357)	(2.130)
Loss	-0.002	-0.002	-0.001
	(-0.211)	(-0.204)	(-0.118)
Constant	0.834***	0.819***	0.763***
	(5.246)	(5.163)	(5.798)
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	2519	2519	2519
Within_R <sup>2</sup>	0.040	0.039	0.047

Table 3			
Reappointment of independent	directors and	related-party	transactions.

*Note:* t-values are reported in brackets. \*, \*\* and \*\*\* represent significance at the 10%, 5% and 1% levels, respectively.

the coefficient of *Sameperiod* is positive at a high significance level of 1 % with respect to *Attend\_Meeting*, but not significant with respect to *Dissent*. This suggests that compared with other independent directors serving concurrently at the firm, reappointed independent directors during their first term do not significantly reduce their dissenting votes. Conversely, they are more proactive in attending board meetings, thereby ruling out the alternative explanation that reappointed independent directors are weak monitors.

# 5.3.4. Test for industry heterogeneity

To address the potential impact of industry characteristics on tunneling by controlling shareholders through related-party transactions (Hou et al., 2017), we use industry-adjusted related-party transaction indicators as the dependent variables. As shown in Table 7, the coefficients of *Back\_dummy* are positive at a high
Variable	(1)	(2)	(3)
	RPT	RPT1	RPT2
Match	-0.014**	-0.014**	-0.009*
	(-2.168)	(-2.150)	(-1.792)
Size	-0.009**	-0.009**	-0.016***
	(-2.258)	(-2.195)	(-5.437)
Top1	0.044*	0.043*	0.067***
*	(1.764)	(1.736)	(3.086)
Boardsize	-0.000	-0.000	0.000
	(-0.254)	(-0.258)	(0.309)
Rindirector	0.062	0.063	0.050
	(1.472)	(1.505)	(1.375)
Tobin's Q	0.003	0.003	0.002
	(1.173)	(1.131)	(0.738)
Lev	-0.016	-0.016	-0.009
	(-0.958)	(-0.971)	(-0.655)
Firm_Age	0.004	0.004	0.012
	(0.359)	(0.377)	(1.187)
InsInvestor	0.085***	0.085***	0.059***
	(3.652)	(3.654)	(3.392)
Cash	0.002	0.003	-0.006
	(0.118)	(0.125)	(-0.341)
ROE	0.005	0.004	0.007
	(0.334)	(0.315)	(0.630)
SOE	0.038***	0.038***	0.033***
	(7.681)	(7.618)	(8.000)
Big4	0.021	0.021	0.018
	(1.597)	(1.577)	(1.592)
Dual	0.002	0.002	-0.001
	(0.328)	(0.347)	(-0.089)
Loss	0.006	0.006	0.002
	(0.524)	(0.517)	(0.273)
Constant	0.121	0.114	0.242***
	(1.279)	(1.211)	(3.327)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	1783	1783	1783
$Adj_R^2$	0.112	0.111	0.101

Table 4Test for omitted variables at the independent director level.

significance level of 5 %. These findings indicate that the primary conclusions of our study remain robust after controlling for industry heterogeneity.

#### 5.3.5. Test for the influence of voluntary resignation of reappointed independent directors

Although the baseline regression controls for reappointed independent directors serving a six-year first term, it does not impose a specific length for the reappointed term, and thus potential interference from voluntary resignations during the reappointed term remain unaddressed. Reappointed independent directors (*Back\_dummy*) are divided into two categories: those who served full six-year terms in both their first term and reappointed term (*Back\_dummy\_6 + 6*) and those who served only a full six-year first term (*Back\_dummy\_Non6 + 6*). The regression results shown in Table 8<sup>8</sup> indicate that the coefficients of

<sup>&</sup>lt;sup>8</sup> In Table 8, the sample is smaller than that of the baseline regression because observations where both *Back\_dummy\_6+6* and *Back\_dummy\_Non6+6* equal 1 are excluded. This exclusion is necessary, as the simultaneous occurrence of both variables equaling 1 makes it challenging to differentiate the governance effects after reappointment.

Variable	(1) <i>RPT</i>	(2) <i>RPT1</i>	(3) <i>RPT2</i>
Back*Post	0.012**	0.012**	0.009*
	(2.095)	(2.072)	(1.956)
Post	-0.006	-0.007	-0.004
	(-0.975)	(-0.983)	(-0.716)
Size	-0.005	-0.004	-0.015***
	(-1.127)	(-1.011)	(-4.245)
Top1	0.087***	0.086***	0.070***
	(2.707)	(2.684)	(2.680)
Boardsize	0.003	0.003	0.002
	(1.496)	(1.495)	(1.253)
Rindirector	-0.126***	-0.125***	-0.128***
	(-2.724)	(-2.715)	(-3.418)
Tobin's Q	0.004**	0.004**	-0.001
	(2.112)	(2.116)	(-0.583)
Lev	-0.041**	-0.041**	0.006
	(-1.997)	(-2.014)	(0.389)
Firm_Age	-0.037	-0.037	-0.008
	(-1.297)	(-1.270)	(-0.348)
InsInvestor	-0.035**	-0.034**	-0.025*
	(-2.049)	(-2.032)	(-1.776)
Cash	0.040**	0.040**	0.034**
	(2.141)	(2.147)	(2.247)
ROE	0.023*	0.023*	0.021**
	(1.926)	(1.927)	(2.154)
SOE	0.027**	0.027**	0.017*
	(2.404)	(2.384)	(1.896)
Big4	0.006	0.007	0.004
	(0.467)	(0.499)	(0.446)
Dual	0.012**	0.012**	0.007
	(2.320)	(2.297)	(1.610)
Loss	0.004	0.004	0.002
	(0.494)	(0.508)	(0.323)
Constant	0.249**	0.235*	0.355***
	(1.992)	(1.885)	(3.514)
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	4428	4428	4428
Within_R <sup>2</sup>	0.023	0.022	0.022

Table 5Test for omitted variables at the firm level.

 $Back\_dummy\_6 + 6$  are positive at a high significance level of 1 %. These findings suggest that the conclusions of our baseline regression remain robust.

# 5.3.6. Test for the alternative explanation of supportive related-party transactions

Controlling shareholders may engage in related-party transactions to support the development of listed companies rather than expropriating their interests. To rule out this alternative explanation, we follow the approach of Cheung et al. (2006) and classify related-party transactions into tunneling-related and supportive-related transactions, and examine the changes in these two types of transactions before and after reappointment. Specifically, transactions such as asset acquisitions or sales, equity transactions, sales (purchases) of goods, provision (receipt) of services and loans or cash guarantees provided by listed firms to related parties are categorized as tunneling-related transactions. Direct cash loans or financial assistance from related

Variable	(1)	(2)
	Attend_Meeting	Dissent
Sameperiod	0.016***	-0.003
-	(5.163)	(-0.816)
Meeting	0.003***	0.001**
	(5.379)	(1.975)
Indir_Age	0.002	-0.003
	(0.167)	(-0.266)
Indir_pay	-0.001	0.000
	(-0.658)	(0.691)
Education	-0.011***	-0.001
	(-5.285)	(-0.401)
Indir_Acc	0.013***	0.003
	(4.311)	(0.965)
Busy	-0.007	0.005
	(-1.452)	(0.946)
Boardsize	-0.000	-0.000
	(-0.100)	(-0.065)
Rindirector	0.058	0.001
	(1.099)	(0.016)
Lev	-0.010	-0.005
	(-0.431)	(-0.213)
Size	0.009	-0.008
	(1.325)	(-1.293)
ROE	-0.017	-0.010
	(-1.310)	(-0.686)
Top1	0.015	0.008
	(0.424)	(0.343)
Growth	0.000	-0.008*
	(0.003)	(-1.749)
Big4	-0.017	-0.004
0	(-1.101)	(-1.198)
SOE	-0.010	0.030
	(-0.811)	(1.616)
Dual	-0.020**	0.010
	(-2.256)	(1.273)
Constant	0.744***	0.175
	(4.747)	(1.334)
Year	Yes	Yes
Firm	Yes	Yes
Ν	4653	4653
Within_ $R^2$	0.029	0.004

Table 6 Test for reappointed independent directors as weak monitors.

parties to listed firms, along with equity and asset transactions between listed firms and their subsidiaries, are categorized as supportive-related transactions. The level of tunneling-related transactions is measured by the ratio of the monetary value of these transactions scaled by total assets at the end of the year ( $RPT\_Bad$ ), while the level of supportive-related transactions is measured by the ratio of their monetary value scaled by total assets at the end of the year ( $RPT\_Bad$ ), while assets at the end of the year ( $RPT\_Good$ ). These two variables are introduced to Model (1) as dependent variables for the regression analysis.

As presented in Table 9, the coefficient of  $Back\_dummy$  is positive at a significance level of 10 % with respect to  $RPT\_Bad$ , whereas the coefficient is not significant with respect to  $RPT\_Good$ . These results suggest

Variable	(1)	(2)	(3)
	$C_medRPT$	C_medRPT1	C_medRPT2
Back_dummy	0.018**	0.018**	0.017**
	(2.297)	(2.298)	(2.502)
Size	-0.023***	-0.023***	-0.027***
	(-4.130)	(-4.063)	(-5.761)
Top1	0.129***	0.127***	0.136***
*	(3.057)	(3.024)	(3.877)
Boardsize	0.001	0.001	0.000
	(0.583)	(0.605)	(0.195)
Rindirector	-0.083	-0.082	-0.076
	(-1.415)	(-1.393)	(-1.586)
Tobin's Q	-0.000	-0.000	-0.004
	(-0.121)	(-0.123)	(-1.392)
Lev	-0.004	-0.004	0.021
	(-0.183)	(-0.210)	(1.260)
Firm_Age	-0.101***	-0.101***	-0.082***
	(-3.207)	(-3.202)	(-3.207)
InsInvestor	-0.013	-0.012	-0.015
	(-0.661)	(-0.618)	(-0.894)
Cash	0.064**	0.064**	0.041*
	(2.113)	(2.113)	(1.837)
ROE	0.001	0.001	0.010
	(0.056)	(0.056)	(0.783)
SOE	0.022	0.022	0.011
	(1.405)	(1.369)	(0.786)
Big4	0.024	0.025*	0.014
	(1.612)	(1.648)	(1.138)
Dual	0.012**	0.011**	0.008*
	(2.528)	(2.494)	(1.952)
Loss	-0.002	-0.001	-0.001
	(-0.164)	(-0.148)	(-0.107)
Constant	0.801***	0.791***	0.814***
	(5.019)	(4.956)	(6.256)
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	2519	2519	2519
Within_ $R^2$	0.038	0.037	0.049

Table 7 Test for industry heterogeneity.

that independent directors exhibit significantly reduced monitoring effectiveness over tunneling-related transactions after reappointment. This finding eliminates the alternative explanation of related-party transactions.<sup>9</sup>

#### 5.3.7. Test for changes in actual controllers

Changes in actual controllers often accompany shifts in a company's fundamentals, such as business activities and industry focus (Hong et al., 2024). Following a change in a company's actual controller, reappointed independent directors may need to revise their understanding of the company. Their role becomes more akin to that during their first term. Therefore, if our findings are valid, the supervision outcomes of reappointed independent directors should not be significantly different from those in their initial term. We divides the sam-

<sup>&</sup>lt;sup>9</sup> In addition, following Jiang et al. (2015), we also conduct tests using changes in the company's operating performance. We find that, compared with the first term, the company's operating performance significantly deteriorates in the reappointment term. This result indirectly supports the idea that controlling shareholders may exploit related-party transactions to expropriate the interests of the listed firms after reappointing independent directors.

Variable	(1)	(2)	(3)
( unuole	RPT	RPT1	RPT2
Back_dummy_6 + 6	0.028***	0.028***	0.026***
	(2.900)	(2.899)	(3.266)
Back_dummy_Non6 + 6	0.013	0.013	0.012*
	(1.626)	(1.619)	(1.772)
Size	-0.024***	-0.024***	-0.026***
	(-4.086)	(-4.028)	(-5.400)
Top1	0.129***	0.128***	0.135***
1	(3.049)	(3.027)	(3.813)
Boardsize	0.001	0.002	0.000
	(0.691)	(0.708)	(0.206)
Rindirector	-0.082	-0.080	-0.087*
	(-1.351)	(-1.331)	(-1.749)
Tobin's O	-0.000	-0.000	-0.003
~	(-0.073)	(-0.070)	(-1.126)
Lev	-0.007	-0.007	0.015
	(-0.331)	(-0.351)	(0.897)
Firm_Age	-0.109***	-0.107***	-0.072***
_ 0	(-3.436)	(-3.390)	(-2.797)
InsInvestor	-0.007	-0.007	-0.030*
	(-0.381)	(-0.359)	(-1.767)
Cash	0.064**	0.064**	0.043*
	(2.096)	(2.105)	(1.855)
ROE	0.000	0.001	0.009
	(0.029)	(0.033)	(0.637)
SOE	0.023	0.023	0.014
	(1.499)	(1.472)	(1.073)
Big4	0.027*	0.028*	0.013
0	(1.707)	(1.738)	(0.994)
Dual	0.012**	0.012**	0.010**
	(2.486)	(2.467)	(2.203)
Loss	-0.002	-0.002	-0.001
	(-0.248)	(-0.239)	(-0.175)
Constant	0.834***	0.819***	0.761***
	(5.118)	(5.036)	(5.600)
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	2478	2478	2478
Within_ $R^2$	0.044	0.043	0.052

 Table 8

 Test for the influence of voluntary resignation of reappointed independent directors.

ple into groups based on whether the firm's actual controller changed or not before and after the reappointment.

Table 10 presents the results. In the group where the actual controller did not change, the coefficients of *Back\_dummy* are positive at a high significance level of 1 %. Conversely, in the group where the actual controller changed, the coefficients of *Back\_dummy* are not significant and are smaller than those in the unchanged group. This finding suggests that a change of actual controller can mitigate the weakening of reappointed independent directors' supervision over controlling shareholders, partially supporting the conclusions of this paper.

Variable	(1)	(2)
	RPT_Bad	RPT_Good
Back_dummy	0.016*	0.007
_ ,	(1.742)	(1.003)
Size	-0.025***	-0.002
	(-3.565)	(-0.520)
Top1	0.057	-0.017
*	(1.216)	(-0.695)
Boardsize	0.002	-0.001
	(1.215)	(-0.838)
Rindirector	-0.104	0.041
	(-1.613)	(1.042)
Tobin's Q	-0.000	0.003**
-	(-0.026)	(2.012)
Lev	0.029	0.068***
	(1.143)	(3.535)
Firm_Age	-0.106***	0.028*
	(-3.249)	(1.798)
InsInvestor	0.032	-0.004
	(1.355)	(-0.323)
Cash	0.045	-0.021
	(1.299)	(-1.156)
ROE	-0.029	-0.035*
	(-1.045)	(-1.816)
SOE	0.010	0.021**
	(0.564)	(2.339)
Big4	0.018	0.014
-	(1.004)	(1.444)
Dual	0.004	-0.002
	(0.818)	(-0.537)
Loss	-0.006	-0.009
	(-0.534)	(-1.384)
Constant	0.857***	-0.040
	(4.667)	(-0.402)
Firm	Yes	Yes
Year	Yes	Yes
Ν	2519	2519
Within_ $R^2$	0.021	0.035

Table 9				
Test for the alternative ex	xplanation of s	supportive related	l-party transa	actions.

# 6. Additional analysis

# 6.1. Mechanism test

Reappointed independent directors primarily participate in corporate governance by attending board meetings, where dissenting on proposals serves as a tangible reflection of their monitoring willingness and ability. To further investigate the monitoring effectiveness of reappointed directors, we follow Quan and Zhang (2021) in constructing Model (2) to examine attendance and dissenting across different terms of appointment. In the

Table 10 Test for changes in actual controllers.

	(1)	(2)	(3)	(4)	(5)	(6)
	RPT	RPT	RPT1	RPT1	RPT2	RPT2
	Unchanged	Changed	Unchanged	Changed	Unchanged	Changed
Back_dummy	0.028***	0.006	0.028***	0.006	0.024***	0.013
	(2.839)	(0.562)	(2.825)	(0.571)	(3.017)	(1.097)
Size	-0.024***	-0.018*	-0.023***	-0.017*	-0.023***	-0.027***
	(-3.548)	(-1.712)	(-3.508)	(-1.670)	(-4.390)	(-3.065)
Top1	0.136**	0.111**	0.134**	0.109**	0.145***	0.108**
*	(2.098)	(2.203)	(2.087)	(2.184)	(2.848)	(2.381)
Boardsize	0.002	-0.001	0.003	-0.001	0.001	-0.002
	(0.892)	(-0.278)	(0.916)	(-0.303)	(0.696)	(-0.830)
Rindirector	-0.098	-0.029	-0.098	-0.026	-0.104*	-0.034
	(-1.194)	(-0.385)	(-1.199)	(-0.341)	(-1.664)	(-0.455)
Tobin's Q	-0.001	0.003	-0.001	0.002	-0.003	-0.003
-	(-0.404)	(0.356)	(-0.389)	(0.336)	(-1.138)	(-0.450)
Lev	-0.008	-0.051	-0.009	-0.051	0.016	-0.031
	(-0.324)	(-1.502)	(-0.344)	(-1.498)	(0.841)	(-1.056)
Firm_Age	-0.162***	0.005	-0.159***	0.005	-0.097**	0.001
	(-3.184)	(0.136)	(-3.145)	(0.132)	(-2.483)	(0.036)
InsInvestor	-0.047*	0.041	-0.047*	0.042	-0.073***	0.036
	(-1.820)	(1.399)	(-1.805)	(1.425)	(-3.497)	(1.229)
Cash	0.047	0.072*	0.047	0.073*	0.019	0.064
	(1.154)	(1.815)	(1.155)	(1.842)	(0.709)	(1.564)
ROE	0.010	0.005	0.010	0.005	0.011	0.016
	(0.511)	(0.177)	(0.524)	(0.179)	(0.726)	(0.696)
SOE	0.018	0.025	0.017	0.025	0.006	0.020
	(0.652)	(1.434)	(0.625)	(1.409)	(0.298)	(1.241)
Big4	0.027	0.011	0.027	0.011	0.020	-0.015
	(1.382)	(0.527)	(1.421)	(0.504)	(1.403)	(-0.702)
Dual	0.012**	0.009	0.012**	0.009	0.010**	0.006
	(2.200)	(1.095)	(2.202)	(1.067)	(2.119)	(0.715)
Loss	-0.015	0.026	-0.015	0.027	-0.009	0.018
	(-1.446)	(1.355)	(-1.451)	(1.375)	(-1.032)	(1.096)
Constant	1.001***	0.347	0.984***	0.336	0.789***	0.540**
	(5.427)	(1.175)	(5.356)	(1.139)	(5.605)	(2.084)
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ν	1711	808	1711	808	1711	808
Within_ $R^2$	0.051	0.047	0.051	0.047	0.058	0.057
P-Value		0.000***		0.000***		0.030**

model, f, i and t denote firm, independent director and year, respectively. The dependent variables at the individual level include *Attend\_Meeting*, *Dissent* and *Dissent1*, which denote meeting attendance, dissenting behavior and dissenting on proposals related to controlling shareholders,<sup>10</sup> respectively.

$$Attend\_Meeting_{f,i,t}/Dissent_{f,i,t}/Dissent_{f,i,t} = b_0 + b_1Back\_ID_{f,i,t} + \gamma\Sigma Controls + \varepsilon_{f,i,t}$$
(2)

Attend\_Meeting refers to the ratio of meetings personally attended by an independent director scaled by the total number of meetings the independent director is required to attend during the year. Independent directors are required to issue opinions on various proposals, including "Agreement," "Qualified opinion," "Adverse opinion," "Disclaimer," "Abstention" and "Others." Following Zhu et al. (2015), the variable *Dissent* is a

<sup>&</sup>lt;sup>10</sup> Proposals related to controlling shareholders include related-party transactions, material assets acquisitions, guarantees, equity transfers and profit distribution, etc.

dummy variable that equals 1 if the director issued any opinion other than "Agreement" during the year, and 0 otherwise. Similarly, *Dissent1* equals 1 if an independent director dissents on proposals related to controlling shareholders, and 0 otherwise. The variable *Back\_ID* is a dummy variable for reappointment that equals 1 if the independent director is within the reappointment term or 0 if within the first term. The controls encompass a series of variables. In addition to some of the firm-level control variables used in Model (1), we control for additional individual-level variables, following Quan and Chen (2016). These include the years of the cooling-off period (*Interval\_time*), the total number of meetings required (*Meeting*), the ages of independent directors (*Indir\_Age*), their compensation (*Indir\_Pay*), educational background (*Education*), accounting and finance expertise (*Indir\_Acc*) and whether they are considered to be busy (*Busy*). The regressions control for year and firm fixed effects.

As shown in Column (1) of Table 11, the coefficient of *Back\_ID* is not significant with respect to *Attend\_Meeting*, indicating that reappointed independent directors do not significantly reduce their attendance relative to their first term. However, Columns (2) and (3) reveal that the coefficients of *Back\_ID* are significant and negative with respect to *Dissent* and *Dissent1*, suggesting that reappointed independent directors are less likely to oppose proposals related to controlling shareholders during their reappointment term.

# 6.2. Heterogeneity analysis

#### 6.2.1. Test for the monitoring willingness and ability of reappointed independent directors

The location and professional expertise of independent directors may independently affect their monitoring willingness and ability. First, as they are distant from the company's local information network, non-local independent directors face greater challenges in accessing company-related information (Sun and Liu, 2014). They also face significantly higher costs in terms of time and effort for activities such as site visits and board meetings, which reduces their motivation to actively participate in monitoring (Masulis et al., 2012). Therefore, we hypothesize that non-local independent directors will be less willing to engage in monitoring than local directors, resulting in less effective monitoring of controlling shareholders' expropriation after reappointment.

Second, professional expertise can have a major influence on the governance effectiveness of independent directors (Zhou et al., 2019). Directors with specialized knowledge are more familiar with issues in their professional domains and provide more targeted advice. Given that the methods used by controlling shareholders to expropriate resources from listed companies often involve specialized finance and law knowledge (Wang et al., 2016), independent directors with financial or legal expertise are likely to better detect such behavior. Therefore, we hypothesize that independent directors with such expertise have a greater monitoring ability, thus mitigating the decline in monitoring effectiveness after reappointment.

To examine the differences in monitoring willingness, we divide the sample based on whether reappointed independent directors' workplaces are located in the same city as the listed firms' headquarters. The resulting groups are the "low monitoring willingness group" (non-local directors) and the "high monitoring willingness group" (local directors). Panel A of Table 12 shows that in the low monitoring willingness group, the coefficients of *Back\_dummy* are positive and significant. Conversely, in the high monitoring willingness group, these coefficients are not significant and smaller than those for the low monitoring willingness group. These findings indicate that non-local independent directors are significantly less willing to monitor and that geographic barriers further weaken the effectiveness of their oversight over controlling shareholders after reappointment.

To distinguish differences in monitoring ability, we categorize the sample based on whether reappointed independent directors possess financial or legal expertise. The groups are labeled as the "low monitoring ability group" (no specialized expertise) and the "high monitoring ability group" (specialized expertise). Panel B of Table 12 shows that the coefficients of *Back\_dummy* in the low monitoring ability group are significant and positive. In comparison, these coefficients are not significant and are smaller in the high monitoring ability group. These results suggest that reappointed independent directors without financial or legal expertise exhibit weaker monitoring abilities, further reducing their effectiveness in monitoring controlling shareholders' expropriation after reappointment.

Table 11	
Mechanism	test.

Variable	(1)	(2)	(3)
	Attend_Meeting	Dissent	Dissent1
Back_ID	0.002	-0.013**	-0.006*
	(0.277)	(-2.485)	(-1.684)
Interval_time	-0.002	-0.001	-0.000
	(-0.912)	(-0.645)	(-1.207)
Meeting	0.001***	0.001	0.000
÷	(3.817)	(1.580)	(0.737)
Indir_Age	0.012	0.009	0.009
-	(0.461)	(0.533)	(0.887)
Indir_pay	0.001	0.001	0.001
	(0.803)	(1.189)	(1.094)
Education	-0.007	0.001	0.001
	(-1.385)	(0.229)	(0.263)
Indir Acc	0.010	0.000	-0.000
	(1.288)	(0.035)	(-0.032)
Busy	-0.001	-0.001	-0.001
	(-0.300)	(-0.197)	(-0.344)
Boardsize	-0.000	-0.000	0.001
2000/00/20	(-0.240)	(-0.140)	(0.988)
Rindirector	-0.025	-0.027	_0.016
Runanceion	(-0.506)	(-0.625)	(-0.427)
Len	-0.016	-0.013	0.003
Lev	(-0.957)	(-0.629)	(0.271)
Size	(-0.957)	0.004	(0.271)
5126	(0.379)	( 1.035)	-0.003
POF	(-0.379)	(-1.055)	(-0.900)
KOL	(0.500)	-0.029	-0.020
Tom1	(0.399)	(-1.500)	(-0.907)
1001	-0.000	(1.024)	0.010
Count	(-0.278)	(1.034)	(0.828)
Growin	0.004	-0.009	-0.009**
D: (	(0.670)	(-1.569)	(-2.000)
Big4	0.003	-0.002	-0.001
60F	(0.251)	(-0.766)	(-0.308)
SOE	0.000	0.001	0.003
	(0.043)	(0.144)	(0.681)
Dual	-0.001	0.006	0.008
	(-0.195)	(1.114)	(1.501)
Constant	0.984***	0.065	0.035
	(6.598)	(0.539)	(0.379)
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	2897	2897	2897
Within $R^2$	0.009	0 009	0.009
w unn K	0.009	0.009	0.008

# 6.2.2. Test for the internal and external governance environment

In a well-functioning governance environment, the information asymmetry between a firm and its stakeholders is low. Reappointed independent directors can then obtain information at lower costs and through more diverse channels, facilitating their monitoring role. Other supervisory authorities also exhibit greater enthusiasm for oversight (Huang et al., 2022), thus alleviating the supervisory pressure on independent directors and compensating for potential lapses in their governance. Conversely, in a poor governance environment, informal institutional factors such as *guanxi* are important within the company (Luo et al., 2017), which may weaken independent directors' monitoring functions.

Accordingly, we examine the impact of internal and external governance environments on the effectiveness of independent directors' monitoring of controlling shareholders after reappointment. Institutional investor ownership and media coverage are used as proxies for the internal and external governance environment, respectively. We divide the sample into a "good (poor) external governance environment group" and a "good (poor) internal governance environment group," based on the industry averages of original media reporting following reappointment and the proportions of institutional investor shareholding following reappointment, respectively.

Table 13 presents the results. Panel A shows the results of the heterogeneity analysis of the external governance environment. Columns (1) to (3) indicate that in the poor external governance environment group, the coefficients of *Back dummy* are significant and positive. However, in the good external governance environment group, these coefficients are not significant and are smaller than those in the poor external governance environment group. These results suggest that a good external governance environment mitigates the weakened monitoring effectiveness of reappointed independent directors over controlling shareholders.

Panel B provides the results of the heterogeneity analysis of the internal governance environment. Columns (1) to (3) indicate that in the poor internal governance environment group, the coefficients of *Back\_dummy* are significant and positive. Conversely, in the good internal governance environment group, these coefficients are not significant and smaller. This finding implies that a high-quality internal governance environment alleviates the supervisory pressure on reappointed independent directors, thereby mitigating their weakened monitoring effectiveness over controlling shareholders.

# 6.3. Test for the impact of the cooling-off period

The existence of a cooling-off period helps restore independence, thus mitigating the decline in monitoring effectiveness over controlling shareholders following reappointment. The regulations on the cooling-off period

Test for the monito	oring willingness and	ability of reappoint	ed independent direc	ctors.		
	(1)		(2)		(3)	
	RPT		RPT1		RPT2	
Panel A: Monitorin	ng willingness					
	Low	High	Low	High	Low	High
Back_dummy	0.034** (2.245)	0.010 (1.146)	0.034** (2.224)	0.010 (1.160)	0.039*** (3.088)	0.006 (0.760)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm & Year	Yes	Yes	Yes	Yes	Yes	Yes
Ν	1130	1389	1130	1389	1130	1389
Within_ $R^2$	0.055	0.067	0.055	0.066	0.071	0.072
P-value		0.040**		0.040**		0.000***
Panel B: Monitorin	g ability					
	Low	High	Low	High	Low	High
Back_dummy	0.032** (2.330)	0.005 (0.578)	0.032** (2.326)	0.005 (0.574)	0.025** (2.301)	0.008 (1.021)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm & Year	Yes	Yes	Yes	Yes	Yes	Yes
Ν	1112	1407	1112	1407	1112	1407
Within_ $R^2$	0.092	0.036	0.092	0.036	0.118	0.045
P-value		0.000***		0.000**		0.010**

Table 12

	ai and external gover	nance environment.				
	(1)		(2)		(3)	
	RPT		RPT1		RPT2	
Panel A: The exter	mal governance envir	onment				
	Poor	Good	Poor	Good	Poor	Good
Back_dummy	0.023** (2.367)	-0.003 (-0.225)	0.023** (2.358)	-0.003 (-0.219)	0.020** (2.363)	0.002 (0.215)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm & Year	Yes	Yes	Yes	Yes	Yes	Yes
N	1818	701	1818	701	1818	701
Within_ $R^2$	0.062	0.050	0.062	0.049	0.071	0.026
P-value		0.000***		0.000***		0.000***
Panel B: The intern	nal governance enviro	onment				
	Poor	Good	Poor	Good	Poor	Good
Back_dummy	0.019*** (3.045)	0.009 (0.567)	0.018*** (3.021)	0.009 (0.574)	0.020*** (3.026)	0.008 (0.659)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm & Year	Yes	Yes	Yes	Yes	Yes	Yes
N	1211	1308	1211	1308	1211	1308
Within_ $R^2$	0.060	0.068	0.060	0.067	0.076	0.080
P-value		0.050*		0.050*		0.030**

Table 13 Test for the internal and external governance environment

for the reappointment of independent directors introduced by the Shanghai and Shenzhen stock exchanges were the first such provisions in China. As a result, the time intervals for reappointments vary extensively, providing an opportunity to empirically examine how the length of the cooling-off period affects the performance of independent directors after reappointment. Statistics show that the shortest cooling-off period is 1 year and the longest 13 years.

We divide *Back\_dummy* into two subcategories based on whether the average cooling-off period exceeds three years. Reappointments with an average cooling-off period of no more than three years (*Back\_dummy\_NonExceed*) are compared with those exceeding three years (*Back\_dummy\_Exceed*).<sup>11</sup> As Columns (1) to (3) in Table 14 indicate, the coefficients of *Back\_dummy\_NonExceed* are positive at a significance level of at least 5 %. In contrast, the coefficients of *Back\_dummy\_Exceed* are not significant. Tests of coefficient differences also largely support the finding that the economic significance of monitoring effectiveness over controlling shareholders is notably weaker for reappointed independent directors with a cooling-off period of no more than three years.

These results indicate that independent directors reappointed within three years exhibit less independence and weaker effectiveness in monitoring controlling shareholders' expropriation activities. In contrast, reappointments after a cooling-off period of more than three years contribute to the restoration of their independence in monitoring.

<sup>&</sup>lt;sup>11</sup> According to Company Law of the People's Republic of China, the tenure for directors shall not exceed three years per term.

Table 14

Test f	or the	impact	of	the	cooling-off	period.
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Variable	(1)	(2)	(3)
	RPT	RPT1	RPT2
Back_dummy_NonExceed	0.021**	0.020**	0.018***
	(2.576)	(2.567)	(2.660)
Back_dummy_Exceed	0.009	0.009	0.012
	(0.868)	(0.878)	(1.481)
Size	-0.024***	-0.023***	-0.026***
	(-4.185)	(-4.126)	(-5.595)
Top1	0.128***	0.127***	0.134***
	(3.038)	(3.016)	(3.811)
Boardsize	0.002	0.002	0.000
	(0.725)	(0.742)	(0.195)
Rindirector	-0.082	-0.081	-0.085*
	(-1.399)	(-1.379)	(-1.762)
Tobin's Q	-0.000	-0.000	-0.003
	(-0.132)	(-0.129)	(-1.188)
Lev	-0.005	-0.006	0.016
	(-0.258)	(-0.279)	(1.000)
Firm_Age	-0.113***	-0.111***	-0.075***
	(-3.557)	(-3.510)	(-2.908)
InsInvestor	-0.008	-0.008	-0.029*
	(-0.416)	(-0.394)	(-1.728)
Cash	0.064**	0.063**	0.042*
	(2.136)	(2.144)	(1.873)
ROE	0.000	0.000	0.009
	(0.026)	(0.029)	(0.702)
SOE	0.021	0.021	0.013
	(1.359)	(1.333)	(0.960)
Big4	0.027*	0.028*	0.014
	(1.799)	(1.829)	(1.122)
Dual	0.011**	0.011**	0.009**
	(2.446)	(2.422)	(2.162)
Loss	-0.002	-0.002	-0.001
	(-0.193)	(-0.185)	(-0.107)
Constant	0.841***	0.825***	0.766***
	(5.262)	(5.178)	(5.785)
Equal effects (p-value):	0.093	0.098	0.311
Back_dummy_NonExceed = Back_dummy_Exceed			
Firm	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ν	2519	2519	2519
Within_R <sup>2</sup>	0.041	0.040	0.048

# 7. Conclusions and implications

# 7.1. Conclusions

The independent director system is a critical component of corporate governance for China's listed companies and an integral part of the modern corporate governance system with Chinese characteristics. With the deepening of capital market reforms, enhancing the supervisory abilities of independent directors to effectively fulfill their governance responsibilities has become a central focus. In this study, we address the common phenomenon of reappointed independent directors and examine the effectiveness of their oversight over tun-

<sup>24</sup> 

neling before and after reappointment. We provide empirical evidence that can help to strengthen the management of independent directors and improve governance mechanisms.

The findings reveal that independent directors are less effective in monitoring controlling shareholders' expropriation during their reappointment term compared with their first term, thus exacerbating the type II agency problem. Mechanism tests reveal that the reduced governance effectiveness of reappointed independent directors is due to their passive participation in corporate governance, as reflected in a decreased probability to dissent. Heterogeneity tests show that reappointed independent directors' greater willingness to monitor and ability, along with better internal and external governance environments, can effectively mitigate the decline in monitoring effectiveness after reappointment. Additionally, the study finds that reappointments with an interval of more than three years help restore the monitoring effectiveness of reappointed independent directors.

#### 7.2. Implications

First, regulatory authorities should establish innovative supervision methods and increase the oversight of independent director reappointments, to prevent controlling shareholders from exploiting regulatory loopholes and appointing individuals who serve their interests as guardians. A database of independent directors should be established from which listed firms can select directors, as this can reduce controlling shareholders' influence during the appointment process. A comprehensive framework for evaluating the performance of independent directors should also be developed, and the authorities can grant minority shareholders greater supervisory powers, such as "no-confidence" voting. This will enable independent directors to play a more objective and impartial role in oversight, thereby safeguarding the interests of minority shareholders.

Second, investors should recognize the strong signaling effect associated with independent director reappointments. This study finds that reappointed independent directors are less effective in monitoring controlling shareholders, likely due to the establishment of closer relationships with company management or controlling shareholders, which can lead to a shift in stance and weakens their role as a corporate governance "firewall." External investors should therefore carefully consider the negative signals accompanying the reappointment of independent directors and conduct thorough evaluations of corporate governance, so they can make more prudent investment decisions and effectively mitigate the risk of shareholder expropriation.

Finally, the various capital market systems related to independent directors should be strictly implemented and continuously improved. The post-appointment management of independent directors should be rigorously enforced, adhering to the regulations set by stock exchanges regarding the reappointment cooling-off period, to protect their independence and enhance their monitoring effectiveness. However, the independent director role relies heavily on the improvement of the capital market governance environment. Coordinated efforts should be made regarding foundational institutional development, to strengthen both the internal and external corporate governance of listed companies and improve information transparency, thus enabling independent directors to perform their monitoring functions more effectively.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# Vertical interlock and corporate tax avoidance

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#### ABSTRACT

This study examines the impact of vertical interlock on corporate tax avoidance in business groups using data on Chinese listed companies from 2003 to 2019. We find that vertical interlock has a negative impact on corporate tax avoidance. Our result is robust to alternative measures, difference-indifferences analysis, the Heckman two-stage sample selection method, an instrumental variable approach, change analysis and controlling for potential omitted variables. The impact of vertical interlock on corporate tax avoidance is more pronounced in firms with more related-party transactions and greater divergence between ownership and control rights. Overall, the findings suggest that vertical interlock exerts a significant influence on corporate tax behavior, providing insights into the ownership structure of business groups.

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# 1. Introduction

"Vertical interlock" refers to the phenomenon whereby the board chairperson or CEO of a listed firm simultaneously holds a position in their direct or indirect controlling shareholder company, resulting in a situation where one individual holds managerial/directorate positions in two firms that are located in different layers of the same business group (Chen and Yang, 2021; Yang et al., 2021). In this circumstance, the decisions of subordinate listed companies can be heavily influenced by the controlling shareholders. Vertical interlock is distinct from horizontal interlock, sometimes referred to as board interlock or board connection, which occurs when an executive simultaneously holds positions in at least two independent companies that do not belong to the same business group. The economic consequences of horizontal interlock receive considerable attention, with studies examining its impact on various corporate decisions, such as mergers and acquisitions

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(Cai and Sevilir, 2012), environmental strategies (Ortiz-de-Mandojana et al., 2012), earnings management contagion (Chiu et al., 2013), corporate innovation (Helmers et al., 2017), short-selling (Cheng et al., 2019) and firm performance (Edacherian et al., 2024). This substantial body of literature on horizontal interlock focuses primarily on developed capital markets, where this phenomenon is widespread. In contrast, the phenomenon of vertical interlock is more common in emerging capital markets. However, research on the economic consequences of vertical interlock is relatively sparse. Statistics show that vertical interlock affected almost 60% of Chinese listed companies between 2003 and 2019, which makes the Chinese market especially well suited to studying this phenomenon.

There are currently two competing perspectives on the economic impact of vertical interlock. One view posits that vertical interlock helps controlling shareholders achieve more efficient monitoring, reduces information asymmetry and alleviates the agency conflict between shareholders and managers. For example, Arnoldi et al. (2019) argue that vertical interlock promotes coordination and information exchange, which helps avoid misunderstandings and thus results in the better alignment of managers' and controlling shareholders' interests. The opposing perspective posits that vertical interlock within pyramidally structured business groups gives large shareholders. For instance, Chen and Yang (2021) find that vertical interlock intensifies agency problems between controlling shareholders and minority shareholders.

In addition to the impact of vertical interlock on agency problems, research focuses on some of its economic consequences. Yang et al. (2021) find that vertically interlocked executives act as representatives of controlling shareholders, which increases managers' bad news holding behavior and raises firms' risk of future stock price crashes. Cao et al. (2022) claim that vertical interlock decreases R&D investment, thus posing a serious threat to firm value. However, the impact of vertical interlock on corporate tax avoidance is yet to be explored. "Corporate tax avoidance" refers to tax-planning strategies involving semi- or quasi-legal ways to reduce firms' explicit tax liability (Hanlon and Heitzman, 2010). In other words, tax avoidance reflects all transactions that have any effect on firms' payment of the minimum amount of taxes, given their level of taxable income (Dyreng et al., 2008). Firms may wish to undertake tax-avoiding activities as a part of their valuemaximizing decision-making, but they may be deterred from doing so for a variety of reasons—perhaps because it may not benefit managers to be as tax aggressive as shareholders may wish, or perhaps because managers do not wish to incur a comprehensive set of non-tax costs (e.g., Desai and Dharmapala, 2008; Hanlon and Heitzman, 2010).

Based on the aforementioned research on the economic impact of vertical interlock, we posit two competing views regarding the effect of vertical interlock on corporate tax avoidance. On the one hand, the literature suggests that firms with more highly concentrated ownership and control do not avoid income tax to the same degree as firms with less concentrated ownership and control (Badertscher et al., 2013). These owner-managers are likely to be more risk averse, making them less likely to engage in aggressive tax-avoiding behavior. Therefore, firms with (vs. without) vertical interlock have more concentrated ownership and control and are less likely to conduct aggressive tax-avoiding activities. In addition, vertical interlock facilitates distortions by larger shareholders, and the market negatively evaluates firms that suffer from potential distortions (Lei et al., 2011). To offset negative public perceptions, firms tend to adopt corporate social responsibility behaviors (Godfrey et al., 2009), such as engaging in less tax avoidance (GRI, 2011).

On the other hand, tax planning is an important tool for saving cash flows to make them available to shareholders and to increase firm value. According to this view, shareholders prefer management to engage in tax avoidance activities. However, managers may view these activities as a distraction from their key role or as extra work, making them reluctant to utilize opportunities for tax-avoidance opportunities. Under vertical interlock, managers represent shareholders, which mitigates their self-interested incentives and promotes their tax-planning activities. Moreover, vertical interlock facilitates the integration of resources and operations within the group, providing vertically interlocked firms with more opportunities and scope for tax management. In addition, vertical interlock may allow for the more efficient allocation of resources among affiliated firms, enabling vertically interlocked firms to use internal capital markets to efficiently manage their tax. In this regard, vertical interlock may be positively associated with corporate tax avoidance. Therefore, it is *ex ante* unclear whether vertical interlock positively or negatively influences corporate tax-planning practices. We study the impact of vertical interlock on corporate tax avoidance in the Chinese context. China provides a natural laboratory setting for this research, because the prevalence of business groups in China—that is, the organizational structure wherein many legally independent firms are ultimately controlled by one common shareholder—provides us with the opportunity to investigate the role of vertical interlock. Developed markets, such as those of the US, consist largely of stand-alone entities with dispersed ownership. In contrast, in developing markets, there is a long tradition of business groups, as this organizational form can compensate for underdeveloped institutions (Khanna and Yafeh, 2007). Vertical interlock is a typical way for the controlling shareholder to strengthen their supervision over subordinate companies. China is a large emerging economy characterized by weak legal institutions, generating a large number of business groups and vertical interlocks. Corporate tax avoidance activities in business groups are not explored in the literature. The prevalence of the business group structure in the Chinese setting enables us to explore whether subsidiary firms exhibit different tax avoidance practices when vertical interlock exists.

We examine the influence of vertical interlock on corporate tax avoidance using data on Chinese A-share listed companies from 2003 to 2019. We reveal a negative association between vertical interlock and corporate tax avoidance, suggesting that vertical interlock can reduce tax aggressiveness. This effect is observed for both vertically interlocked chairpersons and CEOs. In addition, the impact of vertical interlock on corporate tax avoidance is both statistically and economically significant. Our findings are robust to alternative measures, difference-in-differences (DID) analysis, the Heckman two-stage sample selection method, an instrumental variable approach, change analysis and controlling for potential omitted variables. Channel tests confirm that vertical interlock reduces corporate tax avoidance by exacerbating Type II agency problems, as measured by related-party transactions. Cross-sectional analysis suggests that the impact of vertical interlock on corporate tax avoidance is more pronounced for firms with larger control rights and ownership separation.

This study contributes to the literature in the following ways. First, it enriches the burgeoning body of literature on the economic effects of vertical interlock. Although vertical interlock is a critical corporate controlling mechanism between affiliated listed companies in a business group, especially in emerging markets, little attention is paid to the relationship between vertical interlock and corporate decision-making. Some recent studies suggest that vertical interlock negatively impacts firm performance by increasing future stock price crash risk (Yang et al., 2021), reducing R&D investment (Cao et al., 2022) and decreasing the market value of cash holdings (Chen and Yang, 2021). However, there is still no consensus on the impact of vertical interlock; in particular, it remains unclear whether vertical interlock influences corporate tax avoidance. Our study fills this research gap.

Second, this study extends a large and well-established literature on the determinants of corporate tax avoidance, especially from the perspectives of managerial position and heterogeneity. Dyreng et al. (2010) claim that executives' heterogeneity has incremental explanatory power on corporate tax avoidance decisions. Subsequent studies expand on this topic, finding that CEO narcissism (Olsen and Stekelberg, 2016), CEO political preference (Francis et al., 2016), directors' foreign experience (Wen et al., 2020), managerial military experience (Law and Mills, 2017) and managerial ability (Koester et al., 2017) are all determinants of corporate tax aggressiveness. To the best of our knowledge, however, few studies explore the effect of vertical interlock on corporate tax avoidance. Therefore, our findings contribute to this sparse line of research by providing a detailed exploration of the multifaceted effect of vertical interlock on tax avoidance.

Third, this study provides policy implications for emerging countries such as China, in which there is no consensus even among regulatory agencies regarding the actual economic consequences of vertical interlock. On the one hand, the China Securities Regulatory Commission (CSRC) believes that a weak regulatory environment exacerbates the threat of encroachment on minority investors' interests and seeks to limit vertical interlock to strengthen investor protection. On the other hand, the State-owned Assets Supervision and Administration Commission of the State Council (SASAC) believes that vertical interlock improves managerial efficiency and recommends that state-owned enterprises (SOEs) arrange for controlling shareholders to hold positions in listed companies. Clear evidence of vertical interlock reducing tax-avoidance behaviors suggests that vertical interlock does exacerbate Type II agency problems; this aligns with the concerns of the CSRC and may guide future regulations to strengthen supervision over vertical interlock.



*Note*: The figure shows that the board chairperson of listed firm *Northeast Pharmaceutical Group Co., Ltd* (*Angang Steel Co., Ltd*) concurrently holds the position of deputy CEO (director) in the indirect (direct) controlling shareholder company.

Fig. 1. Vertical interlock organization chart. *Note*: The figure shows that the board chairperson of listed firm *Northeast Pharmaceutical Group Co., Ltd (Angang Steel Co., Ltd)* concurrently holds the position of deputy CEO (director) in the indirect (direct) controlling shareholder company.

The remainder of this study proceeds as follows. In Section 2, we introduce the institutional background, literature review and hypothesis development. Section 3 illustrates the research design. Section 4 presents the empirical results and robustness checks. Section 5 reports the results of further analysis. Section 6 concludes the paper.

### 2. Institutional background, literature review and hypothesis development

#### 2.1. Institutional background of vertical interlock in China

"Vertical interlock" refers to the phenomenon whereby the board chairperson or CEO of a listed company simultaneously holds a senior position within its controlling shareholder company (Cao et al., 2022; Chen and Yang, 2021; Yang et al., 2021). For example, as shown in Fig. 1, the board chairperson of the listed firm Northeast Pharmaceutical Group Co., Ltd (Angang Steel Co., Ltd) concurrently holds the position of deputy CEO (director) in the indirect (direct) controlling shareholder company.

In emerging markets, weak investor protection may allow large shareholders to abuse the control they have over listed companies, leading to encroachment on the interests of small investors, which ultimately damages firm value (Claessens et al., 2002). It is precisely because of this concern that the CSRC issued its "Listed Corporate Governance Guidelines"<sup>1</sup> in 2002, explicitly proposing that the controlling shareholder and listed company personnel should be independent of each other to restrict controlling shareholders from concurrently serving in the listed company. However, SASAC holds a different view, positing that vertical interlock can better control listed companies, reduce possible insider control problems and preserve the value of state-

<sup>&</sup>lt;sup>1</sup> https://www.gov.cn/gongbao/content/2003/content\_62538.htm (in Chinese).

owned assets; on this basis, SASAC suggests that state-owned enterprises such as Angang Steel Co., Ltd may wish to arrange for controlling shareholders to hold positions in listed companies. As regulatory bodies have not reached a consensus regarding the economic consequences of vertical interlock, further research on this topic is of great practical significance and may provide regulators with useful insights into this widely observed phenomenon. Indeed, statistics show that between 2003 and 2019, vertical interlock affected 59.8% of A-share listed companies in the Chinese capital market. Thus, focusing on Chinese companies provides a valuable opportunity to examine the impact of vertical interlock on corporate decision-making.

# 2.2. Literature review

This paper extends the research on corporate tax avoidance. Early studies show that numerous firm-level factors affect corporate tax avoidance, such as customer concentration (Huang et al., 2016), risk aversion (Alm et al., 1992) and corporate social responsibility (Hoi et al., 2013). Sánchez-Ballesta and Yagüe (2021) find that when management has incentives to present high earnings in its financial reporting, upward earnings management behavior prevails over tax-minimizing behaviors.

Ownership patterns play an important role in tax behavior (Desai and Dharmapala, 2008). Using Chinese publicly listed firms as their research sample, Richardson et al. (2016) find that ownership concentration has a non-linear (inverted U shaped) impact on corporate tax avoidance. The entrenchment effect and the alignment effect of controlling shareholders play a major role in reducing and increasing the ownership concentration level, respectively. Chen et al. (2010) find a negative association between family ownership and tax aggressiveness. Chow et al. (2019) show that SOEs have stronger incentives than non-SOEs to engage in tax-aggressive behavior, to the point of engaging in tax evasion, regardless of whether they are controlled by the central government or a local government. Li et al. (2017) find that split-share structure reform, which reduces Type II agency conflict, results in a significant increase in tax-avoiding activities (as a means of increasing firm value) for SOEs but not for non-SOEs. Badertscher et al. (2013) find that firms with highly concentrated ownership and control are less tax aggressive than firms with less concentrated ownership and control. Similarly, Hasan et al. (2021) suggest that firms with high (vs. low) levels of organizational capital are more aggressive in tax avoidance.

Recent literature builds on these earlier works, shifting the focus from firm characteristics to examine how heterogeneous managerial characteristics may influence corporate tax decision-making (Dyreng et al., 2010). For example, Law and Mills (2017) find that managers with (vs. without) military experience pay more corporate tax per firm-year instead of evading taxes. Olsen and Stekelberg (2016) find that narcissistic CEOs engage in more tax sheltering than other CEOs. Li et al. (2022) adopt the staggered recognition of the Inevitable Disclosure Doctrine in the US and demonstrate that managers' career concerns have a positive effect on the likelihood of tax avoidance. Francis et al. (2016) find that firms with politically partisan CEOs engage in more corporate tax sheltering activities than their counterparts. Koester et al. (2017) find evidence that higherability managers not only engage in more tax avoidance but also do so in a wider variety of ways. Beyond managerial heterogeneity, recent research shows that cultural diversity can reduce tax avoidance (Lei et al., 2022).

In addition, our study is related to research on the economic consequences of vertical interlock. Although there is a robust literature on the managerial heterogeneity effects of horizontal interlock (e.g., Karim et al., 2022; Lai et al., 2019), the literature on vertical interlock is much sparser. Interest in vertical interlock has grown over the past decade, but there remains a significant gap. Studies examine how vertical interlock impacts firms' economic performance and how it interacts with agency problems to affect corporate decision-making. Arnoldi et al. (2013) argue that vertical interlock is a useful mechanism to counter agency problems, because it substantially mitigates the autonomy of affiliated firms, reduces political interference and promotes firm performance. Arnoldi et al. (2019) show that vertically interlocked firms are effective in dealing with coordination and governance problems. Yang et al. (2024) indicate that firms with vertical interlock are less likely to engage in fraudulent activities than firms without vertical corporate behaviors. However, Chen and Yang (2021) find that vertical interlock intensifies the agency problems that exist between control-ling shareholders and minority shareholders, and they suggest that firms with vertical interlock have a lower

market value of cash holdings than firms without. Thus, there is currently no consensus on whether vertical interlock exacerbates or ameliorates agency problems.

Similarly, research on whether vertical interlock has positive or negative economic consequences for firms is too sparse for a consensus to emerge. However, some recent papers report negative results. For example, Opie et al. (2019) suggest that government-built corporate pyramids protect SOEs from government interference, such that more pyramidal layers lead to higher investment efficiency; however, they find that vertical interlock offsets the positive effects of reducing information costs. Yang et al. (2021) find that firms with vertical interlock face greater risks of stock price crashes and Cao et al. (2022) claim that vertical interlock decreases R&D investment, thus posing a serious threat to firm value.

#### 2.3. Hypothesis development

"Tax avoidance" refers to the act of finding a semi- or quasi-legal way for a firm to pay the minimum amount of taxes, given its level of taxable income. According to Fama and Jensen (1983), when equity ownership and corporate decision-making power are concentrated with a small number of decision-makers, these owner-managers tend to become risk averse. Because tax avoidance is a risky activity that can impose significant costs on firms and their managers (e.g., Desai and Dharmapala, 2008; Hanlon and Heitzman, 2010), Badertscher et al. (2013) suggest that firms with more concentrated ownership and control make less effort to avoid income tax. In light of this discussion, vertical interlock largely benefits large shareholders (Yang et al., 2024), facilitating the concentration of ownership and control and thus encouraging firms to reduce their tax avoidance activities. We argue that in our setting, firms with (vs. without) vertical interlock have more concentrated ownership and control and are therefore less likely to conduct aggressive tax-avoiding activities.

Furthermore, from the perspective of agency conflicts, vertical interlock increases the direct control of large shareholders over subsidiaries, enhancing the incentive and opportunity for tunneling (Chen and Yang, 2021). Moreover, the market may discount the stocks of firms undertaking potentially expropriating transactions (Lei et al., 2011), resulting in negative public perceptions. Often, such firms take actions to mitigate such perceptions and prevent undervaluation. Research argues that corporate social responsibility activities can be used to offset negative public perceptions of firms (e.g., Godfrey et al., 2009). Given that the Global Reporting Initiative (GRI) considers corporate tax payments as a positive contribution to social welfare (GRI, 2011), we infer that firms with vertical interlock strategically engage in lower levels of tax avoidance to reduce the possibility of negative market perceptions arising from severe agency problems. Taken together, we argue that firms with (vs. without) vertical interlock are less likely to engage in aggressive tax-avoidance behaviors. We state our first hypothesis as follows.

# **Hypothesis 1a.** Listed companies with (vs. without) vertical interlock are less likely to engage in tax avoidance.

However, vertical interlock may also facilitate corporate tax avoidance. Research argues that top managers play an important role in firms' tax-planning practices (e.g., Dyreng et al., 2010). Tax planning is an important tool for increasing firm value, as it directly affects the cash flows available to shareholders. Thus, shareholders prefer management to engage in tax avoidance activities and reduce corporate taxes. However, managers may view such activities as a distraction from their key duties or extra work, discouraging them from utilizing tax-avoiding opportunities. Vertical interlock enables controlling shareholders to maintain greater control over the interlocked businesses, and thus these shareholders can directly influence firm managers to adopt more tax-planning activities and take advantage of tax-avoiding opportunities. Furthermore, vertical interlock facilitates the integration of resources and operations within the group, granting management greater opportunities and scope for tax evasion. In addition, vertical interlock may allow for the more efficient allocation of take advantage of internal capital markets in an optimally tax-efficient manner. Drawing on the above discussion, we argue that firms with (vs. without) vertical interlock are more likely to engage in tax-avoidance behaviors. We state our competing hypothesis below.

**Hypothesis 1b.** *Listed companies with* (vs. *without) vertical interlock are more likely to engage in tax avoidance.* 

# 3. Research design

#### 3.1. Sample and data source

We start our research by collating data on a sample of Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2003 to 2019. The sample starts in 2003 because this is the first year in which we can clearly judge whether a firm has a vertically interlocked executive. Firms' annual applicable statutory tax rates are downloaded from the WIND database, and we retrieve firms' annual internal control index from the DIB database. Vertical interlock, financial and corporate governance data are obtained from the China Stock Market and Accounting Research database. All data are cross-checked for consistency.

Our sample selection is based on the following process (described in detail in Panel A of Table 1). We exclude 1) observations of firms in the financial sector, as they have different financial structures and obey different rules to other listed firms; 2) observations of firms under special treatment (ST/\*ST),<sup>2</sup> which are considered financially unhealthy; 3) observations of firms with negative income before taxes (Hoopes et al., 2012); and 4) observations with missing control variables. Our final sample is composed of 23,442 firm-year observations representing 3,193 unique companies.

We report the sample distribution in Panel B and C of Table 1. Regarding the year distribution, the percentage of firms with vertical interlock reaches its highest value of 66.50% in 2009, and its lowest of 51.71% in 2019. Considering the industry distribution, we find that the vertical interlock phenomenon is not clustered in any particular industry. The three industries with the greatest vertical interlock are accommodation and catering (80%), transportation (74.61%) and education (72.73%); conversely, the three industries with the least vertical interlock are scientific research and technical services (39.13%), information and technology (39.98%) and agriculture (47.44%).

#### 3.2. Dependent variable

Our dependent variable is corporate tax avoidance. We adopt the difference between the applicable statutory tax rate and the effective tax rate (*RATE*) as the proxy for corporate tax avoidance. Because the Chinese government implements preferential tax policies and offers favorable tax rates to attract investment to certain industries and regions (Shevlin et al., 2012), a low effective tax rate may result from a preferential tax rate rather than tax avoidance. Therefore, simply using an unadjusted effective tax rate for the applicable statutory tax rate may be misleading. To overcome this issue, we define *RATE* as the difference between the applicable statutory tax rate and the effective tax rate (*ETR*), following the literature (Chan et al., 2016; Tang et al., 2017; Wen et al., 2020). *ETR* is calculated as (total income tax expense – deferred income tax expense) / (income before taxes –deferred income tax expense / statutory income tax rate). A larger value of *RATE* indicates greater tax aggressiveness. Consistent with the literature (Gupta and Newberry, 1997; Law and Mills, 2017), we truncate *RATE* at [0, 1] to avoid the influence of outliers. In the robustness check, we use book– tax differences (*BTD*) and abnormal book–tax differences (*DDBTD*) as alternative measures for corporate tax avoidance.

#### 3.3. Independent variable

We use three measures to proxy for vertical interlock. *LOCK* is a dummy variable that equals one if the board chairperson or CEO of listed firm *i* simultaneously holds positions in its direct or indirect controlling shareholder company in the business group in year *t*, and zero otherwise. We consider both the board chairperson and CEO because they are the primary decision-makers or controllers in Chinese listed companies (Jiang and Kim, 2020). *LOCK\_CHAIR* is a dummy variable that equals one if the board chairperson of listed firm *i* simultaneously serves in its direct or indirect controlling shareholder company in the business group in year *t*, and zero otherwise.

 $<sup>^{2}</sup>$  According to Chinese stock market regulations, a firm receives special treatment (ST/\*ST) if it incurs losses for 2 or 3 consecutive years. Firms labeled ST/\*ST are subject to strict trading restrictions. Therefore, ST/\*ST is often used as a proxy for financial distress for Chinese public companies.

Table 1			
Sample	selection	and	distribution.

Panel A: Sample selection procedure		
	Number of observations	Number of unique firms
Firms listed on the Shanghai and Shenzhen Stock Exchanges in China during	41,511	4,046
2003–2019		
Less: Observations in the financial sector	(986)	(85)
Less: Observations with ST/*ST labels	(1,975)	(16)
Less: Observations with negative income before taxes	(3,704)	(17)
Less: Observations with missing variables	(11,404)	(735)
Final Sample	23,442	3,193

Panel B: Sample distribution by year

Year	N	LOCK=1	LOCK=0	Percentage
(1)	(2)	(3)	(4)	(5) = (3)/(2)
2003	213	128	85	60.09%
2004	362	220	142	60.77%
2005	602	394	208	65.45%
2006	721	469	252	65.05%
2007	827	541	286	65.42%
2008	849	559	290	65.84%
2009	994	661	333	66.50%
2010	1,095	707	388	64.57%
2011	1,489	901	588	60.51%
2012	1,770	1,067	703	60.28%
2013	1,868	1,110	758	59.42%
2014	1,762	1,005	757	57.04%
2015	1,797	1,018	779	56.65%
2016	2,055	1,142	913	55.57%
2017	2,213	1,198	1,015	54.13%
2018	2,427	1,265	1,162	52.12%
2019	2,398	1,240	1,158	51.71%
Total	23,442	13,625	9,817	58.12%

Panel C: Sample distribution by industry

Industry	Ν	LOCK=1	LOCK=0	Percentage
(1)	(2)	(3)	(4)	(5) = (3)/(2)
Agriculture (A)	234	111	123	47.44%
Mining (B)	549	387	162	70.49%
Manufacturing (C)				
Food, beverage, textile, garment, and leather (C1)	1,684	971	713	57.66%
Papermaking, furniture, medical, and chemical (C2)	4,545	2,525	2,020	55.56%
Metal, nonmetal, machinery, and electronics (C3)	8,504	4,848	3,656	57.01%
Other manufacturing (C4)	480	263	217	54.79%
Electricity and gas (D)	811	521	290	64.24%
Construction (E)	613	388	225	63.30%
Wholesale and retail (F)	1,456	890	566	61.13%
Transportation (G)	701	523	178	74.61%
Accommodation and catering (H)	85	68	17	80.00%
Information and technology (I)	1,283	513	770	39.98%
Real estate (K)	1,182	810	372	68.53%
Leasing and business services (L)	292	203	89	69.52%
Scientific research and technical services (M)	161	63	98	39.13%
Public Facilities Management (N)	252	162	90	64.29%
Residents' services (O)	34	19	15	55.88%
Education (P)	11	8	3	72.73%
Health and social work (Q)	41	27	14	65.85%
Culture, sports, and entertainment (R)	174	119	55	68.39%
Comprehensive (S)	350	206	144	58.86%
Total	23,442	13,625	9,817	58.12%

Note: Panel A reports the sample selection procedure. Panel B (Panel C) reports the sample distribution by year (industry).

year *t*, and zero otherwise. *LOCK\_CEO* is a dummy variable that equals one if the CEO of listed firm *i* simultaneously serves in the direct or indirect controlling shareholder company of the business group in year *t*, and zero otherwise.

# 3.4. Control variables

As control variables, we incorporate factors that potentially affect corporate tax avoidance following the literature (e.g., Hanlon and Heitzman, 2010; Richardson et al., 2016; Kovermann and Velte, 2019; Tang, 2020; Wen et al., 2020). We include three main categories of variables: corporate financial characteristics, corporate governance characteristics and non-tax cost variables.

Our corporate financial characteristics control variables include ROA (return on assets), SIZE (firm size, measured as the natural logarithm of total assets), LEV (leverage, measured as total liabilities divided by total assets), BM (the book-to-market ratio, which is the book value divided by the market value), LOSS (firm loss, indicated by a dummy variable that equals one if a firm has a negative net income, and zero otherwise), PPE (property, plant and equipment divided by total assets), *INTANG* (intangible assets divided by total assets), INVENT (inventory divided by total assets), CFO (cash flow from operating activities divided by total assets) and CASH (cash holdings divided by total assets). More profitable firms can gain greater benefits from tax avoidance, and they are more inclined to conduct tax avoidance activities. However, larger firms are more complex and more capable of achieving economic scale in terms of tax avoidance than smaller firms (Rego, 2003). Therefore, we make no sign prediction for ROA. Large companies are more likely to be monitored by tax authorities and the public than small companies, so we expect SIZE to be negatively associated with corporate tax avoidance. The tax shield effect of debt can result in a lower level of tax liability for firms with high leverage, and thus we expect LEV to be negatively correlated with corporate tax avoidance. There are opposing arguments regarding the book-to-market ratio. On the one hand, a lower book-to-market ratio may attract more attention from the public, which may make it difficult for firms to engage in tax avoidance. On the other hand, a lower book-to-market ratio represents better growth opportunities and hence greater capital needs, with such firms being more likely to reduce cash outflows through tax avoidance (Richardson et al., 2016). Therefore, we make no *ex ante* prediction regarding the effect of the book-tomarket ratio on tax avoidance, due to the conflicting opinions in prior research. Losses can reduce currentperiod tax liabilities, reducing the incentives for companies with losses to avoid taxes. We expect LOSS to be negatively related to corporate tax avoidance. R&D expenses have a partial tax shield effect, and therefore firms with more intangible assets may have lower tax burdens than other firms. We expect INTANG to be negatively correlated with corporate tax avoidance. Firms are more likely to use tax avoidance activities to reduce cash outflows when facing cash flow shortages, and thus we hypothesize that CFO and CASH are negatively associated with corporate tax avoidance.

Our corporate governance control variables include ANA (analyst following), IC (internal control), DIRO (director ownership), DUAL (where the CEO simultaneously serves as chairperson) and SOE (state ownership). Allen et al. (2016) suggest that higher analyst coverage increases the visibility of aggressive taxplanning behavior and can have a monitoring effect on corporate tax aggressiveness. Thus, we expect ANA to negatively affect corporate tax avoidance. In terms of the quality of internal control, Bimo et al. (2019) find that effective internal control can reduce tax avoidance. Similarly, Bauer (2016) reveals that firms with internal control weaknesses have higher cash-effective tax rates than firms with strong internal controls. Based on the above literature, we expect IC to be negatively associated with corporate tax avoidance. Badertscher et al. (2013) suggest that firms with higher levels of managerial ownership exhibit lower levels of tax avoidance; therefore, we expect DIRO to be negatively correlated with tax avoidance. Chan et al. (2013) find that CEO-chairperson duality, used as a proxy for corporate governance, is associated with more tax-aggressive behavior by firms. Consistent with their findings, we expect the coefficient on DUAL to be positive. Studies reveal that SOEs engage less in tax avoidance than non-SOEs (Bradshaw et al., 2019). Thus, we expect the impact of SOE on corporate tax avoidance to be negative.

In addition to these fundamental corporate finance and corporate governance variables, we consider another important factor that can affect managers' incentives to conduct tax avoidance—namely, non-tax costs. We define *REGU* as the regulatory cost of pursuing aggressive tax-avoiding activities. Following Mertens (2003) and Xu et al. (2011), we measure *REGU* based on the regional tax enforcement, which is the ratio of the province's actual tax revenue to its expected tax revenue. A larger ratio indicates more intense regional tax enforcement efforts and thus greater regulatory costs. The existence of non-tax costs imposes more pressure on firms to engage in corporate tax avoidance activities. Therefore, we expect *REGU* to be negatively correlated with levels of corporate tax avoidance.

#### 3.5. Model specification

We test our hypothesis using the following ordinary least squares model:

$$RATE_{i,t} = \alpha_0 + \alpha_1 LOCK (LOCK\_CHAIR/LOCK\_CEO)_{i,t} + \alpha_2 ROA_{i,t} + \alpha_3 SIZE_{i,t} + \alpha_4 LEV_{i,t} + \alpha_5 BM_{i,t} + \alpha_6 LOSS_{i,t} + \alpha_7 PPE_{i,t} + \alpha_8 INTANG_{i,t} + \alpha_9 INVENT_{i,t} + \alpha_{10} CFO_{i,t} + \alpha_{11} CASH_{i,t} + \alpha_{12} REGU_{i,t} + \alpha_{13} ANA_{i,t} + \alpha_{14} IC_{i,t} + \alpha_{15} DIRO_{i,t} + \alpha_{16} DUAL_{i,t} + \alpha_{17} SOE_{i,t} + YearFE + FirmFE + \varepsilon_{i,t}$$

$$(1)$$

where  $\alpha_i$  represents the regression coefficients and  $\varepsilon$  is the error term. The dependent variable, *RATE*, represents corporate tax avoidance. Our test variables, *LOCK*, *LOCK\_CHAIR* and *LOCK\_CEO*, are proxies for vertically interlocked executives. The control variables are illustrated in Section 3.4. To mitigate potential problems that may arise from omitting time-invariant firm-specific characteristics, we employ the firm fixed effects model, enabling us to robustly isolate the effect of vertical interlock on tax avoidance. We also include year fixed effects because research suggests that corporate tax avoidance varies across different years (Dyreng et al., 2008). Standard errors are clustered at the firm level. All continuous variables are winsorized at the top and bottom 1% percentile. Detailed variable definitions are provided in the Appendix.

# 4. Empirical results

#### 4.1. Summary statistics

Table 2, Panel A describes the sample with summary statistics. The mean value of *RATE*, the corporate tax avoidance variable, is 0.008, which indicates that Chinese listed companies engage in corporate tax avoidance activities. Considering the vertical interlock variables, the mean value of LOCK is 0.581, suggesting that vertical interlock is a very prevalent phenomenon in China, with almost 58.1% of affiliated listed companies being vertically interlocked. The above result is consistent with the literature (Chen and Yang, 2021; Yang et al., 2021). The means of LOCK\_CHAIR and LOCK\_CEO are 0.567 and 0.263, respectively. Thus, 56.7% (26.3%) of firms have a vertically interlocked chairperson (CEO). In terms of firm-level financial control variables, the firms in our sample have an average return on assets (ROA) of 0.059, firm size (SIZE) of 22.054, leverage (LEV) of 0.434, book-to-market ratio (BM) of 0.291, firm loss (LOSS) of 0.058, property, plant and equipment (PPE) of 0.226, asset intangibility (INTANG) of 0.044, inventory (INVENT) of 0.159, cash flow from operating activities (CFO) of 0.058 and cash ratio (CASH) of 0.196. The descriptive statistics of the control variables match those in other studies (e.g., Bradshaw et al., 2019; Wen et al., 2020). In addition, considering the corporate governance variables, on average the board of directors holds 11.1% of ownership, 24% of the sample firms have a CEO and chairperson who are the same person and 41.5% of the sample firms are SOEs. The distribution of corporate governance control variables is consistent with research in the Chinese setting (e.g., Jiang and Kim, 2015).

Table 2, Panel B reports the univariate analysis results. The mean values of *RATE* are -0.004 (0.024) in the subsample with (without) vertical interlock, where LOCK = 1 (LOCK = 0). The difference in mean values is statistically significant at the 1% level. These results suggest that firms without vertical interlock are more tax aggressive than firms with vertical interlock. Thus, the univariate analysis supports Hypothesis 1a, which states that vertically interlocked firms are less likely to engage in corporate tax avoidance. In terms of other firm characteristics, we find that firms with vertical interlock (LOCK = 1) have a smaller return on assets (ROA), director ownership (DIRO) and CEO–chairperson duality than firms without vertical interlock (LOCK = 0), vertical interlock firms

Table 2 Summary statistics											
Panel A: Descriptive	e statistics										
Variables		7	Mean	Std		Min	P25	Medi	an	P75	Max
RATE	C1	3,442	0.008	0.21	2	-1.212	-0.024	0.0	123	0.085	1.370
LOCK	τN	3,442	0.581	0.49		0.000	0.000	1.0	00	1.000	1.000
LOCK_CHAIR	<del>ر</del> م	3,442	0.567	0.49	5	0.000	0.000	1.0	00	1.000	1.000
LOCK_CEO	τN	3,442	0.263	0.44	0	0.000	0.000	0.0	00	1.000	1.000
ROA	<del>ر</del> م	3,442	0.059	0.05	4	-0.033	0.021	0.0	45	0.079	0.324
SIZE	r.1	3,442	22.054	1.25	5	18.932	21.147	21.8	81	22.761	25.740
LEV	64	3,442	0.434	0.20	0	0.054	0.276	0.4	34	0.587	0.986
BM	<i>د</i> م	3,442	0.291	0.14	4	0.000	0.184	0.2	.66	0.371	0.780
SSOT	64	3,442	0.058	0.23	4	0.000	0.000	0.0	00	0.000	1.000
PPE	64	3,442	0.226	0.16	5	0.001	0.097	0.1	95	0.321	0.735
INTANG	64	3,442	0.044	0.04	~	0.000	0.015	0.0	32	0.056	0.308
INVENT	64	3,442	0.159	0.14	4	0.000	0.064	0.1	22	0.200	0.711
CFO	64	3,442	0.058	0.08	6	-0.256	0.011	0.0	155	0.104	0.358
CASH	64	3,442	0.196	0.16	2	0.003	0.085	0.1	48	0.254	0.925
REGU	64	3,442	0.999	0.193		0.643	0.856	0.0	78	1.101	1.491
ANA	64	3,442	1.493	1.15	7	0.000	0.000	1.3	86	2.485	3.689
IC	64	3,442	6.447	0.65	1	0.000	6.462	6.5	23	6.568	6.823
DIRO	τN	3,442	0.111	0.18	4	0.000	0.000	0.0	00	0.174	0.666
DUAL	τN	3,442	0.240	0.42	7	0.000	0.000	0.0	00	0.000	1.000
SOE	τų	3,442	0.415	0.49.	3	0.000	0.000	0.0	00	1.000	1.000
Panel B: Univariate	analysis										
Variables		LOCK =	1			Τ	OCK=0				Difference
		Obs		Mea			)bs		Mean		
DATE		13675			10	0	817		10.07		***8000
DOA		12,075		0.0-	+0 L 4		,017 017		0.061		070.020
RUA		12,625		0.0	78	סא	,017 817		0.001		-0.004
I EV		12,022		0.0	0/ 60	n d	,017		0.200		+00.00
DIRO		13,625			47	0	,10,		0 199		-0.152***
DUAL		13,625		0.1	71	6	817		0 335		-0.164***
SOE		13,625		0.5	60	6	,817		0.285		0.224***
Panel C: Correlation	n analysis										
		(1)	(2)	(3)	(4)	(5)	(9)	(2)	(8)	(6)	(10)
RATE	(1)	1	$-0.037^{***}$	$-0.036^{***}$	$-0.025^{***}$	-0.015*	-0.005	-0.009	-0.007	$0.037^{***}$	-0.017*
LOCK	(5)	$-0.064^{***}$	1	0.971***	0.507***	$-0.051^{***}$	$0.176^{***}$	$0.152^{***}$	$0.020^{**}$	-0.001	$0.072^{***}$
LOCK_CHAIR	(3)	$-0.063^{***}$	0.971***	1	$0.456^{***}$	$-0.048^{***}$	$0.174^{***}$	0.151***	$0.020^{**}$	-0.003	0.066***
LOCK_CEU ROA	(4) (5)	-0.031 $0.065^{***}$	0.50/ -0.038***	0.450 -0.035***	1 0	-0.006 1	0.094 $-0.048^{***}$	0.04 / -0.356***	$-0.116^{***}$	$-0.01$ / $-0.217^{***}$	0.027 -0.099***
										(continued	l on next page)

W. Wen et al. | China Journal of Accounting Research 18 (2025) 100418

11

Table 2 (continued)											
Panel C: Correlation a	analysis										
		(1)	(2)	(3)	(4)	(5)	(9)	(7)	(8)	(6)	(10)
SIZE	(9)	-0.025***	0.177***	0.174***	0.111***	$-0.029^{***}$	1 0.400***	$0.483^{***}$	0.131***	$-0.037^{***}$	-0.025
BM	(~)	0.003	0.025	$0.024^{***}$	0	-0.304 $-0.166^{***}$	$0.400$ $0.112^{***}$	$-0.322^{***}$	-0.20/ 1	$-0.059^{***}$	0.155***
SSOT	6)	$-0.026^{***}$	-0.001	-0.003	$-0.017^{**}$	$-0.136^{***}$	$-0.037^{***}$	0.091	-0.054	1	$0.052^{***}$
PPE (	10)	-0.015*	$0.087^{***}$	$0.080^{***}$	$0.028^{***}$	$-0.102^{***}$	$0.039^{***}$	0.057***	0.135***	$0.056^{***}$	1 ***
INTANG (.	[11]	-0.017*	0.015*	0.016*	-0.009	-0.003	-0.007	-0.050	0.034	0.030	0.073
INVENT (	12)	-0.039 0.001	0.056	0.061	0.024	-0.128 0.410***	0.121	0.348	-0.137	$-0.015^{***}$	-0.348 0.247***
CFO CASH	(61)	0.018**	-0.064	$-0.063^{***}$	-0.025	$0.409^{***}$	$-0.165^{***}$	-0.12/ -0.301***	-0.040	-0.068	$-0.306^{***}$
REGU	15)	-0.014*	0.044	0.044***	-0.003	-0.002	0.048***	0.007	-0.041***	-0.008	$-0.051^{***}$
ANA	16)	$0.027^{***}$	0.022***	$0.022^{***}$	$0.059^{***}$	$0.387^{***}$	$0.397^{***}$	-0.01	$-0.136^{***}$	$-0.159^{***}$	$-0.025^{***}$
IC (	17)	0.011	0.018	$0.019^{**}$	0.004	0.070***	$0.018^{**}$	-0.012	0.003	-0.077***	0.001
DIRO	18)	0.040	-0.407	-0.404	-0.139	0.155	-0.268	-0.322	-0.050	-0.064	-0.175
DUAL (. SOE (.	19) 20)	0.026 -0.033***	-0.189 0.224	-0.174	0.177 -0.042 <sup>***</sup>	0.061 -0.140	-0.134 0.278***	-0.150 $0.295^{***}$	-0.050 $0.067^{***}$	-0.023 0.025	-0.108 0.219***
Panel C: Correlation a	analysis (	continued)									
		(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
RATE	(1)	-0.030***	$-0.032^{***}$	-0.069***	$-0.037^{***}$	-0.033	$-0.031^{***}$	$-0.030^{***}$	0.01	0.026***	-0.002
LOCK	5	-0.018**	0.038***	0.027***	$-0.066^{***}$	0.042***	$0.021^{**}$	0.081	$-0.360^{***}$	$-0.189^{***}$	0.224***
LOCK_CHAIR	(3)	$-0.018^{**}$	$0.044^{***}$	$0.026^{***}$	$-0.064^{***}$	$0.044^{***}$	$0.022^{***}$	$0.082^{***}$	$-0.354^{***}$	$-0.174^{***}$	$0.225^{***}$
LOCK_CEO	(4)	0.012	$0.030^{***}$	0.017*	$-0.027^{***}$	0.002	0.058***	$0.033^{***}$	$-0.085^{***}$	$0.177^{***}$	$-0.042^{***}$
ROA	(5)	0.00	$-0.135^{***}$	0.379***	$0.372^{***}$	-0.002	0.433	$0.304^{***}$	$0.216^{***}$	0.075***	$-0.171^{***}$
SIZE	(9)	-0.054	0.034	0.026	-0.190	0.033	0.384	0.197	-0.193	-0.141	$0.262^{***}$
LEV	6	-0.128	0.279	-0.118	-0.302	0.001	-0.01	0.110	-0.302	-0.151	0.294
BM	8	0.065	-0.108	-0.043	-0.068	-0.045	-0.131	-0.033	-0.036	-0.050	0.069
	(9)	0.023 0.744 ***	10.0- ^****	-0.001 10.00	-0.098 0.30°***	-0.011 0.050***	-0.160	-0.101	-0.060 	-0.023 0.002***	0.025
INTANG	11)	1	-0.255 -0.165***	0.107***	-0.084	-0.02	0.042	-0.078	-0.101 0.074***	0.022***	$-0.071^{***}$
INVENT (	12)	$-0.218^{***}$	1	$-0.236^{***}$	$-0.093^{***}$	$-0.029^{***}$	-0.058***	0.069	$-0.050^{***}$	$-0.014^{*}$	$0.025^{***}$
CFO	13)	$0.101^{***}$	$-0.253^{***}$	1	$0.148^{***}$	-0.024***	$0.192^{***}$	$0.149^{***}$	-0.009	-0.012	$0.022^{***}$
CASH (	14)	-0.099	$-0.136^{***}$	$0.209^{***}$	-	$0.077^{***}$	$0.145^{***}$	$0.108^{***}$	$0.118^{***}$	$0.069^{***}$	-0.083***
REGU	15)	-0.031	$-0.014^{*}$	-0.022	0.073	-	0.047	0.018	-0.045	$-0.016^{*}$	0.057
ANA (	16)	0.025	-0.063	0.183	0.137	$0.039^{***}$	1 ***	$0.283^{***}$	$0.143^{***}$	0.027	-0.046
IC	17)	-0.017	0.029	0.037	0.034	0.011	0.076	1	-0.081	-0.052	0.141
DIRO	18)	-0.026	-0.105	-0.018	0.138	-0.036	0.082	0.008	[ ** ** **	0.263	-0.565
DUAL (	19)	-0.023	-0.031	$-0.015^{*}$	0.073	-0.022	0.027	-0.005	0.261	] 0.010***	-0.278
30E (.	(07	0.010.0	ccu.u	0.022	160.0-	c/n.n	0.040	0CU.U	-0.400	-0.270	-
<i>Note</i> : This table report Correlation analyses at	ts descrip re presen	otive statistics ted in Panel C	for our main re 3. The left ton a	sgression variabl	les in Panel A. F n trianøles renre	anel B shows th sent the Pearson	ie univariate test 1 and Spearman	s of our main de correlations, re	ependent variab	les—tax avoida and *** indicate	nce (RATE). significance
at the 0.10, 0.05, and (	0.01 leve	ls, respectivel	у. У.						· · · · · · · · · · · · · · · · · · ·		

(LOCK = 1) have higher return on equity (*ROE*), state ownership (*SOE*) and financial leverage (*LEV*) than firms without vertical interlock.

Table 2, Panel C reports the correlation metrics of the main variables. The left bottom and right top triangles present the Pearson and Spearman correlations, respectively. We find that all vertical interlock measures (LOCK, LOCK\_CHAIR and LOCK\_CEO) are negatively correlated with the tax avoidance proxy (RATE) at the 1% level, providing support for the hypothesis that vertical interlock negatively affects corporate tax avoidance. In addition, the correlations between the three vertical interlock measures (LOCK, LOCK\_CHAIR and LOCK\_CEO) are positive and significant at the 1% level, and the coefficients are larger than 0.500. These results suggest that these three vertical interlock proxies capture consistent information. Furthermore, the control variables ROA, CASH, ANA, DIRO and DUAL are positively correlated with RATE, whereas SIZE, LEV, LOSS, PPE, INTANG, INVENT and SOE are negatively correlated with RATE. The correlations between the control variables are relatively weak. To test the existence of multicollinearity, we compute the variance inflation factors (VIFs) for the control variables and find that the largest VIF is 2.50, much smaller than the cutoff threshold of 10.00 for the multiple regression model suggested by Kennedy (1998). The above results indicate that multicollinearity is not a serious issue in our study.

#### 4.2. Baseline regression results

Table 3 presents the baseline regression results for the impact of vertical interlock on corporate tax avoidance. We employ firm fixed effects to mitigate the potential omitted variable issue. The empirical model is elaborated in Section 3.5, and all variables are explained in the Appendix.

Columns (1), (3) and (5) report the results without control variables, whereas Columns (2), (4) and (6) report the results with all control variables added. For all vertical interlock measures, the coefficients are negative and significant at the 1% level. These results indicate that vertically interlocked firms avoid less taxes than firms without vertical interlock. The effect is observed for both vertically interlocked chairpersons and CEOs. We use our preferred specification in Column (2) to illustrate the economic significance. The coefficient on *LOCK* is -0.023 (t = -4.04) in Column (2), which, benchmarked against the standard deviation of *RATE* (0.217), means that vertically interlocked firms reduce their tax avoidance by 10.60% (= -0.023/0.217) compared with firms without vertical interlock. Further, we empirically compare the impact of vertically interlocked chairpersons and CEOs and find that the coefficient difference is nonsignificant (p = 0.756), suggesting that regardless of whether the CEO or the chairperson is responsible for the vertical interlock, the impact on corporate tax avoidance is the same.

# 4.3. Robustness checks

#### 4.3.1. Alternative measures of corporate tax avoidance

We employ two alternative measures of corporate tax avoidance. The first measure is the book-tax difference (BTD), calculated as the difference between income before taxes and taxable income scaled by total assets. Taxable income is calculated as (total income tax expense – deferred income tax expense) / applicable statutory tax rate. A larger value of BTD indicates greater tax aggressiveness. Our second measure is the abnormal book-tax difference. Following Desai and Dharmapala (2006, 2009), we use the abnormal book-tax difference (DDBTD) to proxy for corporate tax avoidance. DDBTD considers the impact of firms' earnings management and is defined as the residual part of regressing BTD on total accruals (TA). By construction, a lower level of DDBTD implies a lower degree of tax aggressiveness.

We present the regression results for the alternative corporate tax avoidance measures in Table 4. Columns (1)–(3) present the results using *BTD* as the dependent variable, whereas Columns (4)–(6) present those using *DDBTD* as the dependent variable. The results show that the vertical interlock proxies are all negative and significant, suggesting that vertical interlock has a negative impact on tax avoidance. The regression results for the alternative tax avoidance measures align with our baseline results, indicating that our results do not suffer greatly from the measurement error arising from using tax avoidance proxies.

			$R_{\ell}$	4TE		
	(1)	(2)	(3)	(4)	(5)	(6)
LOCK	-0.021***	-0.023***				
	(-3.60)	(-4.04)				
LOCK_CHAIR			-0.021***	-0.023***		
LOCK CEO			(-3.77)	(-4.16)	0.01(***	0.010***
LOCK_CEO					$-0.010^{+++}$	$-0.018^{+++}$
ROA		0.302***		0 302***	(-2.75)	(-3.03)
ROA		(6.32)		(6.31)		(6.24)
SIZE		0.002		0.002		0.002
		(0.50)		(0.47)		(0.43)
LEV		-0.023		-0.023		-0.023
		(-1.06)		(-1.05)		(-1.03)
BM		0.013		0.013		0.012
		(0.60)		(0.60)		(0.56)
LOSS		-0.014		-0.014		-0.014
		(-1.31)		(-1.32)		(-1.29)
PPE		-0.028		-0.027		-0.027
		(-1.11)		(-1.09)		(-1.09)
INTANG		-0.090		-0.089		-0.084
		(-1.32)		(-1.31)		(-1.23)
INVENT		-0.036		-0.035		-0.036
CEO.		(-1.18)		(-1.16)		(-1.21)
CFO		-0.020		-0.020		-0.020
CASH		(-0.85)		(-0.85)		(-0.84)
CASH		-0.039***		$-0.039^{-0.0}$		$-0.039^{-0.0}$
PECU		(-2.90)		(-2.94)		(-2.91)
KE00		(0.01)		(0.000)		(0.01)
ANA		0.006**		0.006**		0.006**
		(2.22)		(2.21)		(2.23)
IC		-0.002		-0.002		-0.003
		(-0.71)		(-0.72)		(-0.73)
DIRO		-0.043		-0.043		-0.039
		(-1.53)		(-1.53)		(-1.38)
DUAL		-0.003		-0.002		0.003
		(-0.44)		(-0.37)		(0.49)
SOE		-0.017		-0.017		-0.018
		(-1.25)		(-1.24)		(-1.31)
Constant	0.020***	0.001	0.019***	0.002	0.012***	-0.002
	(5.87)	(0.01)	(6.21)	(0.02)	(7.84)	(-0.01)
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	23,442	23,442	23,442	23,442	23,442	23,442
Adj K <sup>-</sup>	0.055	0.059	0.055	0.059	0.055	0.059

Table 3 Vertical interlock and corporate tax avoidance.

*Note:* This table reports the impact of vertical interlock on corporate tax avoidance. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

# 4.3.2. Difference-in-differences analysis

Our empirical results may suffer from endogeneity problems. For example, firms with a lower level of tax avoidance may be more likely to appoint a vertically interlocked CEO or chairperson, leading to reverse causality. In addition, vertical interlock and corporate tax avoidance might be determined simultaneously by omitted time-invariant characteristics. Therefore, to provide more evidence of the causal influence of vertical interlock on corporate tax avoidance, we adopt a DID approach.

		BTD			DDBTD	
	(1)	(2)	(3)	(4)	(5)	(6)
LOCK	-0.002*			-0.002*		
LOCK_CHAIR	(-1.09)	$-0.002^{*}$		(-1.09)	$-0.002^{*}$	
LOCK_CEO		(-1.70)	$-0.002^{*}$		(-1.70)	$-0.002^{*}$
ROA	0.141***	0.141***	0.140***	0.140***	0.140***	(-1.03) 0.140*** (6.19)
SIZE	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
LEV	$-0.043^{***}$	$-0.043^{***}$	$-0.043^{***}$	$(-0.043^{***})$	(-0.77) $-0.043^{***}$ (-7.27)	$-0.043^{***}$
BM	(-7.20) $-0.011^{**}$	(-7.20) $-0.011^{**}$	(-7.20) $-0.011^{**}$	(-7.27) $-0.011^{**}$	(-7.27) $-0.011^{**}$	(-7.27) $-0.011^{**}$
LOSS	0.002	0.002	0.002	0.002	0.002	0.002
PPE	(1.09) -0.008	(1.09) -0.008	(1.11) -0.008	(1.09) -0.008	(1.09) -0.008	(1.10) -0.008
INTANG	(-1.46) -0.021	(-1.46) -0.021	(-1.46) -0.021	(-1.46) -0.021	(-1.46) -0.021	(-1.46) -0.021
INVENT	(-1.38) -0.031***	(-1.38) -0.031***	(-1.35) $-0.031^{***}$	(-1.39) $-0.031^{***}$	(-1.39) -0.031***	(-1.35) $-0.031^{***}$
CFO	(-4.56) -0.004	(-4.55) -0.004	(-4.58) -0.004	(-4.56) -0.004	(-4.55) -0.004	(-4.58) -0.004
CASH	(-0.55) $-0.031^{***}$	(-0.55) $-0.031^{***}$	(-0.55) $-0.031^{***}$	(-0.53) $-0.031^{***}$	(-0.53) $-0.031^{***}$	(-0.53) $-0.031^{***}$
REGU	(-5.91) -0.006*	(-5.91) -0.006*	(-5.90) -0.007*	(-5.92) -0.006*	(-5.92) -0.006*	(-5.92) -0.007*
ANA	(-1.87) 0.001 (1.45)	(-1.86) 0.001 (1.45)	(-1.88) 0.001	(-1.87) 0.001	(-1.87) 0.001 (1.47)	(-1.88) 0.001
IC	(1.45) 0.001	(1.45) 0.001 (1.45)	(1.46) 0.001 (1.45)	(1.47) 0.001	(1.47) 0.001 (1.45)	(1.47) 0.001
DIRO	(1.46) 0.004	(1.45) 0.004	(1.45) 0.004	(1.46) 0.004	0.004	(1.45) 0.004
DUAL	(0.63) -0.000	(0.63) -0.000	(0.67) 0.000	(0.63) -0.000	(0.63) -0.000	(0.68) 0.000
SOE	(-0.24) -0.001	(-0.22) -0.001	(0.21) -0.001	(-0.24) -0.001	(-0.22) -0.001	(0.21) -0.001
Constant	(-0.45) 0.048* (1.70)	(-0.45) 0.048* (1.71)	(-0.49) 0.048* (1.60)	(-0.45) 0.059**	(-0.45) 0.059**	(-0.48) 0.058** (2.05)
Year FE	(1.70) YES	(1./1) YES	(1.69) YES	(2.07) YES	(2.07) YES	(2.05) YES
Firm FE Observations Adj R <sup>2</sup>	YES 23,442 0.166	YES 23,442 0.166	YES 23,442 0.166	YES 23,442 0.166	YES 23,442 0.166	YES 23,442 0.166

*Note*: This table reports the result of alternative measures of tax avoidance. Columns (1)–(3) present the results using book–tax difference (*BTD*) as the dependent variable. Columns (4)–(6) report the results using the abnormal book–tax difference (*DDBTD*) as the dependent variable. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

We first adopt an entropy balancing model to mitigate sample selection bias and generate our treatment and control samples. The primary benefit of using an entropy balancing model is that it allows us to attribute any observed effect more clearly to the vertical interlock itself, rather than the firm characteristics associated with vertical interlock decisions. We use an entropy balancing model instead of a propensity score matching model to avoid specifying a propensity model or identifying a potentially noisy one-to-one match for each treated observation (McMullin and Schonberger, 2022). In addition, the entropy balancing method does not lead to a sample loss because it adjusts inequalities in representation with respect to the first (mean) and second (variance) moments of covariate distributions. To test whether appointing a vertically interlocked CEO and chairperson can reduce corporate tax avoidance, we regard firms that switch from sample years without vertical interlock to consecutive years with vertical interlock as a treatment group, and we consider firms that do not appoint vertically interlocked executives in the whole sample period as the control group. If a firm repeatedly changes its vertical interlock status, we exclude it from the sample. We first apply entropy balancing to the treatment and control groups based on the means and variances of several firm characteristics, which are the same as those of the control variables in model (1). The descriptive statistics for the treatment and control samples before and after entropy balancing are reported in Panel A of Table 5. The results suggest that there are significant differences between the two groups before entropy balancing, whereas there is no significant difference in any covariates after entropy balancing. Next, we construct the following DID model to test our prediction:

$$RATE_{i,t} = \beta_0 + \beta_1 TREAT \times POST_{i,t} + \beta_i \sum CONTROLS + FirmFE + YearFE + \varepsilon$$
(2)

where *RATE* and the included control variables are the same as in model (1). *TREAT* is a dummy variable that equals one if a firm belongs to the treatment group and zero if a firm belongs to the control group. *POST* is a dummy variable that equals one if the sample year is after the appointment of a vertically interlocked CEO/chairperson and zero otherwise. We focus on the coefficient on the interaction term *TREAT* × *POST*, capturing the difference in the changes in corporate tax avoidance between non-vertically interlocked firms transforming into vertically interlocked firms without any such transitions. Based on the hypothesis, we expect the coefficient on *TREAT* × *POST* to be negative.

Table 5 Panel B reports the results of DID regression analysis based on the entropy balanced sample. Columns (1)–(3) present the results for the transition to vertically interlocked chairperson or CEO, vertically interlocked chairperson and vertically interlocked CEO, respectively. Most of the coefficients on  $TREAT \times POST$ are negative and significant, indicating that the aggressiveness of corporate tax avoidance decreases when a firm appoints a vertically interlocked chairperson or CEO. This result supports the causal effect of vertical interlock on corporate tax avoidance.<sup>3</sup>

We conduct a further DID analysis based on a regulatory exogenous shock. The State Council in China implemented the reform of authorized operation of state-owned capital (hereafter "the reform") in 2014. The reform aims to reorganize or establish a new capital investment/operating company within the treated state-owned business groups. Specifically, the parent controller of a treated group can itself be reorganized into an investment/operating company, or the treated group can establish a new state-owned capital investment/operating company, with these specialized investment/operating company, with these specialized investment/operating companies fulfilling the duty of the state-owned capital contributors to conduct market-oriented capital operations.

In the first case of reorganizing a parent controller into an investment/operating company, the parent controller needs to divest its production and operation activities to subsidiaries to focus on capital operations. Therefore, managers who were responsible for specific production and operation activities in the parent controller may take up concurrent positions in the subsidiaries after the reform, which contributes to an increase in vertically interlocked managers.

In the second case, namely the newly established state-owned capital investment/operating companies, managers may be recruited from the group's subsidiaries, which again is likely to increase the number of

<sup>&</sup>lt;sup>3</sup> In contrast, we test whether the dismissal or departure of a vertically interlocked CEO/chairperson increases corporate tax avoidance. We match firms that switch from sample years with vertical interlock to consecutive years without vertical interlock (the treatment group) with firms that are vertically interlocked during the whole sample period (the control group), and construct a new propensity score matched sample. We then use model (2) to conduct the empirical test and expect the coefficients on *TREAT* ×*POST* to be positive and significant. The untabulated regression results show that the coefficients on *TREAT* × *POST* are positive but nonsignificant, suggesting that the cessation of vertical interlock does not significantly decrease corporate tax avoidance. We argue that the impact of vertical interlock may be persistent, and the dismissal or departure of a vertical interlocked executive does not lead to a sudden increase in corporate tax avoidance.

Difference-iii-c	interences analy	sis based on entro	py balancing.				
Panel A: descr	riptive statistics	before and after en	ntropy balancing u	sing <i>LOCK</i> as th	he dependent varia	ıble	
		Treatment grou $(N = 2703)$	р		Control group (N = 5566)		MeanDiff
Covariate	Mean	Variance	Skewness	Mean	Variance	Skewness	
Before balance	ing						
ROA	0.055	0.003	2.402	0.069	0.003	1.688	-0.014***
SIZE	22.020	1.420	0.488	21.640	1.054	0.904	0.380***
LEV	0.457	0.037	-0.059	0.352	0.035	0.381	0.105***
BM	0.294	0.021	0.851	0.283	0.019	0.859	0.011***
LOSS	0.067	0.063	3.453	0.048	0.046	4.230	0.019***
PPE	0.224	0.024	0.754	0.193	0.018	1.008	0.031***
INTANG	0.044	0.002	2.728	0.043	0.002	3.035	0.001
INVENT	0.169	0.023	1.673	0.138	0.013	2.074	0.031***
CFO	0.051	0.009	0.019	0.057	0.007	0.104	$-0.006^{***}$
CASH	0.195	0.026	1.945	0.221	0.031	1.557	-0.026***
REGU	1.004	0.037	0.599	0.982	0.034	0.687	0.022***
ANA	1.411	1.264	0.173	1.568	1.329	-0.001	-0.157***
IC	6.425	0.503	-8.589	6.458	0.284	-11.540	$-0.033^{**}$
DIRO	0.072	0.021	2.196	0.290	0.047	-0.015	-0.218***

Table 5 Difference-in-differences analysis based on entropy balancing

	11.010	11.120	01100	211010	11001	012 0 1	01000
LEV	0.457	0.037	-0.059	0.352	0.035	0.381	0.105***
BM	0.294	0.021	0.851	0.283	0.019	0.859	0.011***
LOSS	0.067	0.063	3.453	0.048	0.046	4.230	0.019***
PPE	0.224	0.024	0.754	0.193	0.018	1.008	0.031***
INTANG	0.044	0.002	2.728	0.043	0.002	3.035	0.001
INVENT	0.169	0.023	1.673	0.138	0.013	2.074	0.031***
CFO	0.051	0.009	0.019	0.057	0.007	0.104	$-0.006^{***}$
CASH	0.195	0.026	1.945	0.221	0.031	1.557	$-0.026^{***}$
REGU	1.004	0.037	0.599	0.982	0.034	0.687	0.022***
ANA	1.411	1.264	0.173	1.568	1.329	-0.001	-0.157***
IC	6.425	0.503	-8.589	6.458	0.284	-11.540	-0.033 **
DIRO	0.072	0.021	2.196	0.290	0.047	-0.015	-0.218***
DUAL	0.208	0.165	1.439	0.395	0.239	0.431	-0.187***
SOE	0.435	0.246	0.262	0.144	0.124	2.023	0.291***
After balance	ng						
ROA	0.055	0.003	2.402	0.055	0.003	2.414	0.000
SIZE	22.020	1.420	0.488	22.020	1.420	0.635	0.000
LEV	0.457	0.037	-0.059	0.457	0.037	-0.067	0.000
BM	0.294	0.021	0.851	0.294	0.021	0.800	0.000
LOSS	0.067	0.063	3.453	0.067	0.063	3.453	0.000
PPE	0.224	0.024	0.754	0.224	0.024	0.782	0.000
INTANG	0.044	0.002	2.728	0.044	0.002	2.997	0.000
INVENT	0.169	0.023	1.673	0.169	0.023	1.708	0.000
CFO	0.051	0.009	0.019	0.051	0.009	-0.043	0.000
CASH	0.195	0.026	1.945	0.195	0.026	1.981	0.000
REGU	1.004	0.037	0.599	1.004	0.037	0.587	0.000
ANA	1.411	1.264	0.173	1.411	1.264	0.183	0.000
IC	6.425	0.503	-8.589	6.425	0.503	-8.638	0.000
DIRO	0.072	0.021	2.196	0.072	0.021	2.191	0.000
DUAL	0.208	0.165	1.439	0.208	0.165	1.438	0.000
SOE	0.435	0.246	0.262	0.435	0.246	0.262	0.000

Panel B: Difference-in-difference test based on the entropy-balanced sample

	RATE			
	(1)	(2)	(3)	
	LOCK	LOCK_CHAIR	LOCK_CEO	
TREAT×POST	-0.029**	-0.021*	-0.013	
	(-2.27)	(-1.70)	(-1.08)	
ROA	0.252**	0.281**	0.350***	
	(2.09)	(2.46)	(4.39)	
SIZE	0.001	0.002	-0.001	
	(0.05)	(0.22)	(-0.12)	
LEV	0.076	0.098**	-0.000	
	(1.56)	(2.04)	(-0.00)	
BM	0.030	0.052	0.051	
	(0.58)	(1.05)	(1.42)	
LOSS	-0.040	-0.038	-0.023	
	(-1.49)	(-1.38)	(-1.35)	
PPE	$-0.142^{**}$	-0.126**	-0.065	

(continued on next page)

	RATE			
	(1)	(2)	(3)	
	(-2.18)	(-2.10)	(-1.43)	
INTANG	0.108	0.194	0.028	
	(0.67)	(1.11)	(0.23)	
INVENT	-0.153**	-0.145**	-0.043	
	(-2.20)	(-2.05)	(-0.99)	
CFO	-0.059	-0.063	0.001	
	(-1.03)	(-1.13)	(0.01)	
CASH	0.004	-0.000	-0.037	
	(0.12)	(-0.01)	(-1.48)	
REGU	0.013	0.013	-0.002	
	(0.28)	(0.27)	(-0.05)	
ANA	-0.009	-0.007	0.002	
	(-1.41)	(-1.03)	(0.55)	
IC	0.001	-0.002	-0.003	
	(0.07)	(-0.26)	(-0.53)	
DIRO	0.005	0.011	-0.036	
	(0.10)	(0.21)	(-0.82)	
DUAL	0.020	0.011	-0.005	
	(1.33)	(0.74)	(-0.42)	
SOE	-0.032	-0.045	-0.003	
	(-0.89)	(-1.37)	(-0.17)	
Constant	0.018	-0.035	0.053	
	(0.08)	(-0.15)	(0.31)	
Year FE	YES	YES	YES	
Firm FE	YES	YES	YES	
Observations	8,269	8,527	13,741	
Adj R <sup>2</sup>	0.045	0.034	0.073	

 Table 5 (continued)

Panel B: Difference in difference test based on the entropy balanced sample

*Note:* This table reports the result of the difference-in-differences analysis. Panel A reports the descriptive statistics before and after the entropy balancing using the dependent variable of *LOCK*. The results of using *LOCK\_CHAIR* and *LOCK\_CEO* are similar and are available upon request. Panel B presents the difference-in-differences test based on the entropy-balanced sample. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

vertically interlocked CEOs and chairpersons. Taking China Oils and Foodstuffs Corporations (COFCO) as an example, in April 2018, the parent controller acquired a 67% stake in Zhongyuan Special Steel Co., Ltd (ZYSCO),<sup>4</sup> arranging for it to act as a specialized investment/operating company that manages the group's assets. Importantly, the chairperson of the newly merged investment/operating company (i.e., ZYSCO), Yanmin Sun, is the director and manager of COFCO Capital Investment Co., one of the group's subsidiaries. Based on the above discussion, we infer that the reform increases the likelihood of vertical interlock for firms within treated business groups. However, the reform itself may not directly impact corporate tax avoidance. The staggered implementation of the reform provides us with a useful quasi-natural experiment to test how vertical interlock affects corporate tax avoidance.

We hand-collect the treated business groups and their listed subsidiaries, and we construct a staggered DID model as follows:

$$RATE_{i,t} = \beta_0 + \beta_1 AUTHORIZE_{i,t} + \beta_i \sum CONTROLS + FirmFE + YearFE + \varepsilon$$
(3)

where *AUTHORIZE* is a dummy variable that equals one if a firm is affiliated with the treated business group in year *t* onwards, and zero otherwise. *RATE* represents corporate tax avoidance, and *CONTROLS* are the

<sup>&</sup>lt;sup>4</sup> Source: http://www.cninfo.com.cn/new/disclosure/detail?orgId=9900012789&announcementId=1204639131&announcementTime=2018-04-17.

same as in the main regression model. Firm FE and Year FE represent firm and year fixed effects, respectively. We expect the coefficient on  $\beta_I$  to be negative and significant.

Table 6 reports the results of the DID analysis based on the exogenous shock. We find that the coefficients are -0.051 and -0.048 in Columns (1) and (2), respectively, and they are both significant at the 1% level. Furthermore, as the reform is aimed at SOEs, rather than non-SOEs, we confine our sample to SOEs and re-estimate model (3). The results presented in Columns (3) and (4) of Table 6 suggest that our findings still hold.

# 4.3.3. Heckman two-stage sample selection model

Firms' characteristics may influence their decision to appoint vertically interlocked CEOs and chairpersons. To mitigate potential sample selection bias, we adopt the Heckman two-stage sample selection approach (Heckman, 1979). In the first stage, we estimate a probit regression of the determinants of vertical interlock. Following the literature (Ong et al., 2003; Phan et al., 2003; Chen and Yang, 2021; Yang et al., 2021), we control for the following factors that may influence corporate decisions on hiring vertically interlocked executives: return on assets (ROA), firm size (SIZE), leverage (LEV), board independence (INDE) and state ownership (SOE). We include an instrumental variable in the first stage to reduce the high collinearity between the inverse Mills ratio (IMR) and other predictors (Certo et al., 2016). The instrumental variable used in this study is whether the place of registration of the listed company is in the same province as that of the controlling shareholder to assign an executive to be chairperson or CEO for a subordinate listed company. Therefore, the listed company is more likely to have vertically interlocked executives. As the geographical location of controlling shareholders and subsidiaries cannot directly affect corporate tax avoid-ance, we expect this instrument to influence the selection into the sample (first stage) but have no relationship to the ultimate disturbance term in the second stage.

Table 7 reports the result of the Heckman two-stage analysis. The coefficient on *PROVINCE* is positive and significant at the 1% level, suggesting that the instrument is highly correlated with firms' propensity to make vertically interlocked appointments. In the second stage, we add the inverse Mills ratio (*IMR*) as a control variable. In Panel B, the coefficients on *LOCK*, *LOCK\_CHAIR* and *LOCK\_CEO* are negative and significant at the 1% level, further supporting the idea that vertical interlock reduces corporate tax avoidance. In addition, the coefficients on *IMR* are positive but nonsignificant, suggesting that self-selection bias may not be a serious concern in this study.

#### 4.3.4. Instrumental variable approach

Although we control for various financial and corporate governance factors in our main regression model, our results may suffer from the omitted variable problem. To mitigate this potential problem, we use the instrumental variable approach. To qualify as a valid instrument, the instrumental variable should be strongly correlated with the endogenous variable (the validity requirement) but uncorrelated with the error term (the exclusion restriction). We adopt two instrumental variables. The first is the dummy variable PROVINCE, which is explained in 4.3.3. *PROVINCE* equals one if the place of registration of the listed company is in the same province as the controlling shareholder, and zero otherwise. We argue that if a listed company is located geographically near its controlling shareholder, the controlling shareholder is more likely to assign vertically interlocked executives to its subordinate listed companies. However, geographical location cannot directly affect corporate tax avoidance. Therefore, the first instrumental variable meets the validity and exclusion restriction requirement. The second instrumental variable is AVGINTER, defined as the industry-year mean percentage of firms making vertically interlocked appointments, excluding the firm concerned. Firms in the same industry experience similar economic fluctuations and governance regulations in a similar macro-environment; thus, they may have similar incentives to appoint a vertically interlocked executive. However, other firms' decisions regarding appointing a vertically interlocked executive are unlikely to directly affect the tax-avoidance behavior of the firm in question. Thus, we consider AVGINTER to be a valid instrument. We expect *PROVINCE* and *AVGINTER* to be positively associated with the vertical interlock measures.

Table 8 reports the result of the instrumental variable approach. In the first stage, both *PROVINCE* and *AVGINTER* are positive and significant at least at the 5% level, suggesting that our instrumental variables are highly correlated with vertical interlock decisions. We statistically diagnose the validity of the two instrumen-

$\begin{tabular}{ c c c c c c } \hline The full sample of SOEs \\\hline (1) (2) (3) (4) \\\hline (4) \\\hline (6) \hline\hline (6) \\\hline (6) \hline\hline (6)$		RATE						
$\begin{tabular}{ c c c c c c } \hline (1) & (2) & (3) & (4) \\ \hline AUTHORIZE & -0.051*** & -0.043** & -0.043** & -0.043* & -0.040* \\ & (-3.19) & (-3.00) & (-2.54) & (-2.42 \\ ROA & 0.0295*** & 0.510** & 0.510** \\ & (-6.15) & (-6.43 \\ SIZE & 0.000 & 0.00 \\ & (0.06) & 0.032 \\ LEV & -0.021 & -0.06 \\ & (-0.96) & (-1.50 \\ M & 0.015 & 0.000 \\ LOSS & -0.015 & -0.02 \\ & (-0.05) & (-1.45 \\ PPE & -0.024 & -0.02 \\ & (-1.35) & (-1.45 \\ PPE & -0.024 & -0.02 \\ & (-1.23) & (-1.23 \\ INTANG & -0.084 & -0.13 \\ & (-1.23) & (-1.29 \\ INVENT & -0.034 & -0.02 \\ & (-1.44) & (-0.45 \\ CFO & -0.021 & -0.01 \\ CFO & -0.021 & -0.01 \\ & (-1.28) & (-1.29 \\ INVENT & -0.034 & -0.02 \\ & (-1.29 & (-1.29 \\ INVENT & -0.034 & -0.02 \\ & (-0.05** & -0.021 & -0.01 \\ & (-0.58) & (-2.20 \\ REGU & 0.001 & -0.055** \\ & (-2.68) & (-2.20 \\ REGU & 0.001 & -0.055* \\ & (-2.01 & -0.055 \\ IC & -0.003 & -0.005 \\ IC & -0.003 & -0.003 \\ IC & -0.003 & -0.005 \\ IC & -0.003 & -0.003 \\ IC & -0.003 & -0.005 \\ IC & -0.003 & -0.003 \\ IC & -0.003 & -0.003 \\ IC & -0.003 & -0.005 \\ IC & -0.003 & -0.003 \\ IC & -0.003 & -0.000 \\ IC & -0.0$		The full sample		The subsample of S	OEs			
AUTHORIZE $-0.045^{***}$ $-0.043^{**}$ $-0.043^{**}$ $-0.043^{**}$ $-0.040^{**}$ ROA         (-3.19)         (-3.00)         (-2.54)         (-2.42)           SIZE         0.0000         0.000         0.000           LEV         -0.021         -0.046           (-0.96)         (-1.55)         (-1.45)           BM         0.015         -0.021           LEV         -0.024         -0.020           LEV         -0.048         -0.021           DSS         -0.015         -0.021           LEV         -0.024         -0.022           LEV         -0.024         -0.022           LINTANG         -0.034         -0.015           INTANG         -0.034         -0.021           INVENT         -0.036***         -0.025           CFO         -0.021         -0.010           CASH         -0.036***         -0.025           REGU         0.001         -0.055*           IC         -0.036         -0.010           C249         (-2.30)         (-1.23)           IC         -0.003         -0.010           C200         0.0001         -0.0		(1)	(2)	(3)	(4)			
$(-3.19)$ $(-3.00)$ $(-2.54)$ $(-2.42)$ ROA $0.295^{***}$ $0.510^{**}$ SIZE $0.000$ $0.001$ SIZE $0.006$ $0.032$ LEV $-0.021$ $-0.066$ BM $0.015$ $0.000$ DSS $-0.021$ $-0.020$ LOSS $-0.015$ $-0.021$ VEN $-0.024$ $-0.021$ VEN $-0.024$ $-0.021$ VEN $-0.024$ $-0.02$ VEN $-0.024$ $-0.021$ VEN $-0.024$ $-0.024$ VENT $-0.034$ $-0.024$ VENT $-0.034$ $-0.024$ CASH $-0.034$ $-0.025$ CASH $-0.033$ $(-1.35)$ CASH $-0.033$	AUTHORIZE	-0.051***	-0.048***	-0.043**	-0.040**			
ROA $0.295^{***}$ $0.1$ $0.510^{**}$ SIZE $0.000$ $0.00$ LEV $-0.021$ $-0.06$ $(-0.96)$ $(-1.50)$ $0.00$ BM $0.015$ $0.00$ $(-0.86)$ $-0.021$ $-0.02$ $(-1.35)$ $(-1.43)$ $-0.02$ $PPE$ $-0.024$ $-0.02$ $(-1.35)$ $(-1.43)$ $(-1.23)$ $PPE$ $-0.024$ $-0.02$ $(-1.43)$ $(-0.62)$ $(-0.62)$ $INTANG$ $-0.034$ $-0.02$ $(-1.44)$ $(-0.02)$ $(-0.03)$ $(-1.44)$ $(-0.05)$ $(-0.05)$ $(-0.62)$ $(-0.03)$ $(-0.05)$ $(-0.63)$ $(-2.20)$ $(-2.20)$ $REGU$ $0.001$ $-0.034$ $(-0.03)$ $(-0.015)$ $(-2.20)$ $INVENT$ $-0.033$ $(-0.015)$ $(-0.010)$ $(-2.20)$ $(-2.20)$ $REGU$ $0.0001$ $(-0.03)$ <		(-3.19)	(-3.00)	(-2.54)	(-2.42)			
$(6.15)$ $(6.43)$ SIZE       0.000       0.002 $LEV$ $-0.021$ $-0.005$ $LEV$ $-0.021$ $-0.005$ $BM$ 0.015       0.000 $LSS$ $-0.015$ $-0.022$ $CASS$ $-0.015$ $-0.022$ $PE$ $-0.024$ $-0.022$ $(-1.33)$ $(-1.43)$ $(-1.43)$ $PPE$ $-0.024$ $-0.021$ $INTANG$ $-0.034$ $-0.12$ $INVENT$ $-0.034$ $-0.021$ $CFO$ $-0.021$ $-0.021$ $CFO$ $-0.021$ $-0.021$ $CFO$ $-0.024$ $-0.022$ $CFO$ $-0.021$ $-0.035$ $CASH$ $-0.036^{ense}$ $(-2.30)$ $CASH$ $-0.033$ $-0.005$ $CIC_2AB$ $0.006^{ense}$ $(0.001)^{ense}$ $DIRO$ $-0.003$ $-0.0015$ $-1.021$ $CO_2D_2$ $(0.08)$ $(-0.023)$ $(-1.73)$ $DIRO$ $-0.003$ $-0.000$ $-0.003$	ROA		0.295***		0.510***			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(6.15)		(6.43)			
$(0.06)$ $(0.32)$ LEV $-0.021$ $-0.06$ BM $0.015$ $0.00$ DSS $-0.015$ $-0.02$ LOSS $-0.015$ $-0.02$ PE $-0.024$ $-0.02$ INTANG $-0.084$ $-0.13$ INVENT $-0.034$ $-0.02$ INVENT $-0.034$ $-0.02$ CFO $-0.021$ $-0.04$ CFO $-0.034$ $-0.02$ CRSH $-0.036^{***}$ $-0.056^{**}$ CASH $-0.036^{***}$ $-0.054^{**}$ CASH $-0.036^{***}$ $-0.054^{**}$ MA $0.006^{**}$ $0.0011^{**}$ CASH $-0.033$ $-0.005^{**}$ DIRO $-0.028$ $0.09$ MA $0.006^{**}$ $0.0011^{**}$ C224) $(-2.20$ $(0.23)$ DIRO $-0.028$ $0.09$ Costant $0.009^{***}$ $0.029$ $0.02^{**}$ $0.08$ SOE $-0.015$ $-$ - $-$ <td< td=""><td>SIZE</td><td></td><td>0.000</td><td></td><td>0.002</td></td<>	SIZE		0.000		0.002			
LEV $-0.021$ $-0.066$ BM       0.015       0.007         LOSS $-0.015$ $-0.02$ LOSS $-0.024$ $-0.02$ PPE $-0.024$ $-0.02$ INTANG $-0.0864$ $-0.13$ INVENT $-0.084$ $-0.02$ INVENT $-0.024$ $-0.02$ CFO $-0.024$ $-0.02$ CFO $-0.021$ $-0.01$ CASH $-0.021$ $-0.02$ CFO $-0.021$ $-0.01$ CASH $-0.036^{***}$ $-0.055^{**}$ CASH $-0.036^{***}$ $-0.055^{**}$ CASH $-0.036^{***}$ $0.001^{**}$ ANA $0.006^{**}$ $(-1.33$ IC $-0.033$ $-0.015$ IC $-0.003$ $-0.010$ IC $-0.003$ $-0.000$ IC $-0.006$ $(-2.20$ IC $-0.006$ $(-0.23$ IC $-0.003$ $-0.010$ IC $-0.006$ $(-0.23$ IDRO <td></td> <td></td> <td>(0.06)</td> <td></td> <td>(0.32)</td>			(0.06)		(0.32)			
$(-0.96)$ $(-1.50)$ BM       0.015       0.00 $(0.68)$ $(0.07)$ LOSS $-0.015$ $-0.02$ $(-1.35)$ $(-1.45)$ PPE $-0.024$ $-0.02$ $(-0.96)$ $(-0.62)$ INTANG $-0.034$ $-0.02$ $(-1.23)$ $(-1.23)$ $(-1.23)$ INVENT $-0.034$ $-0.02$ $(-1.43)$ $(-0.45)$ $(-0.45)$ CFO $-0.021$ $-0.015$ $(-2.68)$ $(-2.20)$ $(-2.26)$ REGU $0.001$ $-0.055^{**}$ $(-2.68)$ $(-2.20)$ $(-2.20)$ ANA $0.006^{**}$ $0.011$ $(-0.73)$ $(-1.73)$ $(-2.20)$ DIRO $-0.003$ $-0.010$ $(-0.06)$ $(-0.23)$ $(-0.23)$ DUAL $-0.000$ $-0.003$ $(22.02)$ $(0.28)$ $(2.09)$ $(0.53)$ SOE $-0.015$ $-1$ $(-1.21)$ $(-2.35)$ $-10.02$ $-0.028$	LEV		-0.021		-0.060			
BM $0.015$ $0.00$ LOSS $-0.015$ $-0.02$ $(-1.35)$ $(-1.45)$ PPE $-0.024$ $-0.02$ $(-0.96)$ $(-0.68)$ $-0.02$ INTANG $-0.084$ $-0.13$ $(-1.23)$ $(-1.29)$ $(-1.29)$ INVENT $-0.034$ $-0.021$ $(-1.14)$ $(-0.45)$ $(-0.45)$ CFO $-0.021$ $-0.01$ $(-1.14)$ $(-0.45)$ $(-0.35)^{***}$ CASH $-0.036^{***}$ $-0.055^{**}$ CASH $-0.036^{***}$ $-0.054^{**}$ $(0.06)$ $(-2.20)$ $(-2.45)$ REGU $0.006^{**}$ $0.011^{**}$ $(0.06)$ $(-2.20)$ $(-0.33)$ DIRO $-0.003$ $-0.000$ $(-1.02)$ $(0.03)$ $-0.000$ $(-0.06)$ $(-0.23)$ $(-0.23)$ DUAL $-0.002$ $0.029$ $0.029^{**}$ $0.08$ $(22.02)$ $(0.28)$ <			(-0.96)		(-1.50)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	BM		0.015		0.002			
LOSS $-0.015$ $-0.02$ $PPE$ $-0.024$ $-0.02$ $(-1.35)$ $(-1.43)$ $(-0.62)$ $INTANG$ $-0.084$ $-0.13$ $(-1.23)$ $(-1.23)$ $(-1.23)$ $INVENT$ $-0.034$ $-0.02$ $(-1.14)$ $(-0.43)$ $-0.02$ $CFO$ $-0.021$ $-0.01$ $(-1.88)$ $(-0.35)$ $(-0.35)$ $CASH$ $-0.036^{***}$ $-0.055^{**}$ $(-2.68)$ $(-2.20)$ $0.066$ $REGU$ $0.006$ $(-2.01)$ $NA$ $0.006^{**}$ $0.011^{**}$ $REGU$ $-0.028$ $0.001$ $(-1.02)$ $(0.38)$ $(-1.73)$ $DIRO$ $-0.028$ $0.09$ $UAL$ $-0.000$ $-0.000$ $(-1.02)$ $(0.38)$ $(-0.23)$ $DUAL$ $-0.015$ $-0.028$ $(2.02)$ $(0.28)$ $(2.09)$ $(0.53)$ $Year FE$ YES       YES       YES         Firm FE       YES       YES       YES			(0.68)		(0.07)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	LOSS		-0.015		-0.022			
PPE $-0.024$ $-0.02$ INTANG $(-0.96)$ $(-0.62)$ INTANG $-0.084$ $-0.13$ $(-1.23)$ $(-1.23)$ $(-1.23)$ INVENT $-0.021$ $-0.02$ $(-1.14)$ $(-0.45)$ CFO $-0.021$ $-0.01$ $(-0.88)$ $(-0.35)$ CASH $-0.036^{***}$ $-0.055^{**}$ REGU $0.001$ $-0.055^{**}$ $(-2.68)$ $(-2.20)$ REGU $0.006^{**}$ $0.011^{**}$ $(2.24)$ $(2.23)$ $(-2.01)$ $DIRO$ $-0.003$ $-0.010$ $(-1.02)$ $(0.38)$ $(-1.73)$ $DIRO$ $-0.003$ $-0.000$ $(-1.02)$ $(0.38)$ $0.099$ $(-1.02)$ $(0.38)$ $(-0.00)$ $(-1.02)$ $(0.38)$ $(-0.02)$ $SOE$ $-0.015$ $ (-1.11)$ $  Constant$ $0.009^{***}$ $0.029$			(-1.35)		(-1.45)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	PPE		-0.024		-0.023			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(-0.96)		(-0.62)			
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	INTANG		-0.084		-0.132			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(-1.23)		(-1.29)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	INVENT		-0.034		-0.022			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(-1.14)		(-0.45)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	CFO		-0.021		-0.013			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(-0.88)		(-0.35)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	CASH		-0.036***		-0.055**			
REGU $0.001$ $-0.054^*$ $0.066^*$ $0.011^*$ $0.066^*$ $0.011^*$ $(2.24)$ $(2.53)$ $IC$ $-0.003$ $-0.010$ $(-1.73)$ $(-1.73)$ $DIRO$ $-0.028$ $0.094$ $0.011^*$ $(-1.02)$ $(0.38)$ $DUAL$ $-0.000$ $-0.000$ $Constant$ $0.009^{***}$ $0.029$ $(22.02)$ $(0.28)$ $(2.09)$ $(0.53)$ Year FE       YES       YES       YES         Firm FE       YES       YES       YES         Observations $23,442$ $23,442$ $9,666$ $9,666$ $0.055$ $0.059$ $0.088$ $0.099$			(-2.68)		(-2.20)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	REGU		0.001		-0.054**			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(0.06)		(-2.01)			
IC       (2.24)       (2.53         IC $-0.003$ $-0.010$ (IC       (-0.73)       (-1.73         DIRO $-0.028$ 0.090         DUAL $-0.000$ $-0.000$ SOE $-0.015$ $-$ (IC       (-1.11) $-$ Constant $0.009^{**}$ $0.029$ $0.002^{**}$ $0.08$ (IC       (2.02)       (0.28)       (2.09)       (0.53)         Year FE       YES       YES       YES       YES         Firm FE       YES       YES       YES       YES         Observations       23,442       23,442       9,666       9,666         Adi R <sup>2</sup> 0.055       0.059       0.088       0.099	ANA		0.006**		0.011**			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(2.24)		(2,53)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	IC		-0.003		-0.010*			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			(-0.73)		(-1,73)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	DIRO		-0.028		0.096			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2		(-1.02)		(0.38)			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	DUAL		-0.000		-0.003			
SOE $-0.015$ $ (-1.11)$ $-$ Constant $0.009^{***}$ $0.029$ $0.002^{**}$ $0.08$ $(22.02)$ $(0.28)$ $(2.09)$ $(0.53)$ Year FE         YES         YES         YES           Firm FE         YES         YES         YES           Observations $23,442$ $23,442$ $9,666$ $9,666$ Adi $\mathbb{R}^2$ $0.055$ $0.059$ $0.088$ $0.099$			(-0.06)		(-0.23)			
(-1.1)     -       Constant     0.009***     0.029     0.002**     0.08       (22.02)     (0.28)     (2.09)     (0.53)       Year FE     YES     YES     YES       Firm FE     YES     YES     YES       Observations     23,442     23,442     9,666     9,666       Adi R <sup>2</sup> 0.055     0.059     0.088     0.099	SOE		-0.015		_ (			
Constant         0.009***         0.029         0.002**         0.08           (22.02)         (0.28)         (2.09)         (0.53)           Year FE         YES         YES         YES         YES           Firm FE         YES         YES         YES         YES           Observations         23,442         23,442         9,666         9,666           Adi R <sup>2</sup> 0.055         0.059         0.088         0.099			(-1.11)		_			
(22.02)         (0.28)         (2.09)         (0.53)           Year FE         YES         YES         YES         YES           Firm FE         YES         YES         YES         YES           Observations         23,442         23,442         9,666         9,666           Adi R <sup>2</sup> 0.055         0.059         0.088         0.099	Constant	0.009***	0.029	0.002**	0.085			
Year FEYESYESYESFirm FEYESYESYESYESObservations $23,442$ $23,442$ $9,666$ $9,666$ Adi $\mathbb{R}^2$ 0.0550.0590.0880.099		(22.02)	(0.28)	(2.09)	(0.53)			
Firm FE         YES         YES         YES         YES           Observations $23,442$ $23,442$ $9,666$ $9,666$ Adi $\mathbb{R}^2$ 0.055         0.059         0.088         0.099	Year FE	YES	YES	YES	YES			
Observations         23,442         23,442         9,666         9,66           Adi $\mathbb{R}^2$ 0.055         0.059         0.088         0.099	Firm FE	YES	YES	YES	YES			
Adj $\mathbb{R}^2$ 0.055 0.059 0.088 0.09	Observations	23.442	23.442	9.666	9.666			
	Adi R <sup>2</sup>	0.055	0.059	0.088	0.097			

Table 6						
Difference-in-difference	analysis	based	on	an	exogenous	shock.

*Note:* This table reports the result of the difference-in-differences analysis based on the exogenous shock of the state-owned capital authorization management system reform. Columns (1) and (2) present the results of the full sample, whereas Columns (3) and (4) report the results of the SOE subsample. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

tal variables and confirm that our instruments are valid.<sup>5</sup> In the second stage, the coefficients on *LOCK*, *LOCK\_CHAIR* and *LOCK\_CEO* are all negative and significant. The results indicate that after controlling

 $<sup>^{5}</sup>$  The Cragg–Donald Wald F values are all over 500 (much larger than the cut-off threshold of 10), suggesting that our instruments do not suffer from weak instrumental variable problems. The *p* values of the Hansen J statistic tests are larger than 0.682, suggesting that we cannot reject the null hypothesis that the instrumental variables and the error term in the main regression are not correlated. In these cases, we believe that the instrumental variables are valid.

Table 7 Heckman two-stage analysis.

Panel A	LOCK	LOCK_CHAIR	LOCK_CEO	Panel B	RATE	RATE	RATE
	(1)	(2)	(3)		(4)	(5)	(6)
PROVINCE	0.438***	0.439***	0.267***	LOCK	-0.021***		
	(9.18)	(9.31)	(5.62)		(-3.45)		
ROA	-0.000	0.117	-0.187	LOCK_CHAIR		-0.021***	
~~~~	(-0.00)	(0.41)	(-0.63)			(-3.59)	
SIZE	0.143***	0.136***	0.154***	LOCK_CEO			-0.020***
LEV	(6.66)	(6.35)	(7.30)		0.024	0.027	(-3.29)
LEV	0.186	0.201*	0.046	IMK	0.024	(0.027)	(1.22)
INDE	(1.00)	(1.73)	(0.58)	DO 4	(0.03)	(0.72)	(1.52)
INDL	$-0.373^{\circ}$	$-0.390^{\circ}$	0.303	KUA	(5.94)	(5.00)	(5.67)
SOF	(-1.74)	(-1.00)	(1.47)	SIZE	0.004	(3.99)	(3.07)
SOL	(6.50)	(6.67)	(-5,70)	SIZE	(0.57)	(0.59)	(1.04)
	(0.50)	(0.07)	( 5.70)	IFV	-0.015	-0.014	-0.015
					(-0.64)	(-0.60)	(-0.65)
				BM	0.016	0.016	0.015
				20112	(0.68)	(0.67)	(0.64)
				LOSS	-0.014	-0.014	-0.014
					(-1.18)	(-1.18)	(-1.15)
				PPE	-0.023	-0.023	-0.022
					(-0.90)	(-0.88)	(-0.86)
				INTANG	-0.094	-0.093	-0.088
					(-1.26)	(-1.25)	(-1.19)
				INVENT	-0.023	-0.022	-0.025
					(-0.71)	(-0.68)	(-0.76)
				CFO	-0.014	-0.014	-0.014
					(-0.57)	(-0.57)	(-0.58)
				CASH	-0.034**	-0.034**	-0.033 **
					(-2.52)	(-2.52)	(-2.45)
				REGU	0.013	0.013	0.013
					(0.62)	(0.62)	(0.62)
				ANA	0.006**	0.005**	0.006**
					(2.09)	(2.08)	(2.11)
				IC	-0.002	-0.002	-0.002
				DIDO	(-0.44)	(-0.45)	(-0.45)
				DIRO	-0.048	-0.047	-0.046
				DUAL	(-1.64)	(-1.64)	(-1.59)
				DUAL	-0.004	-0.004	0.002
				SOF	(-0.04)	(-0.39)	(0.34)
				SOL	-0.010	-0.009	-0.020
Constant	3 170***	3 778***	1 305***	Constant	(-0.38)	(-0.32)	(-1.30)
Collstant	-3.429	-5.278	( 0.18)	Constant	(-0.44)	(-0.48)	(-0.134)
Year FF	YES	YES	YES	Year FF	YES	YES	YES
Industry FF	YES	YES	YES	Firm FE	YES	YES	YES
Observations	21.043	21.043	21.043	Observations	20.666	20.666	20.666
Pseudo R <sup>2</sup>	0.077	0.076	0.027	Adj R <sup>2</sup>	0.064	0.064	0.064

*Note:* This table presents the Heckman two-stage results. The Z and t statistics in parentheses are based on standard errors adjusted for clustering at the firm level. \*, \*\*, and \*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

for potential omitted variable problems, vertical interlock involving chairmen and CEOs continues to have a negative influence on corporate tax avoidance.

# 4.3.5. Change analysis

To further ensure that vertical interlock has a causal effect on corporate tax avoidance and alleviate the potential omitted variable problem, we conduct change analysis following Huang et al. (2016). Level analysis
Table 8 Instrumental variable analysis.

Panel A	LOCK	LOCK_CHAIR	LOCK_CEO	Panel B	RATE	RATE	RATE
	(1)	(2)	(3)		(4)	(5)	(6)
PROVINCE	0.033***	0.029**	0.050***	LOCK	-0.023*		
	(2.94)	(2.52)	(4.26)		(-1.82)		
AVGINTER	0.688***	0.659***	0.242***	LOCK_CHAIR	· /	-0.024*	
	(56.44)	(52.76)	(18.91)			(-1.82)	
ROA	0.175***	0.190***	0.066	LOCK_CEO		, í	-0.062*
	(2.98)	(3.16)	(1.08)				(-1.77)
SIZE	0.041***	0.037***	0.049***	ROA	0.290***	0.290***	0.290***
	(6.97)	(6.14)	(7.88)		(6.93)	(6.94)	(6.92)
LEV	-0.047*	-0.040	-0.049*	SIZE	0.002	0.002	0.004
	(-1.67)	(-1.38)	(-1.68)		(0.44)	(0.42)	(0.85)
BM	0.025	0.023	-0.024	LEV	-0.017	-0.017	-0.019
	(0.86)	(0.75)	(-0.8)		(-0.87)	(-0.87)	(-0.97)
LOSS	-0.003	-0.007	0.010	BM	0.016	0.016	0.014
	(-0.29)	(-0.69)	(1.03)		(0.78)	(0.78)	(0.68)
PPE	-0.010	0.009	-0.020	LOSS	-0.013 **	-0.013 **	-0.013*
	(-0.36)	(0.31)	(-0.69)		(-1.99)	(-2.00)	(-1.88)
INTANG	-0.014	0.022	0.229***	PPE	-0.022	-0.022	-0.023
	(-0.2)	(0.3)	(3.04)		(-1.12)	(-1.09)	(-1.16)
INVENT	-0.055*	-0.020	-0.075**	INTANG	-0.096*	-0.095*	-0.081
	(-1.67)	(-0.6)	(-2.16)		(-1.88)	(-1.86)	(-1.57)
CFO	-0.039	-0.036	-0.023	INVENT	-0.023	-0.023	-0.027
	(-1.35)	(-1.22)	(-0.76)		(-0.99)	(-0.96)	(-1.13)
CASH	-0.008	-0.004	-0.008	CFO	-0.014	-0.014	-0.014
	(-0.43)	(-0.21)	(-0.4)		(-0.68)	(-0.68)	(-0.70)
REGU	-0.061***	$-0.062^{***}$	-0.097***	CASH	-0.034**	-0.034 **	-0.034**
	(-2.73)	(-2.7)	(-4.17)		(-2.50)	(-2.50)	(-2.52)
ANA	-0.003	-0.004	-0.003	REGU	0.012	0.012	0.008
	(-1.00)	(-1.24)	(-0.74)		(0.77)	(0.77)	(0.47)
IC	0.000	0.000	-0.001	ANA	0.005**	0.005**	0.005**
	(-0.04)	(-0.07)	(-0.2)		(2.35)	(2.33)	(2.30)
DIRO	-0.194***	-0.190 ***	$-0.101^{***}$	IC	-0.002	-0.002	-0.002
	(-5.35)	(-5.12)	(-2.65)		(-0.72)	(-0.72)	(-0.74)
DUAL	$-0.095^{***}$	$-0.082^{***}$	0.195***	DIRO	-0.047*	-0.047*	-0.049*
	(-12.41)	(-10.39)	(24.23)		(-1.81)	(-1.81)	(-1.88)
SOE	-0.005	0.003	-0.044***	DUAL	-0.004	-0.004	0.010
	(-0.35)	(0.21)	(-2.92)		(-0.77)	(-0.73)	(1.16)
				SOE	-0.015	-0.015	-0.018*
					(-1.49)	(-1.47)	(-1.71)
Constant	-1.265***	-1.185***	-1.178***	Constant	-0.078	-0.078	-0.122
	(-8.37)	(-7.66)	(-7.44)		(-0.72)	(-0.72)	(-1.06)
Year FE	YES	YES	YES	Year FE	YES	YES	YES
Firm FE	YES	YES	YES	Firm FE	YES	YES	YES
Observations	21,044	21,044	21,044	Observations	21,044	21,044	21,044

*Note*: This table shows the results of instrument variable tests. Panel A (Panel B) reports the first-stage (second-stage) results. The Z and t statistics in parentheses are based on standard errors adjusted for clustering at the firm level. \*, \*\*, and \*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

may suffer from correlated omitted variables, whereas multivariate change analysis can lessen this problem. If an increase in vertically interlocked executives leads to a decrease in corporate tax avoidance, we can infer that vertical interlock negatively affects corporate tax avoidance. We construct the change model (4), where the dependent variable,  $\triangle RATE_{i,t}$ , represents the change in the corporate tax avoidance level from year t-1 to year t. The independent variables ( $\triangle LOCK_{i,t}, \triangle LOCK\_CHAIR_{i,t}, \triangle LOCK\_CHAIR_{i,t}$ ) represent changes in vertical interlock measures from year t-1 to year t. The control variables are also measured by their corresponding changes from year t-1 to year t. We apply the firm fixed effects model to mitigate potential omitted variable problems. We expect the coefficients on the changes of vertical interlock measures ( $\triangle LOCK_{i,t}, \triangle LOCK\_CHAIR_{i,t}, \triangle LOCK\_CHAIR_{i,t}$ ) to be negative and significant, according to our hypothesis.

$$\Delta RATE_{i,t} = \beta_0 + \beta_1 \Delta LOCK (\Delta LOCK - CHAIR / \Delta LOCK - CEO)_{i,t} + \beta_2 \Delta ROA_{i,t} + \beta_3 \Delta SIZE_{i,t} + \beta_4 \Delta LEV_{i,t} + \beta_5 \Delta BM_{i,t} + \beta_6 \Delta LOSS_{i,t} + \beta_7 \Delta PPE_{i,t} + \beta_8 \Delta INTANG_{i,t} + \beta_9 \Delta INVENT_{i,t} + \beta_{10} \Delta CFO_{i,t} + \beta_{11} \Delta CASH_{i,t} + \beta_{12} \Delta REGU_{i,t} + \beta_{14} \Delta ANA_{i,t} + \beta_{15} \Delta IC_{i,t} + \beta_{16} \Delta DIRO_{i,t} + \beta_{17} \Delta DUAL_{i,t} + \beta_{18} \Delta SOE_{i,t} + FirmFE + YearFE + \varepsilon_{i,t}$$

$$(4)$$

Table 9

Change analysis.

		$\triangle RATE$	
	(1)	(2)	(3)
$\triangle LOCK$	-0.027***		
	(-2.93)		
$\triangle LOCK\_CHAIR$		-0.028***	
		(-3.17)	
$\triangle LOCK\_CEO$			$-0.015^{*}$
			(-1.75)
$\triangle ROA$	0.188***	0.189***	0.186***
	(2.77)	(2.79)	(2.74)
$\triangle SIZE$	0.010	0.010	0.010
	(0.93)	(0.92)	(0.89)
$\triangle LEV$	-0.092**	-0.093**	-0.091**
A 224	(-2.55)	(-2.56)	(-2.52)
$\bigtriangleup BM$	-0.063**	-0.064**	-0.064**
A 1.000	(-2.02)	(-2.03)	(-2.04)
$\triangle LOSS$	0.002	0.002	0.003
^ DDC	(0.17)	(0.16)	(0.20)
$\bigtriangleup PPE$	-0.030	-0.029	-0.029
A INT ANC	(-0.74)	(-0.73)	(-0.73)
$\triangle INIANG$	0.035	0.034	0.038
	(0.26)	(0.26)	(0.29)
$\triangle INVENI$	0.042	0.043	0.041
A 650	(0.76)	(0.77)	(0.75)
$\triangle CFO$	-0.007	-0.007	-0.00/
A CASH	(-0.25)	(-0.26)	(-0.25)
∆CASH	-0.032	-0.032	-0.032
A DECU	(-1.62)	(-1.61)	(-1.01)
$\triangle REGU$	-0.034	-0.034	-0.035
A AN A	(-0.90)	(-0.89)	(-0.94)
$\bigtriangleup ANA$	0.003	0.003	0.003
A 10	(0.90)	(0.89)	(0.89)
$\Delta R$	-0.007	-0.00/	-0.00/*
^ DIRO	(-1.04)	(-1.03)	(-1.05)
$\Delta DIRO$	0.003	0.002	0.000
	(0.03)	(0.03)	(0.11)
riangle DUAL	0.004	0.004	0.008
^ SOF	(0.36)	(0.39)	(0.82)
$\triangle SOE$	-0.040	-0.040	-0.042
C	(-1.26)	(-1.27)	(-1.32)
Constant	-0.003*	-0.003**	-0.003*
	(-1./2)	(-1./1)	(-1.66)
Year FE	YES	YES	YES
FIRM FE	YES	YES	YES
Observations	19,804	19,804	19,804
Adj K <sup>2</sup>	0.118	0.118	0.118

*Note:* This table reports the result of the change analysis. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 9 presents the results of the change analysis. The coefficients on  $\Delta LOCK_{i,t}$ , and  $\Delta LOCK_{CHAIR}_{i,t}$  are negative and significant at the 1% level, and the coefficient on  $\Delta LOCK_{CEO}_{i,t}$  is negative and significant at the 1% level, suggesting that an increase in vertically interlocked chairpersons and CEOs is negatively correlated with corporate tax avoidance. The results provide further support for our Hypothesis 1a, indicating that the differences in levels of tax avoidance can largely be attributed to the varying situations regarding vertical interlocks. The change analysis further ensures the robustness of our results.

#### 4.3.6. Controlling political connection

An institutional feature of Chinese listed companies is that some managers have political connections and their networks with the government may help them to obtain more resources and preferences than other managers (Chen et al., 2021). Politician managers may be less aggressive in their tax-avoidance behavior due to their political connections and concerns. Therefore, managers' political connections may be an omitted variable in our regression model. To mitigate this concern, we include political connections (PC) as an additional variable in the robustness checks. Following the literature (Wang, 2015), we define PC as a dummy variable that equals one if the chairperson or CEO of a listed company is or has been a deputy to the National People's Congress or a member of the Chinese People's Political Consultative Conference, and otherwise equals zero. Table 10 presents the result of this robustness check.<sup>6</sup> The coefficient on PC is negative but nonsignificant, and the vertical interlock measures (LOCK,  $LOCK_CHAIR$ ,  $LOCK_CEO$ ) are all negative and significant at the 1% level. The above result shows that our main results remain robust after including political connections in the regression model.

# 5. Further analysis

# 5.1. Vertical interlock and the tunneling behavior of controlling shareholders

We posit that vertical interlock on behalf of large shareholders facilitates tunneling and thus triggers negative market evaluations. To offset negative public perceptions, vertically interlocked firms are more likely to strategically reduce their tax avoidance. To verify this channel, we test the impact of vertical interlock on the tunneling behavior of controlling shareholders. Following the literature (Li, 2021), we use related-party transactions (RPTs) to proxy for the tunneling activities of controlling shareholders. The use of RPTs is perhaps the most commonly observed method of expropriation, and it is costly for minority shareholders in business groups (Jiang and Kim, 2020). RPTs include asset acquisition, asset sales, equity transfer and loan guarantees. We consider RPTs between listed companies and their business groups, and we expect vertical interlock to facilitate the transfer of interests by controlling shareholders, thus increasing the RPTs in the business groups. Specifically, following the literature (Jian and Wong, 2010; Liao et al., 2014), we employ three variables to measure RPTs, as follows. First, we employ RPTPER, the total amount of money involved in RPTs scaled by firm  $\vec{i}$ 's total revenue at the end of year t. Second, we define RPTBUYER as the total amount of money involved in RPTs when firm i is a buyer, divided by firm i's total revenue at the end of year t. The listed companies' purchases of commercial products from related parties within the same business group result in cash outflows (Jian and Wong, 2010), allowing controlling shareholders to shift resources away from the listed companies. Thus, we specifically consider the transactions where listed companies are the buyers in our second measure. Third, *CRPT* captures both the magnitude and the number of RPTs. We first rank firms according to the number of RPTs and the size of abnormal RPTs and then sum the two rankings for each firm.

We calculate interaction terms between the RPTs (*RPTPER*, *RPTBUYER* and *CRPT*) and the interlock measures (*LOCK*, *LOCK\_CHAIR* and *LOCK\_CEO*) and include them in the main regression model, model (1). Table 11 presents the impact of vertical interlock on RPTs. The coefficients on the interaction terms between the RPTs and the vertical interlock measures are negative and significant, indicating that the impact

 $<sup>^{6}</sup>$  We obtain the political connection data from the CSMAR database. Note that the database only disclosed the data up to 2017, and therefore the sample size for this test is smaller than that for the main regression model.

Table 10
Controlling for political connections.

		RATE	
	(1)	(2)	(3)
LOCK	-0.023***		
	(-3.45)		
LOCK_CHAIR		$-0.022^{***}$	
		(-3.57)	
LOCK_CEO			-0.018***
DO (	0.210***	0.210***	(-2.78)
ROA	0.318***	0.319***	0.315****
CIZE	(0.31)	(0.32)	(0.23)
SIZE	0.003	0.002	0.002
IEV	0.010	0.018	(0.41)
LEV	(0.73)	-0.018	-0.018
BM	0.021	0.021	(-0.71)
DM	(0.80)	(0.80)	(0.78)
1055	-0.012	-0.012	-0.012
2055	(-0.99)	(-1.00)	(-0.97)
PPF	-0.005	-0.004	(-0.97)
11L	(-0.18)	(-0.15)	(-0.18)
INTANG	-0.098	-0.097	_0.092
11111110	(-1.28)	(-1, 27)	(-1, 21)
INVENT	-0.005	-0.004	-0.006
	(-0.15)	(-0.13)	(-0.17)
CFO	-0.010	-0.010	-0.010
CI O	(-0.39)	(-0.39)	(-0.40)
CASH	-0.033**	-0.033**	-0.033**
	(-2.30)	(-2.29)	(-2.26)
REGU	0.016	0.015	0.015
	(0.73)	(0.72)	(0.72)
ANA	0.004	0.004	0.004
	(1.57)	(1.57)	(1.55)
IC	0.002	0.002	0.002
	(0.40)	(0.41)	(0.39)
DIRO	-0.067**	-0.067**	-0.063*
	(-2.03)	(-2.02)	(-1.92)
DUAL	-0.006	-0.006	-0.000
	(-0.89)	(-0.84)	(-0.04)
SOE	-0.023	-0.022	-0.024
	(-1.44)	(-1.43)	(-1.51)
PC	0.006	0.006	0.005
	(1.03)	(1.02)	(0.95)
Constant	-0.055	-0.053	-0.062
	(-0.43)	(-0.41)	(-0.48)
Year FE	YES	YES	YES
Firm FE	YES	YES	YES
Observations	18,379	18,379	18,379
Adj R <sup>2</sup>	0.071	0.071	0.071

*Note:* This table reports the results of controlling for the potential omitted variable of political connections (*PC*). The political connection data end in 2017, Therefore, the sample size in this regression is smaller than that of the main regression. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

of vertical interlock on corporate tax avoidance is more pronounced in firms with more RPTs. Therefore, the empirical results suggest that intensifying tunneling is the channel through which vertical interlock influences corporate tax avoidance.

Table 11 Vertical interlock and the tunneling	activities of co.	ntrolling shareho	olders.						
					RATE				
	(1)	(2)	(3)	(4)	(5)	(9)	(7)	(8)	(6)
LOCK	$-0.013^{**}$			-0.012**			-0.010		
LOCK_CHAIR	(00.7_)	-0.011*			-0.011*			-0.007	
LOCK_CEO		(00.1-)	-0.011*		(-1.00)	-0.012*		(c/.0-)	
LOCK  imes RPTPER	$-0.013^{***}$		(c0.1-)			$(-1.\delta/)$			(0C.1-)
$LOCK\_CHAIR \times RPTPER$	(-2.80)	$-0.015^{***}$							
$LOCK\_CEO \times RPTPER$		(06.6-)	-0.008*						
$LOCK \times RPTBUYER$			(-1.0/)	-0.034***					
LOCK_CHAIR × RPTBUYER				( .?-)</td <td>-0.037***</td> <td></td> <td></td> <td></td> <td></td>	-0.037***				
$LOCK\_CEO \times RPTBUYER$					(-4.16)	-0.015			
LOCK  imes CRPT						(66.1-)	-0000*		
$LOCK\_CHAIR \times CRPT$							(-1.70)		
$LOCK\_CEO \times CRPT$								(-2.11)	-0.000
RPTPER	0.007*	0.007*	0.001						(-0.29)
RPTBUYER	(1.72)	(1.94)	(0.27)	0.018**	0.019**	0.001			
CRPT				(66.7)	(70.7)	(0.24)	0.000	0.000	-0.000
ROA	0 300***	***062.0	0 298***	0 299***	***000	0 299***	(1.06) 0 301***	(1.26) 0 301***	(-0.05) 0 298***
	(6.29)	(6.26)	(6.24)	(6.25)	(6.21)	(6.25)	(6.30)	(6.29)	(6.25)
SIZE	0.003	0.003	0.002	0.003	0.003	0.002	0.003	0.003	0.002
IFV	(0.63)	(0.62)	(0.47)	(0.63)	(0.62)	(0.44)	(0.54)	(0.52)	(0.45)
	(-1.09)	(-1.09)	(-0.96)	(-1.10)	(-1.11)	(-0.97)	(-1.07)	(-1.07)	(-1.02)
BM	0.012	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.012
	(0.53)	(0.54)	(0.53)	(0.56)	(0.57)	(0.56)	(0.58)	(0.59)	(0.57)
LUSS	-0.014 (-1.34)	-0.014 (-1.35)	-0.014 (-1.27)	-0.014 (-1.32)	-0.014 (-1.33)	-0.014 (-1.26)	-0.014 (-1.33)	-0.014 (-1.34)	-0.014 (-1.29)
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					RATE				
	(1)	(2)	(3)	(4)	(5)	(9)	(7)	(8)	(6)
PPE	-0.028	-0.028	-0.027	-0.026	-0.026	-0.027	-0.028	-0.027	-0.027
	(-1.12)	(-1.12)	(-1.08)	(-1.06)	(-1.07)	(-1.06)	(-1.11)	(-1.10)	(-1.08)
INTANG	-0.091	-0.092	-0.085	-0.093	-0.094	-0.085	-0.090	-0.089	-0.084
	(-1.33)	(-1.34)	(-1.25)	(-1.36)	(-1.37)	(-1.25)	(-1.31)	(-1.31)	(-1.23)
INVENT	-0.036	-0.034	-0.038	-0.036	-0.035	-0.036	-0.036	-0.036	-0.037
	(-1.19)	(-1.15)	(-1.26)	(-1.20)	(-1.16)	(-1.21)	(-1.20)	(-1.18)	(-1.22)
CFO	-0.021	-0.021	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020
	(-0.88)	(-0.88)	(-0.86)	(-0.84)	(-0.84)	(-0.84)	(-0.87)	(-0.87)	(-0.85)
CASH	$-0.039^{***}$	$-0.039^{***}$	$-0.038^{***}$	$-0.039^{***}$	$-0.039^{***}$	$-0.038^{***}$	$-0.039^{***}$	$-0.038^{***}$	$-0.039^{***}$
	(-2.91)	(-2.91)	(-2.86)	(-2.91)	(-2.89)	(-2.84)	(-2.92)	(-2.89)	(-2.91)
REGU	-0.000	-0.001	0.001	-0.001	-0.001	0.000	0.000	0.000	0.000
	(-0.02)	(-0.04)	(0.04)	(-0.03)	(-0.04)	(0.02)	(0.01)	(0.00)	(0.01)
ANA	$0.005^{**}$	0.005**	$0.006^{**}$	$0.006^{**}$	$0.006^{**}$	$0.006^{**}$	$0.006^{**}$	$0.006^{**}$	$0.006^{**}$
	(2.13)	(2.12)	(2.18)	(2.20)	(2.20)	(2.19)	(2.20)	(2.20)	(2.23)
IC	-0.003	-0.003	-0.003	-0.002	-0.002	-0.002	-0.002	-0.002	-0.003
	(-0.75)	(-0.78)	(-0.74)	(-0.68)	(-0.70)	(-0.73)	(-0.71)	(-0.72)	(-0.73)
DIRO	-0.037	-0.037	-0.037	-0.037	-0.037	-0.038	-0.038	-0.038	-0.039
	(-1.34)	(-1.33)	(-1.33)	(-1.34)	(-1.34)	(-1.36)	(-1.37)	(-1.36)	(-1.38)
DUAL	-0.003	-0.002	0.003	-0.003	-0.003	0.003	-0.003	-0.002	0.003
	(-0.46)	(-0.40)	(0.46)	(-0.50)	(-0.45)	(0.45)	(-0.45)	(-0.39)	(0.48)
SOE	-0.017	-0.017	-0.018	-0.017	-0.017	-0.018	-0.017	-0.017	-0.018
	(-1.24)	(-1.22)	(-1.33)	(-1.23)	(-1.22)	(-1.33)	(-1.23)	(-1.22)	(-1.31)
Constant	-0.016	-0.015	-0.007	-0.019	-0.017	-0.005	-0.011	-0.011	-0.005
	(-0.15)	(-0.14)	(-0.06)	(-0.18)	(-0.17)	(-0.04)	(-0.10)	(-0.10)	(-0.04)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	23,442	23,442	23,442	23,442	23,442	23,442	23,442	23,442	23,442
$Adj R^2$	0.060	090.0	0.059	0.059	0.059	0.059	0.060	0.061	0.059
<i>Note:</i> This table reports the impaby related-party transactions. St	ct of vertical interl andard errors are	lock on corporate clustered at the 1	e tax avoidance a îrm level. *, **, é	rising through th and *** indicate s	e possible chann ignificance at th	el of the tunnelin e 0.10, 0.05, and	g activities of con 0.01 levels, resp	ntrolling shareho ectively.	lders, proxied

 Table 12

 The effect of the separation of ownership and control rights.

		RATE	
	(1)	(2)	(3)
LOCK	-0.010		
LOGW SEDED	(-1.36)		
$LOCK \times SEPER$	$-0.200^{**}$		
LOCK_CHAIR	( 2.43)	-0.009	
		(-1.25)	
$LOCK\_CHAIR \times SEPER$		-0.213***	
LOCK CEO		(-2.68)	0.009
LOCK_CEO			(-1.07)
$LOCK\_CEO \times SEPER$			-0.142*
			(-1.95)
SEPER	0.009	0.016	-0.092*
	(0.11)	(0.22)	(-1.77)
ROA	0.292***	0.292***	0.290***
	(5.90)	(5.88)	(5.85)
SIZE	0.003	0.003	0.003
1 117	(0.64)	(0.60)	(0.67)
LEV	-0.024	-0.024	-0.025
DM	(-1.06)	(-1.06)	(-1.11)
ВМ	0.010	0.010	0.008
1055	(0.44)	0.011	(0.57)
2033	(-0.99)	(-1.00)	(-0.011)
PPF	-0.030	-0.030	(-0.97)
	(-1.20)	(-1.18)	(-1.20)
INTANG	-0.096	-0.096	-0.087
	(-1.35)	(-1.36)	(-1.24)
INVENT	-0.036	-0.035	-0.037
	(-1.13)	(-1.11)	(-1.16)
CFO	-0.028	-0.028	-0.027
	(-1.16)	(-1.17)	(-1.13)
CASH	$-0.036^{***}$	$-0.036^{***}$	$-0.035^{**}$
	(-2.60)	(-2.59)	(-2.53)
REGU	0.004	0.004	0.003
	(0.19)	(0.20)	(0.18)
ANA	0.004*	0.004*	0.005*
	(1.72)	(1./2)	(1.79)
IC	-0.002	-0.002	-0.002
DIRO	(-0.37)	(-0.38)	(-0.59)
DIKO	(-1.72)	(-1, 70)	(-1, 71)
DIIAI	-0.001	-0.000	0.005
Dente	(-0.11)	(-0.05)	(0.81)
SOE	-0.032**	-0.031**	-0.031**
	(-2.18)	(-2.17)	(-2.16)
Constant	-0.014	-0.011	-0.020
	(-0.13)	(-0.10)	(-0.18)
Year FE	YES	YES	YES
Firm FE	YES	YES	YES
Observations	22,530	22,530	22,530
Adj R <sup>2</sup>	0.059	0.059	0.058

*Note*: This table presents the cross-sectional analysis of the separation of ownership and control rights. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\*\* indicate significance at the 0.10, 0.05, and 0.01 levels, respectively.

#### 29

# 5.2. Ownership and control rights separation

Next, we explore the moderating effect of separating ownership and control rights. La Porta et al. (1999) find that large shareholders can benefit from the separation of ownership and control. In East Asian countries, the control right of large shareholders is enhanced through pyramid structures and cross-holdings (Claessens et al., 2000). Badertscher et al. (2013) find that in firms with more concentrated ownership and control, managers are more risk averse and tend to conduct less risky tax-planning activities. In line with their findings, we expect the impact of vertical interlock on corporate tax avoidance to be more pronounced for firms with greater separation of ownership and control rights.

We define *SEPAR* as the difference in the shareholding percentages of ownership and control rights. We interact *SEPAR* with the vertical interlock variables (*LOCK*, *LOCK\_CHAIR* and *LOCK\_CEO*) and include the interaction variables in model (1). The regression results are presented in Table 12. The coefficients on the interaction variables, *SEPAR* × *LOCK*, *SEPAR* × *LOCK\_CHAIR* and *SEPAR* × *LOCK\_CEO*, are negative and significant. The results imply that in firms with stricter separation of ownership and control rights, vertical interlock has a more significant impact on corporate tax avoidance.

#### 6. Conclusion

This study explores the impact of vertical interlock on corporate tax avoidance. Focusing on the Chinese setting, we suggest that vertical interlock can reduce corporate tax avoidance, and that vertically interlock matters regardless of whether it affects the board chairperson or the CEO. The result holds after controlling for potential endogeneity problems and omitted variables and conducting DID analysis based on the entropy balanced sample and the exogenous shock of the state-owned capital authorization management system reform, the Heckman two-stage model, the instrumental variable approach and change analysis. We also show that vertical interlock induces listed companies to conduct more RPTs than non-vertically interlocked companies, suggesting that vertical interlock facilitates the tunneling activities of controlling shareholders. Cross-sectional analyses reveal that the impact of vertical interlock on corporate tax avoidance is more pronounced in firms that have greater separation of ownership and control rights.

This study augments the related literature by examining the determinants of corporate tax avoidance from the perspective of vertical interlock, a phenomenon that is prevalent within business groups in emerging markets. We find that whether a firm is vertically interlocked does indeed influence corporate decision-making on matters such as tax avoidance. We also extend the literature on the economic consequences of vertical interlock. Our findings are also in line with the concern of the CSRC regarding abuse of the rights of controlling shareholders: we find that vertical interlock exacerbates agency conflicts between controlling shareholders and minority shareholders. Therefore, stricter regulatory policies should be introduced to restrict controlling shareholders from holding positions in listed companies and to strengthen the supervision of vertical interlock.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix.	Variable	definitions

Variable	Definition
Panel A: Tax ave	oidance variables
RATE	Applicable statutory income tax rate minus effect tax rate. The effective tax rate = (total income tax expense – deferred income tax expense) / (income before taxes – deferred income tax expense/ statutory income tax rate).
BTD	Book-tax difference. (Income before taxes – taxable income)/ total assets. Taxable income = (total income tax expense – deferred income tax expense)/ the applicable statutory tax rate.
DDBTD	The residual of regressing total book-tax difference $(BTD)$ on total accruals $(TA)$ . TA is net income minus cash flows from operations divided by total assets.
Panel B: Vertical	interlock variables
LOCK	Vertically interlocked chairperson or CEO. A dummy variable that equals one if the board chairperson or CEO holds a position in its direct or non-direct holding business groups and zero otherwise.
LOCK_CHAIR	Vertically interlocked chairperson. A dummy variable that equals one if the board chairperson holds a position in its direct or non-direct holding business groups and zero otherwise
LOCK_CEO	Vertically interlocked CEO. A dummy variable that equals one if the CEO holds a position in its direct or non-direct holding business groups and zero otherwise.
Panel C: Other w	variables
ROA	Return on assets. Net income divided by year-end total assets.
SIZE	Firm size. The natural logarithm of year-end total assets.
LEV	Leverage. Year-end total liabilities divided by total assets.
BM	Book-to-market ratio. Book value divided by total market value.
LOSS	Firm loss. A dummy variable equals one if the net income is below zero.
PPE	Property, plant and equipment. PPE divided by total assets.
INTANG	Asset intangibility. Year-end intangible assets divided by total assets.
INVENT	Inventory. Inventory divided by total assets.
CFO	Cash flow from operating activities. (Cash flow from operating activities – net cash received from the disposal of fixed assets, intangible assets and other assets – depreciation and amortization)/ total assets.
CASH	Cash ratio. Cash and cash equivalents divided by total assets.
REGU	Regulatory cost. Regional tax enforcement measured by the ratio of provincial actual tax revenue to expected tax revenue. A larger ratio indicates greater intensity of regional tax enforcement and greater regulatory costs (Mertens, 2003; Xu et al., 2011).
ANA	Analyst following. The natural logarithm of analyst following plus one.
IC	Internal control. The natural logarithm of internal control index plus one.
DIRO	Board ownership. The ownership of board members divided by the total number of shares.
DUAL	A dummy variable that equals one if firm has the CEO simultaneously serves as the chairperson of the board and zero otherwise.
SOE	State ownership. A dummy variable that equals one if the firm is state-owned, and otherwise equals zero.
INVENT	Inventory. Year-end inventory divided by total assets.
HHI	Ownership concentration. Herfindahl index of top three shareholder ownership, which is the sum of the squares of the shareholding ratio of firm <i>i</i> 's top three largest shareholders.
INDE	Board independence. The number of independent directors divided by the number of board members.
PROVINCE	A dummy variable that equals one if the registered place or office of the listed company is in the same province as the controlling shareholder, and zero otherwise.

Variable	Definition
AVGINTER	The industry-year mean percentage of firms with vertically interlocked appointments, excluding the firm concerned.
PC	Political connection. A dummy variable that equals one if the chairperson or CEO of a listed company is a deputy to the National People's Congress or a member of the Chinese People's Political Consultative Conference, and otherwise equals zero.
SEPAR	The share percentage difference between ownership rights and control rights.
RPTPER	The total amount of money involved in related-party transactions (RPTs) scaled by firm $i$ 's total revenue at the end of the year $t$ .
RPTBUYER	The total amount of money involved in RPTs when firm $i$ is a buyer, divided by firm $i$ 's total revenue at the end of year $t$ .
CRPT	We first rank firms according to the number of RPTs and the size of abnormal RPTs, and then sum the two rankings for each firm.
IMR	The inverse Mills ratio, calculated from the first stage of the Heckman two-stage sample selection model.
INDUSTRY	The industry classification adopted is that released by the CSRC in 2012.
YEAR	Year fixed effects for 2003–2019.

# **Appendix** (continued)

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# Confucianism and corporate awareness of climate change

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#### ABSTRACT

Drawing on practice theory and Confucian ecological philosophy, this paper explores the relationship between Confucianism and corporate climate change awareness. Using a sample of Chinese A-share listed companies, we find that companies more influenced by Confucianism exhibit stronger climate change awareness. This positive relationship is further strengthened by government environmental governance. Impact channel tests show that Confucianism enhances corporate climate change awareness by promoting humanism, deontology and collectivism. Heterogeneity analysis shows that the positive correlation between Confucianism and climate change awareness persists in both non-carbon-intensive industries and struggling companies. Lastly, economic consequence tests indicate that Confucianism helps reduce corporate carbon emissions by enhancing climate change awareness.

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# 1. Introduction

As crucial players in mitigating the impact of human activities on the climate (Haney, 2017), businesses must acquire a thorough understanding of climate change prior to taking action (Arnell and Delaney, 2006). While achieving rapid economic growth, China has also become the world's largest carbon emitter. Although the Chinese government has made gradual strides toward implementing climate policies in recent years, such as introducing carbon emissions trading systems and setting "carbon neutrality" goals, many enterprises remain in a reactive position compared with their counterparts in developed countries. These enterprises' awareness of climate change requires further substantial improvement. Regarding the impact of

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corporate climate change awareness, social research focuses primarily on education, disaster experience and media publicity as the factors enhancing public awareness of climate change (Lee et al., 2015; Frondel et al., 2017; Baiardi and Morana, 2021). Subsequently, research on the impact of climate change awareness has been gradually extended to include enterprise behavior at the micro level, finding that encounters with extreme weather, the implementation of climate policies and urging by stakeholders and the public are all conducive to improving corporate awareness of climate change (Pinkse and Gasbarro, 2019; Flammer et al., 2021; Wang et al., 2022; Brinkerink and Bammens, 2024; Du et al., 2024). However, the related literature mostly focuses on the external factors driving enterprises, failing to pay attention to or explore the factors characteristic of a culture that promotes spontaneous actions by actors.

Although under the influence of Western culture, modern China is retaining traditional values and their implicit impacts (Yuan et al., 2021); therefore, this article aims to fill the research gap by exploring China's profound traditional culture. As Karl Jaspers once said, "Every great elevation of the individual self stems from renewed contact with the classical world. Barbarism always reappears when this world is forgotten" (Jaspers, 2014). Indeed, human barbarism is undoubtedly responsible for climate issues; perhaps, the wisdom to address current ecological problems can be found in the "Axial Age," when saints emerged simultaneously in both the East and West. Confucianism, an absolute orthodoxy and determinant of traditional mainstream Chinese culture, has profoundly influenced various aspects of economic and social development since the reign of Emperor Wu of Han (156–87 BC) (Kung et al., 2014). Confucianism advocates ecological philosophies such as "harmony between heaven and humanity (*tian ren he yi*, 天人合一)," "benevolence towards all things (*ren ai wan wu*, 仁爱万物)" and "treating all people as siblings and all things as companions (min *bao wu yu*, 民胞物 与)," which still have high ideological value and a strong base of support in modern China.

Most studies on Confucianism primarily focus on the path from culture to practice. Relying on the virtues of benevolence (ren, 仁), righteousness (yi, 义), propriety (li, 礼), wisdom (zhi, 智) and faithfulness (xin, 信), these studies demonstrate the moral behavior of enterprises, including their participation in poverty alleviation (Huang et al., 2024), the implementation of employee stock ownership plans (Xu and Duan, 2023), the reduction in minority shareholder encroachment (Du, 2015) and sustainable marketing (Sun et al., 2023), among others. Additionally, studies point out that the altruism emphasized by Confucianism encourages firms to assume social responsibilities, driving them to enhance their green innovation efficiency (Dong and Li, 2023), reduce pollution emissions (Cao et al., 2023) and actively disclose environmental information (Chao et al., 2023). Previous studies mainly explore this relationship by deconstructing classical Confucian thought, with few studies focusing on the ecological ideas inherent in Neo-Confucianism, especially the lack of understanding of the concept of "harmony between heaven and humanity." Moreover, there is a slight disconnect between the cultural and practical aspects, such that a transition from culture to individual consciousness development is lacking. Therefore, this paper focuses on exploring the impact of Confucianism on corporate awareness of climate change by elucidating the ecological philosophy of Neo-Confucianism. Moreover, the informal institution is regarded as the breeding ground for establishing formal institutions, as rigid regulations often significantly dampen enterprises' enthusiasm. We also want to explore whether formal institutions can have a true complementary effect by reinforcing the roles of informal institutions in enlightenment, namely by discussing the relationship between Confucianism and climate awareness in terms of government environmental governance.

Drawing on Bourdieu's practice theory, and rooted in the ecological philosophy of Confucianism, this paper strongly links the three core elements that affect practice, namely field, habitus and capital, to enterprises. From the perspective of realistic relationships, practice theory emphasizes that actors cannot be separated from the environment in which they are embedded (Emirbayer and Johnson, 2008). This deconstructionist ideology provides a suitable theoretical framework for studying cultural effects on individuals. Using a sample of Chinese A-share listed companies, this paper uses the number of successful candidates in the highest imperial examinations during the Ming and Qing dynasties as a proxy for Confucianism. Additionally, an indicator of corporate climate change awareness is constructed through textual analysis. Exploring the promotional effect of Confucianism (i.e., cultural capital) inherited by enterprises (i.e., actors) on climate change awareness (i.e., habitus) in the context of climate change (i.e., field), we find that government environmental governance reinforces the aforementioned positive relationship. To test for endogeneity, we construct a quasi-natural experiment based on changes in the Confucian atmosphere caused by enterprise relocation, and

a distance-based instrumental variable test using the distance from the enterprise to the ancient printing office. We also use the core elements of Confucianism (Ip, 2009) to examine the channels through which Confucianism influences corporate climate change awareness and the potential timeliness issues involved. According to our analysis of enterprise heterogeneity, Confucianism positively affects non-high-carbon industries and financially struggling enterprises. Finally, we find that Confucianism helps reduce corporate carbon emissions by enhancing awareness of climate change, forming a logical closed loop from culture (capital) to awareness (habitus) to practice in the context of the field.

We make contributions in three general aspects. First, this paper introduces practice theory from sociology to research on the effects of Confucian culture on enterprises at the micro level, effectively revealing the theoretical logic underlying Confucian culture's influence on corporate climate change awareness. Studies have begun to pay attention to the effect of culture on corporate environmental behavior, mostly drawing on institutional theory, imprinting theory, social responsibility theory or cultural dimension theory (Cao et al., 2023; Chao et al., 2023; Xu and Duan, 2023; Yan et al., 2024), and focusing on areas such as corporate pollution emissions and environmental information disclosure; few studies have paid attention to corporate awareness of climate change. Although a few scholars have begun to explore the relationship between Confucian culture and public environmental awareness (Cao et al., 2023), they have failed to effectively reveal the essential logic. In our study, we introduce practice theory (Bourdieu, 1984), which agrees well with our research topic, namely that in the field of climate change, Confucian culture corresponds to cultural capital, and corporate climate change awareness corresponds to the habitus in this field, effectively revealing the mechanism of Confucian cultural influence on corporate climate change awareness. Compared with business research on the interaction between types of capital and the impact of cultural capital on consumer behavior (Holt, 1998; Peltokorpi et al., 2023), our study expands micro-research on practice theory in the environmental field of climate change.

Second, we identify the path by which Confucian culture affects corporate climate change awareness. Confucianism, a vibrant traditional philosophy, is constantly evolving and changing and has been enriched by the collisions of different schools of thought, as well as Chinese historical development (Angle, 2009). This paper focuses on the Confucian ecological concept of "harmony between man and nature" and deeply analyzes its inherent ecological philosophy. Accordingly, drawing on Cao et al.'s (2023) research revealing only the phenomenon of Confucian cultural action mechanism, we combine the perspectives of humanism, moralism and collectivism with practice theory (Ip, 2009) and mechanism testing to demonstrate that Confucian culture influences corporate climate change awareness through corporate accrued earnings management and internal salary gaps. We further use the core elements of Confucianism to test its timeliness and provides a logical paradigm for subsequent climate change research.

Third, drawing on practice theory, we empirically test how government environmental governance enhances the positive effect of Confucianism on corporate awareness of climate change. This is achieved through a discussion of breakthroughs in the boundaries of the climate change field initiated by government environmental governance. Not only does this finding verify the relationship between changes in field boundaries and both habitus and capital, thus enriching the connotation of practice theory, but it also provides insights to support the formulation of government climate policies. Specifically, this finding suggests that the coordinated development of cultural and ecological civilization construction should be promoted as conducive to enhancing proactive ecological consciousness among enterprises.

### 2. Theoretical background and hypothesis development

# 2.1. Confucianism and the ecological philosophy of harmony between heaven and humanity

Confucianism, one of the world's most enduring traditional cultures, has remained remarkably vital for more than 2,000 years. From the Han dynasty (202 BCE–220 CE), when Confucianism was established as the official state ideology, to the collapse of the Qing dynasty (1616–1911 CE), Confucianism dominated the ideological landscape of Chinese society (Ip, 2009). However, Confucianism gradually lost its mainstream influence with the influx of Western thought, the decline of the imperial monarchy, the abolition of the imperial examination system and the rise of natural science. Only after China's reform and opening up did

the revival of Confucianism begin, allowing this open, inclusive and pragmatic philosophy to gain renewed relevance in modern society (Du, 2015).

The relationship between heaven and humanity is a central theme in traditional Chinese philosophy (Angle, 2009). As early as the Western Zhou dynasty (1046–771 BCE), *the Book of Changes* asserted that "A person of noble character must possess virtues that align with heaven and earth, nurturing and accommodating all things (*fu da ren zhe, yu tian di he qi de*, 夫大人者,与天地合其德)." Similarly, Mencius (372–289 BCE) emphasized that a gentleman's actions should "harmonize with the laws of the universe (*shang xia yu tian di tong liu*, 上下与天地同流)." Early Confucian thought focused on the moral harmony between heaven, conceived as an abstract moral authority, and humanity. However, during the Han dynasty, this relationship shifted toward a more religious understanding. Dong Zhongshu (179–104 BCE) proposed the theory of "interaction between heaven and man" (*tian ren gan ying*, 天人感应), suggesting that heaven responds to human actions by rewarding virtue and punishing vice. This ideology was embraced by rulers to legitimize their authority, elevating Confucianism to its esteemed position.

Neo-Confucianism in the Song and Ming dynasties further developed this idea, emphasizing the integration of humanity with the universe and promoting undifferentiated universal love. Zhang Zai (1020–1077 CE) famously stated, "Confucian scholars achieve sincerity through clarity, and clarity through sincerity; hence, harmony between heaven and humanity (*ru zhe ze yin ming zhi cheng, yin cheng zhi ming, gu tian ren he yi*, 儒者则因明致诚, 因诚致明, 故天人合一)." Cheng Hao and Cheng Yi also contributed to this concept, proposing that "heaven and humans are originally one (*tian ren ben wu er*, 天人本无二)." Wang Yangming (1472–1529 CE) extended this notion, arguing that the "benevolent person integrates all things in the universe (*ren zhe yi tian di wan wu wei yi ti*, 仁者以天地万物为一体)," where benevolence pertains not only to moral action but also to an all-encompassing unity with the universe. Even during the Ming and Qing dynasties, scholars such as Zhang Qifeng (1584–1675 CE) and Wang Fuzhi (1619–1692 CE) continued to express their insights into the "integration of heaven and humans." In other words, the idea of "harmony between heaven and humanity" has long been ingrained in traditional Chinese society and has guided our ancestors' daily production.

In essence, "harmony between heaven and humanity" advocates for harmony in all relationships: between individuals, humans and nature, and even with transcendental forces. Unlike Western dualism, which separates form and content, Confucianism emphasizes the unity of all things (Liu, 1974). Although Confucian scholars interpreted heaven in various ways, it undeniably includes the natural environment. The view of humanity and nature as an organic whole, promoting reverence for and adaptation to nature, offers valuable insights for addressing today's pressing climate challenges (Peng et al., 2016). In this sense, the Confucian concept of "harmony between heaven and humanity" can serve as a philosophical foundation upon which to construct an ecological worldview in the face of contemporary environmental crises.

#### 2.2. The connotation of practice theory

Bourdieu (1984) posits the formula of Field + [(Habitus) (Capital)] = Practice. His practice theory consists of three interrelated concepts: field, habitus and capital. These three elements interact with each other, forming the essence of social reality and determining the practices of actors. Bourdieu employs the concept of field to examine social structure, viewing it as a spatial metaphor for a network or configuration of objective relations between different positions. The field is where social forces are configured. Society consists of various contending domains and differentiated strategies, such as political, economic and cultural fields (Husu, 2022). Habitus describes the dispositional system of subjects within the field: a latent cognitive pattern exhibited by actors in specific fields that is closely related to their possessed capital and continuously adjusted with accumulated experience (Bourdieu, 1977). Capital determines an actor's position in the field and is primarily categorized as economic, cultural and social capital. These different types of capital are used to acquire power and alter social status. In summary, actors within a specific field adopt particular strategies to secure or enhance their position within the field, based on their habitus and possessed capital (Bourdieu, 1977). Consequently, field, habitus and capital constitute the behavioral logic of actors within the field, providing theoretical support for exploring the factors motivating corporate actions in this paper.

Regarding the field, climate change is a microscopic epitome or sub-field of the ecological environment field. According to the concept of field, the climate change field is a relationship network in which actors with different capital compositions strive to achieve specific climate goals according to their own stances and value preferences during climate change. Actors in the climate change field pursue various interests and compete for resources and influence through competition, cooperation and other means. Enterprises, the subject of this study, shape their climate practices through actions in this field. Their behaviors, statements and resources stem from the different types of capital they possess in the field, such as scientific knowledge, economic capital, political backgrounds and social relationship networks.

In this article, climate change awareness is the habitus of enterprises in the climate change field. The habitus of an enterprise is essentially a composite of its historical experiences with climate change. It represents the empirical summaries of climate change issues that the enterprise has actively or passively accepted. This habitus is internalized within the enterprise and influences its decisions and actions related to climate issues. For instance, some enterprises may be insensitive or indifferent to climate change issues, prioritizing economic interests over environmental protection and adopting production methods and energy usage patterns with high carbon emissions. In summary, habitus is influenced by both the internal corporate culture and values and external factors and manifests in the daily operations of the enterprise.

Drawing on the concept of cultural capital, this article defines Confucianism as a form of cultural capital for enterprises. As culture has long permeated various aspects of society, Bourdieu introduces the term "cultural capital" with the understanding that social structure cannot be fully analyzed solely from an economic perspective. He defines cultural capital as the summation of social relations encompassing power, status and the accumulation of cultural knowledge. It exists in three forms: the embodied state, encompassing linguistic habits, value orientations and behavioral patterns; the objectified state, represented by items such as artworks and books; and the institutionalized state, manifesting in qualifications and diplomas (Bourdieu, 1984). In a broad sense, Confucianism, as a widely recognized and respected traditional culture, often finds itself in the embodied state of enterprises' cultural capital. As a traditional value system and behavioral guideline ingrained in people's minds, Confucianism is regarded in this article as a form of cultural capital inherited by enterprises.

#### 2.3. Confucianism and corporate awareness of climate change

In the field of climate change, Confucian cultural capital plays a pivotal role in shaping and fostering the habitus of corporate climate change awareness. Confucianism exhibits traits of cultural capital accumulation (McClelland, 1990). Its advocacy of an organic unity between humans and nature, embodying the principles of harmony, respect and alignment with nature, has profoundly impacted the socio-economic structure, resource allocation patterns and living conditions of people throughout history. This influence extends beyond the macro-socioeconomic structure, permeating deeply into the business philosophies and behavioral paradigms of corporate entities. The accumulation of embedded Confucian cultural capital is forged through an enterprise's ongoing practical activities, manifesting in the three forms outlined by Bourdieu (1984), and ultimately being internalized within the behavioral consciousness of the corporate entity. This internalization emphasizes maintaining harmony between humans and nature in business operations, particularly in the climate change field, demonstrating concern for climate change and thereby nurturing and developing the habitus of corporate climate change awareness.

Confucian cultural capital further fortifies the habitus of climate change awareness by influencing the business environment of the region where the enterprise is situated. In the market economy, the business environment of an individual enterprise is intimately tied to the magnitude of capital it possesses. As cultural capital is swiftly transformed into social and economic capital, the historical continuity of Confucian culture enables enterprises located in regions with a higher level of Confucian cultural influence to accrue greater amounts of cultural capital, including rights, resources and knowledge (Bourdieu, 1984). When confronted with climate risk shocks, such as climate disasters, these enterprises exhibit enhanced emergency response capabilities and enjoy increased access to post-disaster recovery resources. For enterprises, the benefits of such cultural capital accumulation manifest not only in economic gains but also in the preservation of the natural environment upon which their business activities rely (i.e., social benefits). Consequently, through a protracted period of practical activities geared toward addressing climate change, enterprises have accumulated extensive historical experience in this field; the resulting increase in their climate change awareness manifests in their daily business operations. Based on this premise, the following hypothesis is proposed:

**Hypothesis 1.** Assuming all other conditions remain unchanged, a firm's inherited Confucianism has a positive impact on increasing its awareness of climate change.

# 2.4. The moderating effect of government environmental governance

As boundaries expand within the climate change field, the influence of Confucian cultural capital on the habitus of corporate climate change awareness manifests in its dynamic adaptation (McClelland, 1990). As economic development progresses, institutional reforms are implemented and social structures are adjusted; the process by which Confucian cultural capital shapes and develops corporate climate change awareness is also evolving. Amid the intensification of global climate change issues and the heightened attention of various nations, the Chinese government is continuously augmenting the intensity of its environmental governance. This shift has led to the dissolution of boundaries within the climate change field where enterprises reside, indicating a transformation of the space of objective relations, with their inherent logic and necessity, resulting in the concurrent evolution of the logic of capital that propels the formation and adjustment of habitus. The reinforcement of government environmental governance inevitably leads to the expansion of the climate change field's boundaries, amplifying the effectiveness of Confucian cultural capital. Enterprises can harness the accumulation and rapid transformation of cultural capital to facilitate novel business activities and behavioral patterns for survival and adaptation in the nascent climate change field, ultimately enhancing their awareness (habitus) pertaining to the cognition and perception of climate change. The government and society consistently reinforce their guidance on cultural capital, the hereditary transmission of which plays a pivotal role in the reproduction of social structures, thus further intensifying the impact of Confucian cultural capital on the habitus of corporate climate change awareness. Based on this premise, the following hypothesis is proposed:

**Hypothesis 2.** Assuming all other conditions remain unchanged, government environmental governance reinforces the positive impact of Confucianism on enterprises' awareness of climate change.

# 3. Data and methods

#### 3.1. Sample and data

The sample in this paper includes Chinese A-share listed companies from 2011 to 2021. The beginning of the observation window marks the start of China's 11th Five-Year Plan and clarifies the overall requirements and key tasks for greenhouse gas emissions. This plan undoubtedly sparked corporate thinking about climate change. To ensure the representativeness of the sample data and the stability of the results, the data are filtered to exclude (1) financial listed companies, (2) ST- or PT-labeled companies with large fluctuations in performance and (3) companies lacking key variables to ensure data integrity. To eliminate the influence of extreme values, both tails of all continuous variables are trimmed by 1%. The Confucianism variables are sourced from the Chinese Research Data Service Platform, enterprises' annual reports are sourced from the Wingo database, financial and longitude/latitude data of listed companies are sourced from the China Stock Market & Accounting Research database, the texts of government work reports are sourced from local government official websites and temperature data are sourced from the National Centers for Environmental Information under the National Oceanic and Atmospheric Administration. The final sample for the empirical analysis includes 27,871 annual company observations covering 3755 firms.

#### 7

# 3.2. Measures

#### 3.2.1. Dependent variable

Corporate climate change awareness (C3A). Definitions used in academic research on climate change awareness often rely on questionnaire surveys, and nationwide quantitative studies are lacking (Dai et al., 2015). According to psychological research, descriptive texts reflect the writer's self-awareness of their current situation and social status (Pennebaker et al., 2003). Considering the objectivity and accessibility of textual information, this paper draws on research on corporate climate risk measurement (Wu et al., 2022; Sautner et al., 2023; Li et al., 2024) and constructs an index of climate change awareness through text analysis of corporate annual reports. The relevant research texts are mostly operational briefs, earnings conference calls or social responsibility reports. Our sample consists of Chinese listed companies. Operational briefs and earnings conference calls are voluntarily disclosed and contain limited data, making them unsuitable for the domestic context. Social responsibility reports also fall under voluntary disclosure and lack unified standards, regulatory mechanisms and independent third-party auditors, which can lead to subjectivity in the content. In contrast, corporate annual reports are legally disclosed and provide a more comprehensive reflection of a company's operational, management and strategic layout, thereby more fully representing its awareness of climate change.

This article integrates the core index vocabulary of climate change constructed in the aforementioned climate research (Wu et al., 2022; Sautner et al., 2023; Li et al., 2024) and performs localization processing according to Chinese vocabulary habits. We summarize a climate change vocabulary list consisting of 122 climate change keywords (see Appendix 1 for details). Using the word frequency statistics module in the Wingo database, we select the annual reports of listed companies for word frequency statistics and use the ratio of the frequency of climate-related vocabulary in the current year to the total number of words in the annual report (counted as one thousandth) to measure climate change awareness at the enterprise level.

#### 3.2.2. Independent variable

The Confucian concentration of firms (Jsh\_N). Researchers use proxy indicators such as Confucian academies, Confucian temples, Confucian cultural centers and *jinshi* (successful imperial examination candidates) to construct measures of Confucianism (Yan et al., 2021; Chao et al., 2023; Huang et al., 2024). However, using Confucius temples and academies may be problematic due to the destruction of many buildings over the centuries, leading to potential deviations in measurement. Furthermore, using the distance from firms to the seven major Confucian cultural centers is an imprecise metric. To circumvent these problems, we take the approach of Gu et al. (2024) and use the number of *jinshi* as a measure of Confucianism. *Jinshi* are candidates who participated in the palace examination, the highest-level exam that was presided over by the emperor. The main testing content of the exam was the Confucian classics, and the imperial examination system was implemented during the Tang and Song dynasties, perfected over several dynasties, peaked during the Ming and Qing dynasties and was abolished in the late Qing dynasty. Scholars and the bureaucratic class played crucial roles in the dissemination and development of Confucianism. Evidently, *jinshi* were not only considered disciples of the emperor but also significant carriers of Confucianism.

The reasons for using the number of *jinshi* during the Ming (1368–1644 CE) and Qing (1636–1912 CE) dynasties to measure the strength of Confucianism are as follows: Neo-Confucianism represents the pinnacle of the ideology of harmony between heaven and humanity. Since its incorporation into the imperial examination content in the mid-Yuan dynasty, this ideology remained a part of elite education until the end of the Qing dynasty (Bol, 2008). Additionally, the Yuan dynasty (1271–1368 CE), the first unified dynasty established by an ethnic minority in China, imposed strict social controls on the Han population (the majority ethnic group in China). As a result, imperial examinations were held far less frequently than during the Ming and Qing dynasties (a total of 16 times during the Yuan dynasty vs. approximately every three years during the Ming and Qing dynasties). We use the native origins (specific to district and county) of 50,060 *jinshi* from the Ming and Qing dynasties to obtain their geographic coordinate information from Baidu Maps. Centering on the enterprise registration location, we calculate the natural logarithm of the number of *jinshi* (plus 1) within a radius of N kilometers (N = 200, 300) around the enterprise, denoted as Jsh\_N, to measure the strength of Confucianism. We take the logarithm because the distribution of *jinshi* around enterprises is



Fig. 1. Thermal map of *jinshi* during the Ming and Qing dynasties. Note: This map shows the provincial distribution of *jinshi* during the Ming and Qing dynasties. It is clear that the *jinshi* were most densely distributed in the eastern region, especially in Henan, Shandong, Jiangxi, Fujian, Jiangsu and Zhejiang.

right-skewed. To provide a more intuitive understanding of regional differences in the Confucian atmosphere, provincial distribution maps and kernel density analysis charts based on the aforementioned data on *jinshi* are provided in this paper (see Fig. 1 and Fig. 2 for details).

#### 3.2.3. Moderating variable

Government environmental governance (GEG). Drawing on the approach of Zhang et al. (2023), we use the frequency of environment-related vocabulary in prefecture-level government work reports as a proxy for government environmental governance. Government work reports are usually released at the beginning of the year, and their contents are based primarily on the previous year's work summary. The more the government emphasizes environmental issues in its summary, the greater the intensity of government environmental governance it represents. For this study, 2937 prefecture-level government work reports issued between 2012 and 2022 are collected from 267 cities. Referring to previous research, 99 environmental vocabulary words (see Appendix 2 for details) are summarized and included in the statistical dictionary. Subsequently, the text of the work reports are segmented using the Jieba word segmentation tool in Python, the frequencies of related words are counted and standardized by the total number of word segments and, finally, a proxy variable for government environmental governance, *GEG*, is obtained.

#### 3.2.4. Control variables

Following previous studies (e.g., Ilhan et al., 2023; Xu and Duan, 2023; Huang et al., 2024), we control for several firm and regional characteristics that may influence a company's awareness of climate change. At the firm level, the following variables are controlled for: (1) firm size (*Size*), as prior research indicates that larger firms may have a greater need for climate awareness than smaller firms (Ilhan et al., 2023); (2) return on assets (*ROA*); and (3) growth rate of operating income (*Grow*). Firms with stronger profitability have more idle funds for green transformation, while an increase in operating income may encourage firms to maintain their current development model (Wang et al., 2023). We also control for (4) financial leverage (*Lev*) and (5) cash ratio (*Cash*). Firms with higher financial leverage and lower cash ratios tend to be more sensitive to climate change than their respective counterparts (Shu et al., 2023).

In addition, we control for (6) state ownership (SOE), as state-owned enterprises are more likely to improve their environmental performance and to respond to national policies than non-state-owned enterprises (Huang et al., 2024); (7) the size of the board of supervisors (BSS), as the board exercises supervisory powers and can urge firms to focus on climate change; (8) duality of roles (*Dual*), as the magnitude of leadership power can influence a firm's climate decisions; and (9) institutional investors (*INST*), who demand that firms



Fig. 2. Analysis of the nuclear density of *jinshi*. Note: This map illustrates the results of kernel density analysis of *jinshi* during the Ming and Qing dynasties. The distribution of *jinshi* is concentrated primarily in the North China Plain, the Yangtze River estuary, the Pearl River Delta region and the coastal areas of Fujian.

increase their concern for the climate (Ilhan et al., 2023). Furthermore, considering the importance placed on climate by other stakeholders (van Halderen et al., 2016), we control for (10) the shareholding ratio of the largest shareholder (*First*) and (11) the ownership structure (*STRU*).

We further control for the regional variables of (12) legal environment (LAW) and (13) public environmental awareness (PEA). The soundness of the legal environment affects firms' understanding of environmental issues, while public environmental awareness promotes firms' green development (Ren and Ren, 2024). Finally, we control for (14) prefecture-level city temperature (TEMP), as temperature affects firms' perception of climate (Wang et al., 2021). Detailed definitions of all of the variables are provided in Appendix 3.

### 3.3. Empirical models

Consistent with Du (2015) and Huang et al. (2024), we use ordinary least squares (OLS) regression to examine the impact of Confucianism on corporate awareness of climate change. The primary model specification is as follows:

$$CCA_{it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$

$$\tag{1}$$

where  $CCA_{it}$  represents corporate awareness of climate change, calculated as the ratio of the frequency of climate-related words to the total frequency of words in the annual report. The independent variable,  $Jsh_{N_{it}}$  (N = 200, 300), denotes the intensity of Confucian culture, measured by the number of scholars (*jinshi*) within a radius of N kilometers around the firm's registration location. Control<sub>it</sub> represents the remaining control variables. Year<sub>t</sub> and Industry<sub>i</sub> represent year and industry fixed effects, respectively.  $\varepsilon_{it}$  is the random error term. To address the issue of heteroscedasticity, robust standard errors are used for correction. We are interested in the coefficient of  $Jsh_N_{it}$ , which captures the impact of Confucianism on corporate awareness of climate change.

To test Hypothesis 2, we construct Model 2:

$$CCA_{it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_2 GEG_{it} + \beta_3 Jsh_N_{it} * GEG_{it} + \beta_j Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(2)

where  $GEG_{it}$  represents the level of government environmental governance, calculated as the ratio of the frequency of environment-related words to the total frequency of words in the government work report. If Hypothesis 2 holds, we expect a positive correlation between  $Jsh_N_{it}$  and  $GEG_{it}$  in Model 2. The definitions of the other variables are the same as in Eq. (1).

# 4. Results

#### 4.1. Descriptive statistics and correlation analysis

Table 1 presents the descriptive statistics and Pearson correlations of all variables in the model. We also calculate the variance inflation factor (VIF) to assess potential multicollinearity issues. The maximum VIF value is 2.58, well below the critical value of 10, indicating no severe multicollinearity.

#### 4.2. Hypothesis testing

Hypothesis 1 predicts that Confucianism positively impacts corporate awareness of climate change. Table 2. demonstrates that the coefficients of Jsh\_N in Models 1 and 2 are positive and significant ( $\beta_{Model1} = 0.008$ , p < 0.01;  $\beta_{Model2} = 0.007$ , p < 0.01), providing support for Hypothesis 1. Regarding the magnitude of the effect, when a firm's Confucian atmosphere increases by one standard deviation (SD = 1.575 and 1.527, respectively), corporate climate change awareness increases by approximately 2.75% (0.008 \* 1.575 / 0.458 \* 100%) and 2.33% (0.007 \* 1.527 / 0.458 \* 100%) standard deviations, respectively.

Hypothesis 2 predicts that government environmental governance reinforces the positive relationship between Confucianism and corporate climate change awareness. As expected, the interaction coefficients of Jsh\_N\*GEG in Models 3 and 4 are all positive and significant. Thus, Hypothesis 2 is supported.

# 4.3. Robustness tests

#### 4.3.1. Possible endogeneity concerns

To measure the impact of Confucianism, we use the number of *jinshi*, which satisfies the condition of exogeneity. However, the statistical significance of the relationship between Confucianism and corporate climate change awareness may be influenced by omitted variables or sample selection bias, potentially leading to spurious correlations. For instance, firms may strategically choose to register or relocate to strongly Confucian regions. To address these potential endogeneity concerns, we use a quasi-natural experiment based on the exogenous event of firm relocation, using a two-stage least squares estimation, one-period lag test and regional fixed effects. The results are presented in Panels A–D of Table 3.

First, referencing the studies conducted by Hasan et al. (2020) and Tan and Wang (2023), we use the exogenous event of firm relocation to construct a quasi-natural experiment. To ensure that the parallel trend assumption is satisfied and address the issue of self-matching, we follow the approach of Böckerman et al. (2009) and use a multi-period difference-in-differences (DID) model combined with time-varying propensity score matching (PSM). The covariates used in PSM remain consistent with the control variables in Eq. (1), and the 1:1 nearest neighbor matching method is applied. This approach is designed to investigate how changes in the Confucian atmosphere triggered by enterprise relocation influence corporate awareness of climate change. Cases involving multiple relocations during the sample period are excluded, thus ensuring that the selected samples have at least one year of data available both before and after the relocation. The models are constructed as follows:

$$C3A_{ii} = \beta_0 + \beta_1 RL\_high_{ii} \times Post_{ii} + \beta_i Control_{ii} + Year_i + Industry_i + \varepsilon_{ii}$$
(3)

$$C3A_{it} = \beta_0 + \beta_1 RL\_low_{it} \times Post_{it} + \beta_j Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$

$$\tag{4}$$

$$C3A_{it} = \beta_0 + \beta_1 RL_r ise_{it} + \beta_2 Post_{it} + \beta_3 RL_{it} \times Post_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{i,t}$$
(5)

Tabl Desc	e 1 riptive sta	atistics and	l Pearson	correlati	ons.														
Varia	able	1	2	3	4	5	6	7	8	6	10	11	12	13	14	15	16	17	18
1	C3A	1.000																	
0	$Jsh_200$	0.027	1.000																
ŝ	$Jsh_{300}$	0.028	0.972	1.000															
4	GEG	-0.012	0.086	0.088	1.000														
S	Size	0.173	-0.020	-0.015	0.017	1.000													
9	Lev	0.110	-0.079	-0.077	-0.009	0.463	1.000												
2	ROA	-0.021	0.077	0.074	0.005	0.036	-0.364	1.000											
8	Cash	-0.117	0.058	0.042	0.052	-0.238	-0.401	0.243	1.000										
6	Grow	0.028	0.002	0.000	-0.001	0.022	0.021	0.201	0.022	1.000									
10	SOE	-0.004	-0.113	-0.096	0.028	0.360	0.280	-0.064	-0.078	0.069	1.000								
11	Dual	0.003	0.069	0.059	-0.004	-0.169	-0.132	0.029	0.064	0.024	-0.305	1.000							
12	BSS	0.016	-0.083	-0.068	0.021	0.284	0.205	-0.023	-0.077	0.047	0.421	-0.176	1.000						
13	INST	0.054	-0.057	-0.047	0.027	0.448	0.200	0.099	-0.014	0.034	0.427	-0.203	0.260	1.000					
14	First	0.007	-0.005	-0.006	0.046	0.230	0.047	0.137	0.036	0.008	0.225	-0.060	0.112	0.516	1.000				
15	STRU	0.021	0.044	0.035	0.029	0.194	-0.067	0.204	0.104	0.050	0.045	0.000	0.032	0.519	0.725	1.000			
16	LAW	0.101	0.487	0.436	-0.102	0.060	-0.080	0.036	0.025	0.002	-0.165	0.118	-0.183	-0.093	-0.047	0.044	1.000		
17	PEA	-0.006	0.322	0.260	0.079	0.029	-0.024	0.011	0.095	0.009	-0.039	0.065	-0.124	-0.033	0.008	0.055	0.371	1.000	
18	TEMP	0.015	0.349	0.294	-0.218	-0.076	-0.063	0.030	0.028	0.008	-0.169	0.112	-0.118	-0.104	-0.055	0.021	0.345	0.046	1.000
	Mean	0.278	7.527	8.047	1.033	22.210	0.431	0.034	0.159	0.190	0.371	0.277	3.527	0.435	0.344	0.533	10.560	3.951	16.530
	SD	0.458	1.575	1.527	0.226	1.307	0.211	0.070	0.124	0.489	0.483	0.447	0.999	0.245	0.147	0.152	3.361	1.007	4.559
	Min	0.000	1.099	1.099	0.554	19.660	0.054	-0.335	0.009	-0.609	0.000	0.000	3.000	0.003	0.092	0.205	2.429	0.342	4.924
	Max	2.774	9.271	9.493	1.590	26.210	0.945	0.201	0.611	3.348	1.000	1.000	7.000	0.905	0.741	0.882	16.510	5.073	24.150

B. Li et al. | China Journal of Accounting Research 18 (2025) 100417

Models 3 and 4 investigate whether a relocation event does or does not occur. The experimental groups consist of firms whose Confucian atmosphere strengthened or weakened due to relocation, while the control group consists of firms that did not relocate. Model 5 further explores the relationship between positive relocation and negative relocation with respect to Confucianism. Specifically, the experimental and control groups consist of firms where the Confucian atmosphere either became stronger or weaker due to relocation, respectively. Here, *Post* serves as a dummy variable indicating a firm's relocation event, taking the value of 1 in the year of relocation and all subsequent years, and 0 otherwise. *RL* represents a dummy variable reflecting

Variable	Model 1	Model 2	Model 3	Model 4	
	Confucianism		Government Environmental Governance		
	Jsh_200	Jsh_300	Jsh_200	Jsh_300	
Jsh_N	0.008***	0.007***	0.008***	0.007***	
	(3.939)	(3.850)	(4.040)	(4.000)	
Jsh_N*GEG			0.025***	0.023***	
			(4.334)	(4.198)	
GEG			0.053***	0.052***	
			(4.236)	(4.197)	
Size	0.049***	0.049***	0.049***	0.049***	
	(17.804)	(17.798)	(17.709)	(17.702)	
Lev	0.097***	0.098***	0.098***	0.099***	
	(6.204)	(6.221)	(6.262)	(6.276)	
ROA	-0.054	-0.054	-0.050	-0.049	
	(-1.414)	(-1.407)	(-1.308)	(-1.292)	
Cash	-0.092***	-0.092***	-0.096***	-0.095***	
	(-4.829)	(-4.789)	(-5.013)	(-4.968)	
Grow	0.015**	0.015**	0.015***	0.015**	
	(2.559)	(2.556)	(2.577)	(2.572)	
SOE	$-0.075^{***}$	-0.075***	-0.075***	$-0.075^{***}$	
	(-11.046)	(-11.072)	(-11.071)	(-11.095)	
Dual	0.013**	0.013**	0.012*	0.012*	
	(2.043)	(2.031)	(1.945)	(1.941)	
BSS	-0.007 **	-0.007 **	-0.007**	-0.007**	
	(-2.427)	(-2.403)	(-2.370)	(-2.358)	
INST	0.068***	0.068***	0.069***	0.069***	
	(4.846)	(4.833)	(4.896)	(4.878)	
First	0.019	0.020	0.019	0.019	
	(0.749)	(0.752)	(0.723)	(0.732)	
STRU	-0.123***	-0.122***	-0.125***	-0.124***	
	(-4.695)	(-4.678)	(-4.762)	(-4.746)	
LAW	0.003*	0.003**	0.002	0.002*	
	(1.934)	(2.233)	(1.391)	(1.677)	
PEA	-0.008**	-0.007**	$-0.008^{***}$	-0.008**	
	(-2.544)	(-2.383)	(-2.667)	(-2.447)	
TEMP	-0.000	-0.000	0.000	0.000	
	(-0.832)	(-0.624)	(0.609)	(0.753)	
Constant	-0.815***	-0.824***	-0.872***	$-0.880^{***}$	
	(-13.752)	(-13.868)	(-14.399)	(-14.508)	
Observations	27,871	27,871	27,871	27,871	
R_squared	0.162	0.162	0.163	0.163	
Year FE	Yes	Yes	Yes	Yes	
Industry FE	Yes	Yes	Yes	Yes	

Table 2 OLS regression results for hypothesis testing

Variable definitions are provided in Appendix 3. Standard errors are reported in parentheses.

\*, \*\* and \*\*\* indicate significance at the 10%, 5% and 1% levels, respectively.

Panel A: Robus	stness tests using PSM-DID model regi	ressions	
Variable	Positive relocation & no relocation (1)	Negative relocation & no relocation (2)	Positive relocation & negative relocation (3)
Post*RL_high	0.066***		
Post*RL_low	(0.000)	-0.049*** (-2.972)	
Post*RL_rise		,	0.114***
Post			(4.402) -0.044** (-2.342)
RL_rise			-0.008
Constant	-0.302* (-1.693)	$-0.394^{**}$ (-2.087)	-0.335** (-2.303)
Observations	2,702	2,923	4,019
R-squared	0.133	0.123	0.117
FE & Controls	Yes	Yes	Yes
Panel B: Robus	tness tests using PSM-DID model regr	essions	
Variable	Jsh_200		Jsh_300
	1st Stage	2nd Stage	1st Stage 2nd Stage
	(1)	(2)	(3) (4)
APP	-0.855***		-0.876***
	(-119.487)		(-114.696)
Jsh_N		0.012***	0.011***
		(3.958)	(3.957)
Constant	8.054***	-0.947***	9.500*** -0.959***
	(63.012)	(-16.141)	(67.315) (-16.256)
Observations	27,871	27,871	27,871 27,871
KP-F	5,919.115		5,676.686
FE & Controls	Yes	Yes	Yes Yes
Panel C: One-po	eriod lagged regressions		
Variable	Jsh_200		Jsh_300
	H1	H2	H1 H2
	(1)	(2)	(3) (4)
L.Jsh_N	0.008***	0.007***	0.008*** 0.008***
	(3.716)	(3.636)	(3.813) (3.849)
L.Jsh_N*L.GEO	Ĝ	0.030***	0.030***
		(4.802)	(4.974)
L.GEG		0.061***	0.060***
		(4.540)	(4.506)
Constant	$-0.841^{***}$	-0.908***	-0.847*** -0.916***
	(-12.908)	(-13.642)	(-12.990) (-13.731)
Observations	23,739	23,739	23,739 23.739
FE & Controls	Yes	Yes	Yes Yes

# Table 3 (continued)

Panel D: Add regional	fixed effects			
Variable	Jsh_200		Jsh_300	
	H1 (1)	H2 (2)	H1 (3)	H2 (4)
Jsh_N	0.013**	0.012** (2.194)	0.011*	0.011*
Jsh_N*GEG	()	0.013** (2.077)	(1170)	0.014** (2.320)
GEG		0.014 (0.935)		0.013
Constant	$-0.923^{***}$ (-9.950)	-0.940***	-0.921*** (-9.487)	-0.943***
Controls	Yes	Yes	Yes	Yes
Observations	27.871	27.871	27.871	27.871
R-squared	0.169	0.169	0.169	0.169
Region FE	Yes	Yes	Yes	Yes
Year &				
Industry FE	Yes	Yes	Yes	Yes
Panel E: Alternative me	easures of Confucianism			
Variable	H1		H2	
	(1)	(2)	(3)	(4)
Jsh_pro	0.023**		0.027***	
Conton	(2.571)	0.001***	(2.997)	0.070***
Center		(2.014)		$0.0/0^{+++}$
I-h*CEC		(2.914)	0 105***	(3.130)
Jsn_pro*GEG			(2,582)	
Contor*CEC			(2.383)	0 726***
Center GLG				(2.496)
CEC			0.049***	(3.400)
GEG			(2.064)	(4.481)
Constant	0.910***	0.954***	(3.504)	(4.401)
Constant	(12,011)	$(-0.834^{+11})$	(-14.424)	-0.918
Observations	(-13.911)	(-14.418)	(-14.424)	(-13.047)
P squared	0.162	0.162	0.162	0.162
FE&Controls	0.102 Vas	0.102 Vas	0.102 Ves	0.102 Vec
Panel F: Alternative me	easures of corporate climate ch	hange awareness (C3A_sent)	103	103
Variable	Jsh_200		Jsh_300	
	H1	H2	H1	H2
	(1)	(2)	(3)	(4)
Jsh_N	0.006***	0.007***	0.006***	0.006***
	(4.252)	(4.336)	(4.145)	(4.262)
Jsh_N*GEG		0.020***		0.019***
		(4.459)		(4.329)
GEG		0.047***		0.046***
		(4.703)		(4.651)
Constant	-0.693***	-0.744***	-0.699***	-0.749***
	(-14.921)	(-15.634)	(-15.015)	(-15.713)
Observations	27,871	27,871	27,871	27,871
R-squared	0.162	0.162	0.162	0.162
FE&Controls	Yes	Yes	Yes	Yes

Table 3 (continued)

Panel G: Alternative measures of government environmental governance (GEG_pro)			
Variable	Jsh_200 (1)	<i>Jsh_300</i> (2)	
Jsh_N	0.010***	0.009***	
	(4.827)	(4.618)	
Jsh_N*GEG_pro	0.222***	0.221***	
*	(3.666)	(3.238)	
GEG_pro	0.699***	0.701***	
*	(5.987)	(5.998)	
Constant	-1.217***	-1.225***	
	(-14.349)	(-14.411)	
Observations	27,871	27,871	
R-squared	0.163	0.163	
FE&Controls	Yes	Yes	

Panel H: Controlling for religious influence and regional economic disparities

Variable	Controlling for religious influence		Controlling for regi disparities	onal economic
	N = 200 (1)	N = 300 (2)	Jsh_200 (3)	<i>Jsh_300</i> (4)
Jsh_N	0.005**	0.005*	0.005***	0.005***
Religion_N	0.004 (1.483)	0.004 (1.296)	(2.023)	(2.743)
GDP	( • • • • )		0.043***	0.044*** (3.438)
GDP_G			0.290*** (2.737)	0.291*** (2.747)
Constant	-0.854*** ( $-14.064$ )	$-0.860^{***}$ (-14.105)	(2.1.27) -1.278*** (-9.119)	-1.294*** (-9.307)
Observations	27,871	27,871	27,871	27,871
R-squared	0.162	0.162	0.162	0.162
FE&Controls	Yes	Yes	Yes	Yes
Panel I: Exclusion of et	hnic minority autonomous reg	ions and relocated enterprises		
Variable	Exclusion of ethnic autonomous region	c minority ns	Exclusion of reloca	ted enterprises
	Jsh_200	Jsh_300	Jsh_200	Jsh_300

	(1)	(2)	(3)	(4)
Jsh_N	0.007***	0.007***	0.010***	0.010***
	(3.202)	(3.113)	(4.424)	(4.563)
Constant	-0.832***	-0.842***	-0.897***	-0.906***
	(-13.521)	(-13.540)	(-12.695)	(-12.839)
Observations	26,755	26,755	19,407	19,407
R-squared	0.158	0.158	0.186	0.186
FE & Controls	Yes	Yes	Yes	Yes

Variable definitions are provided in Appendix 3. Standard errors are reported in parentheses. \*, \*\* and \*\*\* indicate significance at the 10%, 5% and 1% levels, respectively.

changes in Confucian cultural influence due to a firm's relocation. Specifically,  $RL\_high_{it}$  takes the value of 1 if the firm experienced a stronger Confucian cultural influence after relocation and 0 if there was no change.  $RL\_low_{it}$  takes the value of 1 if the Confucian cultural influence weakened after relocation and 0 if it was

unchanged.  $RL\_rise_{it}$  takes the value of 1 when a company relocated from a region with weaker Confucian intensity to one with stronger intensity, and 0 otherwise. The definitions of the other variables are the same as in Eq. (1).

The empirical results are shown in Table 3, Panel A. Column (1) displays the difference between a relocation event leading to stronger Confucianism and no relocation, and the coefficient of *Post\*RL\_high* is positive and significant. Column (2) presents the difference between a relocation event leading to weaker Confucianism and no relocation, and the coefficient of *Post\*RL\_low* is negative and significant. Clearly, compared with companies that did not relocate, the climate change awareness of those that relocated increases (decreases) as Confucianism is stronger (weaker). Column (3) shows the difference between relocation events that strengthened Confucianism and those that weakened it, and the coefficient of *Post\*RL\_rise* is significant and positive. Clearly, positive relocation events have a stronger positive impact on climate awareness than do negative relocation events. The results of this experiment confirm that changes in Confucian intensity caused by corporate relocation influence companies' awareness of climate change, indirectly supporting the positive relationship between Confucianism and climate change awareness.

Second, despite using the quantity of *jinshi* as a proxy for Confucianism, which largely eliminates the issue of reverse causality, it remains possible that crucial variables related to the independent variable, such as religious culture and regional policies, may have been omitted. To address this, we draw on Chen et al. (2017) and Gu et al. (2024) and select the minimum distance from the enterprise's registered location to one of the 19 Ming and Qing dynasty official printing presses, *APP*, as an instrumental variable. These 19 ancient printing presses accounted for 80% of the publishing and printing business nationwide. The unequal distribution of printing resources led to significant variations in the cost of acquiring books for students preparing for exams, thereby influencing the likelihood that scholars from different regions would pass the imperial examination. Consequently, the distance to a printing press is strongly correlated with the density of *jinshi*. The greater the instrumental variable, the fewer candidates would successfully obtain the title of *jinshi*.

The results are presented in Table 3, Panel B. The results of the first stage are based on the regression of APP and  $Jsh_N$ . As indicated in columns (1) and (3), the coefficient of APP is positive and significant at the 1% level, suggesting a negative correlation of Confucianism with the distance between the enterprise and the location of an ancient printing press. Meanwhile, columns (2) and (4) reveal that in the second-stage regression, a positive correlation is observed between the coefficients of  $Jsh_N$  and C3A, which is significant at the 1% level. Furthermore, the KP-F statistic is much greater than 10, indicating that the weak instrumental variable test is passed. Hypothesis 1 remains supported.

Third, although there is no overt reciprocal causal link between Confucianism and corporate awareness of climate change, undetected endogeneity may exist among Confucianism, government environmental governance and the error term. To address this concern, we conduct a one-period lagged regression on the independent variables, moderating variables and interaction terms for both Hypothesis 1 and Hypothesis 2. The detailed results are shown in Table 3, Panel C, and confirm the robustness of our main findings.

Fourth, while we incorporate control variables at the regional level, the correlation between regional culture and climate awareness may be influenced by unobservable regional factors. To mitigate the potential impact of omitted variables, provincial-level regional fixed effects are included in the analysis. The detailed results are presented in Table 3, Panel D.

### 4.3.2. Alternative measures

We reassess the robustness of our main findings, using alternative measures of Confucianism, climate change awareness and government environmental governance. The detailed results are presented in Table 3, Panels E–G. First, to measure the intensity of Confucianism, we adopt two proxies: the number of *jinshi* in provincial administrative regions and the average distance of enterprises from the seven major Confucian centers. Following the methodology of Yan et al. (2021), we standardize the number of provincial *jinshi* by dividing it by the local population, denoted as *Jsh\_pro*. Consistent with Du et al. (2015), we calculate the distances between the enterprises and each of the Confucian centers and standardize these distances by the sum of the maximum and minimum distances across all enterprises, i.e., *Center*. Second, we measure corporate climate

awareness using C3A\_sent, calculated as the ratio of sentences containing key climate-related terms to the total number of words in annual reports. Third, for government environmental governance, we replace city-level government work reports with provincial-level reports, defining the new measure as *GEG\_pro*.

# 4.3.3. Controlling for religious influence and regional economic disparities

Religious culture is a key component of informal institutions (Williamson, 2000). Both Buddhism and Taoism, which emphasize harmony with nature, have long-standing traditions in China. We collect data on over 40,000 Buddhist temples and Taoist monasteries from the State Administration of Religious Affairs. Using a distance-based measure similar to that employed for Confucianism, we develop a proxy for religious culture, *Religion\_N* (N = 200, 300). Following the approach of Li et al. (2020), we incorporate both religious culture and Confucianism into our model. The results, presented in Table 3, Panel H, columns (1)–(2), indicate that the inclusion of religious culture does not diminish the effect of Confucianism on climate change awareness.

We also account for regional economic disparities, as a region's level of economic development influences local businesses' awareness of climate change. To address potential bias, we include regional per capita GDP (log-transformed) and GDP growth rate in our primary regression model. The results, shown in Table 3, Panel H, columns (3)–(4), confirm that controlling for variations in regional economic development does not alter our main findings.

#### 4.3.4. Exclusion of ethnic minority autonomous regions and relocated enterprises

First, as the climate change awareness of enterprises located in ethnic minority regions may be influenced by unique local cultural customs, we exclude enterprises registered in the ethnic autonomous regions of Guangxi, Ningxia, Tibet, Qinghai and Xinjiang from the regression. The results are presented in Table 3, Panel I, columns (1)-(2).

Second, to avoid the influence of enterprise relocation, which can alter the surrounding Confucian atmosphere, we exclude enterprises that relocated during the sample period to ensure the purity of the sample. The results are shown in Table 3, Panel I, columns (3)–(4).

#### 4.3.5. Placebo test

To eliminate the possibility of omitted variables, we refers to the method of Li et al. (2016) and conduct a placebo test on Confucianism, with the results shown in Fig. 3. The intent is to scramble the values of the Confucianism variable and then rerun the regression. If the results remain significant, then the correlation between Confucianism and corporate climate change awareness would be spurious. The distribution is symmetric around x = 0, as shown in Fig. 3, indicating that the expected regression coefficient of virtual Confucian culture should not differ from 0. The mean of the virtual regression coefficients is very close to 0 and differs significantly from the actual values, suggesting that there is no spurious correlation between Confucianism and corporate climate change awareness.

# 5. Additional tests

#### 5.1. Examination of impact channels and timeliness

In this section, we aim to verify the mediating roles of the core elements advocated by Confucianism in the relationship between Confucianism and corporate climate change awareness; therefore, we indirectly assess the relevance of Confucianism in contemporary contexts. While our theoretical analysis underscores the ecological philosophy inherent in New Confucianism, it is plausible that the fundamental principles of Confucianism, namely humanism, deontology and collectivism (Ip, 2009), might enhance corporate climate ethics (Sadler-Smith and Akstinaite, 2022). Furthermore, our measure of Confucianism is based on the number of *jinshi* in the Ming and Qing dynasties. However, this dataset spans centuries, encompassing dynastic changes, the abolition of the imperial examination system, prolonged wars, the establishment of New China and various political movements (Gu et al., 2024). The multitude of uncertainties during this period naturally leads to questions regarding the timeliness of Confucianism. Our investigation focuses on whether using the



Fig. 3. Placebo testing.

number of *jinshi* indicates how Confucianism influences the values of modern companies and, consequently, their level of climate change awareness within the field, as manifested through their habitus.

In selecting variables to represent the core elements of Confucianism, we use environmental, social and governance (ESG), accrual-based earnings management (AEM) and internal pay gap (IPG) to respectively measure the enterprise's humanism, deontology and collectivism. First, the core concept of ESG is closely aligned with humanism. The environmental (E) dimension represents not only harmony between humans and nature but also care for future generations; the social responsibility (S) dimension directly involves concern for stakeholders such as employees, communities and consumers; and the governance (G) dimension emphasizes transparency, fairness and accountability, consistent with the core humanist principles of equality and dignity. Therefore, we draw on Bai et al. (2024) and use the ESG score from Huazheng to measure ESG. Second, AEM, a behavior aimed at whitewashing or concealing the true performance of a company, violates moral principles. Referring to Cai et al. (2021), we estimate manipulable accruals using the Jones model, adjusted annually by industry and use the absolute value of the final calculated residuals to measure the degree of AEM. Third, the size of the IPG within an enterprise reflects the company's consideration of collective interests, with excessive gaps indicating deviation from the spirit of teamwork. Hence, following Wang et al. (2023), *IPG* is defined as the difference between the average salary of management and the average salary of employees (divided by  $10^6$ ). We develop the following models to verify these potential channels and the timeliness of Confucianism:

$$ESG_{it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(6)

$$C3A_{it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_2 ESG_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
<sup>(7)</sup>

$$IPG_{it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(8)

$$C3A_{it} = \beta_0 + \beta_1 Jsh N_{it} + \beta_2 IPG_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$

$$\tag{9}$$

$$AME_{it} = \beta_0 + \beta_1 Jsh\_N_{it} + \beta_j Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(10)

$$C3A_{it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_2 AEM_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(11)

The regression results are presented in Panels A–C of Table 4. Specifically, in columns (2) and (5) across all three panels, the coefficients of *Jsh\_N* are significant, indicating that Confucianism significantly enhances ESG, inhibits earnings manipulation and reduces the pay gap. This finding confirms that Confucianism continues to exert a positive influence on contemporary enterprises. Additionally, in columns (3) and (6), the coefficients of *ESG*, *AEM* and *IPG* are all significant, and the overall mediation effect is positive. This suggests that Confucianism may enhance corporate climate awareness by fostering humanism, deontology and collectivism

Table 4	
Additional	tests.

Panel A: Examinati	ion of impact channel	s and timeliness (H	(umanism)			
Variable	Jsh_200		,	Jsh_300		
	$\frac{-}{C3A}$	ESG	C3A	$\frac{-}{C_{3A}}$	ESG	C3A
	(1)	(2)	(3)	(4)	(5)	(6)
Ish N	0.007***	0.030***	0.006***	0.007***	0.035***	0.006***
J3n_1V	(3.717)	(8 257)	(3,153)	(3.803)	(7.690)	(3 275)
ESG	(5.717)	(0.237)	0.028***	(5.005)	(7.050)	0.028***
			(9.721)			(9.726)
Constant	$-0.790^{***}$	$-2.480^{***}$	$-0.720^{***}$	$-0.799^{***}$	$-2.512^{***}$	$-0.727^{***}$
	(-12.948)	(-19.873)	(-11.676)	(-13.063)	(-20.033)	(-11.772)
Observations	27,123	27,123	27,123	27,123	27,123	27,123
R-squared	0.163	0.199	0.166	0.163	0.199	0.166
FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes
IE Interval		[0.0007	763, 0.0014435]		[0.000	6840 0.0013005]
Panel B: Examinati	on of impact channels	s and timeliness (D	eontology)			
Variable	Jsh_200			Jsh_300		
	C3A	IPG	C3A	C3A	IPG	C3A
	(1)	(2)	(3)	(4)	(5)	(6)
Jsh N	0.008***	-0.001**	0.008***	0.008***	-0.001**	0.008***
	(3.886)	(-2.268)	(3.857)	(3.872)	(-2.291)	(3.844)
IPG	. ,		-0.093*			-0.093*
			(-1.806)			(-1.806)
Constant	-0.790***	0.138***	-0.777***	-0.797***	0.138***	-0.784***
	(-12.239)	(18.772)	(-11.973)	(-12.318)	(18.765)	(-12.050)
Observations	25,665	25,665	25,665	25,665	25,665	25,665
R-squared	0.164	0.097	0.164	0.164	0.097	0.164
FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes
			108, 0.0001647]		[0.0000	113, 0.0001614]
Panel C: Examinati		s and timeliness (C	ollectivism)	X 1, 200		
Variable	Jsh_200			Jsh_300		<i>C2 (</i>
	C3A	AEM	C3A	C3A	AEM	C3A
	(1)	(2)	(3)	(4)	(5)	(6)
Jsh_N	0.007***	-0.024***	0.007***	0.006***	-0.026***	0.006***
	(3.637)	(-13.216)	(3.400)	(3.426)	(-14.531)	(3.156)
AEM			-0.018**			-0.018**
Constant	0.072***	2 002***	(-2.333)	0 0 0 0 ***	2 052***	(-2.321)
Constant	(13,712)	$-5.080^{-11}$	(14.287)	(13.775)	-5.055	-0.885***
Observations	27 382	27 382	(-14.287) 27 382	27 382	27 382	(-14.330) 27 382
R-squared	0.162	0.314	0.163	0.162	0.315	0.162
FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes
IE Interval		[0.0000	748, 0.0008014]		[0.0000	764, 0.0008687]
Panel D: Heterogen	neity analysis (differen	tiation by carbon e	mission level)			
Variable	Jsh_200		,	Jsh_300		
	High-carbon	Non-high-ca	urbon	High-carbon	Non-high-ca	ırbon
	(1)	(2)		(3)	(4)	
Jsh_N	0.008*	0.00	)6***	0.006	0.00	)6***
	(1.829)	(2	2.842)	(1.512)	(2	2.891)
Constant	-1.021***	-0.82	21***	-1.024***	-0.82	29***
	(-6.749)	(-12	2.775)	(-6.780)	(-12	2.875)

(-12.775) 23,583 (-12.875) 23,583 Observations 4,288 4,288 0.138 R-squared 0.266 0.138 0.266 FE & Controls Yes Yes Yes Yes Chow Test -1.855-1.952

Variable	Jsh_200			Jsh_300		
	Operating well (1)	Operating diff (2)	ficulties	Operating well (3)	Operating dif (4)	ficulties
Jsh N	0.007***	0.	015***	0.006***	0	.012***
-	(3.195)		(3.067)	(3.245)		(2.518)
Constant	-0.763***	-0.	924***	-0.770***	-0	938***
	(-11.860)	(-	-5.955)	(-11.960)	(	-6.037)
Observations	25,155		2,696	25,155		2,696
R-squared	0.165		0.165	0.165		0.164
FE & Controls	Yes	Yes		Yes	Yes	
Chow Test			-2.435			-1.819
Panel F: Analysis of	of economic consequen	ces				
Variable	Jsh_200			Jsh_300		
	$lnCO_2$	C3A	$lnCO_2$	$lnCO_2$	C3A	$lnCO_2$
	(1)	(2)	(3)	(4)	(5)	(6)
Jsh_N	0.096***	0.005**	0.096***	$0.079^{***}$	$0.005^{**}$	$0.079^{***}$
	(13.223)	(2.562)	(13.251)	(11.155)	(2.340)	(11.181)
C3A			-0.033*			-0.032*
			(-1.850)			(-1.793)
CO2_per	$0.015^{***}$	$-0.002^{***}$	$0.015^{***}$	$0.015^{***}$	$-0.002^{***}$	$0.015^{***}$
	(6.833)	(-2.965)	(6.804)	(6.849)	(-2.935)	(6.822)
Constant	$-18.521^{***}$	$-0.709^{***}$	$-18.545^{***}$	$-18.583^{***}$	$-0.714^{***}$	$-18.606^{***}$
	(-95.147)	(-11.429)	(-95.021)	(-94.860)	(-11.456)	(-94.734)
Observations	24,156	24,156	24,156	24,156	24,156	24,156
R-squared	0.695	0.143	0.695	0.694	0.143	0.694
FE & Controls	Yes	Yes	Yes	Yes	Yes	Yes
IE Interval		[-0.00051	97, -0.0000073]		[-0.0004]	804, -0.0000028]

Table 4 (continued)					
Panel E: Heterogeneity analysis	(distinction	between the	he operating	conditions	of firms)

Variable definitions are provided in Appendix 3. Standard errors are reported in parentheses.

\*, \*\* and \*\*\* indicate significance at the 10%, 5% and 1% levels, respectively.

within the field, as manifested through habitus. To ensure the robustness of the mediation effect, a modified bootstrap test is conducted using 1000 samples. The indirect effect interval excludes 0, indicating the reliability of the results.

# 5.2. Heterogeneity analysis

# 5.2.1. Differentiation by carbon emission level

High-carbon industries exhibit characteristics distinct from those of general industries, particularly in terms of public opinion and regulatory pressure (Qi et al., 2023), which may alter the impact of Confucian culture. We define the six energy-intensive industries listed in the 2010 National Economic and Social Development Statistics Report as high-carbon industries and analyze the relationship between Confucianism and climate change awareness through the lens of industry heterogeneity. To assess the differences between high-carbon and non-high-carbon industries, we conduct a Chow test, setting the grouping variable to 1 for high-carbon industries and 0 for non-high-carbon industries. As shown in Panel D of Table 4, the Chow test yields a negative and significant t-value, indicating that Confucianism has a stronger effect on climate change awareness in non-high-carbon industries than in high-carbon industries. This may be due to high-carbon industries being key targets of government carbon reduction efforts, as they are major contributors to national carbon emissions. These industries typically have a deeper understanding of climate change issues due to stricter car-

bon reduction demands, resulting in a relatively high level of baseline awareness that limits the marginal effect of Confucianism.

#### 5.2.2. Distinguishing between the operating conditions of firms

Confucius once sighed, "If I hear the truth in the morning, I can die contentedly in the evening (*zhao wen dao xi si ke yi*, 朝闻道夕死可矣) (*Analects of Confucius*)." Confucian scholars have long emphasized the pursuit of morality and righteousness as central to life's value, even in times of adversity (Yuan et al., 2023). Enterprises influenced by Confucian values may show greater concern for social responsibilities, including climate issues, when facing operational challenges than other enterprises. We divide the sample into two groups based on firm profitability, using *ROA* as the metric. Firms in the lowest 10% of *ROA* within their industry-year category are classified as facing operational difficulties, while others are considered to be operating well. To ensure the robustness of the grouping, samples with fewer than five observations per industry-year are excluded. Well-performing firms are assigned a value of 1, while struggling firms are assigned a value of 0. The results, displayed in Panel E of Table 4, reveal a negative and significant t-value from the Chow test, indicating notable differences between the two groups. This suggests that Confucianism's influence on climate awareness becomes more pronounced when firms experience greater operational difficulties.

# 5.3. Analysis of economic consequences

To achieve a dual carbon strategy, raising corporate climate awareness should be not only written but also implemented in the daily practices of enterprises. According to Bourdieu's (1984) practice theory, practice is the product of the interactions between habitus, capital and field, a relationship that can be summarized as [(Habitus) (Capital) + Field] = Practice. Therefore, to explore the economic consequences of increased climate awareness and test the reliability of climate awareness indicators, we conduct an exploratory study from the perspective of corporate carbon emissions. Due to the limited number of listed companies that disclose carbon dioxide emissions among our sample, we refer to Wang et al. (2023), who use industry CO<sub>2</sub> emissions and operating costs to estimate individual carbon emissions. The detailed process is shown in Eq. (12). To account for regional disparities, we also incorporate regional per capita carbon emissions (*CO2\_per*) as a control variable. The model specifications are elaborated in Eq. (13)–(15).

$$\ln CO_2 = \ln \left[ \frac{Operating \text{ Costs of Firm * Industrial CO}_2 \text{ Emissions}}{Operating \text{ Costs of Industry}} \right]$$
(12)

$$\ln CO_{2it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_2 CO_2 \text{-per}_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(13)

$$C3A_{it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_2 CO_2 \text{-per}_{it} + \beta_i Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(14)

$$\ln CO_{2it} = \beta_0 + \beta_1 Jsh_N_{it} + \beta_2 C3A_{it} + \beta_3 CO_2 - per_{it} + \beta_j Control_{it} + Year_t + Industry_i + \varepsilon_{it}$$
(15)

where  $lnCO_{2it}$  represents the estimated carbon emissions of the enterprise,  $C3A_{it}$  represents the enterprise's awareness of climate change,  $CO_{2\_}per_{it}$  represents the per capita carbon emissions and other variables remain consistent with Eq. (1). The results are shown in Panel F of Table 4. In columns (1) and (4), the coefficients of  $Jsh_N$  are positive and significant, indicating that Confucianism increases corporate carbon emissions to some extent. In columns (2) and (5), the coefficients of  $Jsh_N$  remain positive, while in columns (3) and (6), the coefficients of C3A are negative and significant, and their product is also negative. This suggests that considering the reinforcing effect of Confucianism on climate awareness mitigates its impact on carbon emissions. This finding indirectly supports a positive role of corporate climate change awareness in carbon reduction and theoretically establishes a logical pathway from capital to habitus to practice. The modified bootstrap test does not include 0 and lies within the negative range, confirming the robustness of these results.

#### 6. Conclusion and reflection

We analyze 27,871 annual corporate observation samples from 2011 to 2021, covering 3755 listed companies. The results show a positive and significant correlation between Confucianism and corporate awareness of climate change, which is further strengthened by government environmental governance. Specifically, we measure Confucianism based on the number of *jinshi* who passed the imperial examinations during the Ming and Qing dynasties, while we determine the awareness of climate change and government environmental governance through text analysis. In further testing, we verify the timeliness of Confucianism and its possible channels of influence based on its core elements. Heterogeneity analysis reveals that the positive relationship between Confucianism and climate change awareness remains significant for high-carbon industries and struggling businesses. Finally, we find that Confucianism helps reduce corporate carbon emissions by enhancing climate change awareness, forming a logical closed loop from capital to habitus to practice.

Reflecting on our research, it is undeniable that classical Confucianism encompasses some feudal ideologies, including hierarchy and oppression of women. However, it is more meaningful to explore the insights that Confucian thought can bring to practical issues such as business ethics and climate change. As Professor Stephen C. Angle proposes, a "grounded global philosophy" means conducting philosophical research within a specific living philosophical tradition, while maintaining an open approach to stimuli and insights from other philosophical traditions, thus giving it a global nature. Perhaps only by maintaining an open and inclusive attitude and embracing the wisdom of all nations might Confucianism truly be accepted worldwide and contribute positively to global development.

Moreover, we have witnessed the difficult choices and severe problems of environmental pollution faced by Chinese enterprises at the beginning of this century. Fortunately, many like-minded researchers have conducted in-depth studies on the relationship between Confucianism and business ethics, providing guidance for enterprises in the context of globalization. As China's family-oriented society gradually disintegrates, the main path of transmission of Confucianism is severely affected. We should continue to seek ways to carry forward the core values of Confucianism in a timely manner. For example, we are currently facing a global climate crisis: according to the World Meteorological Organization's *State of the Global Climate 2023*, 2023 was the warmest year on record. Global climate issues will continue to suffer due to the current wave of anti-globalization and the impacts of geopolitical conflicts. In this context, enterprises will have to decide between efficiency and carbon reduction in a global economic downturn. How corporate climate ethics can be developed in combination with a cultural background is a significant and timely issue.

#### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# Appendix 1

# Climate change vocabulary

Drought Disaster (旱灾)	Heavy Rain (大雨)	Standard Requirements (标准要求)
High Temperature (高温)	Cold Winter (寒冬)	Climate Change (气候变化)
Flood (洪涝)	Heavy Fog (大雾)	Nitrogen Oxides (氮氧化物)
High Tide (涨潮)	Cloud Layer (云层)	Sulfides (硫化物)
Extreme Heat (酷暑)	Early Winter (初冬)	Mountain Breeze (山风)
Lightning Strike (雷击)	Wind and Hail (风雹)	Green Hills (青山)
Thunder and Lightning (雷电)	Strong Wind (大风)	Effective Control (有效控制)
Precipitation (降水量)	Water Level (水位)	Carbon Emissions (碳排放)
Snowfall (下雪)	Ecosystem (生态系统)	Emission Reduction (减少排放)

#### Appendix 1 (continued)

Amount of Snowfall (降雪量)	Climate (气候)	Gas Emissions (气体排放)
Blizzard (暴风雪)	Global Warming (全球变暖)	Carbon Dioxide
		Reduction (减少二氧化碳)
Thunderstorm (暴风雨)	Coastal Areas (沿海地区)	Carbon Price (碳价格)
Dust Storm (沙尘暴)	Forest (林地)	Energy Regulation (能源监管)
Temperature (气温)	Sea Level (海平面)	Carbon Tax (碳税)
Arctic (北极)	Water Supply (供水)	Carbon Reduction (碳还原)
Atmosphere (大气)	Natural Disasters (自然灾害)	Emissions Trading (排放交易)
Flood Disaster (洪灾)	Rainwater (雨水)	Carbon Dioxide
		Emissions (二氧化碳排放)
Frost (霜冻)	Heavy Snow (大雪)	Nitrogen Oxide
		Emissions (氮氧化物排放)
Tsunami (海啸)	Drainage (排水)	Energy Independence (能源独立)
Mountain Fire (山火)	Seawater (海水)	Energy Efficiency (能源效率)
Typhoon (台风)	Management Area (管理区)	Shale Gas (页岩气)
Hurricane (飓风)	Golf Course (高尔夫球场)	Energy Technology (能源技术)
Earthquake (地震)	Cold Season (寒季)	Renewable Energy (可再生能源)
Storm (暴风)	Cool Season (冷季)	Electric Car (电动车)
Floodwaters (洪水)	Cold Summer (冷夏)	Clean Energy (清洁能源)
Drought (干旱)	Cool Summer (凉夏)	New Energy (新能源)
Wildfire (野火)	Extreme Cold (极寒)	Wind Energy (风能)
Severe Winter (严冬)	Heating Season (供暖季)	Wind Power (风力)
Storm (风暴)	The Coldest (最寒冷的)	Solar Energy (太阳能)
Flooding (水淹)	Coldest (最冷的)	Thermal Power (热动力)
Tropical Storm (热带风暴)	Climate Risk (气候风险)	Renewable Resources (可再生资源)
Heavy Snowstorm (暴雪)	Air Quality (空气质量)	Solar Power Generation (太阳能发电)
Hail (冰雹)	Fossil Fuels (化石燃料)	Gas Purification (气体净化)
Severe Cold (严寒)	Fuel Costs (燃料费)	Vehicle Model (车型)
Weather (天气)	Energy Conservation (节能)	Passenger Car (客车)
Temperature (温度)	Low Carbon (低碳)	Parking Space (车位)
Precipitation (降水)	Energy Security (能源安全)	Battery Charge (电池电量)
Icing (结冰)	Greenhouse Gases (温室气体)	Solar Cell (太阳能电池)
Warm Winter (暖冬)	Carbon Dioxide (二氧化碳)	Electric Vehicle (电动汽车)
Snowfall (降雪)	Air Pollution (空气污染)	Small Car (小型汽车)
Rainfall (降雨)	Environmental Standards (环境标准)	

# Appendix 2. Environmental vocabulary

Environmental Protection (环境保护) Environmental Protection (环保) Environment (环境) Pollution Prevention and Control (污染防治) Coal-to-Gas Conversion (煤改气) Central Heating (集中供热) Reuse (再利用) Recycling (循环)

(continued on next page)

Appendix 2 (continued)

Pollution Control (治污) Pollution Treatment (汚染治理) Pollution Abatement (治理污染)

Greening (绿化) Green (绿色) Green Development (绿色发展) Low Carbon (低碳) Emission Reduction (减排) Ecology (生态) Sewage Treatment (污水处理) Wastewater Management (污水治理) Environmental Impact Assessment (环境景响评价) Environmental Inspection (环保督察) Household Garbage Harmless Treatment (生活垃圾无害化) Environmental Quality (环境质量) Air Quality (空气质量) Pollution (污染) Pollutant Discharge (排污) Chemical Oxygen Demand (化学需氧量) Sulfur Dioxide (二氧化硫) Carbon Dioxide (二氧化碳) Particulate Matter (颗粒物) PM2.5 (PM2.5) Ammonia Nitrogen (氨氮) Nitrogen Oxides (氮氧化物) Air Pollution (大气污染) Pollutants (污染物) Fugitive Dust (扬尘) Dustfall (降尘) Waste (废物) Garbage (垃圾) Emission (排放) Air (空气) PM10 (PM10) Smog (雾霾) Greenhouse Gases (温室气体) Water Consumption (水耗) Energy Consumption (能耗) Consumption (消耗) Resources (资源) Conservation (节约) Intensification (集约) Energy (能源) New Energy (新能源) Clean Energy (清洁能源) Coal-to-Electricity Conversion (煤改电)

Renewable (可再生) Beijing-Tianjin-Hebei Region (京津冀) **Environmental Protection** Coordination (环保协同) Coordinated Development (协同发展) Collaborative Governance (协同治理) Departmental Cooperation (部门合作) Public Participation (公众参与) Border Area (交界地区) Sharing (共享) Transfer (转移) Joint Prevention (联防) Joint Control (联控) Joint Management (联治) Regional Coordinated Development (区域协调发展) Comprehensive River Basin Management (流域综合治理) Regional Cooperation (区域合作) Complementary Advantages (优势互补) Win-Win Cooperation (合作共赢) Joint Promotion (共同推进) Protection Collaboration (保护协作) Collaborative Pollution Control (协同治污) Sustainable (可持续) Blue Sky (蓝天) Clear Water (碧水) Clean Soil (净土) Greenbelt (绿地) Forest (森林) River Chief (河长) River Chief System (河长制) Lake Chief (湖长) Lake Chief System (湖长制) Preserving Green Spaces (留绿) Leaving Open Spaces (留白) Livable (宜居) Tree Planting (植树) Afforestation (造林) Lucid Waters and Lush Mountains (绿水青山) Blue Sky and White Clouds (蓝天白云) Ecological Barrier (生态屏障) Water Conservation (水源涵养) Soil and Water Conservation (水土保持) Development (开发) Soil (土壤) Returning Farmland to Forest (退耕还林) Natural Forest (天然林)
Appendix	3.	Variable	definitions.
Арренина	5.	v al labic	ucinitions.

Variables	Variable description
C3A	The ratio of the frequency of climate change keywords in the annual report of the enterprise to the total number of words in the annual report multiplied by 10^3.
Jsh_200	The natural logarithm of the number of jinshi within a 200-km radius around a firm's registered address plus one
Jsh_300	The natural logarithm of the number of jinshi within a 300-km radius around a firm's registered address plus one
GEG	The ratio of the frequency of environmental vocabulary in the <i>government work report</i> to the total number of segmented words multiplied by 100.
Size	The natural logarithm of total assets
Lev	Total liabilities divided by total assets
ROA	Net income divided by total assets
Cash	The net increase in cash and cash equivalents divided by total assets
Grow	(Current year's operating income - Last year's operating income) / Last year's operating income
SOE	A dummy indicating whether the firm's controlling shareholder is the local or central government. It equals one if the firm's controlling shareholder is the local or central government, and zero otherwise
Dual	A dummy indicating whether the chairman and the manager are the same person. It equals one if the chairman and the manager are the same person, and zero otherwise
BSS	Total number of supervisors
INST	Shareholding ratio of institutional investors
First	Shareholding ratio of the largest shareholder
STRU	Concentration of shareholding of the top five shareholders
LAW	Annual legal environment indices for various regions, as studied by Chen et al. (2021)
PEA	Referring to Ren & Ren (2024), using Baidu Index online platform with "environmental pollution" as the keyword, the daily average search volume at the prefecture-level city level from 2011 to 2021 was obtained.
TEMP	Annual average temperature (in Celsius) of the city where the enterprise is registered

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# Refining employee treatment: Effects of government arrears repayment in China



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#### ABSTRACT

Research on government procurement emphasizes its positive impacts, while paying insufficient attention to the risks posed by government arrears. We show that the implementation of China's Special Supervision Action for Repaying Government Arrears significantly enhances employee treatment, particularly safety management and employee incentives, through monetary compensation, welfare, social security expenditure and investment in skilled human capital. The Special Supervision Action improves employee treatment by alleviating liquidity constraints and enhancing CEO confidence, which in turn boost firm productivity and performance. Cross-sectional tests indicate that the number of nearby bank branches, political connections, financial health, demand for human capital and external job opportunities affect these relationships. Our findings highlight the influence of government arrears repayment on corporate human capital investment.

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#### 1. Introduction

Governments, as large and stable customers, benefit private sector suppliers by easing borrowing constraints (Bonfim et al., 2021) and promoting firm growth (Gabriel, 2024), thereby enhancing these suppliers' resilience to economic slack (Goldman, 2020). However, government discretion in payment timing can result in the accumulation of arrears (Abad et al., 2023). In frictionless financial markets, government arrears do not affect firm behavior, because such arrears can serve as collateral for financing (Checherita-Westphal et al., 2016; Fadic, 2020). However, in financial markets with frictions, government arrears engender a range of negative externalities and expose private sector suppliers to severe liquidity risks (Conti et al., 2021). The literature reveals that government arrears limit firm investment and employment and even threaten firm survival (Murfin and Njoroge, 2015; Barrot, 2016; Checherita-Westphal et al., 2016; Breza and Liberman, 2017; Barrot and Nanda, 2020; Abad et al., 2023). However, it is unclear whether and how government arrears affect firms' employee-treatment strategies.

This lack of research is surprising, given the serious consequences of the recent rapid increase in the accounts receivable of small and medium-sized enterprises (SMEs) related to contracts with governments and state-owned enterprises (SOEs). These consequences include rising incidences of delinquent wage payments and failure to provide legally mandated labor protections. Due to resource constraints, private enterprises, especially SMEs, struggle to offer the competitive employee-treatment strategies needed to attract and retain valuable employees in today's labor market (Li and Freeman, 2015). These challenges are even greater in emerging economies, where worker protections are weak and SMEs face credit discrimination (Ge and Qiu, 2007). In the absence of a sound labor protection system and effective government regulation, firms typically underinvest in employee welfare, as employees possess the weakest bargaining power among stakeholders and labor cost reduces corporate profitability (Shan and Tang, 2023). The outbreak of the COVID-19 pandemic exacerbated these challenges by tightening cash flows, diminishing market demand and disrupting supply chains (Ding et al., 2021), significantly affecting corporate investment in employees. According to the Impact Assessment Report of the COVID-19 Epidemic on Chinese Enterprises released by the United Nations Development Program, 62.78 % of surveyed SMEs identify employee wage payments as their primary cost pressure during the epidemic, compared with only 29.72 % of larger enterprises. Wage arrears for migrant workers in China are also closely related to this issue. As Premier Li Keqiang stated at the State Council's Executive Meeting on 1 December 2021, nearly 290 million rural migrant workers rely primarily on wages as their income; accordingly, ensuring timely and full wage payment is essential for meeting the basic living needs of their families. He stated that governments and SOEs would take measures to clear arrears owed to SMEs and that SMEs must fulfill their legal obligations to pay workers the wages they deserve.<sup>1</sup> Such anecdotal evidence suggests that government arrears significantly hinder the capacity of SMEs in China to make timely wage payments and provide appropriate employee benefits.

Resource-based theory regards employees as a key form of capital and the most significant factor in a firm's competitive success (Coff, 1997, 2002). Both monetary and non-monetary incentives play essential roles in motivating employees (Larkin and Leider, 2012). Beyond financial benefits such as competitive compensation, favorable employee treatment encompasses employee participation in decision-making, the provision of growth and development opportunities, and a healthy and safe workplace (Chen et al., 2016). According to social exchange theory, enhancing employee treatment is a strategy that creates a positive work environment and supports positive relationships between management and the workforce. Employees perceive improved treatment as a reward for their contributions and might thus reciprocate with reduced turnover and increased loyalty, which ultimately benefits the firm. Nevertheless, human capital is costly, and numerous firms, particularly in countries with weak employee protection and limited resources, are reluctant to treat their employees generously (Ghaly et al., 2015). When confronted with liquidity constraints and unstable future cash flows, firms might prioritize short-term financial stability over long-term investments, compromising their ability to invest in employee treatment, despite such investment being essential to shaping their competitive advantage. Thus, when government arrears exacerbate firms' financial constraints and undermine CEO confidence

<sup>&</sup>lt;sup>1</sup> https://english.www.gov.cn/premier/news/202112/02/content\_WS61a79fe9c6d0df57f98e5e1f.html.

in future cash flows (Barrot and Nanda, 2020; Conti et al., 2021), firms reduce or postpone human capital investment. Therefore, we expect that government arrears repayment can improve employee treatment by alleviating liquidity constraints and enhancing CEO confidence.

Specifically, we study the impact of government arrears repayment on employee treatment in the context of a Chinese program aimed at settling local government arrears owed to private sector suppliers. In 2016, the State Council of China mandated the Ministry of Finance to initiate a program called the *Special Supervision Action for Repaying Government Arrears* (hereafter, the Special Supervision Action). Subsequently, the National Development and Reform Commission formed seven supervisory teams, each dispatched to one of seven provinces (cities)—Beijing, Liaoning, Anhui, Shandong, Henan, Hubei and Qinghai—to carry out specialized supervisory actions. As a result, local governments in the supervised regions have greatly increased their efforts to repay arrears owed to private sector suppliers.<sup>2</sup> Firms located in the supervised regions received sizeable unexpected payments, which reduced their accounts receivable, while comparable firms in other regions did not. Therefore, in this study, we assign private SMEs located in the supervised regions to the treatment group and those outside these regions to the control group. The unexpected nature of the program and its selective application to only a few regions make it an ideal setting for studying the effects of government arrears repayment on employee treatment.

Using employee treatment ratings from the Hexun corporate social responsibility (CSR) evaluation system and the Chinese Research Data Services (CNRDS), we find that employee treatment by private SMEs located in the supervised regions significantly improves after the implementation of the Special Supervision Action. These findings remain robust after we control for firm- and city-level characteristics and firm and year fixed effects. To ensure the robustness of our results, we conduct a series of additional tests. First, we conduct a parallel trend test and find that in the pre-Special Supervision Action period, the treatment and control groups exhibit parallel trends in employee treatment. A dynamic effects analysis shows that the impact of the Special Supervision Action on employee treatment becomes evident 2 years after its implementation. Second, we conduct placebo tests by creating false policy shocks and randomly assigning firms to treatment groups, confirming that the baseline regression results are not affected by estimation bias stemming from the omission of variables. Third, we adopt a variety of methods to mitigate sample selection bias, and the results remain unchanged. Further analysis shows that firms prioritize investments in safety management and employee incentives, and increase employee monetary compensation, welfare, social security expenditure and human capital investment after the Special Supervision Action.

One possible channel explaining these results is that government arrears repayment injects liquidity into firms in the supervised regions, enhancing their capacity to invest in employee treatment. Furthermore, government arrears repayment can send a positive signal to private firms about the government's fiscal health and overall economic stability, potentially encouraging private firms to improve employee treatment through the channel of enhanced CEO confidence. To validate these channels, we conduct the following tests. First, we find a significant decrease in government-related accounts receivable among firms in the treatment group in the period after the implementation of the Special Supervision Action. Second, we examine whether the action alleviates the liquidity constraints of firms in the supervised regions. After the Special Supervision Action, there is a significant increase in the operating cash flow of the affected firms, coupled with reduced cash–cash flow and investment–cash flow sensitivity. Finally, using textual analysis to measure CEO confidence, we find that the Special Supervision Action improves CEO confidence regarding future cash flows and the economic environment. These results indicate that the alleviation of liquidity constraints and the improvement of CEO confidence levels are important mechanisms underlying our main result.

Additionally, we perform a set of cross-sectional analyses to understand the heterogeneous impacts of the Special Supervision Action. We anticipate that firms are more susceptible to the effects of the Special Supervision Action when facing substantial financial frictions, which inhibit firms from using government arrears as collateral for financing (Checherita-Westphal et al., 2016; Fadic, 2020). As expected, we observe that the positive effect of the Special Supervision Action on employee treatment is more pronounced for firms with few

 $<sup>^2</sup>$  For example, in Shandong Province, one of the supervised regions, a cumulative sum of 90.9 billion yuan in overdue project funds had been repaid by the end of 2016, accounting for 90.4% of all arrears for project funds. Notably, municipalities such as Weifang, Laiwu and Dezhou, as well as 83 counties (districts), have fully completed the repayment of arrears for project funds.

nearby bank branches than for those with many nearby branches. Second, as political connections influence the allocation of government resources (Schoenherr, 2019), we find that the positive effect of the Special Supervision Action on employee treatment is more pronounced for firms without political connections than for those with political connections. Third, firms with weak financial health are more vulnerable to liquidity risks due to government arrears (Conti et al., 2021), resulting in a more pronounced positive effect for firms with low profitability and tight financial constraints than for their counterparts. Fourth, we expect that when human capital is more critical or employees have more external job opportunities, firms are likely to improve employee retention by improving their treatment. Our empirical evidence supports this notion, illustrating that the Special Supervision Action has a stronger impact on employee treatment in firms with greater demand for human capital and in regions with more external job opportunities than in their counterparts. Finally, our study investigates the economic consequences of the Special Supervision Action, revealing that firms' commitment to improving employee treatment following their receipt of a sizeable unexpected payment from the government enhances their productivity and financial performance.

Our study is related to several strands of literature. First, it contributes to the literature on public procurement and government arrears. This literature primarily emphasizes the positive effects of government procurement on suppliers, such as stable incomes during recessions (Goldman, 2020), easing of borrowing constraints (Bonfim et al., 2021) and promotion of firm growth (Gabriel, 2024), but pays insufficient attention to the risks of government arrears. Although some studies explore the effects of government arrears repayment on firm investment (Abad et al., 2023), employment growth (Barrot and Nanda, 2020) and firm performance (Conti et al., 2021) in developed countries, its impact on employee treatment remains underexplored. Our study integrates resource-based theory and social exchange theory and emphasizes that investing in employee treatment creates a reciprocal relationship between employees and employers, resulting in greater commitment, job satisfaction and productivity among employees, which ultimately benefit the firm. To the best of our knowledge, our study is the first to explore the relationship between government arrears repayment and employee treatment. The most relevant study is by Charoenwong et al. (2021), who find that government indebtedness increases suppliers' accounts receivable in China. Using the Special Supervision Action as a quasi-natural experiment, we further identify the causal impact of government arrears repayment on employee treatment.

Second, our study contributes to a growing stream of research on employee treatment practices. Studies show that supporting employee welfare increases long-term stock returns (Edmans, 2011; Faleye and Trahan, 2011; Edmans et al., 2024), improves performance (Martins, 2021), reduces bankruptcy risk (Verwijmeren and Derwall, 2010), lowers the cost of equity capital (El Ghoul et al., 2011) and mitigates stock price crash risk (Ben-Nasr and Ghouma, 2018) for firms. Nevertheless, numerous firms are reluctant to provide employee welfare because of the potential economic costs associated with human capital investment (Faleye and Trahan, 2011; Ben-Nasr and Ghouma, 2018). Notably, private SMEs tend to provide fewer employee welfare programs than SOEs, including less social security, inferior labor contract coverage (Li and Freeman, 2015), weaker workplace protections and stability (Bai et al., 2006), fewer healthcare, housing and retirement benefits (Lin et al., 2020) and a greater incidence of wage arrears (Li and Freeman, 2015). We contribute to the literature by investigating the relationship between financial frictions and employee treatment. In the context of China, an emerging economy characterized by large financial frictions and weak judicial independence, our study highlights government arrears repayment as an important factor influencing employee benefits. In particular, our findings suggest that in the presence of considerable financial frictions and government intervention, the Special Supervision Action plays a crucial role in improving employee treatment by easing the liquidity constraints and enhancing the confidence of CEO of private SMEs.

Finally, our study contributes to the literature on how governments infuse liquidity into the private sector (Bach, 2014; Banerjee and Duflo, 2014). In emerging economies marked by significant financial market frictions and credit discrimination, private SMEs face great difficulties and high costs in securing financial resources (Ge and Qiu, 2007; Wu et al., 2014). Therefore, trade credit plays a pivotal role as a form of informal financing (Fisman and Love, 2003). Our findings reveal the positive influence of the Special Inspection Action on the repayment of government arrears to private SMEs. It not only alleviates liquidity constraints but also sends a positive signal to SMEs regarding government reliability and responsiveness, leading to enhanced employee treatment through the channel of higher CEO confidence. Furthermore, we demonstrate that the

effect of government arrears repayment on the private sector depends on market dynamics and the policies or legal constraints imposed on the government.

#### 2. Institutional background

The Chinese government has maintained large-scale procurement activities in recent years. According to the Ministry of Finance, the scale of government procurement was approximately 3.7 trillion yuan in 2020, accounting for 10.2 % of national fiscal expenditure and 3.6 % of gross domestic product (GDP). The primary suppliers are SMEs. According to Charoenwong et al. (2021), by the end of 2019, over 95 % of government procurement came from private enterprises, and more than 77 % of these were SMEs.

Nevertheless, delayed procurement payments are common in China. At the end of 2018, overdue repayments for government procurement amounted to over 890 billion yuan, with the majority of the suppliers being SMEs (Charoenwong et al., 2021). Furthermore, a survey of 3,600 firms by the China Center for the Promotion of SME Development reveals that over 65 % of these firms reported payment delays for construction projects. Take the case of China Fortune Land Development, a publicly traded real estate firm currently grappling with a debt crisis. According to its 2020 annual report, the firm's accounts receivable amounted to 64.884 billion yuan. Notably, the top five entities with the highest closing accounts receivable were all local government agencies, collectively constituting 45.13 % of China Fortune Land Development's accounts receivable. The key debtors were the Gu'an County Emerging Industry Demonstration Zone Finance Bureau (14.32 %), Hebei Shacheng Economic Development Zone Management Committee (11.54 %), Yangtze River Delta Jiashan Science and Technology Business Service Zone Management Committee (8.74 %), Xinzheng City Huaxia Fortune Industrial New City Construction Headquarters (5.31 %) and Dachang Hui Autonomous County Finance Bureau (5.2 %).

The substantial amount of government arrears in China may be related to China's institutional background. First, since the reform of the tax-sharing system in 1994, local governments in China have often faced budgetary challenges due to a need to fund infrastructure projects, social services and other initiatives. Excessive local government debt impedes the government's capacity to make timely payments. Second, when new government officials assume their roles, they frequently lack the incentive to address the outstanding arrears left by their predecessors. Third, China has not fully established an independent legal system, and courts are often biased in favor of local governments. Consequently, private SMEs may find themselves without a reliable legal avenue for recovering government arrears. Finally, the Chinese government's engagement in economic activities is substantial, and to sustain their ties with the government, private SMEs frequently tolerate delayed government payments.

Government arrears exacerbate firms' liquidity risks and increase their financing costs. Private SMEs face severe credit discrimination in China (Ge and Qiu, 2007; Wu et al., 2014). The majority of banks in China do not extend loans to private firms for periods exceeding 1 year; thus, firms commonly secure expensive private loans, which carry an interest rate of 24 %, to finance their accounts receivable from the government (Charoenwong et al., 2021). Inner Mongolia Yitai Coal Firm is a typical example. This firm, with the government as its main client, is listed on ChiNext. Because of large government arrears, the firm had to seek external financing, leading to significant financial expenses and resulting in decreases in the firm's performance, stock price and credit rating. These accumulated government arrears to private SMEs undermine the credibility of local governments. Such government default behavior worsens the local business environment and dampens the confidence of private firms, thereby harming the overall economic environment.

In 2016, to mitigate the adverse effects of government arrears on private firms, the State Council of the People's Republic of China issued a notice aimed at reducing government arrears.<sup>3</sup> The notice instructed the Ministry of Finance, in collaboration with relevant departments, to launch a dedicated initiative to repay the arrears owed by local governments to firms. The notice required local governments to, within a specified timeframe, repay project arrears, material procurement payments and unreimbursed deposits owed to private

<sup>&</sup>lt;sup>3</sup> Notice of the General Office of the State Council on Further Effectively Conducting the Work Concerning Private Investment (Document Number: Plain Telegram No. 12 [2016] of the General Office of the State Council).

firms. After the issuance of the notice, the National Development and Reform Commission, in coordination with other relevant departments, formed seven supervisory teams. These teams were dispatched to seven provinces and municipalities—Beijing, Liaoning, Anhui, Shandong, Henan, Hubei and Qinghai—to carry out the Special Supervision Action for repaying government arrears. Since the implementation of the Special Supervision Action, firms have partially recovered government arrears. According to the Ministry of Industry and Information Technology, local governments and large SOEs owed more than 890 billion yuan in overdue arrears to private SMEs at the time of the implementation of the Special Supervision Action, and about 75 % had been paid off by the end of 2019. Therefore, we anticipate finding that the Special Supervision Action alleviates the liquidity constraints of private SMEs and thereby influences their willingness and ability to provide employee benefits.

#### 3. Theoretical framework and hypothesis development

#### 3.1. Theoretical framework

This section discusses the theories and literature that frame our investigation and lays the foundation for our central hypothesis. Resource-based theory underlines the importance of internal resources and financial capabilities, including those derived from the repayment of government arrears, to a firm's ability to invest in employee welfare and shape its competitive edge. Additionally, social exchange theory provides insight into firms' rationales for improving employee welfare with the expectation of creating a reciprocal relationship leading to favorable outcomes. Integrating resource-based theory and social exchange theory, we develop a framework modeling the effects of government arrears repayment on employee treatment and overall firm performance.

Resource-based theory argues that a firm's internal resources and capabilities are its primary sources of competitive advantage. This theory posits that firms can achieve and sustain a competitive advantage by acquiring and leveraging valuable, rare, inimitable and non-substitutable resources and capabilities, including financial, organizational and human capital (Barney, 1991). Human resource theories view employees as the core assets of a firm, who can add substantially to the firm's competitive advantage and thereby enhance its long-term growth (Maslow, 1943; Coff, 1997, 2002). Investing in employee welfare by offering competitive compensation, providing training and development opportunities, and maintaining a healthy work environment can enhance a firm's resource base by fostering a skilled and motivated workforce. However, according to resource-based theory, liquidity constraints and a more negative outlook for the future can force a firm to allocate its limited financial resources primarily to maintaining basic operations and fulfilling immediate financial obligations. Such a situation might reduce investment in human capital, which is essential for building a firm's long-term competitiveness.

Strong human resources improve firm performance and help firms to sustain a competitive edge. Social exchange theory delineates two types of exchange within firms: economic and social. In comparison with economic exchange relationships, which are primarily based on economic characteristics, social exchange relationships foster deeper bonds of reciprocity, gratitude and trust between employees and employers (Blau, 1964). According to this theory, firms promote employee welfare because they believe that investing in their employees' well-being will create a reciprocal relationship and lead to more committed, satisfied and productive employees, which in turn results in favorable outcomes for the firm. Satisfied and motivated employees may contribute more effectively to the firm's success than unsatisfied employees. For example, as skilled human capital is a critical input for innovation, employee welfare policies positively affect firms' financial performance and stock returns by increasing innovation (Chen et al., 2016; Tong et al., 2018; Gambeta et al., 2019; Mao and Weathers, 2019). In addition, favorable employee treatment can enhance firm performance by increasing investment efficiency (Cao and Rees, 2020) and reducing financial fraud (Zhang et al., 2020). The literature also reveals that favorable employee treatment mitigates various risks for firms, such as bankruptcy (Verwijmeren and Derwall, 2010) and stock price crash risk (Ben-Nasr and Ghouma, 2018). As a result, firms providing more favorable employee treatment experience lower equity capital costs and bank loan expenses (Qian et al., 2021). Because of such benefits, firms maintain their investment in employee welfare, even during a financial crisis (Flammer and Ioannou, 2021). In sum, studies emphasize that employee welfare

is essential to a firm's competitiveness, not only because it helps firms retain a skilled workforce but also because it helps firms outcompete peers through superior innovation and better financial performance.

#### 3.2. Hypothesis development

Employee treatment consists of employee-friendly initiatives that provide relationship-based incentives rather than purely monetary incentives (Flammer and Luo, 2017). According to resource-based theory, employees are valuable resources, and ensuring their welfare and development is crucial for sustained competitive advantage (Maslow, 1943). Social exchange theory suggests that providing favorable employee treatment attracts and retains talented employees while reducing these employees' career concerns and enhancing their teamwork (Chen et al., 2016). Abundant studies indicate that favorable employee welfare can improve long-term stock returns (Edmans, 2011; Faleye and Trahan, 2011; Edmans et al., 2024) and financial performance (Martins, 2021) while reducing financing costs (El Ghoul et al., 2011), bankruptcy risk (Verwijmeren and Derwall, 2010) and stock price crash risk (Ben-Nasr and Ghouma, 2018). Hence, employee-friendly environments can help firms achieve and sustain competitive advantage.

However, because of the potential economic costs of investment in human capital (Faleye and Trahan, 2011; Ben-Nasr and Ghouma, 2018; Mao and Weathers, 2019), employee treatment may be restricted by internal and external financial resources. When there is an economic downturn, an unfavorable financing environment or a deterioration in a firm's financial condition, firms tend to reduce investment in their employees, such as by cutting salaries or non-monetary benefits and conducting layoffs (Guthrie and Datta, 2008). For example, Benmelech et al. (2021) find that financial constraints and the availability of credit are important to firms' employment decisions. Flammer and Ioannou (2021) show that firms lay off employees to maintain cash flows during a financial crisis. Thus, firms' commitments to employee welfare can be considered reliable only when they have ample cash flow. For example, Ghaly et al. (2015) find that maintaining a significant cash reserve can demonstrate a commitment to fair employee treatment. Furthermore, employees have a stronger preference for conservative financing policies than shareholders do, because highly leveraged firms in financial distress have strong incentives to increase cash flow by cutting costs related to employee benefits. Consistently, Yehuda et al. (2023) find that managers may consider employee preferences when choosing financing strategies. Bae et al. (2011) discover that a firm can uphold its commitment to employee welfare by opting for a lower debt ratio. These studies show that a firm has the capability to make employee-related investments only when it has sufficient and stable future cash flows.

Therefore, we expect that government arrears shape employee treatment within private SMEs, as they substantially influence such firms' cash flow schemes. In the absence of financial frictions, the timing of government payments is irrelevant to suppliers' financial condition because government procurement contracts can serve as collateral for external financing (Checherita-Westphal et al., 2016; Fadic, 2020). As firms can utilize bank loans for employee-related investments in cases of government payment delays, government arrears should not affect employee treatment. However, financial frictions make it challenging for firms to obtain external financing by collateralizing government procurement contracts. Therefore, government arrears increase bankruptcy risk and reduce profit (Checherita-Westphal et al., 2016). Furthermore, there are substantial frictions in the financial markets in China. Thus, government procurement contracts cannot be effectively utilized as collateral for external financing. In addition, private SMEs have long suffered from credit discrimination, making it difficult for them to access financing (Ge and Qiu, 2007; Wu et al., 2014). Therefore, compared with large enterprises and SOEs, private SMEs struggle to offer competitive employee benefits in the labor market to attract and retain valuable employees. The government's arrears exacerbate the liquidity constraints on private SMEs, which in turn cause them to cut investment in human capital. Moreover, accumulated government arrears signify fiscal instability within the government and broader economic uncertainty. When deliberating on long-term investment strategies to enhance employee treatment, CEOs often weigh the predictability of future cash flows and the prevailing economic conditions. Consequently, government arrears may erode CEOs' confidence in the government's fiscal health and business prospects, making them hesitant to commit to long-term human capital investments.

Thus, the Special Supervision Action has a positive impact on employee treatment by easing firms' liquidity constraints and enhancing CEO confidence. Specifically, the Special Supervision Action accelerates govern-

ment payments, which can directly alleviate the liquidity constraints on private SMEs and increase their cash flow. Therefore, the positive cash-flow shock of accelerated payments increases firms' investment in human capital and thereby improves employee treatment. The act of repaying arrears also transmits a favorable message to CEOs regarding the government's reliability and responsiveness, potentially inspiring them to improve employee treatment. Based on the above analysis, we propose the following hypothesis.

# Hypothesis: After the Special Supervision Action, the employee treatment of firms located in the supervised regions improves.

#### 4. Data and variables

#### 4.1. Data and sample selection

According to Charoenwong et al. (2021), over 90 % of government procurement contracts in China are allocated to private enterprises, most of which are SMEs. Therefore, our study uses annual data from the 2010 to 2020 period on private firms listed on the ChiNext and SME boards. We commence our sample period in 2010 to mitigate any confounding effects stemming from the 2008 financial crisis and conclude it in 2020 to provide a sufficient period for a thorough evaluation of the impacts of the Special Supervision Action.

We collect data from several sources. First, following Cheng et al. (2022) and Wang et al. (2021), we extract CSR data from Hexun.com. Data related to the employee treatment subcategory are supplemented by data from the CNRDS, China Stock Market & Accounting Research (CSMAR), Wind and iFinD databases. Second, firm-level financial and corporate governance data are obtained mainly from the CSMAR database and supplemented by information from the Wind database. To ensure the reliability of our dataset, we exclude financial firms, firms designated for special treatment, insolvent firms, firms with fewer than 10 employees and observations with missing values. Our final sample consists of 10,395 firm-year observations from 1,584 firms.

#### 4.2. Main variables

#### 4.2.1. Employee treatment

The value of our dependent variable, employee treatment (ET), is obtained from Hexun.com.<sup>4</sup> This platform assesses firms' CSR on the basis of information extracted from CSR and financial reports. The CSR evaluation framework encompasses five primary categories: shareholders, employees, supply chain stakeholders, environment and community. These categories are represented by 13 secondary and 37 tertiary indicators, and the dataset provides detailed CSR scores and rankings for all listed firms in China since 2010.

In this study, we adopt the total employee responsibility score, which is evaluated through three subcategories: employee income and training opportunities; workplace safety; and employee well-being. Each subcategory is assigned a score from 0 to 5. The total employee responsibility score thus ranges from 0 to 15. A higher employee responsibility score represents better employee treatment by the firm. In this study, ET equals the natural logarithm of 1 plus the total employee responsibility score.

#### 4.2.2. Special Supervision Action

Our independent variable,  $Treat \times Post$ , is structured following the difference-in-differences (DID) method. We use *Treat* to distinguish the treatment group from the control group and *Post* to distinguish the periods before and after the policy change. *Treat* equals 1 if firms are located in the supervised regions (i.e., Beijing, Liaoning, Anhui, Shandong, Henan, Hubei and Qinghai), and 0 otherwise. *Post* equals 1 for observations after 2016, and 0 otherwise.

<sup>&</sup>lt;sup>4</sup> Data can be downloaded from https://stockdata.stock.hexun.com/zrbg/.

#### 4.2.3. Control variables

We control for firm- and province-level characteristics based on the literature (Wang et al., 2021; Cheng et al., 2022). At the firm level, our model incorporates size (*Size*), calculated as the natural logarithm of total assets; profitability (*Roa*), defined as the ratio of net income to total assets; financial leverage (*Lev*), measured as the ratio of total liabilities to total assets; age (*Age*), the natural logarithm of the number of years since the firm was established; sales growth (*Growth*), determined as the sales revenue growth rate; and the book-to-market ratio (*BM*), the quotient of the market value over the book value of assets. We also consider corporate governance by assessing the number of board members (*Board*), expressed as the natural logarithm of the total number of directors; the proportion of independent directors (*Indep*); the ownership concentration (*Top1*), reflected by the shareholding proportion of the largest shareholder; and chairperson duality (*Dual*), a dummy variable equal to 1 if a firm's CEO is also the chairperson of its board and equal to 0 otherwise. Agency costs (*Mfee*) are calculated as administrative expenses divided by sales revenue. At the provincial level, we measure economic development (*Gdpg*) as the GDP growth rate; regional income (*Income*) as the ratio of general budget revenue to GDP; and financial market development (*FinMkt*) as the scale of regional financial institution deposits and loans relative to GDP. All of the variables are defined in Table A1. We winsorize all of the continuous variables at the 1st and 99th percentiles.

#### 4.3. Descriptive statistics

Table 1 provides the descriptive statistics of the variables. *ET* ranges from 0 to 2.584, indicating that the employee responsibility scores in the sample range from 0 to 12.25 (out of 15). The mean and median values of *ET* are 0.9083 (corresponding to an employee responsibility score of 2.48) and 0.8329 (corresponding to an employee responsibility score of 2.48) and 0.8329 (corresponding to an employee responsibility score of 2.48) and 0.8329 (corresponding to an employee responsibility score of 1.30), respectively, and the standard deviation is 0.5238. These results demonstrate substantial variation in employee welfare investment among Chinese listed firms. The mean value of *Treat* is 0.2405, which indicates that 24.05 % of the study firms are in the treatment group. The mean of *Post* is 0.4643, indicating that 46.43 % of the sample data are from after the implementation of the Special Supervision Action. Regarding the control variables, on average, our sample firms have a size of 21.61, profitability of 4.63 %, leverage of 34.15 % and sales growth rate of 19.49 %, all of which fall within a reasonable range (Wang et al., 2021).

Table 1 Descriptive statistics.

Variables	Obs.	Mean	Std.	Min	P25	P50	P75	Max
ET	10,395	0.9083	0.5238	0.0000	0.5539	0.8329	1.1878	2.5840
Treat	10,395	0.2405	0.4274	0.0000	0.0000	0.0000	0.0000	1.0000
Post	10,395	0.4643	0.4987	0.0000	0.0000	0.0000	1.0000	1.0000
Size	10,395	21.6126	0.9091	19.8673	20.9286	21.5194	22.1925	24.2289
ROA	10,395	0.0463	0.0728	-0.2986	0.0201	0.0487	0.0819	0.2281
Lev	10,395	0.3415	0.1832	0.0395	0.1921	0.3225	0.4731	0.8139
Age	10,395	2.6986	0.3830	1.3863	2.4849	2.7726	2.9444	3.4012
Growth	10,395	0.1949	0.3573	-0.4986	0.0004	0.1433	0.3145	1.9231
BM	10,395	0.6163	0.4502	0.0921	0.3095	0.4970	0.7673	2.5528
Board	10,395	2.0788	0.1831	1.6094	1.9459	2.1972	2.1972	2.4849
Indep	10,395	0.3786	0.0532	0.3333	0.3333	0.3636	0.4286	0.5714
Top1	10,395	0.3203	0.1294	0.0913	0.2188	0.3016	0.4034	0.6667
Dual	10,395	0.4168	0.4931	0.0000	0.0000	0.0000	1.0000	1.0000
Mfee	10,395	0.1013	0.0703	0.0128	0.0550	0.0849	0.1263	0.4013
Gdpg	10,395	0.0926	0.0499	-0.0706	0.0725	0.0892	0.1096	0.2320
Income	10,395	0.1154	0.0335	0.0689	0.0932	0.1099	0.1244	0.2175
FinMkt	10,395	1.5940	0.4852	0.7063	1.1810	1.6758	1.9896	2.5444

Note: This table presents the descriptive statistics, including the mean and standard deviation, minimum, 25th percentile, median, 75th percentile, and maximum. All variable definitions are shown in Table A1.

#### 5. Empirical results

#### 5.1. Research model and main results

To investigate the effect of government arrears repayment on employee treatment, we use the Special Supervision Action as a quasi-natural experiment. After the policy's introduction, firms located in the supervised regions received a sizeable, unexpected payment from the government leading to reductions in their accounts receivable, whereas comparable firms in other regions did not. Accordingly, this policy offers an opportunity to observe exogenous variation in government arrears repayment and to identify its causal impact on employee treatment. Specifically, we use the following DID analysis to compare the changes in employee treatment by firms located in the supervised regions with the changes in firms outside these regions in the periods before and after the introduction of the Special Supervision Action:

$$ET_{i,t} = \alpha_0 + \theta Treat_i \times Post_t + \beta X_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t}$$
<sup>(1)</sup>

where the subscripts *i* and *t* denote the firm and year, respectively. The dependent variable, *ET*, is employee treatment as defined above. The core explanatory variable is the interaction term *Treat* × *Post*, in which *Treat* is a dummy indicating whether a firm belongs to the treatment group and *Post* is a dummy distinguishing the periods before and after the introduction of the Special Supervision Action. *X* denotes a vector of firm-level and province-level characteristics. Detailed variable definitions are presented in Section 4.2. We include firm fixed effects ( $\mu_i$ ) to control for unobservable time-invariant firm traits and year fixed effects ( $\gamma_t$ ) to eliminate time-based variations such as macroeconomic changes and external shocks. Because *Treat* is absorbed by the firm fixed effects ( $\mu_i$ ) and *Post* is absorbed by the year fixed effects ( $\gamma_t$ ), we include only the interaction term *Treat* × *Post*. Here,  $\varepsilon$  is the error term. The standard errors of the estimated coefficients allow for observation clustering at the firm level (Petersen, 2009). In the DID model in Eq. (1), the coefficient  $\theta$  of *Treat* × *Post*, represents the effect of government arrears repayment on employee treatment. According to our main hypothesis, we expect  $\theta$  to be significant and positive.

Table 2 provides the baseline estimation results. Column (1) presents the regression results with the firm and year fixed effects included. Column (2) presents the results with firm-level characteristics included as control variables, and column (3) presents the results with the province-level characteristics additionally incorporated. In all of the model specifications, the coefficients of *Treat* × *Post* are significant and positive, reaching at least the 10 % significance level. Consistent with our main hypothesis, these results indicate that the treatment firms improve their employee treatment after the Special Supervision Action is introduced. Our findings exhibit considerable economic magnitude. In column (3), the coefficient of *Treat* × *Post* is 0.0454, indicating that in comparison with the employee treatment scores of private SMEs located in other regions, the scores of those in the supervised regions improve by  $4.64 \% (e^{0.0454} - 1)$  more after the Special Supervision Action is introduced.<sup>5</sup>

<sup>&</sup>lt;sup>5</sup> In the baseline regression, not all of the firms in supervised regions experience substantial government arrears. To more accurately capture the effects of the Special Supervision Action on employee treatment, we identify government suppliers based on government procurement contract data and define *Treat1* as equal to 1 if firms are located in supervised regions and are suppliers to the local government prior to policy implementation, and 0 otherwise. The untabulated results show that the coefficient of *Treat1×Post* is 0.1334 and statistically significant at the 5% level, which is higher than the coefficient of *Treat×Post* (0.0454) reported in column (3) of Table 2. This indicates that the Special Supervision Action has a greater impact on firms that are suppliers to the government, significantly improving their employee treatment. However, in the subsequent analysis, we continue to include all of the firms in supervised regions as the treatment group. This approach is justified for two reasons. First, the Special Supervision Action enhances the local business environment, improving financing access and CEO confidence for all of the firms in supervised regions, even those not directly affected by government arrears. Second, firms facing government arrears often delay payments to their suppliers, including non-government suppliers. Consequently, through supply chain contagion, the Special Supervision Action can also significantly improve employee treatment for firms indirectly connected to government procurement.

Variables	(1)	(2)	(3)
	ET	ET	ET
Treat  imes Post	0.0377*	0.0451**	0.0454**
	(0.0198)	(0.0196)	(0.0197)
Size		0.1440***	0.1449***
		(0.0125)	(0.0125)
ROA		0.0756	0.0697
		(0.0795)	(0.0795)
Lev		0.1871***	0.1888***
		(0.0459)	(0.0460)
Age		0.0246	0.0233
		(0.0562)	(0.0562)
Growth		0.0595***	0.0585***
		(0.0130)	(0.0130)
BM		-0.1155***	-0.1166***
		(0.0178)	(0.0179)
Board		0.0045	0.0039
		(0.0479)	(0.0479)
Indep		0.1494	0.1451
		(0.1478)	(0.1479)
Top1		-0.2567***	-0.2579***
		(0.0823)	(0.0822)
Dual		-0.0265**	-0.0261**
		(0.0120)	(0.0120)
Mfee		0.4115***	0.3995***
		(0.1096)	(0.1102)
Gdpg			-0.0536
			(0.1317)
Income			0.0036
			(0.4609)
FinMkt			0.0354
			(0.0258)
Constant	0.9042***	-2.2983***	-2.3593***
	(0.0040)	(0.3358)	(0.3428)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	10,395	10,395	10,395
$R^2$	0.6303	0.6437	0.6438

 Table 2

 The effect of the Special Supervision Action on employee treatment.

Note: This table reports the effect of the Special Supervision Action on employee treatment. The dependent variable is employee treatment (ET), measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

#### 5.2. Robustness tests

We conduct a series of robustness checks on the baseline results, including a parallel trend test, placebo tests, mitigating sample selection bias, an examination of alternative subsamples and controlling for contemporaneous shocks.

#### 5.2.1. Parallel trends and dynamic effects

Our identification method relies on the assumption of parallel trends in employee treatment between the treatment and control groups before the introduction of the Special Supervision Action. Fig. 1 illustrates



Fig. 1. Employee treatment over 2010–2020. Note: This figure plots the changes in employee treatment of the control and treatment groups from 2010 to 2020. Specifically, the treatment group consists of firms located in the supervised regions, while the control group includes firms outside these regions. The vertical line marks the Special Supervision Action in 2016.

the trends in employee treatment from 2010 to 2020 for both the treatment and control groups. We find that in the pre-Special Supervision Action period, the treatment and control groups exhibit similar trends. However, there is a notable divergence in the period after 2018: while the employee treatment scores of the control group continue to decline, those of the treatment group exhibit a substantial rebound. Overall, Fig. 1 verifies the parallel trends assumption of our DID analysis, providing preliminary support for the positive impact of government arrears repayment on employee treatment.

While preliminary evidence from Fig. 1 supports this assumption, further rigorous testing is imperative. Following the event study approach of Jacobson et al. (1993), we estimate the following regression:

$$ET_{i,t} = \alpha_0 + \sum_{k=2010,k=2015}^{k=2020} \theta_k Treat_i \times Year^k + \beta X_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t}$$

$$\tag{2}$$

where  $Year^k$  is a dummy variable representing year k. To prevent multicollinearity, we designate the year prior to the policy's implementation as the baseline year and omit it from the regression. Table 3 reports the estimated coefficients of the interaction term in Eq. (2), and Fig. 2 illustrates these coefficients and their corresponding 90 % confidence intervals. We find that the coefficients of the before treatment sample for *Treat* × *Year*<sup>2010</sup> to *Treat* × *Year*<sup>2014</sup> are not significantly different from those for the baseline year, 2015. This lack of a significant differences indicates that the treatment and control groups exhibit parallel trends before the implementation of the Special Supervision Action, providing further support for the validity of our DID estimates. In addition, although the coefficients of *Treat* × *Year*<sup>2016</sup> and *Treat* × *Year*<sup>2017</sup> are not significant, the coefficients of *Treat* × *Year*<sup>2018</sup> to *Treat* × *Year*<sup>2020</sup> are positive and significant at the 10 % level. These findings indicate a lagged impact of the Special Supervision Action on employee treatment due to policy implementation and firm adjustment. Despite this lag, the Special Supervision Action has a lasting positive influence on employee treatment.

13

Dynamic effects.			
Variables	(1) <i>ET</i>	(2) <i>ET</i>	(3) <i>ET</i>
$Treat \times Year^{2010}$	-0.0257	-0.0203	-0.0256
	(0.0566)	(0.0559)	(0.0561)
$Treat \times Year^{2011}$	-0.0018	-0.0075	-0.0117
	(0.0486)	(0.0474)	(0.0477)
$Treat \times Year^{2012}$	0.0413	0.0406	0.0390
	(0.0460)	(0.0449)	(0.0453)
$Treat \times Year^{2013}$	0.0020	0.0006	-0.0006
	(0.0463)	(0.0454)	(0.0456)
$Treat \times Year^{2014}$	0.0071	0.0088	0.0054
	(0.0404)	(0.0399)	(0.0401)
$Treat \times Year^{2016}$	0.0291	0.0401	0.0379
	(0.0465)	(0.0458)	(0.0459)
$Treat \times Year^{2017}$	0.0200	0.0311	0.0285
	(0.0397)	(0.0387)	(0.0388)
$Treat \times Year^{2018}$	0.0532	0.0599	0.0612*
	(0.0373)	(0.0365)	(0.0366)
$Treat \times Year^{2019}$	0.0564	0.0662*	0.0626*
	(0.0363)	(0.0356)	(0.0358)
$Treat \times Year^{2020}$	0.0644*	0.0725*	0.0700*
	(0.0382)	(0.0379)	(0.0381)
Constant	0.9015***	-2.3084***	-2.3731***
	(0.0075)	(0.3359)	(0.3425)
Firm Control	NO	Yes	Yes
Prov Control	NO	NO	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	10,395	10,395	10,395
$R^2$	0.6305	0.6439	0.6440

Note: This table reports the dynamic effects of the Special Supervision Action on employee treatment. The dependent variable is employee treatment (*ET*), measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Year*<sup>k</sup> is a dummy variable indicating year k. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

#### 5.2.2. Placebo tests

Table 3

To ensure that our main results can be attributed to the Special Supervision Action rather than to omitted variables, we perform two placebo tests. First, following Topalova (2010), we conduct a placebo test by creating false policy shock years. Specifically, we designate 2015 (2014, 2013) as a false policy shock year for the Special Supervision Action, constructing a false policy shock variable, *Post15 (Post14, Post13)*, and an associated interaction term, *Treat* × *Post15 (Treat* × *Post14, Treat* × *Post13)*. Then, we replace *Treat* × *Post in* Eq. (1) with *Treat* × *Post15 (Treat* × *Post14, Treat* × *Post13)* and re-estimate the baseline regression. As shown in Table 4, the coefficients of *Treat* × *Post15 (Treat* × *Post14, Treat* × *Post13)* are not statistically significant in any column. These results indicate that our main result is primarily driven by the Special Supervision Action rather than omitted variables.

Second, we conduct a placebo test following Chetty et al. (2009), by randomly assigning firms to a pseudotreatment group and testing whether the effects of the Special Supervision Action are observed in this group. Specifically, we construct a false treatment variable, *Treat\_new*, and an associated interaction term, *Treat\_new* × *Post*, with which we replace the variable *Treat* × *Post* in Eq. (1). If the observed effects on employee treatment are genuine and not due to omitted variables, the estimated coefficient for *Treat\_new* × *Post* should



Fig. 2. Dynamic effects. Note: This figure shows the dynamic effect of the Special Supervision Action on employee treatment from 2010 to 2020. The vertical reference line marks the baseline year 2015, which is one year before the Special Supervision Action.

Table 4	
Placebo	tests.

Variables	(1)	(2)	(3)
	ET	ET	ET
$Treat \times Post15$	0.0341		
$Treat \times Post14$	(0.0207)	0.0283	
$Treat \times Post13$		(0.0232)	0.0200
Constant	-2.3630*** (0.3430)	-2.3568*** (0.3431)	$-2.3515^{***}$ (0.3432)
Firm Control	Yes	Yes	Yes
Prov Control	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	10,395	10,395	10,395
$R^2$	0.6437	0.6437	0.6436

Note: This table reports the placebo test results. The dependent variable is employee treatment (*ET*), measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. The false policy shock variable *Post15* (*Post14*, *Post13*) equals 1 for the years after 2015 (2014, 2013) and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

approach 0. We conduct 1,000 rounds of random sampling; we present the kernel density distribution of the estimated coefficients of *Treat\_new*  $\times$  *Post* in Fig. 3, along with their corresponding *p*-value distributions. The estimated coefficients of *Treat\_new*  $\times$  *Post* are concentrated around 0, with most of their *p* values exceeding



Fig. 3. **Placebo test.** Note: This figure plots the kernel density and p-values of 1,000 estimates about the coefficients of *Treat\_new*  $\times$  *Post* constructed by random assignment of the treatment variable across firms. The X-axis represents the estimated coefficients of the *Treat\_new*  $\times$  *Post*, the Y-axis represents the density value and p-value, the curve is the kernel density distribution of the estimated coefficients, the black dots are the p-values corresponding to the estimated coefficients, and the vertical dotted line is the real estimated value 0.0454 of the baseline results.

0.1. Notably, our original estimate of 0.0454 in Table 2 lies outside the placebo distribution, suggesting that our main finding is indeed driven by the Special Supervision Action rather than by random chance or omitted variables.

#### 5.2.3. Sample selection bias

The selection of supervised regions may not be random, potentially leading to self-selection bias. Although the parallel trend test indicates similar trends for the treatment and control groups in the pre-implementation period, we adopt a variety of methods to mitigate potential sample selection bias.

First, to make the treatment and control groups more comparable, we restrict the control group to firms located in the regions geographically proximate to the supervised regions. Neighboring regions are likely to share similar economic and institutional characteristics, thereby sharpen our identification strategy. The results are presented in column (1) of Table 5. The coefficient of *Treat* × *Post* is 0.0439 and statistically significant at the 5 % level, consistent with the coefficient of *Treat* × *Post* (0.0454) reported in Table 2. This result indicates that our baseline results still hold when our sample is restricted to firms in treated provinces and their neighboring control provinces.

Second, the ex-ante investment behavior of a region may influence the selection of supervised regions for the Special Supervision Action. For instance, when local governments engage in extensive investment projects, particularly large-scale infrastructure and real estate development projects, it is more likely to result in the accumulation of local government debt and delayed payments to private SMEs. To address concerns that ex-ante local government investment characteristics may affect the implementation of the Special Supervision Action, we measure ex-ante local government investment behavior using the mean value of the natural logarithm of total fixed asset investment ( $Pre_Invest$ ) for the 2013–2015 period. We then introduce the interaction term between this variable and the policy shock variable ( $Pre_Invest \times Post$ ) into the regression model. The results, presented in column (2) of Table 5, show that even after controlling for the influence of ex-ante local

Variables	(1)	(2)	(3)	
	Neighborhood DID	Ex-ante investment	PSM	
	ET	ET	ET	
Treat  imes Post	0.0439**	0.0413**	0.0574**	
	(0.0213)	(0.0199)	(0.0242)	
$Pre\_Invest \times Post$		-0.0252*		
		(0.0150)		
Constant	-2.3708***	0.0413**	-3.0081***	
	(0.4233)	(0.0199)	(0.4910)	
Firm Control	No	Yes	Yes	
Prov Control	No	Yes	Yes	
Firm FE	Yes	Yes	Yes	
Year FE	Yes	Yes	Yes	
Obs.	6837	10,395	5889	
$R^2$	0.6322	0.6440	0.6672	

Table 5			
Mitigating	sample	selection	bias.

Notes: This table adopt a variety of methods to mitigate sample selection bias. The dependent variable is employee treatment (ET), measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Total fixed asset investment (*Pre\_Invest*) is measured by the mean value of the natural logarithm of total fixed asset investment over the period 2013–2015. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

government investment behavior on the selection of supervised regions, the coefficient of  $Treat \times Post$  remains significant and positive.

Third, we conduct a propensity score matching (PSM) approach to enhance the credibility of our main findings. Following Abadie and Imbens (2011), we use logistic regression to estimate the probability of a firm being classified into the treatment group and employ 1:2 nearest-neighbor matching to pair each treatment firm with two control firms.<sup>6</sup> We then estimate the effect of the Special Supervision Action on employee treatment using the matched sample, and the results are presented in column (3) of Table 5. Consistent with our baseline finding, the coefficient of *Treat* × *Post* is positive and significant, suggesting that our baseline result is robust to potential sample selection bias.

#### 5.2.4. Alternative subsamples

In this section, we investigate whether our results hold when we use alternative sample periods. Specifically, to avoid the contamination of our results by temporary policy effects and to isolate the causal impact of the Special Supervision Action, which began in July 2016, we exclude the event year, 2016. Column (1) of Table 6 reveals a positive coefficient of *Treat* × *Post* that is significant at the 5 % level. Moreover, to mitigate the impact of the COVID-19 pandemic in 2020, we exclude the firm-year observations from that year. As shown in column (2) of Table 6, the coefficient of *Treat* × *Post* remains positive and significant the 5 % level. Overall, these results indicate the robustness of our main results.

#### 5.2.5. Excluding other contemporaneous shocks

In this subsection, we consider contemporaneous policies that may influence the financial constraints of private SMEs and thus affect our baseline findings. Particularly relevant are the establishment of private banks in 2014 and the reform of local government debt management in 2015.

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<sup>&</sup>lt;sup>6</sup> We take all of the firm-level characteristics as covariates in the matching process. To assess the covariate balance between the matched treatment and control groups, we compare the means of the covariates before and after matching, as shown in Table A3 in the Appendix. We find that all of the covariates pass the balance test after the matching process, indicating that the PSM approach adequately balances firm characteristics between the treatment and control groups.

Table 6	
Employing several alternative subsamples.	

X 1 1	(1)	(2)
Variables	(1)	(2)
	ET	ET
Treat  imes Post	0.0468**	0.0462**
	(0.0203)	(0.0217)
Constant	-2.3408***	-2.7083***
	(0.3480)	(0.3803)
Firm Control	Yes	Yes
Prov Control	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Obs.	9519	9032
$R^2$	0.6499	0.6510

Note: This table reports the results of additional robustness checks. Columns (1) remove samples of 2016 (the event year). Columns (2) remove samples of 2020 (the COVID-19 pandemic). The dependent variable is employee treatment (*ET*), measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

First, Chinese firms rely heavily on state-owned banks for funding (Song et al., 2011), potentially making it more difficult for private enterprises to obtain bank loans. However, the approval of Shenzhen's WeBank in 2014 and the subsequent emergence of 19 private banks across China have diversified the financing options available to private firms. Research suggests that the establishment of private banks alleviates credit discrimination against private firms, enabling them to secure more bank loans (Beck et al., 2004). Therefore, we posit that this policy also enhances firms' investment in their employees and improves their overall employee treatment. To investigate this alternative explanation, we introduce a binary variable, *Bank*, indicating the existence of private banks in a firm's city, and incorporate it into Eq. (1). In column (1) of Table 7, the coefficient of *Treat* × *Post* is significant and positive, indicating that our baseline findings are unaffected by the establishment of private banks.

Second, the Chinese government reformed local government debt management in 2015. This reform mandated that local governments issue bonds after settling historical debts and transitioned government financing from indirect bank loans to direct financing. The literature suggests that this reform effectively mitigates the crowding-out effect of government debt on corporate finance (Huang et al., 2020). As this policy eases financial constraints for firms, it could enhance their capacity for employee-related investment. To account for this possibility, we introduce a dummy variable, *Reform*, into Eq. (1) to indicate whether a firm is located in a city in which this debt reform has been piloted. In column (2) of Table 7, the coefficient of *Treat* × *Post* is 0.454, which remains positive and significant at the 5 % level, consistent with our baseline findings.

Finally, we simultaneously control for the emergence of private banks and the reform of local government debt management; we present the estimation results in column (3) of Table 7. The coefficient of  $Treat \times Post$  remains positive and significant at the 1 % level. Therefore, the positive effect of employee treatment is mainly driven by government arrears repayment rather than by other confounding shocks.

#### 5.3. Further analysis

Employee treatment encompasses numerous facets, spanning both non-pecuniary benefits, such as workplace safety, career training, skill development and involvement in corporate decision-making, and pecuniary benefits, including wages, social security and other financial incentives. In this section, we leverage comprehensive data on employee treatment to examine the ramifications of the Special Supervision Action for a spectrum of pecuniary and non-pecuniary employee benefits.

Variables	(1)	(2)	(3)	
	ET	ET	ET	
Treat  imes Post	0.0547***	0.0454**	0.0549***	
	(0.0198)	(0.0197)	(0.0198)	
Bank	0.0680***		0.0688***	
	(0.0168)		(0.0169)	
Reform		0.0019	-0.0059	
		(0.0149)	(0.0150)	
Constant	-2.3345***	-2.3576***	-2.3396***	
	(0.3417)	(0.3432)	(0.3420)	
Firm Control	Yes	Yes	Yes	
Prov Control	Yes	Yes	Yes	
Firm FE	Yes	Yes	Yes	
Year FE	Yes	Yes	Yes	
Obs.	10,395	10,395	10,395	
$R^2$	0.6446	0.6438	0.6446	

Table /				
Excluding	other	contem	poraneous	shocks

Note: This table reports the results controlling for other contemporaneous shocks. The dependent variable is employee treatment (*ET*), measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. To rule out the establishment of private banks, Column (1) includes a dummy variable *Bank* that equals 1 for firms in cities where a private bank is established and 0 otherwise. To rule out the reform in management system of local government debt, Column (2) includes a dummy variable *Reform* that equals 1 for firms in cities of the government debt reform and 0 otherwise. We add both *Bank* and *Reform* in Column (3). Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

#### 5.3.1. Subcategories of employee treatment

Similar to the KLD database for US firms, the CNRDS database provides data on Chinese firms' employee treatment in CSR reports, evaluated on the basis of seven strengths and two concerns. Potential strengths are a safety management system, a safety production training plan, professional safety certification, on-the-job training, an employee stock ownership plan, employee communication channels and strong retirement benefits. The concern categories are employee safety disputes and layoff policy issues. Leveraging the detailed information provided by CNRDS on the subcategories of employee treatment in Chinese firms, we investigate the effects of the Special Supervision Action on various dimensions of employee treatment.

Following Zhang et al. (2020) and Wang et al. (2021), we classify these strengths and concerns into five subcategories: employee safety management (ET Safety), employee career development (ET Career), employee involvement (ET Involvement), employee retirement benefits (ET Retirement) and employee layoff concerns (ET Lavoff). The strength and concern items for each subcategory in CNRDS are described in Table A2. We construct an employee treatment sub-index by aggregating the score for each subcategory, assigning a value of 1 for a particular strength (or -1 for a concern), and 0 otherwise. Using these data, we investigate the impact of the Special Supervision Action on each employee treatment subcategory. The results are presented in Table 8. We find that the coefficients of  $Treat \times Post$  are 0.1509 and 0.1293 when the dependent variables are ET\_Safety and ET\_Involvement, respectively; both values are significant at the 10% level. However, when the dependent variable is ET\_Career, ET\_Retirement or ET\_Layoff, the coefficient of  $Treat \times Post$  is not statistically significant. These results suggest a tendency for firms to prioritize investment in the types of employee benefits that can be immediately perceived by employees over benefits with longerterm impacts. For example, employee safety measures and employee stock ownership plans can be immediately perceived by employees upon implementation, whereas the impact of career development, retirement benefits and layoff policies is typically observed only after employees achieve substantial skill improvements, retire or are laid off. The results imply that private SMEs may face severe liquidity constraints due to government arrears that limit their investment in employee welfare. Consequently, when policies prompt the government to repay arrears and alleviate financial constraints, firms prioritize investments in safety management and employee incentives because these investments play critical roles in maintaining employee health and safety and fostering commitment and loyalty to the firm.

#### 5.3.2. Other employee-related investments

In this section, we investigate the potential impact of the Special Supervision Action on other employeerelated investments: (i) employee compensation (*Salary*), calculated as the total employee compensation, including base salary, bonuses, allowances and subsidies, divided by the number of employees, and then taking the natural logarithm; (ii) employee welfare (*Welfare*), calculated as the natural logarithm of average employee welfare expenses per employee; (iii) employee education expenses (*Education*), measured as the natural logarithm of average education expenses per employee; (iv) social security (*Insurance*), calculated as the natural logarithm of average social insurance contributions per employee; (v) housing accumulation funds (*Accfund*), calculated as the natural logarithm of average housing accumulation funds per employee; (vi) human capital accumulation (*HCNet*), measured as the growth rate of the number of employees with a bachelor's degree or higher; (vii) human capital creation (*HCC*), which equals *HCNet* if *HCNet* is greater than 0, and 0 otherwise; and (viii) human capital destruction (*HCD*), which equals the absolute value of *HCNet* if *HCNet* is less than 0, and 0 otherwise.

These variables serve as dependent variables in Eq. (1). Table 9 shows the results. Columns (1)–(3) reveal the effect of the Special Supervision Action on employee compensation, employee welfare and employee education expenses. Wages and welfare increase significantly by 4.28 % and 20.43 %, respectively, after the policy implementation, whereas education expenses remain unchanged. This result is consistent with the findings in Table 8, where the Special Supervision Action significantly increases employee-related investments that can be immediately perceived by employees, such as salaries and welfare expenses, but has no significant impact on long-term investments like employee education expenses. Regarding the legally mandated social insurances and housing accumulation funds, as shown in columns (4) and (5), the coefficients of *Treat* × *Post* on *Insurance* and *Accfund* are both positive, but only the former is significant. This indicates that the Special Super-

Subcategories of e	mployee treatment.				
Variables	(1)	(2)	(3)	(4)	(5)
	ET_Safety	ET_Career	ET_Involvement	ET_Retirement	ET_Layoff
$Treat \times Post$	0.1509*	0.0091	0.1293*	-0.0068	-0.0208
	(0.0904)	(0.0206)	(0.0774)	(0.0540)	(0.0183)
Constant	3.3928*	-0.1888	-0.6759	0.5871	-0.1128
	(1.9859)	(0.4411)	(1.7880)	(0.9423)	(0.4095)
Firm Control	Yes	Yes	Yes	Yes	Yes
Prov Control	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Obs.	1359	1359	1359	1359	1359
$R^2$	0.7399	0.5049	0.6228	0.6776	0.3154

Table 8Subcategories of employee treatment.

Notes: This table reports the effects of the Special Supervision Action on subcategories of employee treatment (i.e., employee safety, employee career development, employee involvement, employee retirement benefit, and employee layoff policy). Employee safety management ( $ET\_Safety$ ) is measured by the number of employee safety strengths minus number of employee safety concerns. Employee career development ( $ET\_Career$ ) is measured by the number of employee career development strengths minus number of employee career development concerns. Employee involvement ( $ET\_Involvement$ ) is measured by the number of employee retirement benefits ( $ET\_Retirement$ ) is measured by the number of employee retirement strengths minus number of employee retirement concerns. Employee retirement strengths minus number of employee retirement concerns. Employee retirement strengths minus number of employee retirement concerns. Employee layoff concerns ( $ET\_Layoff$ ) is measured by the number of employee layoff policy strengths minus number of employee layoff policy concerns. Treat equals 1 for firms located in the supervised regions and 0 otherwise. Post equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

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Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Salary	Welfare	Education	Insurance	Accfund	HCNet	HCC	HCD
$Treat \times Post$	0.0428***	0.2043***	-0.0726 (0.0785)	0.0347**	0.0178 (0.1144)	0.0316*	0.0315**	-0.0001 (0.0070)
Constant	9.8344*** (0.3056)	3.9042*** (1.4850)	-0.7081 (1.4726)	6.4317*** (0.3805)	17.0500*** (1.9168)	-1.8658*** (0.3985)	-1.2038*** (0.3471)	0.6620*** (0.1326)
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prov Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	9467	10,388	9095	9429	9751	8878	8878	8878
$R^2$	0.8021	0.6645	0.6692	0.8240	0.4887	0.6698	0.7200	0.2580

Table	9	
Other	employee-related	investment

Notes: This table reports the effects of the Special Supervision Action on other employee-related investment. Employee compensation (*Salary*) is measured by the natural logarithm of average employee compensation. Employee welfare (*Welfare*) is calculated as the natural logarithm of average welfare expenses. Employee education expenses (*Education*) is measured as the natural logarithm of average education expenses. Social security (*Insurance*) is measured by the natural logarithm of average social insurance expenditures per employee. Accumulation fund (*Accfund*) is calculated as the natural logarithm of average housing accumulation funds per employee. Human capital accumulation (*HCNet*) is measured as the growth rate of the number of employees with a bachelor's degree or higher. Human capital creation (*HCC*) equals *HCNet* if *HCNet* is greater than 0 and equal to 0 otherwise; Human capital destruction (*HCC*) equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

vision Action improves corporate compliance with labor contract laws, enabling companies to fully and legally contribute to employees' social insurance after liquidity constraints are alleviated. Columns (6)–(8) present the effects of the Special Supervision Action on human capital accumulation: following the implementation of the policy, the growth rate of the number of highly educated employees in the treatment group increases significantly, primarily driven by human capital creation.

Overall, these findings identify a significant enhancement of employees' pecuniary benefits, including monetary compensation, welfare and social security payments, along with increased investment in highly skilled human capital after the introduction of the Special Supervision Action.

#### 5.4. Mechanism analysis

In this section, we examine the mechanisms by which the Special Supervision Action enhances employee treatment in the supervised regions. Government arrears disrupt the cash flow of firms, especially those reliant on timely payments for their operations. Although firms can leverage government procurement orders as collateral to access financing in frictionless financial markets (Checherita-Westphal et al., 2016), they often struggle to secure financing and suffer from liquidity constraints in markets with financial frictions (Breza and Liberman, 2017; Abad et al., 2023). Consequently, such firms face challenges in providing adequate employee welfare due to the high cost of related investments. However, the Special Supervision Action mandates that local governments clear their project backlogs, material procurement contracts and unpaid deposits owed to private firms within a specified period, thereby injecting liquidity into these firms. This injection may provide additional resources for firms to use to improve employee treatment.

Furthermore, the inability of a government to meet its financial obligations punctually indicates fiscal instability or liquidity issues within the government, as well as broader economic and policy uncertainty. When CEOs deliberate on long-term investment decisions aimed at enhancing employee welfare, they are inclined to consider the predictability of future cash flows and the overall economic environment. Consequently, government arrears can undermine CEO confidence in the government's fiscal health and overall economic stability, leading to reluctance towards committing to long-term human capital investments. In this case, the act of repaying government arrears could convey a positive signal to CEOs about the government's reliability and responsiveness, potentially enhancing CEO confidence and thus encouraging them to undertake long-term human capital investment and improve employee treatment.

To ascertain whether government arrears repayment alleviates the liquidity constraints faced by private SMEs and improves CEO confidence, we conduct three tests: (i) investigating whether the government-related accounts receivable of firms located in the supervised regions decrease significantly after the Special Supervision Action, (ii) assessing how firms' liquidity constraints, in terms of the operating cash flow, cash–cash flow sensitivity and investment–cash flow sensitivity of firms, respond to the Special Supervision Action and (iii) examining the impact of the Special Supervision Action on CEO confidence.

First, when we use the Special Supervision Action as an exogenous shock for government arrears repayment, a fundamental assumption is that it leads to a significant increase in government repayments within the supervised regions, leading to a notable decrease in government-related accounts receivable. To support this assumption, we directly investigate the impact of the Special Supervision Action on firms' governmentrelated accounts receivable. Using detailed data from CSMAR, we identify and measure all firms' government-related accounts receivable ( $AR\_Gov$ ) as the ratio of government-related accounts receivable to total assets. Then, we use  $AR\_Gov$  as the dependent variable in Eq. (1). Column (1) of Table 10 presents the estimation results. We find that the coefficient of  $Treat \times Post$  is -0.0007 and significant at the 10 % level, consistent with our expectation that the Special Supervision Action leads to an increase in local government repayments to firms located in the supervised regions.

We further assess how firms' liquidity constraints respond to the Special Supervision Action Payments, as commercial payments delayed beyond the agreed period can expose firms to severe internal liquidity pressures (Barrot and Nanda, 2020; Conti et al., 2021). In this regard, if the Special Supervision Action accelerates government payments, it should directly increase firms' cash flow. To test this prediction, we measure a firm's cash flow (*Cfo*) as the ratio of its net operating cash flow to its year-beginning total assets and re-estimate Eq. (1) using *Cfo* as the dependent variable. The estimation results are reported in column (2) of Table 10. The coefficient of *Treat* × *Post* is significant and positive, indicating that the Special Supervision Action indeed increases firms' cash flow. In addition, we use the investment–cash flow sensitivity model proposed by Fazzari et al. (1988) and the cash–cash flow sensitivity model proposed by (Almeida et al., 2004) to examine the impact of government arrears repayment on firms' liquidity constraints. Specifically, we construct the following model:

$$Invest_{i,t}/Chcash_{i,t} = \alpha_0 + \theta_1 Treat_i \times Post_t + \theta_2 Treat_i + Post_t \times Cfo_{i,t} + \theta_3 Treat_i \times Cfo_{i,t} + \theta_4 Post_t \times Cfo_{i,t} + \theta_5 Cfo_{i,t} + \beta X_{i,t} + \mu_i + \gamma_i + \varepsilon_{i,t}$$
(3)

where *Invest* is a firm's fixed asset investment, calculated as the ratio of fixed, intangible and other long-term asset expenditures to year-beginning total assets. *Cheash* is the change in eash holdings, calculated as the ratio of the net increase in eash and eash equivalents to year-beginning total assets. Our primary variable of interest, the triple interaction term  $Treat \times Post \times Cfo$ , is expected to yield significant and negative coefficients. The results of Eq. (3) when *Invest* and *Cheash* are the dependent variables are shown in columns (3) and (4) of Table 10, respectively. Notably, the coefficients of  $Treat \times Post \times Cfo$  in columns (3) and (4) are negative and significant at the 1 % and 5 % levels, respectively. These results indicate that after the Special Supervision Action, the investment–cash flow sensitivity and eash–cash flow sensitivity of the affected firms decrease.

Finally, as language can reflect subconscious cognition and preferences, we follow relevant literature (Li, 2010; Loughran and McDonald, 2011) and use textual analysis to examine the tone and sentiment of the Management Discussion and Analysis (MD&A) sections of firms' annual financial statements. Specifically, we conduct word classification based on the LM dictionary (Loughran and McDonald, 2011) for sentiment analysis, counting the number of positive and negative words in an MD&A section. We then define three metrics to measure CEO confidence: *Con1*, calculated as the ratio of the difference between positive and negative word counts to the total word count; *Con2*, computed as the ratio of the difference between positive and negative word counts to the total character count; and *Con3*, determined by the proportion of the difference between positive and negative to their sum. High values in these three CEO confidence metrics

Table 10	
Mechanism	test.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	AR_Gov	Cfo	Invest	Chcash	Con1	Con2	Con3
Treat  imes Post	-0.0007*	0.0059*	0.0072***	0.0063	0.0027***	0.0010***	0.0141***
	(0.0004)	(0.0035)	(0.0026)	(0.0128)	(0.0008)	(0.0002)	(0.0039)
$Treat \times Post \times Cfo$			-0.0729***	-0.3013 **			
			(0.0188)	(0.1432)			
Treat  imes Cfo			0.0351***	0.4813***			
			(0.0046)	(0.0977)			
$Post \times Cfo$			0.0536***	0.0317			
			(0.0161)	(0.1159)			
Cfo			0.0128	0.5324***			
			(0.0123)	(0.1147)			
Constant	-0.0041	0.0217	-0.2475 ***	-1.9725***	0.0786***	0.0193***	0.2875***
	(0.0065)	(0.0771)	(0.0540)	(0.5372)	(0.0136)	(0.0038)	(0.0721)
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prov Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	10,395	9691	9486	9691	10,387	10,387	10,387
$R^2$	0.4073	0.4673	0.5394	0.2072	0.5749	0.5889	0.5948

Note: This table reports the results of mechanism tests. Government-related accounts receivable faced by firms ( $AR\_Gov$ ) is measured by the ratio of accounts receivable from the local government to total assets. Cash flow (Cfo) is measured by the ratio of net operating cash flow over year-beginning total assets. Fixed assets investment (*Invest*) is measured by the ratio of fixed, intangible and other long-term assets expenditures over year-beginning total assets. Change of cash holdings (*Chcash*) is measured by the ratio of the net increase in cash and cash equivalents to the year-beginning total assets. *Con1* is a measure of CEO confidence defined as (number of positive words – number of negative words) / total word count; *Con2* is (number of positive words – number of negative words) / total character count; *Con3* is (number of positive words – number of negative words) / (number of positive words + number of negative words). *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10 %, 5 %, and 1 % levels, respectively.

indicate that the MD&A text is positive, reflecting an optimistic outlook and strong CEO confidence. Columns (5)–(7) of Table 10 present the estimation results using the three CEO confidence metrics as the dependent variables. The coefficients of  $Treat \times Post$  are positive and significant at the 1% level across all specifications, consistent with our expectation that the Special Supervision Action improves CEOs' confidence in their firm's prospects and the economic environment. Overall, the results in Table 10 underscore the importance of alleviating liquidity constraints and enhancing CEO confidence as pivotal mechanisms supporting our main result.

#### 6. Cross-sectional tests and further discussion

#### 6.1. Cross-sectional tests of the effects of government arrears repayment on employee treatment

To provide further support for our main findings, we conduct a series of cross-sectional tests on subgroups that may experience stronger or weaker than average effects of the Special Supervision Action on employee treatment. Specifically, we conduct cross-sectional tests based on the number of bank branches near firms, firms' political connections, firms' financial health, firms' demand for human capital and the existence of external employment opportunities.

#### 6.1.1. Nearby bank branches

Research shows that in the absence of financial frictions, firms can use government arrears as collateral for financing, suggesting that government arrears do not affect firms' investment decisions (Checherita-Westphal

et al., 2016; Fadic, 2020). However, in the presence of financial frictions, government arrears could be detrimental to firm liquidity, constraining firm investment and employment or even threatening firm survival (Murfin and Njoroge, 2015; Barrot, 2016; Checherita-Westphal et al., 2016; Breza and Liberman, 2017; Barrot and Nanda, 2020; Abad et al., 2023). Therefore, we expect that the positive effect of the Special Supervision Action on employee treatment is more pronounced in firms facing severe financial frictions than in their counterparts.

Given the predominant reliance of Chinese firms on banks for financing, we measure financial market frictions by bank availability. Following the methodologies of Francis et al. (2014), we calculate the number of bank branches within 5-, 10- and 20-km radii around firms ( $No_Br5$ ,  $No_Br10$  and  $No_Br20$ , respectively). We split the full sample into two subsamples based on the median number of nearby bank branches and reestimate Eq. (1). Table 11 provides the estimation results. As shown in columns (1), (3) and (5), the coefficients of *Treat* × *Post* are not significant for firms surrounded by a high number of nearby bank branches. However, in columns (2), (4) and (6), the coefficients of *Treat* × *Post* for the sample of firms with low numbers of nearby bank branches are significant at the 5 % level. These results indicate that the Special Supervision Action has a stronger positive impact on employee treatment in firms with few nearby bank branches than in firms with many nearby bank branches, aligning with our expectation that this positive effect is more pronounced for firms facing more severe financial frictions.

#### 6.1.2. Political connections

As political affiliations strongly influence the allocation of government resources (Chen et al., 2011; Schoenherr, 2019), we expect that firms with political connections are less likely to experience local government arrears, particularly when local governments have discretion in using cash or trade credits as payment. Moreover, firms with political connections tend to have greater access to bank loans than those without, making them less vulnerable to financial frictions (Claessens et al., 2008). Therefore, we expect that the positive impact of the Special Supervision Action is more pronounced in firms without political connections than in those with political connections.

Variables	No_Br5		No_Br10		No_Br20	No_Br20	
	>50 %	<50 %	>50 %	<50 %	>50 %	<50 %	
	(1)	(2)	(3)	(4)	(5)	(6)	
	ET	ET	ET	ET	ET	ET	
$Treat \times Post$	0.0391 (0.0335)	0.0622** (0.0281)	0.0288 (0.0292)	0.0623** (0.0289)	0.0386 (0.0312)	0.0568** (0.0278)	
Constant	-2.6327*** (0.6157)	-1.7414*** (0.4927)	-2.2533*** (0.5460)	-1.3290*** (0.5022)	-2.7774*** (0.5756)	-1.1580** (0.4573)	
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes	
Prov Control	Yes	Yes	Yes	Yes	Yes	Yes	
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Obs.	4162	6059	5001	5220	4981	5240	
$R^2$	0.6860	0.6697	0.6744	0.6607	0.6758	0.6400	

Table 11 Cross-sectional test based on nearby bank branches.

Note: This table reports the heterogeneous effect of the Special Supervision Action for subsamples divided by nearby bank branches. We calculate the number of bank branches within a 5 km, 10 km and 20 km radius around the firms, and defined them as  $No\_Br5$ ,  $No\_Br10$  and  $No\_Br20$ , respectively. We then split our full sample into two subsamples based on the annual median number of bank branches. Employee treatment (*ET*) is measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10 %, 5 %, and 1 % levels, respectively.

To test this prediction, following Chen et al. (2011) and Kong et al. (2020), we consider a firm to be politically connected if its chairperson or CEO previously served as a bureaucrat in the central or local government. Next, we split our full sample into two subsamples based on these political connections. We then perform the baseline regression in Eq. (1) separately on the subsamples. Table 12 provides the estimation results. As shown in columns (1), (3) and (5), the coefficients of *Treat* × *Post* for the subsample of firms with political connections, the coefficients of *Treat* × *Post* are statistically significant at the 5 % level, as shown in columns (2), (4) and (6). The results indicate that the effect varies with firms' political connections. Consistent with our expectations, only firms without political connections exhibit a significant improvement in employee treatment after the Special Supervision Action.

#### 6.1.3. Financial health

Table 12

As government arrears lead to underinvestment in employee benefits due to liquidity constraints, a firm's financial health may influence the relationship between government arrears and employee-related investment. Specifically, financially robust firms tend to accumulate internal funds and secure external financing, which mitigate the impact of government arrears. In contrast, financially fragile firms are more likely to face liquidity challenges such as bankruptcy risk, compelling them to reduce investment in employee welfare when they are financially constrained by government arrears. Therefore, we expect the impact of the Special Supervision Action to be more pronounced for firms with weak financial health than for those with strong financial health.

To measure a firm's financial health, we use two types of variables. First, we use profitability proxies, namely earnings before interest and taxes and net profit, to measure firms' financial health. Second, we incorporate established indices frequently used to measure financial constraints, including the SA (Hadlock and Pierce, 2010), WW (Whited and Wu, 2006) and KZ (Kaplan and Zingales, 1997) indices. We split our full sample into two subsamples based on the median values of the aforementioned indicators. Specifically, firms with profitability (financial constraint) indices above (below) the median are assigned to the strong financial health groups. Table 13 provides the estimation results of the regression in Eq. (1) for these subsamples. For firms

Variables	Chairperson or	CEO	Chairperson		CEO	
	Yes	No	Yes	No	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
	ET	ET	ET	ET	ET	ET
$Treat \times Post$	0.0387 (0.0399)	$0.0555^{**}$ (0.0249)	0.0362 (0.0412)	0.0491**	0.0175	0.0547**
Constant	4.2744*** (0.6587)	1.9198*** (0.4550)	3.9139*** (0.6845)	1.9680*** (0.4405)	4.4438*** (1.0313)	2.0921*** (0.4110)
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes
Prov Control	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs. $R^2$	3914 0.6785	6481 0.7147	3627 0.6813	6768 0.7108	2188 0.7036	8207 0.6767

Cross-sectional test based on political connections.

Note: This table reports the heterogeneous effect of the Special Supervision Action for subsamples divided by firms' political connections. We define a firm whose chairman or CEO previously served as a bureaucrat in the central or local government as a politically connected. Next, we split our full sample of firms into political-connected firms and firms without political connections. Employee treatment (ET) is measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

with strong financial health, the coefficients of *Treat*  $\times$  *Post* are not significant, as shown in columns (1) and (3) of Panel A and columns (2), (4) and (6) of Panel B. However, for firms with weak financial health, the coefficients of *Treat*  $\times$  *Post* are statistically significant at least at the 10 % level, as shown in columns (2) and (4) of Panel A and columns (1), (3) and (5) of Panel B. These results align with our expectations, indicating that the Special Supervision Action has a more pronounced impact on firms with weak financial health than on those with strong financial health.

#### 6.1.4. Demand for human capital

Table 13

Research indicates that when employees contribute substantially to corporate value, firms tend to employ diverse strategies to invest in human capital, including initiatives such as wage raises and the provision of non-pecuniary benefits (Zhang et al., 2020). As firms with high human capital demand tend to treat employees

Cross-sectional te	st based on financial	health.					
Panel A: Profitab	ility proxies						
Variables	EBIT			Net profit			
	>50 %		<50 %	>50 %		<50 %	
	(1)		(2)	(3)		(4)	
	ET		ET	ET		ET	
Treat  imes Post Constant		$\begin{array}{c} 0.0291 \\ (0.0325) \\ -2.7554^{***} \\ (0.5907) \end{array}$	$0.0644^{**}$ (0.0292) -0.7152 (0.5554)		$0.0244 \\ (0.0334) \\ -2.7547*** \\ (0.6171)$	$0.0713^{**}$ (0.0290) -0.8301 (0.5488)	
Firm Control Prov Control Firm FE	Yes Yes Yes	(0.5507)	Yes Yes	Yes Yes Yes	(0.0171)	Yes Yes	
Year FE $Obs.$ $R^2$	Yes	5199 0.6976	Yes 5196 0.6782	Yes	5199 0.7012	Yes 5196 0.6702	
Panel B: Financin	ng constraint indices						
Variables	SA Index		WW Index		KZ Index		
	>50 %	>50 % <50 %		<50 %	>50 %	<50 %	
	(1)	(2)	(3)	(4)	(5)	(6)	
	ET	ET	ET	ET	ET	ET	
Treat  imes Post	0.1493*** (0.0294)	-0.0210 (0.0298)	0.0735** (0.0303)	0.0036 (0.0323)	0.0624* (0.0354)	-0.0417 (0.0332)	
Constant	$-2.6482^{***}$ (0.4951)	-0.8792 (0.7231)	-0.3874 (0.5982)	-3.3767*** (0.6722)	-2.5961*** (0.6120)	$-1.4781^{**}$ (0.6449)	
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes	
Prov Control	Yes	Yes	Yes	Yes	Yes	Yes	
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Obs.	5195	5200	4842	4849	4632	4638	
$R^2$	0.6948	0.6385	0.6797	0.6922	0.6604	0.7287	

Note: This table reports the heterogeneous effect of the Special Supervision Action for subsamples divided by firms' financial health. In Panel A, a firm is classified into the stronger (weaker) financial health group if its EBIT (earnings before interest and taxes) or net profit is in the top (bottom) half of the annual index. In Panel B, a firm is classified into the weaker (stronger) financial health group if its SA index, WW index, or KZ index is in the top (bottom) half of the annual index. Employee treatment (ET) is measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

Table 14

favorably to retain and attract talent, we expect a stronger positive impact of the Special Supervision Action on employee treatment in such firms than in their counterparts.

To test this conjecture, we define high-tech firms as having a high demand for human capital, because their employees play a pivotal role in determining firm value (Zingales, 2000). Specifically, to partition the full sample into two subgroups, we use the following three proxies: (i) a dummy variable that equals 1 for high-tech firms, and 0 for others; (ii) a dummy variable that equals 1 for firms in technology-intensive industries, and 0 for others; and (iii) R&D investment measured as the ratio of R&D expenditure to total assets. Firms with R&D investment levels above and below the sample median are classified as having high and low human capital demand, respectively. We then perform the regression in Eq. (1) separately on the subsamples; we report the estimation results in Table 14. For firms with high demand for human capital, the coefficients of *Treat* × *Post* are significant at the 5 % level, as shown in columns (1), (3) and (5). In contrast, for firms with a low demand for human capital, the coefficients of *Treat* × *Post* are not significant, as shown in columns (2), (4) and (6). Consistent with our expectations, these results suggest that the positive effect of the Special Supervision Action on employee treatment is stronger in firms with higher demand for human capital than in their counterparts.

#### 6.1.5. External job opportunities

Research indicates that poor labor market mobility enhances the bargaining power of buyers (i.e., firms) in the labor market by elevating the costs associated with employee job searching and unemployment (Zhang, 2010). Thus, when firms possess greater bargaining power, they can invest less in their employees; for example, by offering lower salaries (Yamaguchi, 2010). Conversely, in markets with higher labor market mobility where employees have more external job opportunities, firms might face greater pressure to attract and retain talent, resulting in potentially greater employee bargaining power. Consequently, we expect that the Special Supervision Action has a more pronounced positive impact on employee treatment in firms where employees have more external job opportunities.

To test this conjecture, following Zhang et al. (2020) and Wang et al. (2021), we use the number of firms in the same industry in a specific city (province) as a proxy for labor market mobility. A greater number of firms

Variables	High-tech Fir	rms	Technology-intens	ive industries	R&D expenditure	R&D expenditure /total assets		
	Yes	No	Yes	No	>50 %	<50 %		
	(1)	(2)	(3)	(4)	(5)	(6)		
	ET	ET	ET	ET	ET	ET		
Treat  imes Post	0.0654**	0.0358	0.0621**	0.0110	0.0791**	0.0222		
	(0.0257)	(0.0401)	(0.0258)	(0.0324)	(0.0309)	(0.0309)		
Constant	1.8058***	2.0562***	1.4172***	2.9918***	2.2694***	2.6905***		
	(0.4611)	(0.6775)	(0.4582)	(0.5694)	(0.5858)	(0.5452)		
Firm Control	Yes	Yes	Yes	Yes	Yes	Yes		
Prov Control	Yes	Yes	Yes	Yes	Yes	Yes		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes		
Year FE	Yes	Yes	Yes	Yes	Yes	Yes		
Obs.	7320	3075	6347	4048	5195	5200		
$R^2$	0.6476	0.7405	0.6694	0.6396	0.6921	0.6775		

Cross-sectional	test	based	on	the	demand	of	human	capital.

Note: This table reports the heterogeneous effect of the Special Supervision Action for subsamples divided by firms' demand of human capital. A firm is classified into the higher human capital demand group if it is qualified as the high-tech firm, belongs to the technology-intensive industries, or its R&D investment measured by the ratio of R&D expenditure to total assets is above the sample median. Otherwise, it is classified into the lower human capital demand group. Employee treatment (*ET*) is measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

in the same industry in the same city (province) suggests greater employee mobility and more external opportunities in the job market. We split our full sample into two subsamples based on the medians of the aforementioned indicators. Table 15 provides the estimation results for the subsamples. For firms where employees have more external job opportunities, the coefficients of *Treat* × *Post* are significant at the 1 % level, as shown in columns (1) and (3). However, for firms where employees have fewer external job opportunities, the coefficients of *Treat* × *Post* are not significant, as shown in columns (2) and (4). These results suggest that external job opportunities increase the impact of the Special Supervision Action on employee treatment.

#### 6.2. Further discussion

Table 15

Our main finding is that firms improve their employee treatment in response to the Special Supervision Action. However, why do firms engage in this costly endeavor related to employee treatment, and what do they gain? Employee benefits, as a type of non-pecuniary incentive, can enhance overall firm performance (Martins, 2021). Given that the Special Supervision Action improves firms' employee treatment, we investigate whether this improved employee treatment is correlated with better firm performance.

To test this conjecture, we use three proxies to measure firm performance: (i) labor productivity (*Mrpl*), calculated as the natural logarithm of employees' average operating income (Bai et al., 2018); (ii) total factor productivity (*TFP*), measured by the LP method (Levinsohn and Petrin, 2003); and (iii) operating revenue (*OR*), determined as the natural logarithm of operating income (Liu et al., 2022). Table 16 provides the estimation results. For *Mrpl* as the dependent variable, we present the results in column (1); the coefficient of *Treat* × *Post* is 0.0381 and significant at the 5 % level, indicating a significant and positive overall impact of the Special Supervision Action on labor productivity. The estimates with *TFP* and *OR* as the dependent variable are presented in columns (2) and (3), respectively. We find that the coefficients of *Treat* × *Post* are

Variables	The number of firms within the same industry in a specific city				The number of firms within the same industry in a specific province			
	>50 %		<50 %		>50 %		<50 %	
	(1) <i>ET</i>		(2) <i>ET</i>		(3) <i>ET</i>	(4)		
							ET	
$Treat \times Post$		0.1017***		0.0061		0.1095***		0.0292
		(0.0304)		(0.0273)		(0.0330)		(0.0262)
Constant		-1.0975 **		-3.1470 * * *		-1.3418***		-3.2065***
		(0.5267)		(0.4527)		(0.4742)		(0.5241)
Firm Control	Yes		Yes		Yes		Yes	
Prov Control	Yes		Yes		Yes		Yes	
Firm FE	Yes		Yes		Yes		Yes	
Year FE	Yes		Yes		Yes		Yes	
Obs.		4802		5593		5022		5373
$R^2$		0.6624		0.6482		0.6873		0.6319

Cross-sectional test based on external job opportunities.

Note: This table reports the heterogeneous effect of the Special Supervision Action for subsamples divided by regions' external job opportunities. In columns (1)–(2), a region is classified into the more (fewer) external job opportunities group if the number of firms within the same industry in a specific city is above (below) the sample median. In columns (3)–(4), a region is classified into the more (fewer) external job opportunities group if the number of firms within the same industry in a specific province is above (below) the sample median. Employee treatment (*ET*) is measured by the natural logarithm of one plus the employee responsibility scores released by Hexun.com. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

Variables	(1)	(2)	(3) OR	
	Mrpl	TFP		
Treat  imes Post	0.0381**	0.0310**	0.0302**	
	(0.0176)	(0.0139)	(0.0134)	
Constant	11.1109***	-2.4288***	5.3718***	
	(0.3435)	(0.2948)	(0.3021)	
Firm Control	Yes	Yes	Yes	
Prov Control	Yes	Yes	Yes	
Firm FE	Yes	Yes	Yes	
Year FE	Yes	Yes	Yes	
Obs.	10,387	9460	10,394	
$R^2$	0.8770	0.9417	0.9674	

 Table 16

 The economic consequence of the Special Supervision Action.

Note: This table presents the economic consequence of enhanced employee treatment caused by the Special Supervision Action. Labor productivity (*Mrpl*) is measured by the natural logarithm of average employees' operating income in all firms. Total factor productivity (*TFP*) is measured by the LP method. Operating revenue (*OR*) is measured by the natural logarithm of operating income. *Treat* equals 1 for firms located in the supervised regions and 0 otherwise. *Post* equals 1 for the years after 2016 and 0 otherwise. Other variable definitions are shown in Table A1. Standard errors reported in parentheses are clustered at the firm level. \*, \*\*, and \*\*\* represent significance at the 10%, 5%, and 1% levels, respectively.

significant and positive, indicating that the Special Supervision Action can improve the total factor productivity and operating revenue of firms. The results in Table 16 collectively suggest that the Special Supervision Action can improve employee treatment and boost subsequent firm productivity and performance.

#### 7. Conclusion and implications

In this study, we investigate whether and how government arrears repayment affects employee treatment practices. According to resource-based and social exchange theories, firms offer favorable employee treatment with the expectation of fostering a reciprocal relationship, aiming to receive benefits in return. To identify the causal relationship, we exploit China's 2016 Special Supervision Action, which promotes the repayment of accumulated local government arrears to private sector suppliers, as a quasi-natural experiment. We find that, in comparison with the employee treatment of private SMEs located in other regions, the employee treatment of private SMEs located in the supervised regions significantly improves by 4.64 % after this action. After a series of robustness tests, our findings remain unchanged. Further analysis shows that firms prioritize investment in safety management and employee incentives because of their pivotal roles in cultivating employee commitment and loyalty. Monetary compensation, welfare, social security expenditure and investment in skilled human capital collectively explain the results. Mechanism tests indicate that the Special Supervision Action enhances employee treatment by reducing government-related accounts receivable, alleviating liquidity constraints and enhancing CEO confidence, which subsequently boost firm productivity and performance. Furthermore, this positive effect is more pronounced for firms with few nearby bank branches, no political connections, weak financial health, high demand for human capital and in regions with more external job opportunities.

This study makes academic contributions to several streams of research. First, it contributes to the literature on government procurement and arrears. To the best of our knowledge, this is the first study to investigate the relationship between government arrears repayment and employee treatment in the context of a developing country. Second, our study is related to a growing stream of research on the determinants of employee treatment. Specifically, we complement the literature by focusing on financial frictions and liquidity constraints, highlighting government arrears repayment as an important factor influencing employee benefits. Finally, our results shed light on how governments provide liquidity to the private sector and influence corporate social behavior; however, the extent of the effects depends on institutional constraints and market dynamics.

Our findings have prominent implications for diverse stakeholders. Our study emphasizes that firms benefiting from government arrears repayment should exhibit responsible business practices. By improving employee well-being, firms contribute to a healthy work environment, demonstrating a sense of responsibility to both their workforce and society. Furthermore, firms' commitment to ethical conduct beyond mere profitmaking ensures fair practices in attracting and retaining talent, enhancing long-run firm productivity and financial performance. Furthermore, our study considers responsible resource allocation. While government arrears repayment injects liquidity into the private sector, concerns may arise if firms fail to direct these benefits toward employee welfare or society as a whole. Firms that prioritize investment in employee welfare when facilitated by government arrears repayment demonstrate commitment to social responsibility. Such commitment reflects transparent and responsible utilization of government resources, aligning with societal expectations of fair employee treatment and contributing to the greater good of society.

#### **Data Availability**

All data are publicly available from the sources identified in the text.

#### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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#### Appendix.

Table A1

Variable definitions.

Variable	Definition
ET	Natural logarithm of one plus the employee responsibility scores released by Hexun.com.
Treat	Dummy variable that equals 1 for firms located in the supervised region and 0 otherwise.
Post	Dummy variable that equals 1 for the years after 2016 and 0 otherwise.
Size	Natural logarithm of total assets.
Roa	Net income divided by total assets.
Lev	Total liabilities divided by total assets.
Age	Natural logarithm of the number of years since the firm was established.
Growth	Growth rate of sales revenues.
BM	Ratio of the market to book value of assets.
Board	Natural logarithm of the total number of directors.
Indep	Percentage of independent directors in the board.
Top1	Shareholding proportion of the largest shareholder.
Dual	Dummy variable equals 1 if a firm's CEO is also the chairman of the board and 0 otherwise.
Mfee	Administrative expenses divided by sales revenues.
Gdpg	Growth rate of GDP.
Income	General budget revenue divided by GDP.
FinMkt	Ratio of total regional financial institution deposits and loans to GDP.

Strength items	Concern items
Safety management system Safety production training plan Professional safety certification	Employee safety disputes
On-the-job training	None
Employee stock ownership plan Employee communication channels	None
Strong retirement benefits	None
	Strength itemsSafety management systemSafety production training planProfessional safety certificationOn-the-job trainingEmployee stock ownership planEmployee communication channelsStrong retirement benefitsNone

Table A2 List of the strength and concern items.

Table A3 Balanced test.

Variables	Match	Control Group	Treatment Group	%Bias	T-value	P-value
Size	U	21.6510	21.6000	5.6000	2.4200	0.0160
	Μ	21.6510	21.6310	2.2000	0.7700	0.4390
Roa	U	0.0484	0.0456	3.8000	1.6700	0.0940
	Μ	0.0484	0.0484	0.1000	0.0300	0.9800
Lev	U	0.3226	0.3475	-13.7000	-5.9300	0.0000
	Μ	0.3226	0.3211	0.8000	0.2900	0.7750
Age	U	2.6946	2.6998	-1.4000	-0.5900	0.5560
-	Μ	2.6946	2.6866	2.1000	0.7400	0.4580
Growth	U	0.2021	0.1926	2.6000	1.1600	0.2480
	Μ	0.2021	0.2108	-2.4000	-0.8100	0.4170
BM	U	0.6044	0.6200	-3.5000	-1.5100	0.1310
	Μ	0.6044	0.6069	-0.6000	-0.2000	0.8440
Board	U	2.0909	2.0750	8.6000	3.7900	0.0000
	Μ	2.0909	2.0892	0.9000	0.3200	0.7470
Indep	U	0.3764	0.3793	-5.4000	-2.3400	0.0190
	Μ	0.3764	0.3771	-1.3000	-0.4500	0.6540
Top1	U	0.3149	0.3220	-5.4000	-2.3600	0.0180
	Μ	0.3149	0.3181	-2.4000	-0.8500	0.3970
Dual	U	0.3868	0.4264	-8.1000	-3.5000	0.0000
	Μ	0.3868	0.3774	1.9000	0.6800	0.4940
Mfee	U	0.1072	0.0995	10.4000	4.7500	0.0000
v	Μ	0.1072	0.1079	-1.0000	-0.3400	0.7350

Notes: This table reports the results of the balanced test. We apply a 1:2 nearest neighbor matching method to select a control firm for each treatment firm, and assess whether there is a statistical difference between the treatment and matched control firms. \*, \*\* and \*\*\* denote significance at the 10 %, 5 % and 1 % levels, respectively.

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