Volume 15 • Issue 4 • December 2022



# China Journal *of* Accounting Research

HOSTED BY
ELSEVIER

Available online at www.sciencedirect.com
ScienceDirect

ISSN 1755-3091

**Aims and Scope**

The focus of the *China Journal of Accounting Research* is to publish theoretical and empirical research papers that use contemporary research methodologies to investigate issues about accounting, corporate finance, auditing and corporate governance in the Greater China region, countries related to the Belt and Road Initiative, and other emerging and developed markets. The Journal encourages the applications of economic and sociological theories to analyze and explain accounting issues within the legal and institutional framework, and to explore accounting issues under different capital markets accurately and succinctly. The published research articles of the Journal will enable scholars to extract relevant issues about accounting, corporate finance, auditing and corporate governance related to the capital markets and institutional environment.

Production and hosting by Elsevier

Radarweg 29, 1043 NX Amsterdam, The Netherlands

ISSN 1755-3091



Founded by Sun Yat-sen University and City University of Hong Kong

Sponsored by:


Published quarterly in March, June, September, and December



**Notice**

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds or experiments described herein. Because of rapid advances in the medical sciences, in particular, independent verification of diagnoses and drug dosages should be made. To the fullest extent of the law, no responsibility is assumed by the publisher for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein.

Although all advertising material is expected to conform to ethical (medical) standards, inclusion in this publication does not constitute a guarantee or endorsement of the quality or value of such product or of the claims made of it by its manufacturer.

http://www.elsevier.com/journals/china-journal-of-accounting-research/1755-3091/guide-for-authors

CHINA JOURNAL OF ACCOUNTING RESEARCH

Volume 15/4 (2022)

Volume 15 Issue 4， December 2022

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# Implications of the "momentum" theory of digitalization in accounting: Evidence from Ash Cloud

Min Zhang [a], Tingting Ye [b,*], Li Jia [c]

[a] School of Business, Renmin University of China, 100872, China
[b] School of Accounting, Shanghai Lixin University of Accounting and Finance, 201620, China
[c] Department of Economics and Management, Jinzhong University, 030619, China

ARTICLE INFO

*Article history:*
Received 3 April 2022
Accepted 11 October 2022
Available online 5 November 2022

*Keywords:*
Digital transformation
Digitalization in accounting
Firm characteristics
Executive characteristics
Organizational capabilities

ABSTRACT

We aim to demystify digitalization in accounting (DIA) based on the case study of Ash Cloud, a digital factory in Shenzhen, China. From the perspective of dynamic capabilities, we develop the "momentum" theory of DIA to illustrate that firm and executive characteristics drive digital transformation and organizational capabilities. Ash Cloud's CEO values and cultivates an organizational culture of transparency and openness, while the firm is characterized by cost pressures. Organizational capabilities shape digitalization in business processes and different approaches to DIA. Our findings suggest that the core competence of Ash Cloud is its capability for systems integration, which includes knowledge of redesign, reconfiguration and redefinition. Ash Cloud stands out because of its knowledge extending beyond the firm's boundaries.


## 1. Introduction

With digital and intellectual technology development, enterprises are paying increasing attention to digitalization in accounting (DIA). The core of DIA is to realize accounting automation and management intelligence, with the aim of empowering firms' decision-making abilities. However, to date, very few firms have achieved DIA (Accenture, 2021).[1] As reported in the Harvard Business Review, 70 % of all digital transfor-

* Corresponding author at: 904 Xulun Building, Shanghai Lixin University of Accounting and Finance, 2800 Wenxiang Road, Songjiang District, Shanghai 201620, China.
*E-mail addresses:* minzhang@ruc.edu.cn (M. Zhang), yetingting_lisa@163.com (T. Ye), jiali_0903@163.com (L. Jia).

[1] Firms do not have a high success rate for digital transformation in practice. According to the Accenture China Enterprise Digital Transformation Index 2021, only 16% of the firms surveyed qualified as "Digital Transformation Champions" in 2021, although this was an increase from 11% in 2020 (Accenture, 2021, p.7). In addition, the COVID-19 pandemic exposed many firms in traditional industries as digitally immature.

https://doi.org/10.1016/j.cjar.2022.100274
1755-3091/

mation initiatives do not reach their goals (Tabrizi et al., 2019).[2] Kane et al. (2015, p.3) argue that a digital strategy drives digital maturity; in other words, "Strategy, not technology, drives digital transformation." Determining the critical success factors of DIA is an important issue that calls for more research. As few studies explore this issue, our study aims to determine these factors.

First, we develop a theoretical framework, namely, "momentum" theory, to identify approaches to DIA. Digitalization in the business process is analogous to streams in relation to DIA, which represents the ocean. Just as streams merge to form rivers, and rivers eventually end up flowing into the ocean, the achievement of DIA can be a natural outcome of digitalization in the business process. In our conceptual model, firm and executive characteristics help to form the momentum and willingness to transform digitally. Accordingly, we propose two determinants of successful DIA: (1) organizational capabilities and (2) digitalization in the business process. Without these two determinants, it is virtually impossible for a firm to realize DIA. Finally, we distinguish four approaches to DIA along two dimensions, architectural knowledge and component knowledge. Incremental and radical approaches are two extreme points on the spectrum, with modular and architectural approaches in the middle.

Next, we apply "momentum" theory to analyze the DIA of Ash Cloud, a digital factory in Shenzhen, China. We choose Ash Cloud because it is one of the first firms to develop an iOS-based enterprise resource planning (ERP) system worldwide. Related information and videos are available on the Apple website.[3] The digital factory of Ash Cloud is an excellent example of the way that digitalization can help the real factory run faster and more transparently than before, and it has attracted many visitors from all over the world, including representatives from Foxconn, the Ministry of Economy, Trade and Industry of Japan, LG Corporation and the Massachusetts Institute of Technology.[4]

Our study makes three main findings. First, the CEO of Ash Cloud highly values and intentionally cultivates an organizational culture of transparency and openness. The firm's business is primarily characterized by cost pressures but, at the same time, this feature matches the CEO's characteristics, which make him focused on minimizing cost and controlling risk. Second, from the evidence of Ash Cloud, we find that DIA is a natural outcome of digitalization in the business process, which is consistent with the "momentum" theory of DIA. Since the launch and development of its internal ERP system, Ash Cloud has accomplished the goal of real-time management of assembly lines. As such, every Ash Cloud employee is engaged in data gathering and entry, and no one oversees the preparation of financial statements, which are automatically generated. Third, Ash Cloud strives to maintain its systems integration capability (Brusoni et al., 2001; Pavitt, 2003) by acquiring knowledge beyond the firm's boundaries. Such core competence enables Ash Cloud to accumulate knowledge on redesign, reconfiguration and redefinition.

Our findings contribute to the literature on DIA, as few studies explore the critical success factors of digitalization or DIA (Finny and Corbett, 2007). Importantly, "momentum" theory can be generalized beyond the specifics of our case study. Referring to our $2 \times 2$ matrix of approaches to DIA, Ash Cloud takes the architecture approach, whereas Alibaba and Midea follow the incremental approach and the modular approach, respectively. The second contribution is that our case study provides a vivid description of how a Chinese manufacturing firm succeeds in DIA. As accounting studies that offer in-depth empirical findings on DIA and its effects remain scarce (Knudsen, 2020), our study expands this literature. A growing number of manufacturing firms have realized the importance of digital transformation, and our findings offer different approaches to achieving their potential.

The remainder of this paper is organized as follows. We develop the "momentum" theory of DIA and a conceptual model of DIA in Section 2. Section 3 describes the research design and methodology. Section 4

[2] Specifically, of the US$1.3 trillion that was spent on digital transformation in 2019, approximately US$900 billion was wasted investment; the primary message for businesses from this experience is to figure out the business strategy before investment (Tabrizi et al., 2019).

[3] Source: https://www.apple.com/ae/business/success-stories/manufacturing/ash-cloud/ (accessed 5 June 2022).

[4] In addition, a video clip from a program (China 2025) that was initially broadcast on CCTV (China Central Television) introduced the CEO of Ash Cloud as a pioneer of smart manufacturing. It is available at https://www.iqiyi.com/v_19rr9ynvms.html (accessed 5 June 2022).

presents the case study description and background. Section 5 analyzes what makes Ash Cloud successful. Section 6 discusses implications and concludes the paper.

## 2. Research framework: "Momentum" theory

We develop our research framework and conceptual model based on dynamic capabilities in strategy management (Teece et al., 1997; Dosi et al., 2000). The interdisciplinary foundations include evolutionary economics (Nelson and Winter, 1982), technological innovation (Teece, 1986) and transaction costs (Williamson, 1975; 1985). From the lens of dynamic capabilities, knowledge and competence are essential sources of competitive advantages. Meanwhile, organizational capabilities are endogenous, continuous and accumulated. Similar to the resource-based view (Penrose, 1959; Wernerfelt, 1984; Barney, 1986), the dynamic capabilities framework regards knowledge and competence as essential resources that are valuable, rare, inimitable and non-substitutable (Barney, 1991). As such, we argue that DIA could be analogous to the "momentum" theory discussed in the next subsection.

### *2.1. The "momentum" theory of DIA*

We propose the "momentum" research framework as an attempt to understand DIA, which may assist in providing insights from an analysis of Ash Cloud or other case studies. Fig. 1 maps the four elements involved in the "momentum" theory of DIA: high hills, flows, sluices and the ocean. Digitalization is the flow, moving from the high hills to the ocean. In other words, digital transformation or digitalization is an inevitable trend; going with the flow is much easier for firms than attempting to move against the flow.

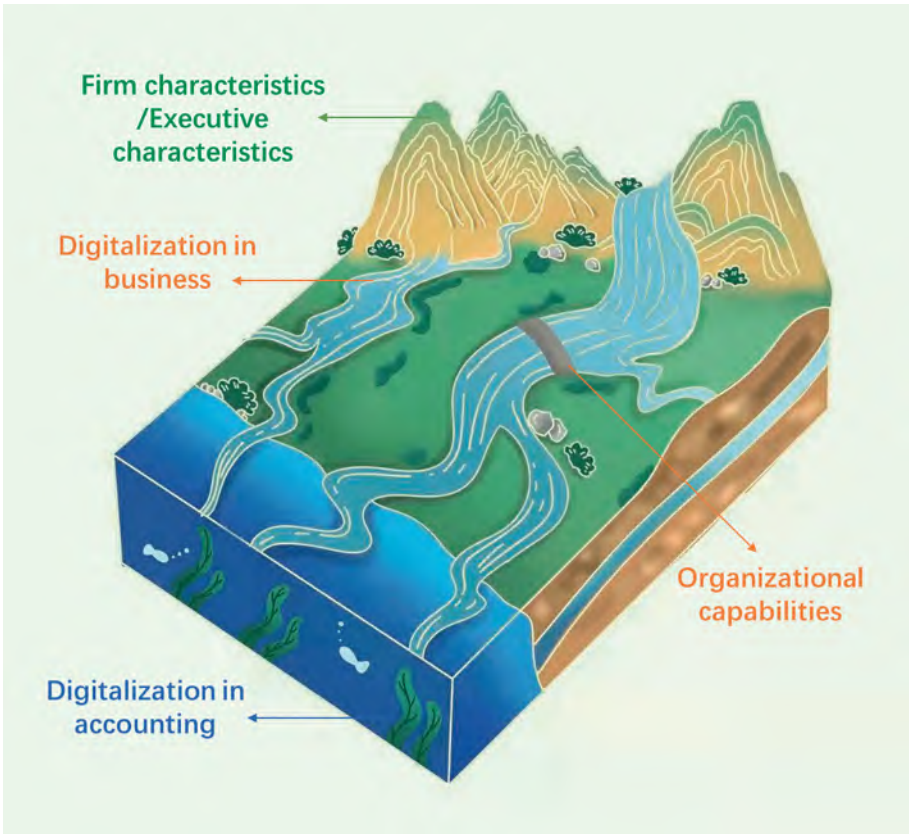



Fig. 1. Conceptualization of DIA.

Specifically, high hills in the upper part of the illustration (Fig. 1) represent firm and executive characteristics, which shape the momentum of digital transformation. They represent the firm's or the management team's willingness to allocate resources (the flows in Fig. 1). Next, the sluice gates represent organizational capabilities, which control the flow and the water level. Firms might be motivated to invest in digital initiatives, but they cannot successfully achieve digitalization without organizational capabilities.

In Fig. 1, digitalization in business is comparable with the streams, whereas DIA is comparable with the ocean. As we know, streams merge to form rivers, while rivers eventually flow into the ocean. Digitalization within a firm often starts with business processes because digitalization in business supports business operations. Business operations are expected to create cash flow and are thus under tremendous pressure. Put differently, no matter what achievements firms have made in business digitalization, "exits" (or outputs) of digitalization are needed, and the exits are DIA. All activities in business operations and all relevant data will merge in the finance office and ultimately realize DIA. Thus, we propose the "momentum" theory of DIA to develop the conceptual model discussed in the next session.

### *2.2. A conceptual model of DIA*

Under the "momentum" theory of DIA, we build a conceptual model of DIA to further the understanding of digital transformation (Fig. 2). The first component of the model is firm characteristics. What kinds of pressure drive firms to initiate digital transformation and what is the "binding force"? From the lens of transaction costs (Williamson, 1975, 1985), digitalization may increase transparency and openness, enhance work efficiency and reduce communication costs, which will eventually lower transaction costs both internally and externally. From the lens of competitive advantages, a firm in a shifting industry (e.g., smart, connected products) must gain a price premium, operate at a lower cost than its competitors or both (Porter and Heppelmann, 2014). By adopting DIA, managers could understand how, where and when a business process creates economic value to choose the processes that should be eliminated, improved or redesigned (Sonnenberg and vom Brocke, 2014). Using an event approach (Sorter, 1969; McCarthy, 1982), Sonnenberg and vom Brocke (2014) propose a process accounting model to illustrate business process-oriented accounting, which combines financial/non-financial information and produces real-time reports on which managers can act. A growing literature studies how organizational mindfulness toward digital transformation influences information processing capabilities (Li et al., 2021). If a firm is under no pressure, it will have little motivation to invest in digitalization. In our case, one of Ash Cloud's key concerns is cost pressure. In the case of state-owned enterprises (SOEs), pressures may come from the State-owned Assets Supervision and Administration Commission of the State Council (SASAC), in line with its longstanding objective of "separating government from corporate governance" (Guo and Lu,

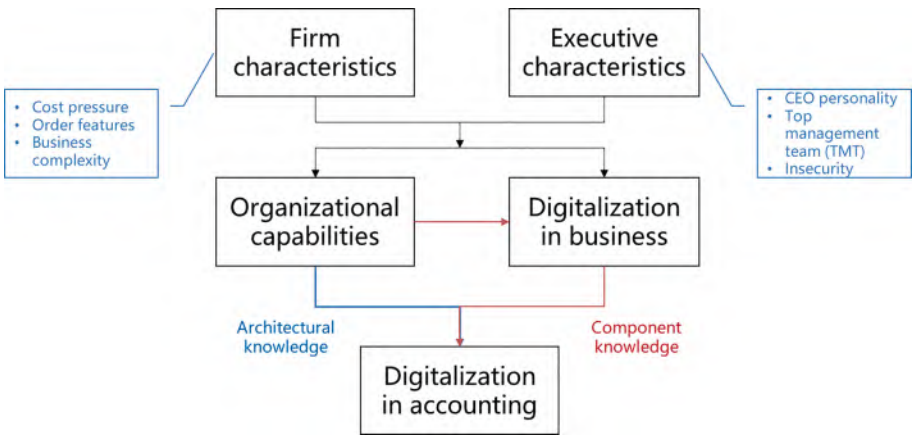



Fig. 2. A conceptual model of DIA.

2007, p.20). Moreover, order features and business complexity are other firm characteristics that affect decision-making in relation to digitalization.

Second, executive characteristics might be an impetus for strategic change. The role of managers in business strategy is critical inside the organization (Augier and Teece, 2009; Porfírio et al., 2021). In addition to allocating expenditure to R&D, managers should orchestrate the resources and dynamic capabilities needed to innovate. According to the framework developed by Winter (2000), leaders' aspiration levels may affect organizational incentives to develop innovative and digital capabilities. In particular, their aspiration level could shape strategic intent (Hamel and Prahala, 1989), and the imbalance between strategic intent and organizational capability might drive firms to accumulate knowledge and experience. From the lens of DIA, an organization's motivation for digitalization is associated with its leaders' aspiration levels and orchestration of resources. In other words, leadership characteristics can promote more advanced stages of digital transformation (Porfírio et al., 2021).

Third, firm characteristics and executive characteristics are associated with organizational capabilities. Indeed, both firm and executive characteristics influence the portfolio of organizational capabilities they would like to accumulate, such as ordinary or dynamic capabilities. The purpose of ordinary capabilities is to increase technical efficiency in business functions, while dynamic capabilities arise from the congruence of technological and business opportunities (Teece, 2014). As foundations to achieve DIA, ordinary capabilities refer to best practices for controlling costs, whereas dynamic capabilities refer to signature processes or organizational routines that have developed over time through the accumulation of tacit knowledge and organizational learning (Winter, 2003; Gratton and Ghoshal, 2005). Financial process mining, one such dynamic capability, requires a prescient assessment of the competitive environment, technological opportunities and resource orchestration (Werner, 2017). Teece (2014) considers that ordinary capabilities can be bought or built through learning, but dynamic capabilities can only be built through learning. However, the ability of a CEO or the top management team to sense a trend, seize a chance and lead a transformation is part of the firm's capabilities or even the most visible feature of its dynamic capabilities (Adner and Helfat, 2003). To some extent, dynamic capabilities and entrepreneurial management can explain heterogeneity among firms (Teece, 2016) because the knowledge of individual managers and the idiosyncratic organizational routines makes rivals difficult to imitate (Gratton and Ghoshal, 2005).

Fourth, organizational capabilities shape digitalization in business processes and eventually lead to DIA. There are two arrows leading to DIA in the lower part of Fig. 2, namely, architecture knowledge and component knowledge. The distinction between the product as a system and the product as a set of components underpins the notion that successful product development requires both component knowledge and architectural knowledge (Henderson and Clark, 1990). If DIA is regarded as a product development process, firms that aim to achieve digital transformation might choose different approaches according to their organizational capabilities and knowledge.

### *2.3. Approaches to DIA*

Next, we distinguish the four approaches to DIA along two dimensions shown in Fig. 3, following Henderson and Clark (1990). The horizontal dimension describes the emphasis of digitalization on component knowledge, while the vertical emphasizes architectural knowledge. Thus, approaches to DIA include I) the incremental approach, II) the modular approach, III) the architectural approach and IV) the radical approach. To some extent, the incremental and radical approaches can be considered two extreme points on the spectrum, while many real cases fall in the middle under the modular and/or architectural approaches.

Quadrant I in Fig. 3 captures an incremental approach to DIA, which requires reinforced component knowledge but few changes in architectural knowledge. The incremental approach involves successful digitalization in business leading to DIA. Under this approach, firms may not necessarily intend to excel in DIA but effectively "drift" into it. For instance, Alibaba provides a good example of such an approach, as its e-commerce features digitalized processes and its digital maturity in To B (business to business) and To C (business to consumer) could be applied easily to its internal financial processes.

Quadrant II of Fig. 3 captures a modular approach that requires overturned component knowledge but few changes in architectural knowledge. For factories that assemble sophisticated products and for large groups

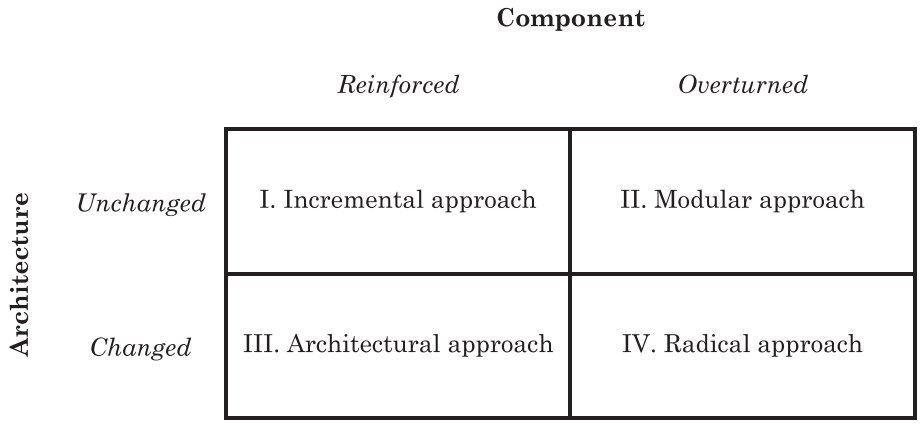



Fig. 3. Approaches to DIA.

with global segments, it may be easiest to choose this approach to DIA to build a "system of systems" (Porter and Heppelmann, 2014) and connect different databases because it is likely that they already possess various systems, such as ERP, supply chain management (SCM), customer relationship management (CRM) and manufacturing execution system (MES). To illustrate the combination of architecture and component knowledge in this quadrant, Midea Group, an electrical appliance manufacturer, provides an example of this modular approach. During Midea Group's digitalization, a few components of its systems have been improved but its architecture as a whole remains unchanged, namely, it is based on Oracle's ERP system.

Quadrant III represents the architectural approach, which requires reinforced component knowledge and changes in architectural knowledge. Ash Cloud provides the best example of this approach, as it has integrated iOS-based ERP across its business processes, including procurement, production, sales and accounting. We will discuss this further in the case description and analysis, i.e., Section 4 and 5.

Compared with the other approaches, the radical approach (Quadrant IV) is more creative but also destructive. Similar to radical innovation (Tushman and O'Reilly, 1997), a radical approach is more difficult for firms to implement due to technological inertia, conflicts of interest and internal culture. In other words, in terms of our conceptual diagram in Fig. 1, it would be very difficult to "create" water and pour it into the ocean, which would exemplify the radical approach. However, a natural question is how a firm could implement DIA in a radical way. Possible solutions are to shift from either Quadrant II to Quadrant IV or from Quadrant III to Quadrant IV. From the perspective of dynamic capabilities, know-how (such as tacit knowledge) should be accumulated through learning (Teece et al., 1997; Dosi et al., 2000). A firm's achievement of DIA might turn out to be a radical innovation, like the iPhone, with news headlines announcing "Apple reinvents the Phone" in 2007.[5] However, the whole journey of digital transformation is done step by step, day by day. The radical approach to DIA is yet to occur in a real-life example, which means that Alibaba, Ash Cloud, Midea and many other firms that are on the path to DIA may have a chance to reinvent DIA.

## 3. Research methodology

### *3.1. Method and case selection*

Regarding the research questions mentioned above, we use a single case study and collect data from semi-structured interviews with Ash Cloud's management teams and workers. First, as Yin (2018) notes, case studies are the preferred strategy when "how" and "why" questions are posed. Second, DIA is a new research area and undergoing change, and case studies are empirical inquiries that are suitable for new research areas or research areas for which existing theory seems inadequate (Eisenhardt, 1989; Yin, 2018). Third, there are few accounting studies offering empirical evidence on the effect of DIA (Knudsen, 2020).

[5] Steve Jobs used this slogan to introduce the iPhone to the world on 9 January 2007. Similarly, the breakthrough Apple made cannot be accomplished with one stroke. It is a result of unique experiences from long-term R&D.

Table 1
Data collection.

| Phases | Methods | Main tasks | Remarks |
|---|---|---|---|
| Phase 1 | • Desk research<br>On-site visit | • Collect media reports on Ash Cloud<br>Observe the real-time management of assembly lines | • Obtain consent for case study<br>Summarize the theoretical foundations |
| Phase 2 | • Online interviews | • Online interviews with the CEO of Ash Cloud and other members of its management team. (15 October 2021) | • Collect first-hand information about digitalization in Ash Cloud |
| Phase 3 | • On-site visit and interviews | • Face-to-face interviews with demand analyst and workers (23–24 November 2021) | • Double-check the conceptual DIA model |

In the appendix, Table A1 lists some selected quotes from our interviews.[6] Following Yin (2018) and Kokina et al. (2021), we employ pattern matching, an analytical technique that compares a pattern found in interview data with a pattern predicted before data collection.[7]

### *3.2. Data collection*

We combine different data collection methods, such as archives, interviews and observations, in our case study research. Table 1 illustrates our data collection processes. In Phase 1, we collect media coverage on Ash Cloud in both English and Chinese to obtain a general idea of its business model and history. In addition, we review the relevant literature to build the theoretical foundations of our research. In Phase 2, we gather first-hand data and materials through online interviews with the CEO of Ash Cloud and other members of the management team and draft the initial conceptual model of DIA. In Phase 3, we modify our conceptual model through the second-round interviews at Ash Cloud. The final phase allows us to cross-validate the information and data obtained during the first two phases (Yin, 2018).

## 4. Case description

### *4.1. Exploration stage: 2004 to 2005*

Ash Cloud was established in Shenzhen, China, in June 2004 to produce mobile phone accessories for global clients. In the early stages of its operations, most leather phone case orders came from Europe. Over time, order quantities became smaller and more diverse. The gross profit margin of mobile phone accessories was quite considerable, often more than 50 %. However, Mr. Guanyi Chen, the CEO of Ash Cloud, realized that production management could be improved to increase profit margins further. The CEO deliberated whether to purchase an ERP system or build one. He found that the prices for mainstream ERP suppliers were high, exceeding Ash Cloud's 1-year operating income at that time. Moreover, the functions of an off-the-shelf ERP system would satisfy at most 80 % of Ash Cloud's requirements, and concerns about system compatibility would remain. A team led by Mr. Chen began investing in digital initiatives to reduce production costs. Specifically, from the second half of 2005, the members of the management team decided to build their own internal ERP system.

### *4.2. Growth stage: 2006 to 2011*

The first version of Ash Cloud's ERP system, launched in 2006, integrated purchases, sales and inventory management. Subsequently, assembly line, human resources, administration and other functions were gradually added to the internal ERP system. With Apple's launch of the iPhone in 2007, Ash Cloud developed an iOS-based ERP system; before that, its ERP system was PC-based. In 2011, Ash Cloud launched its first ver-

[6] All interviews were conducted in Chinese and we translated the quotations to English. All errors are ours.
[7] Referring to Yin (2018), if the predicted and found patterns converge, internal validity is strengthened, allowing conclusions to be drawn.

sion of the iOS application for its internal ERP system and introduced its first iPad device to facilitate process management. In addition, the project team led by Mr. Chen began to redesign the packing factory to use more automated machines than before, which had the double benefits of reducing costs and human errors, as well as helping the management team to improve efficiency by instantly and remotely monitoring production lines.

### *4.3. Optimization stage: 2012 to 2016*

To optimize the iOS application, Ash Cloud supported its software engineers to learn PHP, a scripting language for website development, and MySQL, a database management system, in Beijing. They emphasized aesthetics, quality and durability when seeking suitable materials and machines to redesign leather case manufacturing. In 2016, Ash Cloud introduced the "ALLrounder" injection molding machine for plastics processing by Arburg, a German machine construction company, one of the world's leading manufacturers of such machines. Together with the MES developed, the new injection molding machine enabled Ash Cloud to track and collect all of the data required to produce a mobile phone case. In the smart factory of Ash Cloud, humans and robots can work together, with robotic arms serving as extensions of the human body (Het Nieuwe Instituut, 2018). In Ash Cloud, robots and automated facilities have not replaced humans, but they have become managers. For example, as illustrated in the middle of Fig. A1 in the appendix, a dashboard reports the real-time performance of work in zone E. When the daily performance of a worker is unusually slower (faster), an emoji of a tortoise (rabbit) will display on the dashboard.

### *4.4. Maturity stage: 2017 to the present*

Step by step, Ash Cloud used iPhones, iPads and different applications to modernize its ERP system across the business, from procurement to production, from sales to support and from the factory to the finance office (see Figs. A1 and A2 in the appendix).[8] Thus, its iOS-based ERP system became an integrated information system. Specifically, Ash Cloud's iOS application is not a system of systems (Porter and Heppelmann, 2014) but an integrated system featuring the functions of ERP, SCM, CRM and MES. With the growth of labor costs and the intensity of competition, the gross profit ratios of manufacturing firms in China are decreasing. The average gross profit ratio of its peers is approximately 10 %, whereas that of Ash Cloud is above 18 % (see Fig. A3 in the appendix). Its financial performance provides evidence that digitalization in business and DIA improve the efficiency of production, operations and management, enabling Ash Cloud to outperform its peers.

In addition to producing mobile phone and tablet accessories, since 2017, Ash Cloud has expanded its business to provide other firms with consulting advice and assistance on how to implement their iOS applications and provide solutions for iOS-based ERP systems. That is, although Ash Cloud originally designed the application to fit its own operational processes, it then redesigned it to fit broader business scenarios. Close to 40 manufacturing firms have installed Ash Cloud's application and upgraded their processes and production lines.

When we asked the CEO what were the advantages of Ash Cloud compared with financial software suppliers (such as Yonyou and SAP), the CEO responded as follows:

> It is our front-end business that is real-time reporting. Mr. Hang Chen, the former CEO and founder of Ding (钉钉), visited many industrial Internet platforms around China. From his experience, only Ash Cloud has achieved online business processes (or rather, the real-time reporting of business processes). Ding is famous for its online human resources and online organizations. Mr. Hang Chen spoke highly of Ash Cloud's digitalization, as he said that we are the only one in the market that realizes real-time reporting of business processes.

Ash Cloud's iOS-based ERP system can automatically generate balance sheets and income statements, which was sufficient to satisfy its initial needs; later, it added the cash flow statement in response to demand from its clients. According to our interview with the CEO of Ash Cloud, no one in the company is in charge of

[8] A video clip on "Ash Cloud Open day" is available at https://v.youku.com/v_show/id_XMjg3MjU5NzMzNg==.html?spm=a2h0c.8166622.PhoneSokuUgc_9.dtitle (accessed 5 June 2022).


Fig. 4. The financial statements in Ash Cloud's ERP system.

preparing financial statements. Instead, every Ash Cloud employee participates in data gathering and data entry. Fig. 4 illustrates the details incorporated into the balance sheet. After clicking the "audit" icon, shown in Panel A of Fig. 4, it is possible to check the financial statements in real time. Selecting orders in the pull-down menus of each balance sheet item (e.g., "prepayments" in Panel B) presents detailed information, such as order numbers, debit and credit accounts and original documents (Panel C). Thus, all of Ash Cloud's accounting data are automatically collected based on its iOS-based ERP system.[9]

## 5. Case analysis: What drives a firm's achievement of DIA?

### *5.1. Firm characteristics*

The first firm characteristic that drives manufacturing firms such as Ash Cloud to achieve DIA is cost pressure, in that the profit ratio of this industry is relatively low compared with other industries. In such cases, as the old saying goes, a penny saved is a penny earned. Without DIA, a small and medium-sized enterprise would struggle to survive. Our interview with the CEO of Ash Cloud made his strong intention to control costs evident. In other words, cost minimization was Ash Cloud's top priority. For example, as Mr. Chen commented:

[9] Four video clips on how Ash Cloud realizes DIA via its iOS-based ERP are attached with QR codes in the appendix (Fig. A4): for example, (1) real-time income statements showing details of each order, (2) the user guide for the cash flow statement and (3) a demonstration of direct ICBC (Industrial and Commercial Bank of China) payment.

> Since our establishment in 2004, I would have liked to accept orders featuring a smaller quantity but more diversity. Why? Because large order quantities are associated with price negotiations, while small orders give me pricing power. However, with the number of orders becoming smaller and more diverse, all management is about cost control, including controlling waste, inventory and delivery.

In contrast, cost inefficiency appears to be common for traditional (non-digitalized) firms. For instance, internal transaction costs or frictions will increase if interdepartmental handover delays become frequent. These delays might result from the bureaucratic structure, conflicts of interest or information asymmetry. Accordingly, for traditional non-digitalized firms, it may be harder to achieve digital transformation than for digitalized firms.

Nevertheless, some small and medium-sized enterprises such as Ash Cloud have the motivation and are under pressure to reduce costs. Digital transformation provides them with opportunities to use new technological tools to improve internal transparency, which helps to decrease internal fraud and frictions. Ash Cloud attempts to understand every business and every process. In doing so, it has been made aware of many avoidable costs. For example, consider a situation where we would like to find a vendor to purchase something. Traditionally, we might call the potential vendor without documenting the process and we would have little knowledge of whether the price is fair or, later on, whether there is something wrong with the order. However, in a digitalization scenario, firms use systems (e.g., Oracle and SAP) and applications (e.g., Ash Cloud) to help record and manage the procurement process, which enables them to compare prices from different vendors over time, check the qualifications of suppliers and review the order history of a certain product. In the case of Ash Cloud, the firm kills two birds with one stone, as digitalization not only helps the firm cut costs but also cultivate an organizational culture of transparency and openness.

### *5.2. Executive characteristics*

The trait of Ash Cloud's CEO that drives his firm's achievement of DIA is insecurity. To cope with the insecurity and uncertainty of his business and industry, Mr. Chen endeavors to keep every operational routine under control. As he commented, "In my small business, I would be unable to fall asleep if many processes were out of control."

Specifically, the CEO feels quite insecure when information within the organization is hidden and when there are leadership blind spots in his management. This was what drove him and his team to develop Ash Cloud's internal ERP system. Using their iOS-based ERP application, the CEO of Ash Cloud could reduce uncertainty and insecurity by being able to watch over every corner of his factory.

Another executive characteristic of Mr. Chen is his leadership style. According to Ms. Baimei Yu, a system analyst at Ash Cloud, "Many firms are not willing to use our App in that the finance and accounting function is too transparent and open."

However, the CEO's pursuit of information transparency makes the performance and qualifications of each supplier clear. As Mr. Chen said, "Information disclosure per se is the best defense for our firm, as exposure to the sun seems to be an anti-corrosion treatment. When everyone has a different notebook for accounting, it is easier to generate asymmetric information that may lead to misconduct." In particular, Mr. Chen insists that the iOS-based ERP system should be easy to use, in contrast to the PC-based ERP system, and as simple as possible.

As a detail-oriented person, Mr. Chen believes that one should "buy the furniture items and office stationery that will last however long you want to operate the business." Many trolleys, chairs and tables have been in use since the establishment of Ash Cloud and may have cost more than similar items purchased by peers, but high-quality items cost less in the long run as they do not need to be replaced.

### *5.3. Organizational capability*

An important issue is whether firms that aim to achieve digital transformation are actually capable of digitalization? We argue that they would not accomplish such aims without organizational capability. The distinct capability of Ash Cloud is to redesign or redefine. Over 5,000 people from Foxconn, a famous supplier of Apple, visited Ash Cloud. As Mr. Chen recounted, Mr. Taiming Guo (known as Terry Gou),

the founder of Foxconn, asked Mr. Guanyi Chen,[10] "Don't you worry that I would copy your system and application?"

Mr. Chen answered as follows:

> I don't think you could copy it. For instance, if you employ the world's top maintenance engineers at BMW's 4S (Sale, Spare part, Service, Survey) stores, no matter how many thousands, it would be hardly possible for them to design new automobiles for BMW. As design is disruptive, being a maintenance engineer is not equal to being innovative. Innovation means redefinition. How many soft engineers at Foxconn are capable of redesigning? I think the answer is zero.

Ash Cloud has not applied for any copyright or patent protection for its internal ERP system. Mr. Chen said that he would like to see peers' copies because their imitations mean that Ash Cloud is doing the right thing.

### *5.4. Toward DIA: Ash Cloud's industrial version of LEGO building*

When explaining Ash Cloud's company philosophy, Ms. Baimei Yu (a system analyst at Ash Cloud) said, "Our boss's philosophy is to build an industrial version of LEGO[11]: whatever I want, I will build it myself. For example, those small molds on the shelf are made by us."

As mentioned, Ash Cloud has introduced some advanced machines (e.g., the "ALLrounder" by Arburg) to achieve assembly automation. Hence, to fit its business processes and iOS-based system, the CEO of Ash Cloud always leads his team to redesign the tools, just as one builds one's own creative toy with LEGO's bricks and pieces. According to the management team of Ash Cloud, "We do not achieve a lot of innovation but always try to find the best tool or solution."

No matter how humble they are in recognizing their creative ability, Ash Cloud makes significant progress toward an architectural approach to DIA. Specifically, when describing why Ash Cloud selected iPhones and iPads as terminals, Mr. Chen remarked:

> When we arrived at the offices 10 or 15 years ago, we first started our personal computers or laptops and logged on to the Sina or Yahoo website to read the latest news. Now we read information through notifications from Toutiao (i.e., Tiktok). Likewise, the concept of ERP originated in the 1980s, the system of which is PC-based. Nowadays, terminals like iPhones and iPads are more flexible. Compared with a PC-based ERP system, our iOS-based application is lighter, suggesting that the customer experience of To B apps can be as good as that of To C apps or even better.

As Alex Chen, Operations and Project Manager at Ash Cloud, put it, "Apple has given us the tools we need to build an ideal management system, which has helped us achieve our vision."

### *5.5. The core competence of Ash Cloud*

From the experience of Ash Cloud, its core competence is its systems integration capability (Brusoni et al., 2001; Pavitt, 2003), which includes its knowledge of redesign, reconfiguration and redefinition.

In effect, this systems integration capability has its foundations in daily routines and tacit knowledge. In addition to addressing explicit knowledge, acquiring tacit knowledge is critical for organizational capability. As mentioned, organizational capability is a continuous and accumulated process. Learning by doing helps obtain tacit know-how, which may enhance a firm's core competence (Prahalad and Hamel, 1990). The core competence of systems integration makes Ash Cloud successful in DIA. Because the division of labor can be different from the division of knowledge (Williamson, 1999; Brusoni et al., 2001; Pavitt, 2003), Ash Cloud stands out by possessing knowledge beyond the firm's boundaries (product manufacturing). Specifically, the division of labor may refer to product manufacturing, whereas the division of knowledge may underscore

[10] During our online interview, we asked whether Ash Cloud was afraid of potential competitors for ERP service suppliers, especially from firms with abundant capital resources. Mr. Guanyi Chen quoted the conversations with Mr. Taiming Guo quoted above.

[11] LEGO is a Danish toy production firm based in Billund, Denmark. It manufactures Lego-brand toys, mainly consisting of interlocking plastic bricks (Source: Bing.com).

design and development. Similar to the value chain of Apple's iPhone, there is no one-to-one mapping between the division of knowledge and that of labor.

Overall, the core competence of Ash Cloud, systems integration, is acquired through organizational learning and accumulated through tacit knowledge. As such, the knowledge boundaries of Ash Cloud extend beyond its production boundaries, which helps us to understand its approach to DIA.

### *5.6. Alternative explanation*

As suggested by Yin (2018), an alternative explanation should not be neglected. Admittedly, some may argue that the products of Ash Cloud are not that complex or that its organizational structure is not that large. Thus, in our conceptual model of DIA (Fig. 2), we hypothesize that firm characteristics (such as business complexity) impact digital strategies. To alleviate this concern regarding business complexity and its impact on DIA, we asked whether Ash Cloud's achievement of DIA is partly driven by its relatively simple production process. The management team replied:

> No matter how large the business scale, the key point is to check whether it changes or not. What has changed and what remains unchanged? In my opinion, what remains unchanged is the business processes, whereas the changed parts include production machines and specific procedures. Concerning these changed and unchanged parts, Ash Cloud is quite flexible to fit each production process of manufacturing firms, especially those in intermittent manufacturing. ... For example, a subsidiary corporation of Foxconn Group is a user of our iOS-based ERP system, and its product (computer server) consists of more than 4,000 pieces. It is undoubtedly feasible.

Such evidence shows that the core competence of Ash Cloud arises from its knowledge and experience in systems integration, which further enhances its organizational capabilities to sustain a competitive advantage.

## 6. Implications and conclusions

Our case study shows that the learning and accumulation of organizational capabilities is the foundation of digitalization. At the same time, both firm and executive characteristics can influence a firm's digital strategy or decision to initiate digitalization. In the face of intense competition and technological change, firms are highly unlikely to gain sustainable advantages or achieve digital transformation simply by imitating their peers. However, the development of organizational capabilities makes firms more resilient to market turbulence and more mature in DIA.

### *6.1. Implications*

The organizational implication for firms is that knowledge and capabilities need time and must be accumulated. A product does not appear all of a sudden but as the result of learning and knowledge. That is, product development is a vital way to "learn by doing." Firms aiming for digitalization should emphasize the importance of the "D" (development) part of R&D. Many forms of know-how can only be learned from the experience of product development.

Another implication for policymakers is that leaders of SOEs should take an active part in digital transformation and have more patience to accumulate organizational capabilities. As stated previously, digital transformation is more about strategy than technology (Tabrizi et al., 2019). According to the literature, leadership characteristics shape strategic intent, organizational learning and digital transformation. The digital agenda should be led from the top (Kane et al., 2015). In China, digitalization has become a national plan (the 14th Five-Year Plan), increasing the responsibilities of SOEs to engage in digital initiatives. Digitalization in large firms will have more significant spillover effects than is the case for smaller firms, although their businesses may be much more complicated than those of small and medium-sized enterprises. Digitalization is not the ultimate goal but the way to improve operational efficiency and optimize organizational structure. Digital transformation per se will help SOEs sustain competitive advantages with technological changes such as 5G,

the Internet of Things and blockchains, the knowledge spillovers of which might solve technological pain points beyond the industrial boundaries.

### 6.2. Future directions

Our case study highlights three potential future directions. First, business intelligence or business analytics could be added to further DIA. Many algorithms, such as machine learning, may deepen our understanding of big data and social media. Real-time reporting would help us accomplish nowcasting instead of forecasting.

Second, although DIA is an inevitable trend, there are few studies on relevant topics. A financial decision support system may be the updated version of the accounting information system, as DIA is expected to support financial decision-making.

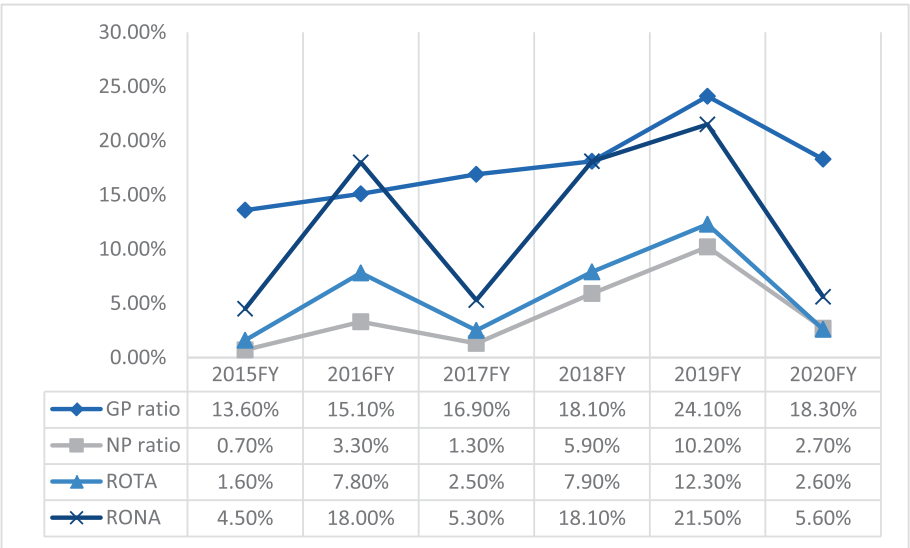
Third, digitalization blurs not only the boundaries of the firm but also the boundaries of professions such as accounting (Kokina et al., 2021). Digitalization may drive profound changes in how accountants think about acquiring, providing and using information for decision-making (Knudsen, 2020). It may even be possible that the role of the chief financial officer under DIA will be replaced with that of a chief information officer, chief technology officer, chief data officer or chief marketing officer, as more and more data from social media impact firm performance.

## 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.


Fig. A1. The smart factory.


Fig. A2. The Ash Cloud app interface.




| | 2015FY | 2016FY | 2017FY | 2018FY | 2019FY | 2020FY |
|---|---|---|---|---|---|---|
| GP ratio | 13.60% | 15.10% | 16.90% | 18.10% | 24.10% | 18.30% |
| NP ratio | 0.70% | 3.30% | 1.30% | 5.90% | 10.20% | 2.70% |
| ROTA | 1.60% | 7.80% | 2.50% | 7.90% | 12.30% | 2.60% |
| RONA | 4.50% | 18.00% | 5.30% | 18.10% | 21.50% | 5.60% |

Fig. A3. Financial performance Notes: FY = fiscal year, GP = gross profit, NP = net profit, ROTA = return on total assets, RONA = return on net assets.

Fig. A4. QR code Notes: This QR code links to videos illustrating how Ash Cloud realizes DIA via its iOS-based ERP.

Table A1
Data analysis and sample quotes.

| Example quote | Open code | Axial code |
|---|---|---|
| Since our establishment in 2004, I would have liked to accept orders featuring a smaller quantity but more diversity. Why? Because large order quantities are associated with price negotiations, while small orders give me pricing power. However, with the number of orders becoming smaller and more diverse, all management is about cost control, including controlling wastes, inventory and delivery. | • Order features<br>• Cost pressure | Firm characteristics |
| No matter how large the business scale, the key point is to check whether it changes or not. What has changed and what remains unchanged? In my opinion, what remains unchanged is the business processes, whereas the changed parts include production machines and specific procedures. Concerning these changed and unchanged parts, Ash Cloud is quite flexible to fit each production process of manufacturing firms, especially those in intermittent manufacturing. . . . For example, a subsidiary corporation of Foxconn Group is a user of our iOS-based ERP system, and its product (computer server) consists of more than 4,000 pieces. It is undoubtedly feasible. | • Business complexity<br>• Architectural knowledge<br>• Component knowledge | Firm characteristics, Organizational capabilities |
| In my small business, I would be unable to fall asleep if many processes were out of control. | • CEO personality<br>• Insecurity | Executive characteristics |
| Many firms are not willing to use our App in that the finance and accounting function is too transparent and open. | • Top management team | Executive characteristics |
| Our boss's philosophy is to build an industrial version of LEGO: whatever I want, I will build it myself. For example, those small molds on the shelf are made by us. | • Architectural knowledge<br>• Component knowledge | Organizational capabilities |
| We do not achieve a lot of innovation but always try to find the best tool or solution. | • Component knowledge | Organizational capabilities |
| When we arrived at the offices 10 or 15 years ago, we first started our personal computers or laptops and logged on to the Sina or Yahoo website to read the latest news. Now we read information through notifications from Toutiao (i.e., Tiktok). Likewise, the concept of ERP originated in the 1980s, the system of which is PC-based. Nowadays, terminals like iPhones and iPads are more flexible. Compared with a PC-based ERP system, our iOS-based application is lighter, suggesting that the customer experience of To B apps can be as good as that of To C apps or even better. | • Digitalization in business<br>• Architectural knowledge<br>• Component knowledge | Approaches to DIA |
| I don't think you could copy it. For instance, if you employ the world's top maintenance engineers at BMW's 4S (Sale, Spare part, Service, Survey) stores, no matter how many thousands, it would be hardly possible for them to design new automobiles for BMW. As design is disruptive, being a maintenance engineer is not equal to being innovative. Innovation means redefinition. How many soft engineers at Foxconn are capable of redesigning? I think the answer is zero. | • Architectural knowledge<br>• Component knowledge | Organizational capabilities, Core competence |

| | | |
|---|---|---|
| Apple has given us the tools we need to build an ideal management system, which has helped us achieve our vision. | • Component knowledge | Approaches to DIA |
| It is our front-end business that is real-time reporting. Mr. Hang Chen, the former CEO and founder of Ding (钉钉), visited many industrial Internet platforms around China. From his experience, only Ash Cloud has achieved online business processes (or rather, the real-time reporting of business processes). Ding is famous for its online human resources and online organizations. Mr. Hang Chen spoke highly of Ash Cloud's digitalization, as he said that we are the only one in the market that realizes real-time reporting of business processes. | • Digitalization in business<br>• Digitalization in accounting | Approaches to DIA |

## Acknowledgements

Min Zhang acknowledges financial support from the "Fostering World-Class Enterprises" program, School of Business, Renmin University of China, 2022.

**Appendix A.** See Figs. A1–A4 and Table A1.

## References

Accenture, 2021. Close the widening gap. Retrieved from https://www.accenture.com/_acnmedia/PDF-168/Accenture-China-Digital-Transformation-Index-2021-Executive-Summary.pdf (accessed 5 June 2022).
Adner, R., Helfat, C.E., 2003. Corporate effects and dynamic managerial capabilities. Strateg. Manag. J. 24 (10), 1011–1025.
Augier, M., Teece, D.J., 2009. Dynamic Capabilities and the Role of Managers in Business Strategy and Economic Performance. Organization Science 20 (2), 410–421.
Barney, J.B., 1986. Strategic factor markets: Expectations, luck, and business strategy. Manage. Sci. 32 (10), 1231–1241.
Barney, J.B., 1991. Firm resources and sustained competitive advantage. J. Manage. 17 (1), 99–120.
Brusoni, S., Prencipe, A., Pavitt, K., 2001. Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make? Adm. Sci. Q. 46 (4), 597–621.
Dosi, G., Nelson, R.R., Winter, S.G., 2000. The nature and dynamics of organizational capabilities. Oxford University Press, Oxford.
Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manag. Rev. 14 (4), 532–550.
Finny, S., Corbett, M., 2007. ERP implementation: A compilation and analysis of critical success factors. Bus. Process Manage. J. 13 (3), 329–347.
Gratton, L., Ghoshal, S., 2005. Beyond best practice. Sloan Manage. Rev. 46 (3), 49–57.
Guo, L., Lu, F., 2007. Self-improvement or self-mutilation? China Economist 2, 20–30.
Hamel, G., Prahala, C.K., 1989. Strategic intent. Harvard Bus. Rev., 63–76
Henderson, R.M., Clark, K.B., 1990. Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. Adm. Sci. Q. 35 (1), 9–30.
Het Nieuwe Instituut, 2018. Assemblages of humans and machines in the Pearl River Delta. Automated Landscapes. Retrieved from https://automated-landscapes.hetnieuweinstituut.nl/en/ (accessed 5 June 2022).
Kane, G.C., Palmer, D., Phillips, A.N., Kiron, D., Buckley, N., 2015. Strategy, not technology, drives digital transformation: Becoming a digitally mature enterprise. Retrieved from https://www2.deloitte.com/us/en/insights/topics/digital-transformation/digital-transformation-strategy-digitally-mature.html (accessed 5 June 2022).
Knudsen, D., 2020. Elusive boundaries, power relations, and knowledge production: A systematic review of the literature on digitalization in accounting. Int. J. Account. Informat. Syst. 36, 100441.
Kokina, J., Gilleran, R., Blanchette, S., Stoddard, D., 2021. Accountant as digital innovator: Roles and competencies in the age of automation. Account. Horizon 35 (1), 153–184.
Li, H., Huang, Y., Cao, D., Wang, Y., 2021. Organizational mindfulness towards digital transformation as a prerequisite of information process capacity to achieve market agility. J. Bus. Res. 122, 700–712.
McCarthy, W.E., 1982. The REA accounting model: A general framework for accounting systems in a shared data environment. Account. Rev. 57 (3), 554–578.
Nelson, R., Winter, S.G., 1982. An Evolutionary Theory of Economic Change. Belknap Press, Cambridge.
Pavitt, K., 2003. Specialization and systems integration. In: Andrea Prencipe, A., Davies, A., Hobday, M. (Eds.), The Business of Systems Integration. Oxford University Press, Oxford, pp. 78–92.
Penrose, E.G., 1959. The Theory of the Growth of the Firm. Wiley, New York, NY.
Porfírio, J.A., Carrilho, T., Felício, J.A., Jardim, J., 2021. Leadership characteristics and digital transformation. J. Bus. Res. 124, 610–619.
Porter, M.E., Heppelmann, J.E., 2014. How smart, connected products are transforming competition. Harvard Bus. Rev. 92 (11), 64–88.
Prahalad, C.K., Hamel, G., 1990. The core competence of the corporation. Harvard Bus. Rev., 79–91

Sonnenberg, C., vom Brocke, J., 2014. The missing link between BPM and accounting: Using event data for accounting in process-oriented organizations. Business Process Manage. J. 20 (2), 213–246.
Sorter, G.H., 1969. An "events" approach to basic accounting theory. Account. Rev. 44 (1), 12–19.
Tabrizi, B., Lam, E., Girard, K., Irvin, V., 2019. Digital transformation is not about technology. Harvard Bus. Rev. Retrieved from https://hbr.org/2019/03/digital-transformation-is-not-about-technology/ (accessed 5 June 2022).
Teece, D.J., 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing, and public policy. Res. Policy 15 (6), 285–305.
Teece, D.J., 2014. The foundations of enterprise performance: Dynamic and ordinary capabilities in an (economic) theory of firms. Acad. Manage. Perspect. 28 (4), 328–352.
Teece, D.J., 2016. Dynamic capabilities and entrepreneurial management in large organizations: Toward a theory of the (entrepreneurial) firm. Eur. Econ. Rev. 86, 202–216.
Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strateg. Manag. J. 18 (7), 509–533.
Tushman, M., O'Reilly, C., 1997. Winning through Innovation: A Practical Guide to Leading Organizational Change and Renewal. Harvard Business School Press, Boston, MA.
Wernerfelt, B., 1984. A resource-based view of the firm. Strateg. Manag. J. 5 (2), 171–180.
Werner, M., 2017. Financial process mining - Accounting data structure dependent control flow inference. International Journal of Accounting Information Systems 25, 57–80.
Williamson, O.E., 1975. Markets and Hierarchies: Analysis and Antitrust Implications. Free Press, New York, NY.
Williamson, O.E., 1985. The Economic Institutions of Capitalism. Free Press, New York, NY.
Williamson, O.E., 1999. Strategy research: Governance and competence perspectives. Strateg. Manag. J. 20, 1087–1108.
Winter, S.G., 2000. The satisficing principle in capability learning. Strateg. Manag. J. 21 (10–11), 981–996.
Winter, S.G., 2003. Understanding dynamic capabilities. Strateg. Manag. J. 24 (10), 991–995.
Yin, R.K., 2018. Case study Research and Applications: Design and Methods. Sage, Thousand Oaks, CA.

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# Does green governance affect financing constraints? Evidence from China's heavily polluting enterprises

Pei Jose Liu *, Congjing Song, Jiayuan Xin

*Newcastle University Business School, Newcastle University, UK*

ARTICLE INFO

*Article history:*
Received 21 October 2021
Accepted 18 August 2022
Available online 16 September 2022

*Keywords:*
Green governance
Financing constraints
Heavily polluting enterprises

ABSTRACT

Given the increasing focus on global sustainable development, many enterprises in developing countries such as China participate in green governance and scale up their green investment; however, many enterprises still experience financing difficulties. Our study investigates whether green governance can mitigate corporate financing constraints. Using a sample of Chinese, A-share listed, high-pollution enterprises from 2013 to 2018, we find that corporate green governance practices, including environmental performance and information disclosure, ease corporate financing constraints. This effect is pronounced in areas with high levels of financial development and for state-owned enterprises. This paper not only proposes a channel for alleviating enterprises' financing constraints but also reveals the importance of industrial transformation and emissions reduction for energy-intensive industries in emerging markets.



## 1. Introduction

Balancing economic growth and environmental protection is crucial to global sustainable development. A large number of countries have collaborated and reached agreements on reducing environmental pollution, such as the Kyoto Protocol of 1997 and the Paris Agreement of 2016. In China, where the development of industrialization and urbanization has been rapid, the problem of environmental pollution merits close attention. Whether China, the second largest economy in the world, can solve its environmental problems is crucial to the global promotion of green development.

* Corresponding author.
*E-mail address:* pei.liu@ncl.ac.uk (P.J. Liu).

https://doi.org/10.1016/j.cjar.2022.100267
1755-3091/

The Chinese government has promulgated a series of policies to address the country's grim situation, particularly in heavily polluting industries, which are the main "perpetrators" of ecological and environmental offenses. With the exacerbation of environmental and resource problems, policy makers and scholars have increasingly turned their attention to industrial transformation. For example, from as early as 1995, the People's Bank of China has promulgated credit policies to strengthen environmental governance, which constitutes China's first attempt to develop green finance. In 2012, the Chinese government put forward the concept of green governance and stated its goal as forming an industrial structure based on resource conservation and environmental protection. Since then, a series of policies have been enacted. For example, the Green Credit Policy, which was implemented in 2012, requires that commercial banks strictly control credit lines to high-polluting enterprises and increase such support to environmentally friendly enterprises. In 2012, the Ministry of Environmental Protection issued the *12th Five-Year Plan for the Prevention and Control of Air Pollution in Key Regions*, which proposes to carry out green governance in key industries and improve the system of air-pollution prevention and control. To achieve this goal, in 2013, the Ministry of Environmental Protection published the *Notice of the Implementation of Special Emission Limits for Air Pollutants* (hereinafter referred to as the 2013 MEP Notice), which sets limits on the emission of air pollutants from six energy-intensive industries (i.e., thermal power, steel, petrochemicals, cement, non-ferrous metals and chemicals) in key control areas in China. In accordance with these policies, every stakeholder, including governments and banks, encourages and pressures enterprises to engage in sustainable economic development (Song and Yu, 2018). An enterprise's environmental responsibility has a vital impact on its financing activities. It is important for investors to judge a given enterprise's environmental uncertainties, predict its future business situation and evaluate its credit risks (Clarkson et al., 2008).

A prominent feature of China's social financing structure is that bank loans play a dominant role in financing, while the proportion of stock market and bond market financing is relatively small. The *2016 Social Financing Statistics Report* released by the People's Bank of China indicates that more than 80 % of social financing comes from various types of loans, meaning that credit financing remains the most important external financing channel for Chinese enterprises. However, Chinese enterprises generally face serious financing constraints due to the incomplete market (Chava et al., 2009). With the increased attention given by creditors such as governments and banks to environmental issues in recent years, enterprises' green governance may play an important role in easing financing constraints. Therefore, the first aim of this paper is to investigate whether green governance practices mitigate corporate financing constraints, taking the polluting industries in the key green governance areas mentioned in the 2013 MEP Notice as samples.

Studies (Demirgüç-Kunt and Maksimovic, 1996; Mitton, 2008) find that a financial system's level of development affects enterprises' financing behaviors. Specifically, a better financial ecological environment usually means that market participants experience an external environment with a high degree of financial marketization, a more developed macro economy and a relatively complete legal system (Mitton, 2008). The link between green governance and corporate financing lies in stakeholders' concerns about enterprises' environmental risks. However, creditors' risk preferences and weighting of corporate environmental risks vary according to the financial ecological environment. Therefore, the varying levels of financial and economic development between regions may affect the relationship between green governance and corporate financing capability to some extent. Therefore, the second aim of this paper is to examine the correlation between green governance and corporate financing constraints under various levels of regional financial development.

Moreover, the nature of corporate equity is also important to financing. As China's financial system involves extensive government intervention, private enterprises are mired in financing difficulties caused by ownership discrimination (Jiang and Zeng, 2014; Chen, 2019). Research shows that financing constraints faced by heavily polluting enterprises have increased significantly since the introduction of green development policies in China (Wang et al., 2020). Shen et al. (2021) suggest that when faced with financial problems, the government bails out state-owned enterprises (SOEs), while non-SOEs are less likely to receive government assistance. Therefore, the third focus of this paper is whether the impact of green governance on the financing capabilities of SOEs and privately owned enterprises in heavily polluting industries differs when green development is valued by stakeholders.

In recent years, research on the effect of green development on corporate behaviors has gradually emerged; however, there remain certain gaps in the literature. First, studies on the influencing factors of financing con-

straints involve multiple aspects, such as enterprise operating characteristics and strategies (Kuppuswamy and Villalonga, 2016; Beladi et al., 2018); however, very few studies investigate the correlation between green governance and corporate financing constraints. Although Zhang et al.'s (2020) empirical tests show that corporate green innovation can significantly mitigate enterprises' financing constraints, they do not further consider the effect of either the regional financial ecological environment or the nature of corporate equity. Second, some studies (Liu et al., 2019; Li et al., 2020) only use the SA index to measure financing constraints, although additional measurements are necessary to test the consistency of the results. Third, as the main culprits of environmental pollution, energy-intensive enterprises may face greater environmental risks than other types of enterprises following the release of relevant policies such as the Green Credit Policy. Studies discuss the relationship between corporate social responsibility (CSR) and financing constraints (Cheng et al., 2014; Li et al; 2020); however, very limited attention is given to energy-intensive enterprises. Thus, further research is urgently needed.

This study makes three main contributions to the literature. First, we examine the influence of green governance on enterprises' financing ability, enriching research in the field of enterprises' financing behaviors. Most research focuses on the effectiveness of various green financial instruments (Liu et al., 2019; Sun et al., 2019; Wen et al., 2021). However, only a few studies focus on the relationship between green governance activities and enterprises' financing behaviors. Our results show that the financing constraints of heavily polluting enterprises are influenced by improved levels of corporate green governance, providing new insight into alleviating corporate financing constraints. Second, this paper enriches the literature in the field of green development, which provides evidence for the effectiveness of green governance. Scholars increasingly are paying attention to the influencing factors and solutions of financing constraints in recent years (Leon, 2015). Because of the increasingly serious problem of environmental pollution, enterprises' green behavior has become a crucial concern for stakeholders. Although certain studies discuss the relationship between CSR and financing constraints (Cheng et al., 2014; Li et al., 2020), they do not focus on heavily polluting enterprises. Energy-intensive enterprises, as the main culprits of environmental pollution, are more constrained with respect to financing capacity than other enterprises since the promulgation of the Green Credit Policy. Therefore, this paper takes heavily polluting enterprises as the research subject and, accordingly, contributes to the study of specific industries. Third, this study considers the influence of regional financial development characteristics and of the nature of corporate ownership. Zhang et al. (2020) find that green innovation is beneficial to mitigating enterprises' financing constraints; however, they do not consider external environment and internal heterogeneity. Our paper fills this gap.

The rest of this paper is organized as follows. Section 2 discusses the literature on green governance, financing constraints, regional financial ecological environments and the nature of corporate equity. Section 3 introduces our data and methodology and describes the variable selection, sample collection and basic model construction. Section 4 presents the empirical results and analysis. Section 5 presents the robustness tests results. Section 6 discusses the findings, and Section 7 concludes the paper.

## 2. Literature review and hypothesis development

### *2.1. Corporate financing: Constraints and measurements*

Applying classical financial theories, Modigliani and Miller (1958) demonstrate that in a perfectly competitive capital market, internal and external financing can be interchangeable; thus, an enterprise's investment behaviors are unrelated to financing methods and depend solely on the present value of an enterprise's future cash flow. However, in the real world, no perfectly competitive capital market exists, as the problem of information asymmetry generally leads to higher external financing costs than internal financing costs; thus, the relationship between the two is not a complete substitution, and corporate financing capability always affects investment behavior to a great extent (Myers and Majluf, 1984). The existence of transaction and information costs in an imperfectly competitive market increases financing costs, thereby restricting enterprises' financing behaviors.

To empirically examine whether enterprises' investment behaviors are affected by their financing methods, Fazzari et al. (1988) are the first to propose using the investment–cash flow sensitivity approach to test cor-

porate financing constraints. Their results show a significantly positive relationship between investment expenditure and internal cash flow and that enterprises with serious financing constraints display relatively high sensitivity of investment to cash flow. Therefore, they conclude that investment–cash flow sensitivity can be used as an indicator to test whether an enterprise faces financing constraints. Using the same methodology, Schaller (1993) finds that the investment expenditure of manufacturing enterprises with diversified equity is quite sensitive to the enterprises' internal cash flow, which is consistent with the conclusion of Fazzari et al. (1988).

The investment–cash flow sensitivity method used to identify financing constraints is used overwhelmingly in the literature; however, some studies suggest that the results of such studies require careful interpretation. Kaplan and Zingales (1997) hold the view that certain managers' irrational decisions or excessive risk aversion may lead them to prefer internal financing to external, even in the absence of any objective cost benefits. Because of such preferences, a positive cash flow sensitivity does not necessarily reflect the existence of financing constraints.

Given a number of deficiencies related to the investment–cash flow sensitivity approach, Almeida et al. (2004) propose a new method: the cash flow sensitivity of cash method (i.e., the cash–cash flow sensitivity model). Their empirical tests find that for enterprises with financing constraints, cash flow has a significant, positive effect on the change in cash holdings. Quader and Abdullah (2016) use the same methodology to measure the financing constraints of 5,086 enterprises in seven European countries. Their results indicate that compared to the investment–cash flow sensitivity approach, the cash–cash flow sensitivity method is a more accurate measurement of the presence of corporate financing constraints. However, Chu et al. (2022) hold the view that there is no recognized best method to measure financing constraints and that research should thus avoid relying on a single method. Therefore, the cash–cash flow sensitivity model and the investment–cash flow sensitivity model may both be used in a single study to verify each other's results, thereby enhancing the robustness of the study's conclusions.

Based on the above discussions and because the investment–cash flow sensitivity method has been widely used in academic circles (Guariglia, 2008; Ryan et al., 2014), this paper mainly uses this method to measure enterprises' financing constraints in its main empirical research tests. It also uses the cash–cash flow sensitivity model for robustness tests.

### *2.2. Green governance and financing constraints*

Passetti et al. (2018) document that green governance includes improving environmental performance (such as green innovation) and environmental information disclosure. Certain studies hold the view that enterprises' financing ability can be enhanced through improvements in environmental performance, according to the stakeholder theory (Lin et al., 2014; Burns et al., 2016). The stakeholders of an enterprise are the individuals or institutions that can affect its corporate development or be influenced by the enterprise; such stakeholders include creditors, governments, financial institutions and shareholders (Freeman, 1994). Substantial research confirms that stakeholder pressure is a vital factor in encouraging enterprises to engage in environmental protection. Chen (2008) indicates that consumers' demands encourage enterprises to produce green products. For example, consumers' resistance to polluting products stimulates enterprises to improve their production methods and products to incorporate green innovation (Paulraj, 2009; Ma et al., 2018). Lin et al. (2014) claim that corporate green governance is affected by both the government and society. Environmental supervision by the government and the public promotes the improvement of green management processes within enterprises (Kitsikopoulos et al., 2018). Stakeholders increasingly view environmental behavior as an important evaluation standard for enterprises; accordingly, Burns et al. (2016) hold the view that through green governance, enterprises may more easily obtain resources and benefits from their stakeholders, such as better social reputation and financing. Green governance is a good means of consolidating the relationship or mitigating conflicts between enterprises and stakeholders, leading to increased stakeholder confidence in such enterprises, which permits enterprises to effectively gain financing support and a competitive advantage (Peloza and Shang, 2011).

The effects of green governance on corporate financing constraints may be realized via various stakeholders, including shareholders, bond buyers, financial institutions and the government. First, for shareholders, the main focus is on increasing their returns from enterprises in the future. Kajander et al. (2012) propose that

green innovation practices are beneficial for increasing enterprises' market value and financial performance, which then attracts more investments. Specifically, as consumers pay increasing attention to environmental protection, they display an increasing demand for green products. Enterprises may benefit from the implementation of green management in various ways. An enterprise can implement technological innovation in the process of production and produce more environmentally friendly products to meet customers' demands, thereby expanding the enterprise's market share (Leonidou et al., 2013). Furthermore, the implementation of green management reform involves the redistribution of resources within an enterprise, enabling it to make more efficient decisions, which is conducive to improving management efficiency and enterprise performance (Shu et al., 2016). Based on these improvements, investors and analysts increase their expectations of the investment value of these enterprises. The issuance of new shares or bonds by an enterprise to raise money may attract more investments from shareholders and creditors. In this way, green innovation activities help enterprises to increase their financing capability.

Second, bank loans are the primary means of financing for most enterprises in China; thus, financial institutions are among the most vital stakeholders with the ability to provide financing support to enterprises with better environmental performance (Sufi, 2009). Currently, China regards sustainable economic development as one of its top priorities. The Green Credit Policy issued by the government imposes certain requirements on bank loans, making it easier for enterprises focusing on sustainable development and implementing green governance to obtain bank loans than for those with high-pollution projects. Through empirical tests, studies prove the effectiveness of the Green Credit Policy in China in recent years (e.g., Wang et al., 2020). For example, using the difference-in-differences (DID) method and taking the Green Credit Guidelines (GCG) promulgated in 2012 as a quasi-natural experiment, Liu et al. (2019) find that under the guidance of the GCG policy, the financing capability of enterprises that implement green governance measures can be improved.

Correspondingly, in the environmental, social and governance (ESG) literature, many studies examine the effect of ESG performance on financial constraints in terms of two primary means of external financing: equity financing and debt financing. These studies conclude that better ESG performance tends to correspond with fewer financial constraints. Specifically, in the equity market, using a sample from the Standard and Poor's (S&P) 500, Sharfman and Fernando (2008) find that enterprises benefit from improved environmental risk management through a reduction in their cost of equity capital. El Ghoul et al. (2011) find that corporations with better CSR scores obtain cheaper equity financing. In contrast, the cost of equity for enterprises involved in the tobacco and nuclear power industries is high. In addition, Chava (2014) provides evidence that enterprises associated with climate change problems have a significantly higher cost of equity than other enterprises. In the debt market, using a sample of 3,996 loans to US enterprises, Goss and Roberts (2011) examine the link between CSR and bank debt and find that enterprises with social responsibility concerns pay between 7 and 18 basis points more than enterprises that are more socially responsible. A study by Schneider (2011) supports the hypothesis that an enterprise's environmental performance is reflected in its bond pricing. Poor environmental performance presents a significant downside risk of future cleanup and compliance costs, which may be large enough to threaten the ability of polluting enterprises to meet their fixed payments to creditors. Similarly, Du et al. (2017) and Jung et al. (2018) document consistent evidence that corporate environmental performance is significantly negatively associated with the interest rate on debt.

Moreover, the government can also furnish financing support to enterprises that implement green innovation. Chen (2008) argues that enterprises' green governance activities stem from governmental requirements and encouragement. The government may provide incentives through a variety of subsidies to enterprises that demonstrate progress in green innovations, causing these enterprises' cash holdings to rise and thereby easing their financing constraints to some extent (Zhao and Chen, 2019). In the context of indirect financing, certain studies suggest that the government can help enterprises displaying good environmental performance to improve their relationship with banks, thus easing corporate financing restrictions (Borghesi et al., 2014; Hou et al., 2018).

Another green governance behavior involves corporate environmental information disclosure. Environmental disclosure helps stakeholders learn about corporate participation in green activities. First, corporate financing difficulties are caused by information asymmetry to a great extent (Stiglitz, 2000). Glosten and Milgrom (1985) demonstrate that timely information disclosure to external investors can effectively reduce information asymmetry problems and thereby mitigate financing constraints. Enterprises' environmental dis-

closure can play a similar role. Orens et al. (2010) show that non-financial information disclosure is beneficial in decreasing enterprises' financing costs, because corporate disclosure of environmental performance can reduce information asymmetry between creditors and enterprises by leading green investors to think that the investment value of the enterprise has increased.

In addition, according to the signaling theory, Fuente et al. (2017) claim that when an enterprise expresses environmental protection concepts to its stakeholders through environmental information disclosure, the investors receive a signal that the enterprise will carry out green practices, causing them to invest more in the enterprise. Using the annual ESG scores of target enterprises, Cheng et al. (2014) construct the comprehensive CSR index. Their study finds a negative correlation between CSR performance and corporate financing constraints and finds that better transparency of CSR performance is beneficial to reducing capital constraints. Given the above arguments, the following hypothesis is proposed:

**Hypothesis 1.** *Corporate green governance mitigates the financing constraints of heavily polluting enterprises.*

### *2.3. Green governance, financial ecological environment and financing constraints*

Demirgüç-Kunt and Maksimovic (1996) point out that the development of a regional finance system can affect the financing ability of local enterprises. A ''good financial ecological environment'' refers to a region with a relatively high degree of financial marketization, developed macro economy, sound legal system and less government intervention. Stakeholders' risk preferences and attention to corporate environmental risks vary according to the relevant financial ecological environment (Mitton, 2008); therefore, differences in the regional financial ecological environment may affect the relationship between green governance and financing constraints differently.

First, for economically underdeveloped areas, local governments and financial institutions may place less importance on green governance activities. Under increased economic development pressure, a local government may choose to sacrifice long-term environment performance to focus on short-term economic interests (Liu et al., 2019). Therefore, in regions with poorer macroeconomic environments, the positive correlation between green governance and corporate financing ability may be weakened. In contrast, in areas with good economic development, local governments value the dual goals of environmental protection and economic performance. As a unique and long-term competitive advantage for enterprises, green governance is readily valued by the government and other stakeholders. Thus, in areas with strong economic development, the implementation of green governance activities can effectively improve enterprises' financing capacity.

Furthermore, in areas where financial services are underdeveloped, information asymmetry is more severe, potentially causing corporate financing costs to increase (Diamond, 1991). Specifically, since the introduction of the Green Credit Policy, financial institutions perception of the risk of lending to heavily polluting enterprises has increased. Compared to those in areas with better financial development, financial institutions in weaker financial ecological environments cannot accurately perceive the investment risk with regard to enterprises associated with heavy pollution because of serious information asymmetries (Liu et al., 2019). Consequently, even if polluting enterprises implement green governance measures, insufficient environmental information disclosure hinders stakeholders' ability to quickly and effectively identify the risks of the enterprises, preventing banks and other creditors from relaxing the financing constraints on these enterprises. We therefore propose the following hypothesis:

**Hypothesis 2.** *The negative relationship between green governance and corporate financing constraints is pronounced in regions with strong financial ecological environments.*

### *2.4. Green governance, nature of equity and financing constraints*

Wang et al. (2020) provide evidence that since the promulgation of a series of green financial policies, heavily polluting enterprises have incurred increased environmental regulatory costs and faced increased public pressure and environmental litigation risks; thus, the financing capacity of heavily polluting enterprises has dropped significantly. First, as China's financial system is still dominated by state-owned banks, the govern-

ment has retained extensive intervention in the system, both in determining lending rates and in rationing credit (Chen, 2019). Jiang and Zeng (2014) show that the Chinese government pressures financial institutions to lend primarily to SOEs and to discriminate against privately owned enterprises. As a result, SOEs are bailed out by the government when they face financial problems, while non-SOEs are less likely to receive government assistance. Moreover, Liu et al. (2019) find that the Green Credit Policy puts more significant restrictions on the financing ability of high-polluting SOEs relative than on private, heavily polluting enterprises. Because SOEs enjoy government guarantees and financing convenience, they correspondingly undertake more national policy-oriented tasks (Liu et al., 2019). Therefore, following the issuance of green finance-related policies such as the Green Credit Guidelines, the Chinese government requires banks to reduce credit and shorten debt maturities to SOEs in heavily polluting industries. Thus, SOEs are exposed to higher environmental regulatory costs, greater public pressure and higher credit risks than before the issuance of such policies. As credit allocation follows this political order, given the same level of corporate green governance, heavily polluting SOEs may obtain more financing support from the government and financial institutions than equally polluting private enterprises. Therefore, we propose the following hypothesis:

**Hypothesis 3.** *Green governance plays a more significant role in reducing the financing constraints of heavily polluting SOEs than of non-SOEs.*

## 3. Empirical methodology

### *3.1. Sample selection and data*

Using China A-share-listed heavily polluting enterprises as the sample, this paper mainly studies the relationship between green governance and financing behavior in heavily polluting industries. The government, financial institutions and enterprises have paid increasing attention to green development since ecological civilization was proposed in China in 2012. To optimize the collection of relevant data, the sample interval is set at 2013–2018. Following the 2013 MEP Notice, this paper defines "heavily polluting enterprises" as those that are required by the government to implement green governance. The 2013 MEP Notice sets key control zones, known as "three regions and ten clusters," and implements special emission limitations for air pollutants in these zones. The "three regions" refer to the Beijing–Tianjin–Hebei urban agglomeration, the Yangtze River Delta and the Pearl River Delta. The 10 urban clusters comprise 47 prefecture-level cities in 19 provinces. The 2013 MEP Notice further sets pollutant emission limits and green governance requirements for enterprises in six industries in these regions, including thermal power, steel, petrochemical processing, cement, nonferrous metals and chemicals. A listed enterprise belonging to one of these six industries and located in one of these regions or clusters is regarded as a heavy polluter. The industry classification of this paper refers to the Guidelines on Industry Classification of Listed Companies (Revised in 2012), issued by the China Securities Regulatory Commission.

To ensure the integrity of the disclosed enterprise data, the following screening process is carried out: (1) delete special treatment (ST) and particular transfer (PT) enterprises, and (2) eliminate enterprises with poor or incomplete financial data. Ultimately, 360 enterprises and 1,789 valid observations are collected. Table 1 presents the sample distribution by year and industry in Panels A and B, respectively. Panel A shows that the observations in the heavily polluting sector gradually increased between 2013 and 2018. As shown in Panel B, most of the observations are from the chemicals and nonmetallic mineral products industries. The petroleum processing, coking and nuclear fuel processing industry has the fewest observations, accounting for 3.8 % of the sample enterprises.

### *3.2. Measuring financing constraints*

To identify financing constraints, this paper follows the investment–cash flow sensitivity approach, which was first proposed by Fazzari et al. (1988). This approach holds that an enterprise's investment level largely depends on the availability of internal cash flow when financing restrictions are relatively serious. In contrast,

Table 1
Sample distribution by year and industry.

| Panel A: Composition by year | | |
|---|---|---|
| Year | Observations | Percentage |
| 2013 | 270 | 15.09 % |
| 2014 | 273 | 15.26 % |
| 2015 | 275 | 15.37 % |
| 2016 | 303 | 16.94 % |
| 2017 | 313 | 17.50 % |
| 2018 | 355 | 19.84 % |
| Total | 1,789 | 100 % |
| Panel B: Composition by industry | | |
| Industry Name | Observations | Percentage |
| Petroleum processing, coking and nuclear fuel processing | 68 | 3.800 % |
| Chemical raw materials and chemical products manufacturing | | |
| Non-metallic mineral products | | |
| Ferrous metal smelting and calendering | | |
| Non-ferrous metal smelting and calendering | | |
| Electricity and heat production and supply | | |
| Chemical raw materials and chemical products manufacturing | 720 | 40.25 % |
| Non-metallic mineral products | 329 | 18.39 % |
| Ferrous metal smelting and calendering | 151 | 8.440 % |
| Non-ferrous metal smelting and calendering | 211 | 11.79 % |
| Production and supply of electricity and heat | 310 | 17.33 % |
| Total | 1,789 | 100 % |

Note: This table presents the number of observations by year and industry in Panels A and B, respectively. The sample covers the 2013–2018 period and six heavily polluting industries. The industry classification refers to the Guidelines on Industry Classification of Listed Companies (Revised in 2012) issued by the China Securities Regulatory Commission.

if enterprises' financing constraints are not severe, the cost advantage of internal financing is also low; therefore, the investment expenditure level is less dependent on the availability of internal funds.

Thus, the dependent variable of the regression model is investment expenditure (*Invest*), and the enterprises' cash flow (*CF*) is the independent variable. An individual enterprise's (*i*'s) investment expenditure is measured by the cash paid for the purchase and construction of its fixed assets, intangible assets and other long-term assets, divided by total assets. *CF* is measured as net cash flow from the operations of enterprise *i*, divided by its total assets. If the coefficient of *CF* is positive and statistically significant, the enterprise has financing constraints.

### *3.3. Identifying green governance level*

The interaction between the green governance variable and corporate cash flow (*CF*) is the main independent variable and reflects the extent to which financing constraints vary with green governance levels. A significantly negative coefficient of the interaction term indicates that green governance alleviates enterprises' financing constraints. A different result indicates that it cannot. This paper uses two measures of enterprise-specific green governance: environmental performance and environmental information disclosure.

Following Shen et al. (2021), this study uses the receipt of a corporate environmental award (*EnAward*) to measure corporate environmental performance. Environmental awards involve third-party reviews of an enterprise's environmental performance, including its environmental management, resource use, compliance with environmental regulations and, ultimately, its environmental impact, such as carbon emissions and water pollution levels (Shen et al., 2021). Thus, environmental rewards reflect external recognition of an enterprise's excellent environmental performance and promote its good reputation. Research proves that environmental rewards contribute to the growth of an enterprise's market valuation (Klassen and McLaughlin, 1996).

Distinct types of corporate environmental awards can be awarded by national, provincial and municipal governments and by non-governmental organizations and other agencies. Such awards include the Cleaner

Production Award, Advanced Enterprise in Energy Conservation and Emission Reduction, Environmental Integrity Enterprise, Provincial Green Factory, China Resource-Saving and Environmentally-Friendly Enterprise. Following Shen et al. (2021), *EnAward* is a dummy variable that equals one if an enterprise received any award for its environmental performance in a particular year, and zero otherwise.

Another measure of corporate green governance is environmental information disclosure. As mentioned in the literature review above, stakeholders can determine enterprises' green governance status according to environmental information for the purpose of allocating more funds to industries that engage in environmental protection. However, at present, Chinese enterprises' environmental accounting information disclosure is insufficient. According to the Evaluation Report on Environmental Responsibility Information Disclosure of China's Listed Companies (2015), only 747 listed enterprises issued environmental information reports, accounting for about 27 % of all listed enterprises. Enterprises' current disclosure of their CSR rating, ESG index and other information reflecting their green governance level is incomplete in China. Furthermore, the relevant statistical data cover a short period (He et al., 2019). Therefore, with reference to Hu and Loh (2018), this study uses a dummy variable (*EnDIS*) indicating whether an enterprise has published a separate environmental report to test the environmental disclosure channel. *EnDIS* is equal to one if the enterprise published a CSR, ESG or sustainability report in a particular year, and zero otherwise.

Environmental award data are manually collected from corporate annual reports, CSR reports, ESG reports, sustainability reports and enterprise websites. Data on the release of an enterprise's environmental reports are collected from the China Stock Market & Accounting Research (CSMAR) database, enterprise websites and the Cninfo website (https://www.cninfo.com.cn), which is a listed enterprise information disclosure website designated by the China Securities Regulatory Commission.

### *3.4. Measurements of financial ecological environment and nature of equity*

To investigate the effect of differences in regional financial ecological environment development on the relationship between green governance and financing constraints, this study uses a financial development indicator (*FD*) as the proxy of the regional financial ecological environment. Aghion and Howitt (2008) point out that financial development should be a comprehensive indicator reflecting the strength of financial development in a country or region. To measure this financial development level, Goldsmith (1969) proposes using the index of financial interrelations ratio (*FIR*), which is defined as the ratio of the value of all financial assets from both primary and secondary financial markets to the national wealth (usually measured by the gross domestic product *GDP*). The relevant calculation model can be expressed as follows:

$$\mathrm{FIR} = (\mathrm{M2} + \mathrm{L} + \mathrm{S})/\mathrm{GDP}$$

where *M2* is broadly defined money, *L* is the amount of bank loans and *S* is the total value of securities. In general, finance influences the real economy through the accumulation and use of capital, and the main channels of this influence are financial intermediaries and the securities market. However, in China, the currently available statistical data on financial assets and *M2* in various regions are incomplete, and finance mainly affects the real economy through the credit system dominated by banks; therefore, the *FIR* index cannot be used directly. Accordingly, referring to Goldsmith (1969) and Liu et al. (2022), this paper uses financial institutions' deposit and loan data as a narrow measure of financial assets to reveal the level of financial development in China. The financial interrelations ratio of China (*FIRC*) can be measured as follows:

$$\mathrm{FIRC} = (\mathrm{D} + \mathrm{L})/\mathrm{GDP}$$

where *D* represents the total financial institution deposits and *L* represents the total loans of financial institutions. *FD* is a dummy variable that equals one if *FIRC* is above the sample median among regions, and zero otherwise. The entire sample is divided into regions with good financial development (*FD = 1*) and regions with weak financial development (*FD = 0*).

To study the various effects of green governance on the financing capacity of SOEs and non-SOEs in high-pollution industries, another dummy variable (*SOE*) is introduced. *SOE* is equal to one for SOEs, and zero for other enterprises. Data on the total deposits and loans of financial institutions are obtained from the People's Bank of China, and the regional GDP data are from the National Bureau of Statistics of China.

### 3.5. Control variables

To accurately assess the effect of green governance on corporate financing constraints, this study also builds several control variables based on available research (Fazzari et al., 1988; Ryan et al., 2014). *Size* represents the enterprise scale, which equals the natural logarithm of total assets. *ROA* is the net profit on an enterprise's assets. *Struc* represents the proportion of an enterprise's fixed assets. *Grow* stands for the operating revenue growth rate. *Lev* is the corporate debt ratio. *Q* represents investment opportunity. As the development status of China's capital market makes it difficult to measure investment opportunities using Tobin's Q (Zhao et al., 2019), this paper uses the future–current investment ratio to identify investment opportunity by drawing on the measurement proposed by Almeida et al. (2004). The calculation formula is $\frac{I_{i,t+1}+I_{i,t+2}}{I_{it}}$, where $I$ represents investment expenditure. All of the financial data and the nature of equity data are derived from the CSMAR database. To eliminate the influence of extreme values on the regression results, the study winsorizes the variables at the 1 % level. Table A.1 in Appendix A illustrates the detailed definitions of all variables.

### 3.6. Model setting

Following the investment–cash flow sensitivity approach, based on the models set by Fazarri et al. (1988), Custódio and Metzger (2014) and Ryan et al. (2014), the basic regression model (1) is constructed as follows:

$$Invest_{i,t} = \alpha_0 + \beta_1 CF_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 ROA_{i,t-1} + \beta_4 Struc_{i,t-1} + \beta_5 Grow_{i,t-1} + \beta_6 Lev_{i,t-1} + \beta_7 Q_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where $\varepsilon$ is the error term and $t$ represents the observation period from 2013 to 2018. It is worth noting that the explanatory variables in the model are lagged by one period to ease endogeneity problems and potential reverse causality between the explained variable (*Invest*) and explanatory variables (Ryan et al., 2014).

Further, to research the effect of green governance on the financing constraints of heavily polluting enterprises, we introduce corporate environmental awards (*EnAward*), corporate environment information disclosure (*EnDIS*) and their interaction terms with the cash flow of the sample enterprises (*EnAward* × *CF*, *EnDIS* × *CF*) into model (1) to construct models (2) and (3)[1] as follows:

$$Invest_{i,t} = \alpha_0 + \gamma_1 EnAward_{i,t-1} \times CF_{i,t-1} + \gamma_2 EnAward_{i,t-1} + \beta_1 CF_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 ROA_{i,t-1} + \beta_4 Struc_{i,t-1} + \beta_5 Grow_{i,t-1} + \beta_6 Lev_{i,t-1} + \beta_7 Q_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

$$Invest_{i,t} = \alpha_0 + \gamma_1 EnDIS_{i,t-1} \times CF_{i,t-1} + \gamma_2 EnDIS_{i,t-1} + \beta_1 CF_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 ROA_{i,t-1} + \beta_4 Struc_{i,t-1} + \beta_5 Grow_{i,t-1} + \beta_6 Lev_{i,t-1} + \beta_7 Q_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

To test Hypothesis 2, we divide the whole sample into two groups according to the level of regional financial development (low versus high), using the sub-samples to run further regressions. Similarly, we divide the whole sample into two groups according to the nature of corporate equity to test Hypothesis 3.

## 4. Empirical results

### 4.1. Descriptive statistics and analysis

Table 2 presents the descriptive statistical results of the main variables. *LCF*, *LGfinan*, *LSize*, *LROA*, *LStruc*, *LGrow*, *LLev* and *LQ* represent one lagged period of the corresponding variables. There are 1,789 observations. During the research period (2013–2018), the average value of corporate investment expenditure (*Invest*) is 0.0518; the minimum value of 0.0011 and maximum value of 0.2171 mean that there is a large dif-

[1] Some of the literature suggests that environmental performance and information disclosure variables are interrelated (e.g., Clarkson et al., 2008), affecting enterprises' financial constraints. The results are consistent if we include these two environmental governance variables simultaneously.

Table 2
Descriptive statistics of variables.

| Variable | Observations | Mean | p50 | SD | Min | Max |
|---|---|---|---|---|---|---|
| *Invest* | 1,789 | 0.0518 | 0.0416 | 0.0426 | 0.0011 | 0.2171 |
| *CF* | 1,789 | 0.0557 | 0.0583 | 0.0672 | −0.1590 | 0.2434 |
| *EnAward* | 1,789 | 0.0632 | 0 | 0.2433 | 0 | 1 |
| *EnDIS* | 1,789 | 0.2582 | 0 | 0.4378 | 0 | 1 |
| *Size* | 1,789 | 22.4408 | 22.1653 | 1.3933 | 19.7773 | 26.3153 |
| *ROA* | 1,789 | 0.0357 | 0.0322 | 0.0613 | −0.1987 | 0.2191 |
| *Struc* | 1,789 | 0.3627 | 0.3470 | 0.1869 | 0.0275 | 0.8067 |
| *Grow* | 1,789 | 0.2412 | 0.0607 | 1.0208 | −0.7891 | 7.9695 |
| *Lev* | 1,789 | 0.4554 | 0.4602 | 0.2153 | 0.0594 | 0.9478 |
| *Q* | 1,789 | 2.9121 | 1.8625 | 3.8788 | 0.2621 | 28.7543 |
| *FD* | 1,789 | 0.7272 | 1 | 0.4455 | 0 | 1 |
| *SOE* | 1,789 | 0.4835 | 0 | 0.4999 | 0 | 1 |
| *LCF* | 1,789 | 0.0529 | 0.0555 | 0.0686 | −0.1921 | 0.2383 |
| *LEnAward* | 1,789 | 0.0660 | 0 | 0.2483 | 0 | 1 |
| *LEnDIS* | 1,789 | 0.2359 | 0 | 0.4247 | 0 | 1 |
| *LSize* | 1,789 | 22.3300 | 22.0434 | 1.4066 | 19.6937 | 26.2850 |
| *LROA* | 1,789 | 0.0343 | 0.0311 | 0.0564 | −0.1768 | 0.1910 |
| *LStruc* | 1,789 | 0.3622 | 0.3480 | 0.1872 | 0.0275 | 0.8302 |
| *LGrow* | 1,789 | 0.2555 | 0.0669 | 1.0205 | −0.7891 | 7.7483 |
| *LLev* | 1,789 | 0.4571 | 0.4651 | 0.2220 | 0.0546 | 0.9523 |
| *LQ* | 1,789 | 2.6925 | 1.7953 | 3.2644 | 0.2601 | 22.8389 |

Note: The definitions of the variables can be found in Table A.1.

ference in investment expenditure among enterprises. The mean of corporate cash flow (*CF*) is 0.0557, with a minimum value of –0.159 and maximum value of 0.2434, indicating that the difference in internal cash flow among enterprises is also large. The mean *EnAward* is 0.0632, which indicates that, on average, 6.32 % of the sample observations were of enterprises that had obtained environmental awards. This value is larger than that found by Shen et al. (2021). A possible reason for this is that our research period is 2013–2018, while Shen et al.'s (2021) research period is 2007–2015. In recent years, enterprises' environmental performance and environmental awards have improved in response to stakeholders' increasing attention to green development. In addition, the mean value of *EnDIS* is 0.2582, which is approximately 0.08 higher than that obtained statistically by Zhang et al. (2020), who take only listed private enterprises as the sample. In contrast, our observation sample includes both listed SOEs and private enterprises. Therefore, the average value of *EnDIS* indicates that less than 26 % of A-share listed heavy polluting enterprises in China disclose environmental information. Moreover, the mean of the regional financial ecological environmental level (*FD*) is 0.7272, indicating that 72.72 % of the sample enterprises are in good financial ecological environment areas and the remaining 27.28 % are in weaker financial ecological environment areas. In all, 48.35 % of the sample observations are of SOEs.

With regard to control variables, the return ratio (*ROA*), fixed assets ratio (*Struc*), operating revenue growth rate (*Grow*) and corporate debt ratio (*Lev*) vary between the sample enterprises. The standard deviations of *Size*, *Grow* and *Q* are 1.3933, 1.0208 and 3.8788, respectively, indicating volatility and differences among enterprises in terms of enterprise size, operating income and investment opportunities, which may affect the investment expenditure.

### *4.2. Correlation analysis*

We test the correlations between the main variables and show the results in Table 3. As shown, there is a significant positive correlation at the 1 % level between *Invest* and one-period lagged *CF* (*LCF*), which preliminarily indicates that high-pollution enterprises display significant investment cash flow sensitivity and that the empirical approach chosen for this study is reasonable. In addition, the correlation between *LEnAward* and *LEnDIS* is equal to 0.3244 and statistically significant at the 1 % level, implying that corporate environmental

Table 3
Correlation coefficients of main variables.

| | *Invest* | *LCF* | *LEnAward* | *LEnDIS* | *LSize* | *LROA* | *LStruc* | *LGrow* | *LLev* | *LQ* | VIF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Invest* | 1 | | | | | | | | | | – |
| *LCF* | 0.1356*** | 1 | | | | | | | | | 1.29 |
| *LEnAward* | −0.0840*** | 0.0378 | 1 | | | | | | | | 1.13 |
| *LEnDIS* | −0.1329 | 0.0410 | 0.3244*** | 1 | | | | | | | 1.27 |
| *LSize* | −0.0074 | 0.1876*** | 0.2155*** | 0.3724*** | 1 | | | | | | 1.84 |
| *LROA* | 0.2615*** | 0.2940*** | −0.0202 | −0.0647*** | −0.0926*** | 1 | | | | | 1.52 |
| *LStruc* | 0.0028 | 0.2859*** | 0.0709*** | 0.1411*** | 0.4282*** | −0.2224*** | 1 | | | | 1.45 |
| *LGrow* | 0.0072 | −0.0309 | −0.0436* | −0.0527** | −0.0663*** | 0.0110 | −0.0447* | 1 | | | 1.02 |
| *LLev* | −0.0735*** | −0.0661*** | 0.0891*** | 0.1289*** | 0.5072*** | −0.4708*** | 0.3583*** | 0.0359 | 1 | | 1.85 |
| *LQ* | 0.0304 | −0.0566*** | −0.0255 | −0.0711*** | −0.0875*** | −0.0146 | −0.1084*** | 0.0581** | −0.0099 | 1 | 1.02 |

Note: *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. VIF is the variance inflation factor. The definitions of the variables can be found in Table A.1.

Table 4
Regression results of green governance and financing constraints.

| | (1) *Invest* | (2) *Invest* | (3) *Invest* | (4) *Invest* | (5) *Invest* | (6) *Invest* |
|---|---|---|---|---|---|---|
| *LCF* | 0.0324* | 0.0285* | 0.0391** | 0.0346** | 0.0444** | 0.0397** |
| | (0.0168) | (0.0166) | (0.0174) | (0.0171) | (0.0190) | (0.0186) |
| *LCF* × *LEnAward* | | | −0.1328*** | −0.1211*** | | |
| | | | (0.0416) | (0.0423) | | |
| *LEnAward* | | | −0.0061* | −0.0090** | | |
| | | | (0.0035) | (0.0038) | | |
| *LCF* × *LEnDIS* | | | | | −0.0807*** | −0.0709** |
| | | | | | (0.0306) | (0.0302) |
| *LEnDIS* | | | | | −0.0088*** | −0.0099*** |
| | | | | | (0.0028) | (0.0027) |
| *LSize* | −0.0013 | 0.0001 | −0.0007 | 0.0008 | 0.0003 | 0.0018** |
| | (0.0009) | (0.0009) | (0.0009) | (0.0009) | (0.0009) | (0.0009) |
| *LROA* | 0.2161*** | 0.1948*** | 0.2164*** | 0.1949*** | 0.2103*** | 0.1883*** |
| | (0.0224) | (0.0221) | (0.0222) | (0.0219) | (0.0225) | (0.0223) |
| *LStruc* | 0.0113* | 0.0021 | 0.0108* | 0.0017 | 0.0113* | 0.0020 |
| | (0.0061) | (0.0064) | (0.0061) | (0.0064) | (0.0062) | (0.0064) |
| *LGrow* | 0.00001 | −0.0005 | −0.0001 | −0.0006 | −0.0002 | −0.0007 |
| | (0.0009) | (0.0010) | (0.0009) | (0.0010) | (0.0010) | (0.0010) |
| *LLev* | 0.0133** | 0.0081 | 0.0131** | 0.0075 | 0.0110* | 0.0058 |
| | (0.0063) | (0.0062) | (0.0063) | (0.0062) | (0.0064) | (0.0063) |
| *LQ* | 0.0005 | 0.0008** | 0.0005 | 0.0008** | 0.0005 | 0.0007* |
| | (0.0004) | (0.0004) | (0.0004) | (0.0004) | (0.0004) | (0.0004) |
| Year | No | Yes | No | Yes | No | Yes |
| Industry | No | Yes | No | Yes | No | Yes |
| Constant | 0.0607*** | 0.0274 | 0.0483*** | 0.0135 | 0.0279 | −0.0074 |
| | (0.0172) | (0.0191) | (0.0174) | (0.0193) | (0.0178) | (0.0194) |
| Observations | 1,789 | 1,789 | 1,789 | 1,789 | 1,789 | 1,789 |
| Adj. R-square | 0.0749 | 0.1150 | 0.0828 | 0.1250 | 0.0916 | 0.1330 |

Note: All of the explanatory variables are lagged by one year to alleviate the endogeneity problem. Heteroskedasticity-consistent standard errors are reported in parentheses. *, ** and *** represent $p < 0.1$, $p < 0.05$ and $p < 0.01$, respectively. Industry- and year-fixed effects are considered in Columns (2), (4) and (6). The definitions of the variables can be found in Table A.1.

performance and environmental information disclosure variables are significantly correlated. The correlation coefficients among the major variables are all less than 0.6 (Lee, 2006), and the variance inflation factor of each variable is below 10 (Li et al., 2020), both of which results confirm that there are no serious multicollinearity problems among the variables.

### *4.3. Regression results analysis*

Table 4 shows the regression results for Hypothesis 1. As mentioned above, to apply the investment–cash flow sensitivity model, all of the explanatory variables are lagged by one year to resolve the endogeneity problem. The first two columns show the regression results of model (1). Columns (3) and (4) show the regression results of model (2). Moreover, Columns (5) and (6) show the regression results of model (3). The regression models in Columns (2), (4) and (6) are controlled for year- and industry-fixed effects.

According to the adjusted R-square values in Table 4, the fitting degree of the baseline model is improved after both the inclusion of the green governance variables and their interaction with cash flow, and the inclusion of time and industry dummy variables. Specifically, Columns (1) and (2) show that the estimated coefficients of *LCF* are 0.0324 and 0.0285, respectively, and both are significant at the 10 % level. In other words, heavily polluting enterprises show an investment–cash flow sensitivity, which indicates that enterprises in heavily polluting industries are generally limited by financing constraints and that the baseline model selected in this paper is reasonable. In addition, Columns (3) and (4) investigate the effect of environmental perfor-

Table 5
Sub-sample regressions based on the regional financial development level.

| | High-financial development areas | | Low-financial development areas | |
|---|---|---|---|---|
| | (1) *Invest* | (2) *Invest* | (3) *Invest* | (4) *Invest* |
| *LCF* | 0.0386** | 0.0494** | −0.0041 | −0.0195 |
| | (0.0190) | (0.0202) | (0.0342) | (0.0371) |
| *LCF × LEnAward* | −0.1560*** | | −0.0595 | |
| | (0.0510) | | (0.0804) | |
| *LEnAward* | −0.0076 | | −0.0044 | |
| | (0.0048) | | (0.0057) | |
| *LCF × LEnDIS* | | −0.1114*** | | 0.0589 |
| | | (0.0358) | | (0.0536) |
| *LEnDIS* | | −0.0090*** | | −0.0142*** |
| | | (0.0033) | | (0.0043) |
| *LSize* | 0.0029*** | 0.0042*** | −0.0050** | −0.0038* |
| | (0.0011) | (0.0011) | (0.0020) | (0.0019) |
| *LROA* | 0.1838*** | 0.1779*** | 0.1968*** | 0.1909*** |
| | (0.0243) | (0.0246) | (0.0422) | (0.0429) |
| *LStruc* | 0.0109 | 0.0110 | −0.0088 | −0.0079 |
| | (0.0082) | (0.0082) | (0.0097) | (0.0097) |
| *LGrow* | −0.0019 | −0.0022 | −0.0010 | −0.0012 |
| | (0.0013) | (0.0014) | (0.0015) | (0.0015) |
| *LLev* | −0.0020 | −0.0028 | 0.0352*** | 0.0299** |
| | (0.0070) | (0.0071) | (0.0124) | (0.0123) |
| *LQ* | 0.0009* | 0.0008 | 0.0011** | 0.0010* |
| | (0.0005) | (0.0005) | (0.0005) | (0.0005) |
| Year | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes |
| Constant | −0.0242 | −0.0507** | 0.1439*** | 0.1205*** |
| | (0.0222) | (0.0224) | (0.0422) | (0.0414) |
| Observations | 1,301 | 1,301 | 488 | 488 |
| Adj. R-squared | 0.1198 | 0.1316 | 0.2101 | 0.2213 |

Note: All of the regressions are controlled for industry- and year-fixed effects. All of the explanatory variables are lagged by one year to alleviate the endogeneity problem. Heteroskedasticity-consistent standard errors are reported in parentheses. *, ** and *** represent $p < 0.1$, $p < 0.05$ and $p < 0.01$, respectively. The definitions of the variables can be found in Table A.1.

mance on the financing constraints on polluting enterprises. The results show that the estimated coefficients of *LCF × LEnAward* are both negatively significant at the 1 % level. This indicates that improving corporate environmental performance reduces investment–cash flow sensitivity and mitigates the financing constraints on heavily polluting enterprises. Similarly, Columns (5) and (6) display the relationship between corporate environmental information disclosure and corporate financing constraints. The regression results show that the estimated coefficients of the term *LCF × LEnDIS* are negatively significant at the 1 % and 5 % levels, respectively, indicating that the increased disclosure of environmental information helps enterprises ease financing constraints. Therefore, Hypothesis 1 is supported.

To further investigate the effect of regional financial ecological environment differences on the relationship between green governance and corporate financing constraints, we divide the full sample according to the level of financial development in the enterprises' areas. The relevant regression results are shown in Table 5, and the year and industry dummies are included in all of the regressions to control for any variations in time and industry.

Columns (1) and (2) in Table 5 display the regression results of the sample of enterprises in good financial ecological environments. The results show that the estimated coefficients of the interaction terms, *LCF × LEnAward* and *LCF × LEnDIS*, are both significantly negative at the 1 % significance level, showing that in areas with high levels of financial development, engaging in green governance activities, including green innovation and environmental information disclosure, helps heavily polluting enterprises to significantly improve their

Table 6
Sub-sample regressions based on the nature of corporate equity.

| | State-owned enterprises | | Privately owned enterprises | |
|---|---|---|---|---|
| | (1) *Invest* | (2) *Invest* | (3) *Invest* | (4) *Invest* |
| *LCF* | 0.0728*** | 0.0875*** | 0.0058 | 0.0108 |
| | (0.0253) | (0.0290) | (0.0231) | (0.0245) |
| *LCF* × *LEnAward* | −0.1410** | | −0.0885 | |
| | (0.0563) | | (0.0597) | |
| *LEnAward* | −0.0097* | | −0.0069 | |
| | (0.0050) | | (0.0054) | |
| *LCF* × *LEnDIS* | | −0.1178*** | | −0.0617 |
| | | (0.0405) | | (0.0452) |
| *LEnDIS* | | −0.0088** | | −0.0050 |
| | | (0.0036) | | (0.0045) |
| *LSize* | 0.0034*** | 0.0048*** | −0.0016 | −0.0013 |
| | (0.0012) | (0.0012) | (0.0016) | (0.0016) |
| *LROA* | 0.1466*** | 0.1310*** | 0.2315*** | 0.2349*** |
| | (0.0293) | (0.0296) | (0.0317) | (0.0319) |
| *LStruc* | −0.0026 | −0.0038 | 0.0149 | 0.0157 |
| | (0.0084) | (0.0085) | (0.0097) | (0.0097) |
| *LGrow* | 0.0001 | −0.0002 | −0.0006 | −0.0007 |
| | (0.0009) | (0.0009) | (0.0022) | (0.0022) |
| *LLev* | 0.0172* | 0.0109 | 0.0044 | 0.0056 |
| | (0.0090) | (0.0092) | (0.0085) | (0.0086) |
| *LQ* | 0.0006 | 0.0004 | 0.0016*** | 0.0015** |
| | (0.0005) | (0.0005) | (0.0006) | (0.0006) |
| Year | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes |
| Constant | −0.0516** | −0.0751*** | 0.0823** | 0.0755** |
| | (0.0238) | (0.0239) | (0.0356) | (0.0355) |
| Observations | 865 | 865 | 924 | 924 |
| Adj. R-squared | 0.1703 | 0.1860 | 0.1137 | 0.1150 |

Note: All of the regressions are controlled for industry- and year-fixed effects. All of the explanatory variables are lagged by one year to alleviate endogeneity problem. Heteroskedasticity-consistent standard errors are reported in parentheses. *, ** and *** represent $p < 0.1$, $p < 0.05$ and $p < 0.01$, respectively. The definitions of the variables can be found in Table A.1.

financing capability. In contrast, for the sample of enterprises in relatively weak financial ecological environments, the estimated coefficients of the interaction terms are not significant in either Column (3) or Column (4), indicating that in regions of lower financial development levels, the financing constraints on heavily polluting enterprises cannot be easily alleviated by green governance practices. To summarize, the regression results shown in Table 5 confirm that in areas with better financial development, green governance has a more significant effect on the easing of corporate financing constraints; thus, Hypothesis 2 is supported.

Similarly, to investigate the effect of the nature of corporate equity on the relationship between green governance and corporate financing constraints, we divide the full sample into two groups: SOEs and privately owned enterprises. The relevant regression results are shown in Table 6, and the year and industry dummies are included in all of the regressions to control for any variations in time or industry.

In Table 6, Columns (1) and (2) show the regression results of the sample of SOEs. The estimated coefficient of the interaction term *LCF* × *LEnAward* (–0.141) is negatively significant at the 5 % level, and the estimated coefficient of *LCF* × *LEnDIS* (–0.118) is negatively significant at the 1 % level, indicating that financing constraints on heavily polluting SOEs are alleviated by green governance. However, the regression results in Columns (3) and (4) demonstrate that the interaction terms are insignificant. Therefore, the regression results in Table 6 prove that the same degree of green governance more significantly alleviates the financing constraints on heavily polluting SOEs than on privately owned enterprises, supporting Hypothesis 3.

Table 7
Regression results of the cash-flow sensitivity of cash model.

| | (1) *dCash* | (2) *dCash* | (3) *dCash* |
|---|---|---|---|
| *CF* | 0.0568* | 0.0661** | 0.0768** |
| | (0.0296) | (0.0298) | (0.0328) |
| *CF* × *EnAward* | | −0.1696** | |
| | | (0.0842) | |
| *EnAward* | | 0.0017 | |
| | | (0.0081) | |
| *CF* × *EnDIS* | | | −0.1051* |
| | | | (0.0552) |
| *EnDIS* | | | 0.0093* |
| | | | (0.0050) |
| *Size* | 0.0027** | 0.0030*** | 0.0022* |
| | (0.0011) | (0.0011) | (0.0012) |
| *Q* | 0.0019*** | 0.0019*** | 0.0019*** |
| | (0.0005) | (0.0005) | (0.0005) |
| *Expen* | −0.2120*** | −0.2167*** | −0.2115*** |
| | (0.0389) | (0.0391) | (0.0390) |
| *dSD* | −0.4529*** | −0.4537*** | −0.4550*** |
| | (0.0433) | (0.0435) | (0.0434) |
| *dNWC* | −0.4045*** | −0.4051*** | −0.4074*** |
| | (0.0350) | (0.0351) | (0.0349) |
| *ROA* | 0.1995*** | 0.2010*** | 0.2019*** |
| | (0.0418) | (0.0418) | (0.0416) |
| Year | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes |
| Constant | −0.0757*** | −0.0811*** | −0.0667** |
| | (0.0243) | (0.0247) | (0.0265) |
| Observations | 1,789 | 1,789 | 1,789 |
| Adj. R-squared | 0.2523 | 0.2538 | 0.2533 |

Note: All of the regressions are controlled for industry- and year-fixed effects. Heteroskedasticity-consistent standard errors are reported in parentheses. *, ** and *** represent $p < 0.1$, $p < 0.05$ and $p < 0.01$, respectively. The definitions of the variables can be found in Table A.1.

## 5. Robustness tests

### *5.1. Using the cash–cash flow sensitivity model to identify financing constraints*

To test the robustness of the relationship between green governance levels and financing constraints on heavily polluting enterprises, this paper also adopts the cash–flow sensitivity model proposed by Almeida et al. (2004) to measure enterprises' financing constraints. The model states that if the relationship between corporate cash flow and changes in cash holdings is significantly positive, corporate financing ability is constrained. Referring to the benchmark model in Almeida et al. (2004) and other literature, for example, Zhang et al. (2020), our model is set as follows:

$$\mathrm{dCash}_{i,t} = \alpha_0 + \beta_1 \mathrm{CF}_{i,t} + \beta_2 \mathrm{Size}_{i,t} + \beta_3 \mathrm{Q}_{i,t} + \beta_4 \mathrm{Expen}_{i,t} + \beta_5 \mathrm{dSD}_{i,t} + \beta_6 \mathrm{dNWC}_{i,t} + \beta_7 \mathrm{ROA}_{i,t} + \varepsilon_{i,t} \quad (4)$$

where the dependent variable is the change in corporate cash holdings (*dCash*). The explanatory variables *CF*, *Size*, *Q* and *ROA* are defined as above in the investment–cash flow sensitivity model. *Expen* is the enterprise's capital expenditure. *dSD* means the change in short-term debt. *dNWC* represents the change in non-cash net working capital. The variable definitions are provided in more detail in Table A.1 in Appendix A.

Similarly, *EnAward*, *EnDIS* and the interaction terms *CF* × *EnAward* and *CF* × *EnDIS* are included in model (4) to construct the extended models (5) and (6) to empirically test the relationship between green governance and corporate financing ability.

Table 8
Robustness tests controlling additional variables for H1.

| | (1) *Invest* | (2) *Invest* | (3) *Invest* |
|---|---|---|---|
| *LCF* | 0.0291* | 0.0357** | 0.0446** |
| | (0.0164) | (0.0169) | (0.0183) |
| *LCF × LEnAward* | | −0.1193*** | |
| | | (0.0415) | |
| *LEnAward* | | −0.0117*** | |
| | | (0.0039) | |
| *LCF × LEnDIS* | | | −0.0858*** |
| | | | (0.0308) |
| *LEnDIS* | | | −0.0094*** |
| | | | (0.0028) |
| *LSize* | 0.0009 | 0.0016 | 0.0026** |
| | (0.0010) | (0.0010) | (0.0010) |
| *LROA* | 0.1821*** | 0.1816*** | 0.1745*** |
| | (0.0206) | (0.0203) | (0.0207) |
| *LStruc* | 0.0064 | 0.0060 | 0.0064 |
| | (0.0065) | (0.0064) | (0.0065) |
| *LGrow* | 0.0004 | 0.0004 | 0.0002 |
| | (0.0010) | (0.0010) | (0.0010) |
| *LLev* | 0.0065 | 0.0056 | 0.0041 |
| | (0.0062) | (0.0061) | (0.0062) |
| *LQ* | 0.0012** | 0.0012*** | 0.0011** |
| | (0.0005) | (0.0005) | (0.0005) |
| *LFirst* | 0.0001 | 0.0001 | 0.0001 |
| | (0.0001) | (0.0001) | (0.0001) |
| *LDual* | 0.0084*** | 0.0085*** | 0.0081*** |
| | (0.0027) | (0.0027) | (0.0027) |
| *LBoard* | 0.0080 | 0.0095 | 0.0085 |
| | (0.0059) | (0.0058) | (0.0058) |
| *LIndr* | 0.0052 | 0.0055 | 0.0040 |
| | (0.0235) | (0.0232) | (0.0230) |
| *LlnRGDP* | 0.0092*** | 0.0092*** | 0.0091*** |
| | (0.0013) | (0.0013) | (0.0013) |
| *LGDPGrow* | 0.0014** | 0.0013** | 0.0014** |
| | (0.0006) | (0.0006) | (0.0006) |
| *LCPI* | −0.0065*** | −0.0060** | −0.0054** |
| | (0.0025) | (0.0025) | (0.0025) |
| Year and Industry | Yes | Yes | Yes |
| Constant | 0.5561** | 0.4841* | 0.4113 |
| | (0.2552) | (0.2534) | (0.2513) |
| Observations | 1,665 | 1,665 | 1,665 |
| Adj. R-squared | 0.1427 | 0.1556 | 0.1624 |

Note: All of the regressions are controlled for industry- and year-fixed effects. All of the explanatory variables are lagged by one year to alleviate the endogeneity problem. Heteroskedasticity-consistent standard errors are reported in parentheses. *, ** and *** represent $p < 0.1$, $p < 0.05$ and $p < 0.01$, respectively. The definitions of the variables can be found in Table A.1.

$$\begin{aligned} dCash_{it} = {} & \alpha_0 + \beta_1 CF_{it} + \gamma_1 CF_{it} \times EnAward_{it} + \gamma_2 EnAward_{it} + \beta_2 Size_{it} + \beta_3 Q_{it} + \beta_4 Expen_{it} \\ & + \beta_5 dSD_{it} + \beta_6 dNWC_{it} + \beta_7 ROA_{it} + \varepsilon_{it} \end{aligned} \tag{5}$$

$$\begin{aligned} dCash_{it} = {} & \alpha_0 + \beta_1 CF_{it} + \gamma_1 CF_{it} \times EnDIS_{it} + \gamma_2 EnDIS_{it} + \beta_2 Size_{it} + \beta_3 Q_{it} + \beta_4 Expen_{it} + \beta_5 dSD_{it} \\ & + \beta_6 dNWC_{it} + \beta_7 ROA_{it} + \varepsilon_{it} \end{aligned} \tag{6}$$

Table 9
Robustness tests controlling additional variables for H2.

| | High-financial development areas | | Low-financial development areas | |
|---|---|---|---|---|
| | (1) *Invest* | (2) *Invest* | (5) *Invest* | (6) *Invest* |
| *LCF* | 0.0347* | 0.0490** | 0.0254 | 0.0128 |
| | (0.0198) | (0.0212) | (0.0305) | (0.0329) |
| *LCF × LEnAward* | −0.1757*** | | −0.0428 | |
| | (0.0504) | | (0.0758) | |
| *LEnAward* | −0.0081* | | −0.0101 | |
| | (0.0048) | | (0.0065) | |
| *LCF × LEnDIS* | | −0.1284*** | | 0.0533 |
| | | (0.0372) | | (0.0538) |
| *LEnDIS* | | −0.0074** | | −0.0163*** |
| | | (0.0035) | | (0.0045) |
| *LSize* | 0.0034*** | 0.0045*** | −0.0026 | −0.0013 |
| | (0.0011) | (0.0012) | (0.0022) | (0.0022) |
| *LROA* | 0.1919*** | 0.1866*** | 0.1438*** | 0.1380*** |
| | (0.0245) | (0.0249) | (0.0367) | (0.0376) |
| *LStruc* | 0.0118 | 0.0121 | −0.0075 | −0.0050 |
| | (0.0083) | (0.0083) | (0.0104) | (0.0104) |
| *LGrow* | −0.0009 | −0.0012 | −0.0006 | −0.0007 |
| | (0.0015) | (0.0016) | (0.0015) | (0.0015) |
| *LLev* | −0.0051 | −0.0051 | 0.0312** | 0.0244** |
| | (0.0070) | (0.0071) | (0.0125) | (0.0123) |
| *LQ* | 0.0014** | 0.0013** | 0.0012* | 0.0011* |
| | (0.0006) | (0.0006) | (0.0006) | (0.0006) |
| *LDual* | 0.0100*** | 0.0093*** | 0.0028 | 0.0038 |
| | (0.0032) | (0.0032) | (0.0052) | (0.0052) |
| *LBoard* | 0.0071 | 0.0044 | 0.0038 | 0.0090 |
| | (0.0067) | (0.0067) | (0.0121) | (0.0119) |
| *LIndr* | 0.0121 | 0.0041 | −0.0691 | −0.0489 |
| | (0.0265) | (0.0261) | (0.0453) | (0.0449) |
| *LFirst* | 0.0002* | 0.0002** | −0.0001 | −0.0001 |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| *LlnRGDP* | 0.0063*** | 0.0058** | 0.0098*** | 0.0100*** |
| | (0.0024) | (0.0024) | (0.0022) | (0.0022) |
| *LGDPGrow* | 0.0002 | 0.0005 | 0.0024*** | 0.0023*** |
| | (0.0011) | (0.0011) | (0.0009) | (0.0009) |
| *LCPI* | −0.0077*** | −0.0064** | 0.0023 | 0.0020 |
| | (0.0029) | (0.0028) | (0.0062) | (0.0062) |
| Year and Industry | Yes | Yes | Yes | Yes |
| Constant | 0.6587** | 0.5131* | −0.2439 | −0.2616 |
| | (0.2943) | (0.2882) | (0.6495) | (0.6508) |
| Observations | 1,223 | 1,223 | 442 | 442 |
| Adj. R-squared | 0.1467 | 0.1558 | 0.2250 | 0.2388 |

Note: All of the regressions are controlled for industry- and year-fixed effects. All of the explanatory variables are lagged by one year to alleviate the endogeneity problem. Heteroskedasticity-consistent standard errors are reported in parentheses. *, ** and *** represent $p < 0.1$, $p < 0.05$ and $p < 0.01$, respectively. The definitions of the variables can be found in Table A.1.

We use the cash–cash flow sensitivity approach to identify financing constraints, and the regression results are shown in Table 7. To avoid the influence of heteroscedasticity and clustering effects on the regression results, cluster-robust standard errors are used. The estimated coefficient (0.0568) of *CF* in Column (1) is positive and significant at the 10 % significance level, showing that financing constraints are widespread in high-pollution enterprises. Columns (2) and (3) show the results of testing the effect of green governance on the financing constraints on energy-intensive enterprises. In Column (2), the estimated coefficient of *CF* × *EnAward* is –0.1696, which is significant at the 5 % level, confirming that improving environmental performance alleviates the cash-flow sensitivity of cash and financing constraints on heavily polluting enterprises. In addi-

Table 10
Robustness tests controlling additional variables for H3.

| | State-owned enterprises | | Privately owned enterprises | |
|---|---|---|---|---|
| | (1) *Invest* | (2) *Invest* | (3) *Invest* | (4) *Invest* |
| *LCF* | 0.0782*** | 0.0951*** | 0.0168 | 0.0219 |
| | (0.0251) | (0.0284) | (0.0225) | (0.0239) |
| *LCF* × *LEnAward* | −0.1323** | | −0.0766 | |
| | (0.0558) | | (0.0635) | |
| *LEnAward* | −0.0136** | | −0.0089 | |
| | (0.0054) | | (0.0060) | |
| *LCF* × *LEnDIS* | | −0.1243*** | | −0.0564 |
| | | (0.0427) | | (0.0451) |
| *LEnDIS* | | −0.0100** | | −0.0051 |
| | | (0.0039) | | (0.0046) |
| *LSize* | 0.0043*** | 0.0056*** | −0.0006 | −0.0003 |
| | (0.0014) | (0.0014) | (0.0016) | (0.0016) |
| *LROA* | 0.1369*** | 0.1178*** | 0.2165*** | 0.2196*** |
| | (0.0290) | (0.0297) | (0.0299) | (0.0301) |
| *LStruc* | 0.0019 | 0.0014 | 0.0073 | 0.0082 |
| | (0.0090) | (0.0090) | (0.0099) | (0.0099) |
| *LGrow* | 0.0016 | 0.0014 | −0.0003 | −0.0004 |
| | (0.0011) | (0.0011) | (0.0020) | (0.0020) |
| *LLev* | 0.0142 | 0.0073 | −0.0009 | 0.0004 |
| | (0.0097) | (0.0098) | (0.0083) | (0.0084) |
| *LQ* | 0.0008 | 0.0006 | 0.0021*** | 0.0020*** |
| | (0.0006) | (0.0006) | (0.0007) | (0.0007) |
| *LDual* | 0.0016 | 0.0022 | 0.0077** | 0.0075** |
| | (0.0052) | (0.0051) | (0.0032) | (0.0032) |
| *LBoard* | 0.0136* | 0.0129* | −0.0018 | −0.0029 |
| | (0.0075) | (0.0072) | (0.0098) | (0.0100) |
| *LIndr* | 0.0212 | 0.0158 | −0.0233 | −0.0236 |
| | (0.0308) | (0.0296) | (0.0345) | (0.0345) |
| *LFirst* | −0.0002** | −0.0002* | 0.0003*** | 0.0003*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| *LlnRGDP* | 0.0063*** | 0.0065*** | 0.0092*** | 0.0091*** |
| | (0.0019) | (0.0019) | (0.0019) | (0.0019) |
| *LGDPGrow* | 0.0014* | 0.0014* | 0.0021** | 0.0021** |
| | (0.0008) | (0.0008) | (0.0010) | (0.0010) |
| *LCPI* | −0.0027 | −0.0016 | −0.0070* | −0.0071* |
| | (0.0032) | (0.0031) | (0.0039) | (0.0039) |
| Year and Industry | Yes | Yes | Yes | Yes |
| Constant | 0.1002 | −0.0319 | 0.6683* | 0.6703* |
| | (0.3276) | (0.3176) | (0.3943) | (0.3969) |
| Observations | 792 | 792 | 873 | 873 |
| Adj. R-squared | 0.1951 | 0.2118 | 0.1406 | 0.1410 |

Note: All of the regressions are controlled for industry- and year-fixed effects. All of the explanatory variables are lagged by one year to alleviate the endogeneity problem. Heteroskedasticity-consistent standard errors are reported in parentheses. *, ** and *** represent $p < 0.1$, $p < 0.05$ and $p < 0.01$, respectively. The definitions of the variables can be found in Table A.1.

tion, the regression results in Column (3) show that the estimated coefficient of *CF* × *EnDIS* is negatively significant at the 10 % level, indicating that corporate information disclosure is negatively related to financing constraints on heavily polluting enterprises. Therefore, Hypothesis 1 is supported by the robustness tests.

### 5.2. Additional control variables

Considering that important factors affecting the examined causal relationship may be ignored or omitted in the model regression analysis, this paper includes certain control variables in the basic model to conduct further robustness tests. As certain corporate governance factors may affect the relationship between green governance and cor-

porate financing constraints (Du et al., 2017), following Liu et al. (2019) and Li et al. (2020), this study adds four more controls related to corporate governance variables to the baseline model. Specifically, *Board* represents board size, *Indr* represents the proportion of independent directors in the boardroom, *First* is the percentage of shares owned by the largest shareholder and *Dual* is a dummy variable equaling 1 if the CEO is also the chairman of board, and zero otherwise. In addition, the literature shows that macroeconomic factors are likely to affect enterprises' financing behaviors (Hackbarth et al., 2006; Chen, 2010; Begenau and Salomao, 2019); therefore, we also control for certain major macroeconomic factors at the province level: the natural logarithm GDP (*lnRGDP*), real GDP growth rate (*GDPGrow*) and consumer price index (*CPI*). The variable definitions are provided in Table A.1 in Appendix A, and the measurement of the real GDP for each province is shown in Appendix B. All of the explanatory variables in the model are lagged by one period to address endogeneity problems and potential reverse causality between the explained variable and explanatory variables (Ryan et al., 2014).

The regression results are shown in Table 8. In Column (1), the estimated coefficient of *LCF* is significantly positive at the 10 % significance level, indicating that financing constraints are widespread in heavily polluting enterprises. In Columns (2) and (3), the estimated coefficients of $LCF \times LEnAward$ and $LCF \times LEnDIS$ are significantly negative at the 1 % level, showing that green governance practices alleviate investment cash-flow sensitivity and financing constraints on heavily polluting enterprises. Therefore, Hypothesis 1 is supported after controlling for additional corporate governance variables and macroeconomic factors; the results are robust.

Table 9 shows the regression results of sub-samples grouped according to regional differences in the level of financial development. Similar to the previous results, the estimated coefficients of the interaction terms $LCF \times LEnAward$ and $LCF \times LEnDIS$ are both significantly negative in Columns (1) and (2) but not significant in the last two columns, supporting the notion that green governance plays a more significant role in mitigating the financing constraints of heavily polluting enterprises in areas with higher levels of financial development than in those with lower levels of financial development, supporting Hypothesis 2. Furthermore, Table 10 presents the regression results for various types of ownership with additional corporate governance and macroeconomic control variables. The coefficients for $LCF \times LEnAward$ and $LCF \times LEnDIS$ are significantly negative for SOEs, while they are not significant for private enterprises. Thus, Hypothesis 3 is supported, and the results are robust.

## 6. Discussion

Consistent with Zhang et al. (2020), we provide additional evidence that green governance activities alleviate corporate financing constraints. This result may be attributable to financial support from vital stakeholders, including the public, the government and financial institutions, who endorse sustainable economic development as among China's most significant development priorities. Heavily polluting enterprises, a main focus of environmental governance, can improve their green innovation and green management to realize green production processes. In this way, they can reduce their resource costs and improve their enterprise efficiency and environmental performance, all of which helps enterprises to increase corporate value and future returns. As a consequence, investors increase their investment in these enterprises, mitigating corporate financing constraints to some extent. In addition, as polluting enterprises that implement green governance practices the Green Credit Policy, financial institutions are incentivized to increase the allocation of loans to them. Moreover, the government provides subsidies to encourage enterprises to develop green projects. Through indirect financial methods, the government may also help enterprises to build better relationships with financial institutions, increasing the enterprises' financing support from banks.

Moreover, increased environmental information disclosure helps enterprises reduce information asymmetry problems with external creditors. Specifically, if investors know more about an enterprise's ESG information, they have a better perception of their own investment risks, thus reducing the cost of loans to enterprises with good green governance and increasing the allocation of funds to such enterprises. Furthermore, through environmental information disclosure, enterprises improve their green reputation by signaling to stakeholders that they are committed to green development. This serves to attract more investment and funding support, increasing such enterprises' financing capability.

This study also finds that green governance plays a more significant role in promoting enterprises' financing capacity in better financial ecological environments than in weaker environments, for two main reasons. First,

in areas with higher levels of financial development, governments and other stakeholders pay more attention to green development. Consequently, shareholders provide increased support and banks tend to provide more loans to enterprises that develop green governance practices. In contrast, regions with weaker financial development face greater pressures for economic development, and local governments may therefore sacrifice long-term environmental benefits for short-term economic interests. Therefore, the negative correlation between green governance and financing constraints is weakened in such areas. Second, in regions with more sound financial systems, financial services are more developed and information disclosure is more efficient than in other regions; thus, it is easier for investors in the former regions to accurately identify enterprises' investment risks and subsequently grant more funds to enterprises that implement green governance activities, further mitigating the financing constraints on such enterprises.

In further research, this paper finds that the implementation of green governance helps heavily polluting SOEs to reduce financing constraints more significantly than heavily polluting private enterprises. Research shows that the financing constraints faced by heavily polluting enterprises have increased significantly since the introduction of green development policies (Wang et al., 2020). As the Chinese government intervenes extensively in the country's financial system, credit allocation generally follows the political order. Therefore, heavily polluting SOEs are likely to receive more financial support from the government and banks than heavily polluting private enterprises, all other conditions being equal, including the enterprises' levels of green governance.

## 7. Conclusion and implications

Selecting as its sample the A-share-listed Chinese enterprises in heavily polluting industries required to limit pollutant emissions and implement green governance practices under the 2013 MEP Notice, this paper investigates the relationship between green governance and corporate financing constraints during the 2013 to 2018 period. The results obtained by using the investment–cash flow sensitivity approach indicate that the improvement of green governance effectively reduces the financing constraints of heavily polluting enterprises. Moreover, green governance plays a more significant role in mitigating the financing constraints on heavily polluting enterprises in areas with higher levels of financial development than in other areas. In addition, the paper investigates the effect of the nature of corporate ownership on the relationship between green governance and financing constrains. The results show that green governance measures are more conducive to easing the financing constraints on heavily polluting SOEs than those on privately-owned enterprises.

The results of this paper have significant practical implications. A large number of Chinese enterprises face serious financing constraints, which prevent corporate development to a certain extent. This paper proposes a new channel that affects enterprises' financing. Specifically, enterprises can obtain more financing support from financial institutions and other investors by strengthening their environmental performance and environmental information disclosure. In addition, this study finds a way to achieve the dual goals of economic development and environmental protection. At present, many enterprises cite the high cost and low return of green governance as reasons why they are not willing to carry out green projects, which hinders sustainable economic development. However, our paper reveals that heavily polluting enterprises gain financial support from creditors by implementing green governance. This finding has great significance in terms of encouraging energy-intensive industries to realize industrial transformation, energy conservation and emissions reduction.

However, this paper has certain limitations that must be explored. First, this study only investigates the relationship between enterprises' green governance and financing constraints; however, green governance may also bring other economic consequences that are not considered in this paper, such as the impact on corporate investment behavior. Future research may seek to explore such economic consequences of green governance activities. In addition, heavily polluting enterprises are selected as the research sample in this study; however, the degree to which green governance alleviates the financing constraints on different types of enterprises may differ. Therefore, other types of enterprises, such as small and medium-sized enterprises (SMEs) and eco-friendly enterprises, may be selected for comparative study in the future.

## Appendix A:. Variable Definition

(See. Table A1.).

Table A1
Definition and description of variables.

| Variable Name | Symbol | Variable Definition | Data source |
|---|---|---|---|
| Investment expenditure | Invest | Cash paid for the purchase and construction of fixed assets, intangible assets and other long-term assets divided by total assets. | CSMAR |
| Cash flow | CF | Corporate net cash flow generated from operating activities divided by total assets | CSMAR |
| Environmental award | EnAward | Dummy variable; equaling 1 if the enterprise received any award for its environmental performance in a particular year, and zero otherwise. | Annual/CSR/ESG/ Sustainability report; firm website |
| Environmental information disclosure | EnDIS | Dummy variable; equaling 1 if the enterprise published one of the CSR, ESG, and sustainability reports in a particular year. and zero otherwise. | CSMAR; firm website; cninfo website |
| The financial interrelations ratio of China | FIRC | calculated by (D + L)/GDP; where D represents total financial institution deposits, L represents total loans of financial institutions. | The People's Bank of China; the National Bureau of Statistics |
| Regional financial development level | FD | Dummy variable; a region with high financial development level (if FIRC is above the sample median among regions) is 1, a region with low financial development level is 0. | The People's Bank of China; the National Bureau of Statistics |
| Equity nature | SOE | Dummy variable; SOE = 1 represents state-owned enterprises, SOE = 0 represents private enterprises. | CSMAR |
| Enterprise scale | Size | The natural log of total assets. | CSMAR |
| Investment opportunity | Q | The calculation formula is $\frac{I_{it+1}+I_{it+2}}{I_{it}}$, where I represents investment expenditure | CSMAR |
| Return on enterprise assets | ROA | Net profit on total assets. | CSMAR |
| Ratio of fixed assets of enterprises | Struc | Ratio of total fixed assets to total assets at the end of the period. | CSMAR |
| Enterprise growth | Grow | Measured by corporate operating revenue growth rate. | CSMAR |
| Corporate debt ratio | Lev | Measure by the ratio of total liabilities to total assets. | CSMAR |
| Capital expenditure | Expen | Cash paid for the purchase and construction of fixed assets, intangible assets and other long-term assets divided by total assets. | CSMAR |
| Change in corporate cash holdings | dCash | Cash is measured as the ratio of the holdings of cash and marketable securities to total assets. | CSMAR |
| Changes in short-term debt | dSD | SD equals the current liabilities to total assets of enterprises | CSMAR |
| Changes in non-cash net working capital | dNWC | NWC = (current assets - current liabilities - cash and cash equivalent)/total assets | CSMAR |
| Duality | Dual | Dummy variable; equaling 1 if the CEO is also the chairman of board, and zero otherwise | CSMAR |
| Board size | Board | The corporate board size. | CSMAR |
| Proportion of independent directors | Indr | The proportion of independent directors in the boardroom. | CSMAR |
| First shareholder's shareholding | First | The percentage of the shareholding owned by the largest shareholder. | CSMAR |
| GDP index (last year = 100) | GDPIndex | The relative number that reflects the trend and degree of variation of gross regional product in a certain period. This index is calculated on the basis of the previous year. | National Bureau of Statistics of China |
| Real gross domestic product | lnRGDP | Natural logarithm of real GDP of the province where a firm operates. | National Bureau of Statistics of China |
| Real gross domestic product growth rate | GDPGrow | Real GDP growth rate of the province where a firm operates. | National Bureau of Statistics of China |
| Consumer price index | CPI | Consumer price index of the province where a firm operates. | National Bureau of Statistics of China |

*Appendix B:. Measurement of real gross domestic product (RGDP)*

The data for nominal GDP, GDP index (last year = 100) and CPI of each province is downloaded from National Bureau of Statistics of China. GDP index (*GDPIndex*) refers to the relative number that reflects the trend and degree of variation of gross regional product in a certain period. This index is calculated on the basis of the previous year. According to the data published by the National Bureau of Statistics of China, the real GDP growth rate is equal to the GDP index minus 100. In addition, with the continuous development of the economy, the price structure of industries will also change constantly. According to the Chinese Statistical Yearbook, to strip out the effects of price changes, the calculation of real GDP requires adjustment of the base period every few years. Since China began to calculate its GDP, there have been nine constant price base years: 1952, 1957, 1970, 1980, 1990, 2000, 2005, 2010 and 2015. Because the sample interval of this paper is 2013–2018, 2010 is taken as the base year to calculate the real GDP of each province. Referring to the Chinese Statistical Yearbook, in the base year (2010), the real GDP is equal to the nominal GDP, and the formula of the real GDP of each year t for province j can be established as:

$$RGDP_{j,t} = RGDP_{j,t-1} * GDPIndex_{j,t}/100$$

## References


Aghion, P., Howitt, P.W., 2008. The Economics of Growth. MIT press.

Almeida, H., Campello, M., Weisbach, M.S., 2004. The Cash Flow Sensitivity of Cash. J. Fin. 59 (4), 1777–1804.

Begenau, J., Salomao, J., 2019. Firm Financing over the Business Cycle. Rev. Finan. Stud. 32 (4), 1235–1274.

Beladi, H., Chao, C.C., Hu, M., 2018. Does Tax Avoidance Behavior Affect Bank Loan Contracts for Chinese Listed Firms? Int. Rev. Finan. Anal. 58, 104–116.

Borghesi, R., Houston, J.F., Naranjo, A., 2014. Corporate Socially Responsible Investments: CEO Altruism, Reputation, and Shareholder Interests. Journal of Corporate Finance 26, 164–181.

Burns, B.L., Barney, J.B., Angus, R.W., Herrick, H.N., 2016. Enrolling Stakeholders under Conditions of Risk and Uncertainty. Strategic Entrepreneurship Journal 10 (1), 97–106.

Chava, S., 2014. Environmental Externalities and Cost of Capital. Manage. Sci. 60 (9), 2223–2247.

Chava, S., Livdan, D., Purnanandam, A., 2009. Do Shareholder Rights Affect the Cost of Bank Loans? Rev. Finan. Stud. 22 (8), 2973–3004.

Chen, Y.S., 2008. The Driver of Green Innovation and Green Image-Green Core Competence. J. Bus. Ethics 81 (3), 531–543.

Chen, H., 2010. Macroeconomic Conditions and the Puzzles of Credit Spreads and Capital Structure. J. Fin. 65 (6), 2171–2212.

Chen, Q., 2019. Has China's Green Credit Policy Been Effectively Implemented? An Analysis of Loan Scale and Cost Based on "Two Highs and One Surplus" Enterprises. Journal of Contemporary Finance and Economics 2, 117.

Cheng, B., Ioannou, I., Serafeim, G., 2014. Corporate Social Responsibility and Access to Finance. Strateg. Manag. J. 35 (1), 1–23.

Chu, S., Oldford, E., Gao, C., 2022. Does Social Capital Alleviate Financing Constraints? A Study of China's Creative Economy. Asia-Pacific Journal of Accounting & Economics, 1–24.

Clarkson, P.M., Li, Y., Richardson, G.D., Vasvari, F.P., 2008. Revisiting the Relation between Environmental Performance and Environmental Disclosure: An Empirical Analysis. Acc. Organ. Soc. 33 (4–5), 303–327.

Custódio, C., Metzger, D., 2014. Financial Expert CEOs: CEO's Work Experience and Firm's Financial Policies. J. Financ. Econ. 114 (1), 125–154.

Demirgüç-Kunt, A., Maksimovic, V., 1996. Stock Market Development and Financing Choices of Firms. The World Bank Economic Review 10 (2), 341–369.

Diamond, D.W., 1991. Monitoring and Reputation: The Choice between Bank Loans and Directly Placed Debt. Journal of Political Economy 99 (4), 689–721.

Du, X., Weng, J., Zeng, Q., Chang, Y., Pei, H., 2017. Do Lenders Applaud Corporate Environmental Performance? Evidence from Chinese Private-Owned Firms. J. Bus. Ethics 143 (1), 179–207.

El Ghoul, S., Guedhami, O., Kwok, C.C., Mishra, D.R., 2011. Does Corporate Social Responsibility Affect the Cost of Capital? J. Bank. Finance 35 (9), 2388–2406.

Fazzari, S.M., Hubbard, R.G., Petersen, B.C., Blinder, A.S., Poterba, J.M., 1988. Financing Constraints and Corporate Investment. Brookings Papers on Economic Activity 1988 (1), 141–206.

Freeman, R.E., 1994. The Politics of Stakeholder Theory: Some Future Directions. Bus. Ethics Q. 4 (4), 409–421.

Fuente, J.A., García-Sanchez, I.M., Lozano, M.B., 2017. The Role of the Board of Directors in the Adoption of GRI Guidelines for the Disclosure of CSR Information. J. Cleaner Prod. 141, 737–750.

Glosten, L.R., Milgrom, P.R., 1985. Bid, Ask and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders. J. Financ. Econ. 14 (1), 71–100.

Goldsmith, R.W., 1969. Financial Structure and Development. Yale University Press, New Haven, London.

Goss, A., Roberts, G.S., 2011. The Impact of Corporate Social Responsibility on the Cost of Bank Loans. J. Bank. Finance 35 (7), 1794–1810.
Guariglia, A., 2008. Internal Financial Constraints, External Financial Constraints, and Investment Choice: Evidence from a Panel of UK Firms. J. Bank. Finance 32 (9), 1795–1809.
Hackbarth, D., Miao, J., Morellec, E., 2006. Capital Structure, Credit Risk, and Macroeconomic Conditions. J. Financ. Econ. 82 (3), 519–550.
He, L., Liu, R., Zhong, Z., Wang, D., Xia, Y., 2019. Can Green Financial Development Promote Renewable Energy Investment Efficiency? A Consideration of Bank Credit. Renewable Energy 143, 974–984.
Hou, X., Li, S., Guo, P., Wang, Q., 2018. The Cost Effects of Shadow Banking Activities and Political Intervention: Evidence from the Banking Sector in China. International Review of Economics & Finance 57, 307–318.
Hu, M., Loh, L., 2018. Board Governance and Sustainability Disclosure: A Cross-sectional Study of Singapore-listed Companies. Sustainability 10 (7), 2578.
Jiang, W., Zeng, Y., 2014. State Ownership, Bank Loans, and Corporate Investment. International Review of Economics & Finance 32, 92–116.
Jung, J., Herbohn, K., Clarkson, P., 2018. Carbon Risk, Carbon Risk Awareness and the Cost of Debt Financing. J. Bus. Ethics 150 (4), 1151–1171.
Kajander, J.K., Sivunen, M., Vimpari, J., Pulkka, L., Junnila, S., 2012. Market Value of Sustainability Business Innovations in the Construction Sector. Building Research & Information 40 (6), 665–678.
Kaplan, S.N., Zingales, L., 1997. Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints? Q. J. Econ. 112 (1), 169–215.
Kitsikopoulos, C., Schwaibold, U., Taylor, D., 2018. Limited Progress in Sustainable Development: Factors Influencing the Environmental Management and Reporting of South African JSE-Listed Companies. Business Strategy and the Environment 27 (8), 1295–1301.
Klassen, R.D., McLaughlin, C.P., 1996. The Impact of Environmental Management on Firm Performance. Manage. Sci. 42 (8), 1199–1214.
Kuppuswamy, V., Villalonga, B., 2016. Does Diversification Create Value in the Presence of External Financing Constraints? Evidence from the 2007–2009 Financial Crisis. Manage. Sci. 62 (4), 905–923.
Lee, G., 2006. The Effectiveness of International Knowledge Spillover Channels. European Economic Review 50 (8), 2075–2088.
Leon, F., 2015. Does Bank Competition Alleviate Credit Constraints in Developing Countries? J. Bank. Finance 57, 130–142.
Leonidou, C.N., Katsikeas, C.S., Morgan, N.A., 2013. "Greening" the Marketing Mix: Do Firms Do it and Does it Pay Off? J. Acad. Mark. Sci. 41 (2), 151–170.
Li, W., Zheng, M., Zhang, Y., Cui, G., 2020. Green Governance Structure, Ownership Characteristics, and Corporate Financing Constraints. J. Cleaner Prod. 260 121008.
Lin, H., Zeng, S.X., Ma, H.Y., Qi, G.Y., Tam, V.W., 2014. Can Political Capital Drive Corporate Green Innovation? Lessons from China. J. Cleaner Prod. 64, 63–72.
Liu, P., Peng, Y., Shi, Y., Yang, J., 2022. Financial Structures, Political Risk and Economic Growth. The European Journal of Finance 28 (4–5), 356–376.
Liu, X., Wang, E., Cai, D., 2019. Green Credit Policy, Property Rights and Debt Financing: Quasi-natural Experimental Evidence from China. Finance Research Letters 29, 129–135.
Ma, Y., Hou, G., Yin, Q., Xin, B., Pan, Y., 2018. The Sources of Green Management Innovation: Does Internal Efficiency Demand Pull or External Knowledge Supply Push? J. Cleaner Prod. 202, 582–590.
Mitton, T., 2008. Why Have Debt Ratios Increased for Firms in Emerging Markets? European Financial Management 14 (1), 127–151.
Modigliani, F., Miller, M.H., 1958. The Cost of Capital, Corporation Finance and the Theory of Investment. Am. Econ. Rev. 48 (3), 261–297.
Myers, S.C., Majluf, N.S., 1984. Corporate Financing and Investment Decisions When Firms Have Information that Investors Do not Have. J. Financ. Econ. 13 (2), 187–221.
Orens, R., Aerts, W., Cormier, D., 2010. Web-Based Non-Financial Disclosure and Cost of Finance. Journal of Business Finance & Accounting 37 (9–10), 1057–1093.
Passetti, E., Cinquini, L., Tenucci, A., 2018. Implementing Internal Environmental Management and Voluntary Environmental Disclosure: Does Organisational Change Happen. Accounting, Auditing & Accountability Journal 31 (4), 1145–1173.
Paulraj, A., 2009. Environmental Motivations: A Classification Scheme and its Impact on Environmental Strategies and Practices. Business Strategy and the Environment 18 (7), 453–468.
Peloza, J., Shang, J., 2011. How can Corporate Social Responsibility Activities Create Value for Stakeholders? A Systematic Review. J. Acad. Mark. Sci. 39 (1), 117–135.
Quader, S.M., Abdullah, M.N., 2016. Cash Flow Sensitivity of Cash: A Cross Country Analysis. International Journal of Economics and Financial Issues 6 (2), 562–572.
Ryan, R.M., O'Toole, C.M., McCann, F., 2014. Does Bank Market Power Affect SME Financing Constraints? J. Bank. Finance 49, 495–505.
Schaller, H., 1993. Asymmetric Information, Liquidity Constraints and Canadian Investment. Canadian Journal of Economics 26 (3), 552–574.
Schneider, T.E., 2011. Is Environmental Performance a Determinant of Bond Pricing? Evidence from the US Pulp and Paper and Chemical Industries. Contemporary Accounting Research 28 (5), 1537–1561.

Sharfman, M.P., Fernando, C.S., 2008. Environmental Risk Management and the Cost of Capital. Strateg. Manag. J. 29 (6), 569–592.
Shen, H., Wu, H., Long, W., Luo, L., 2021. Environmental Performance of Firms and Access to Bank Loans. The International Journal of Accounting 56 (02), 2150007.
Shu, C., Zhou, K.Z., Xiao, Y., Gao, S., 2016. How Green Management Influences Product Innovation in China: The Role of Institutional Benefits. J. Bus. Ethics 133 (3), 471–485.
Song, W., Yu, H., 2018. Green Innovation Strategy and Green Innovation: The Roles of Green Creativity and Green Organizational Identity. Corp. Soc. Responsib. Environ. Manag. 25 (2), 135–150.
Stiglitz, J.E., 2000. The Contributions of the Economics of Information to Twentieth Century Economics. Q. J. Econ. 115 (4), 1441–1478.
Sufi, A., 2009. Bank Lines of Credit in Corporate Finance: An Empirical Analysis. Rev. Finan. Stud. 22 (3), 1057–1088.
Sun, J., Wang, F., Yin, H., Zhang, B., 2019. Money Talks: The Environmental Impact of China's Green Credit Policy. Journal of Policy Analysis and Management 38 (3), 653–680.
Wang, Y., Lei, X., Long, R., Zhao, J., 2020. Green Credit, Financial Constraint, and Capital Investment: Evidence from China's Energy-Intensive Enterprises. Environ. Manage. 66 (6), 1059–1071.
Wen, H., Lee, C.C., Zhou, F., 2021. Green Credit Policy, Credit Allocation Efficiency and Upgrade of Energy-Intensive Enterprises. Energy Econ. 94 105099.
Zhang, Y., Xing, C., Wang, Y., 2020. Does Green Innovation Mitigate Financing Constraints? Evidence from China's Private Enterprises. J. Cleaner Prod. 264.
Zhao, L., Chen, Y., 2019. Optimal Subsidies for Green Products: A Maximal Policy Benefit Perspective. Symmetry 11 (1), 63.
Zhao, X., Wang, Z., Deng, M., 2019. Interest Rate Marketization, Financing Constraints and R&D Investments: Evidence from China. Sustainability 11 (8), 2311.

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# Starts and refutations of the Covid-19 rumors: Evidence from the reaction of the stock market

Zhe Li [a], Zixi Ling [a], Jian Sun [a,*], Congjie Yun [b]

[a] School of Accountancy, Central University of Finance and Economics, Beijing, PR China
[b] Henan Audit Division, Bank of China, Zhengzhou, PR China

ARTICLE INFO

*Article history:*
Received 6 January 2022
Accepted 11 October 2022
Available online 28 October 2022

*JEL:*
G12
G14
M41

*Keywords:*
COVID-19 rumors
Market reaction
Stock price drift
Rumors refutation

ABSTRACT

By manually collecting data on Internet-based rumors concerning COVID-19, we investigate the market reactions to the spread of such rumors and the government's refutation of them. We find that frightening (reassuring) rumors have a negative (positive) impact on investors. The refutation of frightening rumors triggers a positive market response, whereas the refutation of reassuring rumors does not cause a significant market reaction. Further analysis shows that there is a stock price drift when frightening rumors are refuted by governments. Our conclusions remain robust after considering endogeneity. Our findings support the notion that epidemic-related rumors affect investors' decisions, which add to literatures of the market responses of companies in the context of the COVID-19 pandemic and provide incremental evidence for the "the spiral of silence" theory.


## 1. Introduction

This study investigates how investors reacted to rumors related to COVID-19 at the height of the COVID-19 pandemic (hereafter the pandemic) in China in early 2020. We focus on rumors related to COVID-19 that were later confirmed to be false by government agencies (hereafter, we refer to these simply as COVID-19 rumors), in contrast to related research that examines company rumors and gossip in situations where it is difficult to distinguish true from false rumors (Difonzo, 2007). The COVID-19 rumors that arose during the pandemic were often deliberately fabricated, some with very serious effects, and Internet anonymity facilitated their spread. They are fundamentally different from the firm-related rumors that are extensively studied

* Corresponding author.
*E-mail addresses:* lizhewenbei@cufe.edu.cn (Z. Li), lzx13522124054@163.com (Z. Ling), sunjian@cufe.edu.cn (J. Sun).

https://doi.org/10.1016/j.cjar.2022.100272
1755-3091/

in the literature (Bordia et al., 2010; Schmidt, 2019; Jia et al., 2020). First, firm-related rumors are only related to a certain company, whereas the COVID-19 rumors (e.g., "Xinyang city is about to close") often affect all companies in an entire region. Second, firm-related rumors often occur in a relatively ordinary context, whereas the COVID-19 rumors appear in a special or extraordinary environment, that of the pandemic, enabling us to study how investors reacted to rumors that may affect lives and safety in the context of a severe public health crisis.

From the end of 2019 to the beginning of 2020, the outbreak of the COVID-19 pandemic affected all aspects of the Chinese economy and society (Chen et al., 2020; Yang et al., 2020). Many cities implemented the central government's pandemic prevention policy, and large-scale shutdowns began across the country, dealing a serious blow to physical industries as well as to the capital market. Simultaneously, a considerable number of online rumors related to the pandemic raged on Weibo, WeChat and other online platforms, misleading netizens concerned about the pandemic.

COVID-19 rumors related to some areas of China spread widely on the Internet from late January 2020. For example, rumors that a certain city was about to be isolated caused unnecessary panic in local areas, whereas rumors of some cities being reopened were falsely reassuring to the locals. Local government agencies worked diligently on network platforms to constantly refute all kinds of rumors. During the pandemic, great focus was placed on the impact of various rumors and regulating different rumors was a crucial governance matter.

In addition to influencing social stability and national governance, COVID-19 rumors cause volatility in the stock market. For example, on 10 February 2020, the Internet rumor that "Beijing is about to carry out a large-scale disinfection and sterilization activity"[1] sent a false signal to the public that the pandemic situation in Beijing was not optimistic. Although the rumor was quickly refuted, in the meantime, local listed companies in Beijing were affected by investors' negative perceptions of Beijing in response to the rumor. For instance, the stock prices of Shenzhou High-Speed Railway Technology (000008. SZ) and Shenzhou Digital (000034. SZ) fell after trending upward for several trading days before the rumor.

In this paper, we explore whether it is common for investors to be misled by COVID-19 rumors. We use manually collected data on COVID-19 rumors and their refutation to explore the abnormal market reactions caused by different types of rumors in company locations. Considering that governments in other countries seldom refute rumors in an authoritative and formal way, the refutation of COVID-19 rumors by Chinese government agencies provides a unique rumor refutation data set.

Based on the influence of rumors on investor sentiment, we divide COVID-19 rumors into frightening and reassuring rumors. Frightening rumors refer to false news and information that exaggerates the severity of the crisis and causes negative emotions among the public, such as statements that "many cases are confirmed" or "there has been a major spread of infections" in some particular locations. In contrast, reassuring rumors involve information that downplays the severity of the crisis and creates false optimism among the public, such as a certain area "is about to reopen" or "the pandemic control policies are about to be canceled" in some area. We conduct a series of tests based on this classification and find that frightening and reassuring rumors trigger negative and positive market reactions, respectively, and that the refutation of frightening rumors has a positive market response, whereas refuting reassuring rumors does not result in a significant market response. In further analysis, we show that there is a stock price drift after the refutation of frightening rumors. Finally, after controlling for potential endogeneity problems, our conclusions remain valid.

Our study makes three main contributions to the literature. First, by examining the market responses of listed firms to COVID-19 rumors, we improve understanding of the market responses of companies in the context of the COVID-19 pandemic. The literature explores the impact of news reports and other factors on corporate market responses during the pandemic from the perspective of companies (Baker et al., 2020; Chen et al., 2020). Conversely, we examine rumors and take the perspective of investors; although rumors as an alternative channel receive much less attention than news reports, they significantly affect the capital market during the COVID-19 pandemic.

[1] Information reported by official media can be seen via the bellow website https://baijiahao.baidu.com/s?id=1658138496681712872&wfr=spider&for=pc.

Second, we confirm "the spiral of silence" theory from the perspective of investors by investigating the impact of rumor refutation on the stock market. Studies focus on the positive effect of refuting firm-specific gossip and rumors on firm recovery (Mathur and Waheed, 1995; Schmidt, 2019). Conversely, we find that the silent spiral effect means that investors are unwilling to spread disappointing information even when it refutes falsely reassuring rumors, resulting in a decline in the effectiveness of attempts to refute reassuring rumors.

Third, our study reveals that there is a stock price drift after the refutation of frightening rumors during a public crisis. We find that the refutation of frightening rumors does not immediately influence the market, and that Internet penetration improves the speed with which refutation becomes effective. This finding provides a theoretical basis for government agencies to improve the rumor management system. Our findings also have policy implications for capital market regulators regarding stabilizing the market during a public crisis.

## 2. Literature review and hypothesis development

### *2.1. Literature review*

#### *2.1.1. Sentiment, rumors and capital market reactions*

Many studies demonstrate that investor sentiment affects investment decisions. Brown and Cliff (2004) find that investor sentiment influences stock prices, and Schmeling (2009) determines that, on average, investor sentiment inversely predicts the overall return of the stock market. Bollen, Mao and Zeng (2010) construct investor sentiment indicators by analyzing online language and verify the positive impact of investor sentiment on stock prices. Mendel and Shleifer (2012) find that investors' irrational emotions affect stock price volatility. Therefore, emotion-related factors, such as reactions to weather or air quality (Hirshleifer and Shumway, 2003; Hu and Wang, 2012; Li et al., 2019) and beliefs and customs (Block and Kramer 2009), influence stock prices.

During public crises, investors' risk aversion tends to increase. Twemlow et al. (2003) find that terrorist attacks can change the mentality and emotions of residents, thereby changing their daily behaviors. These changes in mood and behavior are often reflected in the stock market, causing stock prices to fall (Jussi and Sami, 2010). Moreover, disasters such as earthquakes and hurricanes can cause negative emotions among investors and lead to irrational investment behavior (Carter and Simkins, 2004). Worthington and Valadkhani (2004) reveal that earthquakes and hurricanes bring about pessimism, which in turn causes negative market reactions. Moreover, research indicates that market anomalies reverse in the short term. Kaplanski and Levy (2010) find that the pessimism caused by air crashes in the US led to declines in the market value of aviation stocks. Overall, the literature emphasizes that investor sentiment tends to be affected by many factors, including the environment and customs, especially during public crises. However, studies seldom discuss the influence of other complex factors on market responses during public crises.

Investors are often disadvantaged by information asymmetry and have an urgent need for information (Davies and Canes, 1978; Dai et al., 2013). Therefore, when they find a simple, low-cost method of obtaining information, investors tend to overestimate its accuracy. To an extent, this explains the importance and reliance of investors on company rumors. In the era of advanced Internet technology and active social media, investors often fail to verify the authenticity of rumors (Toubia and Stephen, 2013). Mathur and Waheed (1995) find that rumors in business magazines affect investors' decision-making, and Clarkson et al. (2006) determine that investors are highly sensitive to rumors of acquisitions on online platforms.

As a suggestive and communicative psychological factor (DiFonzo and Bordia, 2007), rumors related to certain companies often induce irrational decision-making by influencing the mood of the public. For instance, Rosnow (1991) finds that the spread of rumors is closely related to the anxiety and panic created in people. He considers that the spread of rumors leads to anxiety through the construction of scenarios. Schmidt (2019) finds that individual "rumor makers" make profits by creating rumors to affect stock prices. Jia et al. (2020) believe that rumors spread through social media have a misleading effect on market pricing. In summary, investors may not be able to rationally identify the authenticity of rumors, and they are often misled in their decision-making by false rumors. However, there is limited research on whether rumors related to a company affect that company's stock price, and on whether regional rumors related to public crises influence

investors' decision-making. Therefore, in this study, we analyze the impact of COVID-19 rumors on market responses in relation to local listed companies.

#### *2.1.2. Impact of the COVID-19 crisis on market returns*

Studies explore both the direct shock of the pandemic on the capital market and the impact of complex factors on the capital market in the context of the pandemic. In a time-series study, Kim and Thomas (2021) examine the impact of the pandemic in the US and Europe and determine that the first confirmed death had a negative impact on stock prices. Using data from multiple countries, He et al. (2020) find that the pandemic generally had a negative but short-term impact on the stock market. Baek et al. (2020) use negative news about the pandemic to represent its severity and study its impact on different industries, determining that stock prices are quite sensitive to pandemic news.

Alfaro et al. (2020) find that an increase in the number of new COVID-19 cases is related to a decline in overall stock market returns. Giglio et al. (2020) reveal that after the US stock market crashed due to the pandemic, investor confidence in the stock market declined even during the recovery period. Smales (2020) observes that investors' attention to the pandemic is generally negatively correlated with market responses, but several industries may benefit from investors' attention. Izzeldin et al. (2021) note that the market response of G7 countries to the pandemic was relatively synchronized, and that the stock price response was consistent with the financial crisis. As for the governance and prevention of the COVID-19 pandemic, Rui et al. (2020) consider that highly evaluated environmental and social policies help companies to recover from the stock price crash caused by the pandemic. Rouatbia et al. (2021) reveal that the development and uptake of COVID-19 vaccines stabilized global stock markets and reduced stock price volatility.

In China, Yang et al. (2020) observe that risks were transmitted between financial market entities during the pandemic, thereby increasing systemic financial risks. A number of studies analyze the impact of complex factors on the capital market. For example, Baker et al. (2020) find that news reports played a vital role in determining stock prices during the COVID-19 pandemic. Chen et al. (2020) reveal that in the context of the pandemic, the resumption of the pandemic control measures can bring a positive market response, specifically for smaller and growing companies. Liu and Wang (2020) consider that traditional irrational psychological factors, such as anchoring and herd effects, influence stock prices during the pandemic. Although many studies examine the factors influencing stock prices during the pandemic, knowledge about the effects of COVID-19 rumors on the stock market is limited.

### *2.2. Hypothesis development*

#### *2.2.1. Frightening and reassuring rumors during the COVID-19 crisis*

In a public crisis, information asymmetry is likely to prevail between the public and authoritative organizations. The public's desire for reasonable explanations results in unofficial speculation and gossip in an attempt to meet their psychological needs, which leads to the appearance of rumors (Popenoe, 1986; Sunstein, 2014). COVID-19 has inevitably led to the emergence of a considerable number of rumors, which have flooded major online platforms and received considerable attention from investors.

This study focuses on the impact of public opinion and rumors on the capital market during the public crisis. Investors tend to believe in unconfirmed rumors and, therefore, the positive or negative rumors concerning a company's characteristics will affect stock prices (Schmidt, 2019). Investors with limited attention and professional ability are more inclined to use information common to a certain region or industry to make decisions rather than seeking specific information with higher professional and information content (Lin and Wei, 2006). Therefore, regional COVID-19 rumors can often influence the stock prices of local listed companies in a manner that is at least equivalent to rumors concerning specific companies.

To explore the relationship between the COVID-19 rumors related to a specific region and the stock prices of local listed companies, we must clarify-two processes: first, why investors believe the rumors spread during the pandemic; and second, how their belief in the rumors influences the stock prices of local listed companies.

(1) Why do investors believe the rumors during the pandemic?

Investors potentially use two "thinking systems" to deal with received information: the intuitive system, which is related to intuition, instinct and emotions, and the rational system, which is related to caution, analysis and rationality (Wason and Evans, 1975). The intuitive system performs fast, superficial and intuitive heuristic processing of information, and consumes less resources than the rational system. The rational system performs slow, detailed and rational analytical processing of information, which requires much more resources (Kahneman, 2011). When the intuitive system is at work, investors exhibit lower discrimination and cognitive control abilities and produce more emotional and overly relevant cognitions than when the rational system is dominant (Maier et al., 2015). Often, the intuitive system responds first to new information, and then the rational system adjusts to the results of this first response. However, in stressful situations, cognition shifts more toward habit and intuition than toward rationality, and the reprocessing of results from the intuitive system diminishes (Schwabe and Wolf, 2013; Yu, 2016).

During the COVID-19 pandemic, investors' perceptions of information asymmetry and uncertainty regarding the future increase. Under such circumstances, investors instinctively increase their reliance on the intuitive system and reduce the corrective effect of the rational system (Kassam et al., 2009; Schwabe and Wolf, 2013), which leads to a reduction in their cognitive control abilities (Maier et al., 2015) and more intense emotional responses than during normal times (Nolen-Hoeksema, 2012), making their cognition and ehaviour tilt toward intuitive responses.

Therefore, during COVID-19, investors are more likely to believe rumors than to verify them in a rational manner. When investors use the intuitive system to judge rumors and information, they engage in discrimination and verification of that information to a lesser degree than when they think rationally, and they simultaneously make emotional and excessive correlations between the information on the local pandemic and a company's business situation. Therefore, as investors' thinking is skewed toward intuition, we expect (false) frightening and reassuring rumors to influence investors' decision-making.

(2) The impact of rumors on local listed companies

Overestimation (underestimation) of the severity of the COVID-19 pandemic is often associated with more pessimistic (optimistic) judgments of local listed companies. On the one hand, in their consciousness, investors relate a worsening (improving) pandemic situation to stricter (looser) pandemic control and lower (higher) efficiency. On the other hand, investors expect other investors who invest in local listed companies to accept similar information and make similar decisions. When there are frightening (reassuring) rumors concerning the pandemic in a certain area, investors overestimate (underestimate) the severity of the local pandemic and are therefore overly pessimistic (optimistic) about the ability of local listed companies to resume work and production. These responses can lead investors to sell (buy) shares of local listed companies, leading to a negative (positive) market reaction. We therefore propose the following hypothesis:

**H1:** Frightening rumors result in negative market reactions to local listed companies, whereas reassuring rumors result in positive market reactions to local listed companies.

### *2.2.2. The refutation of frightening and reassuring rumors*

According to the noise theory of Kyle (1985) and Black (1986), symmetrical noise cancels out each other's impacts on the market. Rumors and anti-rumor information are symmetrical noises directed at the same event in opposite directions (Carlos et al., 2011). An announcement clarifying that prior information concerning a company was false is informational (Koller, 1992), which produces a market reaction opposite to the previous reaction. When rumors that led to abnormal returns are refuted, the abnormal returns are reversed (Bordia et al., 2010; Einwiller and Kamins, 2010). Therefore, we expect that when frightening or reassuring rumors concerning the local impacts of COVID-19 are refuted by relevant agencies, investors will revise their expectations about local pandemic conditions and the prospects of companies in that location. Thus, the market shock caused by the rumors will reverse.

When frightening rumors are refuted through online platforms, investors obtain accurate information about the local pandemic through these platforms. The provision of additional accurate rumor-clarifying information from official institutions often leads investors to increase their online tracking and attention to official information sources (Jia et al., 2020), and they thereby receive information more quickly and learn to behave more rationally than before. In the learning process, investors update their beliefs, gradually eliminate pessimistic expectations caused by frightening rumors and form relatively optimistic posterior expectations, thereby causing stock prices to rise. Moreover, the positive and accurate refutation of rumors eliminates negative investor sentiment and leads to a further positive market reaction.

Correspondingly, when falsely reassuring rumors are refuted, investors become better informed than before, engage in more rational learning and update their beliefs. Their overly optimistic expectations for the future prospects of local companies are adjusted downwards, resulting in relatively pessimistic posterior expectations, which cause stock prices to fall. The rational and accurate refutation of rumors eliminates investors' previously optimistic sentiment, which leads to further negative market reactions. Therefore, we expect that the refutation of falsely reassuring rumors will lead to negative market reactions. Based on the analyses above for the refutation of frightening or reassuring rumors, we propose the following hypotheses:

**H2a:** Refuting frightening rumors leads to positive market reactions to listed companies.
**H3a:** Refuting reassuring rumors leads to negative market reactions to listed companies.

*2.2.3. The role of trust and communication in the refutation of rumors*

The analysis above establishes that the refutation of rumors influences market reactions. However, at least two factors may reduce this influence: (1) investors may not trust the refutation, particularly when frightening rumors are refuted; and (2) the silent spiral effect may lead investors to be irrationally enthusiastic (Huberman and Regev, 2001) and prevent them from reversing their investment decisions in the case of reassuring rumors.

Often, the effectiveness of rumor refutation depends on the authority of the refuting information (Bordia et al., 2010; Einwiller and Kamins, 2010). In the case of frightening rumors during the pandemic, investors may distrust the information provided and regard the release of the refuting information as merely a cover for bad news. In this case, the refutation of the rumors may not influence market reactions. Therefore, we propose the following hypothesis:

**H2b:** The refutation of frightening rumors does not cause a significant market reaction to listed companies.

Communication theory considers that people will actively speak out when they find that their viewpoints are consistent with the majority viewpoint of the public, whereas they will remain silent when their viewpoints and expectations are contrary to those of the public (Noelle-Neumann, 1991; Lars et al., 2002). This leads to the rapid spread of opinions in line with public expectations, whereas opinions that contradict public expectations gradually decline, forming an asymmetrical development process referred to as the "the spiral of silence" (Noelle-Neumann, 1974, page 43). This effect exists among investors, making them susceptible to strong opinions (Veldkamp, 2006; Tetlock, 2007; Engelberg and Parsons, 2011). "Irrational enthusiasm" is likely to arise when positive opinions become dominant through the silent spiral (Huberman and Regev, 2001). Particularly during the pandemic, when investors are eager for good news, reassuring rumors tend to disseminate and become strong opinions, which can limit the effectiveness of government departments in refuting such rumors. Therefore, we propose the following hypothesis:

**H3b:** The refutation of reassuring rumors does not cause a significant market reaction to listed companies.

## 3. Data and methodology

### 3.1. Data

Our sample includes all A-share non-special treatment public companies listed on the Shanghai and Shenzhen stock exchanges in China. We select the period from the outbreak of COVID-19 to the date when the initial controls were lifted in China, i.e., 20 January to 31 March 2020, as our period of analysis to collect rumors.[2] To ensure that we do indeed focus on rumors, i.e., false and misleading information, we collect only rumors that were subsequently refuted by government agencies and certified as false. We collect market reaction data and other financial data from the China Stock Market and Accounting Research database. Our initial sample includes 131,712 firm-date observations from 20 January to 31 March 2020. After removing observations with missing data, we finally obtain 95,075 firm-date observations to conduct our baseline regression.

### 3.2. Empirical models and variable definitions

#### 3.2.1. Model specification

We use Eq. (1) to examine the influence of frightening or reassuring rumors. The dependent variable *Car* [−1,1] measures the reaction of the stock market and is calculated using two approaches, the market adjustment and market model approaches, denoted by *Car_MA*[−1,1] and *Car_MM*[−1,1], respectively. The independent variables are frightening rumors (*Neg*) or reassuring rumors (*Pos*), which are dummy variables that identify whether frightening or reassuring rumors influence a company's location on a given day. The variable definitions are provided in Table 1. Often, the severity of the pandemic has a systemic impact on stock prices (Baek et al., 2020). To control for this systemic impact and the impact of a company's financial status during the sample period on market responses, we select the logarithm of total assets (*Size*), firm profitability (*Roa*), firm leverage (*Lev*), firm cash holdings (*Cash*) and firm revenue growth (*Growth*) as control variables. Moreover, we control for industry and city fixed effects and factors related to the pandemic (the number of COVID-19 cases, as explained below).

$$Car\_MA(Car\_MM)[-1.1] = \alpha + \beta_1 Neg(Pos) + \beta_2 \sum Controls + \sum ind + \sum city + \mu. \quad (1)$$

We explore the impact of rumor refutation on the market by examining Eq. (2). *Car_MA*[−1,1] and *Car_MM*[−1,1] are the dependent variables, and *Anti_Neg* and *Anti_Pos*, which indicate the refutation of frightening and reassuring rumors, respectively, in a company's location on a given day, are the independent variables.

$$Car\_MA(Car\_MM)[-1.1] = \alpha + \beta_1 Anti\_Neg(Anti\_Pos) +$$
$$\beta_2 \sum Controls + + \sum ind \sum city + \mu. \quad (2)$$

#### 3.2.2. Variables

Table 1 provides the definitions of the variables used in this study. The cumulative abnormal returns calculated using the market adjustment approach and market model approach (*Car_MA* and *Car_MM*) are the proxy variables for market reactions.

We use the market adjustment approach to calculate abnormal returns (*Ar_MA*), as shown in Eq. (3), where $R_{it}$ is the return rate of individual stocks of company $i$ on day $t$, and $R_{mt}$ is the market return on day $t$.

$$Ar\_MA_{it} = R_{it} - R_{mt} \quad (3)$$

[2] Our method for collecting rumors is detailed in the appendix.

Table 1
Variable definition and measurement.

| Variable | Variable definition and measurement |
|---|---|
| *Car_MA*[–1,1] | *CAR*[–1,1] calculated by the market adjustment approach |
| *Car_MM*[–1,1] | *CAR*[–1,1] calculated by the market model approach |
| *Bhar*[1,15] | Buy-and-hold abnormal returns in 1- to 15-day windows |
| *Neg* | Takes a value of 1 if there are frightening rumors where the company is located on a given day, and 0 otherwise |
| *Pos* | Takes a value of 1 if there are reassuring rumors where the company is located on a given day, and 0 otherwise |
| *Anti_Neg* | Takes a value of 1 if frightening rumors are refuted where the company is located on a given day, and 0 otherwise |
| *Anti_Pos* | Takes a value of 1 if reassuring rumors are refuted where the company is located on a given day, and 0 otherwise |
| *Size* | Ln(Total assets at the end of 2019 + 1) |
| *Roa* | Total profit in 2019 / Total assets at the beginning of 2019 |
| *Lev* | Total liabilities at the end of 2019 / Total assets at the end of 2019 |
| *Cash* | Monetary funds at the end of 2019 / Total assets at the end of 2019 |
| *Growth* | (Operating revenue in 2019 – Operating revenue in 2018) / Operating revenue in 2018 |
| *Newcases* | The number of new COVID-19 cases in the company's location the previous day / 100 |

The market model approuch regresses individual stock returns on market returns, as shown in Eq. (4). We estimate Eq. (4) and calculate the residual, which we define as abnormal returns (*Ar_MM*) under the market model approach. The economic meaning of the residual is that it is the part of individual stock returns that cannot be explained by market trends.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \mu_{it} \tag{4}$$

Then, we add *Ar_MA* and *Ar_MM* according to the window period and obtain the cumulative abnormal return rate, as shown in Eq. (5).

$$Car\_MA_{it}(Car\_MM_{it})[-1,1] = \sum_{t-1}^{t+1} Ar\_MA_{it}(Ar\_MM_{it}) \tag{5}$$

We define frightening rumors as rumors that exaggerate the severity of the crisis and can cause panic among investors, whereas reassuring rumors are those that dilute the impact of the crisis and can comfort investors. On this basis, we define our four main variables *Neg*, *Pos*, *Anti_Neg* and *Anti_Pos* as follows: *Neg* (*Pos*) takes a value of 1 when frightening (reassuring) rumors exist within the location of the company, and 0 otherwise, and *Anti_Neg* (*Anti_Pos*) takes a value of 1 if frightening (reassuring) rumors are refuted in the company's location on a given day, and 0 otherwise. In addition to the control variables listed in Table 1, we control for pandemic-related influencing factors (i.e., the number of new cases in the company's location the previous day).[3] To avoid the influence of extreme values, we perform data cleaning on all continuous variables used in the main test.

## 4. Main results

### *4.1. Descriptive statistics*

Table 2 shows the distribution of rumors based on our data collection. Hubei province is the most severely affected province of all provinces at the beginning of 2020, followed by Zhejiang and Hunan provinces. In total, we find that 143 rumors affect Chinese provinces during our study period, and Hubei province is affected by 34 of these rumors. In terms of the nature of the rumors, the majority (118) are frightening rumors, with only 25 being reassuring rumors.

[3] The Chinese Center for Disease Control and Prevention discloses the number of new cases of the previous day. Therefore, to control for the impact of the severity of the pandemic on the stock market, we control for the number of new cases with a lag period.

Table 2
Distribution of the rumors collected.

| Location | Frightening rumors | Reassuring rumors | Total |
|---|---|---|---|
| Hubei | 28 | 6 | 34 |
| Zhejiang | 12 | 0 | 12 |
| Guangdong | 5 | 4 | 9 |
| Beijing | 7 | 2 | 9 |
| Shanghai | 6 | 1 | 7 |
| Jiangsu | 8 | 0 | 8 |
| Henan | 6 | 1 | 7 |
| Hunan | 9 | 1 | 10 |
| Sichuan | 7 | 0 | 7 |
| Anhui | 3 | 3 | 6 |
| Hebei | 4 | 1 | 5 |
| Shaanxi | 2 | 2 | 4 |
| Jiangxi | 3 | 1 | 4 |
| Shanxi | 2 | 0 | 2 |
| Fujian | 2 | 0 | 2 |
| Yunnan | 1 | 1 | 2 |
| Neimenggu | 3 | 0 | 3 |
| Jilin | 0 | 2 | 2 |
| Heilongjiang | 4 | 0 | 4 |
| Hainan | 1 | 0 | 1 |
| Guizhou | 1 | 0 | 1 |
| Gansu | 1 | 0 | 1 |
| Guangxi | 1 | 0 | 1 |
| Chongqing | 2 | 0 | 2 |
| Total | 118 | 25 | 143 |

Table 3
Descriptive statistics.

| *Variable* | N | Mean | SD | *P*1 | P25 | P50 | P75 | P99 |
|---|---|---|---|---|---|---|---|---|
| *Car_MA* [–1,1] | 95,075 | 0.002 | 0.047 | –0.104 | –0.025 | –0.001 | 0.026 | 0.140 |
| *Car_MM* [–1,1] | 95,075 | 0.001 | 0.045 | –0.101 | –0.025 | –0.003 | 0.023 | 0.138 |
| *Bhar* [1,15] | 95,075 | –0.001 | 0.014 | –0.030 | –0.010 | –0.002 | 0.007 | 0.041 |
| *Neg* | 95,075 | 0.033 | 0.179 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| *Pos* | 95,075 | 0.014 | 0.117 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| *Anti_Neg* | 95,075 | 0.014 | 0.119 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| *Anti_Pos* | 95,075 | 0.005 | 0.070 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| *Size* | 95,075 | 22.415 | 1.326 | 20.230 | 21.447 | 22.226 | 23.160 | 26.395 |
| *Roa* | 95,075 | 0.046 | 0.074 | –0.203 | 0.016 | 0.040 | 0.075 | 0.228 |
| *Lev* | 95,075 | 0.425 | 0.189 | 0.078 | 0.277 | 0.417 | 0.563 | 0.853 |
| *Cash* | 95,075 | 0.161 | 0.104 | 0.020 | 0.087 | 0.135 | 0.207 | 0.506 |
| *Growth* | 95,075 | 0.156 | 1.575 | –0.450 | –0.024 | 0.080 | 0.204 | 1.217 |
| *Newcases* | 95,075 | 0.171 | 3.177 | 0.000 | 0.000 | 0.000 | 0.010 | 1.050 |

Table 3 shows the descriptive statistics of the main variables. The mean values of *Car_MA*[−1,1] and *Car_MM*[−1,1] are 0.002 and 0.001, respectively, and their medians are −0.001 and −0.003, respectively. On average, 3.3 % and 1.4 % of the firm-date observations in the sample are affected by frightening and reassuring rumors, respectively, and 1.4 % and 0.5 % of the firm-date observations experience a refutation of frightening and reassuring rumors, respectively.[4] The mean values of *Size*, *Roa*, *Lev*, *Cash*, *Growth* and *Newcases* are 22.415, 0.046, 0.425, 0.161, 0.156 and 0.171, respectively.

[4] In our sample, multiple rumors are refuted on the same day and hence the frequency of refuting rumors is lower than the frequency of the rumors themselves.

Table 4
Baseline regression of the impact of rumors on market reactions.

| *Variable* | *Car_MA*[–1,1] (1) | *Car_MM*[–1,1] (2) | *Car_MA*[–1,1] (3) | *Car_MM*[–1,1] (4) |
|---|---|---|---|---|
| *Neg* | –0.003*** | –0.003*** | | |
| | (–3.56) | (–3.44) | | |
| *Pos* | | | 0.007*** | 0.003** |
| | | | (5.22) | (2.30) |
| *Size* | –0.000** | –0.001*** | –0.000** | –0.001*** |
| | (–2.48) | (–3.79) | (–2.48) | (–3.79) |
| *Roa* | 0.008*** | –0.007*** | 0.008*** | –0.007*** |
| | (3.26) | (–2.74) | (3.26) | (–2.73) |
| *Lev* | 0.001 | 0.002 | 0.001 | 0.002 |
| | (0.95) | (1.46) | (0.95) | (1.46) |
| *Cash* | –0.001 | 0.001 | –0.001 | 0.001 |
| | (–0.91) | (0.46) | (–0.91) | (0.47) |
| *Growth* | –0.000 | 0.000 | –0.000 | 0.000 |
| | (–0.80) | (0.05) | (–0.80) | (0.05) |
| *Newcases* | –0.000 | –0.000* | –0.000 | –0.000** |
| | (–1.06) | (–1.65) | (–1.43) | (–2.02) |
| *Constant* | 0.007* | 0.012*** | 0.007* | 0.012*** |
| | (1.79) | (3.04) | (1.73) | (3.00) |
| Industry fixed effects | √ | √ | √ | √ |
| City fixed effect | √ | √ | √ | √ |
| *N* | 95,075 | 95,075 | 95,075 | 95,075 |
| $R^2$ | 0.006 | 0.007 | 0.006 | 0.007 |

The table reports the coefficients, with the *t*-statistics shown in parentheses. ***, ** and * indicate significance at the 1 %, 5 % and 10 % levels, respectively.

### 4.2. Baseline results

Table 4 reports market responses to different types of rumors. Columns (1) and (2) report the impact of frightening rumors on market reactions using the market adjustment and market model approaches, respectively. The coefficients of *Neg* are both −0.003, which are both statistically significant, indicating that frightening rumors lead to negative market reactions to listed firms. The coefficients of *Pos* in Columns (3) and (4) are 0.007 and 0.003, respectively, indicating that reassuring rumors lead to significant positive market reactions. Thus, the results in Table 4 verify H1, proving that investors are affected by both types of COVID-19 rumors and that they change their expectations and judgments about the prospects of companies at the locality where a rumor is spread. Frightening rumors lead to negative abnormal returns, whereas reassuring rumors are associated with positive abnormal returns. The results of the main test show that Chinese investors experience difficulties in identifying and confirming the authenticity of unofficial information during the pandemic, which leads the stock market to fluctuate under the impact of COVID-19 rumors.

As a robustness test, we exclude all observations of listed companies in Hubei province from the H1 test. Hubei is the center of the pandemic and its high number of confirmed cases and high number of rumors compared with other provinces result in outliers and interference in our data analysis. Therefore, we remove all observations located in Hubei province and rerun the baseline regression. The results, shown in Table 5, indicate that our results remain robust after excluding all listed companies in Hubei province.

Table 6 reports the market reactions caused by the refutation of rumors. The coefficients of *Anti_Neg* in Columns (1) and (2) are positive and significant, which verifies H2a. When frightening rumors are refuted, investors revise their misjudgment of firms' prospects, leading to a positive market reaction. However, the market response to the refutation of reassuring rumors does not meet the expectations of H3a. The coefficients of *Anti_Pos* in Columns (3) and (4) are not significant. Therefore, H3a is rejected and H3b is verified; that is, when investors are affected by reassuring rumors, even if the rumors are subsequently rejected, it is difficult for

Table 5
Baseline regression without Hubei observations.

| *Variable* | *Car_MA*[–1,1] (1) | *Car_MM*[–1,1] (2) | *Car_MA*[–1,1] (3) | *Car_MM*[–1,1] (4) |
|---|---|---|---|---|
| *Neg* | –0.002** | –0.002** | | |
| | (–2.32) | (–2.53) | | |
| *Pos* | | | 0.007*** | 0.004*** |
| | | | (5.02) | (2.76) |
| *Size* | –0.000** | –0.000*** | –0.000** | –0.000*** |
| | (–2.32) | (–2.90) | (–2.32) | (–2.90) |
| *Roa* | 0.008*** | –0.006** | 0.008*** | –0.006** |
| | (3.27) | (–2.28) | (3.27) | (–2.28) |
| *Lev* | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.59) | (0.64) | (0.59) | (0.64) |
| *Cash* | –0.001 | 0.001 | –0.001 | 0.001 |
| | (–0.44) | (0.46) | (–0.44) | (0.46) |
| *Growth* | –0.000 | 0.000 | –0.000 | 0.000 |
| | (–0.70) | (0.09) | (–0.70) | (0.09) |
| *Newcases* | –0.017*** | –0.027*** | –0.017*** | –0.027*** |
| | (–6.28) | (–9.55) | (–6.29) | (–9.62) |
| *Constant* | 0.007* | 0.011*** | 0.007* | 0.010*** |
| | (1.74) | (2.62) | (1.69) | (2.59) |
| Industry fixed effects | √ | √ | √ | √ |
| City fixed effects | √ | √ | √ | √ |
| *N* | 85,117 | 85,117 | 85,117 | 85,117 |
| $R^2$ | 0.006 | 0.009 | 0.006 | 0.009 |

The table reports the coefficients, with the *t*-statistics shown in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 6
Impact of the refutation of rumors on market reactions.

| *Variable* | *Car_MA*[–1,1] (1) | *Car_MM*[–1,1] (2) | *Car_MA*[–1,1] (3) | *Car_MM*[–1,1] (4) |
|---|---|---|---|---|
| *Anti_Neg* | 0.004*** | 0.005*** | | |
| | (3.23) | (3.91) | | |
| *Anti_Pos* | | | –0.000 | –0.002 |
| | | | (–0.10) | (–0.43) |
| *Size* | –0.000** | –0.001*** | –0.000** | –0.001*** |
| | (–2.48) | (–3.79) | (–2.48) | (–3.79) |
| *Roa* | 0.008*** | –0.007*** | 0.008*** | –0.007*** |
| | (3.26) | (–2.73) | (3.26) | (–2.74) |
| *Lev* | 0.001 | 0.002 | 0.001 | 0.002 |
| | (0.95) | (1.47) | (0.95) | (1.46) |
| *Cash* | –0.001 | 0.001 | –0.001 | 0.001 |
| | (–0.91) | (0.47) | (–0.91) | (0.47) |
| *Growth* | –0.000 | 0.000 | –0.000 | 0.000 |
| | (–0.80) | (0.05) | (–0.80) | (0.05) |
| *Newcases* | –0.000 | –0.000** | –0.000 | –0.000** |
| | (–1.43) | (–2.01) | (–1.44) | (–2.02) |
| *Constant* | 0.007* | 0.012*** | 0.007* | 0.012*** |
| | (1.74) | (3.00) | (1.76) | (3.02) |
| Industry fixed effects | √ | √ | √ | √ |
| City fixed effects | √ | √ | √ | √ |
| *N* | 95,075 | 95,075 | 95,075 | 95,075 |
| $R^2$ | 0.005 | 0.007 | 0.005 | 0.007 |

The table reports the coefficients for the impact of refuting frightening and reassuring rumors on market reactions. The *t*-statistics are shown in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

them to rationally correct their overoptimistic expectations. Thus, the refutation of frightening and reassuring rumors has asymmetrical impacts on investors and the market.

The results indicate that investors respond to both types of rumors. However, the refutation of rumors is effective only in the case of frightening rumors; refuting frightening rumors causes market reactions and drives up stock prices, but investors do not react to the refutation of reassuring rumors. To an extent, this indicates that Chinese investors trust the information released by the government to refute rumors. However, because of the silent spiral effect during the pandemic, eradicating the impact of reassuring rumors remains difficult.

To verify the degree of investor trust in the government when it refutes frightening rumors, we further divide the sample into groups according to the level of trust of people in firms affected by rumors. We use regional trust data from the 2018 World Values Survey for mainland China as a measure of local people's trust. In particular, we use the respondents' confidence in the local government and trust in others to represent government and interpersonal trust. We divide the sample into two groups according to whether the level of government (interpersonal) trust is higher or lower than the median. Thus, we obtain a high government (interpersonal) trust group and a low government (interpersonal) trust group. If investors do not place sufficient trust in the government's refutation of rumors in certain areas, then the anti-rumor information is likely to be less effective, such that it would only be effective in areas with a high level of trust. Table 7 shows the results of the cross-sectional tests.

Panel A of Table 7 shows the results of the group tests for the level of government trust. Suest test is an approach for testing between-group differences based on seemingly unrelated regression. The p values of *Suest* are 0.3487 in Columns (1) and (2) and 0.2640 in Columns (3) and (4). This result shows that whether *Car_MA*[−1,1] or *Car_MM*[−1,1] is used as the explained variable, no significant difference exists in the coefficient of *Anti_Neg* between the high and low groups. Panel B shows the results of the group tests for interpersonal trust. The p values of *Suest* are 0.1199 in Columns (1) and (2) and 0.1547 in Columns (3) and (4). Therefore, no significant intergroup difference exists. In fact, the coefficient of *Anti_Neg* is not significantly larger in the low than in the high interpersonal trust group, confirming that the government's effectiveness in refuting frightening rumors is not related to investors' level of trust in the government. The results indicate that investors trust the government's refutation of rumors, and that neither the level of government trust nor the level of interpersonal trust has a significant influence on the effectiveness of the government's refutation of frightening rumors.

## 5. Further analysis: Stock price drift of the refutation of frightening rumors

According to efficient market theory, the impact of any shock on the market forms in a very short period, and then stock prices stabilize at the adjusted position. However, investors' lagging response and information limitations often cause stock price drifts (Bartov et al., 2000). Even when companies clarify unfavorable rumors about themselves, stock prices often cannot respond quickly (Huberman and Regev, 2001; Carlos et al., 2011). As mentioned above, the refutation of frightening rumors leads investors to correct their previous rumor-influenced misjudgments, leading to a positive market reaction, but we expect a drift after the refutation of frightening rumors. We use Eq. (6) to detect the influence of analysts on this drift.

$$Bhar[1,15] = \alpha + \beta_1 Anti\_Neg + \beta_2 \sum Controls + \sum ind + \sum city + \mu \tag{6}$$

To capture the stock price drift, we used the dependent variable *Bhar*[1,15] in Eq. (6) to measure the long-term volatility of the stock market. *Bhar*[1,15] denotes the buy-and-hold abnormal returns of a firm during the [1,15] window period, which are calculated using Eq. (7).

$$Bhar_{it}[1,15] = \prod_{t+1}^{t+15} R_{it} - \prod_{t+1}^{t+15} R_{mt} \tag{7}$$

Table 7
Cross-sectional tests according to the levels of government and interpersonal trust.

**Panel A:** Government trust

| *Variable* | *Car_MA*[–1,1] | | *Car_MM*[–1,1] | |
|---|---|---|---|---|
| | High (1) | Low (2) | High (3) | Low (4) |
| *Anti_Neg* | 0.008 | 0.003** | 0.010* | 0.003** |
| | (1.43) | (2.07) | (1.78) | (2.28) |
| *Size* | –0.001** | –0.000 | –0.001*** | –0.000** |
| | (–2.07) | (–1.47) | (–3.64) | (–2.12) |
| *Roa* | 0.007 | 0.007** | –0.007 | –0.009*** |
| | (1.63) | (2.34) | (–1.57) | (–2.83) |
| *Lev* | 0.003 | 0.000 | 0.003 | 0.001 |
| | (1.57) | (0.12) | (1.38) | (0.72) |
| *Cash* | –0.000 | –0.002 | –0.001 | 0.001 |
| | (–0.02) | (–1.21) | (–0.23) | (0.61) |
| *Growth* | –0.000 | 0.000 | –0.000 | 0.001** |
| | (–1.10) | (0.66) | (–0.85) | (2.39) |
| *Newcases* | –0.000 | –0.036*** | –0.000* | –0.054*** |
| | (–1.28) | (–11.06) | (–1.78) | (–16.16) |
| *Constant* | 0.009 | 0.004 | 0.019** | 0.007 |
| | (1.29) | (0.90) | (2.54) | (1.55) |
| *Suest Chi2* | | 0.88 | | 1.25 |
| *Suest p* | | 0.3487 | | 0.2640 |
| Industry fixed effects | √ | √ | √ | √ |
| City fixed effects | √ | √ | √ | √ |
| *N* | 31,320 | 62,076 | 31,320 | 62,076 |
| $R^2$ | 0.006 | 0.007 | 0.011 | 0.010 |

**Panel B:** Interpersonal trust

| *Variable* | *Car_MA*[–1,1] | | *Car_MM*[–1,1] | |
|---|---|---|---|---|
| | High (1) | Low (2) | High (3) | Low (4) |
| ***Anti_Neg*** | 0.002* | 0.011** | 0.003** | 0.011** |
| | (1.90) | (2.07) | (2.23) | (2.04) |
| *Size* | –0.000** | –0.000 | –0.001*** | –0.001** |
| | (–2.24) | (–1.03) | (–3.24) | (–2.42) |
| *Roa* | 0.005* | 0.014*** | –0.010*** | 0.000 |
| | (1.65) | (2.90) | (–3.50) | (0.03) |
| *Lev* | 0.000 | 0.004 | 0.001 | 0.005** |
| | (0.22) | (1.54) | (0.61) | (2.05) |
| *Cash* | –0.002 | 0.002 | 0.000 | 0.003 |
| | (–1.27) | (0.66) | (0.23) | (0.93) |
| *Growth* | 0.000 | –0.000* | 0.001** | –0.000 |
| | (1.13) | (–1.80) | (2.52) | (–1.54) |
| *Newcases* | –0.037*** | –0.000 | –0.053*** | –0.000* |
| | (–11.67) | (–1.27) | (–16.42) | (–1.79) |
| *Constant* | 0.007 | –0.000 | 0.013*** | 0.003 |
| | (1.64) | (–0.03) | (2.81) | (0.37) |
| *Suest Chi2* | | 2.42 | | 2.03 |
| *Suest p* | | 0.1199 | | 0.1547 |
| Industry fixed effects | √ | √ | √ | √ |
| City fixed effects | √ | √ | √ | √ |
| *N* | 69,399 | 23,997 | 69,399 | 23,997 |
| $R^2$ | 0.006 | 0.009 | 0.009 | 0.015 |

This table presents the test results for the high and low government and interpersonal trust groups. Panel A (Panel B) reports the coefficients for the government (interpersonal) trust groups. The *t*-statistics are shown in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 8
The stock price drift after refutation.

| *VARIABLE* | *Bhar*[1,15] |
|---|---|
| *Anti_Neg* | 0.009*** |
| | (23.22) |
| *Size* | 0.000*** |
| | (6.01) |
| *Roa* | 0.001 |
| | (0.91) |
| *Lev* | 0.000 |
| | (0.21) |
| *Cash* | 0.001* |
| | (1.67) |
| *Growth* | –0.000 |
| | (–0.05) |
| *Newcases* | –0.000*** |
| | (–5.21) |
| *Constant* | –0.007*** |
| | (–6.39) |
| Industry fixed effects | √ |
| City fixed effects | √ |
| *N* | 93,795 |
| $R^2$ | 0.008 |

This table presents the results of the verification of the stock price drift. The coefficients are reported in the table, with the *t*-statistics shown in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

If *Anti_Neg* has explanatory power for the buy-and-hold abnormal returns during the [1,15] window period, then investors continue to be affected by the frightening rumors in the long term after the rumors are refuted, which indicates the existence of a stock price drift. Column (1) of Table 8 reports the regression results and shows that the coefficient of *Anti_Neg* is positive and significant, confirming the existence of a stock price drift.

## 6. Endogeneity

There may be systemic differences between firm-date observations affected by rumors and those not affected by rumors. Therefore, we conduct an entropy balancing procedure (Hainmueller and Xu, 2013). The advantage of such a procedure is that it can eliminate the differences between the treated group and the control group in relation to various control variables under the premise of a full sample. This allows us to use the full sample for a post-matched regression. In Table 9 below, we report the results of the entropy balancing procedure (Panel A) and the results of rerunning the regression using this sample (Panel B). The results show that the signs of the coefficients on *Neg* and *Pos* are in the same direction as our baseline results and are statistically significant, suggesting that our baseline results are robust to the entropy balancing procedure.

The persuasiveness of the baseline test may be influenced by the severity of the pandemic nationally influencing the COVID-19 rumors and therefore the stock prices of all listed companies. To exclude any such interference, we conduct a placebo test. We replace the explanatory variables in the baseline regression with dummy variables for frightening rumors and reassuring rumors in regions other than the location of the firms influenced by rumors in the baseline results, and rerun the regression. *Neg_Othercity* (*Pos_Othercity*) is a dummy variable that takes a value of 1 when frightening (reassuring) rumors exist outside the company's location, and 0 otherwise. The results are shown in Table 10. It is evident that frightening and reassuring rumors in other cities do not influence the stock prices of local listed companies. Thus, our results remain robust after the placebo test.

Table 9
Entropy test results.

**Panel A:** Summary of the distribution after entropy balancing

**Matching results of frightening rumors**

| *Variable* | Pre-matched | | | Post-matched | | |
|---|---|---|---|---|---|---|
| | *Neg* = 0 (N = 91,929) | *Neg* = 1 (N = 3,149) | difference | *Neg* = 0 (N = 91,929) | *Neg* = 1 (N = 3,149) | difference |
| *Size* | 22.41 | 22.61 | –0.207*** | 22.615 | 22.615 | –0.000 |
| *Roa* | 0.046 | 0.041 | 0.006*** | 0.041 | 0.041 | 0.000 |
| *Lev* | 0.425 | 0.438 | –0.013*** | 0.438 | 0.438 | –0.000 |
| *Cash* | 0.161 | 0.171 | –0.010*** | 0.171 | 0.171 | –0.000 |
| *Growth* | 0.156 | 0.152 | 0.004 | 0.152 | 0.152 | 0.000 |
| *Newcases* | 0.095 | 2.390 | –2.295*** | 2.389 | 2.390 | 0.001 |

**Matching results of reassuring rumors**

| *Variable* | Pre-matched | | | Post-matched | | |
|---|---|---|---|---|---|---|
| | *Pos* = 0 (N = 93.762) | *Pos* = 1 (N = 1,313) | difference | *Pos* = 0 (N = 93.762) | *Pos* = 1 (N = 1,313) | difference |
| *Size* | 22.411 | 22.682 | –0.271*** | 22.682 | 22.682 | 0.000 |
| *Roa* | 0.046 | 0.036 | 0.010*** | 0.036 | 0.036 | 0.000 |
| *Lev* | 0.425 | 0.448 | –0.024*** | 0.448 | 0.448 | 0.000 |
| *Cash* | 0.161 | 0.172 | –0.011*** | 0.172 | 0.172 | 0.000 |
| *Growth* | 0.156 | 0.134 | 0.0230 | 0.134 | 0.134 | –0.000 |
| *Newcases* | 0.173 | 0.022 | 0.151* | 0.024 | 0.022 | 0.002 |

**Panel B:** Results after entropy balancing

| *Variable* | (1) | | (2) | (3) | | (4) |
|---|---|---|---|---|---|---|
| | *Car_MA*[–1,1] | | *Car_MM*[–1,1] | *Car_MA*[–1,1] | | *Car_MM*[–1,1] |
| *Neg* | | –0.005*** | –0.004*** | | | |
| | | (–4.405) | (–3.299) | | | |
| *Pos* | | | | | 0.007*** | 0.007*** |
| | | | | | (5.678) | (3.991) |
| *Size* | | –0.000 | –0.000 | | –0.003*** | –0.003*** |
| | | (–0.091) | (–0.171) | | (–4.848) | (–4.189) |
| *Roa* | | 0.005 | –0.014* | | –0.003 | –0.037* |
| | | (0.582) | (–1.755) | | (–0.259) | (–1.802) |
| *Lev* | | 0.000 | –0.000 | | 0.013** | 0.017** |
| | | (0.123) | (–0.134) | | (2.565) | (2.429) |
| *Cash* | | –0.000 | 0.003 | | –0.004 | –0.006 |
| | | (–0.014) | (0.636) | | (–0.615) | (–0.635) |
| *Growth* | | –0.000 | –0.000 | | –0.001 | –0.001 |
| | | (–1.327) | (–0.901) | | (–1.353) | (–0.760) |
| ***Newcases*** | | **0.000** | **–0.000** | | **–0.002***** | **–0.002**** |
| | | **(0.753)** | **(–0.248)** | | **(–3.580)** | **(–2.347)** |
| *Constant* | | 0.007 | 0.006 | | 0.060*** | 0.070*** |
| | | (0.768) | (0.717) | | (4.244) | (4.487) |
| Industry fixed effects | √ | | √ | √ | | √ |
| City fixed effects | √ | | √ | √ | | √ |
| *N* | | 95,075 | 95,075 | | 95,075 | 95,075 |
| $R^2$ | | 0.017 | 0.015 | | 0.028 | 0.011 |

Panel A reports the results of the entropy balancing procedure, whereas Panel B reports the main regression results after this procedure. The coefficients are reported with the *t*-statistics in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 10
Placebo test.

| *Variable* | *Car_MA*[–1,1] (1) | *Car_MM*[–1,1] (2) | *Car_MA*[–1,1] (3) | *Car_MM*[–1,1] (4) |
|---|---|---|---|---|
| *Neg_Othercity* | 0.001 | –0.001 | | |
| | (0.764) | (–0.598) | | |
| *Pos_Othercity* | | | –0.009 | –0.009 |
| | | | (–1.078) | (–1.065) |
| *Size* | –0.000** | –0.001*** | –0.000** | –0.001*** |
| | (–2.483) | (–3.794) | (–2.484) | (–3.795) |
| *Roa* | 0.008*** | –0.007*** | 0.008*** | –0.007*** |
| | (3.257) | (–2.735) | (3.257) | (–2.735) |
| *Lev* | 0.001 | 0.002 | 0.001 | 0.002 |
| | (0.951) | (1.464) | (0.951) | (1.465) |
| *Cash* | –0.001 | 0.001 | –0.001 | 0.001 |
| | (–0.912) | (0.465) | (–0.913) | (0.466) |
| *Growth* | –0.000 | 0.000 | –0.000 | 0.000 |
| | (–0.796) | (0.052) | (–0.798) | (0.053) |
| *Newcases* | –0.000 | –0.000** | –0.000 | –0.000** |
| | (–1.427) | (–2.026) | (–1.437) | (–2.018) |
| *Constant* | 0.007* | 0.012*** | 0.007* | 0.012*** |
| | (1.755) | (3.020) | (1.763) | (3.017) |
| Industry fixed effects | √ | √ | √ | √ |
| City fixed effects | √ | √ | √ | √ |
| *N* | 95,075 | 95,075 | 95,075 | 95,075 |
| $R^2$ | 0.005 | 0.007 | 0.005 | 0.007 |

The table reports the coefficients, with the *t*-statistics shown in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

## 7. Conclusion

In this study, we investigate the impact of COVID-19 rumors on market reactions and find that when frightening (reassuring) rumors exist, they cause irrational pessimistic (optimistic) expectations of local companies and lead to negative (positive) market reactions. In the case of frightening rumors, investors correct their expectations after the rumors are refuted. However, in the case of reassuring rumors, even if the rumors are subsequently refuted, the expectations associated with them often remain and are difficult to correct. Thus, investors are not fully rational in the context of a public crisis, and they react asymmetrically to the refutation of different types of rumors. We find that the impact of the refutation of frightening rumors on the market causes a stock price drift. Finally, our conclusions remain stable after excluding Hubei firms and using an entropy balancing sample to control for endogeneity problems.

This study has several implications. First, in the digital era, the convenience of information transformation and the diversity of information sources make rumors a major hidden danger during a public crisis, and government agencies should be prepared to combat them. Second, during a public crisis, investors should accurately distinguish the quality of information, verify its authenticity and invest cautiously. They must acquire considerable official information from authoritative channels and make rational choices. Finally, for media organizations, information from online platforms and self-media should be strictly reviewed to avoid the spread of rumors.

## Funding

This research was funded by the National Natural Science Foundation of China (Grant No. 71672208 and 71902210), National Social Science Foundation (Grant No. 21BGL095), Humanities and Social Sciences Foundation of Ministry of Education of China (No. 19YJC630092) and Program for Innovation Research in Central University of Finance and Economics.

## 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.

## Appendix A. *A.1. Rumor collection and data selection*

We manually collect the COVID-19 rumors circulating on online platforms (such as Sina Weibo) from 20 January to 31 March 2020, and collect the corresponding refutation from authoritative organizations (including provincial and municipal public security bureaus). Excluding rumors that affect Hong Kong, Macau and Taiwan, we identify 143 rumors for which we can identify the time of appearance and the city of effect; of these, 118 are frightening rumors and 25 are reassuring rumors. We obtain 34 rumors affecting cities in Hubei province, with the remaining rumors distributed across other cities in various provinces. The descriptive statistics in Section 4.1 show the distribution of rumors in detail. The selection period for the rumors is used as the sample period. Then, the financial indicators of each company at the end of 2019 are considered as the corresponding financial control variables.

To obtain and identify the rumors during our selected period, we apply the following four-step data collection method.

1. We search for "COVID-19" and "rumors" as keywords on Baidu and Weibo, China's two main public network platforms, to collect all search results in the selected period (including rumors from Weibo, WeChat and Tieba).
2. For all search results, we check the source of the corresponding rumors to confirm their existence. We eliminate rumors for which we cannot determine a confirmed source.
3. Using the content of the rumor as keywords, we search for refuting information for all of the rumors, confirm the falseness of the rumors and eliminate any "rumors" that are subsequently realized.
4. We manually classify rumors based on their text. We divide rumors into frightening rumors and reassuring rumors. If a rumor exaggerates the severity of the local pandemic, for example, a report that "there is a COVID-19 case in a certain area" when one has not occurred in reality, we define it as a frightening rumor. If a rumor downplays the severity of the local pandemic, for example, a false report that a certain area "will resume work and production" on a certain day, then we define it as a reassuring rumor.

## References

Alfaro, L., Chari, A., Greenland, A.N., Schott, P.K., 2020. Aggregate and firm-level stock returns during pandemics, in real time. National Bureau of Economic Research (NBER) 26950, 1–23. https://doi.org/10.3386/w26950.

Baek, S., Mohanty, S.K., Glambosky, M., 2020. COVID-19 and stock market volatility: An industry level analysis. Finance Res. Lett. 37, 1–10.

Baker, S.R., Bloom, N., Davis, S.J., Cost, K.J., Sammon, S.J., Viratyosin, T., 2020. The unprecedented stock market impact of COVID-19. National Bureau of Economic Research (NBER) 26945, 1–14. https://doi.org/10.3386/w26945.

Bartov, E., Radhakrishnan, S., Krinsky, I., 2000. Investor sophistication and patterns in stock returns after earnings announcements. Account. Rev. 75 (1), 43–63.

Black, F., 1986. Noise. J. Finance 41 (3), 528–543.

Block, L., Kramer, T., 2009. The effect of superstitious beliefs on performance expectations. J. Acad. Mark. Sci. 37 (2), 161–169.

Bollen, J., Mao, H., Zeng, X.J., 2010. Twitter mood predicts the stock market. J. Comput. Sci. 2 (1), 1–8.

Bordia, P., Difonzo, N., Haines, R., Chaseling, E., 2010. Rumors denials as persuasive messages: Effects of personal relevance, source and message characteristics. J. Appl. Soc. Psychol. 35 (6), 1301–1331.

Brown, G.W., Cliff, M.T., 2004. Investor sentiment and the near-term stock market. J. Empirical Finance 11 (1), 1–27.

Carlos, C., Nicholas, K., Emanuel, M., 2011. The persistent effects of a false news shock. J. Empirical Finance 18 (4), 597–615.

Carter, D.A., Simkins, B.J., 2004. The market's reaction to unexpected catastrophic events: The case of airline stock returns and the September 11th attacks. Quart. Rev. Econ. Finance 44 (4), 539–558.

Chen, Y., Shen, Y., Wang, J.Y., 2020. Financial market reaction to dramatic public health shocks (In Chinese). Finance Res. 6, 20–39.

Clarkson, P.M., Joyce, D., Tutticci, I., 2006. Market reaction to takeover rumor in Internet discussion sites. Account. Finance 46 (1), 31–52.

Dai, Y., Kong, D., Li, W., 2013. Information asymmetry, mutual funds and earnings management: Evidence from China. China J. Account. Res. 6 (3), 187–209.
Davies, P., Canes, M., 1978. Stock prices and the publication of second-hand information. J. Bus. 51 (1), 43–56.
DiFonzo, N., 2007. Rumor, gossip and urban legends. Diogenes 54 (1), 19–35.
Einwiller, S., Kamins, M., 2010. Rumor has it: The moderating effect of identification on rumor impact and the effectiveness of rumor refutation. J. Appl. Soc. Psychol. 38 (9), 2248–2271.
Engelberg, J., Parsons, C.A., 2011. The causal impact of media in financial markets. J. Finance 66, 67–97.
Giglio, S.W., Maggiori, M., Stroebel, J., Utkus, J., 2020. Inside the mind of a stock market crash. National Bureau of Economic Research (NBER) 27272, 1–13. https://doi.org/10.3386/w27272.
Hainmueller, J., Xu, Y., 2013. Ebalance: A Stata package for entropy balancing. J. Stat. Softw. 54 (7), 1–18.
He, Q., Liu, J., Wang, S., Yu, J., 2020. The impact of COVID-19 on stock markets. Econ. Polit. Stud. 8 (3), 275–288.
Hirshleifer, D., Shumway, T., 2003. Good day sunshine: Stock returns and the weather. J. Finance 58 (3), 1009–1032.
Hu, C.H., Wang, Y.F., 2012. Investor sentiment and assets valuation. Syst. Eng. Proc. 3, 166–171.
Huberman, G., Regev, T., 2001. Contagious speculation and a cure for cancer: A nonevent that made stock prices soar. J. Finance 56 (1), 387–396.
Izzeldin, M., Muradolu, Y.G., Pappas, V., Sivaprasad, S., 2021. The impact of COVID-19 on G7 stock markets volatility: Evidence from a ST–HAR model. Int. Rev. Financ. Anal. 74 (3), 1–12.
Jia, W., Redigolo, G., Shu, S., Zhao, J., 2020. Can social media distort price discovery? Evidence from merger rumors. J. Account. Econ. 70 (1), 1–64.
Jussi, N., Sami, V., 2010. Terrorism and the stock market sentiment. Financ. Rev. 4 (2), 263–275.
Kahneman, D., 2011. Thinking, fast and slow. Farrar, Straus and Giroux, New York, NY.
Kaplanski, G., Levy, H., 2010. Sentiment and stock prices: The case of aviation disasters. J. Financ. Econ. 98 (2), 174–201.
Kassam, K.S., Koslov, K., Mendes, W.B., 2009. Decisions under distress: Stress profiles influence anchoring and adjustment. Psychol. Sci. 20 (11), 1394–1399.
Kim, J.H., Thomas, H., 2021. Market reactions to the arrival and containment of COVID-19: An event study. Finance Res. Lett. 38, 1–8.
Koller, M., 1992. Rumor rebuttal in the marketplace. J. Econ. Psychol. 13 (1), 167–186.
Kyle, A.S., 1985. Continuous auctions and insider trading. Econometrica 53 (6), 1315–1335.
Lars, W., Lee, W., Detenber, B.H., 2002. Individual level Predictors of Public Outspokenness: A Test of the Spiral of Silence Theory in Singapore. Int. J. Qual. Health Care 14 (4), 391–412.
Li, J.J., Massa, M., Zhang, H., Zhang, J., 2019. Chang air pollution, behavioral bias and the disposition effect in China. J. Financ. Econ. 142 (2), 641–673.
Lin, P., Wei, X., 2006. Investor attention, overconfidence and category learning. J. Financ. Econ. 80 (3), 563–602.
Liu, Y.Z., Wang, C.H., 2020. Analysis of epidemics from the perspective of behavior: An overview of causes, effects and countermeasures (In Chinese). Finance Res. 6, 1–19.
Maier, S.U., Makwana, A.B., Hare, T.A., 2015. Acute stress impairs self-control in goal-directed choice by altering multiple functional connections within the brain's decision circuits. Neuron 87 (3), 621–631.
Mathur, I., Waheed, A., 1995. Stock price reactions to securities recommended in Business Week's "Inside Wall Street". Financ. Rev. 30 (3), 583–604.
Mendel, B., Shleifer, A., 2012. Chasing noise. J. Financ. Econ. 104 (2), 303–320.
Noelle-Neumann, E., 1974. The spiral of silence: A theory of public opinion. J. Commun. 24 (2), 43–51.
Noelle-Neumann, E., 1991. The Theory of Public Opinion: The Concept of the Spiral of Silence. Ann. Int. Commun. Assoc. 14 (1), 256–287.
Nolen-Hoeksema, S., 2012. Emotion regulation and psychopathology: The role of gender. Ann. Rev. Clin. Psychol. 8 (1), 161–187.
Popenoe, D., 1986. Sociology, sixth ed. Prentice-Hall, Englewood Cliffs, NJ.
Rosnow, R.L., 1991. Inside rumor: A personal journey. Am. Psychol. 46 (5), 484–496.
Rouatbia, W., Demir, E., Kizys, R., Zaremba, A., 2021. Immunizing markets against the pandemic: COVID-19 vaccinations and stock volatility around the world. Int. Rev. Financ. Analysis 77 (10), 101819.
Rui, A., Yrjo, K., Yang, S., Zhang, C., 2020. Resiliency of environmental and social stocks: An analysis of the exogenous COVID-19 market crash. Rev. Corporate Finance Stud. 9 (3), 593–621.
Schmeling, M., 2009. Investor sentiment and stock returns: Some international evidence. J. Empirical Finance 16 (3), 394–408.
Schmidt, D., 2019. Stock market rumors and credibility. Rev. Financ. Stud. 8 (8), 3804–3853.
Schwabe, L., Wolf, O.T., 2013. Stress and multiple memory systems: From "Thinking" to "Doing". Trends Cognitive Sci. 17 (2), 60–68.
Smales, L.A., 2020. Investor attention and the response of US stock market sectors to the COVID-19 crisis. Rev. Behav. Finance 13 (1), 20–39.
Sunstein, C.R., 2014. On rumors: How falsehoods spread, why we believe them and what can be done. Princeton University Press, Princeton, NJ.
Tetlock, P.C., 2007. Giving content to investor sentiment: The role of media in the stock market. J. Finance 62 (3), 1139–1168.
Toubia, O., Stephen, A.T., 2013. Intrinsic vs. image-related utility in social media: Why do people contribute content to Twitter? Market Sci. 32 (3), 368–392.
Twemlow, S.W., Sacco, F.C., Hough, G., 2003. A socio-psychoanalytic perspective on group dynamics, cults and terrorism: The context of terrorism. Socio-Analysis 5 (1), 57–78.
Veldkamp, L.L., 2006. Media frenzies in markets for financial information. Am. Econ. Rev. 96 (3), 577–601.

Wason, P.C., Evans, J.St.B.T., 1975. Dual processes in reasoning? Cognition 3 (2), 141–154.
Worthington, A., Valadkhani, A., 2004. Measuring the impact of natural disasters on capital markets: An empirical application using intervention analysis. Appl. Econ. 36 (2), 217–786.
Yang, Z.H., Chen, Y.T., Zhang, P.M., 2020. Macroeconomic shock, financial risk transmission and governance response to major public emergencies (In Chinese). Management World 5, 13–35.
Yu, R., 2016. Stress potentiates decision biases: A stress induced deliberation-to-intuition (SIDI) model. Neurobiol. Stress 3 (6), 83–95.

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# The impact of D&O insurance on excess corporate leverage

Jiamin Liu [a], Yalin Jiang [b], Shengdao Gan [c], Ran Chen [d]

[a] School of Economics and Management, Hubei University of Technology, Wuhan, China
[b] School of Social Audit, Nanjing Audit University, Nanjing, China
[c] Business School, Sichuan University, Chengdu, China
[d] Postdoctoral Research Workstation, Anhui Rural Credit Union, Hefei, China

ARTICLE INFO

*Article history:*
Received 21 October 2021
Accepted 11 October 2022
Available online 5 November 2022

*Keywords:*
D&O insurance
Excess leverage
Monitoring effect
Government interventions

ABSTRACT

The governance effects of directors' and officers' liability insurance (D&O insurance), an important tool for risk diversification, are of strong concern in the capital market. Using a sample of Chinese A-share listed firms from 2009 to 2018, we examine the impact of D&O insurance on excess corporate leverage. We find that D&O insurance is negatively associated with excess corporate leverage and that this result is consistent with a series of robustness tests. Further analyses show that D&O insurance impedes excess corporate leverage mainly because of its effect on external monitoring. The effect is more pronounced for firms that are state-owned, have political connections and are located in provinces with low marketization than for other firms.


## 1. Introduction

Directors' and officers' liability insurance (D&O insurance) is a type of liability insurance purchased by a firm to protect directors and managers against certain losses from lawsuits arising from poor management decisions and other wrongful acts in that capacity (Yuan et al., 2016). D&O insurance was introduced in the United States in the 1930s and is widely adopted in developed countries. In 2014, a survey by Tillinghast-Tower Perrin found that 96 % and 88 % of listed firms in the U.S. and Canada, respectively, purchase D&O insurance; in high-risk industries, the proportion of firms with such insurance even reached 100 % (Hu et al., 2019). China adopted D&O insurance relatively late, as it first formulated and implemented relevant regulations on D&O insurance in 2001, and it was formally first used by Vanke, a large real estate devel-

*E-mail address:* 340434383@qq.com (R. Chen)

https://doi.org/10.1016/j.cjar.2022.100271
1755-3091/

oper, in 2002. However, at present, the percentage of D&O insurance coverage in China remains low, at less than 8 % (Jia et al., 2019).

Scholars hold opposing views on the governance effect played by D&O insurance as an important tool to diversify and transfer managers' risks. The incentive hypothesis argues that D&O insurance can encourage directors and officers to actively perform their duties (Jensen, 1993), which is conducive to attracting and retaining more outstanding talents (Hu et al., 2019), resulting in a virtuous circle of corporate governance. The monitoring hypothesis suggests that by introducing the insurance company as an external supervisor, listed firms can improve the existing supervision mechanism, thereby restraining the opportunistic behavior of managers and reducing agency costs (Ling and Bai, 2017; Wen, 2017). Conversely, the opportunism hypothesis argues that because D&O insurance reduces the rent-seeking cost of executives, it tends to lead executives to engage in opportunistic behaviors, including paying higher acquisition premiums, making unrelated mergers and acquisitions (Lin et al., 2011) and over-investing (Chan et al., 2019).

In recent years, under the dual pressure of economic downturn and overcapacity, the leverage risk of the Chinese economy has become increasingly prominent. To solve the problem of high leverage, the Party Central Committee and the State Council have successively implemented a series of mandatory "deleveraging" policies since the end of 2015. Given that micro-level firm leverage is a central and critical component of the continued growth of macroeconomic leverage (Jin et al., 2017), reducing the former is critical to reducing the latter as well as to defending against financial risks. One important manifestation of the reduction of firms' leverage is the reduction of excess corporate leverage, which is defined as the extent to which a firm's actual debt ratio deviates from its target debt ratio in financing decisions; reducing excess corporate leverage means reducing the leverage ratio to the threshold for effective risk prevention. Therefore, we are interested in the following research questions. As an important tool of corporate governance, can D&O insurance inhibit excess corporate leverage? What are the influencing mechanisms through which D&O insurance affects excess corporate leverage? Does the effect vary for different government interventions?

To answer the above questions, we use Chinese A-share listed firms from 2009 to 2018 to examine the impact of D&O insurance on excess corporate leverage. We find that D&O insurance is significantly negatively associated with excess corporate leverage. This result is consistent with the results of a series of robustness tests, which include tests to exclude market concerns and reduced credit supply by banks as alternative explanations for the inhibiting effect of D&O insurance on excess corporate leverage. Further analyses show that D&O insurance impedes excess corporate leverage by reducing the first type of agency cost,[1] which supports the monitoring effect of D&O insurance. Moreover, government interventions have an important impact on the relationship between D&O insurance and excess corporate leverage. In firms with state-owned property rights, political connections and low marketization levels, D&O insurance has a more significant inhibitory effect on excess corporate leverage than on private firms, firms lacking political connections and firms with high marketization levels.

We make several key contributions. First, we enrich and expand the research on the impact of D&O insurance on corporate behavior. From the perspectives of risk and investment, the literature verifies the impact of D&O insurance on corporate risk-taking (Wen, 2017), diversified investment (Chan et al., 2019) and corporate mergers and acquisitions (Lin et al., 2011). However, whether D&O insurance promotes or inhibits the high-risk behavior of firms remains to be confirmed. Insufficient attention is paid to the relationship between D&O insurance and excess corporate leverage, despite the close relationship between such insurance and corporate investment decisions. By examining the impact of D&O insurance on excess corporate leverage, we provide evidence that D&O insurance plays a positive external governance role in the Chinese capital market and we enrich and expand the research content and theoretical system of D&O insurance.

Second, we provide insights into the mechanism through which D&O insurance influences excess corporate leverage, namely the first type of agency cost. By identifying the effect of D&O insurance on excess corporate leverage under different levels of monitoring and incentives, we find that D&O insurance can inhibit excess

[1] The first type of agency cost reflects the conflict of interest between shareholders and managers, while the second type of agency cost reflects that between controlling shareholders and minority shareholders.

corporate leverage by reducing the first type of agency cost, which provides theoretical guidance on how firms can rely on D&O insurance and insurance companies to restrain excess corporate leverage.

Third, we contribute to further understanding of the micro-level mechanisms through which government interventions affect corporate behavior. The literature considers the effects of government interventions on excess corporate leverage (Chang et al., 2014; Lu et al., 2015), but direct evidence of the effect of government interventions and D&O insurance on excess corporate leverage is lacking. Using China's unique institutional background, we explore the external dependence of the role of D&O insurance from three aspects: the nature of firm ownership, political connections and the level of marketization. We reveal that government interventions can strengthen the inhibiting effect of D&O insurance on excess corporate leverage to a certain extent. We not only deepen the understanding of D&O insurance but also provide empirical evidence for optimizing the internal and external governance environment of firms and deepening the reform of government functions.

## 2. Literature review and hypotheses development

### *2.1. Literature on the governance effect of D&O insurance*

There are three different views on the governance effect of D&O insurance in the literature. The incentive hypothesis considers that D&O insurance can reduce the practice risk of directors and officers, improve their enthusiasm for performing their duties and create a virtuous circle in corporate governance. As D&O insurance can transfer the litigation risks that directors and officers may face in the process of performing their duties, it provides a platform for directors and officers to fully exercise their talents without concern for risks, which is conducive to retaining excellent human capital for listed firms and motivating them to make decisions that are beneficial to corporate governance (Jensen, 1993; Park, 2005). In an empirical study, Chen et al. (2017) find that CEOs in Taiwan regard D&O insurance as a supplement to compensation. From the perspective of contractual terms, Peng et al. (2018) find that the higher (lower) the D&O insurance coverage is, the stronger (weaker) the incentive effect is and the higher (lower) the investment efficiency is, as D&O insurance eases the worries of executives and makes them less risk averse than in the absence of such insurance.

The monitoring hypothesis suggests that by purchasing D&O insurance, a firm effectively introduces the insurance company as an external monitor, which improves regulation of corporate governance practices. Generally, before offering insurance, insurance companies will conduct a thorough investigation of the share price volatility, business fluctuations and risk-taking of firms as a way to assess the risk level of both the firms and their directors and officers, and they will charge premiums corresponding to the assessed risks (Boyer and Stern, 2014). Even during and after enrollment, insurers can improve the agency problem by establishing multiple layers of regulation to constrain the speculative practices of managers (Wen, 2017). Ling and Bai (2017) find that firms that have purchased D&O insurance significantly reduce the first and second types of agency costs. Liou et al. (2017) argue that D&O insurance can play a monitoring role in firms and improve the quality of corporate disclosure.

The opportunism hypothesis argues that the introduction of D&O insurance into the firm will exacerbate the executives' opportunistic behavior. Under the risk aversion effect of D&O insurance, directors and officers have lower rent-seeking costs than before and are more likely to engage in behaviors that maximize their utility, thus conducting high-risk activities, such as over-investment and mergers and acquisitions, which increase losses to shareholders and the firm (Lin et al., 2011; Chan et al., 2019). Chalmers et al. (2002) study the amount of D&O insurance coverage purchased at the time of a firm's IPO and the value of the stock 3 years later; they find a significant negative correlation between the two, demonstrating that the purchase of D&O insurance has a negative impact on corporate governance.

### *2.2. Literature on factors influencing excess corporate leverage*

As noted previously, excess corporate leverage is a phenomenon in which the actual debt ratio deviates from the level and extent of the target debt ratio (Lu et al., 2015), and it is essentially a capital structure problem. Scholars conduct extensive research on the factors influencing excess corporate leverage in terms of the external environment and internal governance. Regarding the external environment, Jiang et al. (2008) find that the more competitive the market is, the more firms will reduce the deviation of debt and finance according

to the target capital structure. Wu and Du (2019) determine that after the 18th National Congress of the Communist Party of China, the government's measures to strengthen the regulation of defaulters have had a significant effect on reducing the excess leverage of private firms. Chen et al. (2020) reveal that higher equity liquidity significantly reduces excess corporate leverage by mitigating information asymmetry and amplifying the exit threat of institutional investors. With respect to internal governance, Titman and Tsyplakov (2007) argue that the existence of agency costs drives firms away from target debt ratios, and financial crisis costs cause the capital structure to be tilted toward target levels. Paligorova and Xu (2012) find that firms with pyramidal ownership structures are significantly more leveraged than non-pyramidal firms. Zona (2016) argues that managers may make errors of judgment in corporate decisions due to their own inexperience or poor communication with the board, leading to excess leverage.

In summary, the literature is yet to form a unified conclusion on whether D&O insurance inhibits or promotes the high-risk financial behavior of enterprises. Moreover, most of the research on the factors influencing excess corporate leverage is based on the external environment and internal governance. Therefore, the impact of D&O insurance on excess corporate leverage needs to be further examined.

### *2.3. Hypothesis development*

Trade-off theory suggests that firms not only weigh the benefits of tax shields generated by debt but also consider the disadvantages of financial constraint costs and bankruptcy costs associated with debt, ultimately concluding that an optimal capital structure exists when the marginal benefit from debt equals the marginal cost. At this point, the firm's cost of capital is at a minimum and its debt is at an optimal level. Excess corporate leverage beyond the optimal level may have adverse consequences. First, excess corporate leverage can cause financial distress, increase agency costs and damage corporate value. Li et al. (2014) point out that excess corporate leverage caused by managers' short-term behavior is a hidden danger for enterprises, which may lead to financial distress and crisis, which in turn lead to an increase in financial and bankruptcy risks. Tian (2004) finds that more debt increases the free cash flow and agency costs of state-owned enterprises (SOEs), which will have an adverse impact on the creation of corporate value. Titman and Tsyplakov (2007) find that, especially for firms with high financial distress costs, there is a strong incentive to reduce debt ratios to prevent future financing distress. Using East Asian firms as an example, Durand et al. (2016) determine that before a foreign acquisition, a firm's leverage has an important disciplinary effect but, as the firm exceeds its optimal leverage level, the agency costs faced by shareholders from excess corporate leverage outweigh any benefits from the mergers and acquisitions. Second, excess corporate leverage is detrimental to capital market development and social stability. Zhang (2005) points out that although speculative behavior is more visible and blamed for the unstable functioning of capital markets, in fact, it is excess corporate leverage that causes unstable capital market behavior. Issa (2020) also find that excess corporate leverage is one of the reasons for the outbreak of financial crises because it increases their probability of occurrence, leading to the emergence of currency crises, asset price plunges and banking crises. In general, excess corporate leverage has a negative impact on the sustainability of firms because it reduces their returns, damages their future growth and imposes a heavy cost burden on society.

Theoretically, D&O insurance may affect excess corporate leverage in different ways. On the one hand, D&O insurance may inhibit excess corporate leverage by retaining good human capital for firms. As D&O insurance can transfer the litigation risks that directors and executives may face in the process of performing their duties, it provides a platform for directors and executives to fully utilize their talents without concern of litigation, which is conducive to retaining excellent human capital for listed firms (Jensen, 1993; Park, 2005) and maintaining the stability of the executive team. Studies indicate that a stable executive team will focus more on long-term corporate value creation, which is conducive to curbing the executive's short-sightedness and reducing over-investment and inefficient investment (Agarwal et al., 2020; Zhang et al., 2020). However, this inefficient investment behavior of blindly using debt to increase investment, or even choosing to raise debt to invest when investment opportunities are not ideal, are among the reasons that firms deviate from their target capital structure and form excess corporate leverage (Dong and Guo, 2019). Therefore, D&O insurance can reduce inefficient investment and thus inhibit excess corporate leverage by retaining good human capital for the firm and maintaining the stability of the executive team.

On the other hand, D&O insurance may inhibit excess leverage by reducing agency costs. That is, by purchasing D&O insurance, firms effectively engage the insurance company as an external supervisor, which can constrain the executive's opportunistic behavior through multiple layers of regulation to mitigate agency conflicts (O'Sullivan, 1997; Ling and Bai, 2017). The insurer will conduct an overall risk assessment of the listed firm and the insured before underwriting the firm, thoroughly analyze the financial status and risk management status of the insured firm and comprehensively investigate and assess the qualifications, professional experience and integrity of the directors and executives and other factors affecting business risks and then assign a rate matching the assumed risk (Boyer and Stern, 2014). Excess corporate leverage may signal the self-interested behavior of executives to stakeholders, including insurance companies, prompting them to restrain this tendency by charging high premiums and setting strict insurance terms (Lu et al., 2015). In underwriting, insurance companies continuously assess the level of corporate governance and project risk and respond to potential increases in compensation risk by modifying the program and raising premiums to put pressure on listed firms (Li and Xu, 2020) to adjust, thus restraining the executive's self-interest, curbing agency costs and avoiding excess corporate leverage. Even in the event of litigation, insurance companies will conduct in-depth investigations to identify corporate exclusions and pay for liabilities resulting from unintentional actions of management in the process of performing their duties (Yuan et al., 2018). Thus, to reduce the risk of litigation for executives and reduce their own loss of interest, insurance companies have an incentive to continuously monitor listed firms and executives and reduce excess corporate leverage. At the same time, to reduce premiums and send signals of good corporate governance to stakeholders such as insurance companies, executives are likely to discipline their own behavior and reduce excess corporate leverage.

Therefore, based on the above analysis, we propose the following hypothesis:

H1a: D&O insurance is negatively associated with excess corporate leverage.

Conversely, however, D&O insurance may also promote excess corporate leverage. First, D&O insurance can exacerbate the moral hazard problem of executives. D&O insurance allows the insured to transfer the liability for damages due to negligence or misconduct during the normal performance of duties to the insurance company, which encourages the insured to ignore the cost of assuming the liability for damages (Song and Sun, 2016). This not only greatly weakens the restraining mechanism and deterrent effect of the law (Li and Xu, 2020), but it also reduces the rent-seeking costs of executives and makes it easy for them to engage in behaviors that maximize their utility, leading to over-investment and inefficient mergers and acquisitions (Lin et al., 2011; Chan et al., 2019), which in turn exacerbate excess corporate leverage. Second, D&O insurance may weaken the supervisory function of directors. The risk sheltering effect of D&O insurance may reduce the professional responsibilities of directors, especially independent directors, and to some extent weaken their motivation to perform their due diligence and supervisory duties, thus providing opportunities for executives or shareholders to engage in opportunistic behavior (Ling and Bai, 2017) and inducing excess corporate leverage.

Therefore, based on the above analysis, we propose the following hypothesis:

H1b: D&O insurance is positively associated with excess corporate leverage.

The relationship between the government and enterprises is a major issue in China's economic reform and development, and the nature of firm ownership, political connections and the level of marketization are the embodiments of government interventions in enterprises (Lin and Li, 2004; Yu et al., 2010; Wu and Jiang, 2019), which is crucial to realizing the deleveraging of micro-enterprises and reducing excess corporate leverage. First, the degree of excess leverage may be lower for SOEs than for non-SOEs. Compared with non-SOEs, SOEs have the advantage of debt financing because of their lower default risk or bankruptcy risk due to their implicit government guarantee. Thus, under the same conditions as non-SOEs, their target debt ratio may be higher and the degree or possibility of their actual debt ratio exceeding the target debt ratio is lower, that is, they have less excess leverage than non-SOEs (Lu et al., 2015). In addition, the convenience of equity financing for SOEs encourages them to reduce excess leverage. Compared with non-SOEs, SOEs have an advantage in gaining equity financing, which reduces SOEs' reliance on debt financing (Xiao and Zou, 2008; Chang et al.,

2014) and hence their excess corporate leverage. Second, the degree of excess leverage may be lower for politically connected firms than for non-politically connected firms. Given the poor institutional development in China and the fact that the government holds most of the power to allocate resources related to firm survival and development, firms have an incentive to establish political connections with the government to obtain government financial and policy support (Yu et al., 2010) as well as lower equity financing costs (Boubakri et al., 2012). Convenient government subsidies and low-cost equity financing may induce politically connected firms to reduce their over-reliance on debt financing and reduce their excess leverage. In addition, because excess corporate leverage can undermine corporate value and capital market stability (Tian, 2004; Issa, 2020), politically connected firms are more inclined to reduce their excess corporate leverage for future growth reasons and to meet the needs of government deleveraging policies than firms without such connections. Finally, the degree of excess leverage may be lower (higher) for firms in regions with lower (higher) levels of marketization. Due to the vast territory of China, differences in political, economic and cultural aspects between regions lead to differences in the degree of marketization. In regions with a low level of marketization, the government may intervene in resource allocation and influence firms' business decisions through administrative means to achieve established political and economic goals (Wu and Jiang, 2019), including limiting firms' debt levels and avoiding excess leverage to achieve its macroeconomic deleveraging goals.

The relationship between D&O insurance and excess corporate leverage can be affected by government intervention as an external environmental factor. On the one hand, government interventions may strengthen the inhibitory effect of D&O insurance on excess corporate leverage. In the context of the transitional market system, government interventions can act as a "supporting hand," indirectly promoting the development and improvement of corporate governance by curbing excessive competition, providing professional guidance, allocating resources and assisting in the introduction of advanced foreign technology (Wang and Duan, 2015). Directors and executives of firms with good corporate governance are generally higher achieving, with greater professionalism and a stronger sense of belonging to the firm than is the case for other firms. Therefore, the personal interests of directors and executives are more likely to be aligned with the interests of the firm in this situation, thus contributing to the positive governance effect of D&O insurance (Hao et al., 2016). Therefore, the combination of government intervention and D&O insurance can best regulate management's performance and corporate financing behavior, such that the sum will be greater than the parts in terms of the disincentive for excess corporate leverage.

On the other hand, government intervention may weaken the role of D&O insurance in promoting excess corporate leverage. As D&O insurance may cause executives to relax their duty of diligence and prudence, because it reduces the cost of rent-seeking for executives, it is likely to induce moral hazard and opportunistic behavior by executives and promote excess corporate leverage. However, this negative effect may be offset to an extent as the government's goals of economic development, employment and social stability will be upheld by enterprises with political connections (Lin and Li, 2004), leading them to prefer to avoid serious financial distress and social burdens from excess corporate leverage. Therefore, even if D&O insurance promotes excess corporate leverage, this will be offset or weakened by government interventions and government influence.

Based on the above analysis, we propose the following hypotheses:

H2a: Government interventions can strengthen the inhibitory effect of D&O insurance on excess corporate leverage.

H2b: Government interventions can weaken the promotional effect of D&O insurance on excess corporate leverage.

## 3. Research design

### *3.1. Sample*

Our initial sample includes Chinese A-share firms listed on the Shanghai and Shenzhen stock exchanges for the 2009–2018 period. We collect our data from several resources. Data on D&O insurance are obtained manually from the annual reports of listed firms. Other data are collected from the China Stock Market &

Accounting Research database. To enable reasonable precision, we exclude firms with special treatment status, firms that belong to financial industries and firms with missing values. The total number of our final sample is 16,301. We winsorize all continuous variables at the 1st and 99th percentiles.

### 3.2. Empirical models

We use the following regression model to capture the effect of D&O insurance on excess corporate leverage:

$$CEL_{i,t} = \alpha_0 + \alpha_1 DO_{i,t} + \alpha_2 Size_{i,t} + \alpha_3 Roa_{i,t} + \alpha_4 Growth_{i,t} + \alpha_5 Fata_{i,t} + \alpha_6 Shr_{i,t} + \alpha_7 Bm_{i,t} + \alpha_8 Ae_{i,t} + \alpha_9 Ndts_{i,t} + \alpha_{10} Etr_{i,t} + \alpha_{11} Msh_{i,t} + \alpha_{12} Vebitta_{i,t} + \alpha_{13} Vcfo_{i,t} + Year_i + Industry_t + \varepsilon_{i,t} \quad (1)$$

where $i$ and $t$ refer to the firm and year, respectively. Following the literature (Lin et al., 2011; Hu et al., 2019), we adopt a dummy variable to measure D&O insurance (*DO*), which equals 1 if a firm purchases D&O insurance in a given year, and 0 otherwise. *CEL* refers to excess corporate leverage. Following Lu et al. (2015), we use the level of excess corporate leverage (*Exlev*) and a dummy variable (*Exlev_dum*) to measure *CEL*, where *Exlev* is measured by the difference between the actual debt ratio and the expected debt ratio, which is determined by internal factors. The expected debt ratio is estimated using model (2):

$$Lev_t = \beta_0 + \beta_1 Soe_{t-1} + \beta_2 Roa_{t-1} + \beta_3 Indlev_{t-1} + \beta_4 Growth_{t-1} + \beta_5 Fata_{t-1} + \beta_6 Size_{t-1} + \beta_7 Shr_{t-1} + Year_i + Industry_t + \varepsilon_{i,t} \quad (2)$$

where $i$ and $t$ refer to the firm and year, respectively. *Soe* denotes the nature of ownership (state-owned or private) of the firm, *Roa* is firm profitability, *Indlev* is the median debt ratio for the industry, *Growth* is the growth rate of total assets, *Fata* is the proportion of fixed assets, *Size* is the scale of the firm, *Shr* is the shareholding ratio of the largest shareholder and $\varepsilon_{it}$ denotes the disturbance.

The larger (smaller) the value of *Exlev* is, the higher (lower) the level of excess corporate leverage is. Using the positive and negative values of *Exlev*, we establish the dummy variable *Exlev_dum*, which equals 1 if *Exlev* is greater than 0, and 0 otherwise. Drawing on the literature (Lu et al., 2015; Wu and Du, 2019), we include the following firm-specific characteristics that could influence a firm's excess leverage: firm size (*Size*), profitability (*Roa*), the growth rate (*Growth*), the proportion of fixed assets (*Fata*), equity concentration (*Shr*), the book-to-market ratio (*Bm*), the management expense ratio (*Ae*), the non-debt tax shield (*Ndts*), the income tax rate (*Etr*), management's shareholding (*Msh*), earnings volatility (*Vebitta*) and cash flow volatility (*Vcfo*). Furthermore, we control for industry (*Industry*) and year (*Year*) effects. The definitions of these variables are provided in Table 1. Robust standard errors are used in the model estimates to eliminate heteroscedasticity.

## 4. Empirical results

### 4.1. Descriptive statistics

Table 2 presents descriptive statistics for D&O insurance by year, industry and the nature of firm ownership (SOEs versus non-SOEs). In terms of the annual distribution, 21 listed firms purchased D&O insurance in 2009, accounting for 6.77 % of the total insured sample. In 2018, 57 listed firms, or 18.39 % of the total insured sample, purchased D&O insurance. In terms of the industry distribution, the manufacturing industry has the highest number of D&O insurance purchases, followed by the real estate, transportation, warehousing and postal industries; the culture, sports and entertainment industry has the lowest number of purchases. In terms of the distribution of property rights, 197 SOEs (63.55 %) purchased D&O insurance, a much higher proportion than that for non-SOEs.

Table 3 shows the descriptive statistics of the variables. The mean value of *Lev* is 0.458 and the standard deviation is 0.206. The mean value of *Exlev_dum* is 0.498, indicating that for 49.8 % of the enterprises in the sample, the actual debt ratio exceeds the target debt ratio. The mean value of *Exlev* is 0.0001. These results are consistent with Lu et al. (2015). The mean value of *DO* is 0.019, indicating that on average, only about 1.9 out of every 100 companies in the sample purchase D&O insurance.

Table 1
Variables definition.

| Variables | Definition |
|---|---|
| *Lev* | The total debt divided by total assets. |
| *Exlev* | The excess leverage ratio of a firm calculated according to model (2). |
| *Exlev_dum* | A dummy variable that equals 1 if the excess leverage ratio of a firm is greater than 0, and 0 otherwise. |
| *DO* | A dummy variable that equals 1 if a firm purchases D&O insurance in a given year, and 0 otherwise. |
| *Soe* | A dummy variable that equals 1 if a firm is a state-owned enterprise, and 0 otherwise. |
| *Roa* | Operating profit divided by total assets. |
| *Indlev* | Median annual industry debt ratio. |
| *Growth* | Total assets growth rate. |
| *Fata* | Fixed assets divided by total assets. |
| *Size* | The natural logarithm of a firm's total assets. |
| *Shr* | The shareholding ratio of the largest shareholder. |
| *Bm* | Total assets divided by the sum of the market value of equity and the book value of liabilities. |
| *Ae* | Administrative expenses divided by operating income. |
| *Ndts* | Depreciation expenses divided by total assets. |
| *Etr* | Total income tax divided by profit. |
| *Msh* | The shareholding ratio of the management. |
| *Vebitta* | Standard deviation of profitability in the previous 3 years, where profitability is calculated by earnings before interest and taxes divided by total assets. |
| *Vcfo* | Standard deviation of cash flow ratios for the previous 3 years, where the cash flow ratio is calculated as the net cash flow from operating activities divided by total assets. |

Table 2
Descriptive statistics for sample firms that purchased D&O insurance.

| Year | N | | Percent | | | Industry | N | |
|---|---|---|---|---|---|---|---|---|
| Percent | | | Property | N | | Percent | | 2009 |
| 21 | 6.77 | | Mining industry | 19 | 6.13 | Non-SOEs | 113 | 36.45 |
| 2010 | 17 | 5.48 | Manufacturing industry | 164 | 52.90 | SOEs | 197 | 63.55 |
| 2011 | 18 | 5.81 | Electricity, heat, gas and water production and supply industry | 11 | 3.55 | | | |
| 2012 | 32 | 10.32 | Construction industry | 6 | 1.94 | | | |
| 2013 | 27 | 8.71 | Wholesale and retail trade industry | 25 | 8.06 | | | |
| 2014 | 26 | 8.39 | Transportation, warehousing and postal industry | 30 | 9.68 | | | |
| 2015 | 34 | 10.97 | Information transmission, software and information technology services industry | 14 | 4.52 | | | |
| 2016 | 30 | 9.68 | Real estate industry | 31 | 10.00 | | | |
| 2017 | 48 | 15.48 | Leasing and business services industry | 2 | 0.65 | | | |
| 2018 | 57 | 18.39 | Water conservancy, environment and public infrastructure management industry | 2 | 0.65 | | | |
| | | | Culture, sports and entertainment industry | 1 | 0.32 | | | |
| | | | Public administration, social security and social organization industry | 5 | 1.61 | | | |
| Total | 310 | 100 | Total | 310 | 100 | Total | 310 | 100 |

### 4.2. Correlation analysis

Table 4 shows the results of the Pearson coefficient tests for the main variables. It is evident that the correlation coefficients of *Exlev* and *Exlev_dum* with *DO* are −0.007 and −0.006, respectively, but they are not significant, indicating that further tests are required to determine whether D&O insurance can significantly inhibit excess corporate leverage. There are significant correlations between other variables but the correlation coefficients are small, indicating that multicollinearity is not a serious problem.

Table 3
Descriptive statistics of the variables.

| Variables | N | Mean | S.D. | Min | Median | Max |
|---|---|---|---|---|---|---|
| *Lev* | 16,301 | 0.458 | 0.206 | 0.057 | 0.456 | 0.925 |
| *Exlev* | 16,301 | 0.0001 | 0.153 | −0.664 | −0.001 | 0.827 |
| *Exlev_dum* | 16,301 | 0.498 | 0.500 | 0.000 | 0.000 | 1.000 |
| *DO* | 16,301 | 0.019 | 0.137 | 0.000 | 0.000 | 1.000 |
| *Soe* | 16,301 | 0.466 | 0.499 | 0.000 | 0.000 | 1.000 |
| *Size* | 16,301 | 22.266 | 1.271 | 19.584 | 22.109 | 26.091 |
| *Roa* | 16,301 | 0.040 | 0.064 | −0.255 | 0.036 | 0.230 |
| *Indlev* | 16,301 | 0.425 | 0.109 | 0.227 | 0.401 | 0.718 |
| *Growth* | 16,301 | 0.186 | 0.403 | −0.314 | 0.098 | 3.139 |
| *Fata* | 16,301 | 0.234 | 0.173 | 0.002 | 0.199 | 0.727 |
| *Shr* | 16,301 | 34.825 | 14.854 | 8.448 | 32.831 | 74.824 |
| *Bm* | 16,301 | 0.598 | 0.248 | 0.113 | 0.589 | 1.139 |
| *Ae* | 16,301 | 0.095 | 0.080 | 0.009 | 0.076 | 0.517 |
| *Ndts* | 16,301 | 0.021 | 0.015 | 0.0004 | 0.018 | 0.070 |
| *Etr* | 16,301 | 0.171 | 0.176 | −0.632 | 0.163 | 0.818 |
| *Msh* | 16,301 | 0.151 | 0.317 | 0.000 | 0.0003 | 2.107 |
| *Vebitta* | 16,301 | 0.029 | 0.040 | 0.001 | 0.016 | 0.291 |
| *Vcfo* | 16,301 | 0.047 | 0.041 | 0.003 | 0.035 | 0.227 |

Table 4
Correlation analysis.

| Variables | (A) | (B) | (C) | (D) | (E) | (F) | (G) |
|---|---|---|---|---|---|---|---|
| (A) *Exlev* | 1.000 | | | | | | |
| (B) *Exlev_dum* | 0.789*** | 1.000 | | | | | |
| (C) *DO* | −0.007 | −0.006 | 1.000 | | | | |
| (D) *Size* | 0.031*** | 0.065*** | 0.121*** | 1.000 | | | |
| (E) *Roa* | −0.186*** | −0.145*** | −0.016** | 0.084*** | 1.000 | | |
| (F) *Growth* | 0.123*** | 0.094*** | −0.012 | 0.106*** | 0.171*** | 1.000 | |
| (G) *Fata* | 0.001 | 0.003 | −0.012 | 0.051*** | −0.116*** | −0.137*** | 1.000 |
| (H) *Shr* | 0.000 | 0.008 | 0.013 | 0.250*** | 0.118*** | 0.025*** | 0.082*** |
| (I) *Bm* | 0.035*** | 0.070*** | 0.071*** | 0.630*** | −0.149*** | 0.025*** | 0.123*** |
| (J) *Ae* | −0.129*** | −0.125*** | −0.030*** | −0.381*** | −0.193*** | −0.038*** | −0.106*** |
| (K) *Ndts* | −0.030*** | −0.025*** | −0.013* | −0.019** | −0.117*** | −0.173*** | 0.818*** |
| (L) *Etr* | 0.002 | 0.025*** | −0.005 | 0.112*** | 0.150*** | 0.026*** | −0.038*** |
| (M) *Msh* | −0.080*** | −0.075*** | −0.032*** | −0.213*** | 0.077*** | 0.105*** | −0.140*** |
| (N) *Vebitta* | 0.062*** | 0.028*** | 0.018** | −0.190*** | −0.274*** | 0.009 | 0.034*** |
| (O) *Vcfo* | 0.130*** | 0.107*** | −0.006 | −0.111*** | −0.024*** | 0.055*** | −0.178*** |
| Variables | (H) | (I) | (J) | (K) | (L) | (M) | (N) |
| (H) *Shr* | 1.000 | | | | | | |
| (I) *Bm* | 0.151*** | 1.000 | | | | | |
| (J) *Ae* | −0.175*** | −0.378*** | 1.000 | | | | |
| (K) *Ndts* | 0.078*** | 0.049*** | −0.078*** | 1.000 | | | |
| (L) *Etr* | 0.060*** | 0.124*** | −0.128*** | −0.055*** | 1.000 | | |
| (M) *Msh* | −0.100*** | −0.101*** | 0.127*** | −0.132*** | −0.071*** | 1.000 | |
| (N) *Vebitta* | −0.057*** | −0.167*** | 0.217*** | 0.098*** | −0.130*** | −0.014* | 1.000 |
| (O) *Vcfo* | 0.040*** | −0.059*** | −0.015** | −0.127*** | 0.049*** | −0.046*** | 0.272*** |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

### 4.3. Regression results

Table 5 reports the results of D&O insurance and excess corporate leverage. The regression estimation results of the OLS model in column (1) show that the coefficient of *DO* is −0.0137, which is significantly negative at the 10 % level. The results of the Logit model in column (2) show that the coefficient of *DO* is −0.2380, which is also significantly negative at the 5 % level. Regardless of which method is used to measure excess cor-

Table 5
D&O insurance and excess corporate leverage.

| Variables | *Exlev* (1) | *Exlev_dum* (2) |
|---|---|---|
| *DO* | −0.0137* | −0.2380** |
| | (−1.8537) | (−1.9892) |
| *Size* | 0.0031** | 0.0765*** |
| | (2.2851) | (3.7404) |
| *Roa* | −0.6646*** | −7.7851*** |
| | (−26.4935) | (−22.0861) |
| *Growth* | 0.0593*** | 0.7237*** |
| | (14.2966) | (10.4582) |
| *Fata* | 0.0655*** | 0.6265*** |
| | (4.7059) | (3.3738) |
| *Shr* | 0.0000 | −0.0005 |
| | (0.0403) | (−0.4264) |
| *Bm* | −0.0657*** | −0.5201*** |
| | (−8.2908) | (−4.6481) |
| *Ae* | −0.4055*** | −4.7976*** |
| | (−18.4554) | (−16.4983) |
| *Ndts* | −1.1175*** | −11.8624*** |
| | (−7.3371) | (−5.8975) |
| *Etr* | 0.0159** | 0.3416*** |
| | (2.0891) | (3.5224) |
| *Msh* | −0.0329*** | −0.3708*** |
| | (−8.3968) | (−6.1462) |
| *Vebitta* | −0.0360 | −1.0379* |
| | (−0.7910) | (−1.9304) |
| *Vcfo* | 0.4671*** | 5.8672*** |
| | (13.6152) | (12.3066) |
| Constant | −0.0246 | −1.3063*** |
| | (−0.8106) | (−2.9435) |
| Year | Yes | Yes |
| Industry | Yes | Yes |
| N | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.1174 | 0.0618 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

porate leverage, the results show that there is a significant negative relationship between D&O insurance and excess corporate leverage, which means that D&O insurance significantly inhibits excess corporate leverage, supporting H1a.

### 4.4. Robustness tests

#### 4.4.1. Instrumental variables tests

We use an instrumental variable two-stage least squares (IV-2SLS) regression to solve potential endogeneity problems, using the province-level crime rate in 2005 (*IV*) as the instrumental variable, which is collected manually from the 2005 China Procuratorial Yearbook and the websites of the Supreme People's Court of each province and city. It is appropriate to select the crime rate in the region where the listed firm is located in 2005 as an instrumental variable for D&O insurance because it satisfies the correlation requirement and the exogenous requirement. First, the selected instrumental variable satisfies the correlation requirement because China's revision and implementation of the Company Law in 2005 clarified the due diligence obligations of directors and officers, improved the civil compensation liability system and the shareholder representative litigation system[2] and greatly enhanced the ability to litigate, exposing directors and officers to a corresponding

[2] Relevant clauses are Clauses 21, 113, 150, 152 and 153.

Table 6
Instrumental variables tests.

| Variables | First step | Second step | |
|---|---|---|---|
| | *DO* | *Exlev* | *Exlev_dum* |
| | (1) | (2) | (3) |
| *IV* | 0.3240*** | | |
| | (6.3696) | | |
| *DO* | | −0.5798*** | −1.5793** |
| | | (−2.8603) | (−2.3625) |
| *Size* | 0.0162*** | 0.0145*** | 0.0496*** |
| | (8.9343) | (4.0451) | (4.1852) |
| *Roa* | −0.0414* | −0.6921*** | −1.8032*** |
| | (−1.8437) | (−23.3697) | (−21.6308) |
| *Growth* | −0.0081*** | 0.0530*** | 0.1268*** |
| | (−3.4179) | (11.5948) | (10.3516) |
| *Fata* | −0.0212* | 0.0351** | 0.0631 |
| | (−1.7307) | (2.2291) | (1.3089) |
| *Shr* | −0.0002** | −0.0000 | −0.0002 |
| | (−2.5339) | (−0.3250) | (−0.7089) |
| *Bm* | −0.0078 | −0.0787*** | −0.1502*** |
| | (−1.0281) | (−8.5015) | (−5.2315) |
| *Ae* | 0.0065 | −0.3908*** | −0.9966*** |
| | (0.4718) | (−16.8968) | (−16.6830) |
| *Ndts* | −0.0075 | −1.0671*** | −2.6586*** |
| | (−0.0671) | (−6.5278) | (−5.4702) |
| *Etr* | −0.0090 | 0.0096 | 0.0618** |
| | (−1.3099) | (1.0824) | (2.4017) |
| *Msh* | −0.0008 | −0.0296*** | −0.0737*** |
| | (−0.2989) | (−7.0205) | (−5.4332) |
| *Vebitta* | 0.1266*** | 0.0250 | −0.1148 |
| | (3.7318) | (0.4555) | (−0.7831) |
| *Vcfo* | −0.0096 | 0.4506*** | 1.2737*** |
| | (−0.3388) | (11.9071) | (11.5855) |
| *GDP_p* | −0.0008 | −0.0098 | −0.0197 |
| | (−0.1951) | (−1.4026) | (−0.9033) |
| *GDP_1* | −0.0019 | −0.0421 | −0.0762 |
| | (−0.0682) | (−0.9646) | (−0.5505) |
| *GDP_2* | −0.0009 | −0.0413 | −0.0740 |
| | (−0.0308) | (−0.9459) | (−0.5346) |
| *GDP_3* | −0.0006 | −0.0424 | −0.0776 |
| | (−0.0219) | (−0.9722) | (−0.5603) |
| Constant | −0.2647*** | 4.0340 | 7.3350 |
| | (−0.0958) | (0.9239) | (0.5299) |
| Year | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes |
| N | 16,301 | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.0229 | −0.1263 | −0.0872 |

Note: (1) ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors. (2) The Kleibergen–Paap rk LM statistic is 40.493 and the corresponding p-value is 0.0000, indicating that it passes the underidentification test. (3) The Kleibergen–Paap rk Wald F statistic is 40.572 and the corresponding critical value at the 10% level of the Stock–Yogo test is 16.38, indicating that it passed the weak identification test.

increase in litigation risk. We expect the increased litigation risk faced by directors and officers under the Companies Act 2005 to prompt them to purchase D&O insurance for risk management. Furthermore, the instrumental variable satisfies the exogenous requirement. The historical crime rate over a period of 5 years in the region where the listed firm is located in 2005 is highly unlikely to affect the excess leverage of the listed firm from 2009 to 2018.

To control for regional-level factors, this part of the regression incorporates the variables gross domestic product (GDP) per capita (*GDP_p*), the share of primary industry output in regional GDP (*GDP_1*), the share of secondary industry output (*GDP_2*) and the share of tertiary industry output (*GDP_3*) in the region where the listed firms are located. Table 6 presents the results of the regressions of the instrumental variables. The results of the first-step regression in column (1) show that the crime rate (*IV*) in the region where the listed firms are located in 2005 has a significantly positive effect on *DO*, which is in line with expectations. The results

Table 7
The regression results of the Heckman model.

| Variables | First step | Variables | Second step | |
|---|---|---|---|---|
| | *DO* | | *Exlev* | *Exlev_dum* |
| | (1) | | (2) | (3) |
| *Size* | 0.2418*** | *DO* | −0.0141* | −0.2417** |
| | (9.1437) | | (−1.9299) | (−2.0179) |
| *Lev* | 0.1932 | *IMR* | −0.0943*** | −1.0844*** |
| | (1.1941) | | (−14.3768) | (−10.9083) |
| *Soe* | 0.0780 | *Size* | −0.0172*** | −0.1551*** |
| | (1.2918) | | (−8.4843) | (−5.0446) |
| *Growth* | −0.1775* | *Roa* | −0.6334*** | −7.6297*** |
| | (−1.8259) | | (−24.9104) | (−20.9861) |
| *Shr* | −0.0043** | *Growth* | 0.0733*** | 0.8921*** |
| | (−2.5448) | | (17.3247) | (12.3877) |
| *Bm* | −0.0550 | *Fata* | 0.0403*** | 0.3273* |
| | (−0.3890) | | (2.8790) | (1.7161) |
| *Msh* | −0.0385 | *Shr* | 0.0003*** | 0.0037*** |
| | (−0.3579) | | (4.1292) | (2.9819) |
| *Vcfo* | 0.7275 | *Bm* | −0.0683*** | −0.5543*** |
| | (1.1628) | | (−8.5659) | (−4.8171) |
| *IV* | 9.6779*** | *Ae* | −0.4057*** | −4.9216*** |
| | (5.9289) | | (−17.9458) | (−16.1445) |
| *GDP_p* | −0.0739 | *Ndts* | −0.8938*** | −9.3176*** |
| | (−0.6647) | | (−5.8468) | (−4.5233) |
| *GDP_1* | 0.1255 | *Etr* | 0.0167** | 0.3552*** |
| | (0.1728) | | (2.2026) | (3.6197) |
| *GDP_2* | 0.1562 | *Msh* | −0.0215*** | −0.2461*** |
| | (0.2151) | | (−5.3614) | (−3.9569) |
| *GDP_3* | 0.1613 | *Vebitta* | −0.0306 | −0.9959* |
| | (0.2222) | | (−0.6631) | (−1.8016) |
| | | *Vcfo* | 0.3894*** | 5.0759*** |
| | | | (11.0866) | (10.2199) |
| | | *GDP_p* | −0.0189*** | −0.1950** |
| | | | (−2.8324) | (−2.1049) |
| | | *GDP_1* | −0.0839** | −0.7261 |
| | | | (−2.0415) | (−1.2458) |
| | | *GDP_2* | −0.0856** | −0.7455 |
| | | | (−2.0834) | (−1.2792) |
| | | *GDP_3* | −0.0867** | −0.7605 |
| | | | (−2.1091) | (−1.3047) |
| Constant | −23.1611 | Constant | 9.5056** | 83.7974 |
| | (−0.3192) | | (2.3120) | (1.4369) |
| Year | Yes | Year | Yes | Yes |
| Industry | Yes | Industry | Yes | Yes |
| N | 15,831 | N | 15,831 | 15,831 |
| Pseudo $R^2$ | 0.1054 | Adj. $R^2$/Pseudo $R^2$ | 0.1396 | 0.0744 |

Note: (1) ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors. (2) The variance inflation factor values of the second-step regression are less than 5, indicating that there is no serious multicollinearity problem.

of columns (2) and (3) show that the regression coefficients of *DO* are significantly negative, which is consistent with the results of the benchmark regression, indicating that the findings of this study are robust.

#### 4.4.2. Heckman two-step sample selection model

We use the Heckman two-step sample selection model to address the underlying self-selection bias. In the first step, referring to Hu et al. (2019) and Yuan et al. (2016), we control for firm size, the debt ratio, the firm ownership type, the growth rate, the equity concentration, the book-to-market ratio, management's shareholding and cash flow volatility. Simultaneously, we increase the exogenous instrumental variable (*IV*), as well as *GDP_p*, *GDP_1*, *GDP_2* and *GDP_3* to estimate the inverse Mills ratio (*IMR*). In the second step, we include *IMR* to control for the potential sample selection bias. Table 7 shows the regression results of the Heckman model. It can be seen from column (2) that the coefficient of *IMR* is significantly negative, indicating

Table 8
Dynamic adjustment model.

| Variables | *Exlev* (1) | *Exlev_dum* (2) |
|---|---|---|
| $Before^{2+}$ | −0.0028 | −0.0515 |
| | (−0.3190) | (−0.4003) |
| $Before^{1}$ | 0.0126 | −0.0856 |
| | (0.8781) | (−0.3653) |
| $After^{1}$ | −0.0162 | −0.3086* |
| | (−1.3007) | (−1.6545) |
| $After^{2+}$ | −0.0132** | −0.1709* |
| | (−2.0263) | (−1.7229) |
| *Size* | 0.0033** | 0.0798*** |
| | (2.4139) | (3.8673) |
| *Roa* | −0.6648*** | −7.7888*** |
| | (−26.4771) | (−22.0779) |
| *Growth* | 0.0592*** | 0.7226*** |
| | (14.2861) | (10.4429) |
| *Fata* | 0.0650*** | 0.6210*** |
| | (4.6680) | (3.3423) |
| *Shr* | −0.0000 | −0.0006 |
| | (−0.0137) | (−0.4856) |
| *Bm* | −0.0659*** | −0.5247*** |
| | (−8.3187) | (−4.6873) |
| *Ae* | −0.4052*** | −4.7965*** |
| | (−18.4349) | (−16.4951) |
| *Ndts* | −1.1125*** | −11.8081*** |
| | (−7.2975) | (−5.8691) |
| *Etr* | 0.0160** | 0.3438*** |
| | (2.0946) | (3.5448) |
| *Msh* | −0.0329*** | −0.3710*** |
| | (−8.4197) | (−6.1470) |
| *Vebitta* | −0.0355 | −1.0254* |
| | (−0.7793) | (−1.9057) |
| *Vcfo* | 0.4674*** | 5.8691*** |
| | (13.6217) | (12.3100) |
| Constant | −0.0293 | −1.3726*** |
| | (−0.9504) | (−3.0682) |
| Year | Yes | Yes |
| Industry | Yes | Yes |
| N | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.1174 | 0.0619 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

that a self-selection bias exists, but the coefficients of *DO* are all significantly negative, which means that the previous conclusions remain robust.

### 4.4.3. Dynamic adjustment model

Drawing on Lai et al. (2019), we use the dynamic adjustment model for robustness testing. We set the base period as the year before the firm first purchased D&O insurance. Then, we use $Before^{2+}$ and $Before^{1}$, to denote 3 years or more before the firm purchased D&O insurance and 2 years before the insurance was purchased, respectively. $After^{1}$ and $After^{2+}$ denote the year in which the insurance was purchased, and the 2nd and subsequent years after the insurance was purchased, respectively. Each takes a value of 1 for the corresponding year, and 0 otherwise. We substitute $Before^{2+}$, $Before^{1}$, $After^{1}$ and $After^{2+}$ for *DO* in model (1) and re-run the regression. The results in Table 8 show that the coefficients of $Before^{1}$ and $Before^{2+}$ are insignificant, and the coefficients of $After^{1}$ and $After^{2+}$ remain significantly negative, indicating that there is no significant

Table 9
Omitted variable test.

| Variables | *Exlev* (1) | *Exlev_dum* (2) | *Exlev* (3) | *Exlev_dum* (4) | *Exlev* (5) | *Exlev_dum* (6) |
|---|---|---|---|---|---|---|
| *DO* | −0.0136* | −0.2372** | −0.0137* | −0.2370** | −0.0135* | −0.2325* |
| | (−1.8360) | (−1.9827) | (−1.8479) | (−1.9809) | (−1.8244) | (−1.9413) |
| *Size* | 0.0029** | 0.0748*** | 0.0034** | 0.0810*** | 0.0032** | 0.0804*** |
| | (2.1023) | (3.6550) | (2.5073) | (3.9367) | (2.3857) | (3.9207) |
| *Roa* | −0.6650*** | −7.7867*** | −0.6637*** | −7.7720*** | −0.6639*** | −7.7672*** |
| | (−26.5283) | (−22.1081) | (−26.4594) | (−22.0490) | (−26.4215) | (−22.0131) |
| *Growth* | 0.0594*** | 0.7244*** | 0.0589*** | 0.7168*** | 0.0592*** | 0.7206*** |
| | (14.3214) | (10.4715) | (14.1607) | (10.3728) | (14.2640) | (10.4297) |
| *Fata* | 0.0650*** | 0.6226*** | 0.0657*** | 0.6287*** | 0.0643*** | 0.5952*** |
| | (4.6681) | (3.3509) | (4.7160) | (3.3807) | (4.6166) | (3.1999) |
| *Shr* | 0.0000 | −0.0005 | 0.0000 | −0.0004 | −0.0000 | −0.0006 |
| | (0.0033) | (−0.4453) | (0.1262) | (−0.3478) | (−0.0128) | (−0.5073) |
| *Bm* | −0.0663*** | −0.5240*** | −0.0655*** | −0.5164*** | −0.0655*** | −0.5164*** |
| | (−8.3553) | (−4.6799) | (−8.2593) | (−4.6151) | (−8.2598) | (−4.6097) |
| *Ae* | −0.4062*** | −4.8015*** | −0.4046*** | −4.7825*** | −0.4047*** | −4.7756*** |
| | (−18.4917) | (−16.5223) | (−18.4079) | (−16.4656) | (−18.4009) | (−16.4199) |
| *Ndts* | −1.1260*** | −11.9187*** | −1.1048*** | −11.6953*** | −1.1056*** | −11.5510*** |
| | (−7.3976) | (−5.9247) | (−7.2482) | (−5.8029) | (−7.2407) | (−5.7360) |
| *Etr* | 0.0160** | 0.3422*** | 0.0161** | 0.3435*** | 0.0158** | 0.3393*** |
| | (2.0984) | (3.5284) | (2.1025) | (3.5404) | (2.0764) | (3.5002) |
| *Msh* | −0.0322*** | −0.3661*** | −0.0340*** | −0.3877*** | −0.0332*** | −0.3810*** |
| | (−8.1997) | (−6.0584) | (−8.6147) | (−6.3510) | (−8.4802) | (−6.3010) |
| *Vebitta* | −0.0376 | −1.0491* | −0.0376 | −1.0576** | −0.0340 | −0.9933* |
| | (−0.8253) | (−1.9521) | (−0.8263) | (−1.9669) | (−0.7468) | (−1.8432) |
| *Vcfo* | 0.4666*** | 5.8626*** | 0.4633*** | 5.8157*** | 0.4657*** | 5.8329*** |
| | (13.6007) | (12.3022) | (13.5108) | (12.1797) | (13.5550) | (12.2211) |
| *Gender* | −0.0192** | −0.1360 | | | | |
| | (−2.3838) | (−1.1923) | | | | |
| *Age* | | | −0.0007* | −0.0098* | | |
| | | | (−1.9034) | (−1.9080) | | |
| *Bshare* | | | | | −0.0087 | −0.2343*** |
| | | | | | (−1.4281) | (−2.8059) |
| Constant | −0.0157 | −1.2435*** | 0.0003 | −0.9583** | −0.0274 | −1.3828*** |
| | (−0.5108) | (−2.7845) | (0.0105) | (−1.9970) | (−0.8991) | (−3.1090) |
| Year | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 16,301 | 16,301 | 16,301 | 16,301 | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.1177 | 0.0618 | 0.1176 | 0.0619 | 0.1175 | 0.0621 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

change in excess corporate leverage before the firm purchases D&O insurance, whereas after the purchase, excess corporate leverage is significantly reduced.

#### 4.4.4. Omitted variable test

Although model (1) controls many influencing factors, it is possible that some firm and management characteristics affect the robustness of our conclusions, resulting in omitted variable bias. Drawing on Li and Xu (2020) and Peng et al. (2018), we further control for missing variables, including the proportion of female executives (*Gender*), the average age of executives (*Age*) and whether listed firms issue B shares (*Bshare*). The results in Table 9 show that the inhibitory effect of D&O insurance on excess corporate leverage does not change, and that the previous conclusions remain robust.

#### 4.4.5. Direction test of excess corporate leverage

To avoid the influence of the direction of excess corporate leverage on the conclusions of this study, we divide the sample into two subsamples according to the positive and negative directions of *Exlev*. The results in Table 10 show that the coefficient of *DO* in column (1) remains significantly negative, and the coefficient of *DO* in column (2) is not significant, indicating that the conclusions of this study are not affected by the enterprises with insufficient debt in the sample.

Table 10
The direction test of excess corporate leverage.

| Variables | *Exlev* > 0 (1) | *Exlev* < 0 (2) |
|---|---|---|
| *DO* | −0.0147** | 0.0046 |
| | (−2.0620) | (0.7124) |
| *Size* | −0.0111*** | 0.0042*** |
| | (−9.8028) | (3.5751) |
| *Roa* | −0.4363*** | −0.0287 |
| | (−19.6415) | (−1.3943) |
| *Growth* | 0.0395*** | 0.0157*** |
| | (11.6581) | (4.4019) |
| *Fata* | −0.0076 | 0.0689*** |
| | (−0.6384) | (5.6742) |
| *Shr* | 0.0001** | −0.0001 |
| | (2.1873) | (−1.1842) |
| *Bm* | −0.0430*** | −0.0156** |
| | (−6.3849) | (−2.3031) |
| *Ae* | −0.0990*** | −0.2051*** |
| | (−4.6147) | (−12.1336) |
| *Ndts* | −0.4077*** | −0.5655*** |
| | (−3.0515) | (−4.5180) |
| *Etr* | −0.0021 | 0.0029 |
| | (−0.3615) | (0.3954) |
| *Msh* | −0.0270*** | −0.0045 |
| | (−7.3923) | (−1.4782) |
| *Vebitta* | 0.2012*** | −0.3810*** |
| | (5.4428) | (−9.3831) |
| *Vcfo* | 0.1577*** | 0.1769*** |
| | (5.5827) | (5.4484) |
| Constant | 0.3940*** | −0.2013*** |
| | (15.4732) | (−7.6891) |
| Year | Yes | Yes |
| Industry | Yes | Yes |
| N | 8,125 | 8,176 |
| Adj. $R^2$ | 0.1743 | 0.0790 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

#### 4.4.6. Controlling the impact of corporate performance

The relationship between D&O insurance and excess corporate leverage may be affected by corporate performance. That is, firms with better performance have lower levels of debt and are not prone to excessive leverage, whereas firms with poor performance have higher debt ratios. At the same time, firms that are able to purchase D&O insurance may be inherently better-performing firms. Although we control for the influence of profitability in the benchmark regression, to further alleviate the possible interference caused by corporate performance, we follow Jia et al. (2019) and add the interaction between D&O insurance (*DO*) and corporate performance (*Roa*). We first centralize *Roa* and *DO* and then construct the interaction term *c_Roa* × *c_DO* for the regression. The results show that the coefficients of the interaction term *c_Roa* × *c_DO* are not significant, which means that the relationship between D&O insurance and excess corporate leverage is not affected by corporate performance Table 11.

#### 4.4.7. Excluding the impact of market concerns

The descriptive statistics results indicate that the percentage of sample firms that purchase D&O insurance is 1.9 %, which is only a minority of all A-share listed firms. Listed firms that purchase D&O insurance may be star companies in the capital market and receive more attention as well as more supervision from the market

Table 11
Controlling the impact of corporate performance.

| Variables | *Exlev* (1) | *Exlev_dum* (2) |
|---|---|---|
| *c_DO* | −0.0140* | −0.2465** |
| | (−1.8824) | (−2.0186) |
| *c_Roa* × *c_DO* | −0.0305 | −1.4967 |
| | (−0.2881) | (−0.7290) |
| *c_Roa* | −0.6644*** | −7.7799*** |
| | (−26.4197) | (−22.0547) |
| *Size* | 0.0031** | 0.0762*** |
| | (2.2779) | (3.7256) |
| *Growth* | 0.0593*** | 0.7235*** |
| | (14.2963) | (10.4562) |
| *Fata* | 0.0655*** | 0.6247*** |
| | (4.7033) | (3.3637) |
| *Shr* | 0.0000 | −0.0005 |
| | (0.0418) | (−0.4174) |
| *Bm* | −0.0656*** | −0.5182*** |
| | (−8.2740) | (−4.6283) |
| *Ae* | −0.4053*** | −4.7909*** |
| | (−18.4432) | (−16.4696) |
| *Ndts* | −1.1170*** | −11.8438*** |
| | (−7.3334) | (−5.8887) |
| *Etr* | 0.0160** | 0.3426*** |
| | (2.0913) | (3.5325) |
| *Msh* | −0.0329*** | −0.3712*** |
| | (−8.3998) | (−6.1536) |
| *Vebitta* | −0.0363 | −1.0467* |
| | (−0.7959) | (−1.9434) |
| *Vcfo* | 0.4672*** | 5.8729*** |
| | (13.6157) | (12.3166) |
| Constant | −0.0511* | −1.6140*** |
| | (−1.6710) | (−3.6169) |
| Year | Yes | Yes |
| Industry | Yes | Yes |
| N | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.1173 | 0.0618 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

compared with other companies (Yuan et al., 2016; Hu et al., 2019). After purchasing D&O insurance, these firms will be prompted by external concerns to more actively promote shareholders' interest, and they will pay attention to regulating their governance mechanisms, which will result in a more pronounced crowding-out effect on excess corporate leverage than is the case for other firms.

Drawing on Yuan et al. (2016), we further examine the impact of D&O insurance on analysts' attention to test whether this alternative explanation is valid. Analysts' concerns (*Analysts*) are measured by the natural logarithm of the number of analysts who track the listed firms. The regression results of D&O insurance (*DO*) and analysts' attention (*Analysts*) in periods *t* and *t + 1* are shown in Table 12. The coefficients of D&O insurance (*DO*) are all positive but insignificant, indicating that purchasing D&O insurance does not attract more attention from the capital market. Thus, the negative relationship between D&O insurance and excess corporate leverage is not driven by market concerns.

### *4.4.8. Excluding the effect of banks reducing the supply of credit*

As noted, we find that D&O insurance can curb excess corporate leverage. However, there is a possibility that banks regard D&O insurance as a high-risk signal (Lin et al., 2013) and deliberately reduce credit supply to such firms, leading to a reduction in excess corporate leverage. In theory, if a firm voluntarily reduces bank loans, it may first consider secured loans. As secured loans reduce the borrowing firm's financial flexibility and its future financing capacity, and because the use of collateral is restricted simultaneously, this will increase the

Table 12
Excluding the impact of market concerns.

| Variables | $Analysts_{i,t}$ (1) | $Analysts_{i,t+1}$ (2) |
|---|---|---|
| *DO* | 0.0295 | 0.0500 |
| | (0.6805) | (0.9351) |
| *Size* | 0.5027*** | 0.4646*** |
| | (70.7788) | (56.1955) |
| *Roa* | 4.4273*** | 4.7747*** |
| | (32.5531) | (30.3074) |
| *Growth* | 0.0479*** | 0.0902*** |
| | (2.7726) | (4.6503) |
| *Fata* | 0.4072*** | 0.4602*** |
| | (5.6609) | (5.7362) |
| *Shr* | −0.0042*** | −0.0035*** |
| | (−9.5155) | (−7.0170) |
| *Bm* | −1.4471*** | −1.3749*** |
| | (−34.6064) | (−28.1437) |
| *Ae* | 0.1026 | 0.3259*** |
| | (0.9581) | (2.6247) |
| *Ndts* | −2.8733*** | −1.3385 |
| | (−3.8061) | (−1.5854) |
| *Etr* | −0.2625*** | −0.3161*** |
| | (−6.3672) | (−6.7765) |
| *Msh* | 0.3972*** | 0.3336*** |
| | (16.8902) | (12.5682) |
| *Vebitta* | −0.6186*** | −1.0330*** |
| | (−2.6307) | (−4.0196) |
| *Vcfo* | −0.6954*** | −0.4476** |
| | (−3.9268) | (−2.2850) |
| Constant | −8.0908*** | −7.3171*** |
| | (−51.5257) | (−40.1923) |
| Year | Yes | Yes |
| Industry | Yes | Yes |
| N | 12,541 | 10,200 |
| Adj. $R^2$ | 0.4146 | 0.3779 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

actual financing costs of borrowing companies. Therefore, companies will give priority to reducing secured loans (Yuan et al., 2010). If banks reduce credit supply, credit loans may be given priority. For banks, if the borrower provides a secured loan, they can reduce credit risk by acquiring collateral or recovering from third parties when the borrower is unable to repay the loan; however, if the borrower provides a credit loan, the bank bears a greater credit risk (Yuan et al., 2010; Lai et al., 2019).

Referring to Lai et al. (2019), we adopt *Sec* to proxy the behavior of firms in voluntarily reducing their loans and *Cred* to denote banks reducing firms' loans. The results are shown in columns (1) and (2), respectively, of Table 13. As the table indicates, *DO* is significantly negatively correlated with *Sec* but not with *Cred*, suggesting that D&O insurance can reduce secured loans but has no effect on credit loans. This indicates that firms that purchase D&O insurance actively reduce their excess corporate leverage, ruling out the explanation that they do so because banks reduce credit supply.

## 5. Additional analyses

### 5.1. Intermediary mechanism tests

The above findings show that D&O insurance can inhibit excess corporate leverage, but the mechanism remains at the theoretical level, with the analysis suggesting that D&O insurance may inhibit excess corporate

Table 13
Excluding the effect of banks reducing the supply of credit.

| Variables | *Sec* (1) | *Cred* (2) |
|---|---|---|
| *DO* | −0.2735*** | 0.1378 |
| | (−2.6282) | (1.5581) |
| *Size* | 0.8415*** | 1.1786*** |
| | (42.6897) | (63.4124) |
| *Roa* | −5.4390*** | −3.7417*** |
| | (−19.1285) | (−11.0197) |
| *Growth* | 0.1424*** | −0.0518 |
| | (3.7905) | (−1.1971) |
| *Fata* | 1.2374*** | 1.1262*** |
| | (8.4451) | (6.8508) |
| *Shr* | −0.0023** | 0.0032*** |
| | (−2.1971) | (2.8354) |
| *Bm* | 0.3198*** | −0.2099* |
| | (3.1370) | (−1.9339) |
| *Ae* | −2.4231*** | −1.3597*** |
| | (−10.9044) | (−4.3228) |
| *Ndts* | −2.8148* | 2.6282 |
| | (−1.7205) | (1.4029) |
| *Etr* | 0.0630 | 0.1802** |
| | (0.8708) | (2.0486) |
| *Msh* | −0.0979* | 0.0056 |
| | (−1.8005) | (0.0877) |
| *Vebitta* | −1.0887*** | −1.1795** |
| | (−2.6142) | (−2.1128) |
| *Vcfo* | 1.6595*** | 2.2690*** |
| | (4.4276) | (4.9267) |
| Constant | 0.7985* | −7.8089*** |
| | (1.9231) | (−18.9044) |
| Year | Yes | Yes |
| Industry | Yes | Yes |
| N | 10,024 | 9,744 |
| Adj. $R^2$ | 0.4278 | 0.5173 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

leverage because it helps firms retain good human capital or because it reduces agency costs. Therefore, we further examine the mechanism by which D&O insurance influences excess corporate leverage.

Referring to Du et al. (2010), we measure the first type of agency cost by the excess management expense ratio (*Abadm*), and the second type by the capital occupancy rate of major shareholders (*Tun*) with reference to Ling and Bai (2017). Following Hu et al. (2019), if the manager attributes leaving to resignation or personal reasons, the abnormal change of the manager (*Change*) takes a value of 1, and 0 otherwise.

The regression results are shown in Table 14. It can be seen from columns (1) and (2) that *DO* is significantly negatively correlated with *Abadm*, whereas the coefficient of *Tun* is not significant. These results indicate that D&O insurance significantly reduces the excess management expense rate but has no significant effect on the capital occupancy rate of major shareholders. Thus, D&O insurance can effectively reduce the first type of agency costs, which supports the external monitoring effect of D&O insurance. As seen in column (3), the coefficient of *DO* is not insignificant, indicating that D&O insurance has no significant impact on abnormal changes of managers. Therefore, the results of the intermediary mechanism tests show that D&O insurance inhibits excess corporate leverage by reducing the first type of agency costs.

Table 14
Intermediary mechanism tests.

| Variables | *Abadm* (1) | *Tun* (2) | *Change* (3) |
|---|---|---|---|
| *DO* | −0.0095*** | −0.0044 | 0.0235 |
| | (−4.4369) | (−0.8840) | (1.2435) |
| *Size* | 0.0210*** | −0.0073*** | −0.0025 |
| | (58.4661) | (−8.6153) | (−1.0265) |
| *Roa* | −0.0887*** | −0.2023*** | −0.2269*** |
| | (−19.3052) | (−13.7126) | (−4.5150) |
| *Growth* | 0.0044*** | −0.0006 | 0.0206** |
| | (5.2183) | (−0.2717) | (2.5094) |
| *Fata* | −0.0232*** | −0.1988*** | −0.0682*** |
| | (−8.5549) | (−28.7268) | (−2.6778) |
| *Shr* | 0.0002*** | −0.0004*** | −0.0002 |
| | (10.7495) | (−7.8437) | (−1.1084) |
| *Bm* | 0.0085*** | −0.0305*** | −0.0090 |
| | (5.1253) | (−6.4775) | (−0.6101) |
| *Ae* | 0.7138*** | −0.1955*** | 0.0869** |
| | (152.2354) | (−14.8127) | (2.0289) |
| *Ndts* | 0.4026*** | −0.2116*** | 0.8559*** |
| | (13.2815) | (−2.9233) | (2.9772) |
| *Etr* | −0.0007 | 0.0031 | 0.0249* |
| | (−0.5397) | (0.7187) | (1.7224) |
| *Msh* | 0.0019*** | 0.0188*** | −0.0171** |
| | (2.6663) | (7.0015) | (−2.5312) |
| *Vebitta* | −0.0031 | −0.0608** | 0.3345*** |
| | (−0.3726) | (−2.4749) | (4.0277) |
| *Vcfo* | 0.0848*** | −0.0463** | 0.1859** |
| | (11.1758) | (−2.1032) | (2.4913) |
| Constant | −0.5363*** | 0.3252*** | 0.1333** |
| | (−69.1408) | (17.9191) | (2.3370) |
| Year | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes |
| N | 14,615 | 16,301 | 16,301 |
| Adj. $R^2$ | 0.7742 | 0.3284 | 0.0130 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

Table 15
Moderating effect tests.

Panel A. Impact of the nature of firm ownership.

| Variables | $Z = Soe$ | | | |
|---|---|---|---|---|
| | *Exlev* (1) | *Exlev_dum* (2) | *Exlev* (3) | *Exlev_dum* (4) |
| *c_DO* | | | −0.0061 | −0.1065 |
| | | | (−0.7829) | (−0.8596) |
| *c_Z* × *c_DO* | | | −0.0427*** | −0.6901*** |
| | | | (−2.8453) | (−2.8477) |
| *c_Z* | −0.0144*** | −0.2067*** | −0.0144*** | −0.2074*** |
| | (−5.1473) | (−5.1674) | (−5.1560) | (−5.1810) |
| CVs | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes |
| N | 16,301 | 16,301 | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.1187 | 0.0628 | 0.1191 | 0.0633 |

Panel B. Impact of political connections.

| Variables | $Z = Pc\_dum$ | | | | $Z = Pc\_rat$ | | | |
|---|---|---|---|---|---|---|---|---|
| | *Exlev* (1) | *Exlev_dum* (2) | *Exlev* (3) | *Exlev_dum* (4) | *Exlev* (5) | *Exlev_dum* (6) | *Exlev* (7) | *Exlev_dum* (8) |
| *c_DO* | | | −0.0140* | −0.2391** | | | −0.0100 | −0.1971 |
| | | | (−1.9236) | (−1.9979) | | | (−1.3692) | (−1.6245) |
| *c_Z* × *c_DO* | | | −0.0557*** | −0.6976*** | | | −0.2125*** | −2.9143*** |
| | | | (−3.4155) | (−2.6079) | | | (−4.4032) | (−2.9516) |
| *c_Z* | −0.0079** | −0.1727*** | −0.0082** | −0.1758*** | −0.0346*** | −0.7641*** | −0.0320*** | −0.7386*** |
| | (−2.3456) | (−3.5451) | (−2.4159) | (−3.6072) | (−3.0781) | (−4.6066) | (−2.8450) | (−4.4350) |
| CVs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 16,301 | 16,301 | 16,301 | 16,301 | 16,301 | 16,301 | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.1176 | 0.0622 | 0.1181 | 0.0626 | 0.1177 | 0.0625 | 0.1185 | 0.0632 |

Panel C. Impact of the level of marketization.

| Variables | $Z = Market\_g$ | | | |
|---|---|---|---|---|
| | *Exlev* (1) | *Exlev_dum* (2) | *Exlev* (3) | *Exlev_dum* (4) |
| *c_DO* | | | −0.0195** | −0.3244** |
| | | | (−2.4046) | (−2.4523) |
| *c_Z* × *c_DO* | | | 0.0172** | 0.2292** |
| | | | (2.5110) | (2.0490) |
| *c_Z* | −0.0034*** | −0.0392*** | −0.0032*** | −0.0357*** |
| | (−4.2187) | (−3.5075) | (−3.9154) | (−3.1731) |
| CVs | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes |
| Industry | Yes | Yes | Yes | Yes |
| N | 16,301 | 16,301 | 16,301 | 16,301 |
| Adj. $R^2$/Pseudo $R^2$ | 0.1184 | 0.0622 | 0.1187 | 0.0625 |

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. *T*-statistics are reported in parentheses and are based on robust standard errors.

### 5.2. Moderating effect tests

To test H2a and H2b, we further explore whether the impact of D&O insurance on excess corporate leverage varies with firm ownership type, political connections and the level of marketization. We construct the following model:

$$CEL_{i,t} = \gamma_0 + \gamma_1 c\_DO_{i,t} + \gamma_2 c\_Z_{i,t} \times c\_DO_{i,t} + \gamma_3 c\_Z_{i,t} + \gamma_4 Size_{i,t} + \gamma_5 Roa_{i,t} + \gamma_6 Growth_{i,t} + \gamma_7 Fata_{i,t} + \gamma_8 Shr_{i,t} + \gamma_9 Bm_{i,t} + \gamma_{10} Ae_{i,t} + \gamma_{11} Ndts_{i,t} + \gamma_{12} Etr_{i,t} + \gamma_{13} Msh_{i,t} + \gamma_{14} Vebitta_{i,t} + \gamma_{15} Vcfo_{i,t} + Year_i + Industry_t + \varepsilon_{i,t} \quad (3)$$

We first centralize the independent variable (*c_DO*) and the moderator variable (*c_Z*), and then construct the interaction term *c_Z* × *c_DO*. *Z* is proxied by firm ownership (*Soe*), political connections (*Pc_dum* and *Pc_rat*) and the level of marketization (*Market_g*). The definition of *Soe* is the same as above. *Pc_dum* is a dummy variable that equals 1 if one of the directors, supervisors or executives serves or has served in government departments, the people's congress and the Chinese People's Political Consultative Conference, and 0 otherwise. *Pc_rat* indicates the percentage of people with political connections. *Market_g* is a sub-item in the marketization index, which is measured by the government–market relationship index. The definitions of other variables remain consistent with the previous ones. The model controls for industry effects and year effects and uses robust standard errors to eliminate heteroscedasticity.

The regression results are shown in Table 15. Panel A first shows the impact of the firm ownership type on the relationship between D&O insurance and excess corporate leverage. It is evident from columns (1) and (2) that the coefficients of *c_Z* (*Z* = *Soe*) are all significantly negative at the 1 % level, indicating that the level of excess leverage of SOEs is indeed low. Columns (3) and (4) report the results after including the interaction term of *c_DO* with *c_Z* (*Z* = *Soe*). The coefficients of *c_Z* × *c_DO* (*Z* = *Soe*) are both significantly negative at the 1 % level, indicating that the disincentive effect of D&O insurance on excess corporate leverage is more significant for SOEs than for non-SOEs. This suggests that the effect of D&O insurance on excess corporate leverage is moderated by the nature of firm ownership.

Panel B reports on the impact of political connections on the relationship between D&O insurance and excess corporate leverage. From columns (1) and (2) and (5) and (6), it can be seen that the coefficient of *c_Z* is significantly negative at least at the 5 % level, regardless of whether the political connection is measured by *Pc_dum* or *Pc_rat*, indicating that political connections have a significant negative impact on excess corporate leverage. The coefficients of the interaction terms *c_Z* × *c_DO* (*Z* = *Pc_dum* or *Pc_rat*) are both significantly negative at the 1 % level, which means that political connection strengthens the inhibitory effect of D&O insurance on excess corporate leverage. This suggests that the effect of D&O insurance on excess corporate leverage is moderated by political connections.

Panel C reports on the impact of the level of marketization on the relationship between D&O insurance and excess corporate leverage. It can be seen from columns (1) and (2) that the coefficients of *c_Z* are all significantly negative at the 1 % level, indicating that the higher the level of marketization is, the lower the possibility and degree of excess leverage of firms are, which conversely implies that the higher the level of government interventions in firms is, the greater the excess leverage of firms is, contrary to expectations. A possible reason is that with fewer government interventions in firms, bank credit decisions become more market-oriented and firms have an incentive to focus on their capital structure and reduce their deviation from the target capital structure to obtain bank support (Jiang and Huang, 2011). Thus, the higher the level of marketization is, the smaller the possibility and degree of excess leverage are. However, the coefficients of the interaction terms *c_Z* × *c_DO* (*Z* = *Market_g*) in columns (3) and (4) are both significantly positive at the 1 % level, suggesting that the level of marketization weakens the disincentive effect of D&O insurance on excess corporate leverage. Conversely, this means that the higher the level of government interventions in firms is, the more significant the crowding out effect of D&O insurance is on excess corporate leverage, implying that government interventions can "stimulate" or encourage listed firms to curb excess corporate leverage through D&O insurance. The results in Table 15 generally support H2a.

## 6. Conclusion

Using China's A-share listed firms from 2009 to 2018 to examine the impact of D&O insurance on excess corporate leverage, we find that D&O insurance is significantly and negatively associated with excess corporate leverage. This result is consistent with the results of a series of robustness tests, which include excluding market concerns and reduced credit supply by banks as alternative explanations for D&O insurance inhibiting

excess corporate leverage. Further analyses show that D&O insurance impedes excess corporate leverage by reducing the first type of agency costs, which supports the monitoring effect of D&O insurance. Moreover, government interventions have an important impact on the relationship between D&O insurance and excess corporate leverage. In firms with state-owned property rights, political connections and low marketization levels, D&O insurance has a more significant inhibitory effect on excess corporate leverage compared with private firms, firms that lack political connections and firms with high marketization levels.

Our findings offer several practical recommendations. First, as a good external governance mechanism, D&O insurance can inhibit excess corporate leverage, improve the capital structure of enterprises and achieve the goal of deleveraging to a certain extent. Therefore, regulators should actively improve relevant laws and regulations to create a good institutional environment so that D&O insurance can fully achieve its governance function. Second, the government, as the holder of key resources, should act as a supporting hand for the development of enterprises and help improve the level of corporate governance. When necessary, the government can increase its interventions in enterprises and the market, enhance the vitality of enterprises and build a service-oriented government, but it should also prevent excessive interference with the market mechanism. Third, insurance companies should give full play to the role of external governance. Insurance companies should formulate insurance contracts reasonably based on the actual development of the enterprise and restrain the opportunistic behavior of management through multi-layer supervision to alleviate agency conflicts.

## 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 study.

## Acknowledgments

This study was supported by the National Social Science Youth Foundation of China (Project No. 20CGL014) and the Social Science Planning Project in Chongqing, China (Project No. 2021BS084).

## References

Agarwal, R., Braguinsky, S., Ohyama, A., 2020. Centers of gravity: The effect of stable shared leadership in top management teams on firm growth and industry evolution. Strateg. Manag. J. 41 (3), 467–498.

Boubakri, N., Guedhami, O., Mishra, D., Saffar, W., 2012. Political connections and the cost of equity capital. J. Corporate Finance 18 (3), 541–559.

Boyer, M.M., Stern, L.H., 2014. D&O insurance and IPO performance: What can we learn from insurers?. J. Financ. Intermediat. 23 (4), 504–540.

Chalmers, J.M.R., Dann, L.Y., Harford, J., 2002. Managerial opportunism? Evidence from directors' and officers' insurance purchases. J. Finance 57 (2), 609–636.

Chan, C.C., Chang, Y.H., Chen, C., Wang, Y., 2019. Directors' liability insurance and investment–cash flow sensitivity. J. Econ. Finance 43 (1), 27–43.

Chang, C., Chen, X., Liao, G., 2014. What are the reliably important determinants of capital structure in China?. Pacific-Basin Finance J. 30, 87–113.

Chen, L.Y., Chen, Y.F., Yang, S.Y., 2017. Managerial incentives and R&D investments: The moderating effect of the directors' and officers' liability insurance. North Am. J. Econ. Finance 39, 210–222.

Chen, Z.L., Gao, K., Huang, W.W., 2020. Stock liquidity and excess leverage. Finance Res. Lett. 32, 1–7.

Dong, Y.Y., Guo, Z.G., 2019. Management equity incentives, dual positioning and excess corporate leverage: An analysis based on two agency theories. Contemporary Finance Econ. 1, 119–130, in Chinese.

Du, X.Q., Chen, Y.H., Du, Y.J., 2010. Rent-seeking, political connections and actual performance: Empirical evidence underlying private listed companies. J. Financ. Res. 10, 135–157, in Chinese.

Durand, R.B., Laing, E., Ngo, M.T., 2016. The disciplinary role of leverage: Evidence from East Asian cross-border acquirers' returns. Financ. Res. Lett. 18, 83–88.

Hao, Z.H., Hu, G.L., Hu, J., 2016. A study on directors' and officers' liability insurance, corporate governance and private earnings of executives. Insurance Stud. 5, 94–108, in Chinese.

Hu, G.L., Zhao, Y., Hu, J., 2019. Directors' and officers' liability insurance, risk tolerance and corporate innovation. Manage. World 35 (8), 121–135, in Chinese.

Issa, S., 2020. Life after debt: The effects of overleveraging on conventional and Islamic banks. J. Risk Financ. Manage. 13 (6), 1–44.
Jensen, M.C., 1993. The modern industrial revolution, exit and the failure of internal control system. J. Finance 48 (3), 831–880.
Jia, N., Mao, X., Yuan, R., 2019. Political connections and directors' and officers' liability insurance—Evidence from China. J. Corporate Finance 58, 353–372.
Jiang, F.X., Huang, J.C., 2011. Marketization process and dynamic adjustment of capital structure. Manage. World 3, 124–134, + 167, in Chinese.
Jiang, F.X., Qu, Y.H., Lu, Z.F., Li, Y., 2008. Product market competition and dynamic adjustment of capital structure. Econ. Res. J. 4, 99–110, in Chinese.
Jin, P.H., Wang, Y., Zhang, L.G., 2017. Financial friction and leverage governance under the condition of steady growth. J. Financ. Res. 4, 78–94, in Chinese.
Lai, L., Tang, Y.Q., Xia, X.L., Ma, Y.Q., 2019. Does directors' and officers' liability insurance reduce corporate risk? Based on the perspective of short-term loan, long-term investment and credit acquisition. Manage. World 35 (10), 160–171, in Chinese.
Li, X.H., Wang, Y.X., Ye, L., 2014. A new explanation of debt heterogeneity hypothesis and capital structure choice theory. Account. Res. 12, 3–10, + 95, in Chinese.
Li, C.G., Xu, R., 2020. Insurance governance and corporate violations: A study on the governance effect of directors' and officers' liability insurance. J. Financ. Res. 6, 188–206, in Chinese.
Lin, Y.F., Li, Z.Y., 2004. Policy burden, moral hazard and soft budget constraint. Econ. Res. J. 2, 17–27, in Chinese.
Lin, C., Officer, M.S., Zou, H., 2011. Directors' and officers' liability insurance and acquisition outcomes. J. Financ. Econ. 102 (3), 507–525.
Lin, C., Officer, M.S., Wang, R., Zou, H., 2013. Directors' and officers' liability insurance and loan spreads. J. Financ. Econ. 110 (1), 37–60.
Ling, S.X., Bai, R.F., 2017. The corporate governance role of directors' and officers' liability insurance: Based on the perspective of double agency costs. Finance Trade Econ. 38 (12), 95–110, in Chinese.
Liou, C.H., Liu, J.L., Jian, P.M., Tsai, C.C., 2017. Effects of director and officer liability insurance coverage on information disclosure quality and corporate fraud. Emerging Markets Finance Trade 53 (4), 806–818.
Lu, Z.F., He, J., Dou, H., 2015. Who is more indebted: State-owned or non-state-owned enterprises?. Econ. Res. J. 50 (12), 54–67, in Chinese.
O'Sullivan, N., 1997. Insuring the agents: The role of directors' and officers' insurance in corporate governance. J. Risk Insurance 61 (3), 545–556.
Paligorova, T., Xu, Z.X., 2012. Complex ownership and capital structure. J. Corporate Finance 18 (4), 701–716.
Park, J., 2005. The effect of directors' and officers' liability insurance and indemnification on voluntary disclosure: Evidence from Canadian firms. Purdue University, p. 3191538.
Peng, S.B., Wang, Y., Tang, J.W., 2018. Directors' and officers' liability insurance and investment efficiency: An empirical test based on contract clauses. Insurance Stud. 3, 76–90, in Chinese.
Song, Y.X., Sun, H.T., 2016. Directors' and officers' liability insurance and investor rights protection. Law Press, Beijing, in Chinese.
Tian, L.H., 2004. Leverage governance, soft budget constraints and the performance of Chinese listed companies. China Econ. Quart. 1, 15–26, in Chinese.
Titman, S., Tsyplakov, S., 2007. A dynamic model of optimal capital structure. Rev. Finance 11 (3), 401–451.
Wang, X.H., Duan, S.S., 2015. Government intervention, corporate governance and performance. Macroeconomics 12, 106–114+128, in Chinese.
Wen, W., 2017. Directors' and officers' liability insurance and enterprise risk taking. J. Shanxi Univ. Finance Econ. 39 (8), 101–112, in Chinese.
Wu, Q.S., Du, Z.Y., 2019. Mixed ownership reform, government implicit guarantees and excessive debt of state-owned enterprises. Bus. Manage. J. 41 (8), 162–177, in Chinese.
Wu, Q.S., Jiang, Y.J., 2019. Degree of marketization, business hospitality fees and excessive leverage of private enterprises. Finance Account. Monthly 18, 15–20, in Chinese.
Xiao, Z.Z., Zou, H., 2008. Influencing factors of capital structure of Chinese listed companies and preference for equity financing. Econ. Res. J. 6, 119–134, + 144, in Chinese.
Yu, M.G., Hui, Y.F., Pan, H.B., 2010. Political connections, rent-seeking and the effectiveness of local government financial subsidies. Econ. Res. J. 45 (3), 65–77, in Chinese.
Yuan, C., Jing, X., Liao, G.M., 2010. Credit preference of state-owned companies: Credit intervention or implicit guarantee? An empirical test based on credit loans. Account. Res. 8, 49–54, + 96, in Chinese.
Yuan, R., Sun, J., Cao, F., 2016. Directors' and officers' liability insurance and stock price crash risk. J. Corporate Finance 37, 173–192.
Yuan, R.L., Wen, W., Xie, Z.H., 2018. D&O insurance and restatement of financial statements. Account. Res. 5, 21–27, in Chinese.
Zhang, Z.X., 2005. Financial assets price fluctuation and risk control. Fudan University Press, Shanghai, In Chinese.
Zhang, T.Z., Zeng, Y.X., Liu, Q., 2020. Research on management team stability and investment behavior of listed companies. Scientific Decision Making 6, 16–40, in Chinese.
Zona, F., 2016. Agency models in different stages of CEO Tenure: The effects of stock options and board independence on R&D investment. Res. Policy 45 (2), 560–575.

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# Impact of macroeconomic policy uncertainty on opportunistic insider trading

Chun Cai, Ruixue Bao *, Peng Wang *, Huiyan Yang *

*School of Accounting, Southwestern University of Finance and Economics, The Center for China's Governmental Auditing Research, China*

ARTICLE INFO

*Article history:*
Received 27 July 2021
Accepted 10 October 2022
Available online 8 November 2022

*Keywords:*
Macroeconomic Policy
Uncertainty
Insider Trading
Opportunism

ABSTRACT

The macroeconomic policy environment affects the internal governance of microenterprises, which may provide opportunities for management to benefit from stock sales while decreasing its motivation to manipulate stock transactions. Using a sample of Chinese A-share listed companies from 2007 to 2018, we study the impact of macroeconomic policy uncertainty on opportunistic insider trading. The results show that macroeconomic policy uncertainty helps restrain the opportunistic trading of shares held by management. When macroeconomic policies are uncertain, enterprises improve their internal governance. Furthermore, strengthening equity governance helps reduce management's opportunistic use of the uncertainty of the policy environment, highlighting the advantageous effect of macroeconomic policy uncertainty and helping regulators standardize managerial behavior and promote the governance effect of macroeconomic policy.


## 1. Introduction

Management insider trading (hereafter, holdings reduction) has increased the public's interest in managerial behavior. Company's arbitrage strategy events have frequently been exposed in major financial media. The China Securities Regulatory Commission (CSRC) and other government regulators supervise the stock trading of directors, supervisors and managers through comment letters, warning letters and other measures. The CSRC issued and implemented revised Certain Provisions on the Insider Trading of Shareholders, Directors, Supervisors and Managers of Listed Companies in 2017 and the draft of the Securities Law of the People's

* Corresponding authors at: School of Accounting, Southwestern University of Finance and Economics, No. 555, Liutai Avenue, Wenjiang District, Chengdu, Sichuan, China.
*E-mail addresses:* 2537218738@qq.com (R. Bao), frankyueyue@163.com (P. Wang), yanghuiyanhy@163.com (H. Yang).

https://doi.org/10.1016/j.cjar.2022.100270
1755-3091/

Republic of China in 2019. In addition, it has released the Detailed Rules for Implementation of the Insider Trading of Shareholders, Directors, Supervisors and Managers of Listed Companies in the Shenzhen Stock Exchange, the Detailed Rules for Implementation of the Insider Trading of Shareholders, Directors, Supervisors and Managers of Listed Companies in the Shanghai Stock Exchange and other relevant laws, regulations and normative documents, all of which strictly regulate the stock trading behavior of directors, supervisors and managers. However, when management's behavior is questioned, ''operation error'' seems to have become the go-to answer. Whether illegal insider trading by management is characterized as an ''intentional act'' or ''operation error'' depends on whether an excess return is obtained. Directors, supervisors and managers have information advantages in predicting asset valuation and cash flow (Piotroski and Roulstone, 2005), providing them with the ability to trade opportunistically. Management's profit-making strategy of using information asymmetry is not conducive to safeguarding the interests of minority shareholders, and it disturbs the order of the stock market. Indeed, the lagging impact of long-term market fluctuation increases the potential financial risks. Ever since the 19th National Congress of the Communist Party of China (NCCPC), winning the battle of risk prevention, especially ''winning the battle of preventing and resolving financial risks,[1]'' has been important to improving the quality and efficiency of financial services to the real economy and achieving high-quality economic development. Therefore, it is critical to study the external environment that affects company's arbitrage strategy events to strengthen the standardization and guidance of management's trading behavior, to promote the market economy's standardization system and ability and to realize high-quality economic development.

Ever since the 18th NCCPC, China has targeted a medium–high level of economic growth and increased its attention to high-efficiency, high-quality economic development. China has also implemented a series of economic policies such as supply-side structural reform, strengthening the reform of state-owned enterprises, developing a mixed ownership economy, adopting measures to intensify the reform of the financial and real estate markets, winning the battle against poverty and coordinating regional development, all with the goal of guiding economic transformation and building a first-class economic power. Internationally, Brexit negotiations and Sino–U.S. trade frictions continue to affect global economic development, and the uncertainty of global economic policy increases every year (Baker et al., 2016). The report of the 19th NCCPC proposed to develop a top-notch economy, achieve multiple high-quality objectives in the complex global economic environment and promote the modernization of China's national governance system and governance capacity to satisfy economic objectives. It is difficult for the government to achieve its goals by merely combining its macro control policies (Julio and Yook, 2012). Accordingly, the goals of those policies change frequently, and uncertainty related to government economic policies is on the rise (Meng and Shi, 2017). Economic policy uncertainty is particularly significant in China's market environment (Li and Yang, 2015). Enterprises are the source of the national government's vitality, and its organizational strategies, business activities and business objectives vary with the macroeconomic environment. Due to the information asymmetry created by listed companies' separation of control and ownership, management uses its information advantage while adapting to the macroeconomic environment, causing a serious agency problem. Thus, in an environment of uncertain economic policy, it is increasingly likely that management will engage in tunneling. The tunneling refers to the company's major shareholders encroaching on the interests of minority shareholders through covert means. In a strong and effective securities market, when the government adjusts its economic policy, investors' response is moderate. In contrast, the policy market is one of the characteristics of China's stock market. As China's stock market has a circuit-breaker mechanism, it is semi-strong, and macroeconomic policy has a substantial impact on trading. Therefore, it is important to study the impact of macroeconomic policy uncertainty on opportunistic insider trading, along with the internal logical mechanism of that impact.

Macroeconomic policy uncertainty is in line with the environment of major national economic events (Yun and Paul, 2020), accompanied by the uncertainty of the international environment, which can create an economic risk (Bloom et al., 2007). Governance of business activities and strategic decisions depends on the macroeconomic policy environment. The agency problem between ownership and control of modern enterprises provides opportunities for opportunistic behavior of management. Corporate governance is crucial

[1] Full text of Xi Jinping's report at 19th CPC National Congress.

to solving the problem of opportunistic insider trading. How can shareholders control the impact of macroeconomic policy uncertainty on management behavior and ensure the maximization of shareholders' interests? In an environment of macroeconomic policy uncertainty, it is worthy of in-depth study for shareholders to improve internal corporate governance to reduce opportunistic insider trading.

We use a sample of China's A-share listed companies' insider-trading transactions from 2007 to 2018 to study the impact of macroeconomic policy uncertainty on opportunistic insider trading. We find that the level of macroeconomic policy uncertainty is significantly negatively correlated with the intensity of opportunistic insider trading. Our mechanism study shows that the higher the level of macroeconomic policy uncertainty, the more significant its role in encouraging enterprises to improve their internal governance, which then restricts management's opportunistic insider-trading behavior. Further, we find that the worse a company's equity governance (i.e., the existence of stock pledges, low equity incentives and a lack of state-owned equity supervision), the more significant the negative correlation between the level of macroeconomic policy uncertainty and the intensity of opportunistic stock sales by management. Through our study, we enrich the literature and provide a new perspective on insider trading, contribute to the study of the macro environment's effect on micro behavior and expand the analytical framework of the impact of macroeconomic policy uncertainty on microenterprises.

Our contributions are as follows. First, we open up a new perspective in the literature on the macroeconomic policy environment's impact on management's behavior, an area in which other studies explore the issues of management turnover (Rao et al., 2017a,b) and management overconfidence (Wu and Liu, 2021). The effect of macroeconomic policy uncertainty on opportunistic insider trading remains unstudied, providing us with a motivation to conduct this study. Second, we study the path from macroeconomic environmental uncertainty to improved internal governance. The literature on opportunistic insider trading focuses on the factors of corporate internal governance, which are as follows: the effectiveness of internal control (Chen and Fang, 2019) and the effectiveness of major shareholder governance (Luo and Huang, 2020). Both of these factors focus on improving internal governance to restrain management opportunism, ignoring both the impact of the macroeconomic environment on management opportunism in microenterprises and the importance of internal governance in an uncertain macroeconomic environment. Third, we enrich the literature on insider trading. Previous studies examine the impact of management's insider trading and short-term insider trading events on market information from the perspective of the characteristics of a microenterprise (Piotroski and Roulstone, 2005; Chen, 2015; Chen and Wen, 2016). In contrast, we study management's motivation for engaging in opportunistic insider trading based on the certain return rate after the stock sale, obtaining a better understanding of the effects of macroeconomic policies. We study the impact of macroeconomic policy uncertainty on opportunistic insider trading, which is expected to help guide and standardize management's market-transaction behavior, build a fair, reasonable and effective market system and achieve high-quality economic development.

## 2. Literature review

### *2.1. Research on the impact of economic policy uncertainty on management behavior*

Management and the enterprise are parties to a principal–agent relationship in which management operates the enterprise, directly engaging in business activities, investment activities and financing activities. Accordingly, we summarize the literature on the impact of economic policy uncertainty on management behavior with respect to these three managerial activities.

The literature on the impact of economic policy uncertainty on management's business activities mainly includes the enterprise's cash flow holding level, research and development (R&D) activities, working capital and tax avoidance. First, the positive impact of economic policy uncertainty on enterprises' cash holding levels is related to the intensity of their financing constraints (Liang and Xie, 2019). When economic policy uncertainty increases, firms often increase their cash holdings to cushion future borrowing needs (Baum et al., 2006; Han and Liu, 2011; Wang et al., 2014; Li and Shi, 2016; Yu et al., 2019), reduce dividend payments (Huang and Wessels, 1988) and improve the speed of cash adjustments (Zhang et al., 2014). Private enterprises, enterprises with a high manager shareholding ratio and enterprises in regions with a low degree of marketization

are more sensitive to macro policy uncertainty than other enterprises (Yu et al., 2019). Second, an uncertain policy environment encourages enterprises to invest in innovation as quickly as possible to improve their future growth options. This incentive relationship is primarily driven by policy uncertainty at the local government level (Liang and Xie, 2019). The stimulus effect of policy uncertainty on enterprise R&D activities is stronger in enterprises with a high level of innovation difficulty, high growth value and fierce product competition (Atanassov et al., 2015). There is also a selection effect among enterprises with different types of ownership (Gu et al., 2018). Third, the greater the uncertainty of economic policy and the broader the range of strategic change, the higher the probability of excessive capital operation. The range of strategic change positively moderates the relationship between the uncertainty of economic policy and excessive capital operation (Wang and Wang, 2019). The higher the uncertainty of economic policy, the greater the degree of corporate tax avoidance. Promoting R&D expenditures, intensifying financing constraints and implementing downward earnings management are three important channel mechanisms for increasing corporate tax evasion due to economic policy uncertainty (Cao et al., 2019).

Economic policy uncertainty inhibits enterprises' investment behavior (Julio and Yook, 2012; Gulen and Ion, 2016) and their investments in short-term tangible assets such as capital expenditures (Li and Yang, 2015; Gulen and Ion, 2016). The influence of economic policy uncertainty on enterprise investment and financing behavior can be extended to financial investment. When economic uncertainty increases, it is difficult for enterprises to form stable expectations of future economic trends. Enterprises exercise increased caution with respect to their investment decisions (Bloom et al., 2007), and the scale (Wang and Song, 2014; Gulen and Ion, 2016) and efficiency (Beaudry et al., 2001) of their investments decline. Economic policy uncertainty increases friction in the financial markets, reduces the credit supply, increases financing and investment costs and causes enterprises to delay or reduce investment (Gilchrist et al., 2014; Rao et al., 2017a,b). The uncertainty of economic policy is positively correlated with enterprises' investment and financing efficiency, and this effect is more obvious for firms that are strongly affected by policy factors (Rao et al., 2017a,b). Additional studies show that from the perspective of on-balance sheet business, the uncertainty of economic policy prompts banks to relax their loan approval conditions and increase the scale of their loans, thus encouraging enterprises to invest. From the perspective of off-balance sheet business, economic policy uncertainty decreases corporate investment by decreasing the size of the shadow banking sector. Economic policy uncertainty also reduces the investment cost of capital sensitivity for firms from relatively opaque countries, firms with no credit rating and firms that are small (Drobetz et al., 2018). The likelihood of non-state-owned enterprises, technology-intensive enterprises, low-productivity enterprises and less financing-constrained enterprises engaging in outward foreign direct investment (OFDI) increases. Financial crises significantly reduce the probability of corporate OFDI under the uncertainty of established economic policies (Yang et al., 2019).

Financing cost is the carrier of the impact of economic policy uncertainty on management's financing activities. This increased uncertainty accelerates the increase of corporate financing costs (Bradley et al., 2016). Economic policy uncertainty reduces the scale of trade credit obtained by enterprises (Wang et al., 2014). Economic policy uncertainty has a significant negative impact on corporate debt-financing costs, and increasing economic policy can narrow the range of the debt-financing costs of state-owned enterprises even more than those of non-state-owned enterprises (Wu and Li, 2019).

### *2.2. Research on the relationship between the corporate governance environment and executives' stock sales*

Research on the impact of the corporate governance environment on executives' stock sales can be viewed from two perspectives. On the one hand, from the perspective of the company's internal environmental characteristics, the executive team's background influences their reduction behavior (Gu and Wang, 2014), and the shareholding ratio of executive shareholders is positively correlated with the reduction ratio (Yao et al., 2016). Managers adjust their discretionary accruals to increase current-period earnings before they sell their own firms' shares (Park and Pask, 2004). Executives use their inside information to lock in short-term gains and to sell stock that they acquired before negative abnormal stock returns (Kyriacou et al., 2008). The media's attention to the company, along with the company's reporting tendency, increase by an abnormal amount during executives' stock-selling periods (Yi et al., 2017). Equity pledges by controlling shareholders (whether pledged or not) have a significant negative correlation with reduced executive holdings in listed companies.

Equity pledge financing by major shareholders is positive information for internal executives, but continuous pledges are negative information, reducing executives' holdings. A good corporate internal government environment can effectively reduce insiders' information superiority, and internal control has a governance effect on opportunistic insider trading (Chen and Fang, 2019). However, from the perspective of the company's external environment characteristics, differences in the external governance environment have little influence on its executives' acquisition of excess returns through trading. In countries with a high level of investor protection, strict insider-trading information disclosure rules can play a more prominent role than in countries with a low level of investor protection. The better the legal environment, the more significant the internal control restrains insiders' opportunistic sales (Chen and Fang, 2019).

Reviewing the literature, we identify the following three points. First, studies on the uncertainty of economic policy on management behavior primarily involve cash holdings, R&D and innovation activities, financing and investment activities. There are few studies on the relationship between macroeconomic policy uncertainty and management sales. Second, studies on the relationship between corporate governance and executive stock sales primarily address the influence of the internal governance environment, including executive characteristics and the executive shareholding ratio, the level of earnings management, ownership structure and internal control as well as market and legal issues. There is no literature study on the impact of the linkage between the external environment and the internal environment on the opportunistic insider trading. Third, executives' opportunistic stock-selling behavior in the prior literature focuses on the corporate internal governance environment. In addition, the literature lacks studies of the impact of external environment on internal environment.

## 3. Theoretical analysis and hypothesis development

The formulation, as well as execution of economic policies, are essential issues for regulatory authorities to acquire macro-control and generate a sound business environment (Baker et al., 2016). Furthermore, economic policy implementation is highly subjective and controllable (Meng and Shi, 2017), and enterprises face numerous uncertainties in the timing, content and expected effect of policy decisions. Due to the fact that uncertainty is a precondition for the emergence of risk. While risk is not synonymous with "negative effects," divergent ways of using risk will have divergent advantages and disadvantages for enterprises.

Frequent changes in macroeconomic policies and unpredictability in the policy implementation process contribute to the uncertainty of economic policy (Gulen and Ion, 2016). This type of uncertainty is more sensitive to business performance than other varieties, and it is reflected in the stock market. The uncertainty level of macroeconomic policy influences significantly the long-term fluctuations of the stock market and can directly send to a bear market decline (Lei et al., 2018). Additionally, economic policy uncertainty has a positive impact on the risk of a stock price crash (Li and Lin, 2019). The unpredictability of external economic policies diminishes the quality of enterprises' information environment, thus aggravating information asymmetry between enterprises and external investors (Chen et al., 2018). For instance, during the 2008 financial crisis, changes in the stock market return rate during the early stage of the government bailout exposed the information held by enterprise insiders (Li and Zhang, 2019). Insiders have numerous types of information that confer a trading advantage, moreover, they have secret methods for exploiting this information, making it challenging for external stakeholders to identify and quantify the insider information advantage. Executives make behavioral decisions on the basis of their interests in accordance with the economic policy environment-likewise, they use insider information to sell stocks when yields are high. On the condition that stock price of a company is higher than its actual value, the management expects that the stock price will recover its actual value after some time, and it engages in opportunistic selling by leveraging information asymmetry. After the financial crisis, international trade frictions were not significantly alleviated, the adjustment range of national macroeconomic policies expanded, stock prices fluctuated under the effect of market policies, and investment project information became less adequate. Management required a substantial cash flow to protect its own interests.

The unpredictability of economic policy has an impact on the internal environment of businesses as a systemic economic risk. An increase in the uncertainty of macroeconomic policy has an adverse effect on operations, increasing the cost of equity financing, creating the need to expend more costs and efforts to obtain the

information required for investment projects, and lowering business performance (Panousi and Papanikolaou, 2012; Gulen and Ion, 2016). All of these occurrences contribute to a pattern where operational costs are notably higher than operating performance, affecting both shareholders' and managers' reasonable judgment when making corporate strategic decisions. Derived from the risk avoidance of a rational economic actor's decisions, management is effectively unaccountable when confronted with systemic risk. Managers employ internal information for private gain, impacting internal governance. The lower the level of internal governance, the more serious the principal-agent problem (Dittmar et al., 2003). The more apparent the deficiencies in internal control, the more prominent the problems of earnings management and information opacity, and the greater the opportunities for management to engage in opportunistic stock-selling behaviors (Chen and Fang, 2019). Consequently, the higher the uncertainty of macroeconomic policies, the greater the impact of that uncertainty on enterprises' internal operating environments and governance levels and the higher the incentive for management to engage in opportunistic selling. Based on the findings presented above, we propose the following hypothesis:

H1a: Macroeconomic policy uncertainty is correlated significantly positively with opportunistic insider trading.

The macroenvironment affects the micro-governance environment. As a systemic economic risk, macroeconomic policy uncertainty has a major impact on the operations of businesses. Systemic risks are unavoidable. For the purpose of coping with and preventing the systemic risks caused by the uncertainty of macroeconomic policies, enterprises should strengthen their governance internally. The greater the uncertainty of economic policies, the greater the future operational risk of enterprises and the likelihood of a liquidity constraint increase as economic policy uncertainty increases (Wang et al., 2014). To cope with the systemic risk caused by economic uncertainty, enterprises take precautions by placing their cash flow in reserve. The uncertainty of macroeconomic policy increases the holding level of corporate cash flow (Yu et al., 2019) and reduces the scale of investment to ensure that the company has moderate financial flexibility (Grahama and Harvey, 2021). Consequently, enterprises can prevent the uncertainty of macroeconomic policies by improving their financial standing. Financial management is a crucial component of the internal governance system and enhanced financial management ability marks increased internal control, which can prevent management from engaging in opportunistic selling (Chen and Fang, 2019).

Increased ambiguity in economic policy may make the information imbalance worse between shareholders and management, making it more arduous for shareholders to supervise and obtain accountability from management (Liu and Han, 2010). To receive the knowledge needed for investment projects, shareholders need to spend more money and effort, which is counterproductive to maximizing their interests and providing management with an opportunistic behavior. Executive stock sales provide unfavorable insight into the company's prospects for future growth (Leland and Pyle, 1977). On the condition that faced with systemic risk, shareholders protect their by enhancing internal governance within the enterprise to prevent opportunistic stock selling by executives. Shareholders need to supervise and motivate management, strengthening internal governance mechanisms to address the operational environment's external uncertainty. On the one hand, shareholders employ auditors to oversee management information disclosure through the board of directors, and improving the quality and transparency of information disclosure is the primary means of reducing the incentive for managers to participate in opportunistic selling (Jin and Myers, 2006). The possibility of management making money from opportunistic stock sales decreases as internal information disclosure quality improves. To enhance the company's information environment and prevent its executives from engaging in opportunistic stock sales, several significant shareholders adopt supervision (Luo and Huang, 2020). Participation of state-owned equity holders in governance will likely enhance oversight. On the contrary, when the macroeconomic policy is uncertain, company performance suffers., As a result, management's performance-based compensation also declines, which increases managers' incentive to participate in opportunistic selling by exploiting information asymmetry. By using this strategy, the significant shareholders who give management equity incentives effectively make up for the flaw in the compensation incentive structure. Managers' intrusion behaviors can be reduced and agency issues can be alleviated with ownership (Lambert et al., 2007). Consequently, increased macroeconomic policy uncertainty is favorable to promoting the internal governance of enterprises, hence discouraging executives from engaging in opportunistic stock sales. Based on the above analysis, we propose the following hypothesis:We suggest the following based on the aforementioned analysis:

H1b: Significantly negative correlation exists between macroeconomic policy uncertainty and opportunistic insider trading.

## 4. Measures, research design and sample selection

### *4.1. Measures and research design*

#### *4.1.1. Measure of opportunistic insider trading*

The gains from insiders' stock sales reflect the information content of the stock transaction, and it is a reflection of insiders' ability to predict performance or correct market mispricing (Piotroski and Roulstone, 2005), which is short-term information transmitted to the market during the transaction process. The sharp drop in abnormal stock returns after executives sell their shares indicates that insiders use private information to trade, reflecting the opportunity for insider trading in the stock market (Kallunkia et al., 2018). Insiders have a stronger internal information advantage than external investors, that is, the higher the company's information asymmetry, the more significant the decline in abnormal returns after the shareholder's stock sale (Huddart and Ke, 2010). Using private information to make opportunistic stock sales, insiders can predict future declines in their stock returns. When they engage in conventional selling stock behavior, insiders cannot predict future negative information (Cohen et al., 2012). Previous studies use the abnormal stock return decline after management's stock sales to measure opportunistic insider trading (Chen and Fang, 2019; Luo and Huang, 2020). Insider trading can predict returns 1 year after the deal, but the majority of abnormal returns occur within 6 months. Articles 44 and 189 of the Securities Law of the People's Republic of China stipulate that the reverse trading time for directors, supervisors and senior managers to buy and sell a company's stocks shall not be shorter than 6 months. Consistent with the literature (Chen and Fang, 2019), we use the buy-and-hold abnormal return (BHAR) 6 months after the selection of directors, supervisors and senior managers to sell their shares (6 months after the insider transaction) to measure opportunistic insider trading.

#### *4.1.2. Measure of insiders' trading in stock*

According to Article 44 of the "Securities Law of the People's Republic of China", the number of shares held by insiders includes shares held by their spouses, parents, children, and other people's accounts or other securities with equity nature. Based on that law, we calculate the number of shares sold (bought) that are held by management. Consistent with the literature (Piotroski and Roulstone, 2005), we use the monthly net shares reduction ratio (NSR) of directors, supervisors and executives to measure the transaction behavior of insider trading in stock. Our calculation formula is expressed as follows:

$$NSR_t = \frac{Sold_t - Purchased_t}{Sold_t + Purchased_t}$$

where $Sold_t$ is the total number of shares held by directors, supervisors and executives in month t, and $Purchased_t$ is the total number of shares held by directors, supervisors and executives in month t. The NSR is between –1 and 1. The larger the value, the larger the proportion that directors, supervisors and senior management reduce their shareholdings.

#### *4.1.3. Measure of stock return (BHAR)*

The sharp decrease (increase) in abnormal stock returns after insiders sell stocks (buy stocks) is a distinct manifestation of insiders' opportunistic trading (Kallunkia et al., 2018), and the post-trade return period should provide a proper measure of the private information advantage held by insiders. The literature on abnormal return calculation is divided into the CAR(Cumulative abnormal return) model and the BHAR model. The premise of the CAR model is that investors constantly change their portfolios and frequently buy and sell. The premise of the BHAR model is that investors buy and hold their stocks for a certain period of time.

Unlike the BHAR model, the CAR model simply accumulates returns, and it does not take into account the impact of early-stage returns on later-stage returns. When measuring returns in different time periods, the

basis of measurement will change accordingly. The calculation does not take into account the compound effects on excess returns. When performing a summation of a relatively long time series, it is necessary to calculate the cumulative value over a long time. From a statistical point of view, it is more reasonable to use the BHAR model to measure stock returns than the CAR model. Therefore, we use the BHAR model to calculate abnormal returns. Considering that insiders selling stocks can avoid possible losses, we take the negative value of the BHAR after insiders sell stocks. When we calculate the BHAR, we control for the effect of company size and the book-to-market value ratio on the BHAR. Our calculation formula for the BHAR is as follows:

$$BHARi, T = \prod_{i=1}^{T}(1 + Ri, t) - \prod_{i=1}^{T}(1 + Rp, t)$$

where the maximum value of T is equal to 180 days. The value of t is equal to 1, representing the first day after the trading day, and so on. $R_{i,t}$ represents the daily rate of return of company i on day t, and $R_{p,t}$ represents the corresponding comprehensive daily market rate of return. We calculate $R_{p,t}$ as follows. First, based on the size of the company's circulating market value at the end of June in year t, we sort and divide it into five groups. Second, based on the data released by the company at the end of t–1, we calculate the book-to-market value ratio and divide it into five groups ordered from small to large. Third, we divide all of the listed companies into 25 groups in each year, and we calculate the equal-weighted daily rate of return $R_{p,t}$ for the 25 groups in each year. In addition, we calculate the BHAR 125 days after the trade to perform a robustness test.

Measure of macroeconomic policy uncertainty (EPU)[2].

Baker et al. (2016) use the economic policy uncertainty index calculated by the South China Morning Post, a publication in Hong Kong, China. The index constructed by Baker and other scholars has a high degree of conformity with China's post-1995 economy and politics (Deng, 2019). We select the monthly index of Baker's economic policy uncertainty indicator, take the average of 12 monthly raw data periods within a year and divide it by 100 as the annual variable of macroeconomic policy uncertainty (Meng and Shi, 2017).

Davis et al. (2019) construct China's economic policy uncertainty index (EPU) based on People's Daily and Guangming Daily, both of which are newspapers in mainland China. As the authority and credibility of the People's Daily and Guangming Daily are higher than those of other publications, we select the monthly index of China's EPU developed by Davis et al. (2019), take the average of the 12-month raw data within a year and divide it by 100 as an independent variable for robustness testing (Meng and Shi, 2017) Table 1.

## 5. Research design

We estimate the following regression model to test H1a and H1b:

$$Nsr = \beta 0 + \beta 1 Bhar + \beta 2 Bhar \times Epu + \beta 3 Epu + \beta 4 Size + \beta 5 Salary$$
$$+\beta 6 Growth + \beta 7 Lev + \beta 8 Attention + \beta 9 Invest + \beta 10 Shrcr + \beta 11 Roe$$
$$+\beta 12 Mb + \beta 13 Div + \beta 14 Management + \beta 15 Pice + \beta 16 Firm + \beta 17 Year + \varepsilon$$

We predict that the coefficient β1 is positive, indicating that there are signs of opportunistic insider selling behavior, and the coefficient β2 represents the degree of influence of macroeconomic policy uncertainty on opportunistic insider stock sales. Following Petersen's (2009) study, we control for year and firm-individual fixed effects in our regression models, and we adjust the firm-level clustering for the standard errors of all regression models.

Based on Chen and Wu (2013) and Chen and Fang (2019), we control for a variety of factors that affect insider stock sales. Those factors include the size of the company (SIZE), the total compensation of the top three directors, supervisors and senior executives (SALARY), growth (GROWTH), financial leverage (LEV), analyst attention (ATTENTION), institutional investor holdings (INVEST), the equity concentration ratio (SHRCR), dividends per share (DIV), the book-to-market ratio (MB), return on equity (ROE), manage-

[2] https://www.policyuncertainty.com/china_monthly.html.

Table 1
Variable definitions.

| Variable | Definition |
|---|---|
| *NSR* | The calculation method is shown in formula (1) |
| *BHAR* | The calculation method is shown in formula (2) |
| *EPU* | A monthly index of China's economic policy uncertainty developed by Baker et al. (2016) |
| *SIZE* | Log (Total assets in the last year) |
| *SALARY* | Log (total remuneration of the top three directors, supervisors and senior executives in the last year) |
| *GROWTH* | The natural growth rate of the company's total assets |
| *LEV* | Asset-liability ratio in the last year |
| *ATTENTION* | Number of analysts tracked by year |
| *INVEST* | Shares of listed companies held by institutional investors as a percentage of outstanding shares |
| *SHRCR* | Shareholding ratio of the largest shareholder in the last year |
| *DIV* | Dividend per share in the last year |
| *MB* | Book value of equity in the last year/Market value in the last year |
| *ROE* | Net profit in the last year/Net asset balance in the last year |
| *MANAGEMENT* | Number of shares held by management/Total shares |
| *PRICE* | The closing price of the stock market the day before management sells stock |

ment variables such as the shareholding ratio (MANAGEMENT) and the stock price before the management reduction (PRICE).

### 5.1. Sample selection

In 2006, China's capital market began to allow insiders (i.e., directors, supervisors and senior executives) to buy and sell their companies' shares on the secondary market, albeit with restrictions. We choose Chinese non-financial firms listed in the A-share market from 2007 to 2018 as our sample to study the impact of macroeconomic policy uncertainty on opportunistic insider trading. We exclude the annual sample of companies without management transactions, ST and *ST firms. We exclude missing data from our sample and ultimately obtain 6,207 firm-year observations. We adopt China's economic policy uncertainty index developed by Baker et al. (2016) based on the Southern Morning Post and Davis et. al (2019) based on the People's Daily and Guangming Daily. We obtain other financial statement data from the China Stock Market and Accounting Research (CSMAR) database. To mitigate concern about outliers, the variables with abnormal outliers (financial leverage and the book-to-market ratio) are winsorized at 1 % and 99 %.

The descriptive statistical results of the research samples of Chinese A-share listed companies from 2007 to 2018 are shown in Table 2. As shown in Table 2, the insider stock selling level (NSR) is between –1 and 1, the

Table 2
Descriptive statistics.

| Variables | N | mean | sd | min | p25 | p50 | p75 | max |
|---|---|---|---|---|---|---|---|---|
| *NSR* | 6207 | 0.5800 | 0.6600 | −1 | 0.2500 | 1 | 1 | 1 |
| *BHAR* | 6207 | −0.0700 | 0.7200 | −31.95 | −0.0900 | −0.0100 | 0.0600 | 2.3300 |
| *EPU* | 6207 | 2.2900 | 1.2300 | 0.8200 | 1.2400 | 1.8100 | 3.6400 | 4.6000 |
| *SIZE* | 6207 | 21.6500 | 1.1300 | 13.7600 | 20.8700 | 21.5200 | 22.2500 | 27.1400 |
| *SALARY* | 6207 | 14.2100 | 0.7600 | 10.9600 | 13.7400 | 14.1800 | 14.6600 | 17.3500 |
| *GROWTH* | 6207 | 0.3000 | 0.6800 | −0.7800 | 0.0400 | 0.1400 | 0.3200 | 15.8900 |
| *LEV* | 6207 | 0.3800 | 0.2000 | 0.0400 | 0.2100 | 0.3600 | 0.5300 | 0.8600 |
| *ATTENTION* | 6207 | 1.7400 | 1.1300 | 0 | 0.6900 | 1.7900 | 2.6400 | 4.1900 |
| *INVEST* | 6207 | 7.4600 | 8.2300 | 0 | 1.2400 | 4.8300 | 10.9600 | 72.1700 |
| *SHRCR* | 6207 | 32.3600 | 13.9100 | 0.2900 | 21.6800 | 30.2000 | 41.9300 | 85.2300 |
| *DIV* | 6207 | 0.1300 | 0.1800 | 0 | 0.0300 | 0.1000 | 0.1700 | 3 |
| *MB* | 6207 | 0.0300 | 0.0200 | 0.0100 | 0.0100 | 0.0200 | 0.0400 | 0.0700 |
| *ROE* | 6207 | 0.0700 | 1.0200 | 0.0103 | 0.0400 | 0.0800 | 0.1300 | 0.1931 |
| *MANAGEMENT* | 6207 | 0.2000 | 0.2100 | 0 | 0 | 0.110 | 0.3800 | 0.9000 |
| *PRICE* | 6207 | 65.3600 | 82.5100 | 0 | 0 | 26.3700 | 97.9500 | 250.0000 |

mean value of NSR is 0.5800, the median value of NSR is 1, indicating that more than half of the companies in the sample are at high levels of management underweight. The mean and median BHAR for the BHAR 6 months after management sold the stock is negative, and the 75 % quantile is positive, indicating that returns decrease after the vast majority of managers sell their holdings. The macroeconomic policy uncertainty index (MEPU) ranges from 0.8200 to 4.600, with a standard error of 1.230, indicating that there is volatility in China's macroeconomic policy uncertainty. The minimum value of SIZE is 13.7600, the maximum value is 27.1400 (i.e., more than twice the minimum value) and the standard error is 1.1300, indicating that the scale of Chinese A-share listed companies varies widely.

## 6. Empirical results

### *6.1. Main results*

In Table 3, we begin reporting the regression results. As shown in the first and second columns, the regression coefficient of the independent variable BHAR is 0.0468, which is statistically significant at the 5 % level, and the regression coefficient of the multiplication term BHAR × EPU is –0.049, which is statistically significant at the 10 % and 5 % levels. The results collectively suggest that insiders use their information advantages to sell their stock opportunistically. The higher the level of macroeconomic policy uncertainty, the less likely insiders are to sell stock opportunistically. The uncertainty of macroeconomic policies helps restrict insiders' opportunities to sell stock. Using the average level of the macroeconomic policy uncertainty index from 2007 to 2018, we divided the EPU into a higher group and a lower group. In the third column of Table 3, the regression coefficient of the independent variable BHAR is 0.0077, which is not statistically significant. In the fourth column, the regression coefficient of the independent variable BHAR in the fourth column is 0.0502, which is statistically significant at the 5 % level. The results further show that the higher the degree of macroeconomic policy uncertainty, the more conducive the uncertainty is to restraining the opportunistic selling of stock by insiders.

### *6.2. Robustness tests*

#### *6.2.1. IV tests*

The main results of this study may have endogeneity problems. Missing variables and other factors that are not considered, such as market environment and policy orientation, can affect the relationship between macroeconomic policy uncertainty and opportunistic stock selling. To address these possible endogeneity problems, we use the methods set forth below.

The measurement indicators of economic policy uncertainty in the research literature include the number of bills received by the National People's Congress each year (Zhang et al., 2015), the appointment and removal of major government officials in the region where the corporate headquarters is located (Hou et al., 2019), the convening of party congresses of the provincial party committees (Yu and Liang, 2019) and the U.S. macroeconomic policy uncertainty index (Hou et al., 2019). As well-known entrepreneurs serve as deputies to the National People's Congress or local people's congresses and participate in policy proposals, the number of proposals received by the National People's Congress each year (Zhang et al., 2015), the appointment and removal of major government officials in the region where the enterprise headquarters is located (Hou et al., 2019) and the convening of provincial party congresses as instrumental variables cannot be completely resolved with the exogenous hypothesis of the random disturbance term. In the era of globalization, the economies of various countries influence each other. As global economic superpowers, trade between China and the U.S. is closely related. We use the lagged period of the U.S. macroeconomic policy uncertainty index as an instrumental variable (IV), and we use two-stage least squares (2SLS) regression to test for endogeneity. In the first column of Table 4, the F value of the relationship between the multiplication term BHAR × IV and the multiplication term BHAR × EPU is 174.515, and the F value is greater than 10, indicating that the selection of instrumental variables is appropriate.

In the second column of Table 4, the regression coefficient of variable BHAR is significantly positively correlated at the 1 % level, and the regression coefficient of the multiplication term BHAR × IV is significantly

Table 3
Main results.

| VARIABLES | (1) Full-sample firm-level clustering *NSR* | (2) Full sample industry-level clustering *NSR* | (3) Higher EPU group *NSR* | (4) Lower EPU group *NSR* |
|---|---|---|---|---|
| *BHAR* | 0.0468** | 0.0468** | 0.0077 | 0.0502** |
| | (2.4041) | (2.4434) | (0.2001) | (2.2058) |
| *BHAR × EPU* | –0.0409* | –0.0409** | | |
| | (–1.8121) | (–2.4674) | | |
| *EPU* | –0.0249 | –0.0249* | | |
| | (–1.1578) | (–1.7829) | | |
| *SIZE* | 0.0342 | 0.0342 | –0.0950 | 0.0875** |
| | (1.2202) | (1.1523) | (–1.4257) | (2.4176) |
| *SALARY* | –0.0261 | –0.0261 | –0.0239 | –0.0276 |
| | (–0.8445) | (–0.6029) | (–0.3582) | (–0.7703) |
| *GROWTH* | 0.0160 | 0.0160* | 0.0126 | 0.0304 |
| | (1.2174) | (2.0753) | (0.5444) | (1.5910) |
| *LEV* | –0.2180** | –0.2180*** | –0.0548 | –0.2340* |
| | (–2.0533) | (–3.4560) | (–0.2496) | (–1.7497) |
| *ATTENTION* | –0.0410*** | –0.0410*** | –0.0176 | –0.0564*** |
| | (–2.9700) | (–5.1041) | (–0.6161) | (–2.9366) |
| *INVEST* | 0.0010 | 0.0010 | 0.0058 | –0.0005 |
| | (0.5766) | (0.6220) | (1.4832) | (–0.2750) |
| *SHRCR* | 0.0042** | 0.0042*** | 0.0069* | 0.0010 |
| | (2.3696) | (4.6323) | (1.6819) | (0.3863) |
| *DIV* | –0.0589 | –0.0589 | –0.1180 | –0.0794 |
| | (–0.7903) | (–1.0620) | (–0.7989) | (–0.8700) |
| *MB* | –0.0001 | –0.0001 | –0.0007 | 0.0003 |
| | (–0.4846) | (–0.8789) | (–1.1621) | (0.7231) |
| *ROE* | –0.0099*** | –0.0099*** | –0.0373 | –0.0111 |
| | (–6.7763) | (–6.6783) | (–0.1485) | (–1.4391) |
| *MANAGEMENT* | –0.1350 | –0.1350** | –0.3530 | –0.2580 |
| | (–1.1307) | (–2.1330) | (–1.5189) | (–1.3565) |
| *PRICE* | 0.0005*** | 0.0005*** | 0.0008*** | 0.0003*** |
| | (7.8098) | (8.4848) | (5.7819) | (5.1301) |
| *YEAR* | Control | Control | Control | Control |
| *FIRM* | Control | — | Control | Control |
| *INDUSTRY* | — | Control | — | — |
| Constant | 0.2480 | 0.2480 | 2.9080** | –0.6990 |
| | (0.4189) | (0.7394) | (2.0201) | (–0.9060) |
| Observations | 6,207 | 6,207 | 2,437 | 3,770 |
| R-squared | 0.0790 | 0.0790 | 0.0570 | 0.1110 |

All of the regressions are estimated using ordinary least squares. The superscripts ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively. The t values are in parentheses.

negative at the 10 % level, indicating that higher the uncertainty of macroeconomic policy, the less likely the management is to reduce opportunistic insider trading. The test conclusion is robust.

*6.2.2. Variables and independent variables measurement method changes*

We perform robustness checks by changing the measure of variables. We use the China EPU index based on newspapers in Chinese Mainland and calculated by Davis et al. (2019) to replace the Baker index, and we measure the insider opportunistic stock trading by using the buy-and-hold stock return 125 days after the insider sells the stock.

In the first and second columns of Table 5, the regression coefficients of the independent variable BHAR are 0.0502 and 0.0429, which are significantly positive at the 5 % and 1 % levels. The regression coefficients of the multiplication term BHAR × EPU are –0.0882 and –0.0432, which is a significantly negative correlation at the 10 % level, indicating that macroeconomic policy uncertainty can constrain management's opportunistic selling of stocks, and the robustness test conclusion is consistent with the above.

Table 4
2SLS results.

| VARIABLES | (1)<br>The first stage of 2SLS<br>*BHAR* × *EPU* | (2)<br>The second stage of 2SLS<br>*NSR* (180 days after trade) |
|---|---|---|
| *BHAR* | 0.1202*** | 0.0380*** |
| | (16.0200) | (2.9029) |
| *BHAR* × *IV* | –1.3624*** | –0.1290* |
| | (–22.2400) | (–1.9298) |
| *IV* | 0.1859** | –0.0185 |
| | (2.2200) | (–1.4119) |
| *SIZE* | –0.0121 | –0.0132 |
| | (–1.6300) | (–1.2014) |
| *SALARY* | 0.0362*** | 0.0152 |
| | (3.9300) | (1.0941) |
| *GROWTH* | 0.0249*** | 0.0179 |
| | (3.0900) | (1.4643) |
| *LEV* | 0.0076 | –0.2020*** |
| | (0.2100) | (–3.8166) |
| *ATTENTION* | –0.0113* | –0.0504*** |
| | (–1.7000) | (–5.0772) |
| *INVEST* | –0.0015** | –0.0003 |
| | (–1.9600) | (–0.2783) |
| *SHRCR* | 0.0006 | 0.0001 |
| | (1.5600) | (0.2333) |
| *DIV* | –0.0121 | –0.0618 |
| | (–0.3600) | (–1.2524) |
| *MB* | –0.0001 | 0.0004* |
| | (–0.4600) | (1.8118) |
| *ROE* | 0.0012 | –0.0080 |
| | (0.2300) | (–1.0476) |
| *MANAGEMENT* | –0.0590*** | 0.1210*** |
| | (–2.020) | (2.7670) |
| *PRICE* | 0.0000 | 0.0018*** |
| | (0.3800) | (17.1000) |
| *YEAR* | Control | Control |
| *FIRM* | Control | Control |
| Constant | –0.1710 | 0.6300*** |
| | (–1.0400) | (2.5868) |
| Observations | 6,207 | 6,207 |
| R-squared | 0.0913 | 0.0960 |

The superscripts ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively. The *t*-values are in brackets for the first stage of 2SLS, and the z-values are in brackets for the second stage of 2SLS.

### *6.2.3. Exclude research samples in special periods*

The 2008 U.S. subprime mortgage crisis had a serious impact on Chinese finance, prompting opportunistic insiders to sell stocks. We remove the research samples in the special period in 2008 and use the fixed effect model to perform our tests. In the third column of Table 5, the robustness test results excluding the research samples in special periods are essentially consistent with the main regression, indicating that the conclusions of this study are relatively robust.

### *6.2.4. Exogenous event impact*

After the 18th NCCPC, China innovated its social governance system and comprehensively enhanced its reforms. Currently, it is in a critical period of transforming its development mode, optimizing its economic structure and transforming its growth drivers. China's structural, institutional and cyclical issues are intertwined. Accordingly, the impact of the "three-phase superposition" continues to pick up strength, and it is

necessary to further intensify the reform of the economic system. Since the 18th NCCPC, the level of certainty of China's macroeconomic policies has increased. We divide the sample into two stages (i.e., before and after the 18th NCCPC) and conduct regression tests. The test results are shown in Table 5.

In the fourth column of Table 5, the stock return rate increases significantly after 6 months of insiders selling stocks before the 18th NCCPC. In the fifth column of Table 5, the influence of insiders selling stocks on the stock return rate after the 18th NCCPC is not significant. After the 18th NCCPC, the uncertainty of macroeconomic policy has an obvious restricting effect on the opportunistic behavior of insiders selling shares, and our research conclusions are consistent.

## 7. Additional tests

### *7.1. Channel inspection*

Chinese economy is still transitioning to a market economy, and enterprises' operating decisions are relatively dependent on government policies, making enterprises more sensitive to economic policy fluctuations than they would be otherwise (Rao et al., 2017a,b). As the government formulates macroeconomic policies based on its research on and judgment of the international situation and environment, there are also volatility risks in the external business environment. As the recipients of economic policies, it is difficult for enterprises to timely and accurately determine either when economic policies will change or the direction and consequences of those changes, putting them at economic risk (Bloom et al., 2007). Enterprises improve and strengthen corporate governance, which is an important strategy to deal with the uncertain impact of the external operating environment. One important mechanism for the inhibitory effect of macroeconomic policy uncertainty on management's opportunistic stock sales is the improvement of internal governance.

To verify the channel inspection of macroeconomic policy uncertainty on corporate internal governance, we select seven indicators based on supervision, incentives and decision-making, and we use principal component analysis to construct comprehensive indicators to measure the corporate internal governance indicator. We use executive compensation (Mana_Pay) and the executive shareholding ratio (Mana_Share) to represent the incentive mechanism in corporate governance, and we use the ratio of independent directors (Outratio) and board size (Board) to represent the supervisory role of the board of directors and institutional shareholding. Proportion (Inst_Share) and shareholding balance (Share_Balance) (the sum of the shareholding ratio of the second to fifth largest shareholders/the shareholding ratio of the controlling shareholder) are used to represent the supervisory role of the shareholding structure, and whether the chairman and the general manager are the same person (Dual) is used to express the decision-making power of the general manager. To facilitate the coefficient interpretation of the empirical results, we multiply the internal corporate governance indicator by –1 to obtain the variable corporate governance level (Governance). The larger the value of Governance is, the lower the level of corporate governance is.

In the first column of Table 6, the regression coefficient of the variable EPU is –0.0306, which is significant and negative at the 1 % level, indicating that higher the degree of uncertainty of macroeconomic policies, the more significant the effect that enterprises improve the level of internal governance. The effect of the level of internal governance is relatively obvious. In the second column, the regression coefficient of the variable GOVERMENT is 0.0307, which is significant and positive at the 5 % level, and the regression coefficient of the cross-term BHAR × GOVERMENT is 0.0389, which is significant and positive at the 1 % level, indicating that the lower the internal governance level, the greater the probability that insiders will sell their stock and the more likely they will be to opportunistically sell their stock. The uncertainty of macroeconomic policies promotes improved corporate internal governance, which is an important channel inspection to restrain management from opportunistically selling its stock.

### *7.2. Cross-sectional tests*

The effect of macroeconomic policy uncertainty on insiders' opportunistic stock sales is mainly reflected in the fact that macroeconomic policy uncertainty promotes the company's internal governance level. Shareholding structure and governance are the core elements of companies' internal governance. We conduct a cross-

Table 5
Robustness results.

| VARIABLES | (1)<br>NSR<br>(Mainland-paper_EPU) | (2)<br>NSR<br>(125 days after trade) | (3)<br>NSR<br>(Exclude the 2008 sample) | (4)<br>NSR (before)<br>(180 days after trade) | (5)<br>NSR (after) |
|---|---|---|---|---|---|
| *BHAR* | 0.0502** | 0.0429*** | 0.1060** | 0.0594** | 0.0113 |
| | (2.5571) | (3.6136) | (1.9944) | (2.4266) | (0.5979) |
| *BHAR × EPU* | –0.0882* | –0.0432* | –0.0306* | — | — |
| | (–1.8428) | (–1.7712) | (–1.6645) | — | — |
| *EPU* | –0.00591 | –0.0321*** | –0.0378* | — | — |
| | (–0.1664) | (–4.2338) | (–1.7196) | — | — |
| *SIZE* | 0.0391 | 0.0110 | 0.0428 | 0.0423 | 0.0348 |
| | (1.4163) | (0.4733) | (1.4812) | (0.8512) | (0.5495) |
| *SALARY* | –0.0354 | –0.0219 | –0.0121 | 0.0095 | 0.0225 |
| | (–1.1495) | (–0.4877) | (–0.3851) | (0.2551) | (0.3610) |
| *GROWTH* | 0.0142 | 0.0157* | 0.0144 | 0.0533** | 0.0085 |
| | (1.0865) | (1.9097) | (1.0879) | (2.6511) | (0.7137) |
| *LEV* | –0.1870* | –0.2730*** | –0.2220** | –0.1660 | –0.2570** |
| | (–1.7901) | (–3.9031) | (–2.0872) | (–0.7744) | (–2.5918) |
| *ATTENTION* | –0.0490*** | –0.0265** | –0.0381*** | –0.0498** | –0.0525*** |
| | (–3.5892) | (–2.4368) | (–2.7239) | (–2.5185) | (–4.7995) |
| *INVEST* | 0.0006 | 0.0009 | 0.0015 | –0.0012 | 0.0046*** |
| | (0.3510) | (0.4869) | (0.8570) | (–0.4778) | (4.1101) |
| *SHRCR* | 0.0041** | 0.0050*** | 0.0045** | 0.0076** | 0.0062*** |
| | (2.3061) | (6.4194) | (2.4299) | (2.3949) | (3.0021) |
| *DIV* | –0.1060 | –0.0339 | –0.0288 | 0.0327 | –0.0990* |
| | (–1.4246) | (–0.6042) | (–0.3928) | (0.3977) | (–1.9188) |
| *MB* | –8.92e–05 | –0.0003* | –5.91e–05 | 0.0004 | 3.35e–05 |
| | (–0.3494) | (–1.9901) | (–0.2222) | (1.0474) | (0.1818) |
| *ROE* | –0.0099*** | –0.0107*** | –0.0151*** | –0.0096*** | –0.0342** |
| | (–6.7052) | (–10.6970) | (–11.2052) | (–14.9590) | (–2.1328) |
| *MANAGEMENT* | –0.1510 | –0.0600 | –0.1100 | –0.2220** | –0.0990 |
| | (–1.2914) | (–1.0523) | (–0.9086) | (–2.3288) | (–0.7713) |
| *PRICE* | 0.0018*** | 0.0004*** | 0.0004*** | 0.0003*** | 0.0007*** |
| | (14.0959) | (9.3499) | (7.6347) | (9.3047) | (11.6517) |
| *YEAR* | Control | Control | Control | Control | Control |
| *FIRM* | Control | Control | Control | Control | Control |
| Constant | 0.1290 | 0.7160** | –0.1190 | –0.6000 | –0.6570 |
| | (0.2236) | (2.5729) | (–0.1982) | (–0.4487) | (–1.1125) |
| Observations | 6,207 | 6,207 | 5,962 | 1,965 | 4,242 |
| R-squared | 0.1020 | 0.0330 | 0.0800 | 0.0560 | 0.1060 |
| DIFF | — | — | — | P-value = 0.0086 | |

All of the regressions are estimated using ordinary least squares. The superscripts ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively. The t values are in parentheses.

Table 6
Channel inspection.

| VARIABLES | (11)<br>GOVERMENT | (12)<br>*NSR* |
|---|---|---|
| *BHAR* | — | 0.0428*** |
| | — | (3.2447) |
| *BHAR × GOVERMENT* | — | 0.0389*** |
| | — | (4.6258) |
| *EPU* | –0.0306*** | –0.0133 |
| | (–3.4992) | (–1.0568) |
| *GOVERMENT* | — | 0.0307** |
| | — | (2.3624) |
| *SIZE* | –0.0340 | –0.0067 |
| | (–1.6498) | (–0.5362) |
| *SALARY* | –0.1120*** | 0.0075 |
| | (–10.0342) | (0.5204) |
| *GROWTH* | –0.0087 | 0.0085 |
| | (–1.0173) | (0.6110) |
| *LEV* | –0.1320* | –0.1650*** |
| | (–1.8806) | (–2.8836) |
| *ATTENTION* | –0.0287*** | –0.0508*** |
| | (–4.4252) | (–5.1482) |
| *INVEST* | –0.0155*** | –0.0003 |
| | (–17.7362) | (–0.2832) |
| *SHRCR* | –0.0089*** | 0.0003 |
| | (–8.7454) | (0.5316) |
| *DIV* | 0.0929** | –0.0587 |
| | (2.1942) | (–1.1006) |
| *MB* | –2.07e–05 | 0.0002 |
| | (–0.1782) | (1.0642) |
| *ROE* | –0.0233 | –0.1660*** |
| | (–0.4762) | (–2.8453) |
| *MANAGEMENT* | 1.7810*** | –0.0269 |
| | (30.0722) | (–0.4743) |
| *PRICE* | –0.0003** | 0.0018*** |
| | (–2.4187) | (20.7669) |
| *YEAR* | Control | Control |
| *FIRM* | Control | Control |
| Constant | 2.8240*** | 0.4950* |
| | (6.6329) | (1.8343) |
| Observations | 6,207 | 6,207 |
| R-squared | 0.2520 | 0.1280 |

All of the regressions are estimated using ordinary least squares. The superscripts ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively. The t values are in parentheses.

sectional test of the companies' internal governance characteristics from the perspectives of equity incentives, shareholder behavior and equity supervision.

*7.2.1. The incentive effect of equity: The perspective of management's shareholding*

Management shareholding provides an incentive method of alleviating the agency problem between management and control. The scale of management's shareholding represents its ownership in the enterprise. The greater the ownership, the lower the management's agency cost. Opportunistic stock sales by insiders reveal the private benefits of management. When managers have a higher shareholding ratio, they have greater ownership of the company as shareholders than when they have a lower shareholder ratio. The higher the degree of management ownership, the higher the degree of alignment between management and the goals of major

shareholders, decreasing management's incentive to behave opportunistically. We select the shares held by management as a proportion of the total share capital of the companies that implement equity incentives to measure the degree of those companies' equity incentives (Ma and Fan, 2021). To do so, we use the mean of the management shareholding ratio in the current period by industry and year divided into higher and lower groups for testing.

The results are presented in Table 7, in which the two columns identify the impact of management ownership, macroeconomic policy uncertainty and insiders' opportunistic stock sales. In the first column of Table 7, the regression coefficient of the variable BHAR and the regression coefficient of the multiplication term BHAR × EPU is insignificant statistically. In the second column of Table 6, the regression coefficient of the variable BHAR is 0.0608, which is statistically significant at the 1 % level. The regression coefficient of

Table 7
A cross-sectional test of management's shareholding.

| | (1) | (2) |
|---|---|---|
| VARIABLES | Higher management shareholding | Lower management shareholding |
| | *NSR* | *NSR* |
| *BHAR* | 0.0323 | 0.0608*** |
| | (1.5206) | (3.1987) |
| *BHAR × EPU* | –0.0573 | –0.0585*** |
| | (–1.7205) | (–3.0648) |
| *EPU* | –0.0457* | –0.0126 |
| | (–2.1054) | (–0.5048) |
| *SIZE* | 0.0223 | 0.0703 |
| | (1.0371) | (1.7231) |
| *SALARY* | 0.0062 | –0.0200 |
| | (0.2765) | (–0.2887) |
| *GROWTH* | 0.0220* | –0.0010 |
| | (2.0239) | (–0.0909) |
| *LEV* | –0.1900 | –0.0873 |
| | (–1.3362) | (–1.5318) |
| *ATTENTION* | –0.0370*** | –0.0480*** |
| | (–3.3712) | (–3.0336) |
| *INVEST* | 0.0047 | 0.0014 |
| | (1.6179) | (0.5218) |
| *SHRCR* | 0.0059* | 0.0031** |
| | (2.0904) | (2.3279) |
| *DIV* | 0.0499 | –0.1650** |
| | (0.5480) | (–2.4531) |
| *MB* | –0.0004** | 0.0003 |
| | (–2.3826) | (1.2995) |
| *ROE* | –0.1000 | –0.0080*** |
| | (–0.8147) | (–7.7800) |
| *PRRICE* | 0.0005*** | 0.0004*** |
| | (6.3509) | (8.1398) |
| *YEAR* | Control | Control |
| *FIRM* | Control | Control |
| Constant | 0.0505 | –0.7550 |
| | (0.1200) | (–1.1342) |
| Observations | 3,186 | 3,021 |
| R-squared | 0.1140 | 0.0580 |

All of the regressions are estimated using ordinary least squares. The superscripts ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively. The t values are in parentheses.

the multiplication term BHAR × EPU is –0.0585, which is significant and negative at the 1 % level, indicating that the lower the shareholding ratio of managers, the more significant the management/control agency problem. The greater the information asymmetry between shareholders and management, the higher the likelihood that management will engage in opportunistic stock sales to defraud the company of cash. As the uncertainty level of macroeconomic policies rises, companies retain their cash flow as a precautionary measure (Yu et al., 2019). To prevent cash flow from being hollowed out by management's opportunistic behavior, companies strengthen internal governance and improve the supervision mechanism. To decrease the risk of punishment, management actively reduces its opportunistic behavior.

*7.2.2. The effect of shareholder behavior: Pledge of stock right*

Pledge of stock right provide a means of refinancing the company. When the company needs cash flow, shareholders pledge their stock to obtain bank loans, which are prone to forced liquidation due to the impact of the stock's market value. In this case, shareholders are particularly sensitive to stock prices. The company is more vulnerable to stock price fluctuations when equity is pledged than when the stock is not pledged. Pledge of stock right is a kind of negative news. It indicates that shareholding managers have more private information than and a high degree of information asymmetry with external investors, providing them with motivation greater than that of the external investors to maximize their own benefits by opportunistically selling their stock. Pledge of stock right has an effect on the relationship between macroeconomic policy uncertainty and insiders' opportunistic stock sales.

To research the impact of pledge of stock right on macroeconomic policy uncertainty and insiders' opportunistic stock sales, we divide our research sample into two parts: one part has a higher proportion of pledge of stock right and the other part has a lower proportion of pledge of stock right. In the first column of Table 8, the regression coefficient of the variable BHAR is 0.0677, which is significantly and positively correlated at the 5 % levels, indicating that compared with companies without pledge of stock right, the level of cash flow after pledge of stock right decreases and market returns decline (Jonathan and Andrew, 2015), increasing the risk of stock price volatility (Baker et al., 2016), and management has a greater incentive to opportunistically sell stock. The multiplier item BHAR × EPU is a significantly negative correlation at the 1 % level, indicating that the effect of macroeconomic policy uncertainty on insiders' opportunistic stock sales is more obvious under the condition of pledge of stock right. In the second column of Table 8, the variable BHAR regression coefficient is not significant, and the regression coefficient of the multiplier item BHAR × EPU is insignificant, indicating that companies that have not implemented pledge of stock right have less stock price volatility, and insiders are less motivated to sell shareholdings opportunistically.

*7.2.3. The effect of shareholding supervision: The perspective of state-owned shareholding*

State-owned shares represent government capital's participation in corporate governance. The higher the proportion of state-owned shares, the greater the dominance of corporate governance. Due to the government's supervision and performance appraisal of the management of state-owned enterprises, management is less motivated to sell stocks in an opportunistic manner. State-owned shares reflect state ownership in non-state-owned enterprises, promote the diversification of the ownership structure of non-state-owned enterprises, realize the complementary advantages of state-owned shares and non-state-owned shares and help repair enterprises' original internal governance defects.

To study the influence of the heterogeneity of ownership supervision on the effect of macroeconomic policy uncertainty on the opportunistic insider trading, we test the influence of the heterogeneity of property rights, dividing our research sample into a state-owned shareholding group and a state-owned shareholding non-shareholding group.

The results in Table 9 show the effect of state shareholder governance on the relationship between macroeconomic policy uncertainty and insiders' opportunistic stock sales. In the first column, the regression coefficient of the variable BHAR is insignificant correlation, and the regression coefficient of the multiplication term BHAR × EPU is insignificant correlation. State-owned shareholding in non-state-owned enterprises strengthens the governance of equity diversification and increases the level of enterprises' internal governance. The government's assessment and supervision of state-owned shareholding capital also indirectly promotes improvement of enterprises' internal governance and effectively restrains management from engaging in

opportunistic behavior. To further verify the test results in the first column of Table 9, we divide our sample of the state-owned shareholding group into a group with a higher shareholding ratio of state-owned shares and a group with a lower shareholding ratio of state-owned shares based on the annual-industry average of the shareholding ratio of state-owned shares. In the second column, the variable BHAR is significantly and negatively correlated with the variable NSR at the 5 % level. In the third column, there is no correlation between the variable BHAR and the variable NSR, further verifying that the higher the shareholding ratio of state-owned shares, the less incentive there is for the managers of non-state-owned enterprises to opportunistically sell their stock. In the fourth column, the coeffifficients on BHAR is significant and positive at the 1 % level, indicating that the lower the supervision level accepted by non-state-owned enterprises with no state-owned shares, the higher the incentive for managers to opportunistically sell their stock. The multiplication term BHAR × EPU is a significantly negative correlation at the 5 % level, indicating that macroeconomic policy uncertainty has improved the governance level of non-state-owned enterprises and restrained managers from hollowing out their enterprises, helping to reduce managers' motivation to engage in opportunistic behavior.

Table 8
A cross-sectional test of equity pledges.

| | (1) | (2) |
|---|---|---|
| VARIABLES | Higher proportion of pledge of stock right *NSR* | Lower proportion of pledge of stock right *NSR* |
| *BHAR* | 0.0677** | 0.0294 |
| | (2.3851) | (1.3656) |
| *BHAR × EPU* | –0.0578* | –0.0381 |
| | (–2.0371) | (–1.0876) |
| *EPU* | 0.0145 | 0.0213 |
| | (0.5050) | (1.0513) |
| *SIZE* | 0.0069 | 0.0539 |
| | (0.0947) | (1.6878) |
| *SALARY* | –0.0022 | –0.0384 |
| | (–0.0432) | (–1.0373) |
| *GROWTH* | 0.0323 | –0.0084 |
| | (1.5555) | (–0.4092) |
| *LEV* | –0.1620 | –0.3530*** |
| | (–1.4864) | (–3.2534) |
| *ATTENTION* | –0.0637*** | –0.0309* |
| | (–3.3809) | (–1.7625) |
| *INVEST* | –0.0003 | 0.0017 |
| | (–0.1570) | (0.7001) |
| *SHRCR* | 0.0046*** | 0.0092*** |
| | (2.9668) | (5.0073) |
| *DIV* | –0.1930 | 0.0312 |
| | (–1.6603) | (0.8843) |
| *MB* | –0.0005* | –7.82e–05 |
| | (–1.8412) | (–0.3654) |
| *ROE* | –0.0799 | –0.0509*** |
| | (–1.1343) | (–3.3636) |
| *MANAGEMENT* | –0.1070 | –0.2790** |
| | (–1.2313) | (–2.8877) |
| *PRRICE* | 0.0021*** | 0.0016*** |
| | (11.2780) | (9.5271) |
| *YEAR* | Control | Control |
| *FIRM* | Control | Control |
| Constant | 0.3030 | –0.3020 |
| | (0.3005) | (–0.3655) |
| Observations | 2,916 | 3,291 |
| R-squared | 0.1060 | 0.1090 |

All of the regressions are estimated by ordinary least squares. The superscripts ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively. The t values are in parentheses.

## 8. Conclusion

Since the split share structure reform in 2005, "majority non-tradable shares" and "minority non-tradable shares" have become hot topics in academia and practice. It is very important to study the impact of the macroeconomic policy environment on stock market trading behavior. We use the data of Chinese A-share listed companies' holdings reduction from 2007 to 2018 as our research sample to study the effect of macroeconomic policy uncertainty on opportunistic insider trading. The results show that macroeconomic policy uncertainty improves companies' internal governance, alleviates the agency problem and effectively inhibits opportunistic insider trading. After considering the endogeneity problem and conducting robustness tests, such as considering the stock return rate 125 days after insider trading, the special period of the 2008 financial crisis and the impact of the events of the 18th NCCPC, our research conclusions is robustness. Equity gover-

Table 9
A cross-sectional test of state-owned shareholding.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *VARIABLES* | State-owned shares *NSR* | Higher proportion of state-owned shares *NSR* | Lower proportion of state-owned shares *NSR* | Non-state-owned shares *NSR* |
| *BHAR* | –0.0145 | –0.2130** | 0.0317 | 0.0609*** |
| | (–0.3365) | (–2.0313) | (0.6468) | (4.2994) |
| *BHAR × EPU* | 0.0003 | –0.0709 | 0.0208 | –0.0344** |
| | (0.0054) | (–0.5477) | (0.2995) | (–2.7353) |
| *EPU* | 0.00184 | 0.2960*** | –0.0206 | –0.0291 |
| | (0.0278) | (4.2741) | (–0.2363) | (–1.5630) |
| *SIZE* | –0.00915 | –0.0199 | 0.1260 | 0.0153 |
| | (–0.2577) | (–0.1804) | (1.0722) | (0.4311) |
| *SALARY* | 0.0649 | 0.0304 | –0.0240 | –0.0113 |
| | (0.9169) | (0.1823) | (–0.2157) | (–0.4289) |
| *GROWTH* | 0.0299** | 0.0478 | 0.0136 | 0.0121 |
| | (2.6638) | (0.8075) | (0.3836) | (0.8991) |
| *LEV* | 0.0491 | 0.0475 | –0.1760 | –0.289** |
| | (0.2107) | (0.0882) | (–0.5344) | (–2.6464) |
| *ATTENTION* | –0.0764*** | –0.1960** | –0.0272 | –0.0423*** |
| | (–2.9497) | (–2.3796) | (–0.4698) | (–5.0868) |
| *INVEST* | 0.0038 | 0.0078 | 0.0102** | 0.0011 |
| | (1.0201) | (0.9829) | (2.0819) | (0.5825) |
| *SHRCR* | 0.0043 | 0.0163** | 0.0038 | 0.0053*** |
| | (1.2231) | (2.1301) | (0.4692) | (4.0636) |
| *DIV* | –0.0288 | –0.0931 | –0.2140 | –0.0993* |
| | (–0.1069) | (–0.3771) | (–0.6063) | (–1.9865) |
| *MB* | –3.76e–05 | –0.0154 | 0.0106 | –0.0004** |
| | (–0.0494) | (–1.3054) | (1.0719) | (–2.4634) |
| *ROE* | –0.3350 | –0.8500*** | 0.00147 | –0.0191*** |
| | (–1.2453) | (–3.4704) | (0.0058) | (–22.9277) |
| *MANAGEMENT* | –0.6280 | –1.3640 | 0.2360 | –0.2440*** |
| | (–1.4699) | (–0.4049) | (0.3569) | (–2.9421) |
| *PRRICE* | 0.0003*** | 0.0020*** | 0.0021*** | 0.0005*** |
| | (4.5123) | (3.1367) | (3.3942) | (7.8638) |
| *YEAR* | Control | Control | Control | Control |
| *FIRM* | Control | Control | Control | Control |
| Constant | –0.2310 | –0.2940 | –2.1280 | 0.5100 |
| | (–0.1856) | (–0.0975) | (–1.1899) | (0.8684) |
| Observations | 1,195 | 498 | 697 | 5,012 |
| R-squared | 0.0870 | 0.221 | 0.139 | 0.0920 |

All of the regressions are estimated using ordinary least squares. The superscripts ***, ** and * indicate two-tailed statistical significance at the 1%, 5% and 10% levels, respectively. The t values are in parentheses.

nance is the core of internal governance. Further study shows that when equity incentives, pledge of stock right and equity supervision is weak, the effect of macroeconomic policy uncertainty on opportunistic insider trading is more prominent. These results show that the worse the effect of equity governance is, the more significant the effect of macroeconomic policy uncertainty is on the improvement of internal governance.

Enterprises are vital to the market economy. In the process of promoting the reform of the modern socialist market economy, the impact of the macroeconomic policy environment on the microeconomy is a topic worth pondering. Based on the above research, we arrive at the following conclusions. First, the uncertainty of macroeconomic policy is apparent, and in essence it can encourage and guide enterprises to improve their governance and realize the advantageous effect of "alleviating the agency problem." Second, the effectiveness of macroeconomic policy uncertainty in improving enterprise internal governance highlights that Chinese companies' equity governance needs further improvement. Third, taking advantage of information asymmetry, directors, supervisors and managers engage in opportunistic stock trading behavior, primarily because Chinese companies' equity governance is imperfect. To alleviate management's opportunistic behavior, we should fully resolve the problem of the effectiveness of equity governance. Fourth, the external policy environment encourages companies to truly and effectively improve their internal governance, which is an important measure to protect investors' interests and stabilize stock prices, further promoting a fair, just and effective market.

Our study is subject to the limitation that we cannot study the dynamic effects of macroeconomic policy uncertainty. We failed to observe the long-term opportunistic behavior decision of the company's management on the uncertainty of macroeconomic policies. There is little evidence in the literature on opportunistic insider trading, which makes it impossible for us to make a broad statement on the universality of our research results. More research is needed on how to map the macro environment into the company's equity trading decisions.

## References


Atanassov, J., Julio, B., Leng, T., 2015. The Bright Side of Political Uncertainty: The Case of R&D. SSRN Working Paper.

Baker, S.R., Bloom, N., Davis, S.J., 2016. Measuring economic policy uncertainty. Quart. J. Econ. 131 (4), 1593–1636.

Baum, C.F., Caglayan, M., Ozkan, N., Talavera, O., 2006. The Impact of macroeconomic uncertainty on non-financial firms' demand for liquidity. Rev. Finan. Econ. 15 (4), 289–304.

Beaudry, P., Caglayan, M., Schiantarelli, F., 2001. Monetary instability, the predictability of price, and the allocation of investment:an empirical investigation using UK panel data. Am. Econ. Rev. 91 (3), 648–662.

Bloom, N., Van Reenen, J., Bond, S., 2007. Uncertainty amd investment dynamics. Rev. Econ. Stud. 74 (2), 391–415.

Bradley, D., Pantzalis, C., Yuan, X., 2016. Policy risk, corporate political strategies, and the cost of debt. J. Corporate Finan. 40 (c), 254–275.

Cao, Y., Dong, H.L., Cu, W.H., Lu, Y., 2019. The impact of economic policy uncertainty on corporate tax avoidance behavior. Secur. Market. Hera. 4, 22–32, in Chinese.

Chen, Z.H., 2015. The relationship between internal control quality and insider rent extraction based on the perspective of insider trading. Secur. Market. Hera. 5, 25–32 (in Chinese).

Chen, Z.H., Fang, H.X., 2019. Can Internal Control Fasten the Fence of opportunistic insider sales. China. Acc. Res. 7, 82–89, in Chinese.

Chen, F., Hope, O.K., Li, Q., Wang, X., 2018. Flight to Quality in International Markets: Investors' Demand for Financial Reporting Quality during Political Uncertainty Events. Contemp. Acc. Res. 35 (1), 117–155.

Chen, Z.H., Wen, L., 2016. Internal Control and Market Reaction to Insider Relatives Sale Trading Behavior—Empirical Evidence from Shenzhen Listed Companies. Collected. Essays. Finan. Econ. 10, 76–84, in Chinese.

Cohen, L., Malloy, C., Pomorski, L., 2012. Decoding Inside Information. SSRN Working Paper.

Davis, S.J., Liu, D., Sheng, X.S., 2019. China policy uncertainty indices based on mainland papers. Economic Policy Uncertainty.

Deng, X.M., 2019. Uncertainty of Economic Policy and Stock Return. Shanghai Finan. 11, 50–54, in Chinese.

Dittmar, A., Mahrt-Smith, J., Servaes, H., 2003. International corporate governance and corporate cash holdings. J. Financ. Quant. Anal. 38 (1), 111–134.

Drobetz, W., El Ghoul, S., Guedhami, O., et al., 2018. Policy uncertainty, investment, and the cost of capital. J. Finan. Stab. 39 (c), 28–45.

Gilchrist, S., Sim,J., Zakrajšek, E., 2014. Uncertainty, financial frictions, and investment dynamics. SSRN Working Paper.

Grahama, J.R., Campbell, R.H., 2021. The theory and practice of corporate finance: evidence from the field. J. Financ. Econ. 60 (2–3), 187–243.

Gu, X.M., Chen, Y.M., Pan, S.Y., 2018. Economic policy uncertainty and innovation: evidence from listed companies in China. Econ. Res. Jour. 2, 109–123, in Chinese.

Gulen, H., Ion, M., 2016. Policy uncertainty andy corporate investment. Rev. Finan. Stud. 29 (3), 523–564.

Han, L.Y., Liu, B.Y., 2011. Corporate Governance Uncertainty and Cash Value. China. Econo. Quar. 18 (3), 987–1008, in Chinese.

Hou, D.S., Dong, M.R., Zhao, Y.F., 2019. Macroeconomic Policy Uncertainty and Related Party Transaction Behaviors of Enterprises. J. Finan. Econ. 45 (12), 99–110, in Chinese.
Huang, S., Wessels, R., 1988. The determinants of capitals structure choice. J. Finan. 43 (1), 1–19.
Huddart, S.J., Ke, B., 2010. Information asymmetry and cross-sectional variation in insider trading. Contemp. Acc. Res. 24 (1), 195–232.
Jin, L., Myers, C.S., 2006. R2 around the world: New theory and new tests. J. Financ. Econ. 79 (2), 257–292.
Jonathan, B., Andrew, D., 2015. The Asset-Pricing Implications of Government Economic Policy Uncertainty. Manage. Sci. 61 (1), 3–18.
Julio, B., Yook, Y., 2012. Political Uncertainty and corporate investment cycles. J. Finance. 67 (1), 45–83.
Kallunkia, J., Kallunkiabc, J.-P., Nilssonc, H., Puhakkaa, M., 2018. Do an insider's wealth and income matter in the decision to engage in insider trading? J. Financ. Econ. 130 (1), 135–165.
Kyriacou, K., Kul, B.L., Bryan, M., 2008. Private Information in Executive Stock Opt-ion Trades: Evidence of Insider Trading in the UK. Economica. 77 (308), 1–24.
Lambert, R., Leuz, C., Verrecchia, R.E., 2007. Accounting Information, Disclosure, and the Cost of Capital. J. Acc. Res. 45 (2), 385–420.
Lei, L.K., Yu, J., Wei, Y., Lai, X.D., 2018. Forecasting volatility of Chinese stock market with economic policy uncertainty. J Manage. Sci. 2018 (06), 88–98, in Chinese.
Leland, H.E., Pyle, D.H., 1977. Informational asymmetries, financial structure, and financial intermediation. J. Finance 32 (2), 1–17.
Li, C.L., Lin, D.J., 2019. Economic Policy Uncertainty and Stock Price Crash Risk. Quart. J. Finan. 4, 253–283, in Chinese.
Li, F.Y., Shi, Y.D., 2016. Economic policy uncertainty and corporate cash holding strategy: Empirical research by using China economic policy uncertainty index. J. Manage. Sci. 19 (6), 157–170 (in Chinese).
Li, F.Y., Yang, M.Z., 2015. Can economic policy uncertainty influence corporate investment?the empirical rsearch by using china economic policy uncertainty index. J. Finan. Res. 4, 115–129, in Chinese.
Li, L., Zhang, D.L., 2019. Economic policy uncertainty, executives'government working experiences and the informativeness of insider trading. J. Shanxi Univ. Finan. Econ. 7, 93–107, in Chinese.
Liang, Q.X., Xie, H.J., 2019. Does Policy Uncertainty Undermine the Long-term Economic Growth of China? Evidence from Corporate Innovation Behavior. J. Central Univ. Finan. Econ. 7, 79–92, in Chinese.
Liu, Y.B., Han, L.Y., 2010. Corporate Governance, Uncertainty and Liquidity Management. J. World Econ. 2, 114–160, in Chinese.
Luo, H., Huang, W., 2020. Research on the impact of multiple large shareholders coexistence on the opportunistic stock selling behaviors of executives. Manage. World. 8, 163–177, in Chinese.
Ma, Q.K., Fan, M.C., 2021. Management incentives, institutional investor shareholding, and corporate heterogeneous R&D investment. Sci. Res. Manage. 42 (9), 140–149, in Chinese.
Meng, Q.B., Shi, Q., 2017. The Impact of macroeconomic policy uncertainty on enterprises'R&D:theoretical analysis and empirical study. J. World Econ. 40 (9), 75–98, in Chinese.
Park, M.S., Pask, T., 2004. Insider sales and earnings management. J. Acc. Public. Policy. 23 (5), 381–411.
Piotroski, J.D., Roulstone, D.T., 2005. Do insider trades reflect both contrarian beliefs and superior knowledge about future cash flow realizations? J. Acc. Econ. 39 (1), 55–81.
Rao, P.G., Yue, H., Jiang, G.H., 2017a. Economic Policy Uncertainty and Firms' Investment. J. World Econ. 4, 21–51, in Chinese.
Rao, P.G., Yue, H., Jiang, G.H., 2017b. Economic policy uncertainty and firms' investment. J. World Econ. 40 (2), 29–53, in Chinese.
Wang, J.H., Li, Q.Y., Xing, P., 2014. Economic Policy Uncertainty, cash holdings and market value. J. Financial Res. 9, 53–68 (in Chinese).
Wang, Z.J., Wang, H., 2019. Economic Policy Uncertainty, scope of strategic change and firm's overcapital operation. Modern. Finan. Econ. 39 (12), 20–34, in Chinese.
Wu, W.J., Li, M.Y., 2019. The Impact of China's economic policy uncertainty on corporate debt financing costs. Contemp. Acc. Res. 11, 61–71, in Chinese.
Wu, H.Z., Liu, W.Q., 2021. Economic Policy Uncertainty and Managerial Overconfidence. Soft. Sci. 35 (9), 139–144, in Chinese.
Yang, D.X., Xu, S.Z., Wei, B.N., 2019. Economic Policy Uncertainty and Corporate Outward Foreign Direct Investment: Inhibition or Promotion? Contemp. Finan. Econ. 2, 108–119, in Chinese.
Yao, Y., Zhao, M., Feng, Y.H., 2016. The signal transmission of insiders' selling. Finan. Res. 5, 15–25 (in Chinese).
Yi, Z.G., Pan, Z.C., Mao, N., Li, X.D., 2017. Strategic Media Disclosure and Wealth Transfer: Evidence from Managers' Stock Selling. Econ. Res. J. 52 (4), 166–180, in Chinese.
Yu, J.W., Gou, K.M., Gong, L.T., 2019. Macro-policy uncertainty and corporate cash holding. China. Econo. Quar. 18 (3), 987–1008, in Chinese.
Yu, W.C., Liang, P.H., 2019. Uncertainty, Business Environment and Private Enterprises' Vitality. China Ind. Econ. 11, 136–154, in Chinese.
Yun, H., Paul, L., 2020. Measuring economic policy uncertainty in China. China Econ. Rev. 59, 1–18.
Zhang, G.L., Han, J.L., Pan, Z.Y., et al., 2015. Economic policy uncertainty and capital structure choice: Evidence from China. Econ. Syst. 39 (3), 439–457.

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# Does a national industrial policy promote financial market stability? A study based on stock price crash risk

Weimin Xie [a,1], Hengxin Zhang [b], Jialu Guo [b,*], Miao He [c]

[a] School of Accounting, China Internal Control Research Center, Dongbei University of Finance and Economics, China
[b] School of Accounting, Dongbei University of Finance and Economics, China
[c] PricewaterhouseCoopers Zhong Tian LLP, Beijing Branch, China

ARTICLE INFO

*Article history:*
Received 21 October 2021
Accepted 14 September 2022
Available online 17 October 2022

*JEL classification:*
D21
E61
G10

*Keywords:*
National industrial policy
Stock price crash risk
Financial market stability

ABSTRACT

Whether the implementation of a national industrial policy can maintain stability in the financial market is a question of theoretical and practical significance. Using data from China's non-financial listed firms from 2007 to 2020, we find that a national industrial policy lowers stock price crash risk. We find that the effect of an industrial policy on lowering stock price crash risk is more pronounced in regions with low levels of regional marketization and if firms have high external uncertainty, low total asset turnover, greater earnings management and receive small increments of long-term loans and fewer government subsidies, suggesting that industrial policies lower stock price crash risk by improving firm fundamentals and reducing external uncertainty, agency costs and information asymmetry.


## 1. Introduction

There are obvious theoretical and practical reasons for maintaining stability in the financial market to enable the financial system to better serve the real economy and achieve sustained and stable economic growth. On 22 February2019, at the 13th collective study of the Political Bureau of the Central Committee

* Corresponding author.
*E-mail address:* 15663423157@163.com (J. Guo).
[1] Weimin Xie acknowledges the financial support of the Key Construction Discipline Project of the Liaoning Provincial Social Science Planning Foundation (L21ZD040).

https://doi.org/10.1016/j.cjar.2022.100269
1755-3091/

of the Communist Party of China (CCP), the general secretary stressed that "preventing and resolving financial risks, especially systemic financial risks, is the fundamental task of financial work".[2]The report of the 19th National Congress of the CCP also states "we should improve the financial supervision system and keep the bottom line against systemic financial risk".[3] Most studies on financial stability take the banking system as their main object of analysis, arguing that banks play a vital role in maintaining stability in the financial system (Mishkin, 1992; Padoa-Schioppa, 2003; Haldane et al., 2005). With the development of financial markets, the connotation of financial stability is no longer limited to stability in the banking system. The stable operations of the stock, futures, bonds and other markets also play a key role in financial stability (Shi et al., 2011; Peng et al., 2018). In recent years, China's financial markets have experienced several stock price crashes caused by a sharp fall in stock prices. A stock price crash not only harms the interests of shareholders but also undermines investor confidence in capital markets and endangers the healthy development of China's capital markets (Wang et al., 2015; Ye et al., 2015; Peng et al., 2018). Therefore, both policymakers and academics are concerned about reducing stock price crash risk and maintaining financial market stability.

A stock price crash refers to the phenomenon of a sudden and sharp drop in stock prices. The literature studies the factors that cause stock price crash risk from the perspective of firms and markets. Many studies discuss the efficient markets hypothesis and behavioral finance theory, yielding a wealth of research conclusions. Many scholars use the perspective of information asymmetry and agency problem to test the effect of top executives' gender(Li and Liu, 2012), stock option incentives (Kim et al., 2011; Yu et al., 2020), behavior of major shareholders (Wu and Li, 2015; Wang et al., 2015), analyst optimism (Xu et al., 2012), external audits (Callen and Fang, 2012; Chu and Fang, 2017), institutional investors (Xu et al., 2013; Ma and Tian, 2020), management tax avoidance (Jiang, 2013), convergence of international accounting standards (Defond et al., 2015), CEO overconfidence (Kim et al., 2016), religious tradition (Li and Cai, 2016), social trust (Li et al., 2017), corporate innovation strategy (Jia, 2018), managerial labor market (Chen et al.,2018) and administrative audit supervision (Wen et al., 2020) on stock price crash risk. According to the capital asset pricing model, firm fundamentals and information quality are key factors of stock price volatility and stock returns (Banz, 1981; Bhandari, 1988; Fama and French, 1992).

An industrial policy guides the upgrading of a country's industrial structure, optimizes the allocation of economic resources and promotes economic growth by formulating economic plans. Since the start of its economic reform and opening up policy in the late 1970s, China has used successive industrial policies covering almost all aspects of the national economy to achieve systematic economic growth (Chen et al., 2016). However, one question remains: Have the industrial policies pursued by China achieved their goal, and what has been the effect of their implementation? The answer to this question is related to the transformation of China's economic development mode, industrial upgrading and industrial structure adjustment and has important theoretical and practical ramifications. There is an ongoing debate about the effectiveness of industrial policies. Some studies find that industrial policies help to make up for market failures and rationalize regional industrial structures (Han et al., 2017), improve resource allocation efficiency (Lin, 2002; Song and Wang, 2013) and promote industrial development (Shu, 2013). Others find that industrial policies considerably hinder the endogenous dynamic evolution of a country's industrial structure and subsidizes upstream industries while increasing costs for downstream industries, thereby reducing their market competitiveness (Jiang and Li, 2010). From a microeconomic perspective, Chen et al. (2010) find that industrial policies help firms obtain more initial public offering(IPO) financing and refinancing opportunities, providing preliminary empirical evidence for the effect of national industrial policies on firm behavior. Follow-up studies show that industrial policies help firms obtain credit support (Zhu et al., 2015) and improve the innovation efficiency of microenterprises (Peters et al., 2012), enterprise technological innovation (Yu et al., 2016) and total factor productivity (Aghion et al., 2015). However, other studies find that industrial policies reduce investment efficiency (Li and Li, 2014; Zhu et al., 2015). Policy support only increases the quantity of innovation but not the quality (Li and Zheng, 2016).Therefore, the research findings on this topic, whether based on the macro perspective or the micro perspective, are mixed and require further in-depth exploration. Although there is a rich literature on

[2] https://www.gov.cn/xinwen/2019-02/23/content_5367953.htm.
[3] https://www.gov.cn/zhuanti/2017-10/27/content_5234876.htm.

the economic consequences of industrial policies, very few studies examine the impact of industrial policies on stock price crash risk by analyzing firm fundamentals. Deng and Zhan (2020) discuss the effect of industrial policies on stock price crash risk and argue that the implementation of national industrial policies induces a "herd effect" among investors and that they "blindly" follow investment trends, which leads to an overheating in the stock market and eventually to a stock price crash. However, they do not analyze the effect of industrial policies on stock price crash risk using firm-level elements, such as firm fundamentals, agency problems and information asymmetry. We believe that it is necessary to further examine the capital market effects of industrial policy implementation in terms of stock price crash risk.

We study the role of industrial policies on stock price volatility from the perspective of stock price crash risk, analyze the effect of industrial policies on the stability of China's financial markets and delve into the channels and mechanisms through which industrial policies affect the stability of financial markets.We examine the effect of national industrial policies on financial market stability from the perspective of stock price crash risk, using a sample of non-financial A-share listed firms in China from 2007 to 2020. We find that firms supported by national industrial policies have significantly lower stock price crash risk than those not covered by the policies, which indicates the stabilizing effect of national industrial policies on financial markets. Moreover, this relationship is more pronounced in regions with low levels of regional marketization than in regions with high levels of regional marketization. Furthermore, our results show that industrial policy implementation lowers stock price crash risk more significantly when firms have high external uncertainty, receive a small increase in long-term loans, receive fewer government subsidies and have low total asset turnover and a high level of earnings management, indicating that national industrial policies reduce stock price crash risk by reducing external uncertainty, agency costs and information asymmetry and improving firm fundamentals.

This study contributes to the literature in the following ways. First, we analyze the effect of national industrial policies on the stability of financial markets from the perspective of stock price crash risk, which enriches the theoretical understanding of the economic consequences of national industrial policies. Second, we link macroeconomic industrial policies with firm stock price crash risk and discuss the mechanism through which industrial policies affect stock price crash risk. We verify that firm fundamentals, agency problems and information asymmetry determine stock price volatility, which enriches the literature on stock price crash risk. Third, our findings have important policy implications. The financial system provides a framework that supports the development of the real economy. Therefore, financial market instability weakens the functioning of the financial system and inhibits the development of the real economy. It is important to understand how to stabilize financial markets. Our study findings provide empirical evidence to support the central government's policy stance that "we should improve the financial supervision system and keep the bottom line against systemic financial risks."Finally, our findings also have obvious practical implications for understanding the relationship between the government and the market and the role of the government during a transition period. As China's financial markets are unstable and provide insufficient support to the real economy at present, the government can control stock price crash risk and stabilize these markets through an appropriate industrial policy.

## 2. Hypothesis development

French et al. (1987) and Bekaert and Wu (2000) find that there is an "asymmetric" feature in the rise and fall of the stock market; that is, the stock market is more prone to sharp falls in stock prices than to sharp increases. Jin and Myers (2006) explain how a stock price crash occurs using information theory. Following these early studies, many studies show that stock price crash risk is due to the withholding of information by management; that is, management hides adverse internal information about the firm for private interests, such as salary incentives, job promotions and tax evasion, resulting in a lack of transparency in firm information. When the hidden adverse information exceeds a certain threshold, it is released all at once on the stock market, causing a sharp decline in stock prices (Jin and Myers, 2006; Hutton et al., 2009; Kim et al., 2011; Piotroski and Wong, 2012). However, the above studies ignore the important role of firm intrinsic value on stock price volatility. Banz (1981), Bhandari (1988) and Fama and French (1992) point out that firm fundamentals are key factors of stock price volatility and stock returns. The deterioration of firm intrinsic value increases the risk of a leftward deviation of stock prices, which is the internal cause of a stock price crash (Konchitchki et al., 2016). Managers

conceal bad news because of opportunistic motives, thus aggravating information asymmetry, which is the direct cause of a stock price crash. Therefore, we consider that a stock price crash is caused mainly by three factors: the possibility of deterioration in the intrinsic value of individual stocks, the motivation and ability of managers to hide bad news and information asymmetry between the firm and external investors.

After the Communist Party of China took over the country, China has implemented many industrial policies through its "Five-Year Plans" formulated by the central government every 5 years. In 1953, China started its first five-year plan for developing heavy industries. Since 1953, China has implemented thirteen five-year plans. Year 2020 marked the last year of the thirteenth Five-Year Plan. China's Five-Year Plans provide a comprehensive long-term plan for major national construction projects, productivity distribution and a major proportion of the national economy, which guides the modernization of industrial structure and provides directions for future economic development. After a Five-Year Plan comes into effect, governments at all levels adopt measures, such as direct intervention and indirect guidance, to implement industrial policies. Direct intervention occurs through market access requirements, project approvals, technology controls, environmental protection controls, production safety controls and other means, while indirect guidance occurs mainly through fiscal and monetary policies (Yu et al., 2016). Government intervention affects the market access threshold, the degree of industrial competition, the financing status of firms, development opportunities and the external business environment, which in turn affect stock price crash risk. We consider that industrial policies affect stock price crash risk through three aspects: firm fundamentals, management agency problem and the information environment.

From the perspective of firm fundamentals, industrial policies reduce external uncertainty and improve firm fundamentals, which then reduce stock price crash risk. However, industrial policies may also aggravate overinvestment and damage firm value, thereby increasing stock price crash risk. Indeed, there is tremendous uncertainty in government behavior under imperfect private property rights, which makes it difficult for investors to predict the future value of a firm (Chen and Yao, 2018); therefore, low external uncertainty is a precondition for investors to use information, such as firm fundamentals, to carry out risk arbitrage. Unlike the traditional view that political intervention increases economic uncertainty (Shleifer and Vishny, 1994; Morck et al., 2000), Chen and Yao (2018) find that China's industrial policies are more of a signal that has a strong guiding effect, thereby reducing firms' external uncertainty. Moreover, while implementing an industrial policy, the government takes measures to promote the development of supported firms. For example, Qian et al. (2015) point out that government subsidies are a direct route for local governments to consciously guide resources to industries, which reduces cash flow pressure for supported firms. In addition, the government guides financial resources to industries through adjustments in bank credit and refinancing policies and other indirect measures, which ease the financing constraints of supported firms (Chen et al., 2010; Yu et al., 2016). Firms need sufficient cash reserves and financial resources to overcome liquidity constraints, increase value-relevant investment such as R&D and improve their intrinsic value, which ultimately reduces stock price crash risk. However, an industrial policy sends a positive message to the market, which raises investor expectations of supported firms. The support of industrial policies greatly increases firm investment opportunities, making firms prone to the "investment wave phenomenon" (Lin, 2007), and leads to overinvestment and an increase in invalid investments, which create new financing constraints (Zhang et al., 2017). Firms' long-term investment in projects with a negative net present value increases operational risks and damages firm value, thereby increasing stock price crash risk.

From the perspective of agency costs, the implementation of an industrial policy affects stock price crash risk through the agency problem. Local governments optimize the business environment by relaxing industrial controls, simplifying administrative approval procedures and reducing industry entry barriers, so as to guide the entry of external capital, eliminate backward firms and improve industry competitiveness (Li and Zheng, 2016; Meng et al., 2016). Improved industrial competition has positive and negative incentive effects on firm managers (Schmidt, 1997). Indeed, managers have an incentive to hide bad news or exaggerate good news (Jin and Myers, 2006; Hutton et al., 2009). Market competition can effectively restrain or supervise managers as an external corporate governance mechanism (Jiang et al., 2009; Liu and Yu, 2009). The higher the degree of market competition, the more likely managers' opportunistic behavior will be discovered by external investors, which reduces the scope of earnings management. Moreover, stakeholders are more likely to require management to adopt a more robust accounting treatment in a competitive market environment, which to some extent

reduces the foam component of a firm's stock price, thereby reducing stock price crash risk. However, competition may lead to a reduction in monopoly rent; the decline in excess profits reduces managers' motivation to work hard, which is not conducive to the stability of stock prices.

From the perspective of information asymmetry, the information conveyed through regulation policies is very important for investors and enterprises in the context of China's capital market information environment needs improvement. Indeed, an industrial policy sends signals about the future development prospects of different industries, which directly reduces the information collection costs of investors. Additionally, the industrial policy lowers the market access threshold, improves the degree of industry competition and promotes the disclosure of the business and financial status of firms (Hayes and Lundholm, 1996; Birt et al., 2006; Chen and Wang, 2015). Together, the signaling effect of the policy and the voluntary disclosure of firm information are conducive to reducing the information asymmetry between external investors and firms, thereby enabling the timely release of bad news and reducing stock price crash risk. However, an industrial policy may also aggravate the information asymmetry between external investors and firms. As firms have to compete for government resources, they have an incentive to whitewash their information to obtain government subsidies, which makes them more likely to hide bad news, thereby reducing the quality of firm information. Moreover, investors at an information disadvantage tend to rely heavily on the signals conveyed by industrial policies, resulting in herd behavior and overheating in the stock market. These behaviors will lead to stock price volatility and increase stock price crash risk (Deng and Zhan, 2020).

Therefore, we propose the following hypotheses.

**H1a:** *Ceteris paribus*, the implementation of a national industrial policy decreases stock price crash risk.
**H1b:** *Ceteris paribus*, the implementation of a national industrial policy increases stock price crash risk.

## 3. Research design

### *3.1. Sample and data*

We take all A-share listed firms in China from 2007 to 2020 as our research sample. New Chinese accounting standards were implemented in 2007, which not only supplements the new standard but also revises the general principles of the original accounting. Considering that the financial indicators are comparable within the sample period, we use 2007 as the first year of the sample period. The 13th Five-Year Plan ended in 2020, so we use 2020 as the last year of the sample period. Following the literature (Wang et al., 2015; Ye et al., 2015; Peng et al., 2018; Chen et al., 2018), we exclude financial firms, firms classified as special treatment, firms with less than 30 weeks of stock returns and firms with missing financial data. Our final sample consists of 31,214 firm-year observations. Table 1 shows the sample selection procedure. The financial data are collected from the China Stock Market and Accounting Research (CSMAR) database, and the industrial policy data are identified and sorted according to China's Five-Year Plans. We winsorize all continuous variables at the 1st and 99th percentiles to reduce the influence of outliers.

### *3.2. Model specification*

Following Xu et al. (2012), Xu et al. (2014), Wang et al. (2015)and Chen et al. (2018), we establish regression model (1) to test the effect of China's industrial policies on stock price crash risk.

$$Crash_{i,t+1} = \alpha_0 + \alpha_1 IP_{i,t} + \alpha_2 Control_{i,t} + \varepsilon_{i,t} \quad (1)$$

### *3.3. Variable definitions*

#### *3.3.1. Independent variable: Industrial policy*

Our research sample covers the 11th Five-Year Plan (2006–2010), 12th Five-Year Plan (2011–2015) and 13th Five-Year Plan (2015–2020). Following Chen et al. (2010), Li and Li (2014), Chen et al. (2017) and

Table 1
Sample selection procedure for supported firms.

| | Firm-year observations | Firms | |
|---|---|---|---|
| **Panel A: Sample selection for firms supported by an industrial policy** | | | |
| All A-share listed firms (2007–2020) | 36,736 | | 3,956 |
| minus: firms with less than 30 weeks of stock returns | 2171 | | 150 |
| minus: financial firms | 715 | | 43 |
| minus: firms classified as special treatment | 1,551 | | 86 |
| minus: firms with missing financial data | 1,085 | | 25 |
| Number of observations after selection | 31,214 | | 3,652 |
| | 11thFive-Year Plan (2007–2010) | 12thFive-Year Plan (2011–2015) | 13thFive-Year Plan (2016–2020) |
| **Panel B: Sample distribution of supported firms** | | | |
| Number of observations after selection | 5,431 | 10,448 | 15,335 |
| Supported firms | 3,882 | 5,658 | 8,525 |
| Proportion (%) | 71.48 | 54.15 | 55.59 |

Chen and Yao (2018), the independent variable *IP* represents all industries supported by China's national industrial policies. If an industry is listed as "encouraged," "supported," "actively developed," "vigorously developed" or "key development industry" in the Five-Year Plan documents for that year, then *IP* takes a value of 1 and otherwise 0. The classification of the supported industries in our sample is provided in Appendix A.

*3.3.2. Dependent variable: Stock price crash risk*

The dependent variable *Crash* represents stock price crash risk, which is measured by *NCSKEW* and *DUVOL*. It is calculated as follows.

First, we use Eq. (2) to calculate market-adjusted stock returns:

$$r_{i,s} = \alpha + \beta_{1,i} \times r_{m,s-2} + \beta_{2,i} \times r_{m,s-1} + \beta_{3,i} \times r_{m,s} + \beta_{4,i} \times r_{m,s+1} + \beta_{5,i} \times r_{m,s+2} + \varepsilon_{i,s} \quad (2)$$

where $r_{i,s}$ is the return of stock $i$ in week $s$ for each year and $r_{m,s}$ is the average return weighted by the current market value of all stocks in week $s$. At the same time, we add a lagged term ($r_{m,s-1}$, $r_{m,s-2}$) and a super front term ($r_{m,s+1}$, $r_{m,s+2}$) for market return to Eq. (2) considering the effect of nonsynchronous stock trading (Dimson, 1979).

Because the distribution of the residual term obtained by Eq. (2) is highly skewed, to make the residual term assume a standard normal distribution, we carry out logarithmic transformation to obtain the weekly return of stock $i$ in week $s$ denoted by $Wi,s$ calculated by Eq. (3):

$$W_{i,s} = \ln(1 + \varepsilon_{i,s}) \quad (3)$$

The first measure of stock price crash risk is *NCSKEW*, and the calculation method is shown in Eq. (4), where $n$ is the number of trading weeks for stock $i$ in year $t$. The higher the value of *NCSKEW*, the higher the degree of negative skewness of the stock return and the greater the stock price crash risk.

$$NCSKEW_{i,t} = -\left[n(n-1)^{3/2}\sum W_{i,s}^3\right] / \left[(n-1)(n-2)\left(\sum W_{i,s}^2\right)^{3/2}\right] \quad (4)$$

The second measure of stock price crash risk is *DUVOL*. According to whether $Wi,\ s$ is higher than the average annual stock return, the stock return data are divided into two subsamples, up weeks and down weeks, and then calculated using Eq. (5),where *nu* (*nd*) is the number of weeks and $W_{i,\ s}$ is above (below) the average stock return. The higher the value of *DUVOL*, the greater the leftward deviation of the stock return and the greater the stock price crash risk.

$$DUVOL_{i,t} = \ln\{[(n_u - 1)\sum_{down} W_{i,s}^2] / [(n_d - 1)\sum_{up} W_{i,s}^2]\} \quad (5)$$

*3.3.3. Control variables*

Following Xu et al. (2013), Xu et al. (2014)and Wang et al. (2014), we control for several variables: monthly excess stock turnover (*Turnover*), standard deviation of weekly stock returns in a year (*Sigma*), average weekly stock return in a year (*Ret*), firm size (*Size*), firm leverage (*Lev*), return on assets (*ROA*), book-to-market ratio (*BM*), cash flow ratio (*PCF*), analyst following (*Ana*) and shareholding ratio of institutional investors (*Hinshold*). Last, we control for industry fixed effects (*Industry*) and year fixed effects (*Year*). The definitions of the variables are provided in Appendix B.

## 4. Empirical results

### *4.1. Descriptive statistics*

The descriptive statistics of the main variables are shown in Table 2. The means of *NCSKEW_F* and *DUVOL_F* are –0.289 and –0.190, respectively, which are roughly similar to the values of–0.248 and –0.218 reported by Xu et al. (2012), and the standard deviations are 0.712 and 0.478, respectively, indicating that there are differences in stock price crash risk among the firms in our sample. The mean *IP* is 0.579, indicating that about 57.9% of the firms in the sample are supported by an industrial policy, slightly lower than the 60.3% reported by Li and Li (2014) and 61.2% reported by Chen and Yao (2018). The descriptive statistics of other control variables are detailed in Table 2 which are generally consistent with existing studies.

### *4.2. Baseline regression results*

Table 3 reports the regression results for the effect of China's industrial policies on stock price crash risk. Columns (1) and (2) show the results after controlling for year and industry fixed effects, and columns (3) and (4) show the results after further controlling for firm fixed effects. Table 3 shows that the coefficients on *IP* are significant and negative at the 1% level, indicating that an industrial policy has a significant inhibitory effect on stock price crash risk, which facilitates stability in financial markets. Thus, H1a is supported.

The regression results of the control variables show that the coefficient on *Turnover* is significant and negative at the 1% level, indicating that the higher the firm's stock trading liquidity, the lower the stock price crash risk. The coefficient on *Size* is significant and negative at the 1% level, indicating that large firms have a greater ability to withstand risk than small firms, so their stock price crash risk is lower. The coefficient on *ROA* is significant and negative at the 1% level, indicating that the better the performance of the firm, the lower its stock price crash risk. These results are consistent with our expectations.

Table 2
Descriptive statistics.

| | N | Mean | Std. Dev. | *P*1 | Median | P99 |
|---|---|---|---|---|---|---|
| *NCSKEW_F* | 31,214 | –0.289 | 0.712 | –2.415 | –0.250 | 1.702 |
| *DUVOL_F* | 31,214 | –0.190 | 0.478 | –1.354 | –0.189 | 1.057 |
| *IP* | 31,214 | 0.579 | 0.494 | 0 | 1 | 1 |
| *NCSKEW* | 31,214 | –0.291 | 0.705 | –2.398 | –0.255 | 1.679 |
| *DUVOL* | 31,214 | –0.194 | 0.474 | –1.349 | –0.194 | 1.049 |
| *Sigma* | 31,214 | 0.065 | 0.024 | 0.026 | 0.060 | 0.146 |
| *Ret* | 31,214 | 0.003 | 0.011 | –0.020 | 0.002 | 0.037 |
| *Turnover* | 31,214 | –0.104 | 0.478 | –1.952 | –0.034 | 0.993 |
| *Size* | 31,214 | 22.240 | 1.421 | 19.730 | 22.010 | 27.290 |
| *Lev* | 31,214 | 0.451 | 0.211 | 0.057 | 0.446 | 0.940 |
| *ROA* | 31,214 | 0.034 | 0.066 | –0.323 | 0.034 | 0.193 |
| *BM* | 31,214 | 0.628 | 0.248 | 0.116 | 0.627 | 1.156 |
| *PCF* | 31,214 | 0.086 | 0.261 | –1.335 | 0.082 | 1.009 |
| *Ana* | 31,214 | 1.462 | 1.194 | 0 | 1.386 | 3.807 |
| *Hinshold* | 31,214 | 0.063 | 0.074 | 0 | 0.036 | 0.348 |

Table 3
Baseline regression results for industrial policy and stock price crash risk.

| | (1) *NCSKEW_F* | (2) *DUVOL_F* | (3) *NCSKEW_F* | (4) *DUVOL_F* |
|---|---|---|---|---|
| *IP* | –0.042*** | –0.032*** | –0.063*** | –0.049*** |
| | (–2.79) | (–3.10) | (–3.20) | (–3.72) |
| *NCSKEW* | 0.055*** | | –0.076*** | |
| | (9.13) | | (–11.33) | |
| *DUVOL* | | 0.049*** | | –0.077*** |
| | | (8.13) | | (–11.51) |
| *Sigma* | –0.272 | –0.514*** | 0.052 | –0.283 |
| | (–0.98) | (–2.76) | (0.15) | (–1.22) |
| *Ret* | 8.088*** | 5.416*** | 5.743*** | 4.079*** |
| | (12.09) | (11.84) | (7.45) | (7.78) |
| *Turnover* | –0.046*** | –0.030*** | –0.052*** | –0.036*** |
| | (–4.63) | (–4.45) | (–4.23) | (–4.36) |
| *Size* | –0.044*** | –0.041*** | 0.022 | –0.003 |
| | (–7.67) | (–10.29) | (1.59) | (–0.30) |
| *Lev* | –0.024 | –0.012 | –0.116** | –0.067** |
| | (–0.90) | (–0.68) | (–2.33) | (–2.01) |
| *ROA* | –0.470*** | –0.317*** | –0.372*** | –0.268*** |
| | (–6.16) | (–6.14) | (–3.84) | (–4.13) |
| *BM* | –0.052* | –0.005 | –0.262*** | –0.148*** |
| | (–1.81) | (–0.27) | (–5.76) | (–4.94) |
| *PCF* | –0.004 | –0.008 | –0.032* | –0.024** |
| | (–0.24) | (–0.74) | (–1.71) | (–2.00) |
| *Ana* | 0.039*** | 0.022*** | 0.013* | 0.008 |
| | (7.73) | (6.64) | (1.75) | (1.59) |
| *Hinshold* | 0.743*** | 0.473*** | 0.737*** | 0.461*** |
| | (11.43) | (10.45) | (7.52) | (6.95) |
| *Constant* | 0.747*** | 0.786*** | –0.482 | 0.068 |
| | (6.27) | (9.31) | (-1.64) | (0.33) |
| *Year FE* | Yes | Yes | Yes | Yes |
| *Industry FE* | Yes | Yes | No | No |
| *Firm FE* | No | No | Yes | Yes |
| *N* | 31,214 | 31,214 | 31,214 | 31,214 |
| *Adj.* $R^2$ | 0.066 | 0.071 | 0.095 | 0.099 |

*Note:* The numbers in parentheses are *t*-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

### *4.3. Cross-sectional effects in different regions with different marketization levels*

External risks and uncertainty lead to difficulties in firm operations, a decline in firms' internal value and a decline in share prices. Compared with firms that are not supported by an industrial policy, those that are supported by such a policy experience reduced external risks and uncertainty; that is, when a firm is in trouble, it can obtain financing through industrial policy support, reduce its financing constraints and cash flow risk and enhance its internal value, leading to a reduction in stock price crash risk.

Regional marketization is an important source of operational risk and uncertainty. In areas with a high level of marketization, the market environment is relatively perfect, the legal system is sound, law enforcement efficiency is high, financial markets are more developed and the external environment of firms is favorable. Shen et al. (2010a, 2010b) find that an improvement in the marketization level helps reduce financing risks and constraints. In areas with a high level of marketization, there is strong protection of property rights, a more robust regulatory system and higher firm information disclosure quality (Cheng et al., 2011). The perfect market environment helps commercial banks safeguard their legitimate rights and reduce credit risk by relying on the system. However, areas with a low level of marketization have weak property rights protection and a weak judicial system and high credit risk. Credit institutions reduce their scale of credit to protect their own rights and interests (Chen and Wang, 2015). Furthermore, the financial market in areas with a low level of

marketization is underdeveloped, firms have fewer external financing channels and transaction costs are high; thus, the external business environment of firms is unfavorable. Firms have difficulty obtaining financing, leading to financing constraints. An industrial policy can reduce operational risk and uncertainty in areas with a low level of marketization. The information and resource effects of a country's industrial policy can effectively reduce firms' financing constraints in areas with a low level of marketization, managers' opportunistic behavior and motivation for earnings manipulation, which reduce noise in stock pricing, improve the information content of stock prices and further reduce stock price crash risk. Therefore, the inhibitory effect of an industrial policy on stock price crash risk is more obvious for firms in regions with low levels of marketization than for those in regions with high levels of marketization.

We use the marketization index from China's Provincial Marketization Index Report (Wang et al., 2019) to examine the effect of the marketization level on industrial policy and stock price crash risk. The higher the regional marketization index, the higher the level of regional marketization. Furthermore, based on the annual industry median of the regional marketization index, the sample is divided into two groups: high and low levelsof regional marketization. The regression results are reported in Table 4. In columns (1) and (2), *NCSKEW_F* is used to measure stock price crash risk; the coefficient on *IP* in the low level of marketization subsample is –0.074, significant at the 1% level, while the coefficient on *IP* in the high level of marketization subsample is not significant. In columns (3) and (4), the coefficient on *IP* in the low level of marketization subsample is –0.056, significant at the 1% level, while the coefficient on *IP* in the high level of marketization subsample is –0.008, but is not significant. The above results show that in regions with low levels of marketization, firms face more external operational risks and uncertainty. Therefore, in this environment, the role of national industrial policies in reducing stock price crash risk is more obvious.

## 5. Robustness tests

### 5.1. Alternative measure of stock price crash risk

Following Luo and Du (2014), we use weekly stock returns (*Wi,t*) as an alternative variable for stock price crash risk (*Crashrisk*):

$$W_{i,t} \leqslant Average(W_{i,t}) - 3.09\sigma_{i,t} \tag{6}$$

where *Average* ($W_{i,t}$) refers to the average weekly stock return that year, $\sigma_{i,t}$ is the standard deviation of weekly stock returns that year and 3.09 standard deviations correspond to the probability interval of 0.1% under the standard normal distribution. If $W_{i,t}$ meets the condition of Formula (6) at least once a year, it means that the firm experienced a stock price crash that year. In this case, *Crashrisk* takes a value of 1 and 0 otherwise. Table 5 shows that the coefficient on *IP* is still significant and negative at the 1% level, indicating that industrial policy implementation reduces stock price crash risk, proving that our findings are robust.

### 5.2. Heckman two-stage model

The design of a national industrial policy and the industries it supports may not be fully exogenous, leading to self-selection bias. The Heckman two-stage model is used to reduce the endogeneity problem caused by self-selection bias. Song and Wang (2013) find that the relative importance of an industry to the national economy and livelihoods determines whether that industry is listed as a supported industry, withits future growth prospects, profitability and contribution to social employment being specific criteria for judging its relative importance. Therefore, in the first stage, we take industry development capacity (*Ind_DC*), industry profitability (*Ind_ROE*) and social employment contribution (*Ind_EC*) as independent variables to determine whether an industry is supported by an industrial policy[4] and then estimate the inverse Mills ratio (*IMR*). The regres-

[4] Ind_DC = (Industry operating income in the current year – Industry operating income in the previous year)/Industry operating income in the previous year.Ind_ROE = Total net profit of firms in the industry/Total owners' equity of firms in the industry.Ind_EC = (Number of employees in the industry in the current year – Number of employees in the industry in the previous year)/Number of employees in the industry in the previous year.

Table 4
Effect of the marketization level on industrial policy and stock price crash risk.

| | (1) High | (2) Low | (3) High | (4) Low |
|---|---|---|---|---|
| | *NCSKEW_F* | | *DUVOL_F* | |
| *IP* | –0.014 | –0.074*** | –0.008 | –0.056*** |
| | (0.67) | (–2.95) | (–0.58) | (–3.32) |
| *NCSKEW* | 0.053*** | 0.054*** | | |
| | (5.77) | (6.67) | | |
| *DUVOL* | | | 0.048*** | 0.047*** |
| | | | (5.47) | (5.83) |
| *Sigma* | 0.095 | –0.625* | –0.337 | –0.711*** |
| | (0.22) | (–1.74) | (–1.18) | (–2.89) |
| *Ret* | 5.468*** | 10.097*** | 4.231*** | 6.491*** |
| | (5.15) | (11.15) | (6.01) | (10.24) |
| *Turnover* | –0.042** | –0.047*** | –0.027** | –0.031*** |
| | (–2.57) | (–3.70) | (–2.47) | (–3.59) |
| *Size* | –0.038*** | –0.051*** | –0.032*** | –0.050*** |
| | (–4.23) | (–6.89) | (–5.14) | (–9.48) |
| *Lev* | 0.019 | –0.047 | –0.000 | –0.014 |
| | (0.48) | (–1.28) | (–0.00) | (–0.57) |
| *ROA* | –0.424*** | –0.517*** | –0.303*** | –0.338*** |
| | (–3.48) | (–5.22) | (–3.72) | (–5.03) |
| *BM* | –0.139*** | 0.018 | –0.074** | 0.048* |
| | (–3.25) | (0.46) | (–2.55) | (1.86) |
| *PCF* | –0.013 | 0.007 | –0.018 | 0.002 |
| | (–0.58) | (0.32) | (–1.19) | (0.12) |
| *Ana* | 0.041*** | 0.038*** | 0.023*** | 0.023*** |
| | (5.29) | (5.59) | (4.37) | (5.16) |
| *Hinshold* | 0.746*** | 0.719*** | 0.498*** | 0.421*** |
| | (8.09) | (7.63) | (7.79) | (6.47) |
| *Constant* | 0.632*** | 0.915*** | 0.601*** | 0.971*** |
| | (3.44) | (5.69) | (4.68) | (8.42) |
| *Year FE* | Yes | Yes | Yes | Yes |
| *Industry FE* | Yes | Yes | Yes | Yes |
| *N* | 13,988 | 17,226 | 13,988 | 17,226 |
| *Adj.R²* | 0.079 | 0.058 | 0.083 | 0.063 |

*Note:* The numbers in parentheses are *t*-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

sion results are reported in column (1) of Table 6. Furthermore, the *IMR* estimate from the first stage is added to the second-stage regression, and the results are shown in columns (2) and (3) of Table 6. The coefficient on *IMR* in the second-stage regression is positive but not significant, and the coefficient on *IP* is still significant and negative at the 1% level. These results show that after controlling for self-selection bias, our main conclusion remains robust.

### *5.3. Propensity score matching method and difference-in-differences*

We use propensity score matching and the difference-in-differences model (PSM-DID) to further control for the endogeneity of the time-series effect of stock price crash risk and other factors that may lead to a difference in stock price fluctuations between industries supported by an industrial policy and industries not supported by such a policy. Following Yu et al. (2016), we divide the sample into two parts, the implementation period of the 11th and 12th Five-Year Plans and the implementation period of the 12th and 13th Five-Year Plans, and set Eq. (7) for the regression.

$$Crash_{i,t+1} = \mu_0 + \mu_1 Treated_{i,t} + \mu_2 Post_{i,t} + \mu_3 Treated_{i,t} \times Post_{i,t} + \mu_4 Control_{i,t} + \varepsilon_{i,t} \quad (7)$$

Table 5
Using an alternative measure to calculate stock price crash risk.

| | *Crashrisk_F* | |
|---|---|---|
| | Coefficient | Z-statistics |
| *IP* | –0.071*** | –3.03 |
| *Crashrisk* | 0.023 | 0.79 |
| *Sigma* | –2.543*** | –3.74 |
| *Ret* | 4.471** | 2.51 |
| *Turnover* | –0.035 | –1.52 |
| *Size* | –0.056*** | –4.02 |
| *Lev* | –0.473*** | –2.71 |
| *ROA* | 0.046 | 0.75 |
| *BM* | –0.103 | –1.60 |
| *PCF* | –0.013 | –0.34 |
| *Ana* | –0.033*** | –2.89 |
| *Hinshold* | 0.545*** | 3.39 |
| *Constant* | 2.517*** | 3.31 |
| *Year FE* | Yes | |
| *Industry FE* | Yes | |
| *N* | 31,214 | |
| *Pseudo* $R^2$ | 0.0269 | |

*Note:* *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

When the sample period is the implementation period of the 11th and 12th Five-Year Plans, *Treated* takes a value of 1 if both Five-Year Plans list an industry as supported and a value of 0 if an industry is supported by the industrial policy of the 11th Five-Year Plan but not supported by the industrial policy of the 12th Five-Year Plan. The shock event is 2011, the year the 12th Five-Year Plan came into effect; after 2011, *Post* takes a value of 1 and 0 otherwise. Similarly, when the sample period is the implementation period of the 12th and 13th Five-Year Plans, *Treated* takes a value of 1 if both Five-Year Plans list an industry as supported and a value of 0 if an industry is supported by the industrial policy of the 12th Five-Year Plan but not supported by the industrial policy of the 13th Five-Year Plan. The shock event is 2016, the year the 13th Five-Year Plan came into effect; after 2016, *Post* takes a value of 1 and 0 otherwise. The control variables are the same as in the baseline regression. The main coefficient here is $\mu_3$; if $\mu_3$ is significant and negative, indicating that stock price crash risk is lower in industries supported by an industrial policy than in industries not supported by such a policy. That is, an industrial policy has a significant inhibitory effect on stock price crash risk.

Furthermore, we adopt PSM to avoid differences in firm characteristics between the treated and control groups on the effectiveness of the DID model. Taking the control variables of Model (1) as covariates, the firms in the control group are one-to-one matched with firms with the most similar firm characteristics in the treated group. The regression results of the matched sample are shown in Table 7. The coefficient on *Post* × *Treated i*s significant and negative at the 1% level, indicating that the regression results for the inhibitory effect of an industrial policy on stock price crash risk are robust (Table 7).

## 6. Mechanism test

### *6.1. Reducing external uncertainty and improving firm fundamentals*

Firm fundamentals are key to asset pricing (Banz, 1981; Bhandari, 1988; Fama and French, 1992). Through industrial policy support, firms can obtain more credit financing, thereby mitigating their financing constraints (Chen et al., 2010), and obtain government subsidies to supplement their cash flow (Qian et al., 2015). An industrial policy reduces external uncertainty, improves firms' ability to withstand systemic risk, enhances their internal value and improves firm fundamentals, which decrease stock price crash risk. We follow Shen et al. (2010a, 2010b) and measure external uncertainty (*EU*) based on changes in firms' sales revenue to test the mechanism for reducing external uncertainty. This indicator accurately reflects the effect of a firm's exter-

nal environment (Tosi et al., 1973; Shen et al., 2010a, 2010b; Zhang et al., 2010). Based on the annual industry average of *EU*, we divide the sample into two groups, high and low *EU*, and show the results in Table 8. Columns (1) and (2) show the results taking *NCSKEW_F* as the dependent variable; the coefficient on *IP* in the low *EU* group is not significant, while the coefficient on *IP* in the high *EU* group is –0.057, which is significant at the 1% level. Columns (3) and (4) are the results taking *DUVOL_F* as the dependent variable; the coefficient on *IP* in the low *EU* group is not significant, while the coefficient on *IP* in the high *EU* group is –0.039, which is significant at the 1% level. The above results show that an industrial policy decreases stock price crash risk by reducing external uncertainty.

Table 6
Regression results of the Heckman two-stage model.

| | (1) | (2) | (3) |
|---|---|---|---|
| | First-stage regression | Second-stage regression | |
| | *IP* | *NCSKEW_F* | *DUVOL_F* |
| *Ind_DC* | 0.001*** | | |
| | (12.84) | | |
| *Ind_ROE* | 0.183*** | | |
| | (7.59) | | |
| *Ind_EC* | 0.323*** | | |
| | (18.29) | | |
| *IP* | | –0.042*** | –0.032*** |
| | | (–2.79) | (–3.09) |
| *IMR* | | 0.004 | –0.020 |
| | | (0.05) | (–0.40) |
| *NCSKEW* | | 0.055*** | |
| | | (9.13) | |
| *DUVOL* | | | 0.049*** |
| | | | (8.13) |
| *Sigma* | | –0.272 | –0.515*** |
| | | (–0.98) | (–2.77) |
| *Ret* | | 8.087*** | 5.420*** |
| | | (12.09) | (11.85) |
| *Turnover* | | –0.046*** | –0.030*** |
| | | (–4.63) | (–4.45) |
| *Size* | | –0.044*** | –0.041*** |
| | | (–7.66) | (–10.30) |
| *Lev* | | –0.024 | –0.012 |
| | | (–0.90) | (–0.68) |
| *ROA* | | –0.470*** | –0.317*** |
| | | (–6.15) | (–6.14) |
| *BM* | | –0.004 | –0.008 |
| | | (–0.23) | (–0.74) |
| *PCF* | | –0.052* | –0.005 |
| | | (–1.81) | (–0.26) |
| *Ana* | | 0.039*** | 0.022*** |
| | | (7.73) | (6.65) |
| *Hinshold* | | 0.743*** | 0.473*** |
| | | (11.43) | (10.45) |
| *Constant* | –1.803*** | 0.743*** | 0.804*** |
| | (–13.57) | (5.30) | (8.37) |
| *Year FE* | Yes | Yes | Yes |
| *Industry FE* | No | Yes | Yes |
| *N* | 31,214 | 31,214 | 31,214 |
| *Pseudo* $R^2$ | 0.071 | | |
| *Adj.*$R^2$ | | 0.066 | 0.071 |

*Note:* *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7
Regression results of PSM-DID.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | 11th and 12th Five-Year Plan | | 12th and 13th Five-Year Plan | |
| | *NCSKEW_F* | *DUVOL_F* | *NCSKEW_F* | *DUVOL_F* |
| *Treated* | 0.150* | 0.109* | 0.123* | 0.081* |
| | (1.73) | (1.77) | (1.78) | (1.78) |
| *Post* | –0.384*** | –0.247*** | 0.217*** | 0.184*** |
| | (–5.24) | (–4.62) | (3.51) | (4.57) |
| *Post × Treated* | –0.184*** | –0.097** | –0.122*** | –0.090*** |
| | (–2.81) | (–2.17) | (–2.59) | (–2.89) |
| *NCSKEW* | 0.001 | | 0.057*** | |
| | (0.07) | | (3.39) | |
| *DUVOL* | | 0.017 | | 0.057*** |
| | | (0.81) | | (3.46) |
| *Sigma* | –0.204 | –0.476 | 1.549* | 0.369 |
| | (–0.19) | (–0.66) | (1.85) | (0.65) |
| *Ret* | 4.866* | 4.884*** | 8.572*** | 6.299*** |
| | (1.93) | (2.97) | (4.18) | (4.53) |
| *Turnover* | 0.022 | 0.035 | –0.106*** | –0.062** |
| | (0.61) | (1.37) | (–2.72) | (–2.36) |
| *Size* | –0.065*** | –0.050*** | –0.033* | –0.040*** |
| | (–3.38) | (–3.80) | (–1.93) | (–3.61) |
| *Lev* | –0.051 | –0.080 | –0.012 | –0.005 |
| | (–0.51) | (–1.16) | (–0.15) | (–0.09) |
| *ROA* | –0.223 | –0.247 | –0.363* | –0.307** |
| | (–0.73) | (–1.17) | (–1.76) | (–2.29) |
| *BM* | 0.009 | 0.022 | –0.010 | –0.009 |
| | (0.27) | (0.91) | (–0.24) | (–0.35) |
| *PCF* | 0.085 | 0.137* | –0.103 | 0.001 |
| | (0.82) | (1.93) | (–1.23) | (0.01) |
| *Ana* | 0.076*** | 0.045*** | 0.046*** | 0.027*** |
| | (4.25) | (3.69) | (3.06) | (2.83) |
| *Hinshold* | 0.821*** | 0.545*** | 0.907*** | 0.568*** |
| | (4.40) | (4.06) | (4.15) | (3.86) |
| *Constant* | 0.922** | 0.778*** | 0.271 | 0.618*** |
| | (2.29) | (2.90) | (0.79) | (2.74) |
| *Year FE* | Yes | Yes | Yes | Yes |
| *Industry FE* | Yes | Yes | Yes | Yes |
| *N* | 2,428 | 2,428 | 4,170 | 4,170 |
| *Adj.R²* | 0.073 | 0.076 | 0.064 | 0.064 |

*Note:* The numbers in parentheses are *t*-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Furthermore, we study the mechanism for the effect of an industrial policy on reducing stock price crash risk by improving firm fundamentals. The implementation of an industrial policy can improve firm fundamentals directly and indirectly. The government can directly implement an industrial policy through subsidies, which supplement firms' cash flow. The total amount of government subsidies received by a firm divided by its operating income is used as a proxy for improvement in firm fundamentals, and the sample is divided into two groups based on the annual industry average of government subsidies. The results are shown in columns (1)–(4) of Table 9. The coefficient on *IP* is significant and negative at the 1% level for firms receiving fewer subsidies, while the coefficient on *IP* is not significant for firms receiving more subsidies, which shows that an industrial policy improves firm fundamentals directly by increasing government subsidies, thus reducing stock price crash risk.

The government can also indirectly improve firm fundamentals through bank credit policies, refinancing policies and other financial policies to increase firms' credit scale and reduce their financing constraints. An increase in long-term loans leads to a greater improvement in credit capacity than an increase in short-term

Table 8
Industrial policy, external uncertainty and stock price crash risk.

| | (1) High | (2) Low | (3) High | (4) Low |
|---|---|---|---|---|
| | *NCSKEW_F* | | *DUVOL_F* | |
| *IP* | –0.057*** | –0.013 | –0.039*** | –0.018 |
| | (–2.85) | (–0.55) | (–2.91) | (–1.05) |
| *NCSKEW* | 0.049*** | 0.063*** | | |
| | (6.40) | (6.12) | | |
| *DUVOL* | | | 0.042*** | 0.059*** |
| | | | (5.50) | (5.77) |
| *Sigma* | –0.604* | 0.204 | –0.791*** | –0.110 |
| | (–1.76) | (0.42) | (–3.43) | (–0.35) |
| *Ret* | 7.426*** | 9.261*** | 5.065*** | 6.095*** |
| | (8.98) | (7.57) | (8.90) | (7.47) |
| *Turnover* | –0.048*** | –0.038** | –0.032*** | –0.023* |
| | (–4.13) | (–2.02) | (–4.06) | (–1.79) |
| *Size* | –0.040*** | –0.050*** | –0.040*** | –0.042*** |
| | (–5.77) | (–5.12) | (–8.35) | (–6.34) |
| *Lev* | –0.025 | –0.008 | –0.016 | 0.004 |
| | (–0.78) | (–0.18) | (–0.74) | (0.13) |
| *ROA* | –0.458*** | –0.462*** | –0.322*** | –0.292*** |
| | (–4.99) | (–3.22) | (–5.14) | (–3.12) |
| *BM* | –0.067* | –0.026 | –0.011 | 0.005 |
| | (–1.92) | (–0.56) | (–0.45) | (0.16) |
| *PCF* | 0.004 | –0.020 | –0.004 | –0.016 |
| | (0.19) | (–0.74) | (–0.32) | (–0.87) |
| *Ana* | 0.035*** | 0.044*** | 0.022*** | 0.023*** |
| | (5.62) | (5.16) | (5.12) | (4.17) |
| *Hinshold* | 0.811*** | 0.646*** | 0.499*** | 0.435*** |
| | (9.48) | (6.64) | (8.42) | (6.39) |
| *Constant* | 0.740*** | 0.635*** | 0.830*** | 0.629*** |
| | (5.25) | (3.02) | (8.26) | (4.39) |
| *Year FE* | Yes | Yes | Yes | Yes |
| *Industry FE* | Yes | Yes | Yes | Yes |
| *N* | 19,635 | 11,579 | 19,635 | 11,579 |
| *Adj.R*$^2$ | 0.063 | 0.070 | 0.070 | 0.072 |

*Note:* The numbers in parentheses are *t*-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

loans and is more aligned with the objective of supporting the long-term development of firms. Following Yu et al. (2016), we take the difference in long-term loans between this year and the preceding year divided by total assets as a proxy for improvement in firm fundamentals through an industrial policy. Based on the average industry annual increase in long-term loans, the sample is divided into two groups: small increments and large increments. Columns (5)–(8) of Table 9 report the regression results. The inhibitory effect of an industrial policy on stock price crash risk is more significant in the small increment subsample, indicating that an industrial policy improves firm fundamentals by increasing firms' credit scale, which decreases stock price crash risk.

### *6.2. Reducing agency costs*

In a modern corporate system with separation of powers, agency problems create room for management to act in its own interests and prevent the integration of firm-specific information into stock prices. As mentioned, to implement an industrial policy, the government lowers market access restrictions in supported industries, which allows more firms to enter a given industry and increases the level of industry competition. Industry competition, as an important external governance mechanism (Allen and Gale, 2000), reduces the agency costs of shareholders and management, discourages earnings management and allows investors access

Table 9
Industrial policy, firm fundamentals and stock price crash risk.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Government subsidies | | | | Long-term loans | | | |
| | More | Less | More | Less | Large | Small | Large | Small |
| | *NCSKEW_F* | | *DUVOL_F* | | *NCSKEW_F* | | *DUVOL_F* | |
| *IP* | –0.032 | –0.048*** | –0.020 | –0.038*** | –0.024 | –0.055** | –0.020 | –0.043*** |
| | (–1.20) | (–2.59) | (–1.09) | (–3.00) | (–0.99) | (–2.39) | (–1.20) | (–2.74) |
| *NCSKEW* | 0.044*** | 0.061*** | | | 0.047*** | 0.060*** | | |
| | (4.13) | (8.12) | | | (5.65) | (6.79) | | |
| *DUVOL* | | | 0.043*** | 0.052*** | | | 0.040*** | 0.055*** |
| | | | (4.04) | (7.02) | | | (4.89) | (6.40) |
| *Sigma* | 0.526 | –0.655* | –0.091 | –0.719*** | –0.458 | –0.136 | –0.533** | –0.558* |
| | (1.12) | (–1.94) | (–0.29) | (–3.17) | (–1.24) | (–0.31) | (–2.16) | (–1.91) |
| *Ret* | 5.404*** | 9.423*** | 3.688*** | 6.279*** | 9.672*** | 6.404*** | 6.492*** | 4.188*** |
| | (4.57) | (11.45) | (4.65) | (10.92) | (10.09) | (6.48) | (9.99) | (6.13) |
| *Turnover* | –0.064*** | –0.036*** | –0.035*** | –0.027*** | –0.050*** | –0.038* | –0.036*** | –0.016 |
| | (–4.01) | (–2.81) | (–3.16) | (–3.17) | (–4.29) | (–1.91) | (–4.61) | (–1.16) |
| *Size* | –0.043*** | –0.045*** | –0.041*** | –0.041*** | –0.046*** | –0.045*** | –0.042*** | –0.041*** |
| | (–4.13) | (–6.68) | (–5.71) | (–8.57) | (–5.80) | (–5.31) | (–7.65) | (–7.25) |
| *Lev* | 0.043 | –0.058* | 0.026 | –0.031 | –0.007 | –0.034 | –0.005 | –0.012 |
| | (0.93) | (–1.77) | (0.84) | (–1.38) | (–0.18) | (–0.89) | (–0.18) | (–0.48) |
| *ROA* | –0.394*** | –0.508*** | –0.264*** | –0.348*** | –0.527*** | –0.401*** | –0.378*** | –0.246*** |
| | (–3.24) | (–5.14) | (–3.19) | (–5.30) | (–5.19) | (–3.44) | (–5.52) | (–3.19) |
| *BM* | –0.086* | –0.036 | –0.032 | 0.007 | –0.080** | –0.035 | –0.018 | –0.004 |
| | (–1.74) | (–1.03) | (–0.96) | (0.29) | (–2.05) | (–0.85) | (–0.68) | (–0.15) |
| *PCF* | –0.015 | 0.004 | –0.023 | 0.007 | –0.008 | –0.019 | –0.008 | –0.017 |
| | (–0.68) | (0.17) | (–1.56) | (0.45) | (–0.36) | (–0.86) | (–0.56) | (–1.12) |
| *Ana* | 0.039*** | 0.038*** | 0.026*** | 0.020*** | 0.037*** | 0.039*** | 0.022*** | 0.021*** |
| | (4.48) | (6.25) | (4.38) | (5.00) | (5.35) | (5.35) | (4.91) | (4.32) |
| *Hinshold* | 0.858*** | 0.694*** | 0.512*** | 0.458*** | 0.647*** | 0.824*** | 0.418*** | 0.521*** |
| | (7.69) | (8.78) | (6.55) | (8.48) | (6.65) | (9.29) | (6.35) | (8.41) |
| *Constant* | 0.605*** | 0.824*** | 0.726*** | 0.811*** | 0.734*** | 0.737*** | 0.677*** | 0.799*** |
| | (2.91) | (5.85) | (4.94) | (8.02) | (4.30) | (4.17) | (5.58) | (6.69) |
| *Year FE* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry FE* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 10,251 | 20,963 | 10,251 | 20,963 | 16,536 | 14,678 | 16,536 | 14,678 |
| *Adj.R*$^2$ | 0.067 | 0.066 | 0.072 | 0.070 | 0.062 | 0.074 | 0.066 | 0.078 |

*Note:* The numbers in parentheses are *t*-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

to accurate firm financials. Hence, stock prices reflect the true value of firms more fairly, which decreases stock price crash risk. Accordingly, we expect the inhibitory effect of a national industrial policy on stock price crash risk to be more pronounced in firms with high agency costs.

Following Jiang et al. (2009), we use the asset turnover ratio to measure firm agency costs and divide the sample into two groups (high and low agency costs) based on the average annual industry turnover ratio. The results are shown in columns (1)–(4) of Table 10,where the coefficient on *IP* is –0.044 and is statistically significant at the 1% level in the low asset turnover subsample when measuring stock price crash risk with *NCSKEW_F*, while the coefficient on *IP* is not statistically significant in the high asset turnover subsample. The results using *DUVOL_F* as the measure of stock price crash risk show that the coefficient on *IP* is significant and negative only in the low asset turnover subsample, while it is not significant in the high turnover subsample.

Jensen and Meckling (1976) point out that external audits reduce information asymmetry and the agency problem of firms. Moreover, when the legal system is weak, external audits can partially replace the judicial system (Fan and Wong, 2005). Studies find that the ‘‘Big Four’’ audit firms provide higher audit quality based on their reputation and professionalism than smaller audit firms (Lang and Maffett, 2010; Xin et al., 2014).

Table 10
Industrial policy, agency costs and stock price crash risk.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Total asset turnover | | | | Audit firms | | | |
| | High | Low | High | Low | Large | Small | Large | Small |
| | *NCSKEW_F* | | *DUVOL_F* | | *NCSKEW_F* | | *DUVOL_F* | |
| *IP* | –0.016 | –0.044*** | –0.016 | –0.030*** | 0.062 | –0.049*** | 0.038 | –0.036*** |
| | (–1.03) | (–3.37) | (–1.63) | (–3.52) | (1.56) | (–3.01) | (1.37) | (–3.21) |
| *NCSKEW* | 0.046*** | 0.060*** | | | 0.048* | 0.054*** | | |
| | (4.65) | (7.89) | | | (1.84) | (8.60) | | |
| *DUVOL* | | | 0.048*** | 0.050*** | | | 0.029 | 0.047*** |
| | | | (4.78) | (6.62) | | | (1.20) | (7.57) |
| *Sigma* | –1.774*** | 0.410 | –1.486*** | –0.045 | –1.064 | –0.150 | –1.261 | –0.415** |
| | (–3.97) | (1.16) | (–4.85) | (–0.19) | (–0.93) | (–0.52) | (–1.53) | (–2.17) |
| *Ret* | 9.851*** | 7.342*** | 6.775*** | 4.723*** | 6.080** | 7.962*** | 6.188*** | 5.144*** |
| | (9.22) | (8.50) | (9.27) | (8.00) | (2.28) | (11.38) | (3.19) | (10.89) |
| *Turnover* | –0.027* | –0.058*** | –0.017 | –0.038*** | 0.002 | –0.050*** | –0.005 | –0.032*** |
| | (–1.71) | (–4.49) | (–1.54) | (–4.46) | (0.04) | (–4.86) | (–0.15) | (–4.70) |
| *Size* | –0.059*** | –0.042*** | –0.047*** | –0.043*** | –0.016 | –0.047*** | –0.022 | –0.043*** |
| | (–7.06) | (–5.59) | (–8.08) | (–8.06) | (–0.81) | (–6.99) | (–1.56) | (–9.37) |
| *Lev* | –0.000 | –0.016 | –0.003 | –0.007 | –0.024 | –0.020 | 0.036 | –0.011 |
| | (–0.01) | (–0.46) | (–0.11) | (–0.32) | (–0.19) | (–0.74) | (0.39) | (–0.58) |
| *ROA* | –0.079 | –0.566*** | –0.078 | –0.373*** | 0.019 | –0.469*** | 0.236 | –0.320*** |
| | (–0.55) | (–6.00) | (–0.80) | (–5.86) | (0.05) | (–5.97) | (0.90) | (–6.04) |
| *BM* | –0.026 | –0.002 | –0.028 | –0.006 | –0.051 | –0.049 | –0.048 | 0.001 |
| | (–0.60) | (–0.13) | (–1.03) | (–0.50) | (–0.43) | (–1.61) | (–0.60) | (0.05) |
| *PCF* | –0.097** | –0.016 | –0.043 | 0.017 | 0.042 | –0.013 | 0.012 | –0.012 |
| | (–2.28) | (–0.45) | (–1.49) | (0.70) | (1.18) | (–0.74) | (0.48) | (–1.04) |
| *Ana* | 0.033*** | 0.044*** | 0.016*** | 0.027*** | 0.026 | 0.038*** | 0.016 | 0.021*** |
| | (4.23) | (6.76) | (3.04) | (6.22) | (1.15) | (7.30) | (1.01) | (6.17) |
| *Hinshold* | 0.600*** | 0.849*** | 0.385*** | 0.540*** | 0.353* | 0.791*** | 0.137 | 0.513*** |
| | (6.34) | (9.95) | (5.94) | (8.85) | (1.71) | (11.46) | (0.94) | (10.80) |
| *Constant* | 1.125*** | 0.638*** | 0.936*** | 0.781*** | 0.511 | 0.789*** | 0.794*** | 0.815*** |
| | (6.51) | (4.07) | (7.69) | (7.00) | (1.25) | (5.76) | (2.78) | (8.52) |
| *Year FE* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry FE* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 12,156 | 19,058 | 12,156 | 19,058 | 2,185 | 29,029 | 2,185 | 29,029 |
| *Adj.*$R^2$ | 0.067 | 0.067 | 0.072 | 0.071 | 0.109 | 0.064 | 0.123 | 0.069 |

*Note:* The numbers in parentheses are *t*-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Financial reports audited by the Big Four are also more reliable, which reflects the financial status of firms more accurately, helps external investors better understand internal firm information and reduces the information disparity between firms and external investors. Therefore, we consider audit firms as another indicator to measure agency costs and divide the sample into two groups for the regression: audits by small firms and audits by large firms. The results are reported in columns (5)–(8) of Table 10. The inhibitory effect of an industrial policy on stock price crash risk is more significant for firms audited by small firms than for those audited by larger firms. The above results show that a national industrial policy decreases stock price crash risk by improving the corporate governance level of firms and reducing agency costs.

### *6.3. Mitigating information asymmetry*

Information asymmetry prevents the full integration of firm information into stock prices and allows management to hide bad news. When all of the bad news accumulated reaches a threshold and is released to the capital market at once, it easily triggers a sudden drastic drop in stock prices or a stock price crash. An industrial policy is a signal of government support for industrial development and reflects the future direction of

that development. It provides additional information to firms and reduces the information asymmetry between firms and external investors. Moreover, the lowering of industry entry barriers through an industrial policy facilitates more intense market competition, forcing firms to disclose more information, which helps reduce the internal and external information asymmetry of firms. Investors get a more accurate representation of a firm's internal conditions, which decreases stock price crash risk. Therefore, we expect the inhibitory effect of a national industrial policy on stock price crash risk to be more significant for firms with a high level of information asymmetry.

High-quality accounting information reflects firm characteristics more accurately and helps investors accurately assess firms' operating conditions, which reduces the gap between future market expectations and actual firm conditions, thus reducing future stock price fluctuations (Healy et al., 1999; Dasgupta et al., 2010). In contrast, low-quality accounting information increases information asymmetry between firms and investors, which leads to large deviations between future market expectations and actual operating conditions,thereby increasing stock price crash risk. The level of earnings management reflects the transparency of a firm's accounting information and affects the level of information asymmetry (Dechow et al., 1995). Following Dechow et al. (1995), we use the absolute value of the residuals of the modified Jones model as a proxy for

Table 11
Industrial policy, information asymmetry and stock price crash risk.

| | (1) High | (2) Low | (3) High | (4) Low | (5) High | (6) Low | (7) High | (8) Low |
|---|---|---|---|---|---|---|---|---|
| | Earnings management | | | | Analyst following | | | |
| | *NCSKEW_F* | | *DUVOL_F* | | *NCSKEW_F* | | *DUVOL_F* | |
| *IP* | –0.054** | –0.029 | –0.047*** | –0.020 | –0.020 | –0.040*** | –0.022 | –0.046*** |
| | (–2.11) | (–1.40) | (–2.63) | (–1.41) | (–1.54) | (–2.76) | (–1.64) | (–2.92) |
| *NCSKEW* | 0.033*** | 0.063*** | | | 0.046*** | 0.061*** | | |
| | (2.93) | (8.71) | | | (5.02) | (7.45) | | |
| *DUVOL* | | | 0.046*** | 0.048*** | | | 0.035*** | 0.051*** |
| | | | (4.26) | (6.68) | | | (3.97) | (6.18) |
| *Sigma* | –0.334 | –0.278 | –0.712** | –0.432* | –0.521 | 0.071 | –0.586** | –0.258 |
| | (–0.69) | (–0.82) | (–2.24) | (–1.89) | (–1.23) | (0.19) | (–1.97) | (–1.05) |
| *Ret* | 6.352*** | 9.110*** | 4.550*** | 5.887*** | 7.527*** | 8.949*** | 6.006*** | 5.145*** |
| | (5.43) | (10.74) | (5.87) | (10.08) | (8.35) | (8.36) | (9.37) | (7.43) |
| *Turnover* | –0.028 | –0.055*** | –0.022* | –0.034*** | –0.036** | –0.055*** | –0.026*** | –0.034*** |
| | (–1.55) | (–4.53) | (–1.78) | (–4.16) | (–2.45) | (–4.04) | (–2.59) | (–3.83) |
| *Size* | –0.044*** | –0.045*** | –0.034*** | –0.045*** | –0.035*** | –0.071*** | –0.031*** | –0.057*** |
| | (–4.19) | (–6.39) | (–4.70) | (–9.09) | (–5.04) | (–7.31) | (–5.94) | (–8.81) |
| *Lev* | 0.007 | –0.036 | –0.003 | –0.012 | –0.123*** | 0.039 | –0.082*** | 0.035 |
| | (0.15) | (–1.08) | (–0.11) | (–0.53) | (–3.09) | (1.13) | (–2.91) | (1.59) |
| *ROA* | –0.508*** | –0.214 | –0.367*** | –0.109 | –0.359*** | –0.511*** | –0.215** | –0.356*** |
| | (–5.24) | (–1.43) | (–5.67) | (–1.11) | (–2.63) | (–5.56) | (–2.20) | (–5.81) |
| *BM* | –0.124** | –0.001 | –0.074** | 0.034 | –0.111*** | 0.073* | –0.027 | 0.069** |
| | (–2.44) | (–0.03) | (–2.16) | (1.43) | (–2.81) | (1.74) | (–0.94) | (2.51) |
| *PCF* | –0.022 | 0.018 | –0.020* | 0.007 | –0.005 | –0.009 | –0.011 | –0.012 |
| | (–1.18) | (0.49) | (–1.66) | (0.28) | (–0.23) | (–0.47) | (–0.65) | (–0.94) |
| *Ana* | 0.036*** | 0.036*** | 0.017*** | 0.021*** | 0.053*** | 0.011 | 0.035*** | 0.002 |
| | (3.96) | (5.80) | (2.80) | (5.19) | (4.66) | (0.99) | (4.29) | (0.30) |
| *Hinshold* | 0.742*** | 0.752*** | 0.476*** | 0.471*** | 0.740*** | 0.612*** | 0.461*** | 0.298*** |
| | (6.33) | (9.63) | (6.03) | (8.53) | (9.54) | (4.91) | (8.47) | (3.57) |
| *Constant* | 0.680*** | 0.766*** | 0.606*** | 0.844*** | 0.628*** | 1.178*** | 0.578*** | 1.066*** |
| | (3.13) | (5.01) | (4.01) | (7.86) | (4.19) | (6.05) | (5.18) | (8.05) |
| *Year FE* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry FE* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 9,805 | 21,409 | 9,805 | 21,409 | 14,808 | 16,406 | 14,635 | 16,579 |
| *Adj.*$R^2$ | 0.059 | 0.071 | 0.063 | 0.076 | 0.084 | 0.052 | 0.092 | 0.060 |

*Note:* The numbers in parentheses are *t*-statistics. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

the transparency of a firm's accounting information. The higher the value, the higher the degree of earnings management and the more serious the information asymmetry. Furthermore, we divide the sample into two groups (low and high earnings management) based on the annual industry average of the absolute value of the residuals of the modified Jones model for the regression. Columns (1)–(4) of Table 11 show that when stock price crash risk is measured using *NCSKEW_F*, the coefficient on *IP* is –0.054 and is significant at the 5% level in the high earnings management subsample. Similarly, when stock price crash risk is measured using *DUVOL_F*, *IP* is significant only in the high earnings management subsample.

In addition, Studies find that analysts, as information intermediaries, help reduce the information asymmetry between firms and external stakeholders (Pan et al., 2011; Ren et al., 2020). Compared with ordinary investors, analysts have professional advantages in collecting and processing information, which is conducive to providing more information about firm value to the capital market (Zhu et al., 2007; Li and Xiao, 2015). We use the analyst following as another proxy for the information asymmetry, and divide the sample into two groups (low and high analysts following) based on the annual industry average of the analyst following. Columns (5)–(8) of Table 11 show that when stock price crash risk is measured using *NCSKEW_F*, the coefficient on *IP* is –0.040 and is significant at the 1% level in the low analyst following subsample. Similarly, when stock price crash risk is measured using *DUVOL_F*, *IP* is significant only in the low analyst following subsample. The above results show that a national industrial policy can lower stock price crash risk by reducing information asymmetry of supported firms.

## 7. Conclusion

Stock price crash risk harms investors' interests, undermines their confidence and inhibits their participation in the market; it is also detrimental to the stability of financial markets. However, the literature on the causes of stock price crash risk does not investigate whether and how a country's industrial policy affects stock price crash risk. We use data from A-share listed firms in China between 2007 and 2020 to theoretically analyze and empirically test the effect of an industrial policy on stock price crash risk and its mechanism. We find that an industrial policy reduces stock price crash risk, and this finding remains robust after several robustness tests. Further analyses show that in regions with low levels of regional marketization, the inhibitory effect of an industrial policy on stock price crash risk is more pronounced. Furthermore, the inhibitory effect of an industrial policy is more significant when firms have high external uncertainty, receive small increments in long-term loans, receive fewer government subsidies and have low asset turnover and a high level of earnings management, indicating that an industrial policy reduces external uncertainty, improves corporate fundamentals and reduces agency costs and information asymmetry, all of which reduce stock price crash risk. This study adds to the literature on the economic consequences of industrial policies by providing new evidence for the effect of an industrial policy on financial market stability and enriches the literature on industrial policies and stock price crash risk.

Furthermore, our study findings have important policy implications. First, the relationship between the government and the market should be handled reasonably. While allowing the market mechanism to play a decisive role in the allocation of resources, the government should not neglect its regulatory role, especially when the market mechanism is dysfunctional. The government should use industrial policy instruments to support the development of the real economy. Second, China's industrial policy plays an important role in capital markets because of its role in lowering stock price crash risk, reducing systemic financial risk, promoting the healthy development of capital markets and providing a policy basis for the central government. Third, the government should deepen its reform process, improve the external business environment of firms and reduce external uncertainty. It is also important to lower the market access threshold, make institutional mechanisms more flexible, strengthen the financial system and eliminate obstacles to firm financing. Fourth, listed firms should actively use industrial policy support to implement industrial and technology upgrading, improve firm fundamentals and enhance their competitive advantage.

Our study has some limitations: First, we discuss the effect of an industrial policy on financial market stability from the perspective of stock price crash risk. However, stock price crash risk is only one of the angles to judge financial market stability. In addition to the stock price, the price fluctuation of other financial assets is also an important factor affecting financial market stability. Future research can supplement empirical evi-

dence based on more perspectives. Second, Industry development prospects, macroeconomic cycle and other factors may affect the formulation process of national industrial policies and stock price fluctuations. Although we try to use some methods to control, it may not be able to solve this endogeneity problem well. How to overcome the interference of missing variables in macroeconomic policy research and better identify the causal relationship between industrial policies and financial market stability is the direction of further research.

## Appendix A. Detailed list of supported industries in the 11th, 12th and 13th Five-Year Plans

| Industry code | 11th Five-Year Plan (2006–2010) | 12th Five-Year Plan (2011–2015) | 13th Five-Year Plan (2016–2020) |
|---|---|---|---|
| A01 | √ | √ | |
| A03 | √ | √ | |
| A05 | √ | √ | |
| A07 | √ | √ | √ |
| A09 | √ | √ | √ |
| B03 | √ | √ | |
| C01 | √ | √ | √ |
| C03 | √ | | |
| C05 | √ | | |
| C14 | √ | | |
| C35 | | √ | |
| C37 | | √ | |
| C43 | √ | √ | √ |
| C47 | √ | √ | √ |
| C49 | √ | | √ |
| C51 | √ | √ | √ |
| C57 | | √ | |
| C61 | √ | | √ |
| C67 | √ | | √ |
| C71 | √ | √ | |
| C73 | √ | √ | √ |
| C75 | √ | √ | √ |
| C76 | √ | √ | √ |
| C78 | √ | | √ |
| C81 | √ | √ | |
| C85 | √ | √ | √ |
| D01 | √ | √ | |
| D05 | | | √ |
| E01 | √ | | √ |
| F01 | √ | √ | √ |
| F03 | √ | √ | √ |
| F05 | √ | √ | √ |
| F07 | √ | √ | √ |
| F09 | √ | √ | √ |
| F11 | √ | √ | √ |
| F19 | √ | √ | √ |
| F21 | √ | √ | √ |
| G81 | √ | √ | √ |

| | | | |
|---|---|---|---|
| G83 | √ | √ | √ |
| G85 | √ | √ | √ |
| G87 | √ | √ | √ |
| H01 | √ | √ | |
| H03 | √ | √ | |
| H09 | √ | √ | |
| H11 | √ | √ | |
| H21 | √ | √ | |
| K01 | √ | √ | √ |
| K10 | √ | √ | √ |
| K20 | | √ | √ |
| K30 | | √ | |
| K32 | | √ | |
| K34 | √ | √ | √ |
| K36 | | √ | √ |
| K37 | √ | √ | √ |
| K99 | √ | √ | √ |
| L01 | | √ | √ |
| L05 | | √ | √ |
| L10 | √ | √ | √ |
| L15 | √ | √ | √ |
| L20 | √ | | √ |
| L99 | √ | √ | √ |

Data source: Following Chen et al. (2010), Li and Li (2014), Chen et al. (2017) and Chen and Yao (2018), we classify supported industries in accordance with the 11th, 12th and 13th Five-Year Plans.
*Note:* The industries are classified according to the three-digit Industry Classification code for listed firms issued by the CSRC in 2001.

## Appendix B. Variable definitions

| Variable | Definition |
|---|---|
| *NCSKEW_F* | According to Eq. (4), this variable captures the negative conditional skewness of stock returns in year $t + 1$. |
| *DUVOL_F* | According to Eq. (5), this variable captures the ratio of stock return fluctuations in year $t + 1$. |
| *IP* | A dummy variable that takes a value of1 if a firm's industry is supported by the national industrial policy and otherwise 0. |
| *NCSKEW* | According to Eq. (4), this variable captures the negative conditional skewness of stock returns in year *t*. |
| *DUVOL* | According to Eq. (5), this variable captures the ratio of stock return fluctuations in year *t*. |
| *Turnover* | Monthly excess stock turnover, average monthly stock turnover rate in year *t* minus average monthly stock turnover rate in year *t*–1. |
| *Sigma* | Standard deviation of weekly stock returns in year *t*. |
| *Ret* | Average value of weekly stock returns in year *t*. |
| *Size* | Firm size, logarithm of total assets in year *t*. |
| *Lev* | Firm leverage, ratio of total debt to total assets in year *t*. |
| *ROA* | Return on assets, ratio of net profit to total assets in year *t*. |
| *BM* | Book-to-market ratio, ratio of a firm's book value to its market value in year *t*. |
| *PCF* | Proportion of cash flow, ratio of operating cash flow to sales revenue in year *t*. |
| *Ana* | Analyst following, logarithm of the number of analysts + 1 in year *t*. |

| | |
|---|---|
| *Hinshold* | Shareholding ratio of institutional investors, ratio of shares held by institutional investors to total shares in year *t*. |
| *Industry* | A dummy variable that takes a value of1 if the observation is from this industry and otherwise 0. |
| *Year* | A dummy variable that takes a value of1 if the observation is from this year and otherwise 0. |

## References


Aghion, P., Cai, J., Dewatripont, M., Du, L.S., Harrison, A., Legros, P., 2015. Industrial policy and competition. Am. Econ. J. Macroecon. 7 (4), 1–32.

Allen, F., Gale, D., 2000. Corporate governance and competition. Corporate Governance: Theoretical and Empirical Perspectives. Cambridge University Press.

Banz, R.W., 1981. The relationship between return and market value of common stocks. J. Financ. Econ. 9 (1), 3–18.

Bekaert, G., Wu, G., 2000. Asymmetric volatility and risk in equity markets. Rev. Fin. Stud. 13 (1), 1–42.

Bhandari, L.C., 1988. Debt/Equity ratio and expected common stock returns: Empirical evidence. J. Fin. 43 (2), 507–528.

Birt, J.L., Bilson, C.M., Smith, T., 2006. Ownership, competition, and financial disclosure. Austr. J. Manage. 31 (2), 235–263.

Callen, J., Fang, X., 2012. Crash risk and the auditor-client relationship. Contemp. Acc. Res. 34 (3), 1911–3846.

Chen, D., Yao, Z., 2018. Will government behavior definitely increase stock price synchronicity? Empirical evidence from China's industrial policies. Econ. Res. J. 53 (12), 112–128, in Chinese.

Chen, D., Li, Z., Xin, F., 2010. Industrial policy and corporate finance—Empirical evidence from China. In: Proceedings of the China Accounting and Finance Review International Symposium, pp. 231–310, in Chinese.

Chen, D., Li, O.Z., Xin, F., 2017. Five-Year Plans, China finance and their consequences. China J. Acc. Res. 10 (3), 189–230.

Chen, D., Kim, J.B., Li, O.Z., Liang, S., 2018. China's closed pyramidal managerial labor market and the stock price crash risk. Acc. Rev. 93 (3), 105–131.

Chen, Y., Liu, Z., Guo, Y., 2016. The problems and transformation of China's macro-control under new normal. J. Party School Central Committee C.P.C. 20 (1), 106–112, in Chinese.

Chen, Z., Wang, S., 2015. Impact of product market competition on corporate cash flow risk—Analysis based on the competition degree of industry and the competitive position of enterprise. China Ind. Econ. 3, 96–108, in Chinese.

Cheng, X., Tan, Y., Xu, L., 2011. Company value, voluntary disclosure and marketization process—Disclosure based on qualitative information. J. Fin. Res. 8, 111–127, in Chinese.

Chu, J., Fang, J., 2017. The external governance effect of government auditing: Evidence from firms' stock price crash risk. J. Fin. Econ. 43 (4), 133–145, in Chinese.

Dasgupta, S., Gan, J., Gao, N., 2010. Transparency, price informativeness, and stock return synchronicity: Theory and evidence. J. Fin. Quantit. Anal. 45 (5), 1189–1220.

Dechow, P.M., Sloan, R.G., Sweeney, A.P., 1995. Detecting earnings management. Acc. Rev. 70 (02), 193–225.

Defond, M.L., Hung, M., Li, S., Li, Y., 2015. Does mandatory IFRS adoption affect crash risk? Acc. Rev. 90 (1), 265–299.

Deng, K., Zhan, W., 2020. Industrial policies and stock price crash risk. Fin. Sci. 2, 49–64, in Chinese.

Dimson, E., 1979. Risk measurement when shares are subject to infrequent trading. J. Financ. Econ. 7 (2), 197–226.

Fama, E.F., French, K.R., 1992. The cross-section of expected stock returns. J. Fin. 47 (2), 427–465.

Fan, J.P.H., Wong, T.J., 2005. Do external auditors perform a corporate governance role in emerging markets? Evidence from East Asia. J. Acc. Res. 43 (1), 35–72.

French, K.R., Schwert, G.W., Stambaugh, R.F., 1987. Expected stock returns and volatility. J. Financ. Econ. 19 (1), 3–29.

Haldane, A.G., Hoggarth, G., Saporta, V., Sinclair, P., 2005. Financial stability and bank solvency. System. Financ. Crises, 83–113.

Han, Y., Huang, L., Wang, X., 2017. Do Industrial policies promote industrial structure upgrading? Theory and evidence from China's development-oriented local government. Econ. Res. J. 52 (8), 33–48, in Chinese.

Hayes, R.M., Lundholm, R., 1996. Segment reporting to the capital market in the presence of a competitor. J. Acc. Res. 34 (2), 261–279.

Healy, P.M., Hutton, A.P., Palepu, K.G., 1999. Stock Performance and intermediation changes surrounding sustained increases in disclosure. Contemp. Acc. Res. 16 (3), 485–520.

Hutton, A.P., Marcus, A.J., Tehranian, H., 2009. Opaque financial report, R2, and crash risk. J. Financ. Econ. 94 (1), 67–86.

Jensen, M.C., Meckling, W., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. J. Financ. Econ. 3 (4), 305–360.

Jia, N., 2018. Corporate innovation strategy and stock price crash risk. J. Corp. Fin. 53, 155–173.

Jiang, X., 2013. Tax enforcement, tax aggressiveness and stock price crash risk. Nankai Bus. Rev. 16 (5), 152–160, in Chinese.

Jiang, F., Huang, L., Zhang, M., 2009. Product market competition, corporate governance and agency costs. J. World Econ. 32 (10), 46–59, in Chinese.

Jiang, F., Li, X., 2010. Direct market intervention and restrict competition: The orientation of China's industrial policy and its fundamental defects. China Ind. Econ. 9, 26–36, in Chinese.

Jin, L., Myers, S.C., 2006. R2 around the world: New theory and new tests. J. Fin. Econ. 79 (2), 257–292.

Kim, J.B., Li, Y., Zhang, L., 2011. CFOs versus CEOs: Equity incentives and crashes. J. Financ. Econ. 101 (3), 713–730.
Kim, J.B., Wang, Z., Zhang, L., 2016. CEO overconfidence and stock price crash risk. Contemp. Acc. Res. 33 (4), 1720–1749.
Konchitchki, Y., Luo, Y., Ma, M.L.Z., Wu, F., 2016. Accounting-based downside risk, cost of capital, and the macroeconomy. Rev. Acc. Stud. 21 (1), 1–36.
Lang, M., Maffett, M., 2010. Economic effects of transparency in international equity markets. Found. Trends Acc. 5, 175–241.
Li, W., Cai, G., 2016. Religion and stock price crash risk: Evidence from China. China J. Acc. Res. 9 (3), 235–250.
Li, W., Li, Y., 2014. Does industrial policy promote corporate investment. China Ind. Econ. 5, 122–134, in Chinese.
Li, X., Liu, H., 2012. CEO vs CFO: Gender and stock price crash risk. J. World Econ. 35 (12), 102–129, in Chinese.
Li, X., Wang, S.S., Wang, X., 2017. Trust and stock price crash risk: Evidence from China. J. Bank. Finance 76, 74–91.
Li, X., Xiao, T., 2015. Are management earnings forecasts useful for analyst forecast revisions. Nankai Bus. Rev. 18 (2), 30–38, in Chinese.
Li, W., Zheng, M., 2016. Is it substantive innovation or strategic innovation? Impact of macroeconomic policies on micro-enterprises' innovation. Econ. Res. J. 51 (4), 60–73, in Chinese.
Lin, Y., 2002. Development strategy, viability and economic convergence. China Econ. Quart. 1, 269–300, in Chinese.
Lin, Y., 2007. Wave phenomenon and the reconstruction of macroeconomic theories for developing countries. Econ. Res. J. 1, 126–131, in Chinese.
Liu, Z., Yu, M., 2009. Research on product market competition and company cash holding value. Inquiry Econ. Issues 2, 140–145, in Chinese.
Luo, J., Du, X., 2014. Media coverage, institutional environment and stock price crash risk. Acc. Res. 9, 53–59+97, in Chinese.
Ma, C., Tian, Y., 2020. Dividend yield, institutional investors and stock price crash risk. Syst. Eng.—Theory Pract. 40 (12), 3019–3033, in Chinese.
Meng, Q., Yin, X., Bai, J., 2016. Does industrial policy affect enterprise innovation? Evidence from the natural experiment of Five-Year Plan's change. S. China J. Econ. 12, 1–25, in Chinese.
Mishkin, F.S., 1992. Anatomy of a financial crisis. J. Evolut. Econ. 2 (2), 115–130.
Morck, R., Yeung, B., Yu, W., 2000. The information content of stock markets: Why do emerging markets have synchronous stock price movements? J. Fin. Econ. 58 (1–2), 215–260.
Padoa-Schioppa, T., 2003. Central banks and financial stability: Exploring the land in between. Transf. Eur. Fin. Syst. 25, 269–310.
Pan, Y., Dai, Y., Lin, C., 2011. Opaque information, analyst attention and the risk of individual stock plunges. J. Fin. Res. 9, 138–151, in Chinese.
Peng, Y., Ni, X., Shen, J., 2018. The effect of transforming the economy from substantial to fictitious financial market stability: An analysis on stock price crash risk. Econ. Res. J. 53 (10), 50–66, in Chinese.
Peters, M., Li, Y., Zhang, L., 2012. The impact of technology-push and demand-pull policies on technical change-Does the locus of policies matter. Res. Policy 41 (8), 1296–1308.
Piotroski, J.D., Wong, T.J., 2012. Institutions and Information Environment of Chinese Listed Firms. University of Chicago Press.
Qian, A., Zhang, C., Bu, D., 2015. Macroeconomic shock, industrial policy and government subsidy. Ind. Econ. Res. 5, 73–82, in Chinese.
Ren, F., Luo, J., Chen, Z., Xiong, X., Li, S., 2020. Information content transmitted to the market by the analysts' in-depth reports: A text decomposition based on "new" and "old" information. Syst. Eng.—Theory Pract. 40 (12), 3034–3058, in Chinese.
Schmidt, K.M., 1997. Managerial incentives and product market competition. Rev. Econ. Stud. 64 (2), 191–213.
Shen, H., Cou, H., Zhang, C., 2010a. An empirical study of financial development, financing constraints and corporate investment. China Ind. Econ. 6, 55–64, in Chinese.
Shen, H., Wu, L., Xiao, Z., 2010b. Environmental uncertainty and audit opinion: An investigation based on ownership structure. Acc. Res. 12, 57–64, in Chinese.
Shi, J., Liu, W., Yang, W., 2011. Test for financial market stability based on quantile regression method. Chinese J. Manage. Sci. 19 (2), 24–29, in Chinese.
Shleifer, A., Vishny, R.W., 1994. Politicians and firms. Quarter. J. Econ. 109 (4), 995–1025.
Shu, R., 2013. Industrial policy must be valid? Empirical analysis based on industrial data. Ind. Econ. Res. 3, 45–54+63, in Chinese.
Song, L., Wang, X., 2013. Key industrial policy, resource reset and industrial productivity. J. Manage. World 12, 63–77, in Chinese.
Tosi, H., Aldag, R., Storey, R., 1973. On the measurement of the environment: An assessment of the Lawrence and Lorsch environmental uncertainty subscale. Adm. Sci. Q. 18 (01), 27–36.
Wang, H., Cao, F., Gao, S., Li, Z., 2014. Investor protection and stock price crash risk. Fin. Trade Econ. 10, 73–82, in Chinese.
Wang, H., Cao, F., Ye, K., 2015. Monitoring or tunneling? The proportion of the proportion held by the big shareholders and the risk of the crash of the stock price. Manage. World 2, 45–57+187, in Chinese.
Wang, X., Fan, G., Yu, W., 2019. Marketization Index of China's Provinces: NERI Report 2018. Social Sciences Academic Press.
Wen, H., Gao, H., Chen, S., Xiao, J., 2020. Administrative supervision over audit firms and stock price crash risk: Evidence from CSRC's random inspection. Syst. Eng.—Theory Pract. 40 (11), 2769–2783, in Chinese.
Wu, Z., Li, X., 2015. Insider selling, information environment and stock price crash risk. Acc. Res. 6 (48–55), 97, in Chinese.
Xin, Q., Kong, D., Hao, Y., 2014. Transparency and stock price volatility. J. Fin. Res. 10, 193–206, in Chinese.
Xu, N., Jiang, X., Yi, Z., Xu, X., 2012. Conflicts of interest, analyst optimism and stock price crash risk. Econ. Res. J. 47 (7), 127–140, in Chinese.
Xu, N., Yu, S., Yi, Z., 2013. Institutional investor herding behavior and stock price crash risk. J. Manage. World 7, 31–43, in Chinese.
Xu, N., Li, X., Yuan, Q., Chan, K.C., 2014. Excess perks and stock price crash risk: Evidence from China. J. Corp. Fin. 25 (2), 419–434.
Ye, K., Cao, F., Wang, H., 2015. Can internet control information disclosure reduce stock price crash risk? J. Fin. Res. 2, 192–206, in Chinese.

Yu, M., Fan, R., Zhong, H., 2016. Chinese industrial policy and corporate technological innovation. China Ind. Econ. 12, 5–22, in Chinese.

Yu, Y., Jiang, Y., Wang, L., 2020. Do non-executive employee equity incentives reduce stock price crash risk? Syst. Eng.—Theory Pract. 40 (11), 2784–2797, in Chinese.

Zhang, X., Zhang, T., Chen, D., 2017. Industrial policy, financing constraints and investment efficiency. Acc. Res. 4, 12–18+95, in Chinese.

Zhang, M., Zhang, S., Wang, C., Shen, H., 2010. Political connection and credit resource allocation efficiency: Empirical evidence from private listed companies in China. J. Manage. World 11, 143–153, in Chinese.

Zhu, J., Han, F., Lu, Z., 2015. Industrial policy, bank connections, and debt financing: An empirical research based on A-share listed companies. J. Fin. Res. 3, 176–191, in Chinese.

Zhu, H., He, X., Tao, L., 2007. Can China's securities analysts improve the capital market efficiency: Empirical evidence based on stock price synchronization and stock price information content. J. Fin. Res. 2, 110–121, in Chinese.

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# Concurrent independent directors in the same industry and accounting information comparability

Shangkun Liang [a], Rong Fu [a], Xue Yang [b,*]

[a] School of Accountancy/China's Management Accounting Research & Development Center, Central University of Finance and Economics, China
[b] School of Intelligent Finance & Accounting Management, Guangdong University of Finance & Economics, China

ARTICLE INFO

*Article history:*
Received 23 February 2022
Accepted 13 September 2022
Available online 12 October 2022

*Keywords:*
Independent directors
Concurrent in the same industry
Accounting information comparability
Industry perception
Audit opinions

ABSTRACT

Using a sample of Chinese A-share listed companies during the 2008–2019 period, we explore the impact of concurrent independent directors in the same industry (hereafter CIDSI) on accounting information comparability. We find that CIDSI can effectively promote accounting information comparability and that this effect is realized mainly through inhibiting earnings management. We also find that CIDSI can provide broader industry perception of the company's board reports. Variations in concurrent companies and internal and external environments have significant moderating effects on the relationship between CIDSI and accounting information comparability. This relationship contributes to reducing audit fees and the possibility of receiving non-standard unqualified audit opinions. Our findings have implications for companies by demonstrating the importance of recruiting independent directors.


## 1. Introduction

Accounting information informs the capital market of a company's financial situation and business performance, and high-quality accounting information can help shareholders and investors improve the efficiency of their decision-making by overcoming information asymmetry (Biddle et al., 2009). However, the quality of accounting information provided by listed companies is not always irreproachable. In recent years, news reports of financial fraud have increased. For instance, on 2 April 2020, the Luckin Coffee Company admitted to falsifying a 2.2 billion RMB transaction between the second and fourth quarters of 2019, and on 12 November 2021, the Kangmei Pharmaceutical Co. was fined 2.459 billion RMB for financial fraud over 3 consecutive

* Corresponding author.
*E-mail address:* 375686973@qq.com (X. Yang).

https://doi.org/10.1016/j.cjar.2022.100268
1755-3091/

years. In the latter case, five of the independent directors of Kangmei were made jointly liable for over 100 million RMB for failing to identify false records in the company's annual reports in a timely manner. This fraud has led not only to an increased focus on accounting information quality by academics and practitioners but also to public doubt in the effectiveness of the independent director system. As a result, whether independent directors are independent, diligent or able to identify fraud is being questioned. Given the significance of the role of independent directors in corporate governance, it is necessary and urgent to discuss the effectiveness of their functions.

Persistent accounting information fraud damages the public's trust in accounting information. Conversely, improving accounting information comparability can enhance the quality and reliability of accounting information. In 1980, the U.S. Financial Accounting Standards Board (FASB) issued a report on *Qualitative Quality Characteristics of Accounting Information*, in which comparability was listed as an important component of the quality of accounting information for the first time. A high level of accounting information comparability enables an objective and neutral assessment of a company's financial status and facilitates comparative performance analyses of different accounting entities, thereby improving the utility of accounting information. It also improves the relevance and reliability of corporate strategic decisions (Yuan and Wu, 2012). However, the accurate measurement of accounting information comparability is a challenging task, and relevant academic research from the early years is scarce. Following the development of the pioneering measurement model for accounting information comparability by De Franco et al. (2011), many studies are investigating accounting standards and internal and external aspects of corporate governance. The literature reveals that the adoption of both International Financial Reporting Standards (IFRS) (Armstrong et al., 2010) and convergent accounting standards (Yi et al., 2017) improves accounting information comparability. Legal supervision intensity (Barth et al., 2012), internal controls (Wang et al., 2019a) and top managers' ties (Zhou et al., 2017) also affect accounting information comparability. Research on accounting information comparability not only provides a reference for the formulation and implementation of accounting standards but also protects the interests of small and medium investors and indicates new directions for government regulation, thus promoting the stable and healthy development of the capital market.

Many studies on accounting information comparability and corporate governance focus on independent directors, who supervise the quality of the information provided in financial reports and offer support and strategic suggestions for important decisions, such as companies' selection of accounting policies (Liu et al., 2019). The effectiveness of independent directors depends largely on the quantity and quality of the information with which they deal. Some researchers focus on the proportion of independent directors, their academic backgrounds and their network centrality as influences on their effectiveness (Quan and Li, 2017; Liang et al., 2018). These studies confirm that independent directors utilize information to play their governance role as external experts. Conversely, other studies fundamentally question the supervisory and consulting abilities of independent directors (Hermalin and Weisbach, 1991). These inconsistent research conclusions on the effectiveness of independent directors may result from differences in the information acquired by the independent directors. A key question that we seek to answer is whether independent directors who hold concurrent positions in the same industry use industry information more objectively and comprehensively (than other directors without concurrent positions in the same industry) to evaluate the company's current operational situation and identify false records in annual reports. Independent directors who are screened by the human capital market and receive concurrent job opportunities in the same industry are likely to have excellent professional knowledge, abundant work experience and stable industry reputations. Our second key question is whether, compared with other directors, the insights and social resources of directors with concurrent same-industry positions help them to identify and avoid risks as early as possible, thus maintaining a high level of accounting information comparability. These questions have ample theoretical and practical significance, as resolving them may improve the effectiveness of the independent director system and enhance accounting information comparability.

This study focuses on the characteristics of independent directors with concurrent positions in the same industry. Using Chinese A-share listed companies for the 2008–2019 period as our research sample, we examine the impact of concurrent independent directors in the same industry (hereafter CIDSI) on accounting information comparability. We find that the higher (lower) the proportion of CIDSI within a company, the higher (lower) the accounting information comparability, and that the primary mechanism underlying this

relationship is the restraint of earnings management. In a further analysis, we show that this positive effect of CIDSI is more significant in industries with lower technology intensity than in those with higher technology intensity. Moreover, we find that CIDSI can provide broader industry perception of the company's board reports. Then, by distinguishing between various companies with CIDSI, we find that their effect on improving accounting information comparability is more (less) influential when their concurrent companies have lower (higher) performance volatility and higher (lower) quality financial reports. We examine different internal and external environments and find that the positive effect of CIDSI is more (less) significant in companies with lower (higher) shareholding ratios of institutional investors, as well as in companies operating in weaker (stronger) regional legal environments. Our exploration of economic consequences reveals that the positive effect of CIDSI on accounting information comparability reduces audit fees and the likelihood of the company being issued non-standard unqualified audit opinions. By combining these findings, this study verifies the positive effect of CIDSI on accounting information comparability.

This study makes two contributions to the literature. First, it enriches the research on factors influencing accounting information comparability from the perspective of independent directors as industry information providers. The literature argues that a high level of corporate governance can contribute positively to accounting information comparability (Zhang and Pan, 2018). However, most studies on the influence of board members on accounting information comparability are conducted from the perspective of the influence of executive characteristics such as gender (Liao and Liao, 2020), independent directorate interlocks (Liu et al., 2019) and top managers' ties (Zhou et al., 2017). Few researchers focus on the governance role of independent directors as advisors with high-value industry information. We find that the characteristics of CIDSI mean that they have an advantage in understanding and being familiar with industry norms and standards, which helps them readily acquire and accurately perceive industry information and industry prospects. We explore the impact of the CIDSI's characteristics on the effectiveness of directors in performing their duties.

Second, we advance the research on the performance of independent directors' functions. Most studies on this topic focus on the influence of independent directors' characteristics such as their overseas experience (Masulis et al., 2012) and academic (Quan and Li, 2017) or political background (Li and Guo, 2022). A few studies explore the effectiveness of the independent director system based on the ranking system of traditional Chinese culture (Zhu et al., 2016). We examine how to fully utilize the supervisory and consulting functions of CIDSI. We find that CIDSI with specific types of information, backgrounds and connections can help companies obtain comparable accounting information from within the same industry, bridge the information gap that prevails among companies and reduce their companies' dependence on the external environment. These findings have both theoretical implications and practical value for optimizing the composition of corporate boards and enhancing the effectiveness of independent directors in the performance of their duties.

Liu et al. (2019) find that interlocking independent directorates can significantly reduce the differences in accounting accruals between two companies.[1] They affirm the effectiveness of independent directors from the perspective of independent director interlocks, and enrich research on the factors influencing accounting information comparability. The findings of our study support Liu et al. (2019) but differ in three ways. First, the research perspectives of the two papers are different. Liu et al. (2019) focus on the interlocks of company pairs of independent directors, whereas we provide a comprehensive portrayal of CIDSI for every company in our sample using a concise calculation method. Our novel research perspective enables us to avoid the tedious steps of defining and matching sample company pairs, and reduces reliance on matching accuracy for the credibility of our findings. Second, the research subjects of the two papers are different. Liu et al. (2019) explore synchronization of the absolute value of the difference in total and discretionary accruals or earnings changes between two companies in independent director interlocks. Conversely, we focus on the impact of the proportion of CIDSI on the level of accounting information comparability for all A-share listed companies during our period of analysis. We define accounting information comparability broadly, according to industry standards, rather than limiting it to specific comparable objects and subjects, which enhances the generalizability

[1] Liu et al. (2019) refer to Francis et al. (2014) in defining their explanatory variable as the absolute value of the difference in total and discretionary accruals between firm *i* and firm *j* in the same industry.

of our research findings. Third, the research methods differ between the two papers. Liu et al. (2019) use dummy variables to distinguish whether there is an independent director interlock, whereas we fully and carefully determine and describe the proportion of CIDSI. Examining the proportion of CIDSI over time during our study period makes it easy to observe the distribution of CIDSI in industries and years and how this distribution changes, which facilitates insights into the characteristics of CIDSI and promotes subsequent research.[2] For instance, the research on the function of CIDSI in subdivided industries and years, also the research based on the personal characteristics of CIDSI.

## 2. Literature review and hypothesis development

### *2.1. Literature review*

Comparability is a significant component of accounting information quality, as it facilitates accurate comparison and analysis of companies' operating situations and evaluation and prediction of their future prospects (Yuan and Wu, 2012). The literature explores the factors influencing accounting information comparability and its economic consequences.

The relevant literature can be divided into three broad areas: accounting standards, internal corporate governance and the external regulatory environment. In terms of the influence of accounting standards on accounting information comparability, Armstrong et al. (2010) study the European stock market and find that the introduction of the IFRS led to an incremental positive market response for companies that previously had low accounting information quality; thus, the IFRS is conducive to improving accounting information comparability. Yi et al. (2017) consider A shares, H shares and Hong Kong shares and identify that the convergence of accounting standards helps improve the comparability of financial reporting. In terms of internal corporate governance, Zhou et al. (2017) and Liu et al. (2019) investigate inter-organizational imitation behavior and find that companies with top managers' ties and independent director interlocks have higher accounting information comparability than other companies. In addition to board characteristics, Wang et al. (2019a) find that good internal controls can reduce analysts' forecasting disagreements by enhancing accounting information comparability. In terms of the external regulatory environment, Barth et al. (2012) find that strict legal regulations help improve the comparability of financial reports. Francis et al. (2014) show that accounting information comparability is higher for companies audited by the "Big 4" than for companies with other auditors.

De Franco et al. (2011) state that a high level of accounting information comparability helps analysts obtain more high-quality information about companies than they could otherwise, which improves the accuracy of analysts' forecasts. Gong et al. (2013) suggest that non-synchronicity of accounting earnings increases the motivation of management to issue accurate earnings forecasts. Liu et al. (2015) explore the behavior of corporate mergers and acquisitions (M&A) transactions and find that the increase in shareholder wealth after M&As can be attributed to a high level of accounting information comparability of the main merging company.

The above review shows that current research on the factors influencing accounting information comparability is focused on accounting standards, internal corporate governance and the external regulatory environment. The exploration of internal corporate governance focuses on independent directors, but the literature does not yet examine the mechanism of their functions in detail nor consider the characteristics of CIDSI in particular. Independent directors play a significant governance role in monitoring the quality of accounting information in financial reports. Therefore, we explore whether CIDSI can help improve accounting information comparability and yield economic benefits for companies.

[2] We establish a CIDSI dummy variable and find that the accounting information comparability is higher for companies with CIDSI than for other companies. To exclude concerns that the conclusion is derived only because of the differences between the independent variable involving zero and non-zero observations, we retest our conclusion using a sample in which the proportion of CIDSI is greater than zero for all companies, and our main result holds.

### 2.2. Hypothesis development

Our study analyzes the impact of CIDSI on accounting information comparability in terms of their motivations and ability to perform their duties. From the perspective of motivation, independent directors may be motivated to perform their duties diligently to avoid wealth loss, seat loss and reputation damage (Tang et al., 2010). In China, the ex-ante fixed annual salary and allowance weaken the direct economic incentive of remuneration in motivating independent directors to perform their duties. However, concurrent independent directors who hold multiple board seats can bring abundant experience and social resources to a company, which can potentially provide resources for additional seats. Therefore, reputation is an important motivation for CIDSI in performing their governance role (Jiang et al., 2016). First, holding concurrent roles in the same industry endows independent directors with high social prestige, thus deepening their pursuit of and desire for an elite identity (Wang, 2007). Second, the extensive and complex social relationships of CIDSI increase their consciousness of the need to maintain their reputations, making them keen to follow prudent principles and avoid litigation risks. To establish a good reputation in the human capital market, CIDSI perform their duties diligently and aim for excellent performance. Consequently, they counter any tendency among the company's management for selective compliance with accounting standards and other self-interested behaviors, and promote similar financial and accounting behaviors and the provision of comparable accounting information among companies in the same industry.

From the perspective of ability, CIDSI are not only familiar with industry regulations and standards but also have access to industry information and prospects, which has four consequences. First, CIDSI are an important channel through which companies can access industry resources and knowledge. Their ability to provide valuable industry information on accounting policies, procedures and methods can help companies fill the information gap that they often face in doing business (Dass, 2014). When a company's financial accounting information is close to industry standards, it helps the company to demonstrate that it has a high level of accounting information comparability. Second, CIDSI are familiar with the accounting standards and specific transaction processes followed by companies in the industries in which they hold directorships and can more readily pinpoint possible earnings management practices and financial data errors in the company's production and operation processes than other (non-CIDSI) directors, and thus provide practical solutions. By curbing the opportunistic behavior of management and improving the quality of financial statements, CIDSI can help users of accounting information obtain accurate and reliable information about companies and conduct cross-sectional and vertical comparative analyses. Third, only independent directors with superior expertise, abundant experience and stable social resources in the industry are likely to be recognized by the human capital market and offered the opportunity to serve in concurrent positions in the same industry. The possession of concurrent appointments in the same industry enables independent directors to actively promote knowledge spillovers and learning effects, as they act as information transmitters in the social network (Liu et al., 2019). Such appointments also help companies perceive industry development trends more accurately, leading to a higher level of accounting information comparability than in the absence of CIDSI. Fourth, accounting information comparability is influenced by the accuracy of the management's interpretation of accounting standards (Liao and Liao, 2020). The characteristics of CIDSI mean that they can interpret accounting standards more accurately than can management, which is beneficial for the stable long-term development of the company; moreover, in contrast with managers, CIDSI do not misinterpret accounting information because of their pursuit of short-term company performance. Thus, they help the company to develop a long-term focus according to the future strategic planning of the industry, thus improving accounting information comparability.[3]

Based on the above analysis, we propose the following research hypothesis:

**Hypothesis.** *CIDSI are helpful in improving accounting information comparability.*

[3] It is possible that CIDSI have a limited impact on accounting information comparability in some companies. Although some companies may suspect that the information provided by CIDSI adds little to the proprietary costs of their concurrent companies (Ke et al., 2020), others may consider that the information possessed by CIDSI is not comprehensive enough to compensate for the information disadvantage of their companies.

## 3. Research design

### 3.1. Model construction and variable definitions

We design regression model (1) to test the relationship between CIDSI and accounting information comparability:

$$Compare_{i,t} = \beta_0 + \beta_1 SameInduR_{i,t} + \Sigma Control_{i,t} + \Sigma Industry + \Sigma Year + \varepsilon_{i,t}. \quad (1)$$

*Compare* is defined following De Franco et al. (2011) and Xu and Liu (2014). Specifically, we use the data of company *i*'s 16 consecutive quarters before period *t* to calculate the accounting information comparability between company *i* and other companies in the same industry. Because an excessive number of companies may bring noise to the assessment results, investors usually select 4–6 companies with the highest comparability in the industry to assess accounting information comparability (Cooper and Cordeiro, 2008). Consequently, we rank the comparability values of company *i* with other companies in the same industry from the largest to the smallest and take the average of the top four values as the accounting information comparability of company *i*. The larger the value of *Compare*, the stronger the accounting information comparability. In reporting coefficients, we refer to Wang et al. (2019a) and multiply the accounting information comparability value by 100 in the regression process.

*SameInduR* is defined as described by Ke et al. (2020). Specifically, we adopt guidelines on the industry classification of listed companies issued by the China Securities Regulatory Commission (CSRC) in 2012. *SameInduR1* is the ratio of the number of companies with CIDSI to the number of all companies with concurrent independent directors in any industry. *SameInduR2* is the ratio of the number of CIDSI to the number of all concurrent independent directors in any industry. *SameInduR3* is the average value of the ratio of the number of companies with CIDSI to the number of all companies with concurrent independent directors in any industry.[4]

Following the literature, we include the control variables *Duality*, *Lev*, *ROA*, *Growth*, *Size*, *Firsthold*, *Sh2_5*, *Manhold*, *Boardsize*, *IndR* and *Listage* in our regression. control variables include the concurrently general manager and chairman of the board *Duality* (*Duality*), leverage (*Lev*), return on assets (*ROA*), growth ability (*Growth*), firm size (*Size*), percentage of shares held by the top shareholder (*Firsthold*), percentage of shares held by the second to fifth largest shareholders (*Sh2_5*), management shareholding ratio (*Manhold*), board size (*Boardsize*), independent director ratio (*IndR*) and company listing years (*Listage*). Panel B of Table 1 summarizes the variables. To avoid the influence of extreme values, we winsorize all continuous variables at the 1 % level.

### 3.2. Data sources and sample selection

Our research sample consists of Chinese A-share listed companies in the 2008–2019 period. We use the following process to refine the sample: (1) elimination of special treatment (ST) and delisting warning (*ST) observations; (2) exclusion of observations for the financial industry; and (3) elimination of missing or abnormal observations. Our final sample includes 16,191 firm-year observations. The data used for this study are obtained from the China Stock Market and Accounting Research (CSMAR) database and Chinese Research Data Services (CNRDS) platform. We perform the statistical analysis using Stata 15.0.

## 4. Empirical results and analysis

### 4.1. Descriptive statistics

Table 2 reports the descriptive statistics of the main variables used in our study. The mean value of *Compare* is –0.002 and the standard deviation is 0.002, indicating that accounting information comparability does

[4] An example is provided in Panel A of Table 1.

Table 1
Examples of Explanatory Variable Measurement and Definitions of Main Variables, Panel A: Measurement of CIDSI, Code: 000030. Year: 2014. Industry classification standard: Guidelines on the industry classification of listed companies issued by the CSRC in 2012., Panel B: Definitions of the main variables in the study.

| Industry | Name of independent director | Code of concurrent company | Industry of concurrent company | Whether concurrent in the same industry | *SameInduR1* | | *SameInduR2* | | *SameInduR3* | |
|---|---|---|---|---|---|---|---|---|---|---|
| C36 | Zhu Wenshan | 000,927 | C36 | 1 | 1 | (1 + 0 | 1 | (1 + 0 | 1/2 | (1/2 + 0 |
| C36 | Zhu Wenshan | 002,338 | C40 | 0 | | + 2)/6 | | + 1)/3 | | + 2/3)/3 |
| C36 | Li Xiao | 600,116 | D(D44) | 0 | 0 | = 0.5 | 0 | = 0.667 | 0 | = 0.389 |
| C36 | Wu Boda | 002,232 | I(I65) | 0 | 2 | | 1 | | 2/3 | |
| C36 | Wu Boda | 000,800 | C36 | 1 | | | | | | |
| C36 | Wu Boda | 600,742 | C36 | 1 | | | | | | |

| Name | Symbol | Definition |
|---|---|---|
| Accounting information comparability | *Compare* | The average accounting information comparability of the top four companies in the industry |
| CIDSI | *SameInduR1* | The ratio of the number of companies with concurrent independent directors in the same industry to the number of companies with concurrent independent directors The ratio of the number of companies with concurrent independent directors in the same industry to the number of companies with concurrent independent directors in any industry |
| CIDSI | *SameInduR2* | The ratio of the number of concurrent independent directors in the same industry to the number of concurrent independent directors The ratio of the number of concurrent independent directors in the same industry to the number of concurrent independent directors in any industry |
| CIDSI | *SameInduR3* | The average value of the ratio of the number of companies with concurrent independent directors in the same industry to the number of companies with concurrent independent directors in any industry |
| Concurrently general manager and chairman of the board | *Duality* | A dummy variable that equals 1 if the general manager and the chairman of the board are the same person, and 0 otherwise |
| Leverage | *Lev* | Total debt/total assets |
| Return on assets | *ROA* | Profit/total assets |
| Growth ability | *Growth* | The ratio of the difference between the operating income at the year end and that at the beginning of the year to the operating income at the beginning of the year |
| Firm size | *Size* | Log (total assets) |
| Percentage of shares held by the top shareholder | *Firsthold* | The shareholding ratio of the largest shareholder |
| Percentage of shares held by the second to fifth largest shareholders | *Sh2_5* | The sum of the shareholding ratios of the second to fifth largest shareholders |
| Management shareholding ratio | *Manhold* | The shareholding ratio of the management |
| Board size | *Boardsize* | Log (total number of board members) |
| Independent director ratio | *IndR* | The ratio of the total number of independent directors to the total number of board members |
| Company listing years | *Listage* | Log (Total number of company's listing years) |

not vary significantly between companies, which is consistent with Liu et al. (2015). The mean values of *SameInduR1*, *SameInduR2* and *SameInduR3* are 0.103, 0.077 and 0.055, respectively, and the standard deviations are 0.224, 0.151 and 0.117, respectively, showing slight differences in the results obtained by the three metrics. Additionally, the mean value of *Duality* is 27.7 %, and those of *Lev, Manhold* and *Listage* are 14.6 %, 42.5 % and 1.885 (approximately 6.6 years), respectively. The descriptive statistics of these variables are within reasonable limits. The variance inflation factors of the main variables in the model regressions are all below 2, indicating that the multicollinearity problem does not seriously affect the empirical results.

### *4.2. Research hypothesis test*

Table 3 reports the regression results for our hypothesis. Model (1) controls for the industry fixed effect (*Industry*) and year fixed effect (*Year*). To improve the robustness of the results, the *T*-values adjusted for firm-level clustering and robust standard errors are reported in parentheses. The results show that the regression coefficients of *ROA* and *Manhold* are positive and significant at the 1 % level. Companies with a higher *ROA* pay more (less) attention to maintaining their industry reputation than do companies with a lower (higher) *ROA*, and companies with higher (lower) management shareholdings (*Manhold*) have lower (higher) agency costs because of the convergence-of-interest effect. The well-developed internal control systems of these companies curb management's incentive to manipulate earnings, which continuously ensures and enhances accounting information comparability. These results are consistent with Zhang and Pan (2018). The regression coefficients of *Size* and *Lev* are negative and significant at the 1 % level, indicating that large-scale companies are more difficult to monitor and manage than smaller companies, and that companies with high debt ratios tend to use earnings management to make their annual financial reports meet debt covenants and creditor requirements; such opportunistic behavior is not conducive to the maintenance of high levels of accounting information comparability. These results are consistent with Liao and Liao (2020). The regression coefficients of *SameInduR1*, *SameInduR2* and *SameInduR3* in columns (1), (2) and (3) are 0.033, 0.056 and 0.066, respectively, and all are significant at the 1 % level. The results suggest that CIDSI can significantly improve accounting information comparability, supporting our research hypothesis.

### *4.3. Robustness tests*[5]

#### *4.3.1. Heckman two-stage method*

The relationship between CIDSI and accounting information comparability may be affected by the endogeneity problem of sample selection bias. For example, the choice of independent directors to serve concurrently in the same industry may be influenced by their personal characteristics. Therefore, we use the Heckman two-stage method to test this relationship. Referring to Zhang and Pan (2018), we use the lagged one-period industry means of CIDSI as an instrumental variable (*Instru*). Additionally, we add the independent directors' personal characteristics variable (*Characteristic*) and firm control variables (*Control*) in the first-stage model.[6] The regression results are shown in columns (1), (2) and (3) of Table 4, Panel A. Controlling for *IMR*, the coefficients of *SameInduR* are positive and significant at the 1 % level.

[5] The sample sizes of the subsequent tests vary slightly because of missing data on individual characteristics or the backgrounds of independent directors.

[6] The explanatory variables in the first stage of the model are the dummy variables for CIDSI, which equal 1 when the company has CIDSI, and 0 otherwise. *Control* is the same as before. *Characteristic* consists of the following variables. *Gender* equals 1 (0) when the independent director is female (male). *Age* is the natural logarithm of the age of the independent director. *Tenure* is the natural logarithm of the number of years of service of the independent director. *Education* corresponds to the independent director's highest level of completed education, and equals 1 for junior college or below, 2 for college, 3 for a bachelor's degree, 4 for a master's degree (other than an MBA or EMBA), 5 for a doctoral degree, 6 for other forms of education (such as an honorary doctorate, correspondence course, etc.) and 7 for an MBA or EMBA. *Professional* equals 1 when the independent director's previous positions were in management, marketing or finance, and 0 otherwise. *Overseas* equals 1 when the independent director has overseas service or study experience, and 0 otherwise.

Table 2
Descriptive Statistics.

| Variable | No. | Mean | SD | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| *Compare* | 16,191 | –0.002 | 0.002 | –0.015 | –0.002 | –0.002 | –0.001 | 0.000 |
| *SameInduR1* | 16,191 | 0.103 | 0.224 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| *SameInduR2* | 16,191 | 0.077 | 0.151 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| *SameInduR3* | 16,191 | 0.055 | 0.117 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| *Duality* | 16,191 | 0.277 | 0.447 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| *Lev* | 16,191 | 0.425 | 0.207 | 0.053 | 0.259 | 0.416 | 0.581 | 0.905 |
| *ROA* | 16,191 | 0.040 | 0.059 | –0.250 | 0.016 | 0.039 | 0.068 | 0.197 |
| *Growth* | 16,191 | 0.424 | 1.233 | –0.666 | –0.028 | 0.135 | 0.423 | 9.492 |
| *Size* | 16,191 | 22.117 | 1.298 | 19.805 | 21.173 | 21.936 | 22.840 | 26.138 |
| *Firsthold* | 16,191 | 0.350 | 0.150 | 0.085 | 0.233 | 0.331 | 0.451 | 0.750 |
| *Sh2_5* | 16,191 | 0.193 | 0.114 | 0.014 | 0.100 | 0.182 | 0.273 | 0.481 |
| *Manhold* | 16,191 | 0.146 | 0.205 | 0.000 | 0.000 | 0.008 | 0.282 | 0.692 |
| *Boardsize* | 16,191 | 2.906 | 0.189 | 2.485 | 2.773 | 2.890 | 3.045 | 3.434 |
| *IndR* | 16,191 | 0.175 | 0.029 | 0.115 | 0.154 | 0.174 | 0.190 | 0.267 |
| *Listage* | 16,191 | 1.885 | 0.971 | –0.607 | 1.229 | 2.070 | 2.712 | 3.247 |

Table 3
CIDSI and Accounting Information Comparability.

| | (1) | (2) | (3) |
|---|---|---|---|
| *DepVar* = | *Compare* | *Compare* | *Compare* |
| ***SameInduR1*** | **0.033*****<br>**(3.47)** | | |
| ***SameInduR2*** | | **0.056*****<br>**(4.09)** | |
| ***SameInduR3*** | | | **0.066*****<br>**(3.74)** |
| *Duality* | –0.001<br>(–0.18) | –0.001<br>(–0.15) | –0.001<br>(–0.14) |
| *Lev* | –0.099***<br>(–5.53) | –0.100***<br>(–5.57) | –0.100***<br>(–5.56) |
| *ROA* | 0.610***<br>(10.05) | 0.608***<br>(10.01) | 0.610***<br>(10.03) |
| *Growth* | –0.001<br>(–0.53) | –0.001<br>(–0.52) | –0.001<br>(–0.51) |
| *Size* | –0.022***<br>(–4.78) | –0.022***<br>(–4.78) | –0.022***<br>(–4.76) |
| *Firsthold* | –0.052**<br>(–2.13) | –0.052**<br>(–2.10) | –0.052**<br>(–2.14) |
| *Sh2_5* | –0.160***<br>(–5.30) | –0.160***<br>(–5.31) | –0.161***<br>(–5.33) |
| *Manhold* | 0.029***<br>(2.71) | 0.028***<br>(2.67) | 0.029***<br>(2.71) |
| *Boardsize* | 0.028<br>(1.38) | 0.029<br>(1.41) | 0.029<br>(1.41) |
| *IndR* | –0.191*<br>(–1.71) | –0.182<br>(–1.62) | –0.182<br>(–1.63) |
| *Listage* | 0.008**<br>(2.46) | 0.008**<br>(2.47) | 0.008**<br>(2.45) |
| *Constant* | 0.169*<br>(1.65) | 0.165<br>(1.61) | 0.164<br>(1.60) |
| *Industry* | Yes | Yes | Yes |
| *Year* | Yes | Yes | Yes |
| *No.* | 16,191 | 16,191 | 16,191 |
| *Adj-$R^2$* | 0.089 | 0.089 | 0.089 |

Note: *T*-statistics in parentheses are based on standard errors adjusted for firm-level clustering. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 4
Robustness Test, Panel A: Heckman, PSM and lagged one-period explanatory variable, Panel B: Alternative measures of the explained and explanatory variables.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| *DepVar =* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* |
| ***SameInduR1*** | **0.042*** ** | | | **0.027*** ** | | | | | |
| | **(4.96)** | | | **(2.67)** | | | | | |
| ***SameInduR2*** | | **0.066*** ** | | | **0.050*** ** | | | | |
| | | **(5.48)** | | | **(3.56)** | | | | |
| ***SameInduR3*** | | | **0.078*** ** | | | **0.054*** ** | | | |
| | | | **(4.96)** | | | **(2.98)** | | | |
| ***SameInduRL1*** | | | | | | | **0.037*** ** | | |
| | | | | | | | **(3.54)** | | |
| ***SameInduRL2*** | | | | | | | | **0.061*** ** | |
| | | | | | | | | **(3.97)** | |
| ***SameInduRL3*** | | | | | | | | | **0.079*** ** |
| | | | | | | | | | **(4.04)** |
| *IMR* | 0.012 | 0.010 | 0.009 | | | | | | |
| | (0.71) | (0.61) | (0.54) | | | | | | |
| *Constant* | 0.242*** | 0.243*** | 0.247*** | 0.191 | 0.180 | 0.183 | 0.282** | 0.280** | 0.278** |
| | (3.20) | (3.23) | (3.27) | (1.52) | (1.43) | (1.46) | (2.39) | (2.37) | (2.36) |
| *Control* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Year* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *No.* | 12,146 | 12,146 | 12,146 | 7,940 | 7,940 | 7,940 | 12,149 | 12,149 | 12,149 |
| *Adj-$R^2$* | 0.098 | 0.098 | 0.098 | 0.089 | 0.090 | 0.089 | 0.097 | 0.098 | 0.098 |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | |
| *DepVar =* | *Compare2* | *Compare2* | *Compare2* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* | |
| ***SameInduR1*** | **0.027*** | | | | | | | | |
| | **(1.96)** | | | | | | | | |
| ***SameInduR2*** | | **0.041** ** | | | | | | | |
| | | **(2.04)** | | | | | | | |
| ***SameInduR3*** | | | **0.049*** | | | | | | |
| | | | **(1.85)** | | | | | | |
| ***SameInduR1_a*** | | | | **0.035*** ** | | | | | |
| | | | | **(3.63)** | | | | | |
| ***SameInduR2_a*** | | | | | **0.057*** ** | | | | |
| | | | | | **(3.96)** | | | | |
| ***SameInduR3_a*** | | | | | | **0.066*** ** | | | |
| | | | | | | **(3.63)** | | | |
| ***SameInduR_b*** | | | | | | | **0.017*** ** | | |
| | | | | | | | **(4.03)** | | |
| ***SameInduR_c*** | | | | | | | | **0.274*** ** | |
| | | | | | | | | **(3.77)** | |
| *Constant* | –0.060 | –0.063 | –0.063 | 0.167 | 0.163 | 0.162 | 0.182* | 0.168 | |
| | (–0.49) | (–0.51) | (–0.51) | (1.63) | (1.59) | (1.59) | (1.78) | (1.64) | |
| *Control* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | |
| *Industry* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | |
| *Year* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | |
| *No.* | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | |
| *Adj-$R^2$* | 0.155 | 0.155 | 0.154 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | |

Note: *T*-statistics in parentheses are based on standard errors adjusted for firm-level clustering. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

### *4.3.2. The propensity score matching (PSM) method*

To mitigate the possible sample self-selection problem in this study, we refer to Ke et al. (2020), who use the PSM method for robustness testing. First, we estimate the propensity score of each company in the treatment group with CIDSI by selecting *Duality*, *Lev*, *ROA*, *Growth*, *Size*, *Firsthold* and *IndR* as covariates. Second, we

conduct a common support hypothesis test. Controlling for industry and year, we use one-to-one nearest-neighbor matching to obtain the companies that do not have CIDSI to form the control group. Finally, we perform a balanced hypothesis test on the matched sample to ensure that the means of the covariates do not differ significantly between the treatment and control groups. The regression results using the matched sample are shown in columns (4), (5) and (6) of Table 4, Panel A. The coefficients of *SameInduR* are positive and significant at the 1 % level.

*4.3.3. Lagged one-period explanatory variable*

Because it takes time for CIDSI to influence accounting information comparability, we conduct a one-period lagged CIDSI (*SameInduRL*) regression. The regression results are shown in columns (7), (8) and (9) of Table 4, Panel A. The coefficients of *SameInduRL* are positive and significant at the 1 % level.

*4.3.4. An alternative measure of the explained variable*

To mitigate the impact of measurement bias on the results, rather than selecting the companies with the highest account information comparability in the industry, we define the mean value of accounting information comparability between company *i* and all other companies in the same industry as *Compare2,* following De Franco et al. (2011). The regression results are shown in columns (1), (2) and (3) of Table 4, Panel B, which indicates that the coefficients of *SameInduR* are positive and significant at the 10 %, 5 % and 10 % levels, respectively.

*4.3.5. An alternative measure of the explanatory variable*

*Subdivision of industry metrics.* In our main analysis, we define the industry classification of *SameInduR* using the commonly adopted method of classifying all industries by primary industry codes except for the manufacturing industry, which is subdivided into secondary industry codes. To mitigate the impact of measurement bias in the explanatory variable on the results, we redefine *SameInduR_a* by subdividing all industries into secondary industry codes. The regression results are shown in columns (4), (5) and (6) of Table 4, Panel B. The coefficients of *SameInduR_a* are all positive and significant at the 1 % level.

*Absolute number measure.* We measure *SameInduR* using a relative number for our main results. As an alternative measure, we use absolute numbers by defining the number of CIDSI of a company as *SameInduR_b* and the number of CIDSI scaled by the total number of board directors as *SameInduR_c*. The regression results are shown in columns (7) and (8) of Table 4, Panel B. The coefficients of *SameInduR_b* and *SameInduR_c* are both positive and significant at the 1 % level.

*4.3.6. Other robustness tests*

We conduct several other robustness tests. First, based on the definition of *SameInduR*, we define the concurrent directors other than independent directors in the same industry as *Dir* and use this as the control variable in the regression. The regression results show that the coefficients of *SameInduR* are positive and significant and that the coefficients of *Dir* are all positive but nonsignificant. The results indicate that concurrent directors (but not independent directors) in the same industry can improve accounting information comparability, but the effect is weaker than that of CIDSI. Thus, our results remain unchanged following the robustness test.

Second, considering that the regression results may be affected by the personal characteristics of independent directors, we add six personal characteristics that control for independent directors' characteristics, namely *Gender, Age, Tenure, Education, Professional* and *Overseas*, to the regression model. The robustness test indicates that our results remain unchanged.

Third, considering that the regression results may be influenced by the existing association of the company, we control for or exclude cases in which the concurrent independent director is located in a company that already has the same actual controller or has top manager or board member ties. The results remain unchanged following the robustness test.

Fourth, considering that CIDSI may influence differences in accounting information comparability between companies, we replace the explanatory variable with the absolute value of the difference between the accounting information comparability of the company in which the CIDSI work and the mean value of the accounting

information comparability of concurrent companies. The regression results show that CIDSI lead to convergence of accounting information comparability between their companies and concurrent companies.

Fifth, we further explore the impact of differences in the backgrounds of CIDSI on accounting information comparability. We find that CIDSI with industry expertise, accounting backgrounds or overseas backgrounds have a significant positive impact on accounting information comparability.

## 5. Further analysis

### 5.1. Mechanism test

We introduce earnings management to further explore the mechanism through which CIDSI enhance accounting information comparability. Earnings management may be driven by varying motives between companies and hence may distort companies' accounting information in different directions, reducing the accounting information comparability. However, CIDSI can provide valuable industry information to companies (Dass, 2014) that may counter this effect. Transferring and sharing information relating to accounting policies, methods and procedures among the different companies for which they are independent directors means that CIDSI gain rich experience in corporate governance. This experience helps them to supervise management reasonably and effectively according to the characteristics of the industry and improves their ability to identify earnings management in a timely manner. Furthermore, by discouraging management from whitewashing statements with the help of earnings management, CIDSI safeguard the authenticity of the signals received by external stakeholders regarding the company's performance. CIDSI ensure that the company's accounting information is handled in accordance with the requirements of accounting standards, thus improving accounting information comparability.

We use the mediation effect to investigate the mechanism of the relationship between CIDSI and accounting information comparability. The models are set up as follows:

$$Compare_{i,t} = \alpha_0 + \alpha_1 SameInduR_{i,t} + \Sigma Control_{i,t} + \Sigma Industry_{i,t} + \Sigma Year_{i,t} + \varepsilon_{i,t}. \quad (2)$$

$$AbsACC_{i.t} = \beta_0 + \beta_1 SameInduR_{i,t} + \Sigma Control_{i,t} + \Sigma Industry_{i,t} + \Sigma Year_{i,t} + \varepsilon_{i,t}. \quad (3)$$

$$Compare_{i,t} = \gamma_0 + \gamma_1 SameInduR_{i,t} + \gamma_2 AbsACC_{i,t} + \Sigma Control_{i,t} + \Sigma Industry_{i,t} + \Sigma Year_{i,t} + \varepsilon_{i,t}. \quad (4)$$

*AbsACC* uses the discretionary accruals calculated by the modified Jones model (Dechow et al., 1995). The remaining variables are defined as before.

The criteria for judging the mediation effect are as follows: $\beta_1$ and $\gamma_2$ are tested sequentially based on the significant $\alpha_1$. If both are significant, a partial intermediation effect is established. A Sobel test is required if either $\beta_1$ or $\gamma_2$ is not significant. If the $Z$ value is significant, the intermediation effect is established; otherwise it is not established (Wen et al., 2004). The regression results are presented in Table 5. The coefficients of *SameInduR* in columns (1), (3) and (5) are negative and significant at the 5 %, 10 % and 10 % levels, respectively. Thus, the results indicate that CIDSI are significantly and negatively associated with earnings management. The coefficients of *AbsACC* in columns (2), (4) and (6) are negative, those of *SameInduR* are positive and those of *AbsACC* are all significant at the 10 % level. Therefore, a Sobel test is not necessary. The results suggest that CIDSI enhance accounting information comparability through their negative effect on earnings management.[7]

### 5.2. Industry characteristic test

#### 5.2.1. Technology intensity

The rapid development and widespread application of information technology in China mean that digital knowledge and technology are key production factors. Technology-intensive industries are primarily engaged

[7] Our study does not support a mediation effect of the convergence of inter-firm asset impairment policies. However, information comparability is a composite of multiple combinations of accounting policies. CIDSI may enhance accounting information comparability by influencing the convergence of other accounting policies.

Table 5
Mechanism Test.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *DepVar =* | *AbsACC* | *Compare* | *AbsACC* | *Compare* | *AbsACC* | *Compare* |
| ***AbsACC*** | | **–0.014*** | | **–0.014*** | | **–0.014*** |
| | | **(–1.95)** | | **(–1.95)** | | **(–1.95)** |
| ***SameInduR1*** | **–0.013**** | **0.033***** | | | | |
| | **(–2.48)** | **(3.45)** | | | | |
| ***SameInduR2*** | | | **–0.017*** | **0.056***** | | |
| | | | **(–1.71)** | **(4.07)** | | |
| ***SameInduR3*** | | | | | **–0.021*** | **0.065***** |
| | | | | | **(–1.92)** | **(3.72)** |
| *Constant* | 0.382*** | 0.174* | 0.383*** | 0.170* | 0.383*** | 0.169* |
| | (6.22) | (1.70) | (6.21) | (1.67) | (6.20) | (1.66) |
| *Control* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Year* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Nol* | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 |
| *Adj-$R^2$* | 0.026 | 0.089 | 0.026 | 0.090 | 0.026 | 0.089 |

Note: *T*-statistics in parentheses are based on standard errors adjusted for firm-level clustering. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

in designing and developing new products, and they tend to invest in human capital and hold intangible assets. This industry characteristic may lead to differences in the importance and availability of information, which may continuously affect the performance of CIDSI. First, industries with higher technology intensity are more competitive than other industries, and it is well known that market competition elicits improvements in companies' corporate governance structure and information disclosure (Durnev and Mangen, 2020). This helps companies in these industries to gain easier access to public information about their product markets and competitors than companies in other industries. Therefore, companies in technology-intensive industries may pay less attention to information obtained by CIDSI than companies in less technology-intensive industries. Second, in industries with high technology intensity, the coordination of company resources is more difficult and exit barriers are higher than in other industries. The organizational strategies of companies in technology-intensive industries tend to be highly rigid and tied to the organization of long-term activities (Finnegan and Longaigh, 2002). It can be difficult for them to make timely strategic adjustments to industry standards in response to the information provided by CIDSI. Therefore, the effect of CIDSI on accounting information comparability may not be significant in companies in technology-intensive industries. Third, more technology-intensive industries have higher technological complexity and faster technological changes than other industries (Carlucci et al., 2004). It is more difficult for companies in technology-intensive industries to implement the information obtained by CIDSI because such information may be obtained at a slower rate than the rate of change, which makes it difficult for CIDSI to play a substantial role. Therefore, we infer that CIDSI are more (less) effective at enhancing accounting information comparability when in less (more) technology-intensive industries.

Intangible assets are the main factors affecting a company's technological innovation (Yuan et al., 2015). Referring to Wang and Hu (2017), we define *Tech* as a dummy variable for industry technology intensity. We use the annual growth rate of intangible assets to measure the technology intensity of each company, and then take the annual median of the industry as the industry technology intensity. When the technology intensity of the industry is higher than the median of the total sample of companies, *Tech* equals 1; otherwise, it equals 0. The regression results are shown in columns (1), (2) and (3) of Table 6. The coefficients of the interaction *SameInduR* × *Tech* are negative and significant at the 1 % and 10 % levels in columns (1) and (3), respectively. The results indicate that the positive effect of CIDSI on accounting information comparability is more (less) significant when the industry is less (more) technology-intensive.

Table 6
Industry Characteristics Test.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *DepVar* = | *Compare* | *Compare* | *Compare* | *IndWords* | *IndWords* | *IndWords* |
| ***SameInduR1*** | 0.062*** | | | **0.072** | | |
| | (4.67) | | | **(1.52)** | | |
| ***SameInduR1* × *Tech*** | **–0.040*** ** | | | | | |
| | **(–2.74)** | | | | | |
| ***SameInduR2*** | | 0.074*** | | | **0.158**** | |
| | | (3.18) | | | **(2.52)** | |
| ***SameInduR2* × *Tech*** | | **–0.026** | | | | |
| | | **(–1.11)** | | | | |
| ***SameInduR3*** | | | 0.100*** | | | **0.165**** |
| | | | (3.46) | | | **(2.04)** |
| ***SameInduR3* × *Tech*** | | | **–0.048*** | | | |
| | | | **(–1.65)** | | | |
| *Tech* | 0.016** | 0.014** | 0.014** | | | |
| | (2.51) | (2.20) | (2.25) | | | |
| *Constant* | 0.158 | 0.154 | 0.153 | 4.842*** | 4.830*** | 4.830*** |
| | (1.55) | (1.52) | (1.51) | (12.50) | (12.48) | (12.47) |
| *Control* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Year* | Yes | Yes | Yes | Yes | Yes | Yes |
| *No.* | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 |
| *Adj-$R^2$* | 0.089 | 0.090 | 0.089 | 0.165 | 0.166 | 0.165 |

Note: *T*-statistics in parentheses are based on standard errors adjusted for firm-level clustering. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

### *5.2.2. Industry perception*

We focus on the information gap that prevails among companies and argue that independent directors with concurrent appointments in the same industry have potentially more valuable information about their industry than is possessed by other directors, and that such information helps the CIDSI to objectively and comprehensively assess a company's current performance. Moreover, only experienced independent directors who have strong expertise and excellent reputations are given the opportunity to serve concurrent independent directorship positions in the same industry. Their insights and social resources as CIDSI facilitate their role as professional advisors, helping companies overcome information challenges and develop future strategies based on industry trends. Therefore, we infer that CIDSI can enhance a company's perception of the industry in which it operates and its business conditions and future strategies.

A company's operations and future strategic planning are disclosed in the management's discussion and analysis (MD&A) section of its annual report. Referring to Luo et al. (2021), we use the "frequency method" to calculate the industry perception variable, which is defined as *IndWords*. Specifically, in using the frequency method, we first read the literature related to topics such as industry development prospects, industry profits and concurrent appointments to construct an industry perception dictionary.[8] Second, after eliminating MD&A deactivation words, (such as the modal particle), we use the "Jieba" Chinese word separation module of Python to automatically separate words from MD&A texts. Thereafter, we extract words closely related to the industry situation. Finally, we calculate the proportion of the extracted industry perception words to the total number of MD&A words in the year as *IndWords*. In reporting the coefficients, *IndWords* is treated the same way as *Compare*, that is, its value is multiplied by 100 in the regression process. The regression results are shown in columns (4), (5) and (6) of Table 6. The coefficients of *SameInduR* are positive and significant at the 5 % level in columns (5) and (6). The results indicate that CIDSI can provide broader industry perception of the company's board reports.

[8] The industry perception dictionary comprises 37 words, such as industry development prospects, industry future profits and competition in the same industry.

### 5.3. Concurrent company situation

#### 5.3.1. Performance volatility

The uncertainty faced by business management causes fluctuations in a company's financial performance (Johnson, 2003). When company performance is highly volatile, the turbulent business environment reduces the board's ability to make objective judgments about the company's situation and the difficulty and riskiness of decision-making increase. In this situation, the additional information that CIDSI obtain from their concurrent companies may not have a significant governance role. Conversely, when the volatility of the concurrent company's performance is low and the quality of accounting information is relatively high, the potential industry resources and knowledge obtained by CIDSI in concurrent companies can help companies significantly overcome information gaps. Their knowledge is helpful in improving accounting information comparability from the perspective of long-term development and maintaining high-level operations when performance volatility is low. That is, we infer that CIDSI play a more (less) important role in enhancing accounting information comparability when concurrent companies have lower (higher) performance volatility.

To test this inference, we introduce *Vol* to the analysis. Referring to Liang and Chen (2014), we measure performance volatility using the standard deviation of the ratio of a company's current-year operating profit to its total assets at the beginning of the year for the past 5 years. The regression results are shown in columns (1), (2) and (3) of Table 7. The coefficients of the interaction *SameInduR* × *Vol* are negative and significant at the 5 % level in columns (2) and (3). These results confirm that the effect of CIDSI on accounting information comparability is more (less) significant when concurrent companies have lower (higher) performance volatility.

Table 7
Concurrent Company Situation Test.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *DepVar* = | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* |
| *SameInduR1* | 0.033*** | | | 0.031*** | | |
| | (3.43) | | | (2.90) | | |
| *SameInduR2* | | 0.055*** | | | 0.053*** | |
| | | (4.02) | | | (3.53) | |
| *SameInduR3* | | | 0.065*** | | | 0.066*** |
| | | | (3.70) | | | (3.57) |
| ***SameInduR1* × *Vol*** | **–0.005** | | | | | |
| | **(–1.58)** | | | | | |
| ***SameInduR2* × *Vol*** | | **–0.013**** | | | | |
| | | **(–2.21)** | | | | |
| ***SameInduR3* × *Vol*** | | | **–0.008**** | | | |
| | | | **(–2.44)** | | | |
| *Vol* | 0.008*** | 0.011*** | 0.007*** | | | |
| | (3.95) | (3.21) | (4.78) | | | |
| ***SameInduR1* × *Inacc*** | | | | **–0.031** | | |
| | | | | **(–1.45)** | | |
| ***SameInduR2* × *Inacc*** | | | | | **–0.035** | |
| | | | | | **(–0.89)** | |
| ***SameInduR3* × *Inacc*** | | | | | | **–0.076**** |
| | | | | | | **(–2.04)** |
| *Inacc* | | | | 0.024** | 0.018 | 0.027** |
| | | | | (2.07) | (1.24) | (2.50) |
| *Constant* | 0.168* | 0.165 | 0.164 | 0.171* | 0.168 | 0.168* |
| | (1.65) | (1.61) | (1.60) | (1.67) | (1.64) | (1.65) |
| *Control* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Year* | Yes | Yes | Yes | Yes | Yes | Yes |
| *No.* | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 |
| *Adj-$R^2$* | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 |

Note: *T*-statistics in parentheses are based on standard errors adjusted for firm-level clustering. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

*5.3.2. Information quality*

Annual financial reports are used to assess a company's performance, but they may be distorted because of staff negligence, calculation errors, misunderstandings or processing errors. Listed companies correct errors in low-quality financial reports through financial restatements (Palmrose et al., 2004). When the quality of the financial reports of concurrent companies is low, the validity and credibility of the information obtained by CIDSI is reduced and the effectiveness of these functions correspondingly is weakened. In contrast, when the financial reports of concurrent companies are of higher quality, there are fewer financial restatements and fewer subjective errors in the financial reports (Yuan et al., 2018), and the higher quality financial reports of concurrent companies ensure the validity and credibility of the information obtained by CIDSI. This information can help improve accounting information comparability. Therefore, we infer that CIDSI play a more (less) important role in enhancing accounting information comparability when the financial reports of concurrent companies are of higher (lower) quality.

To test this inference, we add *Inacc* to the analysis. Following Yuan et al. (2018), we use the restatement of financial statements to indicate the quality of financial reporting. If the financial restatements occur during the year, *Inacc* equals 1; otherwise, it equals 0. The regression results are shown in columns (4), (5) and (6) of Table 7. The coefficients of the interaction $SameInduR \times Inacc$ are negative and significant at the 5 % level in column (6). These results indicate that the effect of CIDSI on accounting information comparability is more (less) significant when the financial reports of concurrent companies are of higher (lower) quality.

*5.4. Internal and external environments*

*5.4.1. Governance structure*

Multilevel institutional investors, such as investment funds, social security funds and insurance companies, hold a high proportion of shares in listed companies. They are an important force in the capital market because of their information processing abilities and professional knowledge and expertise. When the shareholding ratios of institutional investors are high, these advantages can be brought into play to a significant extent (Li et al., 2015). When the transparency of company information is high, the enhancing effect of CIDSI on accounting information comparability is unclear. In contrast, the information environment of companies with lower shareholdings by institutional investors is more imperfect and uncertain than that of companies with higher institutional investor shareholdings. Moreover, shareholders are reluctant to monitor management effectively because of the cost of supervision (Shleifer and Vishny, 1986). In this situation, CIDSI use their abundant information, knowledge and experience to identify and curb the strong speculative mentality of management as early as possible, aiming to comply with the company's long-term development strategy and maintain a high level of accounting information comparability. Therefore, we infer that CIDSI will play a more (less) significant role in enhancing accounting information comparability when the shareholding ratio of institutional investors is lower (higher).

To test this inference, we introduce *InvH* for analysis. Referring to Li et al. (2015), we measure the shareholding ratio of institutional investors by the ratio of the number of shares held by institutional investors to the total number of shares, representing the internal and external regulatory governance of the company. When the shareholding ratio of institutional investors is lower than the annual median of the industry, *InvH* equals 1, and 0 otherwise. The regression results are shown in columns (1), (2) and (3) in Table 8, which indicates that the coefficients of the interaction term $SameInduR \times InvH$ are positive and significant at the 10 %, 10 % and 5 % levels, respectively. These results indicate that the effect of CIDSI on accounting information comparability is more (less) significant when the shareholding ratio of institutional investors is lower (higher).

*5.4.2. Regional environment*

The legal environment in a country or region is more important for the quality of accounting information than technical specifications such as accounting standards (Webb et al., 2008). When the regional legal environment is good, accounting information comparability is guaranteed by the advanced institutions and regulations, and there may not be a strong role for CIDSI to perform their supervisory and advisory functions. In contrast, when the legal environment of the company's registration place is weak or underdeveloped, the lower cost of non-compliance and litigation reduces conformity to the accounting standards and dis-

Table 8
Internal and External Environments Test.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *DepVar* = | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* | *Compare* |
| *SameInduR1* | 0.018 | | | 0.015 | | |
| | (1.24) | | | (1.27) | | |
| *SameInduR2* | | 0.033 | | | 0.033** | |
| | | (1.59) | | | (2.18) | |
| *SameInduR3* | | | 0.034 | | | 0.039** |
| | | | (1.26) | | | (2.01) |
| ***SameInduR1* × *InvH*** | **0.030*** | | | | | |
| | **(1.82)** | | | | | |
| ***SameInduR2* × *InvH*** | | **0.043*** | | | | |
| | | **(1.65)** | | | | |
| ***SameInduR3* × *InvH*** | | | **0.062**** | | | |
| | | | **(2.01)** | | | |
| *InvH* | –0.019*** | –0.018*** | –0.019*** | | | |
| | (–2.60) | (–2.61) | (–2.64) | | | |
| ***SameInduR1* × *Legal*** | | | | **0.037**** | | |
| | | | | **(2.19)** | | |
| ***SameInduR2* × *Legal*** | | | | | **0.048*** | |
| | | | | | **(1.91)** | |
| ***SameInduR3* × *Legal*** | | | | | | **0.057*** |
| | | | | | | **(1.78)** |
| *Legal* | | | | –0.006 | –0.007 | –0.006 |
| | | | | (–1.36) | (–1.40) | (–1.24) |
| *Constant* | 0.200** | 0.195* | 0.195* | 0.173* | 0.170* | 0.168 |
| | (1.97) | (1.93) | (1.93) | (1.69) | (1.66) | (1.64) |
| *Control* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry* | Yes | Yes | Yes | Yes | Yes | Yes |
| *Year* | Yes | Yes | Yes | Yes | Yes | Yes |
| *No.* | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 |
| *Adj-$R^2$* | 0.090 | 0.090 | 0.090 | 0.089 | 0.089 | 0.089 |

Note: *T*-statistics in parentheses are based on standard errors adjusted for firm-level clustering. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

closure rules influencing accounting information comparability. In this case, the industry information provided by CIDSI is significant. It is helpful to prompt companies to disclose accounting information, as required by relevant standards, to reduce economic losses to information users. Therefore, we infer that CIDSI play a more important role in enhancing accounting information comparability when the regional legal environment is weaker (stronger).

To test this inference, we introduce *Legal* to the analysis. To measure the regional legal environment, we follow Li et al. (2021) in using the index provided by Wang et al. (2019b), which measures the "development of market intermediary organizations and rule of law environment." If the value of this index in the location where a company is registered is lower than the median score for all listed companies in that year, *Legal* equals 1; otherwise, it equals 0. The regression results are shown in columns (4), (5) and (6) of Table 8, and the coefficients of interaction *SameInduR* × *Legal* are positive and significant at the 5 %, 10 % and 10 % levels, respectively. These results indicate that the effect of CIDSI on accounting information comparability is more (less) significant when the regional legal environment is weaker (stronger).

### 5.5. Economic consequences

The economic consequences of accounting information comparability are explored extensively in the literature in terms of analysts' behavior (De Franco et al., 2011), management forecast accuracy (Gong et al., 2013) and earnings quality (Xu and Liu, 2014). However, there is little research on how accounting informa-

Table 9
Economic Consequences Test.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *DepVar* = | *Audfee* | *Audfee* | *Audfee* | *Audfee* | *Audfee* | *Audfee* | *Opinion* | *Opinion* | *Opinion* | *Opinion* | *Opinion* | *Opinion* |
| ***SameInduR1*** | **–0.024** | **–0.015** | | | | | **–0.019*** ** | **–0.016*** ** | | | | |
| | **(–1.46)** | **(–0.94)** | | | | | **(–3.13)** | **(–2.76)** | | | | |
| ***SameInduR2*** | | | **–0.054**** | **–0.040*** | | | | | **–0.034*** ** | **–0.031*** ** | | |
| | | | **(–2.26)** | **(–1.67)** | | | | | **(–3.95)** | **(–3.53)** | | |
| ***SameInduR3*** | | | | | **–0.075**** | **–0.058*** | | | | | **–0.040*** ** | **–0.036*** ** |
| | | | | | **(–2.42)** | **(–1.89)** | | | | | **(–3.58)** | **(–3.20)** |
| ***Compare*** | | **–0.256*** ** | | **–0.256*** ** | | **–0.256*** ** | | **–0.065*** ** | | **–0.065*** ** | | **–0.065*** ** |
| | | **(–14.15)** | | **(–14.11)** | | **(–14.11)** | | **(–4.31)** | | **(–4.29)** | | **(–4.31)** |
| *Constant* | 3.978*** | 4.020*** | 3.982*** | 4.023*** | 3.984*** | 4.025*** | 0.404*** | 0.415*** | 0.406*** | 0.417*** | 0.407*** | 0.418*** |
| | (37.92) | (38.54) | (37.95) | (38.56) | (37.97) | (38.57) | (5.74) | (5.88) | (5.78) | (5.91) | (5.78) | (5.91) |
| *Control* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Year* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *No.* | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 | 16,191 |
| *Adj-$R^2$* | 0.617 | 0.621 | 0.618 | 0.621 | 0.618 | 0.621 | 0.102 | 0.108 | 0.103 | 0.108 | 0.103 | 0.108 |
| *Sobel Z* | | 4.472*** | | 5.071*** | | 4.633*** | | 4.268*** | | 4.776*** | | 4.407*** |

Note: *T*-statistics in parentheses are based on standard errors adjusted for firm-level clustering. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

tion comparability affects auditor behavior and audit quality. We focus on audit fees and opinions and analyze them from the perspective of the information environment and agency costs. Information environment theory indicates that an improvement in accounting information comparability implies an improvement in the company's information environment. A more (less) transparent information environment can reduce (increase) a company's liquidity and operational risks (Chen and Jiang, 2017). Information about the industry's external environment is a useful complement to a company's own information and can help auditors improve audit efficiency, thus reducing audit fees (Joseph, 2018). Auditors simultaneously evaluate companies based on a combination of personal judgments about the information environment and the companies' efforts in the audit process. A high (low) level of information transparency and audit efficiency reduces (increases) the likelihood of being issued non-standard, unqualified audit opinions. Agency cost theory indicates that an increase in accounting information comparability may trigger opportunistic behaviors because it makes earnings management behaviors easier to detect, and management may therefore turn to insidious earnings management (Xu and Liu, 2014). Such earnings management means that the company is more difficult to audit, exposes the auditor to greater risk and requires more effort than a company with less insidious earnings management. Consequently, auditors are more likely to charge higher audit fees in this environment than in other environments. In providing their audit opinions, auditors are likely to reflect on their perceived risks, and thus there is a higher (lower) likelihood of being issued non-standard, unqualified audit opinions when there are low (high) levels of information transparency and audit efficiency.

We discuss the significance of the information environment theory based on the materiality principle. By obtaining valuable industry information, CIDSI can improve accounting information comparability and thus reduce the effort required by the auditor in the audit process—accordingly, the audit efficiency is higher and the corresponding audit cost is lower than is the case without CIDSI. As a result, auditors are more (less) likely to judge a company's information condition favorably and are less (more) likely to issue non-standard unqualified audit opinions. Therefore, CIDSI may reduce audit fees and the likelihood of being issued non-standard unqualified audit opinions by enhancing accounting information comparability.

We use the mediation effect to examine the economic consequences of CIDSI on accounting information comparability.[9] The economic consequence variables are *Audfee* and *Opinion*. *Audfee* is the natural logarithm of a company's annual audit fees. *Opinion* equals 0 if the listed company is issued standard unqualified audit opinions for the year, and 1 otherwise.

The regression results are presented in Table 9. When *Audfee* is used as an economic consequence variable, the coefficients of *SameInduR* in columns (1), (3) and (5) are negative, and they are significant at the 5 % level in columns (3) and (5). The results indicate that CIDSI are significantly and negatively associated with audit fees. The regression coefficients of *SameInduR* and *Compare* in columns (2), (4) and (6) are negative, and the coefficients of *Compare* are significant at the 1 % level. Furthermore, the Sobel *Z* value is significant at the 1 % level. The results suggest that CIDSI reduce audit fees through their positive effect on accounting information comparability. When *Opinion* is used as an economic consequence variable, the regression coefficients of *SameInduR* in columns (7), (9) and (11) are negative and significant at the 1 % level. The results indicate that CIDSI are significantly and negatively associated with the issuance of non-standard unqualified audit opinions. The regression coefficients of *SameInduR* and *Compare* in columns (8), (10) and (12) are negative and significant at the 1 % level, and the Sobel *Z* value is significant at the 1 % level. The results suggest that CIDSI reduce the likelihood of being issued non-standard unqualified audit opinions by positively influencing accounting information comparability.

## 6. Conclusions

Using Chinese A-share listed companies for the 2008–2019 period as the research sample, we examine the effect of CIDSI on accounting information comparability. We find that CIDSI significantly enhance account-

[9] The mediation effect model is consistent with models (2), (3) and (4). The explained variables are *Audfee* and *Opinion*, the mediation variable is *Compare* and the explanatory variable is *SameInduR*.

ing information comparability, and this finding remains unchanged after several robustness tests. The mechanism test indicates that CIDSI enhance accounting information comparability primarily by inhibiting earnings management. The industry characteristics test shows that CIDSI have more positive effects and are more efficient in less than in more technology-intensive industries, and that they can provide broader industry perception of the company's board reports. In an additional analysis, we find that the performance volatility and financial reporting quality of concurrent companies play significant moderating roles in the relationship between CIDSI and accounting information comparability. Furthermore, the positive effect of CIDSI on accounting information comparability is more (less) significant when the shareholdings of institutional investors are lower (higher) and the regional legal environment is weaker (stronger). The exploration of economic consequences reveals that the enhancement of accounting information comparability by CIDSI ultimately lowers audit fees and reduces the likelihood of non-standard unqualified audit opinions being issued.

These findings provide the following suggestions and insights. First, most studies focus on the impact of the ratio of independent directors or director interlocks on accounting information comparability. We focus on the value of independent directors as information providers, and how providing industry-related information to companies is related to the characteristics possessed by such independent directors who hold concurrent same-industry positions. Our finding of the enhancing effect of CIDSI on accounting information comparability affirms the reliability of these directors as a source of industry information, which encourages companies to pay attention to them. This helps active independent directors maximize their value and ultimately achieve their fundamental goal of maximizing company value. Second, this study verifies the moderating roles of the internal and external environments in the relationship between CIDSI and accounting information comparability. We confirm the effectiveness of the independent director system and explore the external environmental factors that increase its effectiveness. This confirmation indicates that companies should adjust the intensity and direction of regulation in their production and operation processes in a timely manner according to the regulatory, policy and legal environments. Companies should utilize the interactions between the internal and external factors and aim to match their internal governance mechanism to suit the external economic environment as skillfully as possible. Third, the positive effect of CIDSI on accounting information comparability leads to the positive economic consequences of lower audit fees and a lower likelihood of being issued non-standard unqualified audit opinions. This result suggests that comparable accounting information can help improve audit decision efficiency and that companies can maintain their relationships with accounting firms by maintaining a high level of accounting information comparability. It also provides lessons to relevant regulators to pay attention to the process by which companies generate and disclose financial reports, which helps both reduce audit risks and improve audit quality.

## Acknowledgements

We acknowledge the financial support of the National Natural Science Foundation of China (72272164, 71872196), the National Social Science Foundation of China (21&ZD145, 19ZDA098), the Beijing Social Science Foundation (15JGC176) and the Natural Science Foundation of Zhejiang (LY19G020004). We acknowledge the executive editor of this paper and the anonymous reviewer for their useful comments. We emphasize that we are fully responsible for the content of the paper and any remaining errors.

## References

Armstrong, C.S., Barth, M.E., Jagolinzer, A.D., Riedl, E.J., 2010. Market reaction to the adoption of IFRS in Europe. Acc. Rev. 85 (1), 31–61.

Barth, M.E., Landsman, W.R., Lang, M., Williams, C., 2012. Are IFRS-based and US GAAP-based accounting amounts comparable?. J. Acc. Econ. 54 (1), 68–93.

Biddle, G.C., Hilary, G., Verdi, R.S., 2009. How does financial reporting quality relate to investment efficiency?. J. Acc. Econ. 48 (2–3), 112–131.

Carlucci, D., Marr, B., Schiuma, G., 2004. The knowledge value chain: How intellectual capital impacts on business performance. Int. J. Technol. Manage. 27 (6–7), 575–590.

Chen, Y., Jiang, X., 2017. Can accounting comparability reduce audit fees? Double analyses based on information environment and agency problem. Auditing Res. 2, 89–97, in Chinese.

Cooper, I. A., Cordeiro, L., 2008. Optimal equity valuation using multiples: The number of comparable firms. SSRN 1272349, Working Paper.
Dass, N., 2014. Board expertise: Do directors from related industries help bridge the information gap. Rev. Finan. Stud. 27 (5), 1533–1592.
De Franco, G., Kothari, S.P., Verdi, R.S., 2011. The benefits of financial statement comparability. J. Acc. Res. 49 (4), 895–931.
Dechow, P.M., Sloan, R.G., Sweeney, A.P., 1995. Detecting earnings management. Acc. Rev. 70 (2), 193–225.
Durnev, A., Mangen, C., 2020. The spillover effects of MD&A disclosures for real investment: The role of industry competition. J. Acc. Econ. 70 (1) 101299.
Finnegan, P., Longaigh, S.N., 2002. Examining the effects of information technology on control and coordination relationships: An exploratory study in subsidiaries of pan-national corporations. J. Inform. Technol. 17 (3), 149–163.
Francis, J.R., Pinnuck, M.L., Watanabe, O., 2014. Auditor style and financial statement comparability. Acc. Rev. 89 (2), 605–633.
Gong, G., Li, L.Y., Zhou, L., 2013. Earnings non-synchronicity and voluntary disclosure. Contemp. Acc. Res. 30 (4), 1560–1589.
Hermalin, B.E., Weisbach, M.S., 1991. The effects of board composition and direct incentives on firm performance. Financ. Manage. 20 (4), 101–112.
Jiang, W., Wan, H., Zhao, S., 2016. Reputation concerns of independent directors: Evidence from individual director voting. Rev. Finan. Stud. 29 (3), 655–696.
Johnson, S.A., 2003. Debt maturity and the effects of growth opportunities and liquidity risk on leverage. Rev. Finan. Stud. 16 (1), 209–236.
Joseph, H.Z., 2018. Accounting comparability, audit effort and audit outcomes. Contemporary Accounting Research 35 (1), 245–276.
Ke, R., Li, M., Zhang, Y., 2020. Directors' informational role in corporate voluntary disclosure: An analysis of directors from related industries. Contemporary Accounting Research 37 (1), 392–418.
Li, G., Guo, M., 2022. Do the resignations of politically connected independent directors affect corporate social responsibility? Evidence from China. J. Corp. Fin. 73 102174.
Li, C., Wang, Y., Zhang, X., 2021. Tax avoidance aggressiveness and stock crash risk: Causality identification through the external regulation. Finance & Trade Economics 42 (06), 37–53, in Chinese.
Li, Z., Zhao, X., Cao, F., Liu, X., 2015. Institutional investors' heterogeneity and accounting conservatism: The empirical evidence from Chinese listed companies. Nankai Business Review 18 (03), 111–121, in Chinese.
Liang, S., Chen, D., 2014. Volatility of performance and compensation contracts: Evidence from Chinese listed companies. Journal of Financial Research 1, 167–179, in Chinese.
Liang, S., Chen, D., Fu, B., Fang, K., 2018. Network centrality of independent director and accounting conservatism. Accounting Research 9, 39–46, in Chinese.
Liao, H., Liao, J., 2020. Do female executives raise accounting information comparability? Friends of Accounting 19, 18–26, in Chinese.
Liu, B., Huang, K., Jiu, L., 2019. Can independent director interlocks improve accounting information comparability? Accounting Research 4, 36–42, in Chinese.
Liu, R., Liu, Z., Xu, C., 2015. Accounting comparability of acquirers and long-term stock returns. Accounting Research 11, 34–40, in Chinese.
Luo, Y., Rao, P., Chen, C., 2021. Does managerial macro-cognition have "imprinting?" Evidence from the effect of management style. Journal of Financial Research 5, 171–188, in Chinese.
Masulis, R., Wang, C., Xie, F., 2012. Globalizing the boardroom—The effects of foreign directors on corporate governance and firm performance. J. Acc. Econ. 53 (3), 527–554.
Palmrose, Z., Richardson, V.J., Scholz, S., 2004. Determinants of market reactions to restatement announcements. J. Acc. Econ. 37 (1), 59–89.
Quan, Y., Li, S., 2017. Are academic independent directors punished more severely when they engage in violations? China J. Acc. Res. 10 (1), 71–86.
Shleifer, A., Vishny, R.W., 1986. Large Shareholders and corporate control. Journal of Political Economy 94 (3), 461–488.
Tang, X., Shen, H., Du, J., 2010. Motivation in the supervision of independent directors—Empirical evidence based on independent opinion. Journal of Management World 9, 138–149, in Chinese.
Wang, H., 2007. Interpret the relationship identity of Chinese. Exploration and Free Views 12, 32–36, in Chinese.
Wang, X., Fan, G., Hu, L., 2019b. Marketization index of China's provinces: NERI report 2018. Beijing: Social Sciences Academic Press (China).
Wang, L., Hu, Y., 2017. Does venture capital improve innovation efficiency? Evidence from China's firm-level analysis. Journal of Financial Research 1, 177–199, in Chinese.
Wang, D., Lu, W., Yang, D., 2019a. Internal control, accounting information comparability and analyst behavior. Auditing Res. 6, 70–78, in Chinese.
Webb, K.A., Cahan, S.F., Sun, J., 2008. The effect of globalization and legal environment on voluntary disclosure. International Journal of Accounting 43 (3), 219–245.
Wen, Z., Zhang, L., Hou, J., Liu, H., 2004. Testing and application of the mediating effects. Acta Psychologica Sinica 5, 614–620, in Chinese.
Xu, C., Liu, R., 2014. Can accounting comparability reduce earnings management? Accounting Research 7, 50–57, in Chinese.
Yi, Y., Dai, D., Peng, W., 2017. Convergence of accounting standards, institutional environment and financial reporting comparability: An empirical study comparing A-share with H-share and HK share. Accounting Research 7, 50–57, in Chinese.
Yuan, Z., Jin, Y., Wang, T., 2015. Listing corporation intangible assets index researching—Based on the gem listing corporation empirical test. Accounting Research 5, 72–79, in Chinese.

Yuan, R., Wen, W., Xie, Z., 2018. Directors' and officers' liability insurance and financial restatements. Accounting Research 5, 21–27, in Chinese.

Yuan, Z., Wu, L., 2012. Literature review and future research prospects for accounting information comparability. Accounting Research 9, 9–15, in Chinese.

Zhang, Y., Pan, L., 2018. Customer concentration, corporate governance level and accounting information comparability. Journal of Shanxi University of Finance and Economics 11, 110–124, in Chinese.

Zhou, X., Wang, L., Chen, C., 2017. Inter-corporate top managers' ties and accounting information comparability: An empirical study on the perspective of inter-organizational imitation. Nankai Business Review 20 (03), 100–112, in Chinese.

Zhu, J., Ye, K., Tucker, J.W., Chan, K.C., 2016. Board hierarchy, independent directors and firm value: Evidence from China. J. Corp. Fin. 41, 262–279.

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

journal homepage: www.elsevier.com/locate/cjar

# Covering or monitoring? Independent director connectedness and corporate fraud in China

Jieli Xing [a], Yongjie Zhang [b], Xiong Xiong [b], Guangzhong Li [c,*]

[a] *Economics and Management College, Civil Aviation University of China, Tianjin, PR China*
[b] *College of Management and Economics, Tianjin University, Tianjin, PR China*
[c] *Business School, Sun Yat-Sen University, Shenzhen, PR China*

ARTICLE INFO

*Article history:*
Received 1 April 2022
Accepted 11 October 2022
Available online 5 November 2022

*JEL classification:*
G34
M41
Z13

*Keywords:*
Corporate fraud
Independent director connectedness
Social capital
Monitoring effect
Bivariate probit model with partial observability

ABSTRACT

This paper examines how independent directors' social capital, as measured by their social network, affects corporate fraud. We find that firms with well-connected independent directors are less likely to commit fraud, supporting our monitoring effect hypothesis. This result is robust to a battery of tests. Further analyses show that the effect is stronger for firms with a relatively poor legal environment, for firms whose independent directors face strong reputation incentives and when independent directors are audit committee members. Moreover, we explore a potential economic mechanism of the effect and observe that well-connected independent directors are associated with less absenteeism and more dissension. Overall, our findings suggest that independent directors' social capital plays an important role in corporate governance.


## 1. Introduction

Boards of directors play a key role in corporate governance. Most of the responsibility for monitoring management and mitigating agency problems falls to independent directors (Fama and Jensen, 1983). However,

* Corresponding author.
*E-mail addresses:* xingjieli@tju.edu.cn (J. Xing), yjz@tju.edu.cn (Y. Zhang), xxpeter@tju.edu.cn (X. Xiong), liguangzhong@mail.sysu.edu.cn (G. Li).

https://doi.org/10.1016/j.cjar.2022.100273
1755-3091/

studies on the monitoring effect of independent directors are markedly mixed, and thus it is an important unresolved issue in the literature (Bhagat and Black, 1997; Gordon, 2007; Adams et al., 2010). Although some studies find that independent directors provide effective monitoring (e.g., Dahya et al., 2008; Chen et al., 2014; Zhu et al., 2016), others find that independent directors are not effective monitors (Fich and Shivdasani, 2006; Masulis and Zhang, 2019) or that the monitoring effect varies with a firm's information cost environment (Duchin et al., 2010). This paper attempts to answer the question of whether independent directors provide effective monitoring by examining the effect of independent directors' social capital on corporate fraud.

Theoretically, independent directors' social capital may increase or decrease the incidence of corporate fraud. Similar to other corporate activities, corporate misconduct often requires cooperation and coordination between directors and other executives. Social influence may have a "covering effect" in that it facilitates the acquiescence or coordination required to engage in and conceal fraud (Khanna et al., 2015). However, there may be a "monitoring effect" as independent directors seek to build reputations as diligent monitors of management because their ability to do so directly affects their social capital and probability of obtaining future directorships (Freeman, 1979; Fama, 1980; Fama and Jensen, 1983; Lin, 2002). Thus, greater connectedness would encourage independent directors to strengthen their monitoring and avoid wrongdoing. Which of these effects prevails is an important empirical question.

Analyzing the economic impacts of independent directors' social capital is challenging, largely because of the lack of high-quality data. Following Adler and Kwon (2002) and Lin (2002), we define social capital as those resources (e.g., reputation and influence) accessible through social networks. Specifically, we follow Freeman (1979), Padgett and Ansell (1993) and Jackson (2008) and measure an independent director's social capital as their level of connectedness as revealed by social network analysis, i.e., betweenness centrality.

Using social network analysis, we take all of the directors of Chinese listed firms to construct a yearly social network and calculate the betweenness centrality for each director in this vast network. Our sample has 10,073 firm-year observations from the 2010 through 2017 period. We use Chinese firms because compared with Western countries, Chinese society is more relationship-oriented. Therefore, social networks play an important role in China. In addition, China's investor protection systems and government regulations are still weak and underdeveloped compared with those in Western countries. Examining the impact of independent director connectedness on corporate fraud in the Chinese context has important implications for other emerging markets.

Our results show that the directors in the sample display considerable variance in betweenness centrality. One of the most central independent directors is Rongsheng Qin, who serves as an independent director of Changjiang Securities, Minsheng Bank, Poly Real Estate, Yonyou Network and Industrial Securities. His betweenness centrality ranks in the 100th percentile, meaning that he is one of the most central players in the vast network of business professionals in China. As of 2010, he is on the shortest paths connecting more than 3.2 million other pairs of individuals. At the other end of the spectrum, the lowest betweenness centrality measure is zero, which suggests that some directors have general relationships with other directors, but those relationships are not exclusive in the sense that no other pairs of relationships go through them.

Our main results show that firms with well-connected independent directors are less likely to commit fraud, which supports our monitoring effect hypothesis. In particular, independent director connectedness has a stronger restraining effect on information-based fraud than on non-information-based fraud. These results are robust to two-stage instrumental variable regression estimates. The instrument we use is the average of independent directors' education levels, which increases with independent director connectedness but is unlikely to be related to fraud. To further address potential endogeneity, we use one-year lagged connectedness to re-estimate the model and find that the results hold. Our results are also robust to alternative measures of connectedness and fraud.

We next investigate possible channels of the negative relationship between independent director connectedness and corporate fraud. Director reputation is often mentioned as an important incentive in the literature on board directors (see Harford, 2003; Yermack, 2004; Minnick and Zhao, 2010; Ertimur et al., 2012; Masulis and Mobbs, 2014). The mechanism analysis indicates that independent directors obtain reputation capital through their social network, and reputation motivates effective monitoring. Specifically, we provide evidence that well-connected independent directors are associated with fewer absences from board meetings and more

dissension in board decisions. The evidence shows that independent directors' connectedness reduces the incidence of fraud through the monitoring effect, as reflected by their lower levels of absenteeism and higher levels of dissension relative to their peers.

To provide more evidence of the monitoring role of independent director connectedness in reducing corporate fraud, we conduct several cross-sectional tests to examine how the effect varies with regional legal environment, reputation incentives and independent directors' positions on the board.

First, an independent director's monitoring effectiveness may be influenced by the firm's regional legal environment. We proxy regional legal environment with the percentage of lawyers in a region to further investigate the influence of independent director connectedness on corporate fraud. The results show that independent director connectedness has a stronger negative effect on corporate fraud in poor legal environments.

Second, Fama and Jensen (1983) argue that preserving and enhancing reputation in the directorship labor market is a primary motivation of directors. Therefore, we explore how the reputation incentive affects the relationship between independent director connectedness and corporate fraud. Following Dai et al. (2017), we measure independent director's reputation incentive by whether he/she is a member of or holds a position on any chamber of commerce (*Shanghui*) and find that the negative relationship between independent director connectedness and corporate fraud is more salient for independent directors with stronger reputation incentives.

Finally, we investigate the effect of independent directors' positions on boards of directors on corporate fraud. Although audit committee members do not actively participate in the day-to-day operations of a firm, they do oversee management's preparation of the financial statements. Investors consider audit committee members to be more responsible for financial reporting quality than other directors. Consistent with this argument, we find that independent directors who serve on audit committees have a stronger restraining effect on corporate fraud than those who do not.

This paper contributes to the literature in the following ways. First, we rely on social capital theory to identify which independent directors have better resources (e.g., reputation and influence) accessible through their social networks. By using social capital theory and social network analysis, this paper connects multiple research disciplines and introduces social ties as a new determinant of corporate fraud. Second, we provide empirical evidence that independent director connectedness is negatively associated with corporate fraud, especially information-based fraud. Our results suggest that to enhance the corporate governance role of independent directors, firms would benefit from hiring well-connected independent directors.

In a related study, Wan et al. (2014) find that firms with independent directors with rich network relationships are less likely to engage in corporate fraud. However, the mechanism through which the network position of independent directors influences corporate fraud is under-explored in the literature. We extend Wan et al. (2014) by considering the board meeting attendance and voting behavior of independent directors of listed firms in China. We find that well-connected independent directors are less likely to be absent from board meetings and are more likely to dissent in board decisions than their less well-connected peers. Our work thus provides a more complete picture of how independent directors' network relationships affect corporate fraud.

This paper proceeds as follows. Section 2 reviews the literature and develops our testable hypotheses. Section 3 presents the data, variables and empirical design. Section 4 presents the main results and a battery of additional robustness tests. Section 5 describes the mechanism analysis and several cross-sectional tests. Section 6 concludes the paper.

## 2. Literature review and research hypothesis

### *2.1. Social capital*

Social capital theory and research are relatively recent developments that attract the attention of researchers seeking to explain how individuals (firms) mobilize resources through relationships with others. Horton et al. (2012) use social capital theory and find that social capital (connectedness) is positively associated with a firm's future performance. Kong (2011) and Lins et al. (2017) show that a firm's social capital enhances its value. Hoi et al. (2019) provide evidence that social capital mitigates agency problems by restraining managerial rent extraction via CEO compensation.

How does social capital affect individual behavior? Social capital is considered a social asset that is captured through social networks via an individual's connections and access to resources (e.g., reputation and influence) in the networks or groups of which they are a member. Possessing or having access to resources protects and promotes an individual's standing in the social structure, which confers identity and reputation. Reputation is the aggregation of recognitions received by an individual. It is a function of the extent to which one receives recognition within a social group (Lin, 2002). Masulis and Mobbs (2014) assume that reputation is a strong motivator of director performance based on subsequent changes in directorships held as a reward or penalty for performance. Therefore, one can expect reputation incentives to deter individuals from engaging in wrongdoing or cover-ups.

However, certain strategic social ties may have more value and greater influence and power over an individual's decision-making than types of ties. Such social ties allow a member of a social group to share their interests and resources with others in their group. There is evidence that executives appointed by the CEO are more likely to share similar beliefs and visions with the CEO; they may be more beholden to the CEO who hired or promoted them to their current position than those appointed during a previous CEO's tenure, which may weaken the checks and balances required to prevent corporate fraud (Landier et al., 2012; Khanna et al., 2015). Therefore, we expect that social influence to affect individuals likelihood to engage in wrongdoing or cover-ups.

### *2.2. Corporate fraud*

Over the last decade, allegations of corporate fraud have raised substantial concerns about the effectiveness of corporate governance. Corporate fraud shakes the confidence of investors, reduces shareholder value and leads to the misallocation of capital, thereby increasing the instability of financial markets. Thus, it has attracted great attention from researchers (see Karpoff and Lott, 1993; Chen et al., 2011; Karpoff et al., 2008, 2014; Giannetti and Wang, 2016). Recent studies show that fraudulent firms strategically use socially responsible activities to coordinate their fraudulent financial activities (Li et al., 2021). Liu (2016) and Zhang (2018) analyze the effect of corporate corruption on corporate fraud. Davidson et al. (2015) investigate whether executives' behavior outside the workplace—in terms of ownership of luxury goods and prior legal infractions—affects their propensity to perpetrate fraud. Dimmock et al. (2018) identify the effect coworkers have on an individual's probability of committing fraud. Other studies show that corporate fraud is related to executive compensation (Conyon and He, 2016; Hass et al., 2016; Chen et al., 2020), corporate lobbying (Yu and Yu, 2011) and ownership structure (Alexander and Cohen, 1999).

In related studies, Khanna et al. (2015) and Chidambaran et al. (2011) analyze the effect of CEO–director connections on corporate fraud. They focus on how the internal relationships between the CEO and a firm's directors are related to corporate fraud. In this paper, we use social capital theory to examine whether external relationships—connectedness—provide independent directors with reputational incentives or merely gives them managerial influence that they can wield against the firm for personal gain.

### *2.3. Hypothesis development*

Directors have two types of incentives: monetary and reputational capital (Yermack, 2004). Reputation is a valuable asset for independent directors (Alchian and Demsetz, 1972). Independent directors often establish reputations as good monitors and thus obtain additional directorships (Fama, 1980; Fama and Jensen, 1983). Independent directors are responsible for monitoring firm activities (Ertimur et al., 2012), and the risk of losing a board seat due to malfeasance is an incentive for effective monitoring by independent directors (Harford, 2003). Overall, reputation incentives play an important role in disciplining firms that commit fraud (Karpoff and Lott, 1993). According to social capital theory, well-connected independent directors can easily accumulate more reputation through their social network, which helps strengthen their monitoring and decrease the firm's propensity to commit fraud. Collectively, these factors create a monitoring effect.

Pre-existing personal connections appear to lead to suboptimal behavior and poorer economic outcomes by undermining independent judgment, subverting rational decision-making and interfering with effective corporate governance and director oversight. Specifically, Hwang and Kim (2009) explore the difference between

conventionally independent boards and socially independent boards and find that firms with conventionally and socially independent boards have lower compensation and exhibit stronger pay–performance and turnover–performance sensitivities than firms with conventionally independent boards. Fracassi and Tate (2012) find that firms with more powerful CEOs are more likely to appoint directors with ties to the CEO, thus weakening the intensity of board monitoring.

Similarly, according to social capital theory, directors are more likely to share beliefs and visions with independent directors to whom they are well-connected. Independent director connectedness may facilitate the coordination required to engage in fraud, weaken the checks required to prevent wrongdoing and reduce the expected cost of wrongdoing, and thus promote fraud. This is the covering effect.

In short, our theoretical analysis shows that independent director connectedness has both positive and negative effects on a firm's propensity to commit fraud. The monitoring effect implies that independent director connectedness is negatively correlated with a firm's propensity to commit fraud, whereas the covering effect implies a positive correlation. Therefore, the question of how independent director connectedness affects corporate fraud is a "black box," and which effect dominates is an empirical question. Therefore, we propose two competing hypotheses, stated in the alternative form as follows.

H1a: According to the monitoring effect, independent director connectedness is negatively correlated with a firm's propensity to commit fraud.
H1b: According to the covering effect, independent director connectedness is positively correlated with a firm's propensity to commit fraud.

## 3. Data, variables and empirical design

### *3.1. Data*

Our sample starts with all firms listed on the China A-share stock market from 2010 to 2017. Information about independent directors is obtained from the Chinese Research Data Services (CNRDS) Platform. We obtain data on corporate fraud, firm characteristics and governance measures from the China Stock Market and Accounting Research (CSMAR) database. We exclude the observations with missing variables and winsorize the continuous variables at the 1st and 99th percentiles to reduce the influence of extreme observations and possible data errors. We exclude financial and special treatment companies from the study sample. Our final sample consists of 10,073 firm-year observations.

### *3.2. Variables*

#### *3.2.1. Measuring independent director connectedness*

Directors play a variety of social roles as individual actors in the economy and are also influenced by various social groups. To directly study their role in corporate governance, we construct the yearly networks established by the directors of listed firms concurrently serving on at least one board. Our network focuses on bilateral, non-directional ties.

In social network analysis, "betweenness centrality" indicates how important an individual is in terms of their connections with others, as measured by the frequency with which an individual falls on the shortest path between other pairs in the social network. An individual in such a position can influence the group by facilitating, interrupting or distorting information during its transmission (Freeman, 1979; Padgett and Ansell, 1993; Jackson, 2008). If such an individual is removed, the structure of the network changes. That is, high betweenness centrality indicates that the individual possesses more core resources (e.g., reputation and influence) than those with low betweenness centrality. Therefore, we use betweenness centrality to measure our variable of interest. First, we calculate the betweenness centrality of all of the directors in our sample in each year, and then extract the betweenness centrality of the independent directors by firm. Finally, we calculate the average of each firm's independent directors' betweenness centrality, *Betweenness*, which measures betweenness centrality at the firm level.

*3.2.2. Measuring corporate fraud*

*Fraud* is a dummy variable that equals one if the firm commits fraud, and zero otherwise. The year of the fraud is defined as the year in which the fraud took place, not the year in which it was detected. When an incidence of fraud lasts more than one year, we associate multiple firm-year observations with that fraud. Using the fraud classification from the CSMAR database, we classify the fraud observations into information-based fraud and non-information-based fraud (Wan et al., 2014). Specifically, information-based fraud includes fictitious profits, the misrepresentation of assets, false entries, delayed disclosure, material omissions, inaccurate disclosures and general accounting misrepresentations. Non-information-based fraud includes fraudulent listing, capital contribution fraud, unauthorized change in the use of funds, the misappropriation of company assets, insider trading, illegal stock trading, stock price manipulation and illegal guarantees, among others.

*3.2.3. Control variables*

To obtain a complete dataset, we merge the data from the CNRDS and CSMAR databases and calculate the following variables that are included in our subsequent analyses: *Top10* is the sum of the shares held by the top 10 largest shareholders of a firm. *IndepDirector* is the percentage of independent directors on a firm's board. *BoardSize* is the number of directors on a firm's board. *StateOwned* is the ratio of state-owned shares to total shares. *Duality* is a dummy variable that equals one if a firm's CEO is also the chair of the board. *BoardMeeting* is the number of board meetings. *AuditRanking* is the ranking of accounting firms based on total revenue. *FirmSize* is measured by the natural log of total assets. *Analyst* is the number of analysts following a firm. *Ln( Analyst )* is the natural log of one plus *Analyst*. *Liquidity* is the ratio of operating cash flow to total assets. *Leverage* is the ratio of the book value of debt to the total book value of assets. *Tobin's Q* is measured as the ratio of market value to the book value of total assets. *Profitability* is a firm's annual stock return. *Growth* is the rate of increase in a firm's main business revenue.

*3.2.4. Summary statistics*

In Appendix A, we list the top five independent directors and firms by betweenness centrality in 2010. The top five independent directors include Rongsheng Qin, Jianbiao Zheng, Jipeng Liu, Zhongzhi Ma and Peiyong Gao. In addition, Rongsheng Qin was selected as a top 10 outstanding independent director of listed firms in the 9th China Corporate Governance Forum hosted by the Shanghai Stock Exchange on 18 December 2010.[1] Our research shows that 6 of these 10 outstanding independent directors rank in the top 50 % and four rank in the top 25 % of the 2010 observations in our sample, which indicates that the betweenness centrality is accurate and representative, and that the director connectedness and the relative position of independent directors does impact corporate governance in China. As there was a wave of departures by politically connected independent directors in 2013,[2] we similarly list the top five independent directors and firms in 2017.

Table 1 presents the sample distributions of the firms with and without identified fraud. Panel A shows the sample distribution by year. The number of firms in the sample increases over time, but the number of firms with identified fraud varies considerably. Panel B shows the sample distribution by betweenness centrality, and it shows that the rate of fraud decreases as the betweenness centrality increases.

Table 2 presents the descriptive statistics for all of the key variables. The statistics for the full sample are reported in Panel A. The mean of *Fraud* is 0.084, indicating that fraud observations account for 8.4 % of the firm-year observations. The mean of *Betweenness* is 0.001. Panel B reports the mean of each variable separately for the fraud and nonfraud subsamples in columns (6) and (7), respectively. Column (8) reports the difference between the means for each variable in the fraud and nonfraud subsamples. The nonfraud subsample shows significantly higher *Betweenness* than the fraud subsample, suggesting that well-connected independent directors may help deter fraud. The control variables show, on average, that relative to their peers, the fraud firms are larger, and have less-concentrated ownership, larger boards, more frequent board meetings, lower

[1] For more detailed information, see https://finance.qq.com/a/20101218/001312.htm.

[2] On 19 October 2013, the Central Organization Department issued Document No. 18, "Opinions on Further Regulating the Issue of Party and Government Leading Cadres' Part-time Jobs in Enterprises." The release of this document set off a wave of departures by politically connected independent directors of listed companies. For more detailed information, see https://renshi.people.com.cn/n/2013/1030/c139617-23380219.html.

Table 1
Sample distribution.

Panel A: Sample distribution by year

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Firms with fraud | 21 | 47 | 115 | 113 | 101 | 144 | 166 | 138 | 845 |
| Firms without fraud | 744 | 912 | 918 | 1,066 | 1,128 | 1,245 | 1,447 | 1,768 | 9,228 |
| Total | 765 | 959 | 1,033 | 1,179 | 1,229 | 1,389 | 1,613 | 1,906 | 10,073 |
| Fraud percentage | 2.75 % | 4.90 % | 11.13 % | 9.58 % | 8.22 % | 10.37 % | 10.29 % | 7.24 % | 8.39 % |

Panel B: Sample distribution by *Betweenness*

| *Betweenness* | *Betweenness* ≤ p25 | p25 < *Betweenness* ≤ p50 | p50 < *Betweenness* ≤ p75 | *Betweenness* > p75 | Total |
|---|---|---|---|---|---|
| Firm-year observations with fraud | 216 | 213 | 212 | 204 | 845 |
| Firm-year observations without fraud | 2,302 | 2,305 | 2,312 | 2,309 | 9,228 |
| Total | 2,518 | 2,518 | 2,524 | 2,513 | 10,073 |
| Fraud percentage | 8.58 % | 8.46 % | 8.40 % | 8.12 % | |

Notes: This table presents the distribution of the firm-year observations. Panel A reports the sample distribution by year. Panel B reports the sample distribution by firms' independent director betweenness centrality, *Betweenness*.

Table 2
Summary statistics.

| | Panel A: Full sample | | | | | Panel B: Fraud and nonfraud firm subsamples | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Variable | N | Mean | SD | Min | Max | Fraud | Nonfraud | Fraud–Nonfraud |
| *Fraud* | 10,073 | 0.084 | 0.277 | 0 | 1 | | | |
| *Betweenness* | 10,073 | 0.001 | 0.001 | 0 | 0.006 | 0.001093 | 0.001095 | –0.000002** |
| *Top10* | 10,073 | 0.603 | 0.151 | 0.223 | 0.891 | 0.5645 | 0.6061 | –0.0416*** |
| *IndepDirector* | 10,073 | 0.416 | 0.085 | 0.25 | 0.667 | 0.4121 | 0.4163 | –0.0042 |
| *BoardSize* | 10,073 | 8.798 | 2.224 | 4 | 16 | 9.1740 | 8.7640 | 0.4100*** |
| *StateOwned* | 10,073 | 0.100 | 0.175 | 0 | 0.747 | 0.0028 | 0.0032 | –0.0004 |
| *Duality* | 10,073 | 0.380 | 0.485 | 0 | 1 | 0.3586 | 0.3818 | –0.0232 |
| *BoardMeeting* | 10,073 | 9.855 | 3.798 | 4 | 23 | 11.1941 | 9.7321 | 1.462*** |
| *AuditRanking* | 10,073 | 13.484 | 11.016 | 2 | 48 | 14.1752 | 13.4207 | 0.7545* |
| *FirmSize* | 10,073 | 20.771 | 1.536 | 18.653 | 23.571 | 9.4616 | 9.3835 | 0.0781*** |
| *Ln(Analyst)* | 10,073 | 1.689 | 1.079 | 0 | 3.638 | 1.4444 | 1.7119 | –0.2675*** |
| *Liquidity* | 10,073 | 0.037 | 0.073 | –0.2 | 0.231 | 0.0258 | 0.0376 | –0.0118*** |
| *Leverage* | 10,073 | 0.361 | 0.202 | 0.037 | 0.862 | 0.4324 | 0.3550 | 0.0774*** |
| *Tobin's Q* | 10,073 | 2.975 | 2.444 | 0.318 | 14.477 | 2.5631 | 3.0125 | –0.4494*** |
| *Profitability* | 10,073 | 0.158 | 0.555 | –0.559 | 2.464 | 0.1917 | 0.1550 | 0.0367* |
| *Growth* | 10,073 | 0.217 | 0.388 | –0.554 | 2.204 | 0.2002 | 0.2189 | –0.0187 |

Notes: This table presents the descriptive statistics and compares the fraud and nonfraud subsamples. Panel A reports the statistics for the full sample. Panel B reports the mean of each variable separately for the fraud and nonfraud subsamples. Column (8) reports the difference between the means of the fraud and nonfraud subsamples for each variable. The variable definitions are provided in Appendix B. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

audit rankings, fewer analysts following, lower liquidity, higher leverage, lower Tobin's Q and higher profitability.

### 3.3. Empirical methodology

To address the issue of treating non-observed fraud as no-fraud we follow Wang (2010), Wang et al. (2010) and Khanna et al. (2015) and use a bivariate probit model with partial observability (see Poirier, 1980, for details).

For each firm $i$, we denote by $Fraud_{it}$* and $Detect_{it}$* the latent variables determining firm $i$'s likelihood of committing fraud in year $t$ and the possibility of detecting it as follows:

$$Fraud^{*}_{it} = X_{F,it}\delta + \mu_{it}$$

$$Detect^{*}_{it} = X_{D,it}\eta + v_{it}.$$

$Fraud_{it}$ equals 1 if $Fraud_{it}$* is greater than 0, and 0 otherwise; similarly, $Detect_{it}$ equals 1 if $Detect_{it}$* is greater than 0, and 0 otherwise. We do not directly observe the realizations of $Fraud_{it}$ and $Detect_{it}$; instead, we observe $Z_{it} = Fraud_{it} * Detect_{it}$ where $Z_{it}$ equals 1 if firm $i$ has committed fraud that has been detected. $X_{F,it}$ is a vector of corporate governance variables that explain firm $i$'s propensity to commit fraud in year $t$, and $X_{D,it}$ is a vector of variables that explain why fraud is detected. The variables $\mu_{it}$ and $v_{it}$ are the disturbance terms.

Let $\Phi$ denote the bivariate standard normal cumulative distribution function. The correlation between $\mu_{it}$ and $v_{it}$ is $\rho$. The empirical model for $Z_{it}$ is.

$$P(Z_{it} = 1) = P(Fraud_{it}Detect_{it} = 1) = \Phi(X_{F,it}\delta, X_{D,it}\eta, \rho)$$

$$P(Z_{it} = 0) = P(Fraud_{it}Detect_{it} = 0) = 1 - \Phi(X_{F,it}\delta, X_{D,it}\eta, \rho).$$

Thus, the log-likelihood function for the model is.

$$L(\delta, \eta, \rho) = \sum \log\left(P(Z_{it} = 1)\right) + \sum \log\left(P(Z_{it} = 0)\right).$$

The bivariate probit model estimation requires that $X_{F,it}$ and $X_{D,it}$ do not contain the same set of variables. Following previous studies (Chen et al., 2006; Lu et al., 2012; Wan et al., 2014; El-Khatib et al., 2015; Khanna et al., 2015), we use the variables *Top10*, *IndepDirector*, *BoardSize*, *StateOwned*, *Duality*, *BoardMeeting*, *AuditRanking*, *FirmSize* and *Ln(Analyst)* to model a firm's propensity to commit fraud. *AuditRanking*, *Liquidity*, *Leverage*, *Tobin's Q*, *Profitability and Growth* are used to model the detection of fraud.

Whether a firm's fraud is detected by the regulator depends on the regulators' assessment of the firm's likelihood to commit fraud. Often, poor financial performance triggers an initial investigation by the regulator (Chen et al., 2006). Independent director connectedness is not an important consideration for regulators; therefore, independent director connectedness affects the fraud-commission equation but has little influence on the fraud-detection equation.

## 4. Empirical results

### 4.1. Baseline results

Table 3 reports the bivariate probit estimation results for independent director connectedness. Columns (1) and (2) report the estimated relationships between independent director connectedness and the incidence of fraud, and columns (3) and (4) report the estimated relationships between the control variables and the likelihood that a given fraud is detected. The coefficient on the main variable of interest, *Betweenness*, is statistically significant and negative, suggesting that well-connected independent directors accumulate reputation through their social networks, which strengthens their monitoring and decreases a firm's propensity to commit fraud. This result is consistent with the expectations in H1a.

Some of the control variables also show significant coefficients that are mostly consistent with our conjecture. Fraud firms tend to be larger, have less-concentrated ownership and have larger boards than nonfraud firms. More frequent board meetings are also associated with a higher incidence of fraud. This may indicate that a firm's illegal activities are discussed by the board over a number of meetings. Stock analysts are widely considered to be important external monitors of firms. More analysts following is negatively associated with fraud. Firm performance as measured by *Liquidity* and *Growth* is negatively correlated with fraud detection, and highly leveraged firms are more likely to be associated with fraud than their peers.

Table 3
Bivariate probit model estimation for corporate fraud and connectedness.

| | Fraud | | Detect | |
|---|---|---|---|---|
| Variable | (1) coefficient | (2) *t* -statistic | (3) coefficient | (4) *t* -statistic |
| *Betweenness* | –0.148** | (–2.432) | | |
| *Top10* | –2.045*** | (–3.674) | | |
| *IndepDirector* | 0.644 | (1.108) | | |
| *BoardSize* | 0.042** | (2.110) | | |
| *StateOwned* | 0.422 | (0.363) | | |
| *Duality* | –0.012 | (–0.144) | | |
| *BoardMeeting* | 0.114*** | (4.861) | | |
| *FirmSize* | 0.367*** | (3.082) | | |
| *Ln(Analyst)* | –0.223*** | (–4.050) | | |
| *AuditRanking* | 0.001 | (0.343) | 0.004 | (1.445) |
| Constant | –4.625*** | (–4.506) | –1.371*** | (–13.114) |
| *Liquidity* | | | –0.602* | (–1.790) |
| *Leverage* | | | 0.579*** | (4.298) |
| *Tobin's Q* | | | –0.004 | (–0.512) |
| *Profitability* | | | 0.047 | (1.137) |
| *Growth* | | | –0.047* | (–1.653) |
| Year dummies | | Y | | Y |
| Industry dummies | | Y | | Y |
| Observations | | 10,073 | | 10,073 |
| Prob > $chi^2$ | | 0.000 | | 0.000 |
| Log likelihood | | –2,760 | | –2,760 |

Notes: This table reports the bivariate probit model estimation results. Columns (1) and (2) report the estimated relationships between independent director connectedness and the incidence of fraud, and columns (3) and (4) report the estimated relationships between the control variables and the likelihood that a given fraud is detected. Columns (1) and (3) report the coefficient estimates. Columns (2) and (4) report their *t*-statistics. The variable definitions are provided in Appendix B. Robust standard errors are clustered at the industry level. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

### 4.2. Information-based and non-information-based fraud

The main purpose of introducing independent directors in firms listed in China was to promote objective and timely disclosure of information by listed firms to protect the interests of investors. Independent directors are often considered the directors most responsible for the quality of information disclosures (Srinivasan, 2005). Therefore, independent director connectedness may be more sensitive to the effect of information-based corporate fraud than non-information-based fraud. To further investigate the differentiated effects of independent director connectedness on different types of fraud, we divide fraudulent firms into two groups: information-based fraud and non-information-based fraud. These two groups are added to the nonfraud firms as two subsamples.

Table 4 reports the bivariate probit estimation results for the effect of independent director connectedness on different types of fraud. Panel A shows the results for the information-based fraud group, and Panel B shows those for the non-information-based fraud group. The results in Table 4 show that the coefficient on *Betweenness* is significant and negative for the information-based fraud subsample, indicating that firms with well-connected independent directors are associated with a lower incidence of fraud. In contrast, the coefficient on *Betweenness* is negative but not significant in the non-information-based fraud subsample. Therefore, we infer that independent director connectedness has a more obvious restraining effect on information-based fraud than on non-information-based fraud.

### 4.3. Robustness checks

#### 4.3.1. Endogeneity

Thus far, we assume that the negative relationship between independent director connectedness and corporate fraud is more likely to indicate causality from independent director connectedness to fraud than the other

Table 4
Information-based fraud and noninformation-based fraud.

| | Panel A: Information-based fraud group | | | | Panel B: Noninformation-based fraud group | | | |
|---|---|---|---|---|---|---|---|---|
| | Fraud | | Detect | | Fraud | | Detect | |
| | (1) coefficient | (2) *t* -statistic | (3) coefficient | (4) *t* -statistic | (5) coefficient | (6) *t* -statistic | (7) coefficient | (8) *t* -statistic |
| *Betweenness* | –0.115** | (–2.087) | | | –0.153 | (–1.568) | | |
| *Top10* | –2.842*** | (–4.600) | | | –1.271* | (–1.957) | | |
| *IndepDirector* | 0.963 | (1.524) | | | 0.478 | (0.561) | | |
| *BoardSize* | 0.040* | (1.947) | | | 0.031 | (0.970) | | |
| *StateOwned* | 0.548 | (0.423) | | | 1.849 | (0.973) | | |
| *Duality* | –0.045 | (–0.520) | | | –0.018 | (–0.153) | | |
| *BoardMeeting* | 0.091*** | (4.286) | | | 0.146*** | (4.169) | | |
| *FirmSize* | 0.572*** | (3.826) | | | 0.080 | (0.470) | | |
| *Ln(Analyst)* | –0.257*** | (–4.460) | | | –0.195*** | (–3.025) | | |
| *AuditRanking* | 0.000 | (0.046) | 0.006** | (2.013) | 0.003 | (0.402) | 0.006 | (1.448) |
| Constant | –6.100*** | (–4.856) | –1.742*** | (–11.547) | –2.328 | (–1.251) | –1.440*** | (–10.373) |
| *Liquidity* | | | –0.575 | (–1.391) | | | –0.074 | (–0.217) |
| *Leverage* | | | 0.825*** | (4.967) | | | 0.411*** | (2.876) |
| *Tobin's Q* | | | 0.049 | (1.184) | | | –0.032** | (–2.315) |
| *Profitability* | | | –0.012 | (–0.307) | | | 0.070* | (1.707) |
| *Growth* | | | –0.056 | (–1.436) | | | –0.046 | (–1.165) |
| Year dummies | | Y | | Y | | Y | | Y |
| Industry dummies | | Y | | Y | | Y | | Y |
| Observations | | 9,904 | | 9,904 | | 9,793 | | 9,793 |
| Prob > $chi^2$ | | 0.000 | | 0.000 | | 0.000 | | 0.000 |
| Log likelihood | | –2,307 | | –2,307 | | –2,080 | | –2,080 |

Notes: This table reports the bivariate probit estimation results for the effect of independent director connectedness on different types of fraud. Panel A shows the results for information-based fraud. Panel B presents the results for non-information-based fraud. In particular, columns (1), (2), (5) and (6) report the estimated relationships between independent director connectedness and the incidence of fraud, and columns (3), (4), (7) and (8) report the estimated relationships between the control variables and the likelihood of detection given fraud. The variable definitions are provided in Appendix B. Robust standard errors are clustered at the industry level. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

way around. Although we postulate that high independent director connectedness decreases the propensity to commit fraud, the negative relationship between the two variables may be driven by reverse causality (i.e., firms less likely to engage in fraud are more likely to attract well-connected independent directors).

To infer causality, we adopt an instrumental variable two-stage least squares approach. The basic requirement for validity is that our instrument has no effect on corporate fraud other than through its effect on the suspected endogenous independent variable, *Betweenness*. Consistent with Faleye et al. (2014), we adopt the average of independent directors' education level, *Education*, as our instrumental variable. From the perspective of relevance, highly educated independent directors often have larger friendship networks and are more likely to hold an important position in elite circles than independent directors with less education. In addition, from the perspective of exogeneity, there is currently no evidence that the education level of an independent director affects a firm's propensity to commit fraud. Following Khanna et al. (2015), the first-stage estimation results are reported in Panel A of Table 5, columns (1) and (2). We find that *Betweenness* increases with independent directors' education level, and the relationship is significant at the 1 % level. The value of the *F*-statistic is well above 10. The second-stage estimates are reported in columns (3) and (4). The predicted values of *Betweenness* are significant and negatively related to the incidence of fraud.

To further address potential endogeneity, we replace *Betweenness* with the one-year lagged variable, $Betweenness_{t-1}$, and re-estimate the bivariate probit model. Panel B of Table 5 reports the results for the effect of lagged connectedness on corporate fraud. Columns (5) and (6) of Table 5 indicate that the coefficient on $Betweenness_{t-1}$ is also statistically significant and negative, suggesting that the negative effect of independent director connectedness on corporate fraud remains even after controlling for potential endogeneity. In short, after controlling for potential endogeneity issues, independent director connectedness is significantly negatively correlated with the incidence of fraud, which is in line with the expectations in Hypothesis H1a.

Table 5
Endogeneity issues.

| | Panel A: Two-stage least squares regression | | | | Panel B: Lagged independent variable | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st stage | | 2nd stage | | Fraud | | Detect | |
| | (1) coefficient | (2) *t* -statistic | (3) coefficient | (4) *t* -statistic | (5) coefficient | (6) *t* -statistic | (7) coefficient | (8) *t* -statistic |
| *Betweenness* | | | –0.296* | (–1.753) | | | | |
| $Betweenness_{t-1}$ | | | | | –94.761* | (–1.951) | | |
| *Education* | 0.426*** | (20.162) | | | | | | |
| Controls | Y | | Y | | Y | | Y | |
| Year dummies | Y | | Y | | Y | | Y | |
| Industry dummies | Y | | Y | | Y | | Y | |
| Observations | | 9,822 | | 9,822 | | 7,710 | | 7,710 |
| Adjusted $R^2$ | | 0.0649 | | | | | | |
| Log likelihood | | | | –2,156 | | –2,387 | | –2,387 |
| *F*-statistic | | 69.14 | | | | | | |
| Prob > *F* | | 0.000 | | | | | | |

Notes: This table reports the results after controlling for potential endogeneity. Panel A presents the two-stage least squares regression results with the average of independent directors' education level, *Education*, as the instrumental variable. Columns (1) and (2) give the results of the first-stage regressions, and columns (3) and (4) give the results of the second-stage regressions. Panel B presents the results when we replace *Betweenness* with the lagged variable, $Betweenness_{t-1}$, as the independent variable. Columns (5) and (6) report the estimated relationships between lagged independent director connectedness and the incidence of fraud, and columns (7) and (8) report the estimated relationships between the control variables and the likelihood a given fraud is detected. The variable definitions are provided in Appendix B. Robust standard errors are clustered at the industry level. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

#### *4.3.2. Alternative measure of independent director connectedness*

To make *Betweenness* comparable across time, we generate percentile values of *Betweenness*, *BetweennessPercen*, with the 1st percentile being the least connected and the 100th being the most connected. This transformation preserves the rank order of each firm and makes the size of the social network irrelevant and thus directly comparable across different years. The results in Panel A of Table 6 show that *BetweennessPercen* is significantly and negatively related to the incidence of fraud. This result is consistent with our baseline finding.

#### *4.3.3. Alternative measure of corporate fraud*

To further assess the robustness of our results, we perform an alternative test of our hypothesis by examining the relationship between independent director connectedness and the number of fraud cases, *FraudNum*. *FraudNum* is the number of times a firm commits fraud in a given year. The results of both the OLS and Tobit in Panel B of Table 6 show that independent director connectedness is significantly and negatively related to *FraudNum*, indicating that firms with well-connected independent directors have fewer instances of fraud. This result is consistent with our baseline finding.

## 5. Extension

### *5.1. Mechanism analysis*

Our analysis so far indicates that firms with well-connected independent directors are less likely to commit fraud, which is consistent with the monitoring effect. To reinforce our understanding of the influence of independent director connectedness on corporate fraud, we conduct a mechanism analysis. Board meeting attendance is a measure of directors' commitment to their directorship responsibilities. Masulis and Mobbs (2014)

Table 6
Alternative measures.

| | Panel A: Alternative measure of connectedness | | Panel B: Alternative measure of fraud | |
|---|---|---|---|---|
| | Connectedness | | | |
| | (1) Fraud | (2) Detect | (3) OLS | (4) Tobit |
| *BetweennessPercen* | –0.011*** | | | |
| | (–2.806) | | | |
| *Betweenness* | | | –77.789*** | –77.789* |
| | | | (–2.782) | (–1.824) |
| Controls | Y | Y | Y | Y |
| Constant | –4.616*** | –1.371*** | –0.927 | –0.927 |
| | (–4.518) | (–13.042) | (–1.423) | (–1.433) |
| Year dummies | Y | Y | Y | Y |
| Industry dummies | Y | Y | Y | Y |
| Prob > $chi^2$ | 0.000 | 0.000 | | |
| Log likelihood | –2,760 | –2,760 | | |
| $R^2$ | | | 0.038 | |
| Pseudo $R^2$ | | | | 0.018 |
| Observations | 10,073 | 10,073 | 845 | 845 |

Notes: This table presents the results of the robustness checks. Panel A gives the bivariate probit estimation results with the alternative measure of independent director connectedness. Column (1) reports the estimated relationships between independent director connectedness and the incidence of fraud, and column (2) reports the estimated relationships between the control variables and the likelihood a given fraud is detected. Panel B gives the OLS and Tobit regression results with the alternative measure of fraud. The variable definitions are provided in Appendix B. Robust standard errors are clustered at the industry level. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

study reputation incentives in the director labor market and find that when directors experience an increase in reputation incentives, their rate of board attendance increases, which affects the quality of director monitoring. Jiang et al. (2016) suggest that directors with better reputations than their peers dissent more often and that director dissension improves corporate governance. Therefore, we examine two potential economic mechanisms through which independent director connectedness may affect corporate fraud: (1) whether, relative to their less well-connected peers, well-connected independent directors are less likely to be absent from board meetings, which strengthens monitoring and reduces the incidence of fraud and (2) whether well-connected independent directors are more likely than their less well-connected peers to dissent, thereby improving corporate governance and leading to fewer incidences of fraud.[3]

We measure board attendance with the variable, *Absence*, which is the average percentage of independent directors absent from each firm's board meetings. Following Jiang et al. (2016), we use the terms "reservation," "objection," "abstain" and "dissent" to identify dissention. A director's age is associated with their propensity to dissent and with board attendance rate (Masulis and Mobbs, 2014; Jiang et al., 2016). Therefore, we use *Ln(Age)* as an additional control variable. The empirical models are estimated using both OLS and Tobit. Panel A of Table 7 presents the results for *Absence*, and Panel B presents those for *Dissension*. These results show a significantly negative relationship between *Betweenness* and *Absence* and a significantly positive relationship between *Betweenness* and *Dissension*, which suggests that well-connected independent directors are less likely to be absent from board meetings but more likely to dissent than their less well-connected peers. Thus, the presence of well-connected directors on a board improves the quality of monitoring and reduces the incidence of corporate fraud. Combined with our main finding that independent director connectedness decreases the likelihood of fraud, this evidence indicates that well-connected directors with stronger reputation incentives tend to provide strong monitoring by attending board meetings and dissenting, resulting in a lower incidence of corporate fraud.

[3] Li et al. (2017) use the same approach to analyze the economic mechanisms through which social trust affects crash risk.

Table 7
Mechanism analysis.

| | Panel A: *Absence* | | | | Panel B: *Dissension* | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Tobit | | (2) OLS | | (3) Tobit | | (4) OLS | |
| Variable | coefficient | *t* -statistic | coefficient | *t* -statistic | coefficient | *t* -statistic | coefficient | *t* -statistic |
| *Betweenness* | –9.551** | (–2.456) | –0.171* | (–1.949) | 76.494* | (1.837) | 0.777 | (1.431) |
| *Top10* | 0.013 | (0.505) | 0.003 | (0.357) | –0.487** | (–2.469) | –0.003** | (–2.075) |
| *IndepDirector* | 0.103** | (2.224) | 0.004** | (2.360) | –0.379 | (–1.024) | –0.003 | (–1.589) |
| *BoardSize* | 0.006*** | (3.387) | 0.002*** | (3.112) | 0.054*** | (3.673) | 0.002* | (1.955) |
| *StateOwned* | –0.048 | (–0.275) | 0.001 | (0.155) | –1.113 | (–0.551) | 0.001 | (0.168) |
| *Duality* | –0.005 | (–0.549) | 0.004 | (0.146) | –0.102 | (–1.553) | –0.001 | (–1.615) |
| *BoardMeeting* | 0.003*** | (3.289) | –0.001 | (–0.406) | 0.007 | (0.942) | 0.004 | (0.875) |
| *FirmSize* | –0.016* | (–1.645) | –0.001* | (–1.698) | –0.216*** | (–2.658) | –0.002 | (–1.552) |
| *Ln(Analyst)* | –0.001 | (–0.291) | 0.002 | (1.227) | –0.080** | (–2.496) | –0.005*** | (–2.612) |
| *AuditRanking* | 0.001** | (2.000) | 0.002 | (1.514) | –0.001 | (–0.395) | 0.002 | (0.565) |
| *Liquidity* | –0.054 | (–1.379) | –0.002 | (–0.842) | 0.378 | (1.276) | 0.003 | (1.319) |
| *Leverage* | 0.016** | (2.284) | 0.002 | (1.223) | 0.008 | (0.199) | 0.002 | (1.123) |
| *Tobin's Q* | 0.001 | (0.640) | 0.002 | (0.691) | –0.001 | (–0.214) | –0.004 | (–0.775) |
| *Profitability* | –0.010 | (–1.456) | –0.002 | (–1.302) | 0.007 | (0.143) | –0.002 | (–1.334) |
| *Growth* | –0.001 | (–0.324) | –0.004 | (–1.060) | 0.002 | (0.121) | 0.001 | (1.007) |
| *Ln(Age)* | 0.013 | (0.320) | –0.002 | (–1.260) | –0.462 | (–1.496) | –0.005 | (–0.307) |
| Constant | –0.324* | (–1.805) | 0.013* | (1.648) | 2.341* | (1.693) | 0.020** | (2.053) |
| Year dummies | Y | | Y | | Y | | Y | |
| Industry dummies | Y | | Y | | Y | | Y | |
| $R^2$ | | | 0.008 | | | | 0.006 | |
| Pseudo $R^2$ | 0.038 | | | | 0.145 | | | |
| Observations | 10,070 | | 10,070 | | 9,882 | | 9,882 | |

Notes: This table reports the estimation results of the mechanism analysis. Panel A presents the results for the effect of independent director connectedness on board attendance rate. Panel B presents the results for the effect of independent director connectedness on dissension. The variable definitions are provided in Appendix B. Robust standard errors are clustered at the industry level. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

In an unreported analysis, we also examine the relationship between independent director connectedness and corporate fraud from the perspective of the covering effect. We find no evidence that independent director connectedness is positively correlated with a firm's propensity to commit fraud.

### 5.2. Cross-sectional tests of the effect of independent director connectedness

#### 5.2.1. Regional legal environment

The development of legal systems and the effectiveness of law enforcement can enhance public accountability, curb fraud and promote the healthy development of firms (Chen et al., 2013). Generally, regions with better legal environments rely on rules to restrain the market, whereas regions with poor legal environments rely more on informal institutions. Drawing on the research by Pistor and Wellons (1999) and Djankov et al. (2006), we measure regional legal environments using *Lawyer*—the percentage of lawyers in a region—to further investigate the influence of independent director connectedness on fraud in different legal environments.

Panel A of Table 8 reports the bivariate probit estimation results for the influence of independent director connectedness on fraud in different legal environments. The regression results show that the coefficient on the interaction term is statistically significant and positive, indicating that independent director connectedness has a stronger negative effect on corporate fraud in a poor legal environment. We interpret this result as evidence that informal social ties can substitute for formal institutions in regulating market order.

#### 5.2.2. Reputation incentive

The monitoring effect indicates that connectedness enables independent directors to obtain reputational capital, thus strengthening their monitoring of the firm. Reputation is a key determinant of corporate direc-

Table 8
Regional legal environment and reputation incentive.

| | Panel A: Regional legal environment | | | | Panel B: Reputation incentive | | | |
|---|---|---|---|---|---|---|---|---|
| | Fraud | | Detect | | Fraud | | Detect | |
| | (1) coefficient | (2) *t* -statistic | (3) coefficient | (4) *t* -statistic | (5) coefficient | (6) *t* -statistic | (7) coefficient | (8) *t* -statistic |
| *Betweenness* | –0.216** | (–2.209) | | | –0.156** | (–2.466) | | |
| *Betweenness*Lawyer* | 11.203* | (1.905) | | | | | | |
| *Betweenness*ChamberRatio* | | | | | –25.928* | (–1.906) | | |
| *Lawyer* | –0.022** | (–1.998) | | | | | | |
| *ChamberRatio* | | | | | –0.338* | (–1.915) | | |
| Controls | Y | | Y | | Y | | Y | |
| Constant | –4.339*** | (–3.813) | –1.318*** | (–10.915) | –4.664*** | (–4.445) | –1.366*** | (–12.996) |
| Year dummies | Y | | Y | | Y | | Y | |
| Industry dummies | Y | | Y | | Y | | Y | |
| Observations | 10,073 | | 10,073 | | 10,073 | | 10,073 | |
| Prob > $chi^2$ | 0.000 | | 0.000 | | 0.000 | | 0.000 | |
| Log likelihood | –2,759 | | –2,759 | | –2,760 | | –2,760 | |

Notes: This table presents the results of the cross-sectional tests related to regional legal environment and reputation incentive. Panel A reports the bivariate probit estimation results for the influence of independent director connectedness on fraud in different legal environments. Panel B reports the bivariate probit estimation results for the relationship between independent director connectedness and corporate fraud under reputation incentives. Columns (1), (2), (5) and (6) report the estimated relationships between independent director connectedness and the incidence of fraud, and columns (3), (4), (7) and (8) report the estimated relationships between the control variables and the likelihood a given fraud is detected. The variable definitions are provided in Appendix B. Robust standard errors are clustered at the industry level. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

tors' market value (Minnick and Zhao, 2010). Following Dai et al. (2017), we measure an independent director's reputation incentive by whether he/she is a member of or holds a position on any chamber of commerce (*Shanghui*). In general, an independent director who is a member of or holds a position on any chamber of commerce attracts more market attention and suffers greater reputational damage for misconduct. Therefore, the reputation incentive motivates independent directors to strengthen their monitoring and reduce the probability of corporate fraud to maintain their status.

The variable *ChamberRatio* is the percentage of a firm's independent directors who are a member of or hold a position on any chamber of commerce. Panel B of Table 8 shows that the coefficient on the interaction term is statistically significant and negative, suggesting that the negative effect of independent director connectedness on corporate fraud is more pronounced for firms with independent directors with stronger reputation incentives.

### *5.2.3. The effect of independent directors' positions*

The board of directors of a listed company should have an audit committee and may also have strategy, nomination, remuneration and appraisal and other relevant special committees as needed.[4] Independent directors, especially audit committee members, bear reputational costs for financial reporting failures (Srinivasan, 2005). The literature suggests that firms with well-connected audit committees are less likely to misstate their annual financial statements (Omer et al., 2020). Therefore, theoretically, there may be differences in the monitoring effect on corporate fraud between independent directors who serve on the audit committee and those who do not.

We divide the independent directors into two groups according to whether they serve on the audit committee, and we use their average betweenness centrality as the independent variable in the bivariate probit model. Table 9 reports the bivariate probit estimation results for the difference between the effect of independent director connectedness on corporate fraud for independent directors who are audit committee members versus those who are not. Panel A shows the results for the non-audit-committee independent directors, and Panel B

[4] See https://www.csrc.gov.cn/pub/zjhpublic/zjh/201809/t20180930_344906.htm.

Table 9
Effect of independent directors' positions.

| | Panel A: Non-audit-committee independent directors | | | | Panel B: Audit-committee independent directors | | | |
|---|---|---|---|---|---|---|---|---|
| | Fraud | | Detect | | Fraud | | Detect | |
| Variable | (1) coefficient | (2) *t* -statistic | (3) coefficient | (4) *t* -statistic | (5) coefficient | (6) *t* -statistic | (7) coefficient | (8) *t* -statistic |
| *Betweenness* | –0.328 | (–1.319) | | | –0.563** | (–1.969) | | |
| *Top10* | –2.062*** | (–3.739) | | | –2.113*** | (–3.563) | | |
| *IndepDirector* | 0.675 | (1.181) | | | 0.757 | (1.253) | | |
| *BoardSize* | 0.043** | (2.133) | | | 0.049** | (2.268) | | |
| *StateOwned* | 0.401 | (0.339) | | | 0.485 | (0.403) | | |
| *Duality* | –0.014 | (–0.165) | | | –0.013 | (–0.155) | | |
| *BoardMeeting* | 0.112*** | (4.697) | | | 0.120*** | (4.958) | | |
| *FirmSize* | 0.366*** | (3.118) | | | 0.381*** | (2.996) | | |
| *Ln(Analyst)* | –0.220*** | (–3.961) | | | –0.228*** | (–4.129) | | |
| *AuditRanking* | 0.001 | (0.319) | 0.004 | (1.519) | 0.001 | (0.228) | 0.005 | (1.567) |
| Constant | –4.626*** | (–4.588) | –1.378*** | (–13.405) | –4.841*** | (–4.368) | –1.371*** | (–13.225) |
| *Liquidity* | | | –0.605* | (–1.805) | | | –0.588* | (–1.774) |
| *Leverage* | | | 0.584*** | (4.321) | | | 0.565*** | (4.193) |
| *Tobin's Q* | | | –0.004 | (–0.490) | | | –0.005 | (–0.564) |
| *Profitability* | | | 0.046 | (1.105) | | | 0.046 | (1.153) |
| *Growth* | | | –0.047* | (–1.666) | | | –0.045 | (–1.598) |
| Year dummies | | Y | | Y | | Y | | Y |
| Industry dummies | | Y | | Y | | Y | | Y |
| Observations | | 10,073 | | 10,073 | | 10,073 | | 10,073 |
| Prob > $chi^2$ | | 0.000 | | 0.000 | | 0.000 | | 0.000 |
| Log likelihood | | –2,760 | | –2,760 | | –2,760 | | –2,760 |

Notes: This table reports the bivariate probit estimation results for the effect of independent directors' positions on corporate fraud. Panel A shows the results for non-audit-committee independent directors. Panel B presents the results for audit-committee independent directors. In particular, columns (1), (2), (5) and (6) report the estimated relationships between independent director connectedness and the incidence of fraud, and columns (3), (4), (7) and (8) report the estimated relations between the control variables and the likelihood that a given fraud is detected. The variable definitions are provided in Appendix B. Robust standard errors are clustered at the industry level. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

shows those for the audit-committee independent directors. The results show that independent director connectedness is significantly and negatively associated with corporate fraud only in the audit-committee independent director group. In addition, the coefficient on *Betweenness* is much smaller in the audit-committee independent director group than in the non-audit-committee independent director group. These results indicate that independent directors who serve on audit committees have a stronger restraining effect on corporate fraud than those who do not.

## 6. Conclusion

The collective behavior of executives is often a critical factor in corporate fraud, and independent directors frequently play a central monitoring role. In this study, we use social network analysis to measure independent director connectedness within the entire director network, which helps us better understand the influence of social capital on economic decisions.

We find that independent director connectedness is negatively correlated with the likelihood of committing fraud, especially information-based fraud. This finding is robust to two-stage IV regressions and alternative measures. We further identify the possible channel through which independent director connectedness decreases the incidence of fraud, namely, by motivating well-connected independent directors with stronger reputation incentives to provide rigorous monitoring. Consistent with our theoretical analysis, the results show that well-connected independent directors are less likely to be absent from board meetings and more likely to raise objections in such meetings.

We also find that the relationship between independent director connectedness and corporate fraud varies according to the regional legal environment, independent directors' reputation incentives and independent directors' audit committee membership status. Specifically, independent director connectedness has a stronger negative effect on corporate fraud in poor legal environments than in relatively strong legal environments. This implies that in a relationship-oriented society, social ties have a similar effect on corporate economic behavior to that of formal institutions (Jin and Yu, 2018). Furthermore, the negative relationship between independent director connectedness and corporate fraud is more pronounced for firms with independent directors facing strong reputation incentives, which implies that reputation is a powerful incentive for independent directors. Finally, we find that independent directors who serve on a firm's audit committee have a stronger restraining effect on corporate fraud, which implies that the monitoring strength of audit committee members is critical to preventing fraud.

Taken together, these results imply that independent director connectedness is a key factor in reducing a firm's likelihood of committing fraud and thus deserves attention from investors, regulators and governance specialists. Further, our results underscore the importance of social capital built through social networks in assessing the quality of corporate governance. Social capital is therefore an important reference for improving corporate governance and developing capital markets.

**Appendix A.** *Top five independent directors and firms by betweenness centrality*

The following table presents the top five independent directors and firms by betweenness centrality. Panel A shows the top five independent directors by betweenness centrality in 2010 and 2017. Panel B shows the top five firms by betweenness centrality in 2010 and 2017. The betweenness centrality values are presented in parentheses.

Panel A: Top five independent directors by betweenness centrality

| Rank | 2010 | 2017 |
|---|---|---|
| 1 | Rongsheng Qin (0.030871) | Guoping Yang (0.025383) |
| 2 | Jianbiao Zheng (0.023696) | Wei Lv (0.022538) |
| 3 | Jipeng Liu (0.022592) | Yuexiang Jiang (0.020495) |
| 4 | Zhongzhi Ma (0.021678) | Haiwu Zhu (0.020350) |
| 5 | Peiyong Gao (0.021673) | Mianzhi Yang (0.015224) |

Panel B: Top five firms by betweenness centrality

| Rank | 2010 | 2017 |
|---|---|---|
| 1 | 002083-Sunvim Group Company Limited (0.0118) | 002107-Shandong Wohua Pharmaceutical Company Limited (0.0114) |
| 2 | 002107-Shandong Wohua Pharmaceutical Company Limited (0.0118) | 000517-Rongan Property Company Limited (0.0106) |
| 3 | 600588-Yonyou Network Technology Company Limited (0.0113) | 603998-Hunan Fangsheng Pharmaceutical Company Limited (0.0088) |
| 4 | 000861-Guangdong Haiyin Yongye Company Limited (0.0089) | 002001-Zhejiang NHU Company Limited (0.0086) |
| 5 | 002016-Guangdong Shirong Zhaoye Company Limited (0.0085) | 002226-Anhui Jiangnan Chemical Industry Company Limited (0.0078) |

**Appendix B.** *Variable descriptions*

| Variable | Description |
|---|---|
| *Betweenness* | The average of each firm's independent directors' betweenness centrality. Because of its small size, we adjust the coefficients of *Betweenness* to *Betweenness**$10^3$ or *Betweenness**$10^{-3}$. |
| *Fraud* | A dummy variable that equals one if the firm commits fraud, and zero otherwise. |
| *Top10* | The total shares held by a firm's top 10 largest shareholders. |
| *IndepDirector* | The percentage of independent directors on the board. |
| *BoardSize* | The number of directors on the board. |
| *StateOwned* | The ratio of state-owned shares to total shares. |
| *Duality* | A dummy variable that equals one if the CEO is also the chair of the board, and zero otherwise. |
| *BoardMeeting* | The number of board meetings. |
| *AuditRanking* | A ranking of accounting firms based on total revenue. |
| *FirmSize* | The natural log of total assets. |
| *Analyst* | The number of analysts following a firm. |
| *Ln(Analyst)* | Ln(1 + *Analyst*). |
| *Liquidity* | The ratio of operating cash flow to total assets. |
| *Leverage* | The ratio of the book value of debt to the total book value of assets. |
| *Tobin's Q* | Tobin's Q, measured as the ratio of market value to the book value of total assets. |
| *Profitability* | A firm's annual stock return. |
| *Growth* | The rate of increase of a firm's main business revenue. |
| *Lawyer* | The percentage of lawyers in a region. |
| *ChamberRatio* | The percentage of independent directors that are members of or hold positions on any chamber of commerce. |
| *Education* | The average education level of the independent directors in each firm. |
| $Betweenness_{t-1}$ | The one-year lagged *Betweenness*. |
| *BetweennessPercen* | The percentile values of *Betweenness*. |
| *FraudNum* | The number of times a firm commits fraud in a given year. |
| *Absence* | The average percentage of independent directors absent from board meetings in each firm. |
| *Dissension* | The opinions expressed by independent directors on corporate decisions, including "reservation," "objection," "abstain" and "dissent." |
| *Age* | The average age of independent directors in each firm. |
| *Ln(Age)* | The natural log of *Age*. |

## References


Adams, R.B., Hermalin, B.E., Weisbach, M.S., 2010. The role of boards of directors in corporate governance: A conceptual framework and survey. J. Econ. Literat. 48, 58–107. https://doi.org/10.1257/jel.48.1.58.

Adler, P.S., Kwon, S.W., 2002. Social capital: Prospects for a new concept. Acad. Manag. Rev. 27, 17–40. https://doi.org/10.5465/amr.2002.5922314.

Alchian, A.A., Demsetz, H., 1972. Production, information costs, and economic organization. Am. Econ. Rev. 62, 777–795.

Alexander, C.R., Cohen, M.A., 1999. Why do corporations become criminals? Ownership, hidden actions, and crime as an agency cost. J. Corporate Finan. 5, 1–34. https://doi.org/10.1016/S0929-1199(98)00015-7.

Bhagat, S., Black, B., 1997. The uncertain relationship between board composition and firm performance. SSRN. https://doi.org/10.2139/ssrn.11417.

Chen, G.M., Firth, M., Gao, D.N., Rui, O.M., 2006. Ownership structure, corporate governance, and fraud: Evidence from China. J. Corporate Finan. 12, 424–448. https://doi.org/10.1016/j.jcorpfin.2005.09.002.

Chen, Y., Wang, Y., Lin, L., 2014. Independent directors' board networks and controlling shareholders' tunneling behavior. China J. Acc. Res. 7 (2), 101–118.

Chen, D., Wei, G., Xiao, Z., 2013. Law efficiency, financial deepening and family control preferences. Econ. Res. J. 48 (10), 55–68, in Chinese.
Chen, D., Wang, F., Xing, C., 2020. Financial reporting fraud and CEO pay-performance incentives. J. Manage. Sci. Eng. 6, 197–210. https://doi.org/10.1016/j.jmse.2020.07.001.
Chen, Y., Zhu, S., Wang, Y., 2011. Corporate fraud and bank loans: Evidence from China. China J. Acc. Res. 4 (3), 155–165.
Chidambaran, N., Kedia, S., Prabhala, N., 2011. CEO director connections and corporate fraud. Fordham University Schools of Business Research Paper, p. 1787500.
Conyon, M.J., He, L., 2016. Executive compensation and corporate fraud in China. J. Bus. Ethics 134, 669–691. https://doi.org/10.1007/s10551-014-2390-6.
Dahya, J., Dimitrov, O., McConnell, J.J., 2008. Dominant shareholders, corporate boards, and corporate value: A cross-country analysis. J. Financ. Econ. 87, 73–100. https://doi.org/10.1016/j.jfineco.2006.10.005.
Dai, Y., Yu, W., Ning, B., Pan, Y., 2017. Party membership of the chairman of a private enterprise and corporate financial fraud. Acc. Res. 6, 75–81, in Chinese.
Davidson, R., Dey, A., Smith, A., 2015. Executives' "off-the-job" behavior, corporate culture, and financial reporting risk. J. Financ. Econ. 117, 5–28. https://doi.org/10.1016/j.jfineco.2013.07.004.
Dimmock, S.G., Gerken, W.C., Graham, N.P., 2018. Is fraud contagious? Coworker influence on misconduct by financial advisors. J. Finan. 73, 1417–1450. https://doi.org/10.1111/jofi.12613.
Djankov, S., Qian, Y., Roland, G., Zhuravskaya, E., 2006. Entrepreneurship in China and Russia compared. J. Eur. Econ. Assoc. 4, 352–365. https://doi.org/10.1162/jeea.2006.4.2-3.352.
Duchin, R., Matsusaka, J.G., Ozbas, O., 2010. When are outside directors effective? J. Financ. Econ. 96, 195–214. https://doi.org/10.1016/j.jfineco.2009.12.004.
El-Khatib, R., Fogel, K., Jandik, T., 2015. CEO network centrality and merger performance. J. Financ. Econ. 116, 349–382. https://doi.org/10.1016/j.jfineco.2015.01.001.
Ertimur, Y., Ferri, F., Maber, D.A., 2012. Reputation penalties for poor monitoring of executive pay: Evidence from option backdating. J. Financ. Econ. 104, 118–144. https://doi.org/10.1016/j.jfineco.2011.12.004.
Faleye, O., Kovacs, T., Venkateswaran, A., 2014. Do better-connected CEOs innovate more? Journal of Financial and Quantitative Analysis 49, 1201–1225. https://doi.org/10.1017/S0022109014000714.
Fama, E.F., 1980. Agency problems and the theory of the firm. Journal of Political Economy 88, 288–307. https://doi.org/10.1086/260866.
Fama, E.F., Jensen, M.C., 1983. Separation of ownership and control. J. Law Econ. 26, 301–325. https://doi.org/10.1086/467037.
Fich, E.M., Shivdasani, A., 2006. Are busy boards effective monitors? J. Finan. 61 (2), 689–724. https://doi.org/10.1111/j.1540-6261.2006.00852.x.
Fracassi, C., Tate, G., 2012. External networking and internal firm governance. J. Finan. 67, 153–194. https://doi.org/10.1111/j.1540-6261.2011.01706.x.
Freeman, L.C., 1979. Centrality in social networks: Conceptual clarification. Social Networks 1, 215–239. https://doi.org/10.1016/0378-8733(78)90021-7.
Giannetti, M., Wang, T.Y., 2016. Corporate scandals and household stock market participation. J. Finan. 71, 2591–2636. https://doi.org/10.1111/jofi.12399.
Gordon, J., 2007. The rise of independent directors in the United States, 1950–2005: Of shareholder value and stock market prices. Stanford Law Review 59, 1465.
Harford, J., 2003. Takeover bids and target directors' incentives: The impact of a bid on directors' wealth and board seats. J. Financ. Econ. 69, 51–83. https://doi.org/10.1016/S0304-405X(03)00108-9.
Hass, L.H., Tarsalewska, M., Zhan, F., 2016. Equity incentives and corporate fraud in China. J. Bus. Ethics 138, 723–742. https://doi.org/10.1007/s10551-015-2774-2.
Hoi, C.K., Wu, Q., Zhang, H., 2019. Does social capital mitigate agency problems? Evidence from Chief Executive Officer (CEO) compensation. J. Financ. Econ. 133, 498–519. https://doi.org/10.1016/j.jfineco.2019.02.009.
Horton, J., Millo, Y., Serafeim, G., 2012. Resources or power? Implications of social networks on compensation and firm performance. Journal of Business Finance & Accounting 39, 399–426. https://doi.org/10.1111/j.1468-5957.2011.02276.x.
Hwang, B.H., Kim, S., 2009. It pays to have friends. J. Financ. Econ. 93, 138–158. https://doi.org/10.1016/j.jfineco.2008.07.005.
Jackson, M.O., 2008. Social and economic networks. Princeton University Press, Princeton, NJ.
Jiang, W., Wan, H., Zhao, S., 2016. Reputation concerns of independent directors: Evidence from individual director voting. Rev. Finan. Stud. 29, 655–696. https://doi.org/10.1093/rfs/hhv125.
Jin, X., Yu, J., 2018. Government governance, executive networks and corporate investment efficiency. China Finan. Rev. Int. 8, 122–139. https://doi.org/10.1108/CFRI-06-2016-0053.
Karpoff, J.M., Lee, D.S., Martin, G.S., 2014. The economics of foreign bribery: Evidence from FCPA enforcement actions. Available at SSRN. https://www.stern.nyu.edu/sites/default/files/assets/documents/con_046060.pdf.
Karpoff, J.M., Lee, D.S., Martin, G.S., 2008. The consequences to managers for financial misrepresentation. J. Financ. Econ. 2, 193–215. https://doi.org/10.1016/j.jfineco.2007.06.003.
Karpoff, J., Lott, J., 1993. The reputational penalty firms bear from committing criminal fraud. J. Law Econ. 36, 757–802. https://doi.org/10.1086/467297.
Khanna, V., Kim, E.H., Lu, Y., 2015. CEO connectedness and corporate fraud. J. Finan. 70, 1203–1252. https://doi.org/10.1111/jofi.12243.

Kong, X., 2011. Why are social network transactions important? Evidence based on the concentration of key suppliers and customers in China. China J. Acc. Res. 4 (3), 121–133.
Landier, A., Sauvagnat, J., Sraer, D., Thesmar, D., 2012. Bottom-up corporate governance. Rev. Finan. 17, 161–201. https://doi.org/10.1093/rof/rfs020.
Li, X., Wang, S.S., Wang, X., 2017. Trust and stock price crash risk: Evidence from China. J. Bank. Finan. 76, 74–91. https://doi.org/10.1016/j.jbankfin.2016.12.003.
Li, X., Kim, J.B., Wu, H., Yu, Y., 2021. Corporate social responsibility and financial fraud: The moderating effects of governance and religiosity. J. Bus. Ethics 170, 557–576. https://doi.org/10.1007/s10551-019-04378-3.
Lin, N., 2002. Social capital: A theory of social structure and action. Cambridge University Press, Cambridge, UK.
Lins, K.V., Servaes, H., Tamayo, A., 2017. Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis. J. Finan. 72, 1785–1824. https://doi.org/10.1111/jofi.12505.
Liu, X., 2016. Corruption culture and corporate misconduct. J. Financ. Econ. 122, 307–327. https://doi.org/10.1016/j.jfineco.2016.06.005.
Lu, Y., Zhu, Y., Hu, X., 2012. An empirical study of institutional investors' shareholding and listed companies' frauds. Nankai Manage. Rev. 15 (1), 13–23, in Chinese.
Masulis, R.W., Mobbs, S., 2014. Independent director incentives: Where do talented directors spend their limited time and energy? J. Financ. Econ. 111, 406–429. https://doi.org/10.1016/j.jfineco.2013.10.011.
Masulis, R.W., Zhang, E.J., 2019. How valuable are independent directors? Evidence from external distractions. J. Financ. Econ. 132, 226–256. https://doi.org/10.1016/j.jfineco.2018.02.014.
Minnick, K., Zhao, M., 2010. Backdating and director incentives: Money or reputation? J. Financ. Res. 32, 449–477. https://doi.org/10.1111/j.1475-6803.2009.01257.x.
Omer, T.C., Shelley, M.K., Tice, F.M., 2020. Do director networks matter for financial reporting quality? Evidence from audit committee connectedness and restatements. Manage. Sci. 66, 3361–3388. https://doi.org/10.1287/mnsc.2019.3331.
Padgett, J.F., Ansell, C.K., 1993. Robust action and the rise of the Medici, 1400–1434. Am. J. Sociol. 98, 1259–1319. https://doi.org/10.1086/230190.
Pistor, K., Wellons, P.A., 1999. The role of law and legal institutions in Asian economic development. Oxford University Press, Oxford, UK.
Poirier, D.J., 1980. Partial observability in bivariate probit models. J. Econometr. 12, 209–217. https://doi.org/10.1016/0304-4076(80)90007-X.
Srinivasan, S., 2005. Consequences of financial reporting failure for outside directors: Evidence from accounting restatements and audit committee members. J. Acc. Res. 43, 291–334. https://doi.org/10.1111/j.1475-679x.2005.00172.x.
Wan, L., Deng, L., Zheng, X., 2014. Network position, governance role of independent directors and corporate violation of rules: Using a bivariate probit model with partial observability. Syst. Eng.—Theory Pract. 34 (12), 3091–3102, in Chinese.
Wang, T.Y., 2010. Corporate securities fraud: Insights from a new empirical framework. J. Law Econ. Organ. 29, 535–568. https://doi.org/10.1093/jleo/ewr009.
Wang, T.Y., Winton, A., Yu, X., 2010. Corporate fraud and business conditions: Evidence from IPOs. J. Finan. 65, 2255–2292. https://doi.org/10.1111/j.1540-6261.2010.01615.x.
Yermack, D., 2004. Remuneration, retention, and reputation incentives for outside directors. J. Finan. 59, 2281–2308. https://doi.org/10.1111/j.1540-6261.2004.00699.x.
Yu, F., Yu, X.Y., 2011. Corporate lobbying and fraud detection. J. Financ. Quant. Anal. 46, 1865–1891. https://doi.org/10.1017/S0022109011000457.
Zhang, J., 2018. Public governance and corporate fraud: Evidence from the recent anti-corruption campaign in China. J. Bus. Ethics 148, 375–396. https://doi.org/10.1007/s10551-016-3025-x.
Zhu, J., Ye, K., Tucker, J.W., Chan, K.C., 2016. Board hierarchy, independent directors, and firm value: Evidence from China. J. Corporate Finan. 41, 262–279. https://doi.org/10.1016/j.jcorpfin.2016.09.009.

China Journal of Accounting Research
Volume 15, 4 (2022)



Website:
http://www.elsevier.com/locate/cjar
http://www.cb.cityu.edu.hk/research/cjar/



ELSEVIER