China Journal of Accounting Research

Volume 14, 2 (2021)

Website:
http://www.elsevier.com/locate/cjar
http://www.cb.cityu.edu.hk/research/cjar/

14/2 China Journal of Accounting Research Vol. 14/2 (2021) 101–230

ELSEVIER

Volume 14 • Issue 2 • June 2021

China Journal *of* Accounting Research

HOSTED BY
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Available online at www.sciencedirect.com
ScienceDirect

ISSN 1755-3091

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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: 广州注册会计师协会

Published quarterly in March, June, September, and December

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CHINA JOURNAL OF ACCOUNTING RESEARCH

Volume 14/2 (2021)

China Journal of Accounting Research 14 (2021) 101–128

HOSTED BY

Contents lists available at ScienceDirect

China Journal of Accounting Research

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

External regulation, independent director attendance, and governance effects

Leilei Song [a], Gary Gang Tian [b], Guanmin Liao [c,*]

[a] *School of Accountancy, Shandong University of Finance and Economics, China*
[b] *Department of Applied Finance, Macquarie University, Australia*
[c] *School of Business, Renmin University of China, China*

ARTICLE INFO

Article history:
Received 14 January 2020
Accepted 6 February 2021
Available online 25 March 2021

Keywords:
External regulation
Independent director board meeting attendance
Corporate governance effect
Independent director dissent

ABSTRACT

In this study we examine how the regulation of director attendance disciplines directors' behavior, and consider the governance effect of such regulations. This examination exploits the differences between the requirements for director attendance at board meetings enacted by the Shanghai Stock Exchange (SHSE) and by the Shenzhen Stock Exchange (SZSE). Using a difference-in-differences model with a sample of A-share listed firms from 2006 to 2017, we document that the rate of meeting attendance by independent directors who serve with firms listed on the SHSE (SHIDs) has increased significantly since the exchange's enforcement of the regulation on attendance. This positive effect has been more pronounced for independent directors with legal backgrounds. Further investigations find that the regulation of attendance plays a corporate governance role through the mechanism of enhanced monitoring. The attendance regulation increases the SHIDs likelihood of casting dissenting votes, and it leads to both better accounting performance and higher firm value. In addition, SHIDs are more likely to depart from firms listed on the SHSE, and to transfer their directorships to firms listed on the SZSE, which has a less constraining attendance requirement. Our findings provide evidence of how external regulation shapes director attendance and voting behavior in emerging markets.

* Corresponding author.
E-mail addresses: gary.tian@mq.edu.au (G.G. Tian), liaoguanmin@rmbs.ruc.edu.cn (G. Liao).

☆ This study is supported by the National Natural Science Foundation of China, Grant No. 71972180.

https://doi.org/10.1016/j.cjar.2021.02.002
1755-3091/

1. Introduction

We investigate whether and how external regulation disciplines director behavior, and explore the effects of such regulation on corporate governance. Independent directors are vital monitors of firms (Fama and Jensen, 1983). Although independence is essential for these directors to effectively monitor firms, greater independence often means that a director has difficulty obtaining complete internal information on a firm. Theoretical research finds that the governance effect of independent directors relies on access to information (Guo and Jiang, 2003; Adams and Ferreira, 2007). Van Ees et al. (2008), Duchin et al. (2010), and Ye and Jermias (2016) provide empirical evidence showing that the functions of directors depend on their ability to acquire information. Diligent behavior helps independent directors to obtain information on listed firms, and attending board meetings in person is an essential way for them to access information, monitor the management team, and provide consultation or support in making decisions (Guo and Jiang, 2003; Malenko, 2013). However, the actual behavior of independent directors is often unsatisfying to investors. For example, independent directors with multiple directorships are frequently absent from board meetings. According to Yang and Huang (2015), a questionnaire survey on the behavior of independent directors in China finds that only one-fifth of the respondents attend all board meetings in person. Absence from board meetings may be one reason for the low effectiveness of monitoring by independent directors in China. To maintain the effectiveness of the independent director system, regulatory departments such as the China Securities Regulatory Commission (CSRC), the Shanghai Stock Exchange (SHSE), and the Shenzhen Stock Exchange (SZSE) have promulgated a number of regulations. However, it remains unclear if such external regulatory measures can effectively monitor the presence of independent directors at meetings.

China's unique institutional background provides a good opportunity for conducting this study. First, the SHSE and the SZSE have long maintained different regulations on director attendance. In 2009, the SHSE issued and implemented its *Guidelines on the Selection and Behavior of Directors of Listed Firms on the Shanghai Stock Exchange* (hereafter, the *Guidelines*). These *Guidelines* emphasize that independent directors who miss attending over half of the board meetings during a year are deemed ineligible to act as directors for at least the next three years. In contrast, the SZSE had no similar attendance requirements until 2017, when it revised its *Record Measures for the Independent Directors of Shenzhen Stock Exchange* (hereafter, the *Measures*). Therefore, between 2009 and 2017, the SHSE's requirements for board meeting attendance by directors who served listed firms were much stricter than those for directors who served with firms listed on the SZSE.

A second reason why China is a helpful setting for this study is that data on attendance by independent directors are mandatorily disclosed in China. According to the requirements of the *Listing Rules of the SZSE* and the *Listing Rules of the SHSE* (in 2004), it is mandatory for listed firms to disclose information on the attendance of each director in their board meeting announcements. Therefore, we can obtain the complete record on attendance at director-level board meetings in China. In other nations, the rates of meeting attendance by each director are rarely available. For example, in the US, according to the disclosure rules of the Securities and Exchange Commission (SEC), firms are required to report directors who miss more than 25% of the meetings in a year, instead of disclosing each director's actual meeting attendance.

In taking advantage of the difference in regulations on director meeting attendance between the SHSE and the SZSE, we examine whether external regulation can shape the behavior of independent directors, and how such influence works. Using a difference-in-differences model, we find that after the SHSE implemented its *Guidelines*, the personal attendance rate of independent directors[1] serving with SHSE firms (SHIDs) increases more rapidly than that of the independent directors serving with SZSE firms (SZIDs). This increase in attendance is more pronounced among independent directors with legal backgrounds. Further analysis finds that the implementation of the *Guidelines* increases the possibility of dissenting votes by SHIDs, and it leads to both better accounting performance and higher firm value. These findings indicate that regulation of attendance takes effect through the mechanism of monitoring by directors. In addition, our findings show that inde-

[1] The personal attendance reported here includes remote attendance. In accordance with the *Guidelines*, when board meetings are held via e-mail, fax, telephone, or video, attending remotely is also considered personal attendance.

pendent directors are more likely to resign from SHSE firms and move to serving SZSE firms, which have a less constrained attendance requirement.

Our study makes three contributions. First, it adds to the growing literature on how external regulation influences the effectiveness of corporate governance. Past research examines the influence of supervision on the effectiveness of various corporate governance mechanisms, such as the director system (Armstrong et al., 2014; Liang and Zeng, 2016) and governance by shareholders (Liao et al., 2008; Wei et al., 2014). Other studies investigate how external regulation affects the identification and rectification of problems through corporate governance mechanisms (Ke and Zhang, 2019). We provide new evidence that regulation of director attendance contributes to more diligent behavior on the part of independent directors, which enables higher firm value. Therefore, we expand the literature on the behavior of independent directors. When investor protection is weak, the interests of small and medium investors are exposed to higher risk. In that case, the protection provided by independent directors is even more crucial. However, in situations with a low risk of litigation and in under-developed markets for independent directors, strengthening the external supervision of independent directors is an alternative way to improve the effectiveness of governance. As an emerging market with weak investor protection, China provides a typical example of how regulation can affect the attendance behavior of directors. We find that strengthening the regulation of board meeting attendance raises the rate of personal attendance, promotes monitoring by independent directors, and improves both accounting performance and firm value. Our results can offer guidance for other economies, especially emerging market countries, on how to improve the effectiveness of independent director governance through external regulation.

Furthermore, the evidence from previous studies focuses mainly on the regulatory authority of stock markets, such as the SEC and the CSRC (Ke and Zhang, 2019). We supplement these studies with evidence on the influence that external regulation has on the effectiveness of corporate governance at the stock exchange level. We provide evidence that front-line regulation by the stock exchange can improve the effectiveness of governance by independent directors. Our findings provide a reference to other countries seeking to enhance corporate governance and market efficiency by strengthening the regulation of stock exchange members. At the same time, our findings indicate that harsh measures may lead to evasion of the exchange's regulations. Therefore, a proper and balanced approach to regulation is essential for maintaining the intended effects.

The second contribution of our study is to extend the literature on meeting attendance by independent directors. Our findings contribute to research on the factors that influence board meeting attendance. Numerous studies show that various individual characteristics of directors, such as busyness (Jiraporn et al., 2009; Ferris et al., 2003; Quan and Chen, 2016), reputation (Masulis and Mobbs, 2014), gender (Adams and Ferreira, 2009), and background (Masulis et al., 2012; Chou et al., 2013; Min and Chizema, 2018) have effects on meeting attendance by independent directors. In addition, other studies find that board characteristics such as meeting fees (Adams and Ferreira, 2008) and meeting frequency (Gray and Nowland, 2018), or firm characteristics such as ownership by block shareholders (Chou et al., 2013) and liability insurance for directors and officers (Jia and Tang, 2018) are related to director attendance. We find that strengthening the external regulation of director behavior improves the rate of personal attendance by independent directors, and our study therefore enriches the literature on external regulation. Furthermore, our investigation expands research on the economic consequences of meeting attendance by independent directors. Various other studies provide empirical evidence that director attendance leads to the alleviation of tunneling (Liu et al., 2016), declines in corporate tax avoidance (Barros and Sarmento, 2019), improvements in accounting performance (Gray and Nowland, 2018), and increases in firm value (Chou et al., 2013; Min and Verhoeven, 2013). However, these findings are firm-level economic consequences of directors' attendance. Our results also show that after the implementation of the *Guidelines*, and with the increased rate of in-person meeting attendance by independent directors, the probability of dissent by independent directors increases significantly. Therefore, our study enriches the literature on the economic consequences of directors' attendance, and it does so from the perspective of individual voting behavior.

A third contribution of our study is that it solves the endogenous problem taking advantage of China's unique institutional environment. Other studies have various endogeneity problems, because the attendance of independent directors is endogenously determined. We take the implementation of the *Guidelines* as an

exogenous shock, and perform a difference-in-differences test involving firm and director fixed effects, thereby addressing the endogeneity problem.

The remainder of this study is organized as follows. Section 2 discusses the literature. Section 3 introduces the institutional background and develops the hypotheses. Section 4 explains the research design and the sample selection. Sections 5 and 6 describe the empirical findings, and Section 7 presents the conclusions.

2. Literature review

2.1. The effectiveness of independent director monitoring

According to Fama and Jensen (1983), a board of directors acts as a decision control system that maintains the separation of rights over decisions and control. Mace (1986) argues that most research on this topic focuses on what the directors should do instead of what they really do, and that there is a difference between the two. Research on the effectiveness of monitoring by independent directors considers factors such as the effects of board structure (Armstrong et al., 2014; Liang and Zeng, 2016), the directors' personal characteristics (Giannetti et al., 2015; Hu et al., 2020; Chen et al., 2019), board meeting minutes (Schwartz-Ziv and Weisbach, 2013), and the voting behavior of independent directors (Jiang et al., 2016; Ye et al., 2011). These studies find that board independence improves a firm's information environment (Armstrong et al., 2014; Liang and Zeng, 2016) and increases firm value (Liu et al., 2015). Dissent by independent directors also plays a positive role in corporate governance and market transparency (Jiang et al., 2016). Independent directors also tend to "vote with their feet," which sends a signal of bad news that causes negative market returns (Fahlenbrach et al., 2017).

The early studies on the supervisory role of independent directors focus mainly on examining the degrees of board independence and the individual characteristics of directors. Further research investigates how director dissent improves corporate governance, and how director departure transmits a firm's private information. These studies make an implicit assumption that independent directors have full access to their firms' information. However, this assumption is not always accurate. Therefore, it remains to be empirically tested whether accessibility to firm information affects monitoring by independent directors.

2.2. Board meeting attendance by independent directors

The literature finds that the characteristics of directors, boards, and firms all have effects on the attendance of independent directors at board meetings. An independent director's number of directorships, his or her time, energy, and geographical distance from the firm, plus the factors of reputation, gender, professional experience, and background, all affect the director's meeting attendance. Specifically, Jiraporn et al. (2009) find that directors with multiple board seats are more likely to miss attending board meetings. Masulis and Zhang (2019) provide evidence that exogenous events that seriously distract the directors' attention can cause significant declines in the rates of board meeting attendance. However, Ferris et al. (2003) find no evidence that directors with multiple board memberships tend to shirk their responsibilities. Both Masulis and Mobbs (2014) and Quan and Chen (2016) show that directors are less likely to miss board meetings in their higher-ranked directorships. The attendance records of female directors are better than those of male directors (Adams and Ferreira, 2009). Highly qualified directors are more likely to attend board meetings in person (Chou et al., 2013). Foreign directors miss more board meetings (Masulis et al., 2012; Min and Chizema, 2018). Directors experiencing regulatory sanctions at other firms have higher rates of meeting attendance (Zhong et al., 2017). Rookie directors attend more meetings in person (Chen and Keefe, 2020).

Board characteristics also affect the attendance rates of independent directors, including the fees and frequencies of meetings, and the contagion effects among board fellows. Adams and Ferreira (2008, 2012) find that independent directors have fewer problems attending the meetings of firms that pay higher remuneration for attendance. Higher frequency of board meetings tends to reduce the rate of attendance (Gray and Nowland, 2018). Behavior related to meeting attendance is contagious among colleagues on the same boards, and among colleagues on other boards where the directors concurrently sit (Nowland and Simon, 2018).

Empirical evidence also shows that firm characteristics such as capital structure, financial distress, and liability insurance for directors and officers, all have an influence on the attendance rates of independent directors. For example, higher levels of ownership by the largest shareholder can increase the directors' attendance rates (Chou et al., 2013). Jia and Tang (2018) find that directors tend to miss board meetings in firms that have liability insurance for the directors and officers. Attendance by independent directors does not increase when the firm faces financial distress (Chou et al., 2010). In addition, the overview by Nowland (2019) shows that the attendance rates of independent directors are lower in emerging markets.

These various studies leave a number of questions unanswered, such as how external factors like regulations affect the meeting attendance of independent directors.

A few studies investigate the economic consequences of directors' board meeting attendance. Liu et al. (2016) find that higher rates of attendance by independent directors alleviate tunneling by large shareholders. Barros and Sarmento (2019) show that board meeting attendance is related to a firm's engagement in tax avoidance, especially in firms that practice less tax avoidance. Increasing the rate of board meeting attendance leads to better economic performance (Gray and Nowland, 2018) and higher firm value (Chou et al., 2013; Min and Verhoeven, 2013). However, although these studies show the consequences of independent directors' meeting attendance at the firm level, they offer little evidence on its consequences at the individual level.

2.3. External regulation and independent directors

External regulation plays an essential role in the governance of independent directors. The regulatory norms given in relevant provisions or documents affect the board independence and the process of nominating directors. For example, to establish an effective system for independent directors, the CSRC required that by June 30, 2003, at least one-third of the directors for all listed firms had to be independent directors. Similarly, the New York Stock Exchange (the NASDAQ Stock Exchange) required that all listed companies had to have at least 50% independent directors on their boards by August (October) 2002. Taking these regulatory requirements as an opportunity for research, Armstrong et al. (2014) and Liang and Zeng (2016) examine the effects of independent directors on the information environments of affected firms. For another example, Norway passed a law in 2003 requiring that at least 40% of all independent directors should be female. A study by Ahern and Dittmar (2012) examines how this gender quota shock affects firm value. In addition to these studies, both Hu et al. (2020) and Chen et al. (2019) use China's restrictions (in 2013 and 2015) on appointments of independent directors with political or academic backgrounds to test the relationship between the backgrounds of independent directors and firm value. These studies show significant findings on a range of these regulatory settings, but to date there is little research on how external regulation shapes the behavior of independent directors.

To fill this gap in the research, our study examines whether and how regulatory requirements for director behavior affect directors' board meeting attendance. Our study also analyzes the consequences of these requirements at both the director and firm levels. This research enriches studies on the influencing factors and consequences of meeting attendance by independent directors, and our work has policy implications for the practice of supervising corporate governance.

3. Institutional background and hypotheses development

The duty of diligence, which is known as the "duty of care" under common law, is one of the fiduciary responsibilities of a company board director. The 2005 revisions of China's Company Law gave a common law–style classification of the directors' duty of diligence, including requirements for the directors' allocations of time and energy and their attendance at board meetings. These duties of diligence impose restrictions on a manager's opportunistic behavior (Xu et al., 2013).

Attending board meetings in person is a legal responsibility, and such attendance is necessary for independent directors to perform their duty of diligence. First, attending board meetings in person is a way of acquiring information. For external directors, attending board meetings in person is an essential means to obtain knowledge about the firms' operational situation and to gain access to soft information. Van Ees et al. (2008), Duchin et al. (2010) and Ye and Jermias (2016) all find that directors' roles of monitoring or giving

advice depend on their access to relevant information. In the absence of sufficient information and communication, the asymmetry of information increases, which hinders the capacity of independent directors to monitor firms (Hart, 1995; Nowak and McCabe, 2003). Second, attending board meetings in person helps directors to discuss and reach a consensus on proposals, and thereby to make prudent decisions. Malenko (2013) finds that direct discussion among directors improves decision-making, especially when the directors have a diversity of opinions. Therefore, attending meetings in person is a valuable source of information for independent directors and an effective way for them to supervise listed firms.

However, being rational economic people, independent directors have their own opportunistic motives and patterns of behavior (Hart, 1995). How diligently an independent director performs, and specifically whether he or she attends board meetings in person, is partly determined by the costs and benefits of fulfilling the expected duties. These duties involve supervision costs, and dereliction of duty has a cost. The supervision costs are the energy and time that the independent director expends to access information and supervise managers. The dereliction cost can involve punishment and loss of reputation due to a failure in supervision. The benefits of directorship include reputation, relationships, and payment. The reputational value is accumulated through diligence and integrity, which in return can bring the director future career opportunities and increased income. The relationship value is embodied in the relation between the director and the controlling shareholder. The payment value is the remuneration, or the direct board meeting fee, that listed firms provide for an independent director's presence at a board meeting (Ning and Zhang, 2012). Any change in costs or benefits can influence a director's decisions. Increased external supervision leads to higher costs for dereliction of duty, which are expected to motivate independent directors to increase their efforts for meeting their obligations.

To restrain opportunistic behavior among independent directors, China's regulators have promulgated several guidelines, some of which are related to board meeting attendance by directors. On August 21, 2001, the CSRC issued its *Guidance Opinion on the Establishment of an Independent Director System in Listed Companies*. This policy statement mandated all listed firms to have at least two independent directors by June 30, 2002. The number of independent directors was required to reach one third of each board by June 30, 2003. The boards were also required to dismiss directors who missed three consecutive meetings in person. Directors were required to express their opinions on major events, including selections and appointments of the management teams, and decisions on managerial pay. The CSRC issued the *Code of Corporate Governance for Listed Companies in China* in January 2002, and requested directors to attend their board meetings and voice their opinions on proposals. When directors could not attend board meetings in person, they could designate other directors as their proxies for voting.

In 2004, both the SHSE and the SZSE revised the *Stock Listing Rules*. They jointly required that directors perform their duties of care, and noted that their primary obligation was to attend board meetings diligently. In addition, these exchanges indicated that listed firms should disclose the resolutions of board meetings concerning major events, and disclose the attendance and voting records of directors. After that, the SHSE and the SZSE issued separate guidelines to regulate the selection and behavior of directors.

In 2005 the SZSE issued the *Shenzhen Stock Exchange Independent Directors Filing Measures* (the *Measures*). This set of regulations (and those of the 2008 and 2011 revisions) noted that the SZSE would observe which independent directors were often absent from board meetings. However, the SHSE applied an even more rigorous regulation on August 25, 2009, issuing its *Guidelines on the Selection and Behavior of Directors of Listed Companies on the Shanghai Stock Exchang*e (the *Guidelines*). According to these guidelines, a director who was absent for over half of all board meetings within one year was ineligible to serve as a director of any listed firm for at least three years. This regulation also held in future revisions of the *Guidelines*, and it was the most stringent quantified requirement yet made concerning the duty of diligence for independent directors. The *Guidelines* was much stricter than the *Measures* of the SZSE, because they explicitly warned that directors with a large proportion of absences were under the threat of losing directorships. It was not until the 2017 revision of the *Measures* that the SZSE made a similar explicit attendance requirement. Thus, between the implementation of the *Guidelines* by the SHSE in 2009 and the revision of the *Measures* by SZSE in 2017, SHIDs were required to be more diligent than SZIDs, because they faced a stricter attendance requirement. Therefore, we formulate the following hypothesis:

H1: The ratio of personal attendance at board meetings by independent directors tends to rise among SHSE-listed firms with the increase in pressure from external regulation.

4. Research design and the sample

4.1. Sample construction

We obtain our data on independent directors' meeting attendance and voting, and the accounting and market information on listed firms, from the China Stock Market and Accounting Research Database. The information on the backgrounds and networks of the independent directors come from the Chinese Research Data Services Platform. For the initial sample, we select all of the independent directors of firms that are publicly traded on the A-shares market in the SHSE or the SZSE from 2006 to 2017. Following the literature, we drop observations from the financial industry. We also exclude ChiNext listed firms, because the ChiNext Market has different requirements concerning size, profitability, and corporate governance than other firms on the SZSE.[2] We also delete observations with a leverage larger than one. We remove observations with missing data on director attendance or other variables included in the regression. We retain observations only when a director serves the firm for a whole fiscal year, to eliminate the influence of unusual behavior after a director gains a directorship in a new firm or before leaving an old firm.[3] The final sample consists of 43,266 firm-director-year observations, and 18,408 unique firm-year observations, which involve 9,247 unique independent directors. We winsorize the continuous variables at the 1st and 99th percentiles.

4.2. Models and variables

To examine the policy's effect on the board meeting attendance of independent directors, we design the following difference-in-differences model at the firm-director-year level:

$$AttendRate_{ijt}=\beta_0+\beta_1\mathrm{Treat}_i\times\mathrm{Post}_t+\gamma X_{jt}+\delta X_{it}+\tau_t+\nu_i+\mu_j+\varepsilon_{ijt} \quad (1)$$

where $AttendRate_{ijt}$is the percentage of attendance for independent director j in firm i in year t. Following Jia and Tang (2018), we use this measure to denote the percentage of times that an independent director attends board meetings in person.[4] The measure equals the number of board meetings that an independent director ought to attend (N1), minus the number of board meetings that s/he entrusts others to attend or the number of absences, scaled by N1. $Treat_i$ is an indicator variable that equals one if the firm i is listed on the SHSE, and zero otherwise. $Post_t$ is an indicator variable that equals one if the year is 2010 or after 2010 (because the policy was enacted in late 2009), and zero otherwise.

X_{jt} is a set of control variables that represents director characteristics. Following Chou et al. (2013), Quan and Chen (2016), and Jia and Tang (2018), we include variables that potentially affect director attendance, including the age of each independent director (*Age*), the number of months that the director has served the firm (*Tenure*), the number of directorships that the director holds in all listed firms (*Seats*), the directorship of highest rank (*HighRank*), the annual pay that the director receives from the listed firm (*Allowance*), the director's governmental work experience (*GovExp*), the director's industrial expertise (*IndEpt*), the director's executive positions in another firms (*CmpExect*), whether the independent director works in the same province as the listed firm (*SamePlace*), and the network position of each independent director (*Network*). X_{it} is a vector of firm-level control variables that includes the size of the listed firm (*Size*), its financial leverage (*Leverage*), its

[2] The listing standards of the main board and the small and medium-sized enterprise (SME) board are the same, but the requirements to list on the ChiNext Market are less strict. See http://www.szse.cn/English/listings/standards/index.html for more details. Therefore, the ChiNext Market listed firms are different from those of the main board and from the SME board listed firms in terms of size, profitability, and corporate governance structure. To ensure that these differences do not affect our results, we exclude observations from the ChiNext Market sample. However, if the ChiNext Market sample observations are retained, the regression results remain unchanged.

[3] The results remain robust if we do not drop observations of directors who serve their firms for less than a whole fiscal year.

[4] This measure is also consistent with the requirement of the *Guidelines*.

sales growth (*Growth*), the percentage of shares held by the largest shareholder (*Top1*), an indicator variable denoting when the firm CEO is also the Chairman of the board (*Dual*), the size of the board (*BoardSize*), the percentage of shares held by the management team (*MShare*), and an indicator variable for a state-owned enterprise (*SOE*). Table 1 provides the definitions of these variables.

We include year fixed effects in the model, which are indicated as τ_t. To capture the unchangeable features at the firm and director level, we add firm fixed effects, v_{i} and director fixed effects, μ_{j}. $Treat_i$ and $Post_t$ are excluded, because we include the year and firm fixed effects. ε_{ijt} is the residual. Standard errors are clustered at the firm level. β_1 captures the difference-in-differences effect that the policy has on independent director attendance. We expect this value to be significantly positive if the policy indeed motivates the independent directors to attend board meetings in person.

Table 1
Variable definitions.

Variable	Definition
Dependent Variables	
AttendRate	The rate (in percent) of attendance in person, which equals the number of board meetings an independent director should attend (N1), minus the number of board meetings that the director entrusts others to attend, minus the number of absences, scaled by N1.
EnAttend	The rate (in percent) of entrusted attendance by an independent director, which equals the number of meetings that a director entrusts others to attend, divided by N1.
Departure	An indicator that equals one if an independent director serves the firm for less than three years (one term), and zero otherwise.
Seats_SH	The number of directorships that an independent director holds in SHSE listed firms.
Seats_SZ	The number of directorships that an independent director holds in SZSE listed firms.
Dissent	A dummy variable equals one if an independent director casts at least one dissenting vote in a board meeting, and zero otherwise. A director dissent means that the director votes "against," "reservation," "abstention," or another opinion that does not support a board proposal.
ROA	Returns on assets, which equal the net income, scaled by the total assets.
TQ	Tobin's Q, which equals the market value of equity, plus the book value of liabilities, scaled by the total assets.
Variables of Interest	
Treat	An indicator that equals one if the firm is listed on the SHSE, and zero otherwise.
Post	An indicator denoting that the *Guidelines* are enacted, which takes a value of one if the year is 2010 or later, and zero otherwise.
Control variables for director characteristics	
Age	The age of an independent director. This variable enters regressions in logarithm form.
Tenure	The number of months that an independent director serves a firm. This variable enters regressions in logarithm form.
Seats	The number of directorships of listed Chinese firms that an independent director holds. This variable enters regressions in logarithm form.
HighRank	A dummy variable that takes a value of one for an independent director's board membership if that membership is in the highest-ranking firm (with the largest market value) of any firm for which that person serves as an independent director, and zero otherwise.
Allowance	The pay that an independent director gets from a listed firm, in Chinese yuan. This variable enters regressions in logarithm form.
GovExp	An indicator that equals one if an independent director has governmental work experience, and zero otherwise.
IndEpt	An indicator that equals one if an independent director has industrial expertise, and zero otherwise.
CmpExect	A dummy variable that equals one if an independent director serves other firms as a senior executive, (not counting any independent director position), and zero otherwise.
SamePlace	An indicator that equals one if the independent director works in the same province as the listed firm, and zero otherwise.
Network	The network position of an independent director, as calculated by Pajek.
Control variables of firm characteristics	
Size	The amount of total assets. This variable enters regressions in logarithm form.
Leverage	Total liability divided by total assets.
Growth	The rate of growth in sales.
Top1	The ownership stake of the largest shareholder.
Dual	A dummy variable that equals one if the chair of the board is also the CEO, and zero otherwise.
BoardSize	The total number of directors.
MShare	The fraction of shares held by the management group.
SOE	A dummy variable that equals one if the largest shareholder is the state government or its affiliates, and zero otherwise.

Table 2
Summary statistics.

Variables	Obs.	Mean	SD	Min.	Median	Max.
Panel A: Independent director characteristics (firm-director-year)						
AttendRate	43,266	97.053	6.928	66.667	100	100
Age	43,266	3.943	0.167	3.555	3.932	4.304
Tenure	43,266	3.216	0.747	0	3.332	4.357
Seats	43,266	0.553	0.593	0	0.693	1.792
HighRank	43,266	0.692	0.462	0	1	1
Allowance	43,266	10.734	1.687	0	11.002	12.206
GovExp	43,266	0.284	0.451	0	0	1
IndEpt	43,266	0.120	0.324	0	0	1
CmpExect	43,266	0.149	0.356	0	0	1
SamePlace	43,266	0.568	0.495	0	1	1
Network	43,266	18.947	13.041	5.000	14.000	59.000
EnAttend	43,266	2.728	6.625	0	0	33.333
Departure	41,165	0.097	0.296	0	0	1
Seats_SH	30,681	0.699	0.774	0	1	5
Seats_SZ	30,681	0.910	0.842	0	1	5
Dissent	43,266	0.015	0.120	0	0	1
Panel B: Firm characteristics (firm-year)						
Treat	18,408	0.455	0.498	0	0	1
Post	18,408	0.771	0.420	0	1	1
Size	18,408	21.995	1.270	19.302	21.850	25.742
Leverage	18,408	0.463	0.207	0.059	0.467	0.903
Growth	18,408	0.189	0.499	−0.591	0.099	3.347
Top1	18,408	35.737	15.245	8.680	33.840	75.720
Dual	18,408	0.215	0.411	0	0	1
BoardSize	18,408	8.948	1.786	5	9	15
MShare	18,408	0.085	0.173	0	0.000	0.680
SOE	18,408	0.481	0.500	0	0	1
ROA	18,408	0.038	0.053	−0.167	0.035	0.198
TQ	18,202	0.318	1.492	−4.414	−0.028	9.886

Panel C: Independent director attendance difference-in-differences test

	SHIDs Mean (1)	SZIDs Mean (2)	Difference (1)-(2)
Before (year, <= 2009)	94.276	95.784	−1.508***
After (year, >2009)	97.235	97.997	−0.762***
Difference (After-Before)	2.960***	2.214***	0.746***

This table presents an overview of the main variables. Table 1 provides the definitions of the variables. The summary statistics for directors (at the firm-director-year level) are listed in Panel A. The summary statistics for firms (at the firm-year level) are given in Panel B. Panel C shows results of the difference-in-differences test of independent director attendance. The statistical significance for the differences in mean values between the treatment group and the control group is represented by *, **, and *** at the 10%, 5%, and 1% levels, respectively. The continuous variables are winsorized at the 1st and 99th percentiles.

5. Main results

5.1. Summary statistics

In Table 2, Panel A, we report the summary statistics for the independent directors' characteristics at the director-year level. The average rate of meeting attendance for independent directors during the sample period is 97.053%, and the standard deviation is 6.928%. This statistic is consistent with that of Jia and Tang (2018), who report that the mean personal attendance of independent directors is around 94%, and the standard deviation is 7%. Comparative evidence worldwide shows that the director attendance rate in China is 95.44%, and the rate for all emerging markets is 90.15% (Nowland, 2019). In general, this finding shows that most directors are diligent for participating in board meetings. Furthermore, the average age of an independent director

(*Age*) is 52,[5] and these directors gain an average of 6,570 USD (45,886 RMB) in allowance from each listed firm per year (*Allowance*). The average tenure of an independent director (*Tenure*) is 25 months, and the longest tenure in a particular firm is 78 months. The average and the largest numbers of directorships for the independent directors are 2 and 6, respectively (*Seats*). These statistics correlate with the requirements stated in the regulations.[6] These results are also consistent with the findings of Jiang et al. (2016). Among the directors in our sample, 28% have governmental working experience (*GovExp*), and 12% have industrial expertise (*IndEpt*). Fifteen percent of the directors work as senior executives in other listed firms (*CmpExect*). Fifty-seven percent of the directors live in the same province as the listed firms they serve (*SamePlace*).

The statistics given in Table 2, Panel B show that the average leverage of a listed firm (*Leverage*) is 46%, and the average rate of sales growth (*Growth*) is 19%. On average, the largest shareholder (*Top1*) holds 36% of the firm's shares, which confirms the perception that firms in Asian countries have concentrated ownership (La Porta et al., 1999). The board chair is also the CEO (*Dual*) for about 22% of the firms. The boards consist of nine members on average (*BoardSize*). The management team holds an average of 9% of the shares (*MShare*). Nearly half of the firms are state-owned enterprises (*SOE*).

Panel C in Table 2 presents the results for the difference-in-differences tests on the independent directors' personal meeting attendance. These results show that the personal attendance of SHIDs and SZIDs increases after the SHSE enacts the *Guidelines*, and SHIDs attend 0.746% more board meetings in person. These tests show that the policy works, and that it promotes board meeting participation by SHIDs.

5.2. The policy's effect on the board meeting attendance of independent directors

To test H1, we first estimate Model (1) and examine the policy's effect on the independent directors' board meeting attendance. The results given are in Table 3. The first two columns report the results without control variables. The director and firm characteristic control variables are included in Columns (3), (4), (5), and (6). We include firm, year, and director fixed effects in Columns (1), (3), and (5). We then add the interaction fixed effect of the stock exchange and independent director in Columns (2), (4), and (6). As some directors hold directorships on both stock exchanges, it is possible that their levels of board meeting attendance may vary between the two stock exchanges. To capture this stock-exchange-level behavioral difference for individual directors, the director × stock exchange fixed effect is added into the model.

As Table 3 shows, the interaction of *Treat* and *Post* shows that all of the regressions are significantly positive. The coefficient of *Treat* × *Post* is around 0.8 in all of the regressions, regardless of whether we exclude or include director and firm character control variables. This pattern indicates that the policy is exogenous. When the director × stock exchange fixed effect is added to the regression, as shown in Columns (2), (4), and (6), the coefficients remain significant, although they become slightly smaller. Specifically, the results are listed with all fixed effect and control variables in Column (6), and the interaction term is 0.794, which shows that after the *Guidelines* are enacted, the average personal attendance rate of SHIDs increases by 0.794% more than the attendance rate of SZIDs. Given that the average attendance rate of the sample is 97.053%, this increase of 0.794% is about 1% of the mean level. This finding indicates that SHIDs raise their attendance rate by 1% more, on average, than SZIDs after the policy enactment. Although this change seems trivial in magnitude, given that the average attendance level is 97%,[7] there is only 3% left to improve. In this sense, our evidence shows that external regulations on director behavior have a significant effect. In addition, compared with the univariate analysis result of 0.746% shown in Panel C, Table 2, the magnitude of the change becomes larger after controlling for the director and firm characteristics, and for the fixed effects. This evidence supports Hypothesis H1.

[5] Exp (3.943) = 51.57. *Allowance*, *Tenure*, and *Seats* are calculated similarly.

[6] The CSRC enacted the *Guidance Opinion on the Establishment of an Independent Director System in Listed Companies* in 2001, and set the upper limit on tenure of an independent director in each firm at six years, with the maximum number of directorships at five.

[7] Observers may be concerned about the motivation for our study, as the attendance rate is already high. In response, we note first that high attendance is a worldwide phenomenon (Nowland, 2019), but it remains important to improve the attendance of directors. Second, the enactment of the *Guidelines* in China provides us with a quasi-natural experiment to shed light on how such regulation affects the behavior of directors and the effects of governance.

Table 3
Policy's effect on board meeting attendance by independent directors.

AttendRate	(1)	(2)	(3)	(4)	(5)	(6)
Treat × *Post*	0.827***	0.809***	0.822***	0.806***	0.813***	0.794***
	(3.08)	(2.70)	(3.07)	(2.70)	(3.03)	(2.67)
Age			−4.605	−5.141	−4.878	−5.341
			(−1.06)	(−1.07)	(−1.13)	(−1.12)
Tenure			−0.051	−0.080	−0.047	−0.077
			(−0.88)	(−1.27)	(−0.80)	(−1.23)
Seats			−0.189	−0.234	−0.232	−0.265
			(−0.84)	(−0.97)	(−1.02)	(−1.10)
HighRank			0.077	0.041	−0.004	−0.032
			(0.64)	(0.32)	(−0.03)	(−0.25)
Allowance			0.036	0.032	0.032	0.030
			(1.07)	(0.89)	(0.96)	(0.81)
GovExp			0.420*	0.497**	0.422*	0.498**
			(1.94)	(2.17)	(1.94)	(2.18)
IndEpt			0.062	−0.485	0.050	−0.505
			(0.14)	(−0.98)	(0.11)	(−1.02)
CmpExect			−0.127	−0.036	−0.132	−0.038
			(−0.75)	(−0.20)	(−0.78)	(−0.21)
SamePlace			−0.394*	0.020	−0.367*	0.057
			(−1.85)	(0.08)	(−1.72)	(0.22)
Network			0.008	0.008	0.008	0.007
			(0.89)	(0.82)	(0.90)	(0.76)
Size					0.421***	0.469***
					(2.90)	(2.97)
Leverage					−0.951**	−0.488
					(−2.00)	(−0.96)
Growth					−0.105	−0.112
					(−1.37)	(−1.40)
Top1					−0.002	−0.006
					(−0.19)	(−0.60)
Dual					−0.072	−0.143
					(−0.46)	(−0.87)
BoardSize					−0.042	−0.024
					(−0.71)	(−0.39)
MShare					1.187	1.743**
					(1.54)	(2.09)
SOE					−0.191	−0.249
					(−0.48)	(−0.55)
Constant	96.784***	96.794***	114.743***	116.845***	107.564***	108.081***
	(1,098.85)	(989.88)	(6.74)	(6.16)	(6.27)	(5.69)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	Yes	No	Yes	No	Yes	No
Director × Stock Exchange FE	No	Yes	No	Yes	No	Yes
Observations[10]	41,165	40,664	41,165	40,664	41,165	40,664
R-squared	0.456	0.487	0.457	0.488	0.457	0.488

This table reports the effects of the policy on the board meeting attendance of independent directors at the firm-director-year level. The dependent variable is *AttendRate*. All of the variables are defined in Table 1. The analysis applies an OLS model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

[10] According to Correia (2015), when the high dimension fixed effect is included, 2,101 observations are dropped in the regressions for Columns (1), (3), and (5), and 2,602 observations are dropped in the regressions for Columns (2), (4), and (6).

The coefficients of the control variables show that governmental working experience (*GovExp*) is positively related to the personal meeting attendance by independent directors, and that firm size (*Size*) is significantly and positively related to the *AttendRate*. These findings are consistent with those in the literature (Quan and Chen, 2016; Jia and Tang, 2018).

5.3. Parallel trend test of the policy's effects

We next perform a parallel trend test to examine whether the attendance patterns of SHIDs and SZIDs had a common trend before the SHSE enacted the *Guidelines*. First, we generate year dummy variables including *Year2007*, *Year2008*, *Year2009*, *Year2010*, *Year2011*, and *Year2012after*, which represent the years 2007, 2008, 2009, 2010, 2011, and the years after 2012 (2012 included), respectively. We then interact these year dummy variables with *Treat*, and replace the *Treat* × *Post* of Model (1) with the year dummy and *Treat* interaction terms. We run the regressions, and show the results in Table 4. The control variables and fixed effects in the regressions of each column correspond to the columns in Table 3. Table 4 shows that in all of the regressions, the coefficients of *Treat* × *Year2007*, *Treat* × *Year2008*, and *Treat* × *Year2009* are not significantly different from zero. In contrast, after the *Guidelines* are enacted, the coefficients of the interaction terms *Treat* × *Year2010*, *Treat* × *Year2011*, and *Treat* × *Year2012after* are larger and more pronounced below the 10% statistical significance level. Taking the regression with all of the control variables and fixed effects as an example, as listed in Column (6), the interaction terms start to be positively significant from 2010. This pattern shows that before the enactment of the policy, there was no significant difference in the patterns of director attendance between SHIDs and SZIDs. This set of findings further confirms that the observed effect is indeed caused by the *Guidelines* enacted by the SHSE.

5.4. The effect of director legal background

Independent directors with legal backgrounds tend to show greater compliance with policies and regulations, due to their rich accumulations of legal sense and literacy (Litov et al., 2014). Therefore, we expect the *Guidelines* to have a more significant effect on the behavior of independent directors who have legal backgrounds. To test this expectation, we first generate a dummy variable, *LawBack*, to denote a director with a legal background. *LawBack* takes a value of one if the director has a law degree, a legal professional qualification certificate, has teaching experience in a law school, or has experience working in the juridical system, and zero otherwise. Second, we interact *LawBack* with *Treat* × *Post.* Specifically, we add together *LawBack*, *Treat* × *LawBack*, *Post* × *LawBack*, and *Treat* × *Post* × *LawBack* in Model (1). All of the other variables and fixed effects included are the same as those used in Model (1). The standard errors are clustered by firm. The regression results are given in Table 5. In Columns (1), (3), and (5), the interaction term *Treat* × *Post* × *LawBack* is positive and statistically pronounced at the 5% level. In Columns (2), (4), and (6), we include the director × stock exchange fixed effect, and the results still hold consistently. This evidence indicates that legal background plays a role in binding the directors to better comply with the policy.

5.5. Robustness tests

In this section, we perform the following checks to ensure that our results are robust.

5.5.1. The policy's effect on independent director board meeting attendance in matched samples

In the main results, we provide evidence with the full sample. As the listing rules for firms listed on the main board (or SME board) are the same for both the SHSE and SZSE (as discussed in Section 4.1), there are no large differences between the treatment firms (SHSE listed firms) and the control firms (SZSE listed firms). In addition, we include the firm, year, and director × stock exchange fixed effects to alleviate the omitted variable

Table 4
Parallel trend test of the policy's effect.

AttendRate	(1)	(2)	(3)	(4)	(5)	(6)
Treat × Year2007	0.805	0.811	0.806	0.815	0.783	0.792
	(1.45)	(1.42)	(1.45)	(1.43)	(1.41)	(1.39)
Treat × Year2008	0.947	1.017	0.943	1.007	0.919	0.984
	(1.56)	(1.59)	(1.55)	(1.57)	(1.51)	(1.54)
Treat × Year2009	0.739	0.837	0.712	0.795	0.682	0.760
	(1.18)	(1.25)	(1.13)	(1.19)	(1.08)	(1.13)
Treat × Year2010	1.053*	1.191*	1.052*	1.185*	1.048*	1.169*
	(1.71)	(1.80)	(1.71)	(1.79)	(1.71)	(1.77)
Treat × Year2011	1.800***	1.932***	1.788***	1.912***	1.757***	1.874***
	(3.01)	(2.94)	(2.99)	(2.91)	(2.94)	(2.86)
Treat × Year2012after	1.620***	1.675***	1.595***	1.635**	1.551***	1.584**
	(2.81)	(2.60)	(2.77)	(2.54)	(2.70)	(2.47)
Age			−4.558	−5.104	−4.836	−5.310
			(−1.05)	(−1.06)	(−1.12)	(−1.11)
Tenure			−0.047	−0.076	−0.043	−0.074
			(−0.80)	(−1.21)	(−0.74)	(−1.17)
Seats			−0.185	−0.226	−0.227	−0.256
			(−0.82)	(−0.94)	(−1.00)	(−1.06)
HighRank			0.075	0.039	−0.004	−0.034
			(0.63)	(0.30)	(−0.04)	(−0.26)
Allowance			0.035	0.032	0.032	0.029
			(1.04)	(0.87)	(0.93)	(0.80)
GovExp			0.416*	0.494**	0.418*	0.496**
			(1.92)	(2.16)	(1.93)	(2.17)
IndEpt			0.064	−0.491	0.052	−0.510
			(0.14)	(−0.99)	(0.12)	(−1.03)
CmpExect			−0.128	−0.037	−0.133	−0.038
			(−0.76)	(−0.21)	(−0.79)	(−0.22)
SamePlace			−0.395*	0.014	−0.369*	0.050
			(−1.86)	(0.05)	(−1.73)	(0.20)
Network			0.007	0.007	0.007	0.007
			(0.85)	(0.76)	(0.86)	(0.70)
Size					0.414***	0.461***
					(2.85)	(2.93)
Leverage					−0.926*	−0.470
					(−1.95)	(−0.93)
Growth					−0.100	−0.108
					(−1.30)	(−1.35)
Top1					−0.002	−0.006
					(−0.20)	(−0.59)
Dual					−0.073	−0.141
					(−0.46)	(−0.86)
BoardSize					−0.039	−0.020
					(−0.65)	(−0.32)
MShare					1.147	1.728**
					(1.48)	(2.07)
SOE					−0.200	−0.251
					(−0.51)	(−0.56)
Constant	96.465***	96.441***	114.251***	116.363***	107.226***	107.774***
	(423.70)	(385.54)	(6.71)	(6.15)	(6.25)	(5.68)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	Yes	No	Yes	No	Yes	No
Director × Stock Exchange FE	No	Yes	No	Yes	No	Yes
Observations	41,165	40,664	41,165	40,664	41,165	40,664
R-squared	0.457	0.488	0.457	0.488	0.457	0.488

This table reports the parallel trend test of the board meeting attendance behavior of independent directors before the policy at the firm-director-year level. The dependent variable is *AttendRate*. All of the variables are defined in Table 1. The analysis applies an OLS model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5
Effects of the policy on directors with legal backgrounds.

AttendRate	(1)	(2)	(3)	(4)	(5)	(6)
Treat × *Post* × *LawBack*	1.302**	1.253*	1.351**	1.303*	1.348**	1.315*
	(2.19)	(1.84)	(2.28)	(1.92)	(2.26)	(1.93)
Treat × *Post*	0.590**	0.585*	0.575*	0.571*	0.567*	0.558*
	(2.00)	(1.79)	(1.96)	(1.75)	(1.93)	(1.71)
Treat × *LawBack*	−1.219**	−5.581	−1.251**	−5.998	−1.248**	−6.717
	(−2.06)	(−1.16)	(−2.11)	(−1.25)	(−2.11)	(−1.38)
Post × *LawBack*	−0.156	−0.126	−0.241	−0.223	−0.233	−0.221
	(−0.41)	(−0.31)	(−0.62)	(−0.54)	(−0.60)	(−0.53)
LawBack	−3.255	−5.409	−3.092	−5.186	−3.181	−5.030
	(−1.61)	(−1.23)	(−1.50)	(−1.19)	(−1.53)	(−1.15)
Age			−5.124	−5.717	−5.409	−5.933
			(−1.17)	(−1.17)	(−1.24)	(−1.22)
Tenure			−0.051	−0.080	−0.046	−0.077
			(−0.86)	(−1.28)	(−0.79)	(−1.23)
Seats			−0.214	−0.257	−0.257	−0.288
			(−0.95)	(−1.06)	(−1.13)	(−1.19)
HighRank			0.074	0.038	−0.007	−0.037
			(0.62)	(0.29)	(−0.06)	(−0.28)
Allowance			0.036	0.032	0.032	0.029
			(1.06)	(0.86)	(0.95)	(0.79)
GovExp			0.380*	0.468**	0.380*	0.469**
			(1.74)	(2.03)	(1.74)	(2.03)
IndEpt			0.073	−0.438	0.062	−0.455
			(0.16)	(−0.88)	(0.14)	(−0.92)
CmpExect			−0.127	−0.029	−0.132	−0.030
			(−0.75)	(−0.16)	(−0.78)	(−0.17)
SamePlace			−0.389*	0.028	−0.363*	0.064
			(−1.83)	(0.11)	(−1.70)	(0.26)
Network			0.009	0.008	0.009	0.008
			(0.98)	(0.91)	(1.00)	(0.85)
Size					0.426***	0.475***
					(2.93)	(3.01)
Leverage					−0.934**	−0.451
					(−1.96)	(−0.89)
Growth					−0.107	−0.114
					(−1.40)	(−1.42)
Top1					−0.002	−0.006
					(−0.23)	(−0.64)
Dual					−0.071	−0.142
					(−0.45)	(−0.86)
BoardSize					−0.042	−0.023
					(−0.69)	(−0.37)
MShare					1.166	1.767**
					(1.51)	(2.12)
SOE					−0.193	−0.240
					(−0.49)	(−0.53)
Constant	97.564***	98.377***	117.563***	120.709***	110.341***	111.886***
	(234.77)	(179.36)	(6.84)	(6.28)	(6.37)	(5.82)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	Yes	No	Yes	No	Yes	No
Director × Stock Exchange FE	No	Yes	No	Yes	No	Yes
Observations	41,165	40,664	41,165	40,664	41,165	40,664
R-squared	0.457	0.488	0.457	0.488	0.457	0.488

This table reports how a director's legal background influences the policy's effect at the firm-director-year level. The dependent variable is *AttendRate*. *LawBack* is a dummy variable that takes a value of one if the director has a law degree, a legal professional qualification certificate, has teaching experience in a law school, or has working experience in the juridical system, and zero otherwise. The other variables are defined in Table 1. The analysis applies an OLS model. The *t*-statistics are in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

problem. In this section, we make a further attempt to reduce endogeneity by making robust analyses using a matched sample.

As the policy was enacted in 2009, we choose the firm level characteristics in 2008[8] to perform a one-to-one nearest neighbor propensity score match. We run the logit regression of the dependent variable *Treat* on all of the firm characteristic variables including firm size (*Size*), leverage (*Leverage*), sales growth (*Growth*), the ownership stake of the largest shareholder (*Top1*), an indicator variable that equals one if the Chairman of board is also the CEO (*Dual*), the total number of directors (*BoardSize*), the percentage of shares held by the management group (*MShare*), and the indicator variable for a state-owned enterprise (*SOE*). The firms that are listed on the SHSE are matched with firms that are listed on the SZSE, according to the nearest propensity scores.[9]

The *t*-tests of the matched sample in Panel A, Table 6, show that there are no significant differences in the firm characteristics of the SHSE firms and SZSE firms. We estimate Model (1) again using the matched sample, and present the results in Panel B. These results are consistent with those for the full sample as given in Table 3. The coefficients of *Treat* × *Post* are significantly positive when controlling for the year, firm, and director fixed effects, as shown in Columns (1), (3), and (5). These coefficients are also significantly positive after adding the director × stock exchange fixed effects in Columns (2), (4), and (6). The results show that the enactment of the *Guidelines* increases the personal attendance rate of SHIDs, and further confirm the main results discussed above.

5.5.2. Subsample examinations of independent directors concurrently serving on firms in the SHSE and SZSE

In the main results, we include the director × stock exchange fixed effects in the regression model to eliminate the self-selection problem. We further conduct a robustness check with a subsample of independent directors who are serving concurrently in firms listed on the SHSE and the SZSE, to determine whether the directors behave differently in firms listed on the different stock exchanges. We run the OLS regression of *AttendRate* on *Treat* × *Post*, and present the results in Table 7. The coefficients of the *Treat* × *Post* results are significantly positive in all of the columns, as is consistent with our main evidence shown in Table 3.

5.5.3. Entrusted board meeting attendance of independent directors

In the main regression, we measure director attendance in terms of in-person board meeting participation. However, we also follow Quan and Chen (2016) and Jia and Tang (2018) and examine the rate at which independent directors entrust board meeting attendance to others as proxies (*EnAttend*). *EnAttend* equals the number of meetings that a director entrusts others to attend, divided by the number of board meetings that s/he should attend, plus 100. We regress *EnAttend* on the interaction of *Treat* and *Post*, and list the results in Table 8. In each regression, the *Treat* × *Post* interaction is significantly negative, which shows that the policy contributes to a decrease in entrusted board meeting attendance. The coefficient in Column (6) is −0.626, and the economic consequence shows that after the *Guidelines* are enacted, the SHIDs reduce their rate of entrusted board meeting attendance by 0.626% more than the SZIDs. This percentage equals 23% of the mean level of the change in *EnAttend* (2.728, as seen in Table 2). This evidence reveals that the policy improves the diligence of the independent directors by decreasing their rate of entrusting board meeting attendance to proxies, and increasing their rate of personal attendance, thereby further confirming our main findings.

6. Corporate governance effect analyses

6.1. Policy's effect on firm value

According to the previous tests, we find that after the *Guidelines* are enacted, SHIDs attend more board meetings in person (than SZIDs), rather than entrusting others to attend the meetings. The evidence we find indicates that the stringent regulation on board meeting attendance shapes directors' behavior. However, it

[8] This starting date helps to identify the effects of the *Guidelines* on corporate characteristics in 2009.

[9] We keep the estimated difference in propensity scores to within 0.005, to control for the difference between the treatment and control groups.

Table 6
Policy's effect using the propensity score matched sample.

Panel A: *t*-test after propensity score match

Variable	Control Firm Mean	Treat Firm Mean	*t*-statistics
Size	21.548	21.515	0.461
Leverage	0.501	0.501	0.007
Growth	0.177	0.181	−0.11
Top1	35.945	35.493	0.454
Dual	0.12	0.139	−0.884
BoardSize	9.307	9.18	1.026
MShare	0.017	0.015	0.299
SOE	0.659	0.63	0.895

Panel B: Policy's effect with matched sample

AttendRate	(1)	(2)	(3)	(4)	(5)	(6)
Treat×Post	0.939***	0.862**	0.959***	0.896**	0.929***	0.867**
	(2.62)	(2.23)	(2.69)	(2.33)	(2.62)	(2.26)
Age			−3.193	3.437	−3.356	3.336
			(−0.45)	(0.43)	(−0.47)	(0.42)
Tenure			−0.009	−0.013	0.001	−0.003
			(−0.10)	(−0.13)	(0.01)	(−0.03)
Seats			−0.412	−0.437	−0.489	−0.483
			(−1.14)	(−1.13)	(−1.35)	(−1.26)
HighRank			0.030	0.012	−0.075	−0.082
			(0.15)	(0.05)	(−0.37)	(−0.37)
Allowance			0.042	0.045	0.039	0.041
			(0.82)	(0.83)	(0.77)	(0.76)
GovExp			0.635**	0.658**	0.627**	0.639**
			(2.20)	(2.17)	(2.18)	(2.12)
IndEpt			0.055	−1.614	0.078	−1.476
			(0.06)	(−1.41)	(0.08)	(−1.28)
CmpExect			−0.385	−0.283	−0.381	−0.276
			(−1.47)	(−1.04)	(−1.45)	(−1.01)
SamePlace			−0.480	0.142	−0.403	0.211
			(−1.13)	(0.25)	(−0.95)	(0.38)
Network			0.015	0.018	0.017	0.018
			(1.09)	(1.22)	(1.20)	(1.24)
Size					0.518**	0.515**
					(2.32)	(2.17)
Leverage					−0.756	−0.367
					(−1.00)	(−0.46)
Growth					−0.129	−0.118
					(−1.20)	(−1.06)
Top1					0.014	0.025
					(0.92)	(1.53)
Dual					−0.235	−0.235
					(−0.96)	(−0.95)
BoardSize					−0.069	−0.033
					(−0.76)	(−0.35)
MShare					3.638	4.156
					(1.16)	(1.13)
SOE					−0.343	−0.491
					(−0.63)	(−0.79)
Constant	96.315***	96.351***	108.536***	82.190***	98.570***	71.219**
	(851.98)	(790.55)	(3.86)	(2.64)	(3.47)	(2.28)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	Yes	No	Yes	No	Yes	No
Director×Stock Exchange FE	No	Yes	No	Yes	No	Yes
Observations	20,757	20,616	20,757	20,616	20,757	20,616
R-squared	0.477	0.501	0.478	0.502	0.478	0.502

This table reports the policy's effect on the board meeting attendance of independent directors at the firm-director-year level, using the matched sample. The dependent variable is *AttendRate*. All of the variables are defined in Table 1. The analysis applies the OLS model. The *t*-statistics are in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7
Policy's effect using a subsample of independent directors serving concurrently in firms on the SHSE and the SZSE.

AttendRate	(1)	(2)	(3)	(4)	(5)	(6)
Treat × *Post*	1.024*	1.128**	1.060*	1.160**	1.051*	1.144**
	(1.78)	(2.08)	(1.83)	(2.12)	(1.80)	(2.07)
Age			2.396***	−27.861**	2.323***	−28.758**
			(2.96)	(−2.47)	(2.88)	(−2.54)
Tenure			0.059	0.029	0.066	0.025
			(0.53)	(0.24)	(0.58)	(0.21)
Seats			0.648	−0.228	0.538	−0.274
			(1.17)	(−0.29)	(0.98)	(−0.36)
HighRank			0.340	0.148	0.274	0.082
			(1.51)	(0.64)	(1.19)	(0.34)
Allowance			0.084	0.045	0.080	0.044
			(1.43)	(0.57)	(1.37)	(0.56)
GovExp			−0.045	−0.009	−0.041	−0.010
			(−0.20)	(−0.01)	(−0.18)	(−0.02)
IndEpt			−0.851	0.556	−0.890*	0.485
			(−1.59)	(0.52)	(−1.68)	(0.46)
CmpExect			−0.006	0.132	−0.016	0.119
			(−0.02)	(0.32)	(−0.05)	(0.29)
SamePlace			−1.207***	−0.020	−1.166***	0.045
			(−3.63)	(−0.05)	(−3.47)	(0.11)
Network			−0.009	0.013	−0.006	0.015
			(−0.62)	(0.69)	(−0.39)	(0.81)
Size					0.352	0.336
					(1.29)	(0.99)
Leverage					−0.802	−1.113
					(−0.83)	(−1.12)
Growth					−0.165	−0.092
					(−1.01)	(−0.54)
Top1					0.017	0.007
					(1.01)	(0.37)
Dual					−0.383	−0.208
					(−1.20)	(−0.59)
BoardSize					−0.175	−0.163
					(−1.49)	(−1.35)
MShare					−0.817	−2.491
					(−0.55)	(−1.47)
SOE					−0.202	0.442
					(−0.25)	(0.44)
Constant	96.745***	96.705***	86.280***	205.928***	80.452***	203.830***
	(430.37)	(456.24)	(27.02)	(4.64)	(12.55)	(4.53)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	No	Yes	No	Yes	No	Yes
Observations	8,243	8,091	8,243	8,091	8,243	8,091
R-squared	0.352	0.520	0.356	0.521	0.358	0.521

This table reports the policy's effect on the board meeting attendance of independent directors at the firm-director-year level, and as it appears in a subsample. This subsample is composed of independent directors who concurrently hold directorships of firms listed on both the SHSE and SZSE. The dependent variable is *AttendRate*. All of the variables are defined in Table 1. The analysis applies the OLS model. The *t*-statistics are in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

remains to be determined whether higher board meeting attendance contributes to firm value. Therefore, we further examine the relationship between board meeting attendance by directors and firm performance.

Following Ye et al. (2011), we measure accounting performance by using the firms' returns on assets (*ROA*), and measure the firm value by the industry-adjusted Tobin's Q (*TQ*). *ROA* equals net income scaled by total assets, and *TQ* equals the market value of equity plus the book value of liabilities, scaled by total assets. All of the other variables are the same with those used in Model (1). The first (last) three columns

Table 8
Effects of the policy on entrusted board meeting attendance.

EnAttend	(1)	(2)	(3)	(4)	(5)	(6)
Treat × *Post*	−0.741***	−0.638**	−0.737***	−0.634**	−0.730***	−0.626**
	(−2.86)	(−2.19)	(−2.85)	(−2.19)	(−2.82)	(−2.16)
Age			4.251	4.567	4.477	4.724
			(1.05)	(1.01)	(1.11)	(1.05)
Tenure			0.028	0.056	0.024	0.053
			(0.50)	(0.91)	(0.42)	(0.87)
Seats			0.171	0.214	0.198	0.233
			(0.79)	(0.93)	(0.91)	(1.01)
HighRank			−0.093	−0.083	−0.019	−0.014
			(−0.81)	(−0.68)	(−0.16)	(−0.11)
Allowance			−0.001	0.004	0.003	0.007
			(−0.03)	(0.12)	(0.09)	(0.20)
GovExp			−0.350*	−0.448**	−0.350*	−0.448**
			(−1.66)	(−2.01)	(−1.66)	(−2.01)
IndEpt			−0.068	0.431	−0.057	0.450
			(−0.16)	(0.88)	(−0.13)	(0.92)
CmpExect			0.166	0.062	0.169	0.063
			(1.03)	(0.36)	(1.05)	(0.37)
SamePlace			0.465**	−0.066	0.442**	−0.097
			(2.23)	(−0.27)	(2.11)	(−0.40)
Network			−0.007	−0.007	−0.006	−0.006
			(−0.83)	(−0.74)	(−0.77)	(−0.63)
Size					−0.392***	−0.445***
					(−2.75)	(−2.90)
Leverage					0.795*	0.376
					(1.74)	(0.77)
Growth					0.118	0.127*
					(1.61)	(1.66)
Top1					−0.000	0.004
					(−0.04)	(0.42)
Dual					0.074	0.139
					(0.48)	(0.86)
BoardSize					0.003	−0.009
					(0.05)	(−0.15)
MShare					−0.959	−1.377*
					(−1.38)	(−1.86)
SOE					0.120	0.170
					(0.32)	(0.40)
Constant	2.981***	2.945***	−13.945	−15.120	−6.708	−6.278
	(35.08)	(30.98)	(−0.87)	(−0.85)	(−0.41)	(−0.35)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	Yes	No	Yes	No	Yes	No
Director × Stock Exchange FE	No	Yes	No	Yes	No	Yes
Observations	41,165	40,664	41,165	40,664	41,165	40,664
R-squared	0.450	0.482	0.450	0.482	0.450	0.482

This table reports the policy's effect on the rate at which independent directors entrust their board meeting attendance to proxies at the firm-director-year level. The dependent variable is *EnAttend*, which equals the number of meetings that a director entrusts others, divided by the number of board meetings s/he should attend, plus 100. All of the variables are defined in Table 1. The analysis applies the OLS model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

of Table 9 present the estimates from the regression of *ROA* (*TQ*) on *Treat* × *Post*. The coefficient of the interaction term in each regression is positively associated with the firm value variables, and is significantly below the 5% level. Taking Columns (3) and (6) as examples, we show that after the *Guidelines* are enforced, the *ROA* (*TQ*) of firms listed on the SHSE increases by 0.005 (0.102) more than that of the SZSE listed firms. This con-

Table 9
Policy's effect on firm value.

Dependent Var.	*ROA*			*TQ*		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat × Post	0.007***	0.007***	0.005**	0.196***	0.192***	0.102**
	(3.02)	(3.01)	(2.52)	(3.42)	(3.37)	(2.03)
Age		−0.001	−0.001		−0.020	0.041
		(−0.43)	(−0.92)		(−0.47)	(1.09)
Tenure		−0.001***	−0.001**		−0.024**	−0.023**
		(−2.84)	(−2.29)		(−2.20)	(−2.36)
Seats		0.004***	0.003***		0.052**	0.111***
		(3.57)	(2.99)		(1.99)	(4.86)
HighRank		0.007***	0.004***		0.140***	0.260***
		(8.14)	(5.44)		(7.20)	(15.11)
Allowance		0.001**	0.000**		−0.001	0.005
		(2.48)	(1.97)		(−0.25)	(0.92)
GovExp		−0.001	−0.001		−0.024*	−0.014
		(−1.48)	(−1.10)		(−1.75)	(−1.15)
IndEpt		0.001	0.001		−0.016	0.002
		(1.00)	(1.14)		(−0.86)	(0.13)
CmpExect		−0.002**	−0.001		−0.011	−0.011
		(−2.06)	(−1.29)		(−0.52)	(−0.56)
SamePlace		−0.001	−0.001		0.014	−0.012
		(−1.15)	(−1.21)		(0.83)	(−0.82)
Network		−0.000	−0.000		−0.000	0.001
		(−0.44)	(−1.14)		(−0.17)	(0.98)
Size			0.005***			−0.844***
			(3.27)			(−24.12)
Leverage			−0.119***			−0.446***
			(−21.69)			(−3.86)
Growth			0.019***			0.128***
			(20.99)			(6.37)
Top1			0.000***			0.009***
			(4.43)			(4.03)
Dual			0.001			0.007
			(0.49)			(0.21)
BoardSize			−0.000			0.004
			(−0.35)			(0.34)
MShare			0.048***			0.330
			(4.85)			(1.43)
SOE			−0.011***			−0.262***
			(−2.59)			(−2.66)
Constant	0.036***	0.031***	−0.024	0.189***	0.240	18.400***
	(43.74)	(4.40)	(−0.75)	(9.90)	(1.36)	(23.51)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	43,222	43,222	43,222	42,467	42,467	42,467
R-squared	0.479	0.481	0.557	0.585	0.586	0.652

This table reports the effects of the policy on firm performance. The dependent variables are *ROA* and *TQ*. All of the variables are defined in Table 1. The analysis applies an OLS model. The *t*-statistics are in parentheses, and the coefficients are based on standard errors, clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

sistent evidence indicates that the increase in the directors' personal board meeting attendance improves the performance and the value of the firms.

6.2. Monitoring mechanism

As the evidence given in Table 9 shows that regulation of director attendance improves accounting performance and firm value, we further examine the potential mechanism of this change. Independent directors play

Table 10
Monitoring mechanism tests.

Dissent	(1)	(2)	(3)	(4)
Treat × *Post*	0.629***	0.631***	0.031***	0.026***
	(5.26)	(5.29)	(5.40)	(4.75)
Treat	−0.580***	−0.601***		
	(−6.41)	(−6.36)		
Age	−0.143	−0.138	−0.101	−0.133*
	(−1.18)	(−1.16)	(−1.38)	(−1.78)
Tenure	0.046	0.045	−0.002	−0.002
	(1.17)	(1.16)	(−0.92)	(−1.19)
Seats	−0.110	−0.119	0.007	0.007
	(−1.04)	(−1.12)	(1.59)	(1.45)
HighRank	0.092	0.102	0.003	0.002
	(1.42)	(1.59)	(1.38)	(0.95)
Allowance	0.009	0.009	−0.000	−0.000
	(0.47)	(0.50)	(−0.20)	(−0.49)
GovExp	−0.017	−0.024	0.002	0.003
	(−0.30)	(−0.43)	(0.64)	(0.78)
IndEpt	−0.062	−0.072	−0.005	−0.001
	(−1.03)	(−1.20)	(−0.75)	(−0.09)
CmpExect	0.131*	0.122*	0.000	−0.000
	(1.89)	(1.74)	(0.18)	(−0.04)
SamePlace	0.095**	0.126***	0.003	−0.002
	(1.98)	(2.68)	(0.77)	(−0.44)
Network	0.006	0.007	−0.000	−0.000
	(1.33)	(1.47)	(−0.38)	(−0.57)
Size	−0.054*	−0.056*	0.002	0.003
	(−1.69)	(−1.80)	(0.47)	(0.96)
Leverage	0.200	0.228	−0.008	−0.009
	(1.09)	(1.26)	(−0.70)	(−0.75)
Growth	0.010	0.014	−0.001	−0.001
	(0.24)	(0.33)	(−0.55)	(−0.64)
Top1	−0.004**	−0.005**	0.000	0.000
	(−2.12)	(−2.31)	(0.17)	(0.05)
Dual	−0.109	−0.126	0.000	−0.001
	(−1.35)	(−1.55)	(0.05)	(−0.33)
BoardSize	−0.030	−0.035*	−0.002	−0.001
	(−1.57)	(−1.89)	(−1.35)	(−0.77)
MShare	−0.411*	−0.429*	−0.013	0.002
	(−1.91)	(−1.95)	(−0.79)	(0.11)
SOE	−0.080	−0.055	−0.012	−0.006
	(−1.12)	(−0.77)	(−0.91)	(−0.39)
Constant	0.513	0.797	0.395	0.483
	(0.62)	(0.96)	(1.34)	(1.59)
Firm FE	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	No	No
Province FE	No	Yes	No	No
Director FE	No	No	Yes	No
Director × Stock Exchange FE	No	No	No	Yes
Model	Probit	Probit	LPM	LPM
Observations[11]	43,083	42,809	41,165	40,664
Pseudo R-squared/R-squared	0.258	0.270	0.362	0.393

This table reports the results of tests on the monitoring mechanism. The dependent variable is *Dissent*, which is an indicator that equals one if the independent director casts at least one dissenting vote, and zero otherwise. The other variables are defined in Table 1. A probit model is performed, and the results are presented in Columns (1) and (2), with the *z*-statistics given in parentheses. An LPM model is run in Columns (3) and (4), to better control for the director × stock exchange fixed effect, and the *t*-statistics are given in parentheses. The standard errors are estimated as clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

[11] When the high dimension fixed effect is included, there are 183, 457, 2,101, and 2,602 observations dropped in the regressions of Columns (1), (2), (3), and (4), respectively.

Table 11
Advisory mechanism tests.

Dependent Var.	*ROA*		*TQ*		*ROA*		*TQ*	
Complexity Level	*Diversification*				*Scale*			
	High	Low	High	Low	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treat × Post	0.004	0.003	0.057	0.077	0.002	0.007**	0.071	0.068
	(1.56)	(0.96)	(0.91)	(0.89)	(0.62)	(2.09)	(1.09)	(0.88)
Age	−0.001	0.000	0.028	0.076	−0.002	−0.001	0.026	0.023
	(−0.36)	(0.09)	(0.73)	(1.37)	(−1.45)	(−0.39)	(0.85)	(0.45)
Tenure	−0.001**	−0.001*	−0.007	−0.024	−0.000	−0.001*	−0.018	−0.028*
	(−2.16)	(−1.83)	(−0.66)	(−1.39)	(−0.51)	(−1.69)	(−1.58)	(−1.94)
Seats	0.002*	0.004***	0.084***	0.106***	0.002**	0.003	0.023	0.191***
	(1.65)	(2.72)	(3.31)	(2.92)	(2.34)	(1.51)	(1.11)	(4.63)
HighRank	0.004***	0.004***	0.222***	0.261***	0.005***	0.003**	0.147***	0.328***
	(4.63)	(3.75)	(12.43)	(8.63)	(6.28)	(2.06)	(9.25)	(12.57)
Allowance	0.000**	0.000	0.002	0.003	0.000*	0.000	0.004	−0.001
	(2.05)	(1.34)	(0.43)	(0.38)	(1.77)	(1.04)	(0.95)	(−0.15)
GovExp	−0.000	−0.000	−0.010	−0.002	−0.000	−0.001	−0.008	0.011
	(−0.24)	(−0.59)	(−0.70)	(−0.14)	(−0.42)	(−0.67)	(−0.68)	(0.58)
IndEpt	0.000	0.001	0.002	0.006	0.001	−0.000	−0.008	−0.003
	(0.37)	(1.30)	(0.12)	(0.25)	(0.84)	(−0.10)	(−0.51)	(−0.11)
CmpExect	−0.001	0.000	−0.017	0.023	−0.001	−0.000	−0.030*	0.003
	(−0.92)	(0.35)	(−0.85)	(0.73)	(−1.53)	(−0.26)	(−1.81)	(0.09)
SamePlace	−0.001	0.000	−0.009	−0.005	0.000	−0.001	−0.001	−0.007
	(−1.40)	(0.54)	(−0.54)	(−0.22)	(0.07)	(−0.80)	(−0.05)	(−0.30)
Network	−0.000	−0.000	0.001	0.001	−0.000	−0.000	0.002**	−0.000
	(−0.69)	(−0.68)	(0.90)	(0.66)	(−0.46)	(−1.06)	(2.14)	(−0.08)
Size	0.006***	0.004	−0.780***	−1.036***	0.003	0.002	−0.477***	−1.347***
	(3.22)	(1.62)	(−17.25)	(−15.72)	(1.45)	(0.64)	(−10.98)	(−23.45)
Leverage	−0.122***	−0.125***	−0.488***	−0.271	−0.147***	−0.112***	−0.623***	−0.266*
	(−16.71)	(−13.06)	(−3.17)	(−1.37)	(−16.86)	(−15.02)	(−4.79)	(−1.72)
Growth	0.017***	0.023***	0.084***	0.165***	0.015***	0.020***	0.074***	0.104***
	(15.75)	(12.89)	(3.45)	(4.66)	(11.82)	(15.34)	(3.75)	(3.53)
Top1	0.000***	0.000**	0.009***	0.003	0.000***	0.001***	0.005**	0.004
	(3.22)	(2.38)	(3.26)	(0.82)	(2.67)	(3.84)	(2.36)	(1.00)
Dual	−0.001	0.002	−0.018	0.017	0.000	0.001	0.079**	−0.006
	(−0.55)	(0.70)	(−0.42)	(0.27)	(0.18)	(0.41)	(2.02)	(−0.11)
BoardSize	−0.001	0.001	0.004	−0.001	−0.001	0.000	0.002	−0.007
	(−0.92)	(0.75)	(0.33)	(−0.06)	(−1.24)	(0.50)	(0.20)	(−0.39)
MShare	0.043***	0.061***	0.171	0.941***	0.031**	0.052***	0.945***	0.625**
	(2.86)	(4.97)	(0.50)	(2.78)	(1.97)	(4.03)	(3.13)	(2.15)
SOE	−0.006	−0.017***	−0.234**	−0.278	−0.005	−0.010**	−0.188*	−0.133
	(−1.01)	(−2.71)	(−2.22)	(−1.33)	(−0.67)	(−2.09)	(−1.86)	(−0.97)
Constant	−0.055	−0.024	17.106***	22.492***	0.048	0.019	10.636***	28.945***
	(−1.27)	(−0.43)	(17.44)	(14.91)	(1.02)	(0.37)	(10.40)	(22.50)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	25,888	17,239	25,532	16,842	21,577	21,572	21,519	20,875
R-squared	0.567	0.665	0.676	0.719	0.673	0.562	0.719	0.679
Z test	$Z = 0.177$, $P = 0.859$		$Z = -0.182$, $P = 0.855$		$Z = -1.087$, $P = 0.277$		$Z = 0.032$, $P = 0.975$	

This table reports the tests of the advisory mechanism. The dependent variables are *ROA* and *TQ*. All of the variables are defined in Table 1. The analysis applies an OLS model. The *t*-statistics are in parentheses, and the coefficients are based on standard errors, clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

supervisory and advisory roles, among which director dissent is a form of monitoring. Previous studies find that dissent is an important way for directors to oversee and guide the management team (Schwartz-Ziv and Weisbach, 2013; Jiang et al., 2016). Therefore, we attempt to examine whether the attendance regulation

plays a governance role by motivating independent directors to dissent. We test whether independent directors are more likely to dissent when they attend more board meetings in person. Other studies find that when independent directors attend board meetings in person, it can improve the efficiency of communication, decrease information opacity, and lead to better supervision (Hiltz et al., 1986). Tang et al. (2013) and Jiang et al. (2016) provide evidence that director dissension improves corporate governance.

To examine whether the *Guidelines* have an influence on director dissent via attendance, we generate the variable *Dissent*, which has a value of one if an independent director dissents at least once in a board meeting, and zero otherwise. A director dissent means that the director votes "against," "reservation," "abstention," or gives some other opinion that does not support a proposal to the board. We regress *Dissent* on *Treat* × *Post* and the control variables in Model (1), which involves a probit model. The results are given in Table 10.

In Columns (1) and (2), the interaction term for *Treat* and *Post* is significantly positive at the 1% level. In Column (2), the coefficient of the interaction term is positive and significantly different from zero at the 1% level. The marginal effect shows that after the policy is enacted, the probability of dissent by SHIDs becomes 2.4% higher than that by SZIDs. This increase is 1.5 times as much as the average probability of dissent by an independent director. To control for the director fixed effect, we also run a linear probability model (LPM) regression, and present the results in Columns (3) and (4). The results remain significantly positive. This evidence shows that strengthening the attendance regulation not only encourages independent directors to attend more meetings in person, but also enhances the probability of dissent by those directors. The results also indicate that regulation of director attendance improves accounting performance and firm value through the mechanism of improved monitoring.

6.3. Advisory mechanism

The tests described in Section 6.2 show that the mechanism of director monitoring is an important channel by which the regulation of director attendance takes effect. However, it remains to be further tested whether the regulation of director attendance improves accounting performance and firm value via the directors' advisory role. Although it is difficult to directly measure director advisory behavior, Coles et al. (2008) find that complex firms have a greater need for advisors. We try to examine the advisory mechanism by testing the cross-sectional differences in the effects of regulating attendance among firms with different levels of complexity. Following Coles et al. (2008), we measure firm complexity by the degree of diversification and by firm size. A higher level of diversity or a larger size indicates that a firm has a higher level of complexity, and a greater need for directors to play advisory roles. If the advisory mechanism works, it can be expected that in firms of high complexity, the effect that regulating the directors' meeting attendance has on accounting performance and firm value should be more significant.

To conduct this test, we obtain data on firm diversification from the WIND database. Then we measure the firms' levels of diversification by the numbers of industries that each firm operates (*Segment*), and measure the firms' sizes by the natural logarithm of their operating incomes (*Scale*). We divide the sample into two groups, namely, a high complexity group (high diversity, large scale) and a low complexity group (low diversity, small size), according to whether they rank above or below the median measures of *Segment* or *Scale*. We run regressions with each group. The results given in Table 11 show that in high complexity firms, the coefficients of *Treat* × *Post* are not consistently larger than the coefficients in low complexity firms. The *z*-tests show that there is no significant difference between the *Treat* × *Post* coefficients of the high complexity group and the low complexity group.

This evidence shows that the effectiveness of the regulation on attendance is almost the same in firms with differing board advisory requirements. Therefore, we cannot conclude that the positive effects of the regulation on accounting performance and firm value are achieved through the advisory mechanism.

6.4. Policy's effect on the career outcomes of independent directors

The enforcement of the *Guidelines* causes a regulatory difference regarding board meeting attendance between the SHSE listed firms and the SZSE listed firms. A director working in an SHSE listed firm has to be more diligent in attending board meetings in person. Otherwise s/he is more likely to be punished by

Table 12
Policy's effect on the career outcomes of independent directors.

Panel A: Test for the possibility of director departure

Departure	(1)	(2)	(3)	(4)
Treat × Post	0.304***	0.310***	0.017**	0.017***
	(4.22)	(4.32)	(2.18)	(2.90)
Treat	−0.213***	−0.227***		
	(−3.09)	(−3.31)		
Age	−0.175**	−0.180**	0.325*	0.147
	(−2.06)	(−2.13)	(1.93)	(1.08)
Tenure	−0.314***	−0.316***	−0.020***	−0.011***
	(−19.84)	(−20.14)	(−11.70)	(−8.13)
Seats	−0.106*	−0.107**	0.027***	0.006
	(−1.94)	(−1.98)	(3.81)	(1.11)
HighRank	−0.075**	−0.075**	−0.006	−0.004
	(−2.09)	(−2.14)	(−1.46)	(−1.05)
Allowance	−0.032***	−0.033***	−0.003***	−0.001**
	(−5.12)	(−5.32)	(−3.26)	(−1.99)
GovExp	0.048	0.044	0.003	0.008
	(1.56)	(1.45)	(0.50)	(1.42)
IndEpt	0.102**	0.093**	−0.031	0.054
	(2.46)	(2.25)	(−1.00)	(1.42)
CmpExect	0.239***	0.240***	0.001	0.001
	(6.61)	(6.65)	(0.29)	(0.36)
SamePlace	0.064**	0.089***	0.007	0.019
	(2.06)	(2.77)	(0.54)	(1.04)
Network	0.000	−0.000	−0.001***	−0.000
	(0.03)	(−0.09)	(−2.82)	(−0.78)
Size	−0.072***	−0.068***	−0.014***	−0.011***
	(−3.84)	(−3.68)	(−2.91)	(−2.81)
Leverage	−0.074	−0.075	0.017	0.011
	(−0.82)	(−0.83)	(1.16)	(0.97)
Growth	0.017	0.021	0.002	0.002*
	(0.81)	(1.00)	(1.18)	(1.68)
Top1	0.001	0.001	−0.000*	−0.001**
	(1.06)	(1.14)	(−1.70)	(−2.32)
Dual	0.016	0.021	−0.006	−0.004
	(0.40)	(0.53)	(−1.21)	(−0.95)
BoardSize	0.014	0.017	0.003	0.001
	(1.34)	(1.59)	(1.54)	(0.88)
MShare	0.433***	0.453***	0.083**	0.026
	(4.13)	(4.35)	(2.42)	(0.94)
SOE	−0.071*	−0.074*	0.035**	0.033***
	(−1.84)	(−1.86)	(2.03)	(2.74)
Constant	2.099***	2.049***	−0.843	−0.253
	(4.33)	(4.15)	(−1.27)	(−0.47)
Firm FE	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	No	No
Province FE	No	Yes	No	No
Director FE	No	No	Yes	No
Director × Stock Exchange FE	No	No	No	Yes
Model	Probit	Probit	LPM	LPM
Observations[12]	41,165	41,165	39,158	38,682
Pseudo R-squared/R-squared	0.061	0.068	0.775	0.872

[12] The regressions in Panel A use the full sample. The observations decrease to 41,165 because of the missing values for *Departure*. Furthermore, when the high dimension fixed effect is included, 2,007 and 2,483 observations are dropped in the regressions for Columns (3) and (4).

Panel B: Directorships with SHSE listed firms

$Seats\_SH_{t+1}$	(1)	(2)	(3)	(4)	(5)	(6)
Treat × *Post*	−0.108***	−0.111***	−0.103***	−0.106***	−0.102***	−0.105***
	(−4.96)	(−4.51)	(−4.83)	(−4.42)	(−4.78)	(−4.39)
Age			−0.225	−0.258	−0.234	−0.263
			(−0.46)	(−0.48)	(−0.47)	(−0.49)
Tenure			−0.033***	−0.031***	−0.033***	−0.032***
			(−6.61)	(−6.33)	(−6.63)	(−6.34)
Seats			0.338***	0.339***	0.336***	0.338***
			(11.86)	(11.39)	(11.78)	(11.32)
HighRank			−0.036***	−0.034**	−0.037***	−0.035**
			(−2.67)	(−2.33)	(−2.67)	(−2.39)
Allowance			0.005	0.003	0.005	0.003
			(1.61)	(1.04)	(1.60)	(1.04)
GovExp			−0.012	−0.015	−0.012	−0.015
			(−0.56)	(−0.67)	(−0.56)	(−0.67)
IndEpt			0.003	0.027	0.002	0.027
			(0.07)	(0.59)	(0.05)	(0.58)
CmpExect			−0.089***	−0.083***	−0.090***	−0.083***
			(−4.29)	(−3.84)	(−4.32)	(−3.85)
SamePlace			−0.016	0.022	−0.015	0.022
			(−0.70)	(0.80)	(−0.68)	(0.81)
Network			0.002	0.001	0.002	0.001
			(1.48)	(0.70)	(1.53)	(0.73)
Size					0.008	0.012
					(0.62)	(0.85)
Leverage					−0.021	0.003
					(−0.46)	(0.07)
Growth					−0.005	−0.005
					(−0.73)	(−0.60)
Top1					−0.000	−0.001
					(−0.53)	(−0.63)
Dual					0.009	−0.007
					(0.51)	(−0.43)
BoardSize					−0.002	−0.003
					(−0.51)	(−0.53)
MShare					−0.053	−0.028
					(−0.61)	(−0.30)
SOE					0.015	0.003
					(0.39)	(0.07)
Constant	0.742***	0.742***	1.471	1.607	1.375	1.411
	(110.14)	(98.06)	(0.76)	(0.76)	(0.70)	(0.67)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	Yes	No	Yes	No	Yes	No
Director × Stock Exchange FE	No	Yes	No	Yes	No	Yes
Observations[13]	28,744	28,333	28,744	28,333	28,744	28,333
R-squared	0.767	0.791	0.780	0.802	0.780	0.802

[13] The regressions in Panels B and C use the full sample. The observations decrease to 30,681 because of the missing values for $Seats\_SH_{t+1}$ and $Seats\_SZ_{t+1}$. Furthermore, when the high dimension fixed effect is included, 1,937 observations are dropped in the regressions for Columns (1), (3), and (5), and 2,348 observations are dropped in the regressions for Columns (2), (4), and (6).

Panel C: Directorship on SZSE listed firms

$Seats\_SZ_{t+1}$	(1)	(2)	(3)	(4)	(5)	(6)
Treat × *Post*	0.114***	0.139***	0.122***	0.146***	0.120***	0.143***
	(4.78)	(5.23)	(5.55)	(5.99)	(5.45)	(5.86)
Age			0.001	0.259	0.031	0.279
			(0.00)	(0.47)	(0.06)	(0.51)
Tenure			−0.039***	−0.038***	−0.039***	−0.037***
			(−7.49)	(−7.11)	(−7.45)	(−7.02)
Seats			0.572***	0.569***	0.575***	0.573***
			(17.72)	(16.71)	(17.79)	(16.81)
HighRank			−0.006	−0.004	−0.004	−0.003
			(−0.38)	(−0.23)	(−0.25)	(−0.17)
Allowance			0.009***	0.010***	0.009***	0.010***
			(3.20)	(3.38)	(3.19)	(3.33)
GovExp			−0.021	−0.018	−0.020	−0.018
			(−0.95)	(−0.79)	(−0.92)	(−0.79)
IndEpt			0.064	0.063	0.067	0.068
			(1.51)	(1.12)	(1.56)	(1.22)
CmpExect			−0.201***	−0.206***	−0.201***	−0.206***
			(−9.46)	(−9.35)	(−9.45)	(−9.35)
SamePlace			−0.001	−0.017	−0.003	−0.019
			(−0.03)	(−0.52)	(−0.12)	(−0.59)
Network			−0.002*	−0.002*	−0.002*	−0.002*
			(−1.69)	(−1.68)	(−1.80)	(−1.81)
Size					−0.013	−0.011
					(−0.92)	(−0.71)
Leverage					−0.041	−0.091*
					(−0.81)	(−1.66)
Growth					−0.002	−0.006
					(−0.27)	(−0.76)
Top1					0.000	0.001
					(0.01)	(0.76)
Dual					0.004	0.018
					(0.19)	(0.88)
BoardSize					0.007	0.009
					(1.37)	(1.60)
MShare					0.144	0.194
					(1.31)	(1.59)
SOE					−0.026	0.013
					(−0.65)	(0.27)
Constant	0.900***	0.894***	0.627	−0.398	0.747	−0.330
	(121.60)	(109.13)	(0.32)	(−0.18)	(0.38)	(−0.15)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Director FE	Yes	No	Yes	No	Yes	No
Director × Stock Exchange FE	No	Yes	No	Yes	No	Yes
Observations	28,744	28,333	28,744	28,333	28,744	28,333
R-squared	0.764	0.786	0.785	0.805	0.785	0.805

This table reports the policy's effects on the career choices of independent directors at the firm-director-year level. *Departure* is an indicator that equals one if an independent director serves the firm less than three years (one term), and zero otherwise. *Seats_SH* indicates the directorships of independent directors with the SHSE listed firms. *Seats_SZ* indicates the directorships of independent directors in the SZSE listed firms. The other variables are defined in Table 1. The analysis applies a probit model in Panel A, Columns (1) and (2), with the *z*-statistics given in parentheses. We run LPM regressions in Panels B and C, and the *t*-statistics are shown in parentheses. The coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

the SHSE. This difference in regulations may further influence the decisions that directors take, if all other conditions are unchanged. Specifically, when the SHSE tightens the requirement for meeting attendance by directors, they have several potential responses. Independent directors may increase their personal attendance at board meetings immediately after the *Guidelines* are enacted. However, it is also possible that they may seek various ways to avoid pressure from the regulation, such as switching their directorships from SHSE listed firms to SZSE listed firms. To test whether this kind of evasion of the regulation occurs, we first conduct a regression on departures from boards to examine whether the policy has an effect of stimulating departures.

Following the measure used by Jiang et al. (2016), we generate the variable *Departure*, which takes a value of one if a director resigns from a firm before his or her term ends, and zero otherwise. All of the other variables are the same as those in Model (1). The results are given in Panel A, Table 12. We show the results of probit regressions in Columns (1) and (2), and find that the coefficient of *Treat* × *Post* is significantly and consistently positive. To better control for the director × stock exchange fixed effect, we then regress *Departure* on *Treat* × *Post* and all of the control variables with an LPM model, and the results are reported in Columns (3) and (4). In Column (4) for example, SHIDs are 1.7% more likely to resign from their current positions before their terms end after the SHSE enacts the *Guidelines*.

To provide further insight into the adjustments of the independent directors, we investigate the changes in directorship on each stock exchange. We split the total seats that a director holds into his or her seats with the SHSE listed firms (*Seat_SH*) and the seats with the SZSE listed firms (*Seat_SZ*). We run the OLS regression of *Seat_SH* on *Treat* × *Post*, with all of the control variables and the firm, year, and director fixed effects. The results are given in Panel B. The interaction term is found to be negative and significant at the 1% level. Similarly, the results of the regression of *Seat_SZ* on *Treat* × *Post* are given in Panel C. The coefficients are consistently positive and significant at the 1% level. In Column (6), Panels B and C, the results reveal that after the policy is enacted, SHIDs depart from 0.105 more seats with firms listed on the SHSE, and they add 0.143 more seats with firms listed on the SZSE. SHIDs show a tendency to resign from the SHSE listed firms, and to prefer serving with the SZSE listed firms as a means to avoid pressure when the SHSE tightens its director attendance requirement.

7. Conclusion

Independent directors are vital monitors of management teams. To accomplish their duties, their diligence and active participation are essential. Although a number of other studies investigate the monitoring roles of independent directors, little research is available on how the regulation of directors affects their meeting attendance, or how such regulation affects corporate governance and firm performance. In 2009, the SHSE of China enacted guidelines to require that directors must personally attend at least half of all board meetings each year, but the SZSE did not enact any such regulation. Therefore, starting in 2009, the SHIDs and SZIDs faced different requirements concerning their attendance at board meetings.

We take advantage of this quasi-natural experiment to examine whether the SHSE's tightening of the board meeting attendance requirements leads to more diligent attendance and monitoring by independent directors. We find that after the SHSE's *Guidelines* imposed a stricter attendance requirement, the SHIDs attended more board meetings in person than the SZIDs. The results are more significant for directors who have a legal background. Further evidence shows that the attendance regulation improves the performance and market value of SHSE firms, due to the mechanism of better monitoring by independent directors. Specifically, after the *Guidelines* were enacted, the SHIDs were more likely to cast dissenting votes on proposals in their board meetings. This finding shows that the attendance regulation prompts the directors to more closely monitor those firms. However, this restriction on independent directors also affects the directors' career choices. We find that independent directors are more likely to resign from SHSE listed firms and seek directorships with SZSE listed firms to avoid pressure from the regulation.

China is a typical emerging market with weak investor protection. Our study fills a gap in the research on the governance of Chinese firms by using Chinese data to provide insight on the effects of a regulation on board meeting attendance by directors. Our evidence shows that this regulation is effective, and that it is helpful for enhancing the quality of supervision by directors as a means to improve firm value. Furthermore, our findings imply that much stricter regulation is likely to cause passive evasion in the long run. Therefore, it may

be important to strike a balance between disciplining and encouraging independent directors. Our findings provide policy implications for improving the effectiveness of corporate governance in an economy with weak investor protection and an under-developed market for independent directors. The findings also show that strengthening systems for the external regulation of independent directors is an important means of achieving such improvement.

Declaration of Competing Interest

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

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China Journal of Accounting Research 14 (2021) 129–149

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China Journal of Accounting Research

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Adjustment costs of institutional tax changes from the audit pricing perspective: Empirical evidence from the VAT reform

Binglei Duan [a], Xinxiao Ma [b,*], Taijie Tang [a], Guojian Zheng [b]

[a] *Guanghua School of Management, Peking University, China*
[b] *Sun Yat-sen Business School, Sun Yat-sen University, China*

ARTICLE INFO

Article history:
Received 2 June 2020
Accepted 27 April 2021
Available online 14 May 2021

Keywords:
Institutional changes
VAT reform
Audit pricing
Audit fees

ABSTRACT

Institutional changes inevitably impose adjustment costs on firms while also generating benefits. However, empirical evidence regarding the adjustment costs of institutional changes is limited, with much of the focus centered on benefits. Using data on China's A-share listed companies from 2010 to 2018 and the nation's staggered adoption of the "business tax to value-added tax reform" (hereafter, "VAT reform") as a natural experiment, we examine the impact of this reform on a particular corporate cost: audit fees. We find audit fees to be 8.11% higher for VAT reform firms than for non-VAT reform firms. This difference does not exist before or after the reform year. That is, it is only observed in the year of VAT reform implementation. This indicates the existence of an adjustment cost specifically related to the VAT reform. Furthermore, we observe larger fee increases among firms audited by Big 4 international audit firms, firms that require more audit work, firms that are more complex, and firms with weak internal controls. From the audit pricing perspective, we provide evidence of the economic consequences of tax reform. The corporate adjustment costs that arise from institutional changes deserve more attention from decision-makers.

1. Introduction

In recent years, China's ongoing market-oriented reforms have brought institutional changes and associated benefits. The pilot "business tax to value-added tax reform" (hereafter, "VAT reform") launched during

* Corresponding author.
E-mail address: maxx3@mail2.sysu.edu.cn (X. Ma).

https://doi.org/10.1016/j.cjar.2021.04.001
1755-3091/

the 13th Five-Year Plan period is one of the most distinctive aspects of China's tax reform. Following the expansion of the scope of value-added tax in 2009, the Ministry of Finance and the State Administration of Taxation decided to implement institutional VAT reform with approval from the State Council. The aim was to further reduce corporate tax burdens and optimize the value-added tax system. Since first being piloted in Shanghai's transportation and modern service industries (hereafter, "1 + 6 industries") in 2012, the VAT reform has been gradually adopted by other provinces and industries. The VAT reform policy has been fully implemented nationwide since 2016. It represents the significant decision to reduce corporate tax burdens, stimulate market vitality, promote industrial and consumption upgrades, and extend supply-side structural reforms. It directly changes the tax calculation method and also profoundly affects companies' actual tax burdens (Wang and Li, 2014), investment in research and development (R&D; Li and Zhang, 2015), total factor productivity (Yuan et al., 2015), business scope (Chen and Wang, 2017), and various other business activities and governance behaviors.

The literature mainly highlights the various benefits of the VAT reform (Li and Zhang, 2015; Chen and Wang, 2017), with few studies focusing on its potential costs. Theoretical and practical evidence indicates that the adjustment costs induced by the VAT reform cannot be ignored. The VAT reform greatly affects a firm's accounting treatment, tax planning, and accounting procedures (Deng, 2016; Wang, 2019). After a firm adopts the VAT reform, the conversion from business tax accounting to value-added tax accounting causes changes in accounting confirmation, measurement, and recording, thereby affecting the firm's operating income, operating costs, total profits, income tax, urban construction tax, and accounting processes, such as bill processing and tax declaration (Yan, 2015). The special accounting treatment during the transition period after the VAT reform serves as an example. Firms encounter four specific difficulties during the transition period,[1] namely, the pilot taxpayer's differential taxation, the value-added tax deduction at the end of the period, the acquisition of transitional financial support, and special equipment for the value-added tax control system and technical maintenance costs to deduct the value-added tax. These issues give rise to a series of accounting changes after VAT reform implementation.

It is also difficult for auditors, with their existing knowledge, to resolve the changes in accounting treatments that arise from the VAT reform. Therefore, auditing firms that audit VAT reform pilot firms must learn the corresponding institutional details and spend more hours and effort on the audit process. In turn, their learning costs increase. Such hidden audit costs, which arise because of system changes, are eventually passed on to audit clients, thereby increasing audit fees. At the same time, because of the staggered adoption of the VAT reform, the risk of major misstatements in financial reports and the policy concerns of pilot firms may also be higher. Thus, audit firms face higher audit risk when auditing such firms, which may also increase audit fees.

The literature on audit pricing mainly focuses on two kinds of determinants, audit risk and audit effort (Simunic, 1980), which largely determine audit fees. Audit risk is influenced by corporate operating risks (Francis, 1984), financial risks (Bhaskar et al., 2019; Du and Lai, 2018), financial reporting risks (Houston et al., 1999; Houston et al., 2005), litigation risks (Abbott et al., 2017), and corporate governance structure (Larcker and Richardson, 2004). Audit effort is affected by company size (Francis, 1984; O'Keefe et al., 1994), audit firm size (Blokdijk et al., 2006), reputation (DeFond et al., 2000), industry experience (Deis et al., 1996), audit hours (Gong et al., 2016), and audit inquiry (Ball et al., 2012). However, the literature only considers the effects of micro-factors on audit pricing and ignores the effect of macro-institutional changes. The effect of macro-institutional changes on audit pricing can be examined using the staggered adoption of a policy to establish a causal relationship (DeFond et al., 2020).

Some studies examine the impact of institutional changes on audit pricing, but most of these studies explore China's 2007 accounting standards reform (Luo et al., 2008; Lu and Zhang, 2009; He et al., 2012; Li et al., 2013; Tan et al., 2014; Dai et al., 2017). As discovered by international scholars, the introduction of these new accounting standards not only improved the quality of accounting information but also gave managers more discretionary powers, thereby increasing the severity of earnings manipulation. This "double-edged

[1] For details, please refer to the "Regulations on Accounting Treatment of Enterprises in the Pilot Program of Reforming Business Tax to Value-Added Tax" issued by the Ministry of Finance in 2012 and the "Regulations on Accounting Treatment of Value-Added Tax" issued in 2016.

sword" characteristic of the accounting standards reform makes it subject to an endogeneity problem when studying the reform's impact on audit pricing. In contrast, the VAT reform reduces firms' tax burden by merging related tax categories. The changes to tax accounting treatment resulting from the VAT reform are verifiable and simple. Therefore, the impact of the VAT reform on auditors is direct, relatively simple, and less affected by other factors. In addition, the staggered nationwide adoption of the VAT reform at the regional and industry levels can effectively exclude the impact of other institutional changes and macro-environmental changes. Hence, it can ensure the exogeneity of institutional change. In conclusion, the VAT reform is a suitable experimental context in which to explore the adjustment costs of institutional tax changes.

The difference in companies' audit fees before and after their VAT reform adoption is plotted in Fig. 1. The horizontal axis is the time before and after companies are affected by the VAT reform, and the vertical axis is the proportion of audit fees in operating income. The figure shows significantly higher audit fees for the VAT reform firms in the year of VAT reform adoption than in the 2-year window (i.e., the first and second years before and after) around the reform adoption year. This indicates that the VAT reform significantly increases the audit fees of firms in the first year of the pilot program. This finding is consistent with the notion that the VAT reform imposes an adjustment cost on firms. The VAT reform not only changes the accounting methods of enterprises, but it also changes the working methods and scope of audit firms, prompting auditors to learn and practice new knowledge. The VAT reform may increase audit fees in the following three ways. First, the VAT reform changes a pilot firm's accounting treatment. This requires the pilot firm's auditor to upgrade its relevant accounting knowledge, increasing audit hours and costs. Second, as the VAT reform is implemented during the fiscal year, transition issues before and after the implementation are inevitable. As a result, the auditor's workload during the audit also increases. Third, the VAT reform is an important part of extending the supply-side structural reform. The financial reports of pilot firms may be more prone to error, and they receive more attention and supervision from taxation authorities, local governments, the public, and investors, thereby increasing auditors' litigation risk. In this case, whether accounting firms require more audit cost compensation and audit risk premiums by increasing audit fees becomes an important empirical problem that warrants academic investigation.

In this context, using the data of China's A-share listed companies from 2010 to 2018 and the nation's staggered adoption of the VAT reform as a natural experiment, we examine the impact of this reform on a particular corporate cost: audit fees. We find audit fees to be 8.11% higher in firms' first year of VAT reform implementation, compared with firms not affected by the VAT reform. This effect does not exist before or after the reform year, indicating the existence of an adjustment cost specifically related to the VAT reform. This fee increase is greater among firms audited by the Big 4 international audit firms, firms that require more audit work, firms that are more complex, and firms with weak internal controls. Our findings remain unchanged under a series of robustness tests.

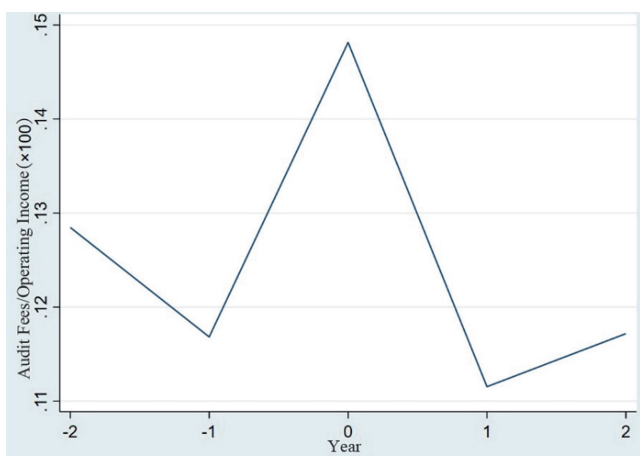

Fig. 1. The difference in companies' audit fees before and after their VAT reform adoption, Sources: China Stock Market & Accounting Research database; Stata15.0 (for the calculation and illustration).

We make the following contributions. First, we add to the literature on the impacts of institutional changes on audit pricing and echo the future prospects proposed by DeFond et al. (2020). Audit research on Chinese issues in international journals is conducted from three main perspectives: unique disclosure, unique system characteristics, and unique regulatory changes (DeFond et al., 2020). From those three perspectives, the literature on unique regulatory changes mainly focuses on how changes in the audit system, such as the wave of mergers and acquisitions (Gong et al., 2016), the implementation of new audit standards in 1995 (DeFond et al., 1999), and the limited liability system reform in 1998 (Firth et al., 2012), affect auditing behavior. Few studies explore how institutional changes in non-audit factors affect corporate audit pricing. Only a few Chinese studies examine the impacts of institutional changes in the capital market and the reform of accounting standards on audit fees (Dai et al., 2017; Luo and Wu, 2018). No studies address how the changes in the taxation system represented by the VAT reform affect audit pricing. Nonetheless, as a key institutional reform involving taxation and accounting treatment, the VAT reform has a direct and significant impact on audit fees.

Second, we enrich the literature on the VAT reform policy, which mainly focuses on its general introduction (Cui, 2014). Research on the impact of the VAT reform on corporate behavior is mainly concentrated on tax avoidance (Fan and Peng, 2017), R&D investment (Li and Zhang, 2015), total factor productivity (Yuan et al., 2015), and business scope (Chen and Wang, 2017). We enrich the literature from the perspective of audit fees, thereby contributing to a comprehensive understanding of the economic consequences of the VAT reform policy.

Third, we use an appropriate experimental scenario in the empirical design and verify the existence of adjustment costs. In the literature, policy implementation tends to be unified, making it difficult to rule out interference from other events. We use the staggered adoption of VAT reform to better control potential endogeneity problems (e.g., missing variables) and thus reach a strong conclusion. Our findings also reveal the cost-passing phenomenon related to auditors' learning behaviors, adding to the classic audit pricing model (Simunic, 1980) in the growing literature related to audit behavior.

2. Institutional background and theoretical analysis

2.1. The VAT reform and audit pricing

As an important recent tax reform in China, the VAT reform is considered "an important part of the current promotion of structural reforms, especially supply-side structural reforms, and a major tax reduction measure to implement a proactive fiscal policy."[2] After the value-added tax was fully implemented with the Provisional Regulation of the People's Republic of China on Value-Added Tax in 1994, China's tax system has included both a value-added tax and a business tax. At that time, the service industry was small and the reform was complicated, so the government kept the business tax to avoid contradictions and problems. However, the rapid development of China's economy has increasingly highlighted the drawbacks of having both the business tax and value-added tax. Problems such as double taxation, collection difficulties, and mixed sales have become increasingly serious. Following the 2009 expansion of the scope of the value-added tax, action was taken to further reduce corporate tax burdens and optimize China's value-added tax system. For example, firms from the 1 + 6 industries in Shanghai led the launch of the VAT reform on January 1, 2012. Beginning on August 1, 2012, the VAT reform was gradually expanded from Shanghai to other cities (e.g., Beijing and Tianjin) and provinces (e.g., Jiangsu, Zhejiang, Anhui, Fujian, Hubei, and Guangdong). The pilot industries were then expanded from the 1 + 6 industries to other service industries. On May 1, 2016, the VAT reform was adopted nationwide. A detailed reform timeline is shown in Table 1. Its staggered adoption allows the VAT reform to serve as an exogenous natural experimental context for the study of audit pricing.

[2] Chinese State Council: "Notice of the State Council on Doing a Good Job in Comprehensively Launching the Pilot Program of the VAT Reform." Accessed October 19, 2019, at http://www.mof.gov.cn/zhengwuxinxi/caizhengxinwen/201604/t20160430_1973069.html.

Table 1
Timeline of the VAT reform.

Date	Reform Industry	Reform Province
January 1, 2012	Transportation industry; six modern service industries: R&D service, information technology service, cultural creativity service, logistics and supporting service, tangible movable property leasing, and authentication consulting	Shanghai
September 1, 2012	Transportation industry; six modern service industries: R&D service, information technology service, cultural creativity service, logistics and supporting service, tangible movable property leasing, and authentication consulting	Beijing
October 1, 2012	Transportation industry; six modern service industries: R&D service, information technology service, cultural creativity service, logistics and supporting service, tangible movable property leasing, and authentication consulting	Jiangsu, Anhui
November 1, 2012	Transportation industry; six modern service industries: R&D service, information technology service, cultural creativity service, logistics and supporting service, tangible movable property leasing, and authentication consulting	Fujian, Guangdong
December 1, 2012	Transportation industry; six modern service industries: R&D service, information technology service, cultural creativity service, logistics and supporting service, tangible movable property leasing, and authentication consulting	Tianjin, Hubei, Zhejiang
August 1, 2013	Transportation industry; six modern service industries: R&D service, information technology service, cultural creativity service, logistics and supporting service, tangible movable property leasing, and authentication consulting	Nationwide (except for the pilot areas above)
August 1, 2013	Radio and television service	Nationwide
January 1, 2014	Railway transportation, postal industry	Nationwide
June 1, 2014	Telecommunications	Nationwide
May 1, 2016	Construction industry, real estate industry, financial industry, life service industry	Nationwide

The literature on the VAT reform mainly focuses on the macro, meso, and micro levels. First, on the macro level, scholars examine the impact of the VAT reform on the economy, the energy consumption structure, consumer wealth, and the national income distribution. According to Sun and Zhang (2015), the VAT reform optimizes the distribution of the national income by increasing the income of residents and business sectors and by reducing the income of government departments. Second, on the meso level, scholars focus on the short-term effects of the VAT reform on the fiscal revenue of local governments and on its impact on industry transformation and upgrading. Li et al. (2015) find that fiscal revenue reduction during the reform process intensifies tax competition between local governments. Their results suggest that to improve the equalization of public services and the efficiency of public resource allocation, the value-added tax distribution should be reconstructed and the tax authority should be redivided. Li and Yan (2018) find that the tax reduction effect of the VAT reform in the service industry indeed leads to the transformation and upgrading of the manufacturing industry, marked by productivity improvement. Fan and Peng (2017) find that collaboration across regions improves after the VAT reform and that the technical abilities of firms significantly improve. Third, at the micro level, scholars examine the impact of the VAT reform on the actual tax burden, investment behavior, financing behavior, innovation behavior, corporate growth, and corporate performance. Wang and Li (2014) and Li and Li (2016) examine the impact of the VAT reform on the tax burden of listed companies in the transportation industry. They find that the tax burden of general value-added tax taxpayers in the transportation industry increases and that profitability decreases after the VAT reform. Chen and Wang (2017) find that listed companies' business scope and service outsourcing demand expand after the VAT reform. Tong et al. (2015) find that the less bargaining power a supplier has, the greater the increase in the nominal tax burden of the firm after the VAT reform, but the increased tax burden does not undermine the firm's performance. However, little research shows how the VAT reform affects the potential costs of companies. Research on the adjustment costs of the VAT reform from the audit pricing perspective is particularly lacking.

As intermediaries in the capital market, auditors provide important guarantees for the reliability and accuracy of corporate financial information, thereby playing a critical role in the implementation of the VAT reform. The VAT reform changes not only the accounting methods of enterprises but also the working methods and scope of audit firms, which are ultimately reflected in the changes in audit fees. The classic model of audit fees proposed by Simunic (1980) provides a logical and clear guide for the analysis of the adjustment

costs created by the VAT reform for firms. These costs can be analyzed from both the audit effort and audit risk perspectives.

From the audit effort perspective, after a firm adopts the VAT reform, the conversion from business tax accounting to value-added tax accounting causes changes in accounting confirmation, measurement, and recording. Consequently, the firm's operating income, operating costs, total profits, income tax, and urban construction tax are affected. Its accounting processes (e.g., bill processing and tax declaration) are also affected.[3] These changes can be summarized as changes in two aspects: accounting subject processing and accounting procedures. First, after implementing the VAT reform, firms must adopt special accounting treatments during the transition period, during which they encounter four specific difficulties: the pilot taxpayer's differential taxation, the value-added tax deduction at the end of the period, the acquisition of transitional financial support, and special equipment for the value-added tax control system and technical maintenance costs to deduct the value-added tax. These issues give rise to a series of accounting changes.[4]

Second, after VAT reform adoption, companies implement many adjustments in the accounting treatment of related businesses. One example is the financial leasing business (Xu et al., 2018). Before the VAT reform, lessors needed to account for the initial direct costs and the first lease payment received on the actual starting date of the lease, record the unguaranteed residual value, and distribute the unrealized financial lease income according to the lease term. After the VAT reform, when purchasing equipment, the leasing company must confirm and deduct the input value-added tax amount. When the equipment is leased as a financial lease and the rent is collected, the corresponding value-added output tax must be calculated. Furthermore, when the lessor's value-added tax liability is confirmed, firms can carry out many flexible treatments because the financial lease accounting standards are not sound. For example, firms can choose between confirming the value-added tax payable on the lease start date, deferring the output tax and transferring it out gradually, or confirming it once the rent is actually received.

Third, many changes occur in firms' invoice management and tax accounting processes after adoption of the VAT reform (Wang, 2019). Value-added tax is a national tax collection item. As such, firms must issue special value-added tax invoices. As business tax is a land tax collection item, firms must issue ordinary invoices for business tax services. The acquisition, authentication, issuance, and management of special value-added tax invoices are stricter than the processes for ordinary invoices, and dealing with many value-added tax return forms and their associated complex data items requires firm personnel to learn and recheck to avoid mistakes (Deng, 2016). Therefore, it is difficult for auditors to handle the changes in the accounting treatment brought about by the VAT reform using their existing knowledge. The annual audit project report must also be completed by an audit team comprised of auditors at various levels and with different experiences. Thus, the auditors of VAT reform firms must train their staff on the VAT reform, thereby increasing their costs. Auditors must also spend more time and effort on auditing firms under the VAT reform, as those accounting treatments are relatively new. This also increases audit firms' costs, audit investment, and audit pricing. In addition, the VAT reform is not carried out at the beginning or end of a certain fiscal year. The discontinuity between accounting and tax policies presents auditors with two sets of accounting treatments at the same time. Hence, the amount of work to be undertaken during voucher sampling and walk-through testing also increases.

From the audit risk perspective, the VAT reform may increase audit fees by increasing the audit risk of audit firms. First, a VAT reform firm may use the changes in accounting treatment caused by the reform to conduct tax planning, earnings management, or other manipulation behaviors (Li and Li, 2016), making its accounting treatment deviate from its economic substance and thereby increasing the risk of a material misstatement in its financial reports. Second, the changes in accounting treatment caused by the reform are new knowledge for audited companies. As such, companies are more prone to accounting errors, which may also increase the risk of major misstatements in their financial reports. Third, as VAT reform firms face more com-

[3] For example, the Sohu News report from February 28, 2017, "Review | Special Considerations for the 'VAT Reform' in the Audit of 2016 Financial Statements." For details, please refer to https://www.sohu.com/a/127434317_395649.

[4] For details, please refer to the "Regulations on Accounting Treatment of Enterprises in the Pilot Program of Reforming Business Tax to Value-Added Tax" issued by the Ministry of Finance in 2012 and the "Regulations on Accounting Treatment of Value-Added Tax" issued in 2016.

plicated invoice management and accounting procedures, they are more likely to manipulate earnings and implement tax avoidance (Tong et al., 2015). This makes them more susceptible to inspection by government tax authorities and the media. As a result, according to deep pocket theory, their auditors are more likely to charge a higher risk premium (Li and Wu, 2004).

The fierce competition in the Chinese audit market may make it difficult for auditors to translate higher audit costs into higher audit fees. To resolve this, the increase in labor and training costs during the VAT reform pilot period are indeed compensated by an audit fee premium. In some cases, increased audit fees can still be negotiated during the audit process, despite the audit contract being signed at the beginning of the fiscal year.[5] Although the VAT reform has a long-term sustainable impact on enterprises' operations and investments, it only affects corporate audit fees in the year of implementation due to the unique determinants of these fees. There are two reasons for this. First, the accounting treatment of the affected companies in the VAT reform year undergoes a sudden change. This makes the accounting treatment more complicated and error prone. Second, auditors have insufficient experience and learn relevant knowledge only when they are auditing firms with new accounting changes. Therefore, auditors put more effort into auditing VAT reform firms and face greater audit risk in the year of VAT reform implementation. In turn, they charge higher audit fees. In the years after the reform, the accounting treatment changes gradually become ordinary treatments, and the auditors become familiar with the new treatments. As such, audit effort and audit risk do not increase during these years. Furthermore, companies no longer bear secondary adjustment costs[6] in the years after VAT reform adoption. The logical framework of this study is illustrated in Fig. 2.

In summary, audit firms' audit effort and audit risk are higher in the year of VAT reform adoption than in the years before and after it. Accordingly, audit firms charge higher audit fees in the year of VAT reform adoption. We propose the following hypothesis:

H1: Audit fees are significantly higher for firms during their year of VAT reform adoption, particularly compared with non-VAT reform firms and with the years before and after their VAT reform implementation.

2.2. The VAT Reform, auditor competency, and audit pricing

International Big 4 audit firms tend to make much greater long-term investments than other audit firms in training high-quality auditors. They also establish complete quality control mechanisms and provide high-quality audit services, thereby fostering their good reputation in the audit market (DeAngelo, 1981; Pittman and Fortin, 2004). Because of the relatively high competency of their auditors and their complete training systems, Big 4 audit firms demonstrate stronger bargaining power in terms of translating increased audit costs into audit fees when they encounter changes arising from the VAT reform. They are also more likely to rip their customers off when they face such institutional changes. Thus, the increase in audit fees may be even greater in Big 4 audit firms than in non-Big 4 audit firms.[7] We propose the following hypothesis:

H2: The increase in audit fees as a result of VAT reform adoption is higher for firms audited by Big 4 audit firms than for those audited by non-Big 4 audit firms.

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[5] The announcement of listed companies' appointment and re-appointment of audit firms demonstrate that the employment and renewal contracts of audit firms do not necessarily disclose the corresponding audit fees. They may clearly disclose the agreed on audit fees, not mention audit fees at all, or indicate audit fees that were determined through follow-up negotiation, among many other circumstances. For example, according to Hiconn's announcement on renewing its appointment of Zhongshen Zhonghuan as its audit agency in 2020, the relevant audit fees would be determined by the company and Zhongshen Zhonghuan through negotiation based on business conditions.

[6] Shentong Metro (600834) is one example. Registered in Shanghai, Shentong Metro is a local state-owned listed company engaged in rail transit investment and operations. It is mainly engaged in the operation of Shanghai Metro Line 1 and other financial leasing businesses. On January 1, 2012, Shentong Metro became a pilot enterprise of the VAT reform. At the end of 2012, the auditor of its financial report was Shanghai Shanghui Accounting Firm. From 2009 to 2011, the audit fee for Shentong Metro was 300,000 yuan, which suddenly increased to 350,000 yuan in 2012 when it became a VAT reform pilot firm.

[7] For example, refer to the Sina News report, "The Big Four Accounting Firms High Fees Swallowing the Domestic Auditing Market" at http://finance.sina.com.cn/b/20041031/14091121345.shtml for details.

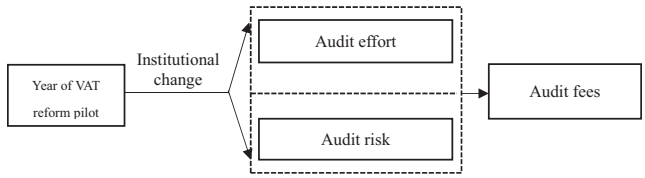

Fig. 2. The impact mechanism of the VAT reform on audit fees.

2.3. The VAT Reform, audit workload, and audit pricing

Auditor input is an important determinant of audit fees (Simunic and Stein, 1996; DeFond and Zhang, 2014). Auditors who audit VAT reform firms must invest more auditing effort as a result of increased learning costs, so they charge higher audit fees. Companies with higher operating income usually generate more business operations, produce more business vouchers that require auditing, and have a greater workload for auditors than companies with low operating income (Menon and Williams, 2001; Wu, 2003). Hence, in the first year of a company's participation in the VAT reform pilot program, audit institutions must spend more energy and time conducting audits, leading to higher audit fees. At the same time, the compulsory changes imposed by VAT reform regulations mean that businesses must change their audit processes more, thereby increasing audit risk. Consequently, companies with higher audit workloads and high operating income are also charged more due to the greater audit fee risk premium. That is, audit fees increase to a greater extent for high operating income companies than for low operating income companies under the VAT reform, as the latter have lower audit workloads. Accordingly, we propose the following hypothesis:

H3: The increase in audit fees as a result of VAT reform adoption is higher for firms with greater audit workloads than for those with smaller audit workloads.

2.4. The VAT Reform, business complexity, and audit pricing

The business complexity of audited firms determines the difficulty and workload of the audit process. The more complex the operations of an audited entity, the more effort an auditor must exert to obtain reasonable assurance of accurate financial statements. Among VAT reform companies, those with greater business complexity have more types of business affected by the reform. This requires their auditors to learn and update more audit processes and examine more accounting vouchers. Therefore, audit costs increase more than for VAT reform companies with low business complexity. High business complexity also triggers opportunistic behaviors by major shareholders and management (Bushman et al., 2004), which makes auditing risky. When a VAT reform firm under audit has higher business complexity, the opportunistic tendency of its managers increases the possibility of misstatement and hence its auditor's risk. Therefore, auditors charge such firms a higher risk premium. We propose the following hypothesis:

H4: The increase in audit fees as a result of VAT reform adoption is higher for firms with high business complexity than for those with low business complexity.

2.5. The VAT Reform, internal controls, and audit pricing

Finally, the internal-control quality of an audited firm may also moderate the relationship between the VAT reform and audit fees. Internal-control deficiencies may result in ineffective controls over the accurate and complete recording of business information, causing more mistakes in financial reports when facing the more complex accounting and taxation policy under the VAT reform. In addition, when audited firms have weak internal controls, auditors not only need to exert more effort but also face a relatively higher audit risk. Therefore, we propose the following hypothesis:

H5: The increase in audit fees as a result of VAT reform adoption is higher for firms with low internal-control quality than for those with high internal-control quality.

3. Research design and sample selection

3.1. Data Sources and sample selection

To test our hypotheses, we obtain financial data on China's A-share listed companies from the China Stock Market & Accounting Research database for the 2010 to 2018 period. We manually collect and organize the data on the VAT reform pilot firms according to the industry category and year announced by the State Council. Stata15.0 is the statistical software used for this study. Following the literature, we exclude observations from the financial industry. We also exclude observations from special treatment (ST) companies, observations from newly listed companies, and observations with missing or abnormal data. Observations from ST companies are excluded because when audit firms audit ST companies, the profitability, debt status, continuing operations ability, regulatory risks, and other aspects of ST companies constitute important determinants of audit pricing. The performance pressures and regulatory requirements faced by ST companies in different years make their own audit pricing less comparable before and after. As such, ST firms have no suitable control group, making them an unsuitable sample for the examination of the impact of the VAT reform on audit fees. To control the extreme value problem, we winsorize the continuous variables at the 1st and 99th percentiles. The final sample consists of 20,204 firm-year observations.

3.2 . Models and variables

To examine the effect of the VAT reform on audit fees, we design model (1):

$$LNFEE = \beta_0 + \beta_1 YGZ + \beta_2 CONTROLS + FIRM + YEAR + \varepsilon \quad (1)$$

where the dependent variable is *LNFEE*, which is the natural logarithm of the audit fees of client firm *i* in year *t*. The independent variable is *YGZ*, which is a dummy variable that equals 1 in the first year of a firm's VAT reform adoption and 0 otherwise. Following the literature, such as Huang et al. (2014) and Gong et al. (2016), we control for company size, accounts receivable, inventory, the asset-liability ratio, cash flow from operating activities, accounting performance, company age, Big 4 status, audit opinions, CEO duality, the independent director ratio, managers' compensation, and firm- and year-fixed effects. Standard errors are clustered at the firm level. To test H2 to H4, we include the production of *YGZ* and the moderator in model (1). The definitions of these variables are provided in Table 2.

Table 2
Variable definitions.

Variable	Definition
LNFEE	Natural logarithm of audit fees
YGZ	Dummy variable that equals 1 in the first year of a firm's VAT reform adoption and 0 otherwise
SIZE	Natural logarithm of total assets
REC	Accounts receivable/Total assets
INV	Inventory/Total assets
LEV	Total liabilities/Total assets
ROA	Net profit/Total assets
OCF	Net cash flow from operating activities/Total assets
BIG4	Dummy variable that equals 1 for Big 4 audit firms and 0 otherwise
MAO	Dummy variable that equals 1 if an auditor issues a modified auditing opinion and 0 otherwise
COMPENSATION	Natural logarithm of the sum of a company's top three executive salaries
DUALITY	Dummy variable that equals 1 if the chair of the board is also the CEO and 0 otherwise
CASH	(Cash at the end of the period + cash equivalents at the end of the period)/Total assets
TOP1	Largest shareholder's shareholding ratio
GROWTH	(Operating income of the implementation period − operating income of the previous period)/Operating income of the implementation period
TURNOVER	Total operating income/Total assets
AGE	Firm age
BOARD	Natural logarithm of the number of board members
INDP	Number of independent directors/Number of directors

3.3. Descriptive statistics

The descriptive statistics of the main variables are shown in Table 3. The average value of the audit fee (*LNFEE*) is 13.725 and the median is 13.592. These results indicate that the average annual audit fee paid by listed companies is approximately 908,900 yuan and that the sample is approximately normally distributed. The mean value of *YGZ* is 0.011, indicating that 1% of the observations in the sample implemented the VAT reform in the first year. The statistics of the control variables are consistent with the literature (Wu et al., 2012).

4. Empirical results and discussion

4.1 . The VAT Reform and audit pricing

The regression results obtained for the testing of H1 are shown in Table 4. The results without the control variables are reported in columns (1) and (2). The control variables are included in columns (3) and (4) and firm- and year-fixed effects are included in columns (2) and (4). The coefficients of *YGZ* in columns (1) to (4) are significantly positive, indicating that audit fees increase significantly in the year of VAT reform implementation. These findings suggest the existence of adjustment costs due to institutional changes. For example, as shown in column (4), the economic significance of the coefficient is 0.0811 (e^0.078–1 = 0.0811). This suggests that in the first year of VAT reform implementation, firms' audit fees increased by 8.11% on average, which indicates that the adjustment costs of institutional changes are considerable. Thus, H1 is supported.

4.2. The VAT Reform, auditor competency, and audit pricing

Next, we empirically test how auditor ability affects the relationship between the VAT reform and audit pricing. We use the interaction between the VAT reform (*YGZ*) and the international Big 4 audit firms (*BIG4*) to test the moderating effect. The results are shown in column (1) of Table 5. The coefficient of *YGZ* × *BIG4* is significantly positive at the 5% level, indicating that the increase in audit fees for the companies audited by international Big 4 audit firms is significantly higher than that of the companies audited by non-Big 4 audit firms. Thus, H2 is supported. This result shows that the international Big 4 audit firms are afforded strong bargaining power through their comprehensive training mechanisms and auditor competency. This allows them to translate the higher costs that result from business changes due to VAT reform adoption

Table 3
Descriptive statistics of the main variables.

Variable	Obs.	Mean	SD	Min.	P25	Median	P75	Max.
LNFEE	20,204	13.725	0.712	12.346	13.236	13.592	14.078	16.455
YGZ	20,204	0.011	0.105	0.000	0.000	0.000	0.000	1.000
SIZE	20,204	22.133	1.324	18.988	21.212	21.976	22.881	26.423
REC	20,204	0.111	0.102	0.000	0.028	0.086	0.165	0.466
INV	20,204	0.156	0.147	0.000	0.062	0.118	0.195	0.731
LEV	20,204	0.451	0.223	0.051	0.276	0.443	0.612	1.274
ROA	20,204	0.034	0.063	−0.320	0.012	0.033	0.062	0.209
OCF	20,204	0.039	0.074	−0.212	0.001	0.039	0.082	0.262
BIG4	20,204	0.055	0.227	0.000	0.000	0.000	0.000	1.000
MAO	20,204	0.043	0.202	0.000	0.000	0.000	0.000	1.000
COMPENSATION	20,204	14.328	0.712	11.983	13.882	14.310	14.752	16.326
DUALITY	20,204	0.247	0.431	0.000	0.000	0.000	0.000	1.000
CASH	20,204	0.155	0.125	0.000	0.068	0.120	0.203	0.675
TOP1	20,204	34.938	15.013	8.860	23.140	32.900	45.050	75.770
GROWTH	20,204	0.067	0.342	−2.143	−0.020	0.103	0.221	0.818
TURNOVER	20,204	0.620	0.449	0.041	0.328	0.515	0.768	2.610
AGE	20,204	16.221	5.549	3.000	12.000	16.000	20.000	29.000
BOARD	20,204	2.142	0.198	1.609	1.946	2.197	2.197	2.708
INDP	20,204	0.373	0.054	0.273	0.333	0.333	0.429	0.571

Table 4
The VAT reform and audit pricing: Main results.

	Dep. Var. = LNFEE			
Variable	(1)	(2)	(3)	(4)
YGZ	0.433***	0.114***	0.119***	0.078***
	(7.58)	(5.00)	(4.05)	(4.38)
SIZE			0.361***	0.326***
			(44.19)	(29.43)
REC			0.234***	0.013
			(3.52)	(0.17)
INV			−0.280***	−0.090*
			(-5.92)	(-1.70)
LEV			0.004	0.015**
			(0.49)	(2.38)
ROA			−0.639***	−0.206***
			(-7.77)	(-4.11)
OCF			0.093	0.061*
			(1.56)	(1.82)
BIG4			0.632***	0.233***
			(14.65)	(4.80)
MAO			0.197***	0.114***
			(8.29)	(6.96)
COMPENSATION			0.096***	0.046***
			(9.18)	(4.60)
DUALITY			0.035***	0.002
			(2.83)	(0.25)
CASH			−0.048	−0.030
			(-0.98)	(-0.85)
TOP1			−0.001**	0.001
			(-2.06)	(1.41)
GROWTH			−0.056***	−0.020**
			(-5.16)	(-2.49)
TURNOVER			0.110***	0.077***
			(6.88)	(4.14)
AGE			0.010***	−0.015
			(8.01)	(-0.82)
BOARD			−0.106**	0.080***
			(-2.56)	(2.67)
INDP			0.134	0.091
			(1.01)	(1.06)
CONSTANT	13.720***	13.226***	4.316***	5.463***
	(1,117.60)	(1,523.90)	(20.98)	(15.07)
FIRM	No	Yes	No	Yes
YEAR	No	Yes	No	Yes
N	20,204	20,204	20,204	20,204
Adj-R^2	0.004	0.481	0.658	0.642

This table reports the effects of the VAT reform on audit fees. The dependent variable is *LNFEE*. All of the variables are defined in Table 2. The analysis is based on an ordinary least squares model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

into higher audit fees. Given the high reputation of the international Big 4 audit firms, the VAT reform increases audit risk for them even more than for other audit firms. As such, their audit fees increase more than those of other auditors for VAT reform firms.

4.3 . The VAT Reform, audit workload, and audit pricing

We conduct an empirical test of how audit workload affects the relationship between the VAT reform and audit pricing. According to the literature, the higher a company's operating income, the greater its business

Table 5
The VAT reform and audit pricing: Cross-sectional results.

	Dep. Var. = LNFEE			
Variable	(1)	(2)	(3)	(4)
YGZ × BIG4	0.099**			
	(2.29)			
YGZ × H_REV		0.078**		
		(2.33)		
YGZ × H_TAXA			0.072**	
			(2.06)	
YGZ × L_IC				0.043
				(1.63)
YGZ	0.058***	0.031	0.040	0.025***
	(2.91)	(1.40)	(1.52)	(4.83)
H_REV / H_TAXA / L_IC		0.033***	−0.003	0.070**
		(3.21)	(-0.73)	(2.01)
BIG4	0.230***	0.234***	0.232***	0.326***
	(4.77)	(4.85)	(4.79)	(29.53)
SIZE	0.326***	0.320***	0.326***	0.015
	(29.47)	(28.79)	(29.41)	(0.19)
REC	0.013	0.012	0.013	−0.092*
	(0.17)	(0.15)	(0.17)	(-1.73)
INV	−0.090*	−0.087*	−0.091*	0.015**
	(-1.69)	(-1.65)	(-1.71)	(2.40)
LEV	0.015**	0.014**	0.015**	−0.204***
	(2.38)	(2.40)	(2.38)	(-4.06)
ROA	−0.206***	−0.217***	−0.209***	0.060*
	(-4.10)	(-4.36)	(-4.12)	(1.79)
OCF	0.060*	0.060*	0.060*	0.234***
	(1.79)	(1.80)	(1.82)	(4.82)
MAO	0.114***	0.109***	0.114***	0.101***
	(6.97)	(6.69)	(6.98)	(6.08)
COMPENSATION	0.046***	0.046***	0.046***	0.045***
	(4.61)	(4.66)	(4.61)	(4.55)
DUALITY	0.002	0.003	0.002	0.002
	(0.25)	(0.32)	(0.25)	(0.20)
CASH	−0.029	−0.028	−0.030	−0.034
	(-0.83)	(-0.78)	(-0.85)	(-0.95)
TOP1	0.001	0.001	0.001	0.001
	(1.40)	(1.49)	(1.41)	(1.40)
GROWTH	−0.019**	−0.020***	−0.020**	−0.019**
	(-2.48)	(-2.60)	(-2.48)	(-2.46)
TURNOVER	0.077***	0.068***	0.077***	0.077***
	(4.14)	(3.59)	(4.15)	(4.13)
AGE	−0.015	−0.016	−0.015	−0.015
	(-0.82)	(-0.86)	(-0.82)	(-0.82)
BOARD	0.080***	0.081***	0.080***	0.079***
	(2.68)	(2.71)	(2.67)	(2.67)
INDP	0.090	0.093	0.091	0.085
	(1.05)	(1.08)	(1.05)	(0.98)
CONSTANT	5.461***	5.577***	5.465***	5.460***
	(15.07)	(15.45)	(15.06)	(15.06)
FIRM	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes
N	20,204	20,204	20,204	20,204
Adj-R^2	0.642	0.642	0.642	0.643

This table reports the results of the cross-sectional tests. The dependent variable is *LNFEE*. All of the variables are defined in Table 2. The analysis is based on an ordinary least squares model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

volume and the more vouchers and business operations involved in the implementation of substantive procedures by the auditor during the audit process, thereby increasing the audit workload (Menon and Williams, 2001; Wu, 2003). Therefore, we construct a dummy variable (*H_REV*) that equals 1 when a company's revenue is larger than the sample median. We include the interaction between *YGZ* and *H_REV* in model (1). The results are shown in column (2) of Table 5. The coefficients of $YGZ \times H\_REV$ are significantly positive at the 5% level, indicating that audit fees increase more for VAT reform firms with higher audit workloads. Thus, H3 is supported.

4.4 . The VAT Reform, business complexity, and audit pricing

We also conduct an empirical test of how business complexity affects the relationship between the VAT reform and audit pricing. The literature on corporate tax avoidance and accounting information quality points out that companies usually adopt a series of complex transaction behaviors to avoid tax, which negatively affects the transparency and quality of accounting information (Weber, 2009; Chen and Tang, 2012; Hanlon et al., 2012). In addition, firms that demonstrate a high degree of tax avoidance have more serious agency problems (Crocker and Slemrod, 2005). Such firms also exhibit more complicated transaction behaviors and more opaque accounting information. When auditing firms practice substantial tax avoidance, their auditors must undertake more complicated economic operations and may even encounter opportunistic behavior by management. Therefore, the degree of tax avoidance is a good measure of business complexity. As the VAT reform is a change in tax regulations, greater tax avoidance indicates more complicated tax treatment. This in turn largely increases auditors' difficulty in and risk of applying the new tax regulations to their client firms' business. To measure business complexity, we use the degree of tax avoidance, where tax avoidance is defined as the difference between the actual tax rate and the nominal tax rate.[8] We construct a dummy variable (*H_TAXA*) that equals 1 when a company's tax avoidance is greater than the sample median. We also include the interaction between *YGZ* and *H_ TAXA* in model (1). The results are shown in column (3) of Table 5. The coefficient of $YGZ \times H\_TAXA$ is significantly positive at the 5% level, indicating that the VAT reform has a greater impact on audit fees when client firms' business complexity is high. Thus, H4 is supported.

4.5. The VAT Reform, internal controls, and audit pricing

Finally, we conduct an empirical test of how internal-control quality affects the relationship between the VAT reform and audit pricing. Following Li et al. (2011), we deem non-standard audit opinions, administrative penalties by regulatory authorities, major internal-control defects, invalid internal controls, and companies' disclosure of major negative news in the media to be reflective of low internal-control quality. We construct a dummy variable (*L_IC*) that equals 1 for firms with low internal controls and 0 otherwise. To examine the internal-control adjustment, we include the interaction between *YGZ* and *L_IC* in model (1). The results are shown in column (4) of Table 5. The coefficient of $YGZ \times L\_IC$ is significantly positive at the 5% level, indicating that the VAT reform has a greater impact on audit fees when internal-control quality is low. Thus, H5 is supported.

5. Robustness tests

5.1 . Dynamic test

To better test the one-time characteristics of the impact of the VAT reform on audit fees, we construct the following dynamic model:

[8] The actual tax rate is the income tax expense divided by the total profit.

$$LNFEE = \beta_0 + \beta_1 YGZ_{-2} + \beta_2 YGZ_{-1} + \beta_3 YGZ_0 + \beta_4 YGZ_1 + \beta_5 YGZ_{\geq 2} + \beta_6 CONTROLS + FIRM + YEAR + \varepsilon \quad (2)$$

where YGZ_{-2}, YGZ_{-1}, YGZ_0, YGZ_1, and $YGZ_{\geq 2}$ indicate the second year before, the year before, the year of, the year after, and the second year after and beyond the VAT reform, respectively. The regression results are shown in columns (1) and (2) of Table 6. The coefficients of YGZ_{-2}, YGZ_{-1}, YGZ_1, and $YGZ_{\geq 2}$ are not significant. The regression coefficient of YGZ_0 is significantly positive at the 1% level. Thus, the impact of the VAT reform on audit fees is only evident in the implementation year. In column (2), we control for industry- and year-fixed effects. The results are consistent with those in column (1). Overall, the results confirm that the VAT reform can impose adjustment costs on firms. Therefore, our findings are robust.

5.2. Robustness tests of the variables and models

To alleviate the model setting problem and enhance the robustness of the research findings, we conduct the following five robustness tests.

First, we redefine the time dimension of the VAT reform by constructing two dummy variables: *YGZ_630* and *YGZ_930*. When the region and industry of a listed company implements the VAT reform before (after) June 30 of the implementation year, *YGZ_630* equals 1 in the implementation year (the year after the implementation year). Similarly, when the region and industry of a listed company implements the VAT reform before (after) September 30 of the implementation year, *YGZ_930* equals 1 in the implementation year (in the year after the implementation year). Then, we use *YGZ_630* and *YGZ_930* as the independent variables and additionally control for whether a change in accounting firm (*AUDIT_CHANGE*) occurs. The results are shown in columns (1) and (2) of Table 7. The coefficients of *YGZ_630* and *YGZ_930* in columns (1) and (2), respectively, are significantly positive at the 1% level, which indicates that the conclusions remain consistent after changing the definition of the time dimension of the VAT reform.

Second, we replace the variable for the spatial dimension of the VAT reform. Given that the VAT reform is affected by both industry and region, we select firms from the same industry as a control group and rerun our regressions. The coefficient of *YGZ* in column (3) of Table 7 is significantly positive at the 1% level. This further indicates that our findings remain consistent after changing the setting in the spatial dimension of the VAT reform.

Third, to alleviate the omitted variables problem, we additionally control for whether the client firm has an audit firm change (*AUDIT_CHANGE*), the degree of economic development of the province in which the client firm is located (*GDP*), and the marketization index of the province in which the sample company is located (*MARKET*). The results are shown in column (4) of Table 7. The coefficient of *YGZ* is significantly positive at the 1% level, which indicates that the results remain robust after alleviating the missing variable problem.

Fourth, to mitigate the effects of price changes on audit fees, we use the consumer price index (CPI) in the first year of the sample period as the base period to adjust the non-ratio corporate financial control variables, including audit fees, total assets, and management compensation. The regression results are shown in column (1) of Table 8. The coefficient of *YGZ* is significantly positive at the 1% level, indicating that the findings hold after accounting for the impact of price changes on audit fees and corporate financial variables.

Fifth, to alleviate the variable definition errors, we examine the impact of the VAT reform on changes in audit fees. Following Su and Wu (2017), we use the first difference of *LNFEE* to measure changes in audit fees (*CH_LNFEE*) and rerun our regression. The results are shown in column (2) of Table 8. The coefficient of *YGZ* is significantly positive at the 1% level. This indicates that the VAT reform can significantly increase the audit fee changes among the pilot firms, further suggesting the robustness of our findings.

5.3 . Propensity score matching regression

Finally, given that the data distribution of firms under the VAT reform are biased, we adopt the propensity score matching (PSM) method to alleviate the interference caused by other control variables in the empirical results. Adopting 1:1, 1:2, and 1:3 matching, we sample without replacement. The 1:1 matching results are shown in Table 9. To conserve space, we do not report the 1:2 or 1:3 matching results. We observe a consid-

Table 6
The VAT reform and audit pricing: Robustness test 1.

	Dep. Var. = LNFEE	
Variable	(1)	(2)
YGZ_{-2}	0.003	0.053
	(0.16)	(1.58)
YGZ_{-1}	0.007	0.040
	(0.34)	(1.22)
YGZ_{0}	0.067***	0.097***
	(2.70)	(3.09)
YGZ_{1}	0.007	0.032
	(0.31)	(1.20)
$YGZ_{\geq 2}$	−0.033	−0.002
	(-1.44)	(-0.05)
SIZE	0.326***	0.361***
	(29.42)	(43.85)
REC	0.013	0.048
	(0.17)	(0.66)
INV	−0.087	−0.158***
	(-1.64)	(-2.82)
LEV	0.015**	0.018**
	(2.38)	(2.42)
ROA	−0.206***	−0.548***
	(-4.09)	(-6.93)
OCF	0.061*	−0.037
	(1.82)	(-0.65)
BIG4	0.231***	0.661***
	(4.75)	(15.12)
MAO	0.114***	0.193***
	(6.95)	(8.50)
COMPENSATION	0.045***	0.055***
	(4.58)	(5.10)
DUALITY	0.003	0.018
	(0.28)	(1.52)
CASH	−0.029	−0.024
	(-0.82)	(-0.49)
TOP1	0.001	−0.001**
	(1.40)	(-2.28)
GROWTH	−0.020**	−0.052***
	(-2.51)	(-5.03)
TURNOVER	0.077***	0.154***
	(4.16)	(8.83)
AGE	−0.016	0.005***
	(-0.84)	(3.36)
BOARD	0.081***	−0.037
	(2.71)	(-0.91)
INDP	0.091	0.096
	(1.06)	(0.75)
CONSTANT	5.462***	4.720***
	(15.07)	(22.43)
FIRM	Yes	No
INDUSTRY	No	Yes
YEAR	Yes	Yes
N	20,204	20,204
Adj-R^2	0.642	0.686

This table reports robustness test results. The dependent variable is *LNFEE*. All of the variables are defined in Table 2. The analysis is based on an ordinary least squares model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7
The VAT reform and audit pricing: Robustness tests 2 to 4.

	Dep. Var. = LNFEE			
Variable	(1)	(2)	(3)	(4)
YGZ_630	0.038***			
	(2.66)			
YGZ_930		0.076***		
		(4.79)		
YGZ			0.182***	0.077***
			(2.74)	(4.30)
SIZE	0.327***	0.326***	0.304***	0.327***
	(29.41)	(29.41)	(3.34)	(29.45)
REC	0.015	0.014	0.044	0.016
	(0.19)	(0.18)	(0.05)	(0.20)
INV	−0.091*	−0.091*	0.026	−0.088*
	(-1.71)	(-1.71)	(0.11)	(-1.66)
LEV	0.015**	0.015**	0.055	0.015**
	(2.41)	(2.40)	(1.01)	(2.40)
ROA	−0.205***	−0.206***	0.527	−0.208***
	(-4.08)	(-4.11)	(1.03)	(-4.14)
OCF	0.062*	0.061*	0.235	0.063*
	(1.84)	(1.82)	(1.40)	(1.88)
BIG4	0.235***	0.234***	–	0.233***
	(4.85)	(4.84)	–	(4.81)
MAO	0.116***	0.115***	0.091	0.114***
	(7.06)	(6.99)	(1.22)	(6.94)
COMPENSATION	0.046***	0.046***	0.011	0.046***
	(4.60)	(4.60)	(0.14)	(4.64)
DUALITY	0.002	0.002	0.045	0.003
	(0.26)	(0.26)	(0.48)	(0.27)
CASH	−0.030	−0.030	0.348*	−0.031
	(-0.83)	(-0.85)	(1.67)	(-0.87)
TOP1	0.001	0.001	0.001	0.001
	(1.42)	(1.41)	(0.34)	(1.37)
GROWTH	−0.019**	−0.019**	−0.031	−0.019**
	(-2.41)	(-2.41)	(-0.49)	(-2.44)
TURNOVER	0.077***	0.077***	0.047	0.078***
	(4.11)	(4.12)	(0.22)	(4.18)
AGE	−0.015	−0.015	0.284***	−0.017
	(-0.80)	(-0.82)	(3.51)	(-0.91)
BOARD	0.078***	0.078***	−0.079	0.078***
	(2.62)	(2.63)	(-0.49)	(2.62)
INDP	0.091	0.092	−0.482	0.088
	(1.06)	(1.07)	(-1.21)	(1.02)
GDP				−0.000
				(-0.48)
MARKET				−0.022**
				(-2.54)
AUDIT_CHANGE	−0.015***	−0.015***		−0.016***
	(-2.70)	(-2.70)		(-2.80)
CONSTANT	5.451***	5.463***	3.010	5.627***
	(15.04)	(15.08)	(1.39)	(15.19)
FIRM	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes
N	20,204	20,204	454	20,204
Adj-R^2	0.641	0.642	0.757	0.642

This table reports robustness test results. The dependent variable is *LNFEE*. All of the variables are defined in Table 2. The analysis is based on an ordinary least squares model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 8
The VAT reform and audit pricing: Robustness tests 5 and 6.

Variable	*Dep. Var. = LNFEE_CPI* (1)	*Dep. Var. = CH_LNFEE* (2)
YGZ	0.069***	0.105***
	(4.32)	(3.75)
SIZE_CPI / SIZE	0.330***	0.101***
	(30.35)	(14.80)
REC	0.012	−0.064
	(0.18)	(-1.18)
INV	−0.082*	−0.096**
	(-1.75)	(-2.48)
LEV	0.015**	0.011***
	(2.25)	(3.18)
ROA	−0.167***	0.060
	(-3.77)	(1.41)
OCF	0.057*	−0.012
	(1.93)	(-0.34)
BIG4	0.205***	0.105***
	(4.87)	(2.95)
MAO	0.101***	0.021
	(6.95)	(1.52)
COMPENSATION_CPI / COMPENSATION	0.045***	−0.026***
	(4.69)	(-2.76)
DUALITY	0.000	−0.005
	(0.05)	(-0.70)
CASH	−0.035	−0.043
	(-1.12)	(-1.45)
TOP1	0.001	0.001
	(1.26)	(1.50)
GROWTH	−0.019***	0.085***
	(-2.69)	(9.89)
TURNOVER	0.072***	−0.010
	(4.37)	(-0.78)
AGE	−0.008	0.012
	(-0.51)	(1.43)
BOARD	0.070***	−0.037
	(2.62)	(-1.51)
INDP	0.086	−0.051
	(1.11)	(-0.75)
CONSTANT	5.346***	−1.780***
	(15.91)	(-9.19)
FIRM	Yes	Yes
YEAR	Yes	Yes
N	20,204	17,039
Adj-R^2	0.849	0.068

This table reports robustness test results. All of the variables are defined in Table 2. The analysis is based on an ordinary least squares model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

erable difference between the control variables of the treatment and control groups before PSM. After matching, the differences between the control variables of the treatment and control groups are no longer significant. The matched nuclear density curve is shown in Fig. 3. It does not show any significant difference between the treatment and control groups. We also examine the differences in the mean values of all of the control variables between the treatment and control groups in the 3-year window around (i.e., the first, second, and third year before and after) the VAT reform. After PSM, the differences between the mean values of the control variables in the treatment and control groups are almost not significant (unreported due to space limitations). Therefore, PSM diminishes the difference between the treatment and control groups in the years before

Table 9
Variable differences between propensity scores before and after matching (1:1 matching).

	Before PSM				After PSM			
	Treated	Control	Diff.	*t*-stat.	Treated	Control	Diff.	*t*-stat.
SIZE	22.707	22.126	0.581	6.58	22.707	22.767	−0.060	−0.41
REC	0.092	0.111	−0.020	−2.90	0.092	0.095	−0.004	−0.38
INV	0.117	0.156	−0.039	−3.97	0.117	0.103	0.015	1.22
LEV	0.484	0.465	0.019	0.45	0.484	0.489	−0.005	−0.22
ROA	0.038	0.034	0.003	0.75	0.038	0.034	0.003	0.61
OCF	0.046	0.039	0.007	1.36	0.046	0.048	−0.002	−0.33
BIG4	0.207	0.053	0.154	10.17	0.207	0.119	0.088	2.55
MAO	0.062	0.042	0.019	1.44	0.062	0.031	0.031	1.56
COMPENSATION	14.497	14.326	0.171	3.60	14.497	14.454	0.043	0.65
DUALITY	0.198	0.247	−0.049	−1.71	0.198	0.163	0.035	0.97
CASH	0.160	0.155	0.005	0.55	0.160	0.167	−0.007	−0.60
TOP1	36.829	34.916	1.913	1.91	36.829	38.413	−1.584	−1.05
GROWTH	0.076	0.067	0.009	0.38	0.076	0.039	0.036	1.05
TURNOVER	0.538	0.621	−0.083	−2.77	0.538	0.603	−0.065	−1.45
AGE	16.278	16.220	0.058	0.16	16.278	17.150	−0.872	−1.62
BOARD	2.192	2.142	0.050	3.75	2.192	2.187	0.005	0.27
INDP	0.373	0.373	0.000	0.05	0.373	0.375	−0.001	−0.22

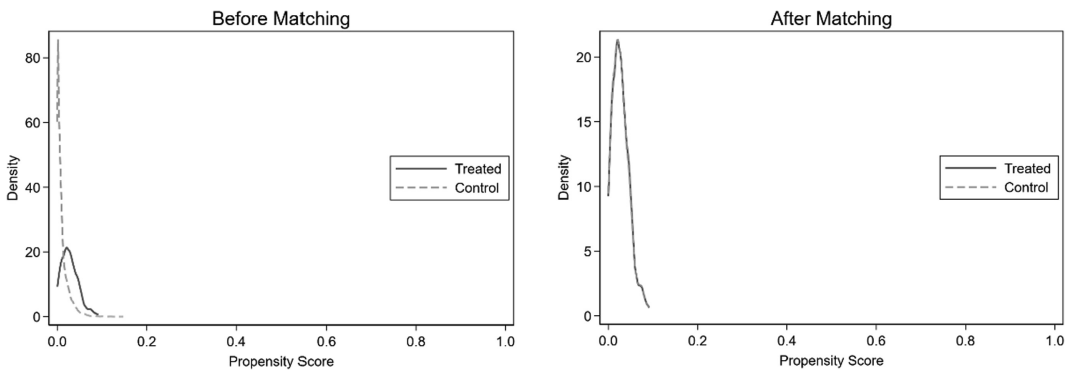

Fig. 3. The kernel density function graph before and after PSM (1:1 matching).

and after the VAT reform, suggesting the effectiveness of the PSM method. We rerun our regression using the PSM sample. The results are shown in Table 10. The coefficients of *YGZ* are significantly positive, supporting our baseline results. Overall, our findings remain unchanged after a series of robustness tests.

6. Conclusion

Using data on China's A-share listed companies from 2010 to 2018 and the nation's staggered adoption of the VAT reform as a natural experiment, we examine the impact of this reform on a particular corporate cost: audit fees. We find audit fees to be 8.11% higher for firms in their VAT reform implementation year than for firms that do not adopt the VAT reform. This effect does not exist before or after the reform year, which indicates the existence of an adjustment cost specifically related to the VAT reform. This fee increase is also greater for firms audited by the Big 4 international audit firms, firms that have a greater audit workload, firms that are more complex, and firms with weak internal controls. From the perspective of audit pricing, we provide evidence of the economic consequences of a tax reform. The corporate adjustment costs that arise from institutional changes warrant more attention from decision-making executives.

Table 10
The VAT reform and audit pricing: Robustness test 7.

	Dep. Var. = LNFEE					
	1:1 matching		1:2 matching		1:3 matching	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
YGZ	0.158**	0.092*	0.135**	0.127**	0.129***	0.094**
	(2.03)	(1.91)	(2.07)	(2.35)	(2.62)	(2.27)
SIZE		0.279**		0.344***		0.361***
		(2.50)		(3.90)		(6.37)
REC		0.121		−0.074		−0.178
		(0.15)		(-0.07)		(-0.24)
INV		−0.630		−0.830*		−0.681
		(-0.78)		(-1.66)		(-1.31)
LEV		−0.279		−0.282		−0.421**
		(-0.88)		(-1.05)		(-2.01)
ROA		−0.179		−0.153		−0.015
		(-0.50)		(-0.31)		(-0.05)
OCF		0.666*		0.411		0.034
		(1.73)		(0.84)		(0.12)
BIG4		0.511***		0.475***		0.562***
		(2.70)		(3.28)		(4.43)
MAO		−0.231*		−0.128		−0.091
		(-1.67)		(-0.93)		(-0.59)
COMPENSATION		0.015		0.051		0.067
		(0.39)		(1.16)		(1.45)
DUALITY		−0.045		0.103		0.142
		(-0.36)		(1.01)		(1.55)
CASH		−0.438		−0.525		−0.478**
		(-1.10)		(-1.50)		(-2.03)
TOP1		−0.005		−0.002		−0.001
		(-0.97)		(-0.42)		(-0.30)
GROWTH		0.047		−0.087		−0.045
		(0.59)		(-0.92)		(-0.66)
TURNOVER		−0.199		−0.067		0.024
		(-1.30)		(-0.51)		(0.21)
AGE		0.003		0.076		0.036
		(0.18)		(1.13)		(0.56)
BOARD		−0.189		0.195		−0.073
		(-0.70)		(0.79)		(-0.47)
INDP		−1.337**		−0.460		−0.316
		(-2.10)		(-0.83)		(-0.67)
CONSTANT	13.881***	8.827***	13.563***	4.455**	13.565***	4.794***
	(108.46)	(3.47)	(117.39)	(2.25)	(173.93)	(3.00)
FIRM	Yes	Yes	Yes	Yes	Yes	Yes
YEAR	Yes	Yes	Yes	Yes	Yes	Yes
N	434	434	652	652	863	863
Adj-R^2	0.309	0.724	0.380	0.628	0.375	0.589

This table reports robustness test results. All of the variables are defined in Table 2. The analysis is based on an ordinary least squares model. The *t*-statistics are given in parentheses, and the coefficients are based on standard errors clustered at the firm level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

We offer practical suggestions to policy makers. Research on the VAT reform focuses on its benefits without considering its costs. Although a policy may be implemented with the goals of improving economic efficiency and reducing taxation, policy makers and administrators must not ignore the adjustment costs imposed on firms as a result of such institutional changes. We find that the implementation of the VAT reform increases audit fees by 8.11% in the implementation year. Furthermore, the more complex and detailed the policy formulation, the higher the adjustment costs imposed on the affected company are. Therefore, when

policy makers are implementing policies, it is necessary as much as possible to clarify the policy details, to hold briefings on relevant policies, and to introduce corresponding policy application guidelines to reduce the adjustment costs that firms face. Only in this way can the overall benefits of a policy be improved.

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.

Acknowledgments

We thank Hang Liu, Donghui Wu, and the CJAR Summer Research Workshop participants at the City University of Hong Kong. We also thank Qianqian Hu for her excellent work as a research assistant. Finally, we gratefully acknowledge the financial support by the National Natural Science Foundation of China (Project No. 71790603). All errors are our own.

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China Journal of Accounting Research 14 (2021) 151–182

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Do goodwill impairments affect audit opinions? Evidence from China

Ziye He *, Dong Chen, Jianxin Tang

Economics and Management School, Wuhan University, Wuhan, Hubei 430072, China

ARTICLE INFO

Article history:
Received 2 June 2020
Accepted 14 March 2021
Available online 20 April 2021

JEL classification:
M41
M42

Keywords:
Goodwill impairments
Audit opinions
Material misstatements
Earnings management
Economic fundamentals

ABSTRACT

There has been a steady growth of goodwill impairments in the Chinese stock market since the adoption of the impairment approach in accounting. The influence of goodwill impairments on a firm's financial position and profitability give reason to doubt its current and future performance. We examine whether auditors, as a crucial external monitor, identify the information risks of goodwill impairments and express their concerns about financial reporting quality in their audit opinions. Using a sample of firms listed on China's A-share market from 2007 to 2017, we test the association between goodwill impairments and the type of audit opinion received in the same financial period. Our findings are as follows. First, the probability of receiving a modified opinion increases with the amount of goodwill impairments. Second, the positive association between goodwill impairments and modified audit opinions is driven primarily by earnings management risks. Third, this positive association is more salient when auditors are industry experts and there is no auditor–client mismatch. Fourth, auditors are more sensitive to the amount of goodwill impairments than to their mere existence. Overall, we document that auditors perceive goodwill impairments as a signal of information risks and communicate their concerns to investors to avoid litigation.

1. Introduction

According to the International Accounting Standards adopted in 2004, " a cash-generating unit to which goodwill has been allocated shall be tested for impairment" by comparing the carrying amount with the recov-

* Corresponding author.
E-mail addresses: ziyehe@whu.edu.cn (Z. He), dongchen@whu.edu.cn (D. Chen), 00000121@whu.edu.cn (J. Tang).

https://doi.org/10.1016/j.cjar.2021.03.002
1755-3091/

erable amount of the unit. That is, goodwill should be test for impairment by the firm at least annually (IAS 36, paras. 90&96). Since the adoption of this "impairment-only approach", there has been an ongoing debate about whether it best reflects the economic reality of goodwill and provides more useful information than the "amortization approach", or whether it is more vulnerable to manipulation. China adopted the new impairment method in 2007. Since then, due to an increasing number of mergers and acquisitions, goodwill and impairments in China's A-share market have been growing rapidly. We observe cases where firms recognize no impairment in the first two years after acquisition but record a significant amount of goodwill impairments in the third year, when the performance target set at acquisition cannot be met. This phenomenon has unanticipated effects on the stock market, leading to security mispricing and resource misallocation.

In this study, we examine whether auditors are responsive to goodwill impairments recognized by their clients, and how audit opinions are affected by the different risks signaled by goodwill impairments. An auditor's main duty is to obtain sufficient audit evidence and assess whether there are material misstatements. Accordingly, if auditors are satisfied with the presentation of financial reports, they express the unmodified opinion that the financial reports comply with accounting standards and give a true and fair view in all material respects. However, the nearly unverifiable nature of the fair value of goodwill makes it similarly difficult for auditors to verify goodwill impairments (Ramanna, 2008; Ayres et al., 2019). Goodwill impairments have profound effects on a firm's financial position and profitability. On the one hand, firms may be aggressive in recording large amounts of goodwill to make their acquisitions look successful. On the other hand, firms may be conservative in recognizing impairments to retain market expectations. Goodwill is likely to be impaired if a firm does not meet its promised performance target within the required timeframe (e.g., a 3-year performance commitment period). Alternatively, impairments may result from opportunistic incentives for management to manipulate earnings (Holthausen and Watts, 2001; Watts, 2003). Hence, goodwill impairment signals risks associated with both economic fundamentals and earnings management. Reliable information on goodwill is essential for shareholders and potential investors when making investment decisions and appraising firm performance (Zeff and Barton, 2009). Thus, auditors face possible litigation and damage to their reputation if they fail to uphold professional skepticism and issue inappropriate audit opinions.

We find a significant positive association between the probability of receiving a modified opinion and the amount of goodwill impairments, based on a sample of firms listed on China's A-share market from 2007 to 2017. First, we show that auditors identify the material information risks signaled by goodwill impairments and express their concerns about the quality of financial reporting by issuing modified opinions. Second, the positive association between goodwill impairments and modified opinions is driven primarily by risks related to earnings management, rather than to economic fundamentals. One possible explanation is that earnings management increases the risks of material misstatements in financial reports, and investors may be misled by unreliable information when making decisions. Therefore, auditors tend to communicate their concerns about low-quality financial reporting by issuing modified opinions to avoid litigation. As for risks related to economic fundamentals, auditors will not issue a modified opinion if they are satisfied that the entity will continue as a going concern for the relevant period. Although information risks related to economic fundamentals do not mediate the relationship between impairments and modified opinions, our untabulated results show that there is a significant and positive association between material goodwill impairments and information risks related to economic fundamentals. In robustness tests, we address endogeneity issues, use alternative variables, add control variables, and reconstruct the sample. Overall, our results remain unchanged. Cross-sectional tests reveal that the positive association is more salient when the auditor is an industry expert and there is no auditor–client mismatch. Furthermore, auditors are more sensitive to the amount of goodwill impairments than to their mere existence.

Our study makes several important contributions to the literature. First, this study enriches our understanding of auditors' reaction to information risks in the setting of goodwill auditing (Zeng and Lu, 2016; Duan and Chen, 2017; Bo and Wu, 2011). Our results imply that auditors perceive goodwill impairment as a signal of information risks and focus more on "procedural justice" (whether the client engages in earnings management) than on "substantive justice" (whether there are systemic risks related to economic fundamentals). Second, unlike prior studies that focus on clients or auditors (Lobo et al., 2017; Ayres et al., 2019; Carcello et al., 2020), our study examines the relationship between goodwill impairments and modified audit opinions from the perspective of investors. Investors' reliance on auditors for assurance of reporting quality

places external pressure on them during their audit of goodwill impairments, and auditors face damage to their reputation or litigation if they fail to identify risks and issue inappropriate opinions. Third, this study has important implications for auditors and investors. Auditors should have a comprehensive understanding of the industry environment and the historical performance of their clients prior to the audit, and also maintain a high level of professional skepticism in auditing goodwill so that audit resources can be efficiently used to improve audit quality. Investors should be more prudent in relying on audit opinions so that mispricing problems can be mitigated.

The remainder of this paper is organized as follows. Section 2 outlines the related literature and develops the hypotheses. Section 3 provides the research design. Section 4 presents the empirical results and robustness tests. Section 5 extends the discussion of our findings. The final section offers our concluding remarks.

2. Literature review and hypothesis development

2.1. Prior literature on goodwill impairment

There are various sources of goodwill impairments, such as takeover premiums (Hayn and Hughes, 2006), overvaluation of stock prices (Gu and Lev, 2011), and managerial incentives to manipulate earnings (Francis et al., 1996). Studies indicate that goodwill impairments are value relevant and provide information for decision-making (Churyk, 2005; Bens et al., 2011). Using data on European firms, AbuGhazaleh et al. (2012) find that investors incorporate impairment losses into their valuation of firms. Li et al. (2011) suggest that investors and analysts update their expectation of a firm's future profitability after the announcement of impairment. Nonetheless, fair value for goodwill is highly subjective, difficult to verify, and susceptible to managerial opportunism (Holthausen and Watts, 2001; Watts, 2003). SFAS 142 gives managers the discretion to manipulate earnings by delaying goodwill impairments (Ramanna and Watts, 2012). Li and Sloan (2017) compare the timeliness of goodwill impairments before and after the implementation of SFAS 142. They posit that in the post-SFAS 142 period, goodwill balances are more inflated and impairments are recognized in a less timely manner. However, investors do not fully anticipate the decreased timeliness of goodwill impairments, and the discretion in SFAS 142 leads to real effects, such as security mispricing. The adoption of SFAS 142 also opens the door to potential earnings manipulation, and the negative impacts of goodwill impairments on reported earnings are used by small firms that engage in a "big bath" strategy (Sevin and Schroeder, 2005; Jordan & Clark, 2004). AbuGhazaleh et al. (2011) provide similar evidence from the U.K. that goodwill impairments are associated with CEO changes, income smoothing, and incentives to take a big bath. Stenheim and Madsen (2016) posit that firms report more and larger impairment losses if they exhibit strong smoothing or big bath incentives. In general, there is ample evidence that managerial self-interest and earnings management often motivate firms' impairment decisions (Lhaopadchan, 2010).

2.2. Prior literature on audit opinions

The results for the association between accounting accruals and modified opinions are mixed. Bartov et al. (2001) document a positive association between the absolute value of discretionary accruals and the probability of receiving a modified opinion. Bradshaw et al. (2001) find a non-insignificant relationship between accruals and modified opinions. Butler et al. (2004) posit that modified opinions indicate auditors' concerns about the going concern basis of accounting and are not related to earnings management. Studies that use data from China also yield mixed results. On the one hand, investors rely on the earnings information of listed firms to make investment decisions. If investors are misled by earnings management, the auditors who provide assurance of financial reporting quality may face litigation. Consequently, auditors express their concerns by issuing modified opinions to reduce these risks (Xu, 2004). On the other hand, Xia and Yang (2002) posit that auditors tend to focus more on firms' losses due to management fraud than on their engagement in earnings management. Other studies examine the relationship between information risks and modified audit opinions. Several suggest that the probability of receiving modified opinions increases as the risk of bankruptcy, default, or litigation increases (Lennox, 2000; Biddle and Hilary, 2006; Lam and Mensah, 2006). Duan and Chen (2017) provide evidence that asset impairment influences the assessment of audit risk and is positively associ-

ated with the probability of receiving a modified opinion. Using evidence from China, Bo and Wu (2011) find a significant and positive relationship between clients' information risks and modified opinions. Auditors react to information risks related to both earnings management and economic fundamentals but treat them differently (Zhang, 2012). Zhang (2012) argues that the risks of opportunistic disclosure strategies are likely to attract the attention of investors and regulators. In this case, auditors are more stringent in applying professional skepticism to avoid potential detection risks (Song and He, 2008), and consequently, the probability of issuing a modified opinion increases.

2.3. Prior literature on goodwill auditing

Auditors may be poorly positioned to evaluate the assumptions made in determining the fair value of goodwill, and sometimes they neglect the indicators of impairments (Glaum et al., 2018). Due to the technical difficulty of evaluating impairment decisions, auditors and clients may hold opposite opinions. Ayres et al. (2019) find that the likelihood of an auditor dismissal is negatively associated with the favorability of management's goodwill impairment decisions. Subsequent to the dismissal, firms are more likely to employ new auditors who support the management's impairment decisions. Lobo et al. (2017) find that firms audited by a Big 4–non-Big 4 auditor pair are more likely to record impairments than firms audited by a Big 4–Big 4 auditor pair. A recent study on this topic suggests that non-audit fees are negatively related to the likelihood of goodwill impairments. This association is driven primarily by clients' motivation to influence external auditors (Carcello et al., 2020). In addition, unverifiable impairment tests are more difficult to audit, and the increased audit risk leads to higher audit fees (Ye et al., 2016). Auditors attest to the acquired goodwill with professional skepticism, and increase their audit fees to maintain a high-quality audit (Zheng and Li, 2018).

2.4. Goodwill impairment in a Chinese setting

In 2007, China implemented a new corporate accounting standard, *CAS 8 Impairment of Assets*. It abandons the amortization approach and requires goodwill, and its cash-generating units (CGUs), to be tested annually for impairments (CAS 8, para 2). Between 2014 and 2015, a relatively loose liquidity environment and related policies facilitated the diversification of financing and payment methods used to facilitate mergers and acquisitions (M&As), resulting in a surge in acquired goodwill (Wei and Zhu, 2019). In 2018, the total amount of goodwill and impairments in the A-share market reached 1.45 trillion Chinese yuan and 60 billion Chinese yuan, respectively. On the one hand, target firms commit to high performance to attract acquirers, who then overvalue them to boost the share price. On the other hand, achieving performance targets may trigger the vesting conditions that serve as equity incentives for the management of acquirers. This alignment of interests aggravates the collusion between acquirers and acquirees, leading to the common phenomenon in the Chinese M&A market of "high performance commitment, high acquired goodwill and high goodwill impairments related to earnings management" (Li and Yao, 2019). The same impairment approach adopted by the U.S. and the E.U. has also been criticized for providing management with the discretion to determine the fair value of goodwill in certain scenarios (Holthausen and Watts, 2001; Watts, 2003). In addition, goodwill constitutes an increasing portion of total assets (Zeff and Barton, 2009). In summary, studies of different countries show that goodwill accounting is relatively unverifiable and that management has incentives to manipulate and delay goodwill impairments.

2.5. Hypothesis development

Internal managers have the discretion to make impairment decisions using proprietary information about goodwill. Given the unverifiable nature of goodwill impairments and their broad effects on financial position and profitability, there is more uncertainty regarding the true and fair presentation of financial reports when a large amount of impairments is recognized. In this case, auditors weigh their tolerance of accounting manipulation against the risks of material misstatements (Zeng and Lu, 2016).

If auditors agree that misstatements related to goodwill impairments will not affect the true and fair presentation of financial reports in a material way, they tend to communicate the issues to management before

issuing audit opinions. Hence, in this case, we expect to find no association between goodwill impairments and modified opinions. On the contrary, if auditors find it particularly difficult to verify the estimations and assumptions used in impairment tests, and the unverifiable impairments will materially compromise the quality of accounting information, they tend to express their concerns about financial reporting quality with a modified opinion to avoid potential audit failure and litigation from investors (Menon and Williams, 1994). Therefore, in this case, we anticipate a positive association between goodwill impairments and modified opinions. For these reasons, we propose the following hypothesis:

H1: Ceteris paribus, the probability of receiving a modified audit opinion is not associated with the amount of goodwill impairments.

Information risk is the possibility that the quality of firm-specific information related to investors' pricing decisions is low, and the risk is undiversifiable. There are two types of information risks. The first is innate, such as risks related to the business model or operating environment; the second is discretionary and subject to management interventions (Francis et al., 2005). Goodwill impairment may arise from innate factors, such as poor decision-making or a performance target set at acquisition that is difficult to meet because of a weak economic environment. Consequently, auditors may question the firm's future profitability or even its ability to continue as a going concern. Alternatively, goodwill impairment may arise from discretionary factors, such as managerial manipulation of accounting earnings (Liu and Liu, 2014). In such a case, the accounting information does not reliably reflect true financial performance, and users who rely on this information to make decisions may be misled (Liu, 2009; Cao and Bu, 2013).

In both scenarios, the recognized goodwill impairment indicates potential information risks and the lower quality of the client's accounting information. Auditors are responsible for assuring investors that the accounting information contained in financial statements is not materially misstated, and tend to issue a modified audit opinion if the client exhibits high information risks related to goodwill impairments, to avoid reputational damage and loss of the client (Zeng and Lu, 2016). Collectively, we propose the following hypothesis:

H2: The association between goodwill impairments and the probability of receiving a modified audit opinion is driven by information risks related to both economic fundamentals and earnings management.

3. Data and research design

3.1. Data

We focus on firms listed on the A-share market of the Shenzhen and Shanghai stock exchanges between 2007 and 2017. We retain non-special treatment (ST) firms with positive balances of goodwill in the CSMAR database and exclude firms from the financial sector. We also replace all missing values of goodwill impairments with 0 and require all control variables to have non-missing data. By adopting this screening standard, we obtain a final sample of 8,504 firm-year observations for H1. We include year and industry dummies and cluster standard errors at the firm level in all of the regressions. All of the continuous variables are winsorized at the 1% and 99% levels. See Table 1 for the sample selection process.

3.2. Research design

We use the following logistic regression model to test H1:

$$\begin{aligned} OPINION_{it} = {} & \beta_0 + \beta_1 IMPAIR_{it} + \beta_2 LAGOP_{it} + \beta_3 LOSS_{it} + \beta_4 LNTA_{it} + \beta_5 AGE_{it} + \beta_6 GROWTH_{it} \\ & + \beta_7 SOE_{it} + \beta_8 LEV_{it} + \beta_9 ROA_{it} + \beta_{10} COST_{it} + \beta_{11} BIG4_{it} + \beta_{12} HARD_{it} + \beta_{13} SP_{it} \\ & + \beta_{14} OCF_{it} + \beta_{15} CAPINTEN_{it} + \sum Year + \sum Industry + \varepsilon \end{aligned} \quad (1)$$

The dependent variable $OPINION_{it}$ equals 1 if the auditor issues a modified opinion or an unmodified opinion with an explanatory paragraph, and 0 otherwise. The independent variable $IMPAIR_{it}$ is the ratio of goodwill impairments to total assets. Following the literature (Ayres et al., 2019; Francis, 2011; Bo and Wu, 2011), we control factors that could potentially affect audit opinions, such as audit opinions received in a prior financial year (*LAGOP*), audit fees (*COST*), auditor expertise (*BIG4*), and the difficulty of the audit work (*HARD*). In general, auditors are more likely to issue a modified opinion if they issued a modified opinion in the prior year, if they are employed by a Big 4 audit firm, or if the audit work is difficult to perform (Blay and Geiger, 2013; Ayres et al., 2019; Zeng and Lu, 2016). However, higher audit fees may not improve audit quality and have no association with modified opinions (Craswell et al., 2002; Francis, 2011). We control for factors that may affect impairment decisions, including loss before extraordinary items (*LOSS*), low profitability (*SP*), operating cash flows (*OCF*), and capital intensity (*CAPINTEN*). Firms are more likely to experience financial risks and impair goodwill if they post a loss, exhibit low profitability or operating cash flows, or have higher capital intensity (Ayres et al., 2019; Zeng and Lu, 2016). We also control for firm-level characteristics (Gu and Lev, 2011; Reynolds et al., 2004; Carcello et al., 2020), including firm size (*LNTA*), firm age (*AGE*), sales growth (*GROWTH*), leverage ratio (*LEV*), profitability (*ROA*), and state ownership (SOE). See Appendix A1 for variable definitions.

To examine H2, we first use the following model to calculate information risks:

$$VOL_{it} = \beta_0 + \beta_1 DA_{it} + \beta_2 LEV_{it} + \beta_3 GROWTH_{it} + \beta_4 OCF_{it} + \beta_5 LNTA_{it} + \beta_6 SOE_{it} + \beta_7 HOLD_{it} + \beta_8 IND_{it} + \beta_9 LEAVE_{it} + \beta_{10} DUAL_{it} + YEAR\_FE + FIRM\_FE + \varepsilon \quad (2)$$

Here, information risks are proxied by the performance volatility of the firm across multiple financial periods so that the deviation of performance from the normal level can be extracted for each financial year. First, higher operating risks and poor financial performance increase performance volatility; second, earnings management also increases performance volatility once the manipulated earnings are reversed in the following periods. Overall, this annual deviation represents both operating risks and earnings management risks (Quan and Wu, 2010; Zhang and Li, 2012), and will significantly affect the auditors' evaluation of the risks of material misstatements in the financial reports. Therefore, performance volatility is an appropriate proxy for information risks (Bharath et al., 2008). In particular, performance volatility (VOL_{it}) is the 3-year standard deviation of return on equity from *t-2* to *t* (Adams et al., 2005; Cheng, 2008; Quan and Wu, 2010). Unlike Zeng and Lu (2016), Francis et al. (2005) posit that the quality of accruals reveals the mapping of accounting earnings to cash flows and that lower earnings quality implies higher information risks. However, the estimation of information risks depends on the specific model used to measure accrual quality, and will probably increase the noise in calculations in our setting. We therefore use accrual quality as an alternative proxy

Table 1
Sample selection.

Panel A H1

	Company-year
Data from the CSMAR database for the years 2007 to 2017 (ST firms and firms from financial sectors are excluded)	10,879
Less missing values for all control variables	2,375
Total observations for H1 (2007–2017)	8,504

Panel B H2

	Company-year
Data from the CSMAR database for the years 2007 to 2017 (ST firms and firms from finance sectors are excluded)	10,879
Less missing values for all control variables	2,375
Less missing values for risks related to earnings management and risks related to economic fundamentals	1,701
Total observations for H2 (2007–2017)	6,803

for information risks in a robustness test to provide comparable evidence. We use the following model from Kothari et al. (2005) to calculate earnings management (DA_{it}), because it considers the future increase of non-discretionary accruals and controls for firms' growth:

$$\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1 \frac{1}{A_{i,t-1}} + \alpha_2[\frac{\Delta REV_{i,t}}{A_{i,t-1}}] + \alpha_3 \frac{PPE_{i,t}}{A_{i,t-1}} + \alpha_4 \frac{ROA_{i,t}}{A_{i,t-1}} + \varepsilon$$

Here, $A_i$represents a firm's total assets in year *t-1*; ΔREV_idenotes the firm's current operating revenue; PPE_i is the firm's current property, plant, and equipment;ROA_i is the firm's current return on assets. Apart from the measures included in model (1), measures of the efficiency of corporate governance (Zeng and Lu, 2016) are added as control variables in model (2). They include the ratio of independent directors (*IND*), shares owned by the largest shareholder (*HOLD*), duality of CEO and chairperson (*DUAL*), and CEO turnover (*LEAVE*). We use the absolute value of *DA* to ensure that it increases with the level of earnings management. Risks related to earnings management (*DARISK*) are calculated as *DA* times its coefficient, $DARISK = \beta_1 DA_{it}$. Risks associated with economic fundamentals (*INRISK*) are the portion of performance volatility that cannot be explained by information risks related to earnings management, $INRISK = VOL - DARISK$.

Next, we adopt the following three-step method to investigate the mediating effects of total information risks, risks related to economic fundamentals, and risks related to earnings management (Deng and Xu, 2017; Lin et al., 2018):

Step 1: Regress audit opinion (*OPINION*) on goodwill impairment (*IMPAIR*). This gives the coefficient for the association between the dependent and the independent variable, *c* (see model 1).

Step 2: Regress the mediators (*VOL*, *DARISK*, and *INRISK*) on the independent variable. This gives the coefficients for the association between the mediators and the independent variable, a_1, a_2, and a_3:

$$VOL_{it}(DARISK_{it}\ or\ INRISK_{it}) = \beta_0 + \beta_1 IMPAIR_{it} + \beta_2 LOSS_{it} + \beta_3 LNTA_{it} + \beta_4 GROWTH_{it} + \beta_5 AGE_{it} + \beta_6 SOE_{it} + \beta_7 LEV_{it} + \beta_8 ROA_{it} + \beta_9 BIG4_{it} + YEAR\_FE + FIRM\_FE + \varepsilon \quad (3)$$

Step 3: Regress the dependent variable on both the independent variable and the mediators. This gives the coefficients for the association between the dependent variable and the mediators, b_1, b_2, and b_3:

$$OPINION_{it} = \beta_0 + \beta_1 IMPAIR_{it} + \beta_2 VOL_{it}(DARISK_{it}\ or\ INRISK_{it}) + Controls + \sum Year + \sum Industry + \varepsilon \quad (4)$$

Controls are the control variables used in Eq. (1). Last, we use the coefficients *a*, *b*, and *c* to conduct a Sobel test to judge whether mediation occurs. We anticipate that the mediating effects will occur if both types of information risks materially impair financial reporting quality.

4. Empirical results and robustness tests

4.1. Descriptive statistics

In Table 2, Panel A shows the descriptive statistics of the full sample. The average ratio of goodwill impairments to total assets is 0.2% and the maximum is 5.5%, which is economically significant. In general, the sample firms have an annual sales growth rate of 4.7%, a leverage ratio of 45%, and an average return on assets of 4%. The proportion of shares owned by the largest shareholder varies from 2% to 89%. About 37% of the board directors are independent. The average values for performance volatility and earnings management are 7.1% and 7.5%, respectively. Panel B provides a comparative analysis of impaired and unimpaired firms. The number of unimpaired firms is almost twice that of impaired firms. Impaired firms are slightly larger and have a lower sales growth rate, higher leverage level, and lower profitability. Moreover, impaired firms have less concentrated ownership, higher capital intensity, and higher performance volatility. Panel C reports the distribution of audit opinions between 2007 and 2017. The number of observations increased significantly during this period. The majority of audit opinions are unmodified opinions, followed by unmodified opinions

Table 2
Descriptive statistics.

Panel A Summary statistics of the full sample

VarName	Obs.	*M*	SD	Min	P25	Median	P75	Max
OPINION	8,504	0.022	0.147	0.000	0.000	0.000	0.000	1.000
IMPAIR	8,504	0.002	0.007	0.000	0.000	0.000	0.000	0.055
DUMMY	8,504	0.332	0.471	0.000	0.000	0.000	1.000	1.000
LAGOP	8,504	0.021	0.144	0.000	0.000	0.000	0.000	1.000
LOSS	8,504	0.070	0.255	0.000	0.000	0.000	0.000	1.000
LNTA	8,504	22.270	1.263	19.256	21.380	22.098	22.978	25.936
AGE	8,504	2.162	0.689	0.693	1.609	2.197	2.773	3.178
GROWTH	8,504	0.047	3.915	−22.152	−0.384	0.110	0.510	20.491
SOE	8,504	0.395	0.489	0.000	0.000	0.000	1.000	1.000
LEV	8,504	0.448	0.206	0.052	0.285	0.447	0.602	1.076
ROA	8,504	0.042	0.050	−0.191	0.016	0.038	0.066	0.202
HOLD	8,504	33.848	14.998	2.197	22.130	31.575	44.270	89.090
IND	8,504	0.372	0.056	0.182	0.333	0.333	0.400	0.800
LEAVE	8,504	0.165	0.372	0.000	0.000	0.000	0.000	1.000
DUAL	8,504	0.239	0.426	0.000	0.000	0.000	0.000	1.000
COST	8,504	13.787	0.753	12.468	13.305	13.688	14.152	16.640
BIG4	8,504	0.066	0.248	0.000	0.000	0.000	0.000	1.000
HARD	8,504	0.269	0.169	0.005	0.142	0.247	0.369	0.761
SP	8,504	0.040	0.194	0.000	0.000	0.000	0.000	1.000
OCF	8,504	0.043	0.071	−0.193	0.005	0.042	0.084	0.252
CAPINTEN	8,504	2.514	2.144	0.384	1.294	1.921	2.966	16.482
VOL	6,803	0.071	0.140	0.004	0.021	0.036	0.067	1.412
DA	6,803	0.075	0.083	0.001	0.023	0.051	0.098	0.557
DARISK	6,803	0.008	0.009	0.000	0.002	0.005	0.010	0.057
INRISK	6,803	0.063	0.139	−0.050	0.014	0.029	0.060	1.412
LNMV	8,504	22.710	0.954	20.681	22.058	22.646	23.307	25.390
RETVOL	8,504	0.139	0.065	0.044	0.093	0.125	0.167	0.394
RETURN	8,504	0.242	0.716	−0.694	−0.231	0.031	0.501	3.162
EBITDA	8,504	0.006	0.040	−0.187	−0.003	0.006	0.017	0.185
ACQ	8,504	0.182	0.386	0.000	0.000	0.000	0.000	1.000
RESTRU	8,504	0.222	0.415	0.000	0.000	0.000	0.000	1.000
DIFF	8,504	0.000	0.454	−0.927	−0.531	0.226	0.330	0.845
SDROA	6,852	0.030	0.043	0.001	0.010	0.018	0.034	0.542
AQ	5,062	0.145	0.255	0.008	0.044	0.077	0.139	1.926

Panel B Comparative analysis of impaired and non-impaired firms

VarName	Obs.		*M*		Median		*t*-test	Wilcoxon test
	Impair = 0	Impair = 1	Impair = 0	Impair = 1	Impair = 0	Impair = 1		
OPINION	5,683	2,821	0.015	0.036	0.000	0.000	−6.861***	−6.975***
IMPAIR	5,683	2,821	0.000	0.006	0.000	0.001	−44.394***	−99.382***
LAGOP	5,683	2,821	0.016	0.032	0.000	0.000	−5.113***	−5.296***
LOSS	5,683	2,821	0.053	0.105	0.000	0.000	−9.966***	−9.766***
LNTA	5,683	2,821	22.224	22.343	22.048	22.170	−4.256***	−4.877***
AGE	5,683	2,821	2.090	2.307	2.197	2.398	−15.323***	−14.252***
GROWTH	5,683	2,821	0.056	0.022	0.122	0.081	0.314	3.959***
SOE	5,683	2,821	0.391	0.400	0.000	0.000	−0.721	−0.984
LEV	5,683	2,821	0.442	0.459	0.442	0.459	−3.560***	−3.712***
ROA	5,683	2,821	0.046	0.034	0.040	0.033	12.040***	9.497***
HOLD	5,683	2,821	34.506	32.459	32.510	30.060	6.745***	6.670***
IND	5,683	2,821	0.371	0.375	0.333	0.333	−3.269***	−2.565**
LEAVE	5,683	2,821	0.159	0.177	0.000	0.000	−2.343**	−2.358**
DUAL	5,683	2,821	0.230	0.253	0.000	0.000	−2.743**	−2.536**
COST	5,683	2,821	13.709	13.929	13.592	13.816	−13.897***	−15.097***
BIG4	5,683	2,821	0.057	0.079	0.000	0.000	−3.911***	−4.240***
HARD	5,683	2,821	0.271	0.269	0.249	0.246	0.677	0.354

(*continued on next page*)

Table 2 (*continued*)

Panel B Comparative analysis of impaired and non-impaired firms

VarName	Obs.		*M*		Median		*t*-test	Wilcoxon test
	Impair = 0	Impair = 1	Impair = 0	Impair = 1	Impair = 0	Impair = 1		
SP	5,683	2,821	0.039	0.040	0.000	0.000	−0.747	−0.390
OCF	5,683	2,821	0.043	0.042	0.042	0.042	0.684	0.739
CAPINTEN	5,683	2,821	2.464	2.567	1.904	1.928	−2.703**	−0.431
VOL	4,546	2,257	0.068	0.074	0.034	0.039	−1.947*	−5.976***
DA	4,546	2,257	0.077	0.071	0.052	0.049	3.666***	3.108***
DARISK	4,546	2,257	0.008	0.007	0.005	0.005	3.666***	3.108***
INRISK	4,546	2,257	0.061	0.066	0.027	0.033	−1.865*	−6.723***
LNMV	5,683	2,821	22.694	22.745	22.635	22.673	−2.573**	−2.701***
RETVOL	5,683	2,821	0.141	0.133	0.127	0.121	5.558***	5.706***
RETURN	5,683	2,821	0.273	0.182	0.054	−0.004	6.110***	4.571***
EBITDA	5,683	2,821	0.007	0.005	0.006	0.006	3.385***	2.157**
ACQ	5,683	2,821	0.179	0.187	0.000	0.000	−0.897	−0.897
RESTRU	5,683	2,821	0.236	0.192	0.000	0.000	5.068***	5.062***
DIFF	5,683	2,821	0.678	−0.346	0.643	−0.304	170.431***	82.746***
SDROA	4,578	2,274	0.027	0.029	0.018	0.020	−2.501***	−5.934***
AQ	3,392	1,670	0.153	0.130	0.079	0.072	4.197***	4.069***

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

Panel C Distribution of audit opinions

Year		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Observations		388	486	556	689	820	969	1,098	1,254	1,499	1,714	1,932	11,405
Unmodified opinions		369	463	533	671	803	954	1,074	1,229	1,472	1,684	1,886	11,138
Unmodified opinions with explanatory paragraphs		16	17	19	15	14	10	14	19	24	19	25	192
Modified opinions	Qualified opinions	2	3	0	3	3	4	7	4	2	6	16	50
	Adverse opinions and disclaimers of opinions	1	3	4	0	0	1	3	2	1	5	5	25

Panel D Audit opinions and impaired clients

	Observations	Unmodified opinions	Unmodified opinions with explanatory paragraphs	Qualified opinions	Adverse opinions and disclaimers of opinions
Impaired firms	3,760 (33%)	3,608 (32%)	103 (54%)	32 (64%)	17 (68%)
Unimpaired firms	7,645 (67%)	7,530 (68%)	89 (46%)	18 (36%)	8 (32%)
Total	11,405 (100%)	11,138 (100%)	192 (100%)	50 (100%)	25 (100%)

with explanatory paragraphs (we classify the latter as modified opinions in our empirical analysis). In each year, adverse opinions and disclaimers of opinions are rarely issued. We further compare the distribution of audit opinions between impaired and unimpaired firms. Panel D shows that 68% of the unmodified opinions were issued to unimpaired firms. Consistently, auditors issued more modified opinions to impaired clients. In addition, we observe a large increase in the amount of goodwill, goodwill impairments, and impaired firms between 2007 and 2017 (see Figs. 1–3). In Appendices 2–4, we detail the distribution of impaired firms, the amount of goodwill, and the amount of goodwill impairments in different industries. Industries with a large amount of goodwill are conservative in recognizing impairments, and industries with a large amount of impairments are aggressive in impairing goodwill.

Table 3 shows the correlation coefficient matrix of all of the variables used in Eq. (1). We observe a significant and positive association between goodwill impairments and the probability of receiving modified audit opinions. Information risks, earnings management risks, and economic fundamental risks are all positively related to modified audit opinions and goodwill impairments, except that the association between earnings management risks and goodwill impairments is not significant. In addition, the type of audit opinion received

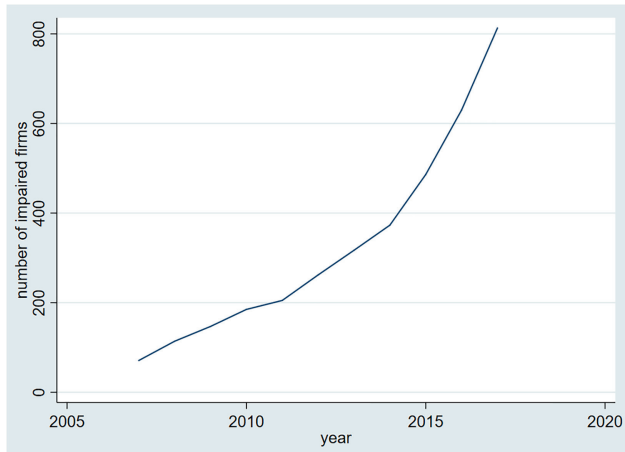

Fig. 1. Number of impaired firms.

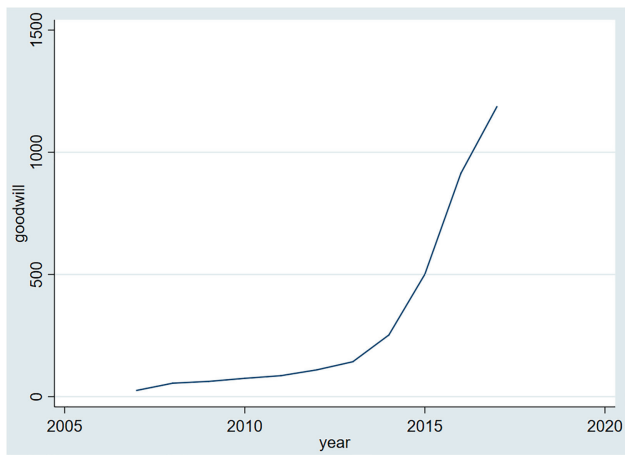

Fig. 2. Magnitude of goodwill (unit: billion yuan).

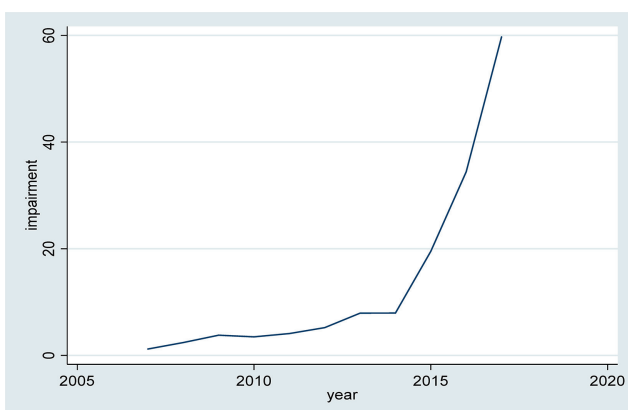

Fig. 3. Magnitude of goodwill impairment (unit: billion yuan).

Table 3
Correlation coefficient matrix.

	OPINION	IMPAIR	LAGOP	LOSS	LNTA	AGE	GROWTH	SOE	LEV	ROA	COST	BIG4	HARD	SP	OCF	CAPINTEN	VOL	DARISK
IMPAIR	**0.13**																	
LAGOP	**0.45**	**0.10**																
LOSS	**0.20**	**0.19**	**0.13**															
LNTA	**−0.07**	**−0.14**	**−0.07**	**−0.08**														
AGE	**0.03**	**−0.04**	**0.05**	**0.03**	**0.28**													
GROWTH	**−0.02**	**−0.04**	−0.02	**−0.17**	0.01	0.00												
SOE	0.00	**−0.09**	0.01	**0.05**	**0.28**	**0.38**	**−0.04**											
LEV	**0.07**	**−0.08**	**0.06**	**0.13**	**0.49**	**0.30**	**−0.03**	**0.25**										
ROA	**−0.17**	**−0.17**	**−0.10**	**−0.57**	−0.01	**−0.09**	**0.17**	**−0.09**	**−0.35**									
COST	−0.02	**−0.03**	−0.01	**−0.02**	**0.76**	**0.23**	0.00	**0.18**	**0.31**	−0.02								
BIG4	**−0.03**	**−0.03**	**−0.03**	**−0.03**	**0.38**	**0.07**	−0.00	**0.16**	**0.12**	**0.05**	**0.50**							
HARD	**−0.03**	**−0.03**	**−0.04**	**−0.03**	**0.04**	**−0.04**	0.01	**−0.12**	**0.30**	**−0.08**	**−0.02**	**−0.06**						
SP	**0.02**	0.00	0.00	**−0.06**	**−0.03**	0.01	**−0.05**	**0.03**	**−0.02**	**−0.16**	**−0.02**	**−0.03**	**−0.03**					
OCF	**−0.06**	−0.02	**−0.05**	**−0.15**	**−0.02**	−0.01	**0.03**	**0.03**	**−0.18**	**0.40**	0.02	**0.10**	**−0.31**	**−0.08**				
CAPINTEN	**0.08**	**0.07**	**0.09**	**0.12**	−0.00	**0.08**	−0.01	**−0.07**	**−0.07**	**−0.20**	**−0.08**	**−0.06**	**−0.07**	**0.11**	**−0.23**			
VOL	**0.21**	**0.08**	**0.22**	**0.22**	**−0.05**	**0.11**	**−0.05**	**0.05**	**0.21**	**−0.19**	0.00	−0.02	**0.02**	−0.00	**−0.07**	**0.03**		
DARISK	**0.05**	0.01	**0.05**	**0.03**	−0.00	0.02	**0.06**	−0.02	**0.07**	**0.02**	**−0.04**	**−0.03**	**0.12**	**−0.05**	**−0.25**	**0.08**	**0.11**	
INRISK	**0.20**	**0.08**	**0.22**	**0.22**	**−0.05**	**0.11**	**−0.05**	**0.06**	**0.21**	**−0.19**	0.00	−0.02	0.02	0.00	**−0.05**	**0.03**	**0.10**	**0.05**

Notes: This table shows the Pearson correlation coefficients of the variables used in Eq. (1). Coefficients that are significant at the 5% level are shown in bold.

Table 4
H1—Goodwill impairments and modified opinions.

	Dependent variable = OPINION	
	(1)	(2)
IMPAIR	54.247***	21.644***
	(9.586)	(2.875)
LAGOP		3.423***
		(12.379)
COST		0.303
		(1.364)
BIG4		−0.223
		(−0.394)
HARD		−1.862***
		(−2.818)
LOSS		0.934***
		(2.660)
SP		0.976***
		(2.762)
OCF		−2.158
		(−1.584)
CAPINTEN		0.058*
		(1.768)
LNTA		−0.448***
		(−3.290)
AGE		0.042
		(0.235)
GROWTH		0.012
		(0.829)
SOE		−0.297
		(−1.184)
LEV		2.947***
		(5.764)
ROA		−6.443***
		(−2.736)
cons	−2.470***	0.711
	(−3.646)	(0.311)
Year	Yes	Yes
Industry	Yes	Yes
Obs.	8,504	8,504
Pseudo R^2	0.102	0.416

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

in the previous period is positively related to that in the current period. Loss, firm age, leverage, and capital intensity are positively related to the probability of receiving a modified opinion. Firm size, profitability, auditor expertise, audit difficulty, and operating cash flows are negatively related to modified opinions. Overall, these results are consistent with our expectations.

4.2. Empirical analysis

Table 4 presents the results for H1. The independent variable *IMPAIR* is the ratio of goodwill impairments to total assets. The dependent variable *OPINION* equals 1 for modified opinions and unmodified opinions with explanatory paragraphs. In column (1), we find a statistically and economically significant and positive association between *IMPAIR* and *OPINION* without control variables. Similarly, the association is not altered in column (2), in which we add the control variables that have been documented in the literature as influencing audit opinions and goodwill impairments. When the amount of goodwill impairments increases by 1%, the marginal probability of receiving a modified opinion increases by 34.1%. Auditors perceive the

Table 5
Panel A H2—The mediating effect of VOL.

	(1) OPINION	(2) VOL	(3) OPINION
IMPAIR	18.897**	0.956***	18.467**
	(2.328)	(3.785)	(2.315)
VOL			0.880**
			(2.298)
LNTA	−0.525***	−0.026***	−0.454***
	(−3.448)	(−9.623)	(−2.842)
LOSS	0.904**	0.081***	0.975**
	(2.273)	(8.250)	(2.523)
LEV	2.763***	0.220***	2.318***
	(4.805)	(11.424)	(3.952)
ROA	−6.611**	0.054	−5.751**
	(−2.555)	(0.891)	(−2.382)
BIG4	−0.514	0.018***	−0.496
	(−0.760)	(2.842)	(−0.737)
AGE	−0.067	0.023***	−0.077
	(−0.273)	(6.907)	(−0.310)
GROWTH	0.010	−0.000	0.011
	(0.589)	(−0.230)	(0.674)
SOE	−0.258	0.001	−0.310
	(−0.910)	(0.335)	(−1.084)
LAGOP	3.454***		3.386***
	(11.039)		(10.936)
COST	0.418*		0.353
	(1.704)		(1.417)
HARD	−1.549**		−1.575**
	(−2.269)		(−2.302)
SP	0.950**		0.995**
	(2.436)		(2.527)
OCF	−0.852		−0.864
	(−0.527)		(−0.547)
CAPINTEN	0.030		0.027
	(0.773)		(0.692)
cons	1.217	0.497***	0.764
	(0.479)	(9.194)	(0.302)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Obs.	6,803	6,803	6,803
Pseudo R^2/ R^2	0.384	0.146	0.386
Sobel test			1.965**
Aroian test			1.917*
Goodman test			2.017**

For columns (1) and (3), robust z-statistics are given in brackets; for column (2), robust t-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Panel B H2—The mediating effects of DARISK and INRISK

	(1) OPINION	(2) DARISK	(3) OPINION	(4) INRISK	(5) OPINION
IMPAIR	18.897**	0.029**	24.996***	0.188	19.665**
	(2.328)	(2.256)	(2.928)	(0.430)	(2.424)
DARISK			0.382**		
			(2.477)		
INRISK					0.885**
					(2.256)
LNTA	−0.525***	−0.000	−0.469***	−0.030***	−0.456***

(*continued on next page*)

Table 5 (*continued*)

Panel B H2—The mediating effects of DARISK and INRISK

	(1) OPINION	(2) DARISK	(3) OPINION	(4) INRISK	(5) OPINION
	(−3.448)	(−0.242)	(−3.328)	(−5.326)	(−2.870)
LOSS	0.904**	0.003***	0.988***	0.027***	1.001**
	(2.273)	(6.801)	(2.814)	(3.251)	(2.553)
LEV	2.763***	0.003***	2.652***	0.197***	2.318***
	(4.805)	(4.498)	(5.787)	(5.772)	(3.978)
ROA	−6.611**	0.019***	−5.917***	−0.074	−5.447**
	(−2.555)	(5.725)	(−2.644)	(−1.144)	(−2.292)
BIG4	−0.514	−0.001***	−0.370	0.005	−0.504
	(−0.760)	(−3.882)	(−0.379)	(0.305)	(−0.737)
AGE	−0.067	−0.000	0.018	0.041***	−0.090
	(−0.273)	(−0.182)	(0.175)	(6.597)	(−0.330)
GROWTH	0.010	0.000***	0.015	−0.001	0.012
	(0.589)	(2.777)	(0.835)	(−1.643)	(0.666)
SOE	−0.258	−0.001***	−0.097	−0.008	−0.296
	(−0.910)	(−2.633)	(−1.155)	(−0.882)	(−1.075)
LAGOP	3.454***		3.567***		3.380***
	(11.039)		(12.267)		(10.715)
COST	0.418*		0.281		0.358
	(1.704)		(1.463)		(1.451)
HARD	−1.549**		−2.086***		−1.603**
	(−2.269)		(−2.829)		(−2.336)
SP	0.950**		1.008***		1.006**
	(2.436)		(2.908)		(2.555)
OCF	−0.852		−2.347*		−0.845
	(−0.527)		(−1.803)		(−0.541)
CAPINTEN	0.030		0.048		0.031
	(0.773)		(1.286)		(0.764)
cons	1.217	0.010***	1.233	0.593***	0.773
	(0.479)	(4.308)	(0.185)	(5.331)	(0.293)
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Obs.	6,803	6,803	6,803	6,803	6,803
Pseudo R^2/ R^2	0.384	0.131	0.403	0.157	0.387
Sobel test			1.668*		0.423
Aroian test			1.598		0.392
Goodman test			1.748*		0.463

For columns (2) and (4), robust t-statistics are given in brackets; for columns (1), (3), and (5), robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 6
Endogeneity—Propensity score matching (PSM).

Panel A Balancing test

Variable	Obs.	Unmatched	*M*		% reduct		*t*-test	
		Matched	Treated	Control	%bias	|bias|	*t*	$p > \|t\|$
LAGOP	8,445	U	0.031	0.017	9.4	91.8	4.76	0.000
		M	0.026	0.025	0.8		0.31	0.757
LOSS	8,445	U	0.105	0.052	19.5	96.6	9.86	0.000
		M	0.089	0.088	0.7		0.26	0.797
LNTA	8,445	U	22.328	22.323	7.6	81.2	3.67	0.000
		M	22.34	22.358	−1.4		−0.58	0.563
AGE	8,445	U	2.310	2.108	30.6	85.6	14.30	0.000
		M	2.302	2.332	−4.4		−1.91	0.056

(*continued on next page*)

Table 6 (*continued*)

Panel A Balancing test								
Variable	Obs.	Unmatched	*M*		% reduct		*t*-test	
		Matched	Treated	Control	%bias	|bias|	*t*	$p > \|t\|$
GROWTH	8,445	U	0.040	0.038	0.1	−4235.3	0.03	0.987
		M	0.019	-0.077	2.4		0.96	0.339
SOE	8,445	U	0.397	0.387	1.9	56.0	0.93	0.354
		M	0.399	0.403	−0.8		−0.35	0.728
LEV	8,445	U	0.457	0.443	6.6	80.1	3.15	0.002
		M	0.455	0.457	−1.3		−0.54	0.589
ROA	8,445	U	0.034	0.046	–23.7	98.3	−11.66	0.000
		M	0.037	0.037	−0.4		−0.17	0.862
COST	8,445	U	13.918	13.709	27.8	98.6	13.47	0.000
		M	13.91	13.913	−0.4		−0.15	0.878
BIG4	8,445	U	0.077	0.057	8.9	92.0	4.38	0.000
		M	0.078	0.077	0.7		0.27	0.785
HARD	8,445	U	0.267	0.271	−2.0	−40.5	−0.97	0.331
		M	0.268	0.263	2.9		1.17	0.241
SP	8,445	U	0.042	0.039	1.8	−9.3	0.86	0.389
		M	0.043	0.046	−2.0		−0.77	0.443
OCF	8,445	U	0.042	0.043	−1.5	3.9	−0.71	0.475
		M	0.043	0.044	−1.4		−0.59	0.555
CAPINTEN	8,445	U	2.604	2.480	5.5	89.8	2.73	0.006
		M	2.577	2.565	0.6		0.23	0.820

Panel B PSM	
	OPINION
IMPAIR	25.560***
	(3.025)
cons	1.093
	(0.401)
Control variables	Yes
Year	Yes
Industry	Yes
Obs.	5,328
Pseudo R^2	0.422

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

goodwill impairments of clients as a signal of information risks and are concerned about the quality of their financial reports. Hence, they express these concerns in the form of modified opinions to avoid reputational damage or litigations. Consistent with our expectations, we find that firms are more likely to receive modified opinions when they are smaller, received a modified opinion in the previous year, post a loss or small profit, or have higher leverage ratios or lower returns. Nonetheless, auditors may put more effort into auditing clients with more accounts receivable and inventory on hand, resulting in a negative relationship between *OPINION* and *HARD*.

In Table 5, Panel A shows the results from testing the mediating effect of total information risks. First, goodwill impairments are significantly and positively related to the probability of receiving a modified opinion, as shown in column (1). Second, there is a significant and positive relationship between goodwill impairments and total information risks (*VOL*) in column (2). Third, *VOL* is positively related to the probability of receiving a modified opinion with the presence of goodwill impairments, as reported in column (3). Last, the Z-statistic of the Sobel test is significant at the 5% level, indicating that total information risks have a mediating effect.

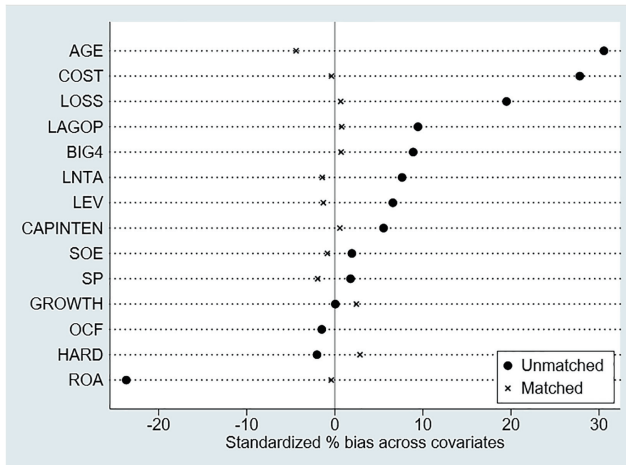

Fig. 4. Standardized bias of covariates.

Table 7
Endogeneity—Instrumental variable.

	First stage regression (1) Dependent variable = IMPAIR	Second stage regression (2) Dependent variable = OPINION
IMPAIR		4.958**
		(2.278)
LAGOP	0.004***	0.426***
	(7.854)	(12.554)
LOSS	0.003***	0.049***
	(8.303)	(3.898)
LNTA	−0.001***	−0.009***
	(−11.467)	(−2.600)
AGE	0.001***	−0.004
	(7.012)	(−1.480)
GROWTH	−0.000	0.001*
	(−1.439)	(1.907)
SOE	−0.001***	0.001
	(−5.434)	(0.198)
LEV	−0.002***	0.089***
	(−4.023)	(6.184)
ROA	−0.018***	−0.066
	(−8.948)	(−0.835)
COST	0.001***	0.001
	(9.173)	(0.314)
BIG4	−0.000	0.004
	(−0.193)	(0.833)
HARD	−0.000	−0.043***
	(−0.616)	(−4.184)
SP	−0.000	0.016*
	(−1.232)	(1.698)
OCF	0.004***	−0.042
	(4.019)	(−1.360)
CAPINTEN	0.000***	0.002*
	(3.572)	(1.859)
IV	0.004***	
	(8.342)	
cons	0.007***	0.160***

(*continued on next page*)

Table 7 (*continued*)

	First stage regression (1) Dependent variable = IMPAIR	Second stage regression (2) Dependent variable = OPINION
	(4.156)	(4.558)
Year	Yes	Yes
Industry	Yes	Yes
Obs.	8,504	8,504
Pseudo R^2/R^2	0.089	0.251
Kleibergen–Paap F statistic	32.098	

For column (1), robust t-statistics are given in brackets; for column (2), robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 8
Robustness—Alternative measures.

	(1) OPINION	(2) OPINION	(3) OPINION2
GISALES	5.251**		
	(2.119)		
GIE		11.876***	
		(3.287)	
IMPAIR			20.351**
			(2.198)
cons	Yes	Yes	Yes
Control variables	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Obs.	8,504	8,504	8,504
Pseudo R^2	0.414	0.417	0.343

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 9
Robustness—Material impairments.

	OPINION
IMPAIR	30.466***
	(2.715)
cons	−6.910
	(−1.424)
Control variables	Yes
Year	Yes
Industry	Yes
Obs.	1,041
Pseudo R^2	0.495

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Panel B shows the results from testing the mediating effects of information risks related to earnings management and to economic fundamentals. The results in columns (1)–(3) imply that information risks related to earnings management (*DARISK*) play a mediating role. However, we find a positive but non-significant association between impairments and information risks related to economic fundamentals (*INRISK*) in column (4)

Table 10
Robustness—Mediating effects.

Panel A Alternative measure of performance volatility

	(1) OPINION	(2) DARISK2	(3) OPINION	(4) INRISK2	(5) OPINION
IMPAIR	21.645***	0.018***	23.454***	0.317***	18.483**
	(2.875)	(3.857)	(2.763)	(3.076)	(2.756)
DARISK2			34.512**		
			(2.380)		
INRISK2					0.856**
					(2.418)
cons	0.715	0.006***	0.160	0.237***	0.103
	(0.313)	(8.033)	(0.071)	(4.635)	(0.046)
Control variables	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Obs.	6,852	6,852	6,852	6,852	6,852
Pseudo R^2/R^2	0.416	0.128	0.406	0.078	0.386
Sobel test			2.026**		1.901*
Aroian test			1.978**		1.842*
Goodman test			2.077**		1.966*

For columns (2) and (4), robust t-statistics are given in brackets; for columns (1), (3), and (5), robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Panel B Alternative measures of information risks

	(1) OPINION	(2) INNATEAQ	(3) OPINION	(4) DISCAQ	(5) OPINION
IMPAIR	21.374***	1.092	26.116**	3.116**	27.646**
	(2.735)	(0.361)	(2.098)	(2.324)	(2.061)
INNATEAQ			0.060		
			(0.312)		
DISCAQ					0.106**
					(2.452)
cons	0.633	1.732***	0.129	−1.144***	0.535
	(0.273)	(4.224)	(0.146)	(−3.540)	(0.176)
Control variables	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Obs.	5,062	5,062	5,062	5,062	5,062
Pseudo R^2/ R^2	0.436	0.065	0.511	0.172	0.507
Sobel test			0.236		1.687*
Aroian test			0.102		1.617
Goodman test					1.766*

For columns (2) and (4), robust t-statistics are given in brackets; for columns (1), (3), and (5), robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

and a non-significant Z-statistic of the Sobel test in column (5).[1] Thus, the risks related to economic fundamentals are not a mediator. These findings may indicate that impairment does not represent the genuine reaction of clients to an economic downturn or reflect poor performance after an acquisition. Rather, goodwill is impaired due to managerial incentives to manipulate earnings. Earnings management increases the risk of

[1] We regress economic fundamental risks on material goodwill impairments (i.e., goodwill impairments that are greater than 0.5% of sales revenue). The untabulated results show a significant and positive association between material goodwill impairments and all three measures of economic fundamental risks (i.e., *INRISK*, *INRISK2*, and *INNATE*), providing evidence that a larger amount of goodwill impairments reflects higher information risks related to economic fundamentals.

Table 11
Robustness—Control for impairments in the prior year.

OPINION	(1)	(2)
IMPAIR		22.336**
		(2.353)
LGI	8.600	−1.986
	(0.916)	(−0.195)
cons	1.439	1.230
	(0.564)	(0.467)
Control variables	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
Obs.	7,200	7,200
Pseudo R^2	0.416	0.420

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 12
Robustness—Multicollinearity.

OPINION	(1)	(2)
IMPAIR	21.644***	21.644***
	(2.875)	(2.875)
LNTA	−0.448***	
	(−3.290)	
AGE	0.042	
	(0.235)	
LEV	2.947***	
	(5.764)	
COST	0.303	
	(1.364)	
LNTASD		−0.565***
		(−3.290)
AGESD		0.029
		(0.235)
LEVSD		0.608***
		(5.764)
COSTSD		0.228
		(1.364)
Control variables	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
Obs.	8,504	8,504
Pseudo R^2	0.416	0.416

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

material misstatements in financial reports, which may result in unreliable information that misleads investors. Hence, auditors tend to issue modified opinions to communicate their concerns about financial reporting quality. As for risks related to economic fundamentals, auditors will not issue a modified opinion if they are satisfied with the going concern basis of accounting for the relevant period.

Overall, we posit that (1) the association between goodwill impairments and modified opinions is driven primarily by risks related to earnings management; and (2) in auditing goodwill impairments, auditors focus more on ‘‘procedural justice” (whether the client engages in earnings management, such that the financial

information is unreliable and misstated) than on "substantive justice" (whether there are systemic risks associated with the industry's operating environment or macroeconomic conditions).

4.3. Endogeneity

The association between goodwill impairments and modified audit opinions has a potential endogeneity issue, which implies that regression (1) could suffer from reverse causality. Unobserved audit characteristics may affect impairment decisions. We use two approaches to address this concern. First, we use propensity score matching (one-to-one nearest neighbor matching with a caliper of 0.05 and no replacement) to match impaired firms with unimpaired firms based on the control variables in model (1). The standardized biases of all of the covariates are significantly reduced to 4% after matching, and the *t*-test results do not reject the hypothesis that the treatment and control groups are systemically indifferent (see Table 6, Panel A and Fig. 4). We then keep the matched sample (i.e., *_weight*==1) and run model (1) again. In doing so, we mitigate noise from other factors and ensure that differences in outcomes are primarily driven by variations in the amount of goodwill impairments. In Table 6, Panel B shows the results of model (1) using the matched sample. The significant and positive relationship between the dependent and independent variables still exists.

Second, we use the current impairment recognized by peer firms within the same industry as the instrumental variable (IV). On the one hand, peer firms' goodwill impairments may indicate the economic environment or managerial incentives at the industry level, and consequently affect the amount of goodwill impairments recorded by other industry peers (satisfying the inclusion criterion). On the other hand, there is little evidence that the impairment of peer firms is directly related to modified audit opinions of other industry peers in the same financial year (satisfying the exclusion criterion). The results of our IV regression are reported in Table 7. There is a significant and positive relationship between the IV and goodwill impairments in the first-stage regression. The Kleibergen–Paap Wald F-statistic test for a weak instrument reveals an F-statistic of 32, which is much greater than 10 (Stock and Yogo, 2005). Thus, we believe that the IV is valid. We still find a significant and positive relationship between the instrumented impairments and modified opinions in the second-stage regression. Overall, the IV regression confirms the robustness of the association between goodwill impairments and the probability of receiving a modified audit opinion after controlling for endogeneity.

4.4. Robustness tests

First, we use alternative measures for the dependent and independent variables. In particular, we replace the independent variable *IMPAIR* with *GISALES* (*GIE*), the ratio of goodwill impairments to sales revenue (total shareholders' equity). Columns (1) and (2) of Table 8 report the results of Eq. (1) using the alternative

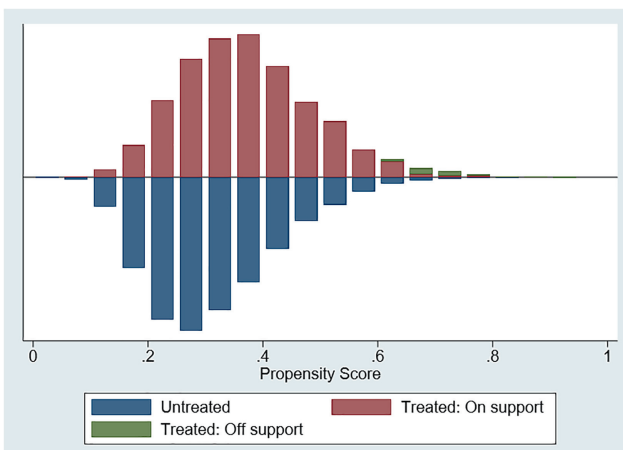

Fig. 5. Propensity scores.

independent variables. The significant and positive association between impairments and modified opinions still exists. We also replace the dependent variable *OPINION* with *OPINION2*, which equals 1 for unmodified opinions, 2 for unmodified opinions with explanatory paragraphs, 3 for modified opinions, and 4 for adverse opinions or disclaimers of opinions. Using the ordered probit model (1), we find a significant and negative average marginal effect when unmodified opinions are issued, and positive marginal effects in the other scenarios (unreported). In general, the selection of proxies does not drive our results.

Following Ayres et al. (2019), we focus on goodwill impairments that are greater than 0.5% of sales revenue. Therefore, the number of observations is greatly reduced. In Table 9, the significant and positive coefficient of *IMPAIR* implies that auditors are more conservative in issuing unmodified opinions when clients record a significant amount of goodwill impairments.

In the baseline regression, we measure the variations in firm performance across different accounting periods (vertical comparison) rather than the volatility between firms (horizontal comparison). Here, we calculate the performance volatility as the 5-year standard deviation of return on assets (*SDROA*) from *t-4* to *t* (Adams et al., 2005; Cheng, 2008; Quan and Wu, 2010). Again, we perform the three-step process to test the mediating effects. We provide the results for the mediating effects of earnings management risks in columns (2) and (3) of Table 10, Panel A, which are in line with the results reported in Table 5.

Table 13
Cross-sectional tests.

Panel A The auditor–client relationship

	Dependent variable = OPINION					
	(1) Mismatch = 0	(2) Mismatch = 1	(3) Misdown = 0	(4) Misdown = 1	(5) Misup = 0	(6) Misup = 1
IMPAIR	21.968*	17.824	26.334***	57.446	15.427	23.886**
	(1.832)	(1.548)	(3.369)	(1.576)	(1.280)	(2.167)
cons	−0.091	0.042	−0.877	4.821	−0.839	0.244
	(−0.023)	(0.015)	(−0.357)	(0.762)	(−0.222)	(0.082)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	2,865	4,472	6,180	1,157	2,875	4,462
Pseudo R^2	0.526	0.423	0.415	0.634	0.511	0.424
Chi^2		2.84*		10.26***		3.29*

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Panel B Auditor industry expertise

	Dependent variable = OPINION	
	(1) IMSD = 1	(2) IMSD = 0
IMPAIR	29.470**	19.867
	(2.204)	(0.432)
cons	2.393	−4.940
	(0.207)	(−1.279)
Control variables	Yes	Yes
Year	Yes	Yes
Industry	Yes	Yes
Obs.	2,817	4,520
Pseudo R^2	0.336	0.560
Chi^2		3.03*

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

We address the concern that the mediating effects documented in Table 5 are driven by the selection of specific measures by replacing the proxies for earnings management risks and economic fundamental risks with those used in Francis et al. (2005). First, we calculate information risks (accruals quality, AQ) as the standard deviation of the residual value of the DD model (Dechow et al., 1995) from year *t-4* to year *t*. Second, we use the following specification to compute the information risks related to economic fundamentals and earnings management:

$$AQ_{i,t} = \alpha + \beta_1 LNTA_{i.t} + \beta_2 \sigma(OCF)_{i.t} + \beta_3 \sigma(SALE)_{i.t} + \beta_4 OperCycle_{i.t} + \beta_5 NegEarn_{i.t} + \varepsilon_{i,t}$$

The predicted value of AQ represents the information risks related to economic fundamentals ($INNATEAQ$). The residual value is the discretionary portion of information risks ($DISCAQ$). Appendix A1 includes the definitions of these variables. Finally, we repeat the three steps described in Section 3.2 to examine the mediating role of $INNATEAQ$ and $DISCAQ$. In Table 10, Panel B, we find results similar to those reported in Table 5. Although both types of information risk are positively associated with goodwill impairment, only information risks related to earnings management play a mediating role (see columns (4) and (5)).[2]

We are interested in the time-lag effects of impairments (see Table 11); that is, whether lagged goodwill impairments (LGI) affect current audit opinions. First, we replace $IMPAIR$ with LGI in Eq. (1). Second, we include LGI as a control variable. In both cases, the main results remain unchanged. Therefore, the exclusion of lagged impairments from Eq. (1) does not alter the results in Table 4.

In the correlation coefficient matrix, several variables exhibit significant correlations with almost all of the other variables. Therefore, we conduct a collinearity diagnosis. First, we calculate the variance inflation factor (VIF) of each variable in Eq. (1). We find that 4 out of 14 variables have a VIF over 10 (i.e., $LNTA$, AGE, LEV, and $COST$). Second, we standardize these variables and run model (1) using the standardized variables. Column (1) of Table 12 shows the results of the baseline regression. The documented association is not altered by the standardization of the variables, as shown in column (2). Last, we consider the monitoring role that corporate governance plays in reducing earnings management when making impairment decisions (Ye et al., 2016). In an untabulated test, we control for the ratio of independent directors (IND), shares owned by the largest shareholder ($HOLD$), CEO turnover ($LEAVE$), and duality of CEO and chairperson ($DUAL$) in Eq. (1). The results remain the same (see Fig. 5).

5. Further discussion

5.1. Cross-sectional tests

Above, we examined the association between goodwill impairments and the probability of receiving a modified audit opinion, and the mechanisms underlying this association. In this section, we explore how the auditor–client relationship and auditor industry expertise affect the positive association between impairments and modified opinions.

The auditor–client pair should be stable because the clients of large audit firms have significantly different characteristics from those of small audit firms (Bills, 2012). Nonetheless, the relationship is more dynamic in reality. The audit–client pair may be reconstructed if audit firms actively change their targeted clients during certain phases of development, or if clients change auditors to meet their own needs (Johnson and Lys, 1990). An upward clientele-mismatch occurs when a client with characteristics that suit a small audit firm employs a large audit firm. A downward clientele-mismatch occurs when a client with characteristics that suit a large audit firm employs a small audit firm. The second clientele-mismatch may influence whether auditors are able (or willing) to identify opportunistic earnings manipulation and objectively report financial misstatements (Watts and Zimmerman, 1983). Moreover, a downward mismatch is related to lower audit fees, higher earnings management, and lower accounting conservatism (Dong et al., 2018; Wang et al., 2020). We use the following model to construct the clientele-mismatch variable (Shu, 2000; Wang et al., 2020):

[2] We also use the three-step method to test the mediating effect of total information risks (i.e., $SDROA$ and AQ). The untabulated results are similar to those reported in Table 5, Panel A.

$$Big10 = \alpha + \beta_1 LNTA_{i,t} + \beta_2 LEV_{i,t} + \beta_3 ATURN_{i,t} + \beta_4 CR_{i,t} + \beta_5 ROA_{i,t} + \sum IND + \sum YEAR + \varepsilon,$$

where *Big10* equals 1 if the client is audited by a Big 10 audit firm, and 0 otherwise (the list of Big 10 audit firms can be found on the website of the Chinese Institute of Certified Public Accountants), *ATURN* is the turnover of total assets, and *CR* is the current ratio. The fitted value of *Big10* represents the probability that a client will employ a Big 10 audit firm (*Prob10*). We then calculate the optimal cutoff value that minimizes the sample misclassification rates for each year. Last, we define the related variables as follows:

Big10	*Prob10*	Mismatch	Misup (upward mismatch)	Misdown (downward mismatch)
1	<= cutoff value	1	1	0
0	> cutoff value	1	0	1
1	> cutoff value	0	0	0
0	<= cutoff value	0	0	0

The results are shown in Table 13, Panel A. A significant and positive association between impairments and modified audit opinions exists when there is (a) no mismatch between client and auditor (column (1)), (b) no downward mismatch (column (3)), or (c) an upward mismatch (column (6)). In these circumstances, the quality of the audit is higher. Auditors are more capable of detecting misstatements from earnings management and will issue appropriate opinions to maintain their reputation.

Auditors with industry expertise are perceived to have a better understanding of their client's operations and industry environment, to possess more professional skills, and to provide higher-quality audit services compared with non-experts (Fan et al., 2013; Zhao and Ni, 2020). We follow Krishnan (2003) and measure an auditor's industry market share (*IMS*) as the ratio of the total sales revenue of the clients of audit firm i in industry k to the total sales revenue of all clients in industry k. We define audit firm i as an expert in industry k ($IMSD = 1$) if its *IMS* is higher than 10%. Panel B shows the comparative results of $IMSD = 1$ and $IMSD = 0$. Consistently, auditors are more likely to issue a modified opinion if they are concerned with potential material misstatements in financial reports when they are an expert in the industry (column (1)). That is, audit firms with industry expertise are better at providing high-quality information and external monitoring for financial report users.

5.2. Further analysis

One previous study documents a positive association between differences in impairment decisions and auditors' dismissals (Ayres et al., 2019). Likewise, we consider whether these differences in impairment decisions affect the type of audit opinion that clients receive. Accordingly, we measure the appropriateness of the existence of goodwill impairments (*DIFF*) as the difference between actual impairment decisions and the predicted probability of impairment ($DIFF = DUMMY - IMPAIRS$). Here, *IMPAIRS* is the predicted value of the dependent variable of the following equation:

$$IMPAIRS_{it} = \beta_0 + \beta_1 LNMV_{it} + \beta_2 RETVOL_{it} + \beta_3 LOSS_{it} + \beta_4 LEV_{it} + \beta_5 ROA_{it} + \beta_6 EBITDA_{it} + \beta_7 RETURN_{it} + \beta_8 BIG4_{it} + \beta_9 RESTRU_{it} + \beta_{10} ACQ_{it} + INDUSTRY\_FE + YEAR\_FE + \varepsilon$$

The dependent variable *IMPAIRS* equals 1 if a client records goodwill impairments in the current period, and 0 otherwise (Ayres et al., 2019). The independent variables (Beatty and Weber, 2006; Hayn and Hughes, 2006; Gu and Lev, 2011; Ramanna and Watts, 2012) include the market value of equity (*LNMV*), volatility of stock returns (*RETVOL*), annual stock return (*RETURN*), earnings (*EBITDA*), restructuring costs (*RESTRU*), and acquisition (*ACQ*). Accordingly, *DIFF* is a continuous variable that takes a value between −1 and 1, where positive values indicate impairment decisions that are less favorable to clients (e.g., recognize an impairment that could not be recorded). Last, we regress *OPINION* on *DIFF* using Eq. (1). Appendix A1 gives the definitions of the variables.

Table 14
Panel A Predicted probability of impairment.

	IMPAIRS
LNMV	−0.036
	(−0.575)
LOSS	0.408***
	(3.126)
LEV	0.173
	(0.695)
ROA	−4.089***
	(−3.734)
ACQ	−0.254***
	(−3.640)
EBITDA	0.779
	(1.235)
RETURN	−0.038
	(−0.766)
RETVOL	−0.947*
	(−1.702)
BIG4	0.576***
	(2.825)
RESTRU	−0.192***
	(−3.253)
cons	−0.418
	(−0.305)
Year	Yes
Industry	Yes
Obs.	8,504
Pseudo R^2	0.058

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Panel B Further analysis

	Amount of goodwill impairments		Appropriateness of their existence
	(1)	(2)	(3)
OPINION	HGI = 0	HGI = 1	
DIFF			0.210
			(1.104)
IMPAIR	54.088	39.196***	
	(0.396)	(3.640)	
LAGOP	4.341***	2.238***	3.406***
	(4.277)	(4.327)	(12.420)
LOSS	1.882**	0.188	1.039***
	(2.028)	(0.358)	(4.430)
LNTA	−0.251	−0.778***	−0.438***
	(−0.903)	(−2.718)	(−3.268)
AGE	1.110	−0.709*	−0.033
	(1.408)	(−1.827)	(−0.189)
GROWTH	0.003	−0.039	0.008
	(0.073)	(−1.516)	(0.567)
SOE	−2.060***	0.665	−0.392
	(−2.897)	(1.559)	(−1.604)
LEV	4.333***	5.804***	2.635***
	(2.591)	(5.396)	(4.993)
ROA	−7.762	−6.018*	−8.362***
	(−1.014)	(−1.765)	(−4.737)
COST	−0.196	1.255**	0.290
	(−0.356)	(2.439)	(1.332)
BIG4	0.056	−0.216	−0.200
	(0.059)	(−0.291)	(−0.352)

(*continued on next page*)

Table 14 (*continued*)

Panel B Further analysis			
	Amount of goodwill impairments		Appropriateness of their existence
	(1)	(2)	(3)
HARD	−4.166**	−0.422	−1.615**
	(−1.986)	(−0.451)	(−2.378)
SP	0.977	1.146	0.441
	(2.147)	(1.628)	(1.293)
OCF	−3.646	1.563	−1.488
	(−1.031)	(0.544)	(−1.094)
CAPINTEN	0.036	0.165***	0.049
	(0.247)	(2.586)	(1.511)
cons	0.501	−5.218	0.733
	(0.081)	(−1.089)	(0.333)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Obs.	990	1,831	8,504
Pseudo R^2	0.586	0.511	0.412
Chi^2		3.43*	

Robust z-statistics are given in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Moreover, we distinguish auditors' reaction to the amount of goodwill impairments from their reaction to the appropriateness of the mere existence of goodwill impairments by running model (1) in groups with above-median ($HGI = 1$) and below-median ($HGI = 0$) impairments. In particular, we drop firms with zero impairments and then divide the remaining observations into subgroups according to the industry median.

Table 14 shows the results of the analysis. First, goodwill impairments are significantly and positively associated with the probability of receiving a modified opinion only when the impairments of clients are greater than the industry median (see column (2), Panel B), which is consistent with the results in Table 4. Second, we find a positive but non-significant association between impairment decision differences and the probability of receiving a modified opinion in column (3), Panel B. In an untabulated test, we divide the decision differences into those that are more favorable to clients ($DIFF = [-1, 0]$) and those that are more favorable to auditors ($DIFF = (0.1]$). Again, we do not find any significant association in these scenarios. In summary, we provide evidence that auditors are more sensitive to the amount of goodwill impairments than to the appropriateness of their mere existence. Disagreements between auditors and clients about impairment decisions may not be a major reason for the issuance of modified opinions.

6. Conclusions

Impairment accounting presents auditors with new challenges in applying professional skepticism to detect material misstatements in financial reports. In this study, we examine the relationship between goodwill impairments and modified opinions and the mechanisms underlying this association. This study enriches our understanding of auditors' reaction to information risks in the setting of goodwill auditing. Our results imply that auditors perceive goodwill impairment as a signal of information risks and focus more on "procedural justice" (whether the client engages in earnings management) than on "substantive justice" (whether there are systemic risks related to economic fundamentals). Unlike prior studies, our study examines the relationship between goodwill impairments and modified audit opinions from the perspective of investors. Investors' reliance on auditors for assurance of reporting quality places external pressure on auditors during their audit of goodwill impairments, and auditors face damage to their reputation or litigation if they fail to identify risks and issue inappropriate opinions. This study also has important implications for auditors and investors. Auditors should have a comprehensive understanding of the industry environment and the historical performance of their clients prior to the audit, and also maintain a high level of professional skepticism in auditing goodwill, so that audit resources can be efficiently used to improve audit quality. Investors should be more prudent in relying on audit opinions to mitigate mispricing problems. A limitation of this research is that

we do not explore the negotiations between auditors and clients regarding goodwill impairments before the issuance of audit opinions. Future research could provide more analysis in this area.

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.

Acknowledgement

For helpful comments, we are grateful to Qingyuan Li, Mengmeng Guo, we also thank Siming Yu for comments on revisions. The views expressed herein are those of the authors and do not necessarily reflect the views of Economics and Management school of Wuhan University.

Appendix. See Tables A1–A4.

Table A1
Variable definitions.

Dependent variables	
OPINION	Indicator variable, which equals 1 for modified opinions and unmodified opinions with explanatory paragraphs, and 0 otherwise.
OPINION2	Indicator variable, which equals 1 for unmodified opinions, 2 for unmodified opinions with explanatory paragraphs, 3 for modified opinions, and 4 for adverse opinions or disclaimers of opinions.
AQ	Alternative measure of information risks, calculated as the 5-year (*t-4* to *t*) standard deviation of the residuals from the DD model (Dechow et al., 1995).
SDROA	Alternative measure of performance volatility, calculated as the 5-year standard deviation of return on assets from year *t-4* to year *t*.
VOL	Performance volatility, measured as the 3-year standard deviation of return on equity from year *t-2* to year *t*.
Independent variables	
DA	Proxy for earnings management, which is computed using the formula of Kothari et al. (2005): $\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1 \frac{1}{A_{i,t-1}} + \alpha_2[\frac{\Delta REV_{i,t}}{A_{i,t-1}}] + \alpha_3 \frac{PPE_{i,t}}{A_{i,t-1}} + \alpha_4 \frac{ROA_{i,t}}{A_{i,t-1}} + \varepsilon$ $A_i$represents a firm's total assets in year *t-1*; ΔREV_irepresents its operating revenue in year *t*; PPE_i is the amount of current property, plant, and equipment; andROA_i is its return on assets in year *t*.
DARISK	Risks related to earnings management, measured as $\beta_1 DA_{it}$ using the following equation: $VOL_{it} = \beta_0 + \beta_1 DA_{it} + \beta_2 LEV_{it} + \beta_3 GROWTH_{it} + \beta_4 OCF_{it} + \beta_5 LNTA_{it} + \beta_6 SOE_{it} + \beta_7 HOLD_{it} + \beta_8 IND_{it} + \beta_9 LEAVE_{it} + \beta_{10} DUAL_{it} + INDUSTRY\_FE + YEAR\_FE + \varepsilon$
DARISK2	Alternative proxy for risks related to earnings management in which information risks are calculated as the 5-year standard deviation of return on assets from year *t-4* to year *t*.
DIFF	The difference between actual impairment decisions (*DUMMY*) and the predicted probability of impairment (*IMPAIRS*). *IMPAIRS* is the fitted value of the dependent variable of the following equation: $IMPAIRS_{it} = \beta_0 + \beta_1 LNMV + \beta_2 LOSS + \beta_3 LEV + \beta_4 ROA + \beta_5 ACQ + \beta_6 EBITDA + \beta_7 RETRUN + \beta_8 RETVOL + \beta_9 BIG4 + \beta_{10} RESTRU + INDUSTRY\_FE + YEAR\_FE + \varepsilon$

(*continued on next page*)

Table A1 (*continued*)

DISAQ	Alternative proxy for risks related to earnings management, calculated as the residuals of the following model: $AQ_{it} = \beta_0 + \beta_1 LNTA$ $+\beta_2\sigma(\text{OCF})$ $+\beta_3\sigma(\text{SALE}) + \beta_4 OperCycle$ $+\beta_5 NegEarn + \varepsilon$
DUMMY	Equals 1 if a goodwill impairment is recorded in year *t*, and 0 otherwise.
GIE	Alternative measure of goodwill impairments, calculated as the ratio of goodwill impairments to total shareholders' equity.
GISALES	Alternative measure of goodwill impairments, calculated as the ratio of goodwill impairments to sales revenue.
IMPAIR	Ratio of goodwill impairments to total assets at year end.
INRISK	Risks related to economic fundamentals, measured as the difference between performance volatility (*VOL*) and risks related to earnings management (*DARISK*).
INRISK2	Alternative proxy for risks related to economic fundamentals, in which information risks are calculated as the 5-year standard deviation of return on assets from year *t-4* to year *t*.
INNATEAQ	Alternative proxy for risks related to economic fundamentals, calculated as the predicted value of the dependent variable of the following model: $AQ_{it} = \beta_0 + \beta_1 LNTA + \beta_2\sigma$ $(\text{OCF}) + \beta_3\sigma(\text{SALE}) + \beta_4 OperCycle$ $+\beta_5 NegEarn + \varepsilon$
LGI	Goodwill impairments recognized in year *t-1*.
Control variables	
ACQ	Indicator variable, which equals 1 if the firm performed an acquisition to increase goodwill during the current year, and 0 otherwise.
AGE	Proxy for firm age, calculated as the natural logarithm of 1 plus the current year less the first observable year available in the CSMAR database.
BIG4	Equals 1 if the firm is audited by a Big 4 auditor, and 0 otherwise.
CAPEX	Capital expenditures divided by sales revenue in the prior year.
CAPINTEN	Capital concentration, calculated as the ratio of total assets to operating income.
COST	The natural logarithm of audit fees in year *t*.
DUAL	Equals 1 if the CEO and chair of the board are the same person, and 0 otherwise.
EBITDA	The ratio of the change in earnings before interest, taxes, depreciation, and amortization to the market value of equity.
GROWTH	Sales growth rate, measured as the change in sales revenue from year *t-1* to year *t* divided by sales revenue in year *t-1*.
HARD	Difficulty of audit work, measured as the sum of net accounts receivable and net inventory divided by total assets.
HOLD	The proportion of shares owned by the largest shareholder.
IND	Board independence, measured as the number of independent directors divided by the total number of directors.
LAGOP	Audit opinion received in year *t-1*. Equals 1 for modified opinions and unmodified opinions with explanatory paragraphs, and 0 otherwise.
LEAVE	Equals 1 if the CEO or chair of the board leave the firm during the year, and 0 otherwise.
LEV	Ratio of total debt to total assets at year end.
LNMV	Natural logarithm of the firm's market value of equity.
LNTA	Firm size, measured as the natural logarithm of total assets in year *t*.
LOSS	Equals 1 for firms with negative profit before extraordinary items, and 0 otherwise.
OCF	Ratio of net cash flow from operating activities to beginning total assets.
RESTRU	Equals 1 if restructuring costs are incurred during the current year, and 0 otherwise.
RETURN	Annual stock return when considering cash dividends and re-investment.
RETVOL	The standard deviation of the firm's stock return over the current year.
ROA	Return on assets, calculated as net income divided by total assets.
SOE	Equals 1 for state-owned enterprises, and 0 for non-state-owned enterprises.
SP	Equals 1 if the firm has a return on equity between 0 and 1%, and 0 otherwise.
σ(OCF)	The standard deviation of cash flows from operating activities from year *t-9* to year *t*.
σ(SALE)	The standard deviation of sales revenue from year *t-9* to year *t*.
OperCycle	The natural logarithm of firm *i*'s operating cycle.
NegEarn	The number of years in the past 10 years that firm *i* reported a loss.

Table A2
The industry distribution of impaired firms.

	Industry (number of impaired firms)				
Rank	1	2	3	4	5
2007	Pharmaceuticals (**7**)	Retail (**5**)	Food processing (**5**)	Others **(4)**	Real estate **(4)**
2008	Pharmaceuticals (**10**)	Telecom & network equipment (**9**)	Others (**7**)	Retail (**9**)	Real estate (**17**)
2009	Pharmaceuticals (**13**)	Telecom & network equipment (**12**)	Retail (**9**)	Real estate (**9**)	Others (**9**)
2010	Telecom & network equipment (**16**)	Real estate (**16**)	Pharmaceuticals (**15**)	Retail (**12**)	Food processing (**9**)
2011	Telecom & network equipment (**20**)	Pharmaceuticals (**17**)	Real estate (**17**)	Chemical raw materials & chemical products manufacturing (**14**)	Retail (**13**)
2012	Telecom & network equipment (**29**)	Chemical raw materials & chemical products manufacturing (**19**)	Pharmaceuticals (**17**)	Retail (**16**)	Software & information technology services (**16**)
2013	Telecom & network equipment (**35**)	Pharmaceuticals (**25**)	Software & information technology services (**22**)	Chemical raw materials & chemical products manufacturing (**19**)	Retail (**18**)
2014	Telecom & network equipment (**33**)	Pharmaceuticals (**32**)	Electrical machinery & equipment manufacturing (**23**)	Chemical raw materials & chemical products manufacturing (**22**)	Software & information technology services (**21**)
2015	Telecom & network equipment (**42**)	Pharmaceuticals (**39**)	Electrical machinery & equipment manufacturing (**42**)	Software & information technology services (**33**)	Chemical raw materials & chemical products manufacturing (**26**)
2016	Telecom & network equipment (**62**)	Pharmaceuticals (**42**)	Electrical machinery & equipment manufacturing (**42**)	Special equipment manufacturing (**38**)	Software & information technology services (**27**)
2017	Telecom & network equipment (**80**)	Electrical machinery & equipment manufacturing (**57**)	Special equipment manufacturing (**55**)	Pharmaceuticals (**54**)	Software & information technology services (**54**)

Notes: This table shows the industry distribution of impaired firms. The first five industries with the most impaired firms are listed in descending order. The bold number in brackets represents the number of impaired firms in the industry. Between 2007 and 2017, the pharmaceuticals, telecom, and network equipment industries had the largest number of impaired firms, followed by the real estate, chemical raw materials, and electrical machinery manufacturing industries.

Table A3
The amount of goodwill impairments.

Year	2007		2008		2009		2010		2011		2012	
Rank	Industry	Impairments	Industry	Impairments	Industry	Impairments	Industry	Impairments	Industry	Impairments	Industry	Impairments
1	Alcohol, beverage & tea manufacturing	199,626,368 (**45%**)	Air transportation	642,828,032 (**65%**)	Petroleum & gas extraction	1,391,000,064 (**7%**)	Real estate	512,935,072 (**30%**)	Business services	487,617,248 (**33%**)	Public facilities management	653,512,896 (**49%**)
2	Pharmaceuticals	199,255,888 (**13%**)	Real estate	267,530,272 (**30%**)	Air transportation	337,996,000 (**33%**)	Business services	428,719,136 (**32%**)	Power, heat production & supply	457,927,552 (**3%**)	Power, heat production & supply	543,522,240 (**3%**)
3	Others	109,624,944 (**22%**)	Alcohol, beverage & tea manufacturing	217,532,592 (**47%**)	Alcohol, beverage & tea manufacturing	217,532,592 (**36%**)	Building decoration & other construction industry	241,956,000 (**30%**)	Real estate	409,824,800 (**29%**)	Real estate	485,830,720 (**20%**)
4	Real estate	98,953,248 (**21%**)	Automobile manufacturing	194,741,056 (**17%**)	Real estate	215,206,208 (**21%**)	Alcohol, beverage & tea manufacturing	219,627,264 (**23%**)	Automobile manufacturing	313,280,000 (**15%**)	Automobile manufacturing	422,771,136 (**14%**)
5	Computer, communication & other electronic equipment manufacturing	86,899,064 (**12%**)	Pharmaceuticals	191,031,152 (**11%**)	Automobile manufacturing	199,261,712 (**17%**)	Automobile manufacturing	217,111,776 (**12%**)	Building decoration & other construction industry	284,116,000 (**22%**)	Civil engineering construction	419,379,776 (**8%**)

Year	2013		2014		2015		2016		2017	
Rank	Industry	Impairments	Industry	Impairments	Industry	Impairments	Industry	Impairments	Industry	Impairments
1	Power, heat production & supply	1,519,811,968 (**9%**)	Public facilities management	922,326,272 (**53%**)	Power, heat production & supply	3,351,096,832 (**17%**)	Mining auxiliary activities	4,705,821,184 (**58%**)	Electrical machinery & equipment manufacturing	6,659,684,352 (**7%**)
2	Public facilities management	798,143,488 (**60%**)	Software & information technology services	745,295,232 (**4%**)	Computer, communication & other electronic equipment manufacturing	1,398,310,528 (**3%**)	Power, heat production & supply	3,451,939,584 (**16%**)	Computer, communication & other electronic equipment manufacturing	5,418,539,520 (**5%**)
3	Computer, communication & other electronic equipment manufacturing	527,474,528 (**5%**)	Non-metallic mineral products industry	524,880,992 (**9%**)	Software & information technology services	1,389,537,280 (**3%**)	Computer, communication & other electronic equipment manufacturing	3,376,087,296 (**3%**)	Mining auxiliary activities	4,612,263,936 (**54%**)
4	Real estate	478,975,072 (**17%**)	General equipment manufacturing	505,029,152 (**12%**)	Pharmaceuticals	1,100,580,224 (**3%**)	Real estate	1,686,721,664 (**11%**)	Software & information technology services	4,174,721,024 (**5%**)
5	Civil engineering construction	459,458,592 (**8%**)	Real estate	468,993,952 (**10%**)	Mining auxiliary activities	1,008,980,736 (**16%**)	Software & information technology services	1,590,496,640 (**3%**)	Power, heat production & supply	3,965,471,744 (**16%**)

Notes: This table reports the first five industries with the largest amount of goodwill impairments in descending order. The percentage in brackets is the ratio of goodwill impairments to total goodwill in a given year. Industries with a large amount of impairments remain relatively constant each year and their goodwill impairments account for a significant proportion of total goodwill.

Table A4
The amount of goodwill.

Year	2007		2008		2009		2010		2011		2012	
Rank	Industry	Goodwill	Industry	Goodwill	Industry	Goodwill	Industry	Goodwill	Industry	Goodwill	Industry	Goodwill
1	Petroleum & gas extraction	15,690,000,384 (**0%**)	Petroleum & gas extraction	17,808,541,696 (**0%**)	Petroleum & gas extraction	20,154,472,448 (**7%**)	Power, heat production & supply	14,207,736,832 (**1.2%**)	Power, heat production & supply	16,177,765,376 (**3%**)	Power, heat production & supply	17,319,483,392 (**3%**)
2	Non-ferrous metal smelting	2,404,116,480 (**0%**)	Power, heat production & supply	11,690,562,560 (**1.5%**)	Power, heat production & supply	12,082,382,848 (**1.6%**)	Petroleum & gas extraction	12,760,017,920 (**0%**)	Petroleum & gas extraction	12,457,206,784 (**0%**)	Petroleum & gas extraction	10,971,077,632 (**0%**)
3	Pharmaceuticals	1,490,920,576 (**13%**)	Non-ferrous metal smelting	2,589,202,176 (**0.03%**)	Non-ferrous metal smelting	2,685,785,600 (**0.2%**)	Air transportation	10,416,660,480 (**1.2%**)	Pharmaceuticals	8,584,333,824 (**2%**)	Pharmaceuticals	7,354,402,304 (**2%**)
4	Automobile manufacturing	1,153,491,712 (**0.1%**)	Electrical machinery & equipment manufacturing	2,414,225,664 (**0.4%**)	Retail	2,545,250,304 (**4%**)	Pharmaceuticals	2,899,251,712 (**7%**)	Electrical machinery & equipment manufacturing	4,205,152,000 (**6%**)	Computer, communication & other electronic equipment manufacturing	6,718,632,960 (**4%**)
5	Civil engineering construction	935,900,864 (**0.5%**)	Special equipment manufacturing	2,305,367,296 (**0.6%**)	Electrical machinery & equipment manufacturing	2,461,065,472 (**0.8%**)	Non-ferrous metal smelting	2,740,823,040 (**0%**)	Software & information technology services	4,080,908,288 (**2%**)	Civil engineering construction	5,088,548,864 (**8%**)

Year	2013		2014		2015		2016		2017	
Rank	Industry	Goodwill	Industry	Goodwill	Industry	Goodwill	Industry	Goodwill	Industry	Goodwill
1	Power, heat production & supply	16,952,892,416 (**9%**)	Pharmaceuticals	23,989,344,256 (**2%**)	Computer, communication & other electronic equipment manufacturing	49,399,160,832 (**3%**)	Computer, communication & other electronic equipment manufacturing	97,926,078,464 (**3%**)	Computer, communication & other electronic equipment manufacturing	113,964,122,112 (**5%**)
2	Pharmaceuticals	11,487,026,176 (**3%**)	Computer, communication & other electronic equipment manufacturing	18,820,114,432 (**2%**)	Software & information technology services	44,409,069,568 (**3%**)	Electrical machinery & equipment manufacturing	68,429,651,968 (**2%**)	Electrical machinery & equipment manufacturing	101,777,080,320 (**7%**)
3	Petroleum & gas extraction	10,375,837,696 (**0%**)	Software & information technology services	17,900,877,824 (**4%**)	Pharmaceuticals	41,796,796,416 (**3%**)	Pharmaceuticals	67,693,322,240 (**1%**)	Software & information technology services	81,609,490,432 (**5%**)
4	Computer, communication & other electronic equipment manufacturing	10,014,821,376 (**5%**)	Power, heat production & supply	17,538,435,072 (**0.9%**)	Electrical machinery & equipment manufacturing	25,919,782,912 (**1%**)	Software & information technology services	62,724,104,192 (**3%**)	Pharmaceuticals	77,823,827,968 (**2%**)
5	Chemical raw materials & chemical products manufacturing	8,072,478,208 (**3%**)	Automobile manufacturing	15,061,773,312 (**3%**)	Chemical raw materials & chemical products manufacturing	24,363,988,992 (**2%**)	Petroleum & gas extraction	53,184,176,128 (**0%**)	Internet & related services	66,142,105,600 (**3%**)

Notes: This table shows the top five industries with the largest amount of goodwill in descending order. The percentage in brackets is the ratio of goodwill impairments to goodwill for the industry in a given year. Industries that recognize a large amount of goodwill remain relatively constant each year and their impairments account for a very small proportion of total goodwill.

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China Journal of Accounting Research 14 (2021) 183–205

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China Journal of Accounting Research

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

CEO organizational identification and firm cash holdings

Meihua Zhou [a], Jian Cao [b,*], Bin Lin [c]

[a] School of Accountancy, Jiangxi University of Finance and Economics, 169 East Shuanggang Road, Nanchang, Jiangxi 330013, China
[b] School of Economics and Management, Harbin Institute of Technology, Shenzhen HIT Campus of University Town of Shenzhen, Shenzhen, Guangdong 518055, China
[c] School of Business, Sun Yat-sen University, 135 Xingang West Road, Guangzhou, Guangdong 510275, China

ARTICLE INFO

Article history:
Received 15 September 2020
Accepted 10 March 2021
Available online 1 May 2021

Keywords:
CEO organizational identification
Financial development
Economic policy uncertainty
Cash holdings

ABSTRACT

As the decision-makers and implementers of a firm's financial strategy, executives play a critical role in cash holding activities, and their psychological characteristics have a major impact on cash holdings. This paper investigates the association between CEO organizational identification and firm cash holdings. The empirical results show that CEO organizational identification is negatively associated with firm cash holdings, and the negative association is more pronounced when the level of financial development is higher and economic uncertainty is lower. Further analysis reveals that the higher a CEO's organizational identification, the higher the firm's R&D investment and capital expenditure, and high CEO organizational identification can increase the value of firm cash holdings. Overall, our findings supplement the literature on organizational identification and cash holdings, and on the effect of executives' psychological characteristics on corporate financial decision-making.

1. Introduction

Akerlof and Kranton (2005) point out that an important source of employees' motivation, their self-image as part of the organization (e.g., organizational identification), is omitted in current economic models. Organizational identification plays an important role in employees' work effort, contract design, and organizational design. For example, from the perspective of motivation and constraint, Akerlof and Kranton (2008) examine how employees perceive intrinsic motivation in their relationship with the company and find that self-

* Corresponding Author.
E-mail address: kerrycao@hit.edu.cn (J. Cao).

https://doi.org/10.1016/j.cjar.2021.03.001
1755-3091/

motivated employees are less hostile to the company and require less compensation; thus, the optimal management design relies on employees' identification with the organization (Abernethy et al., 2017; Boivie et al., 2011).[1]

Firms' cash holding decisions have attracted widespread attention from academics and practitioners. Due to the principal-agent problem and information asymmetry, firms may reserve a large amount of cash due to the opportunistic behavior of major shareholders or management. Dittmar et al. (2003) declare that the principal-agent problem is the most important determinant of firm cash holdings, and based on multinational data they find that listed firms' cash holdings in countries with lower investor protection are twice as high as in countries with better investor protection. Xin and Xu (2006) also find that the cash holdings of firms with better corporate governance are more reasonable, which is consistent with the free cash flow hypothesis proposed by Jensen (1986). Executives with higher organizational identification are more likely to make decisions in the interest of their firm, instead of their self-interest, and do their best to avoid the negative impact of individuals on the firm. Therefore, firms whose executives have higher organizational identification should have less cash holdings. In addition, as a scarce resource, cash can be easily abused by agents; thus, it is logical to ask whether CEO organizational identification may exert a corporate governance function for cash holdings. We therefore investigate the association between CEO organizational identification and cash holdings in this paper.

Previous studies show that corporate cash holdings are closely related to the external environment, especially in emerging markets such as China, where local financial development and national economic policies have a greater impact on firms. Financial development affects the firms' financing constraints, and financing convenience has a direct impact on firm cash holdings. Fluctuations in economic policy induce operation uncertainty, and firms will in response defensively increase their cash holdings (Wang et al., 2014; Li and Shi, 2016). Following this line of research, we examine the moderating effects of financial development and economic policy uncertainty on the association between CEO organizational identification and cash holdings.

Using a questionnaire sent to listed firms' CEOs in 2014, we empirically investigate the association between CEO organizational identification and cash holdings. The results show that CEO organizational identification is significantly negatively associated with cash holdings; that is, the higher the CEO's organizational identification, the lower the cash holdings, which indicates that CEO organizational identification mitigates agency problems. Considering financial development and economic policy uncertainty, we find that financial development strengthens the negative association between CEO organizational identification and cash holdings, while economic policy uncertainty weakens the negative association between CEO organizational identification and cash holdings. These results reveal that when making financial decisions, CEOs are influenced by the firm's operating environment. In addition, we examine the association between CEO organizational identification and investment expenditure, and find that CEO organizational identification is significantly positively associated with R&D investment and capital expenditure, and can increase the value of firm cash holdings. Overall, our findings suggest that the higher a CEO's organizational identification, the lower the firm's cash holdings. Furthermore, the CEO will make more investments, which further increases the value of the firm's cash holdings. In a robustness test, we add CFO organizational identification to the regression model, and construct CEO organizational identification using the principal component analysis method, and the results remain unchanged. Our findings supplement the literature on organizational identification and cash holdings, and shed light on the effect of executives' psychological characteristics on corporate financial decision-making.

Our paper contributes to the literature in the following ways. First, the psychological characteristics of executives have a major impact on firm decision-making. However, due to data availability, studies in this area mainly focus on the impact of overconfidence (Hsieh et al., 2018; Jiang et al., 2009) and narcissistic personality (Wen et al., 2015; Olsen and Stekelberg, 2016) on firm performance and financial behavior. Unlike these psychological characteristics, organizational identification derives from individuals' emotional dependence on an organization, which has a greater impact on the enterprise. At present, China is at the stage of emerging eco-

[1] The 2008 financial crisis severely hurt Lenovo Group, and Mr. Chuanzhi Liu took up his former post (Chairman of Lenovo Group) again in February 2009. In an interview with the media, he said, "Lenovo is my life, when it needs me, it's my duty to come out." Ultimately, he led Lenovo Group out of its crisis, which reflects the important role of senior executives' organizational identification. Source: http://tech.sina.com.cn/it/2009–02-05/14402796517.shtml.

nomic development, as manifested by high economic policy uncertainty, an imperfectly constructed legal system, and weak law enforcement. In such an environment (e.g., a weak external governance environment), the organizational identification of senior executives may exert a corporate governance role. CEOs with stronger organizational identification are more likely to care about the future of the firm and be cautious when making financial decisions to avoid future financial distress. They are also more concerned about outsiders' evaluation of the firm, so would try their best to prevent the firm from being involved in legal disputes. Based on developed markets, Boivie et al. (2011) study the role of CEO organizational identification in corporate governance from the perspective of the principal-agent theory, and find that CEO organizational identification enhances pay-performance sensitivity, and decreases CEOs' personal use of corporate aircraft. Unlike Boivie et al. (2011), this paper focuses on the world's largest developing country and studies the association between CEO organizational identification and cash holdings from the perspectives of the principal-agent theory and defensive incentive, thus adding to the literature on organizational identification (the psychological characteristics of executives).

Second, this paper finds that in regions with higher levels of financial development, CEOs with higher organizational identification further decrease cash holdings, whereas when economic policy uncertainty is higher, CEOs with higher organizational identification increase cash holdings. The results indicate that CEOs carefully consider the external environment when making financial decisions, which provides direct evidence for the effect of the macro environment on the micro-decision-making behavior of the firm.

Third, when analyzing executive behavior, traditional economics is premised on a rational-economic assumption and excludes executives' psychological characteristics such as organizational identification from the analytical framework. Obviously, the explanatory power of this theoretical paradigm is limited. A series of studies by Akerlof and Kranton (2005. 2008) has pointed out that organizational identification is an important motivation mechanism, and we provide empirical evidence for this assertion.

2. Literature review

2.1. Organizational identification

Ashforth and Mael (1989) introduced the theory of social identification into the organizational environment and redefined the concept of organizational identification. Since then, organizational identification has become an important topic in the study of organizational behavior and received more and more attention from scholars (Pratt, 1998; Rousseau, 1998). Organizational identification plays an important role at the individual, group, and organization levels. An individual with higher organizational identification will be more supportive of the organization. Social identification theory is the dominant paradigm in research on the outcome variables of organizational identification. It proposes three mechanisms to explain the impact of organizational identification on an employee's attitudes and behavior: identity consistency, depersonalization, and self-affirmation. According to Mael and Ashforth (1992), alumni with a high sense of identification with their alma mater are more likely to donate to it and participate in or persuade others to attend events there. Employees with high organizational identification tend to rate characteristics positively when they share them with their organization. Dick et al. (2004) examine the association between organizational identification and job satisfaction, and find that the evaluation dimension of career identification and team identification can significantly improve job satisfaction. Guo and Xiao (2017) find that the organizational identification of employees in state-owned enterprises inhibits deviant work behavior. Further, Bamber and Iyer (2002) show that organizational identification can significantly reduce organization-career conflicts and employee turnover intention. Zhang and Liu (2016) use meta-analysis to explore the association between organizational identification and turnover intention, and find that organizational identification and turnover intention are highly negatively correlated.

In empirical studies of organizational identification, researchers generally collect data on organizational identification from questionnaires; the studies discussed above are all based on surveys of employees or alumni. Boivie et al. (2011) embed CEO organizational identification into the corporate governance framework and explore its role in corporate governance. The results show that CEO organizational identification can significantly mitigate agency costs. They also show that when CEO organizational identification is high,

the governance effect of board independence on agency cost is diminished, indicating that there is a substitution effect between the two, and CEO organizational identification can play a role in corporate governance. This paper extends the research on the psychological characteristics of executives to research in corporate governance. Using Chinese state-owned listed firms as a sample, Zhu and Yoshikawa (2016) investigate how board members with government backgrounds supervise and manage firms. They find that board directors with higher corporate identification provide more efficient supervision and more resource supports, and board directors with higher government identification modify the two effects according to the state-owned equity. Abernethy et al. (2017) study the association between CFO organizational identification and earnings manipulation from the perspective of executive compensation contracts and firms. The results show that CFOs with higher organizational identification are less likely to manipulate earnings to satisfy compensation contracts, indicating that organizational identification is an effective complement to compensation contracts.

2.2. Cash holdings

The determinants of cash holdings can be divided into two main categories: defensive incentives and agency problems. Based on the precautionary motive of cash holdings, Opler et al. (1999) find that when the external financing cost is high and the firm has more investment opportunities, it will hold more cash, which is consistent with the prediction of Kim et al. (1998). Kim et al. (1998) argue that the optimal cash holding level of a company is determined by low return on cash and the need to ensure financial support for future investment opportunities. Bates et al. (2009) find that from the early 1980s to the early 2000s, the level of cash holdings of American companies doubled, accounting for about a quarter of total assets. Further studies show that the increase of cash holdings is related to the risk associated with cash flow, which leads to a defensive incentive. Companies' tendency to hold onto large amounts of cash may be a global phenomenon. Ferreira and Vilela (2004) focus on European companies and Ozkan and Ozkan (2004) focus on British companies, and both find that the level of cash holdings is positively correlated with the companies' investment opportunities and negatively correlated with bank debts. Song and Lee (2012) find that due to the defensive incentive, the affected listed companies increased their cash holdings after the Asian financial crisis. Duchin et al. (2010) find that the excess cash held by American companies is positively correlated with capital investment during the 2008 financial crisis. Jiang and Liu (2011) also find that during an economic recession, listed companies hold more cash. Based on the defensive incentive, Luo and Zhang (2007) find that companies increase the value of intertemporal investment options by reducing investment and increasing cash reserves to cope with the risk of cash shortage caused by economic uncertainties.

The financing conditions of a company will significantly affect its cash flow and cash holding level. Almeida et al. (2004) find that financing constraints will increase the propensity of a company to retain cash to ensure future investment. Han and Qiu (2007) also find that financing constrained companies increase the level of cash holdings to defend against the risks resulting from cash flow volatility. McLean (2011) analyzes data on corporate cash holdings from the 1970s to the 2000s and finds that companies are more likely to obtain cash by issuing new shares than from operating cash flows. Further research has shown that this trend is associated with greater defensive incentive, and especially R&D investment and cash fluctuations. Yang et al. (2016) find that industry growth is significantly positively correlated with cash holdings, and that greater industry competition and financing constraints increase this preventive effect. Zhu and Lu (2009) also find that when monetary policy is stricter, external financing constraints become stronger, and enterprises increase their cash holdings. All of these studies find that the financing environment has an important impact on a company's cash holding level.

The effect of the macro environment on the micro behavior of enterprises is currently a subject of much debate. Khurana et al. (2006) study the effect of financial development on financing constraints and find that it increases a company's financial capital market channels and reduces the defensive incentive for cash holdings; Kusnadi and Wei (2011) obtain results consistent with this finding, but use a multinational sample and study countries' legal systems rather than financial development. Economic policy uncertainty also has a significant impact on the management strategy and financial behaviors of enterprises. Wang et al. (2014), Li and Shi (2016), and Phan et al. (2019) use the monthly China economic uncertainty index jointly issued by Stanford University and the University of Chicago as a measure of economic policy uncertainty, and find that the

higher it is, the higher the level of cash holdings. Julio and Yook (2012) find that political uncertainty increases companies' cash holdings and reduces investment projects. Building on the literature, this paper examines the moderating effects of financial development and economic policy uncertainty on the association between CEO organizational identification and cash holdings in different scenarios.

Due to the separation of ownership and control rights, there is a widespread agency problem in listed firms. Shareholders expect management to distribute the remaining cash to them as dividends after all profitable projects have been invested in. However, Jensen (1986) points out that self-interested managers may invest cash in unprofitable but personally beneficial projects instead of issuing dividends, or the company may keep excess cash directly. Therefore, the more serious the agency problem, the more cash the company will hold, and the lower the value will be. Yang et al. (2014) provide empirical evidence that the more powerful the management is, the greater the cash holdings. If cash holding is the consequence of agency problems, then mechanisms that alleviate agency problems should also reduce cash holdings. Nikolov and Whited (2014) find that the lower the management's shareholding, the higher the company's cash holdings. Similarly, Liu et al. (2017) find that equity incentive plans can reduce cash holdings, especially of excess cash, supporting the agency view of cash holdings. Elyasiani and Zhang (2015) find that companies with serious agency problems are more inclined to hold current assets, which can reduce the company's risks and increase the security of senior executives. The board of directors has a statutory obligation to supervise the company executives, and an effective board can reduce the firm's cash levels if the agency motive of cash holding is in operation. However, Harford et al. (2008) and Mikkelson and Partch (2003) fail to find a significant relationship between board structure (e.g., board independence) and cash holdings. Masulis and Reza (2015) study the philanthropic use of corporate cash and find that cash is often donated to charitable organizations related to the firm's independent directors, which at least shows that the senior executives destroy the independence of the independent directors. Masulis et al. (2009) find that when executives' voting rights increase relative to cash flow rights, the value of the firm's cash holdings decreases. They argue that the reason for this result is that the anti-takeover clause protects the company from being taken over, and then the executives can usurp the private gains of the cash holdings. According to the principal-agent perspective, executives desire to build an "Enterprise Empire." Harford (1999) finds that companies flush with cash are more likely to conduct mergers and acquisitions, but after completion the value of the company is destroyed. These findings are consistent with the predictions of the principal-agent theory. Liu et al. (2015) find that family firms hold more cash based on opportunistic behavior.

2.3. Summary

The preceding literature review shows that the determinants of cash holdings include the macro environment, corporate financial situation, and corporate governance, and that research has focused on the defensive incentive and agency problems perspectives. There have been few studies of the determinants of cash holdings from the perspective of executives' psychology, especially organizational identification, largely due to the lack of data. Generally, the measurement of organizational identification comes from questionnaires, and it is extremely difficult to survey the executives of listed firms. By issuing questionnaires to executives of listed firms through CSRC (China Securities Regulatory Commission), we ensure the response rate and relatively accuracy of the questionnaires. At the same time, we use the internationally recognized organizational identification scale to measure CEO organizational identification objectively, and investigate the association between CEO organizational identification and cash holdings, thus expanding and supplementing the research to date.

3. Theoretical analysis and research hypothesis

3.1. CEO organizational identification and firm cash holdings

The separation of ownership and control rights leads to the possibility that the goals pursued by managers may not be consistent with those of shareholders, resulting in a so-called Type 1 agency problem (Jensen and Meckling, 1976). In emerging markets such as China, equity shareholding is relatively concentrated, and major shareholders encroach on minority shareholders, which is a so-called Type 2 agency problem. From the perspective of the principal-agent theory, managers tend to hold more cash no matter whether an agency

problem exists, because more cash holdings provide managers with the opportunity for more perquisite consumption, and because more cash holdings act as a "buffer," which means that when the firm makes a poor investment, there is no shortage of cash, so managers can avoid the constraints of the capital market or creditors. Finally, when the firm accumulates a large amount of cash, self-interested managers may carry out inefficient mergers and acquisitions to build their own "Enterprise Empire" (Jensen, 1986).

Organizational identification is a form of social identification that derives from the relationship between individuals and organizations. It emphasizes the influence of organizational membership on individuals' self-concept, and their sense of belonging to and agreement with organizations. Strong organizational commitment will have a strong influence on individual behavior. For example, Akerlof and Kranton (2008) study employees' intrinsic motivation in their relationship with their company, and find that self-motivated employees are less hostile to the company and require less compensation; thus, optimal management should rely on employees' organizational identification. Boivie et al. (2011) find that CEO organizational identification can relieve agency problems and perform a corporate governance function. Therefore, from the perspective of principal-agent theory, firms with severe agency problems may have more cash holdings, while firms with higher CEO organizational identification will have less cash holdings because the CEO's organizational identification restrains agency problems. In addition, when individuals and the organization conform, executives are more likely to safeguard the organization's interests, avoid the negative impact of personal behavior on the organization, and maintain and enhance its positive image. The CEO will devote himself/herself to the enterprise, binding his/her personal career to the destiny of the firm more closely when he/she has strong organizational identification. Such a CEO will pay more attention to the firm's long-term performance goals and development. Therefore, we propose that the higher the CEO's organizational identification, the lower the firm's cash holdings.

In addition, the defensive incentive for cash holdings suggests that firms need to hold a certain amount of cash for emergencies when their investment opportunities are uncertain or they are facing financing constraints (Opler et al., 1999). In addition to the need to seize investment opportunities, it is worth noting that many companies founder or even go bankrupt due to cash flow shortage, which is one reason for the gradual increase of cash holdings in American firms (Bates et al., 2009). Therefore, when the CEO has higher organizational identification, he/she is more closely bound to the firm's fate, and will care more about the firm's future, which in turn leads to more cash holdings. Thus, we propose the following competing hypotheses.

H1a: Ceteris paribus, CEO organizational identification is negatively associated with firm cash holdings.
H1b: Ceteris paribus, CEO organizational identification is positively associated with firm cash holdings.

3.2. Moderating effect of financial development

Firm cash holdings also depend on financial development. First, financial development eases firms' financing constraints and promotes economic growth (Rajan and Zingales, 1998). Zhu et al. (2006) find that financial development reduces the dependence of firm investment on internal cash flow; that is, high financial development makes it easier to find an external financing source and firms may therefore have lower cash holdings. Second, financial intermediaries perform various functions, including centralized savings, liquidation and payment, information transmission and processing, resource allocation, supervising and motivating managers, and dispersing risks, which helps to alleviate the firms' principal-agent problem. Third, law and finance research shows that the financial development of a country or a region is closely related to its institutional environment. A strong legal environment and a high level of investor protection will limit the motivation and ability of insiders to usurp private gains from control rights, thereby decreasing managers' earnings management (Leuz et al., 2003), and further improving corporate transparency. Hail and Leuz (2006) demonstrate that strict information disclosure requirements, a high level of securities supervision, and a strict enforcement mechanism can lower the cost of equity financing. Therefore, from the perspectives of both financing convenience and principal-agent problem, the negative association between CEO organizational identification and cash holdings would be more pronounced in regions with high financial development. In particular, although the overall level of financial development in China is still relatively low (Allen et al.,

2005), remarkable progress has been made since the reform and opening-up. However, due to regional differences in the reform process, the institutional environment varies considerably across provinces (Fan et al., 2011), which provides a unique setting for examining the moderating effect of financial development on the association between CEO organizational identification and firm cash holdings. Based on the above analysis, we propose Hypothesis 2.

H2: Ceteris paribus, the level of financial development strengthens the negative association between CEO organizational identification and firm cash holdings.

3.3. Moderating effect of economic policy uncertainty

Currently, China's economy is characterized by government intervention, frequent policy adjustments, weak investor protection, and political connection (Piotroski and Wong, 2012), which means that the management decisions of Chinese firms are highly dependent on the government's economic policy. As a result, executives are more sensitive to economic policy uncertainty, and reallocate the firm's liquid assets accordingly (Baum et al., 2006). According to the defensive incentive for cash holdings, when external environmental uncertainty increases, firms will directly increase cash holdings to deal with sudden external shocks and provide a buffer against temporary cash flow shortage. Previous studies have consistently shown a significantly positive association between economic policy uncertainty and cash holdings (Baum et al., 2006; Wang et al, 2014; Li and Shi, 2016).

Greater economic policy uncertainty will reduce the observability of management's efforts, increase the difficulty of shareholders' supervision, and lead to more serious information asymmetry between shareholders and management (Liu and Han, 2010), which will make it easier for self-interested managers to hold more cash to engage in opportunistic behavior (Li and Shi, 2016). Therefore, economic policy uncertainty will lead to an increase in firm cash holdings from the perspectives of both the defensive incentive or principal-agent theory. Rational CEOs will consider the risk of financial distress or bankruptcy induced by cash shortage when making cash holding decisions, and CEOs with higher organizational identification will care more about the firm's future development. Therefore, when economic policy uncertainty increases, CEOs will appropriately increase cash holdings. Based on the above analysis, we propose Hypothesis 3.

H3: Ceteris paribus, economic policy uncertainty weakens the negative association between CEO organizational identification and firm cash holdings.

4. Research design

4.1. Data source and sample selection

The CEO organizational identification data we use in this paper come from a survey sponsored by the Listed Firms Internal Control Research Group of the China Securities Regulatory Commission. On September 5, 2014, the Research Group sent the questionnaires to A-share listed companies, certified accounting firms with a securities and futures practicing qualification, and institutional investors, through the Shanghai Stock Exchange, Shenzhen Stock Exchange, Accounting Department of China Securities Regulatory Commission, and Asset Management Association of China. As of October 31, 2014, 2,536 A-share listed companies were issued questionnaires, and 2,154 sets of questionnaires (12,551 copies) were collected, with an overall response rate of 84.95%.[2] Other data are from the CSMAR and Wind databases.

Following previous studies, we use the following criteria to select our sample: (1) we exclude listed companies in the finance industry; (2) we exclude samples with missing data; (3) all continuous variables are win-

[2] The questionnaires were issued by the China Securities Regulatory Commission, which imposed certain legal constraints. Therefore, the response rate and the authenticity are remarkably high. In addition, members of the Research Group conducted field surveys of more than 10 companies, provided telephone guidance, and paid return visits to many companies in an effort to ensure the authenticity and reliability of the survey data. For a more detailed account of the survey process, please refer to Zhao et al. (2015).

sorized at the levels of 1% and 99%; and (4) given that organizational identification would not change greatly in a short time, we expand our sample period one year forward and backward. The sample period is thus from 2013 to 2015, and we further exclude firms whose CEO resigned during these three years. The final sample contains 5,081 firm-year observations.

4.2. Variable definitions

(1) Cash holdings

The dependent variable is measured in two ways. The first is cash holdings (*Cash*), based on Dittmar et al. (2003) and Wang et al. (2014); we define *Cash* as the ratio of cash and cash equivalents to total assets minus cash and cash equivalents. The second is industry adjusted cash holdings (*INDCash*), based on Opler et al. (1999) and Li et al. (2018); we define *INDCash* as *Cash* minus the average *Cash* of a specific industry to eliminate the impact of industry.

(2) CEO organizational identification

The independent variable in this paper is CEO organizational identification (*OI*), which is measured by the 6-item scale developed by Mael and Ashforth (1992).[3] The scale focuses on employees' emotions towards the organization and has a simple and clear structure and high credibility of 0.81; it is favored by many scholars.[4] The questionnaire asks the respondent to assess to what extent he or she agrees with the following statements (1 = Strongly disagree; 5 = Strongly agree): "When someone criticizes (name of firm), it feels like a personal insult"; "I am very interested in what others think about (name of firm)"; "When I talk about this firm, I usually say 'we' rather than 'they'"; "This firm's successes are my successes"; "When someone praises the firm, it feels like a personal compliment"; and "If a story in the media criticized the firm, I would feel embarrassed." When calculating organizational identity variables, we sum the total scores of the six items.

(3) Financial development

Following Zhong and Wang (2017), financial development is constructed at the provincial level and is measured as stock market development (*Stocksize*) and banking sector development (*Banksize*). *Stocksize* is the ratio of the stock market value to the GDP of the province, and *Banksize* is the ratio of the sum of deposit balances of the financial institutions to the GDP of the province.

(4) Economic policy uncertainty

Consistent with Li and Shi (2016), we use the monthly China economic policy uncertainty index (*EPU*) released by Stanford University and the University of Chicago as an indicator.[5] To measure economic policy uncertainty in China, they construct a scaled frequency count of articles about policy-related economic uncertainty in the *South China Morning Post* (SCMP), Hong Kong's leading English-language newspaper. First, they identify SCMP articles about economic uncertainty pertaining to China by flagging all articles that contain at least one term from each of the China economic uncertainty term sets. Second, they identify the subset of these articles that also discusses policy matters. Third, they apply these requirements to an automated search of every SCMP article published since 1995. This search yields a monthly frequency count of SCMP articles about policy-related economic uncertainty. Fourth, they divide the monthly frequency count by the total number of SCMP articles in the same month. Finally, they normalize the resulting series to a mean value

[3] Another widely used scale is the three-dimensional (membership, loyalty, and similarity) questionnaire developed by Cheney (1983). The initial version of the questionnaire had 30 questions, and the updated version has 25 questions. The main controversy over this questionnaire is that there are too many questions and too many of them concern organizational commitment. In contrast, Mael and Ashforth's scale is more representative of organizational identification.

[4] For example, Zhu and Yoshikawa (2016) and Boivie et al. (2011) use the same scale as the one used in Mael and Ashforth (1992).

[5] Data download address: http://www.policyuncertainty.com/scmp_monthly.html.

of 100 from January 1995 to December 2020 by applying a multiplicative factor. Because we use quarterly data for our empirical test of H3, we average the three-month data of a quarter to convert monthly data into quarterly data and obtain the quarterly economic policy uncertainty index (Li and Shi, 2016).

4.3. Empirical model

To empirically test our hypotheses, we refer to Li and Shi (2016), Li et al. (2018), and Xu et al. (2016) to construct Model (1).

$$\begin{aligned} Cash_{it} &= \alpha_0 + \alpha_1 OI_{it} + \alpha_2 Cash_{it-1} + \alpha_3 LEV_{it} + \alpha_4 CF_{it} + \alpha_5 AGE_{it} \\ &+\alpha_6 NWC_{it} + \alpha_7 CAPEX_{it} + \alpha_8 SIZE_{it} + \alpha_9 DSD_{it} + \alpha_{10} CFVOL_{it} + \alpha_{11} BM_{it} \\ &+\alpha_{12} DIV_{it} + \alpha_{13} LOSS_{it} + \alpha_{14} SOE_{it} + \alpha_{15} FIRST_{it} + \sum IND + \sum YEAR + \varepsilon_{it} \end{aligned} \quad (1)$$

The dependent variable is measured in two ways. The first is cash holdings (*Cash*), defined following Dittmar et al. (2003) and Wang et al. (2014) as the ratio of cash and cash equivalents to total assets minus cash and cash equivalents. The second is industry adjusted cash holdings (*INDCash*), defined following Opler et al. (1999) and Li et al. (2018) as *Cash* minus the average *Cash* of a specific industry to eliminate the impact of industry. The independent variable is firm *i*'s CEO's organizational identification in year *t* (*OI*). $CASH_{it-1}$ is firm *i*'s cash holdings in year *t-1*, which is used to control the continuity of corporate cash holdings. In addition, we control firm *i*'s leverage rate in year *t* (LEV_{it}), net cash flow from operations in year *t* (CF_{it}), listing age in year *t* (AGE_{it}), net working capital in year *t* (NWC_{it}), capital expenditure in year *t* ($CAPEX_{it}$), size in year *t* ($SIZE_{it}$), short-term debt changes rate in year *t* (DSD_{it}), fluctuation of operating cash flow in year *t* ($CFVOL_{it}$), book-to-market ratio in year *t* (BM_{it}), whether firm *i* pays cash dividends in year *t* (DIV_{it}), whether firm *i* posts a loss in year *t* ($LOSS_{it}$), the nature of property rights of firm *i* in year *t* (SOE_{it}), and the largest shareholder's shareholding ratio of firm *i* in year *t* ($FIRST_{it}$). See Table 1 for the variable definitions.

To test the moderating effect of financial development and economic policy uncertainty, we first add the interaction of financial development (*Stocksize* and *Banksize*) and *OI* to Model (1) to test Hypothesis 2, and then add the interaction of economic policy uncertainty (*EPU*) and *OI* to Model (1) to test Hypothesis 2.

Table 1
Variable Definitions.

Variable	Definition
Cash	Cash and cash equivalents/(Total assets - Cash and cash equivalents)
INDCash	*Cash* adjusted by industry (*Cash* - average value of *Cash* in the specific industry)
OI	Natural logarithm of the CEO's response to the 6-item scale (Mael and Ashforth, 1992)
Stocksize	Natural logarithm of the ratio of the stock market value to GDP in the specific province
Banksize	Natural logarithm of the ratio of sum of deposit balances of financial institutions to the GDP of the specific province
EPU	Natural logarithm of the Economic Policy Uncertainty Index published by Stanford University and the University of Chicago
LEV	Total liabilities/Total assets
CF	Net cash flow from operations/Total assets
AGE	Ln (Listed years + 1)
NWC	Net working capital/(Total assets - Cash and cash equivalents)
CAPEX	Capital expenditure/(Total assets - Cash and cash equivalents)
SIZE	Ln (Total assets)
DSD	(Short-term debt in year *t* - Short-term debt in year *t-1*)/Total assets
CFVOL	Standard deviation of each firm's net operating cash flow in the same industry in year *t*
BM	Book equity value/Market equity value
DIV	If the firm paid cash dividends in year *t*, equal to 1, and otherwise 0
LOSS	If the firm posted a loss in year *t*, equal to 1, and otherwise 0
SOE	If the firm is a state-owned enterprise, equal to 1, and otherwise 0
FIRST	Shares held by the largest shareholder/Outstanding shares × 100
IND	CSRC industry classification standards
YEAR	Year effect

5. Empirical results

Table 2 presents the descriptive statistics. The mean and median of cash holdings (*Cash*) are 0.2162 and 0.1288, respectively, which is consistent with the literature (Yang and Yin, 2018). The standard deviation of *Cash* is 0.2792, indicating that the cash holding level of listed firms varies considerably. *OI* is the logarithmic value of CEO organizational identification, and *CEO_OI* is the original value of CEO organizational identification before being convert to the logarithm value, with a mean and median of 25.547 and 26. Furthermore, the min and max of *CEO_OI* are 6 and 30, indicating that *CEO_OI* is right skewed and CEOs have relatively high organizational identification with their firms. The mean and median of *EPU* are 4.9144 and 4.7769 respectively, which differ from the findings of Wang et al. (2014) to some extent, possibly because the sample period is different (2003 to 2011 in Wang et al., 2014). The mean value of *DIV* is 0.7142, indicating that a large proportion of listed firms pay cash dividends, which is probably because of the semi-mandatory dividend payout requirements in China. Other variables are basically consistent with the literature, such as Li et al. (2018).

Table 3 shows the correlations of selected variables. It should be noted that the number of observations for calculating the correlation coefficient is 5,081, so *EPU* is not included in Table 3. CEO organizational iden-

Table 2
Descriptive statistics.

VARIABLE	*N*	*Mean*	*Sd.*	*Median*	*Min*	*Max*
Cash	5081	0.2162	0.2792	0.1288	0.0059	2.4542
INDCash	5081	0.0628	0.2691	−0.0138	−0.2160	2.2388
OI	5081	3.2265	0.1789	3.2581	1.7918	3.4012
CEO_OI	5081	25.547	3.8464	26	6	30
Stocksize	5081	0.4439	0.7504	0.1660	−0.9995	2.0577
Banksize	5081	2.7067	0.3279	2.6396	2.1159	3.3953
EPU	20,317	4.9144	0.3718	4.7769	4.4896	5.6881
LEV	5081	0.4366	0.2183	0.4207	0.0354	1.1471
CF	5081	0.0490	0.0910	0.0463	−0.2688	0.3200
AGE	5081	2.2461	0.6405	2.2725	0.6222	3.2600
NWC	5081	0.0556	0.2125	0.0654	−0.7371	0.5521
CAPEX	5081	0.0555	0.0551	0.0404	−0.0233	0.2593
SIZE	5081	22.0146	1.2385	21.8595	14.9416	28.0035
DSD	5081	0.0165	0.0653	0.0136	−0.1963	0.2162
CFVOL	5081	0.3313	0.6547	0.1049	0.0636	2.8144
BM	5081	0.8609	0.9719	0.5484	0.0752	7.9269
DIV	5081	0.7142	0.4518	1	0	1
LOSS	5081	0.1092	0.3120	0	0	1
SOE	5081	0.3757	0.4844	0	0	1
FIRST	5081	0.3531	0.1471	0.3346	0.0863	0.7525

Table 3
Correlations of selected variables.

VARIABLE	*Cash*	*INDCash*	*OI*	*Stocksize*	*Banksize*	*CF*	*SIZE*
Cash	1.0000						
INDCash	0.9814	1.0000					
	(0.0000)						
OI	−0.0069	−0.0047	1.0000				
	(0.6252)	(0.7359)					
Stocksize	0.1365	0.1115	0.0133	1.0000			
	(0.0000)	(0.0000)	(0.3439)				
Banksize	0.0798	0.0577	−0.0024	0.7663	1.0000		
	(0.0000)	(0.0000)	(0.8635)	(0.0000)			
CF	0.1827	0.1818	0.0069	0.0454	0.0250	1.0000	
	(0.0000)	(0.0000)	(0.6208)	(0.0012)	(0.0751)		
SIZE	−0.2606	−0.2377	0.0054	0.0140	0.0515	0.0286	1.0000
	(0.0000)	(0.0000)	(0.6993)	(0.3187)	(0.0002)	(0.0416)	

Notes: *P* value are in parentheses.

tification (*OI*) is negatively correlated with both cash holdings variables (*Cash* and *INDCash*), but the coefficients are insignificant. The two financial development variables (*Stocksize* and *Banksize*) are positively correlated with cash holdings (*Cash* and *INDCash*), which is intuitively consistent. The correlation coefficient between stock market development (*Stocksize*) and banking sector development (*Banksize*) is 0.7663, indicating that both types of development represent the level of financial development in the region. Both cash holdings variables (*Cash* and *INDCash*) are significantly positively correlated with net cash flow from operations (*CF*) and negatively correlated with firm size (*SIZE*).

Table 4 shows the regression results from testing Hypothesis 1. Following Li and Shi (2016), we add lagged cash holdings as a control variable, because cash is a firm's most liquid and flexible asset and its cash policy is often affected by previous periods. The dependent variables in column (1) and (2) are cash holdings (*Cash*) and cash holdings adjusted by industry (*INDCash*). The coefficients of *OI* are significantly negative at the 5% level in both regression models, suggesting that CEOs with higher organizational identification have lower firm cash

Table 4
CEO organizational identification and cash holdings.

VARIABLE	(1) *Cash*	(2) *INDCash*
OI	−0.0402**	−0.0385**
	(−2.4241)	(−2.3153)
$Cash_{t-1}$	0.6230***	
	(80.6378)	
$INDCash_{t-1}$		0.6205***
		(80.1132)
LEV	−0.1835***	−0.1856***
	(−10.4866)	(−10.5664)
CF	0.1487***	0.1451***
	(5.4113)	(5.2581)
AGE	−0.0007	−0.0052
	(−0.1536)	(−1.1034)
NWC	−0.1542***	−0.1551***
	(−9.9523)	(−9.9696)
CAPEX	−0.1021**	−0.0929**
	(−2.2397)	(−2.0316)
SIZE	−0.0079***	−0.0087***
	(−2.9062)	(−3.1593)
DSD	−0.2206***	−0.2210***
	(−6.3750)	(−6.3621)
CFVOL	0.0022***	0.0019***
	(5.5014)	(4.6085)
BM	0.0040	0.0037
	(1.1375)	(1.0633)
DIV	0.0061	0.0071
	(0.9916)	(1.1510)
LOSS	0.0163**	0.0161**
	(2.2900)	(2.2507)
SOE	0.0153***	0.0164***
	(2.7149)	(2.8873)
FIRST	0.0149	0.0142
	(0.9257)	(0.8798)
IND	YES	YES
YEAR	YES	YES
Constant	0.4080***	0.3786***
	(5.0722)	(4.6970)
F	305.68***	270.93***
Observations	5,081	5,081
Adj-R^2	0.6894	0.6629

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

holdings, which is consistent with H1a. The results indicate that CEO organizational identification can alleviate the agency problem and improve firm transparency, and thus firm cash holdings are lower.

Among the other variables, we find that firms with higher net cash flow from operations (*CF*) and higher cash flow volatility (*CFVOL*) usually have more cash holdings. In addition, state-owned enterprises (*SOE*) also tend to retain more cash. However, leverage (*LEV*), net working capital (*NWC*), capital expenditure (*CAPEX*), and short-term debt changes rate (*DSD*) are significantly negatively associated with cash holdings.

Table 5
Moderating effect of financial development.

VARIABLE	(1) *Cash*	(2) *INDCash*	(3) *Cash*	(4) *INDCash*
OI	−0.0238*	−0.0227*	0.0297	0.0297
	(−1.8888)	(−1.7982)	(0.9380)	(1.1101)
Stocksize	0.0409**	0.0410**		
	(2.1741)	(2.1879)		
OI × *Stocksize*	−0.0135**	−0.0136**		
	(−2.1054)	(−2.1305)		
Banksize			0.0745**	0.0835**
			(2.3543)	(2.3250)
OI × *Banksize*			−0.0211**	−0.0244**
			(−2.0705)	(−2.0995)
$Cash_{t-1}$	0.6269***		0.4689***	
	(25.5354)		(74.6902)	
$INDCash_{t-1}$		0.6200***		0.5000***
		(24.8250)		(75.4808)
LEV	−0.1721***	−0.1774***	−0.1764***	−0.1874***
	(−7.9222)	(−8.1006)	(−12.4536)	(−12.4991)
CF	0.1466***	0.1426***	0.1296***	0.1427***
	(3.4109)	(3.3076)	(5.7690)	(6.0607)
AGE	0.0002	−0.0055	−0.0068*	−0.0105***
	(0.0410)	(−0.9114)	(−1.7873)	(−2.6119)
NWC	−0.1384***	−0.1487***	−0.0918***	−0.1196***
	(−8.1109)	(−8.6502)	(−7.3795)	(−9.0111)
CAPEX	−0.1030*	−0.0944	−0.0183	−0.0278
	(−1.7113)	(−1.5579)	(−0.4939)	(−0.7111)
SIZE	−0.0083**	−0.0095***	−0.0073***	−0.0085***
	(−2.2687)	(−2.6086)	(−3.2794)	(−3.6395)
DSD	−0.2088***	−0.2194***	−0.1569***	−0.1849***
	(−6.0694)	(−6.3613)	(−5.5567)	(−6.2364)
CFVOL	0.0022***	0.0018**	0.0010***	0.0011***
	(2.9134)	(2.4656)	(2.9287)	(3.0612)
BM	0.0020	0.0038	−0.0015	0.0020
	(0.7293)	(1.4058)	(−0.5175)	(0.6638)
DIV	0.0069	0.0073	0.0076	0.0082
	(1.0217)	(1.0864)	(1.5115)	(1.5711)
LOSS	0.0158**	0.0166**	0.0157***	0.0245***
	(2.4116)	(2.5228)	(2.6901)	(3.4422)
SOE	0.0153***	0.0155***	0.0204***	0.0195***
	(2.8304)	(2.8876)	(4.4423)	(4.0446)
FIRST	0.0119	0.0131	0.0234*	0.0221
	(0.7728)	(0.8522)	(1.7765)	(1.6017)
IND	YES	YES	YES	YES
YEAR	YES	YES	YES	YES
Constant	0.3529***	0.3416***	0.1815*	0.1547*
	(4.0538)	(3.8998)	(1.6606)	(1.6531)
F	87.81***	73.67***	350.56***	246.80***
Observations	5,081	5,081	5,081	5,081
Adj-R^2	0.6901	0.6650	0.6737	0.6536

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

Table 5 shows the moderating effect of financial development on the association between CEO organizational identification and firm cash holdings. The financial development in columns (1) and (2) is stock market development (*Stocksize*), and in columns (3) and (4) is banking sector development (*Banksize*). The empirical results show that the coefficients on financial development are significantly positive in all four models, while the four interactions of CEO organizational identification and financial development ($OI \times Stocksize$; $OI \times Banksize$) are significantly negative at the 5% level, suggesting that in regions with greater financial development, higher CEO organizational identification leads to lower firm cash holdings. The reason is that financing is easier to obtain in regions with better financial development, and CEOs with stronger organizational identification are more likely to invest cash into projects in such an environment. The results are consistent with H2.

Table 6
Moderating effect of economic policy uncertainty.

VARIABLE	(1) *Cash*	(2) *INDCash*
OI	−0.0711***	−0.0696***
	(−3.7551)	(−3.6660)
EPU	−0.0095	−0.0090
	(−1.0557)	(−1.0038)
$OI \times EPU$	0.0050**	0.0049*
	(2.0043)	(1.9457)
$Cash_{t-1}$	0.8250***	
	(63.3413)	
$INDCash_{t-1}$		0.8252***
		(63.1756)
LEV	−0.2197***	−0.2200***
	(−18.2144)	(−18.2507)
CF	0.0346	0.0370
	(1.0480)	(1.1043)
AGE	−0.0126***	−0.0123***
	(−3.8931)	(−3.7825)
NWC	−0.2450***	−0.2457***
	(−21.4415)	(−21.3372)
CAPEX	−0.2195***	−0.2214***
	(−4.2552)	(−4.2512)
SIZE	−0.0073***	−0.0075***
	(−3.5973)	(−3.6485)
DSD	−0.3285***	−0.3281***
	(−13.7738)	(−13.6958)
CFVOL	0.0007**	0.0007**
	(2.5375)	(2.5157)
BM	0.0089***	0.0092***
	(5.8068)	(5.8828)
DIV	0.0074**	0.0074**
	(2.2780)	(2.2636)
LOSS	−0.0016	−0.0017
	(−0.4485)	(−0.4656)
SOE	0.0036	0.0033
	(1.2656)	(1.1604)
FIRST	0.0023	0.0030
	(0.2576)	(0.3291)
IND	YES	YES
YEAR	YES	YES
Constant	0.3797***	0.2229***
	(4.9763)	(2.8808)
F	237.24***	220.37***
Observations	20,317	20,317
Adj-R^2	0.6279	0.5975

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

Table 6 shows the results of the moderating effect of economic policy uncertainty on the association between CEO organizational identification and firm cash holdings. Following Wang et al. (2014) and Li and Shi (2016), we use firm-quarter observations (20,317) for the empirical test presented in Table 6. The results show that the coefficients on the interaction between economic policy uncertainty and CEO organizational identification ($OI \times EPU$) are significantly positive, which illustrates that the negative association between CEO organizational identification and firm cash holdings is weakened by higher economic policy uncertainty, and further demonstrates the defensive incentive for cash holdings. The moderating effects of financial development and economic policy uncertainty suggest that the association between CEO organizational identification and firm cash holdings varies with different contexts, which further supports the association between CEO organizational identification and firm cash holdings.

6. Further analysis

The results above show that CEO organizational identification lowers firm cash holdings, but they raise an interesting and intuitive question: where does this cash go? According to the preceding analysis, CEOs with stronger organizational identification are more likely to care about the firm's long-term performance; thus, it might seem logical that he/she would invest more to support firm development. To further explore this matter, we examine two possible channels: the association between CEO organizational identification and R&D investment, and the association between CEO organizational identification and capital expenditure. CEO organizational identification would alleviate agency costs and ensure the CEO has a longer investment horizon when making investment decisions. Therefore, we can infer that CEO organizational identification should be significantly positively associated with R&D investment and capital expenditure. We construct Model (2) to test this hypothesis.

$$R\&D_{it}/CAPEX_{it} = \alpha_0 + \alpha_1 OI_{it} + \alpha_2 LEV_{it} + \alpha_3 SIZE_{it} + \alpha_4 CF_{it} + \alpha_5 ROA_{it} + \alpha_6 Tobin'sQ + \alpha_7 SOE_{it} + \alpha_8 TOP_{it} + \sum IND + \sum YEAR + \varepsilon_{it} \quad (2)$$

Table 7
CEO organizational identification and investment expenditure.

	(1)	(2)
VARIABLE	*R&D*	*CAPEX*
OI	1.2026***	0.0097**
	(2.6711)	(1.9995)
LEV	−7.2521***	−0.0225***
	(−15.3136)	(−5.6731)
SIZE	0.6256***	0.0024***
	(6.7808)	(3.2073)
CF	4.5357***	0.0926***
	(3.7725)	(11.6639)
ROA	−10.2180***	0.0540***
	(−6.8458)	(3.3458)
Tobin'sQ	0.2531***	−0.0010***
	(5.3698)	(−3.1464)
SOE	−1.1638***	−0.0146***
	(−6.5407)	(−9.6357)
TOP	−0.0878	0.0009
	(−0.1639)	(0.1943)
Constant	−13.9900***	−0.0148
	(−5.6104)	(−0.6548)
LR chi2/F	2369.24***	36.94***
Observations	5,081	5,081
PseudoR^2/Adj-R^2	0.0975	0.1739

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

The dependent variable in Model (2) is either R&D investment (*RD*) or capital expenditure (*CAPEX*). *RD* is defined as the ratio of the firm's R&D investment to operating income. We also add *Tobin's Q* as a control variable. All of the other variables are as defined in Table 1.

Table 7 shows the regression results of Model (2). Column (1) reports the estimates from the Tobit model and shows that higher CEO organizational identification is associated with higher R&D investment. The dependent variable in Column (2) is capital expenditure and the coefficient on CEO organizational identification (*OI*) is significantly positive, indicating that CEOs with stronger organizational identification are associated with more capital expenditure. Taking these results together, we find that CEOs with stronger organizational identification are more likely to make long-term plans for the firm, hold less cash, and make more investment expenditures to seize development opportunities.

We further investigate whether CEO organizational identification promotes the value of cash holdings. Based on the agency motivation for cash holdings, we expect that CEO organizational identification can enhance the firm value of cash holdings. Following Zheng et al. (2014) and Li et al. (2018), we construct Model (3) for our test.

$$\begin{aligned} ROA_{it}/Tobins'Q_{it} &= \alpha_0 + \alpha_1 OI_{it} + \alpha_2 Cash_{it} + \alpha_3 OI_{it} \times Cash_{it} + \alpha_4 LEV_{it} \\ &+\alpha_5 SIZE_{it} + \alpha_6 FIRST_{it} + \alpha_7 SOE_{it} + \alpha_8 SALE_{it} + \sum IND + \sum YEAR + \varepsilon_{it} \end{aligned} \tag{3}$$

$SALE_{it}$ refers to firm *i*'s revenue growth rate in year *t*, and other variables are the same as in Table 1. In Model (3), we use the accounting performance indicator ROA_{it} (firm *i*'s return on total assets in year *t*) and the market performance indicator *Tobin's* Q_{it} as the measurement variable for firm value.

In columns (1) and (3) of Table 8, where ROA_{it} is the dependent variable, the interaction of CEO organizational identification and cash holdings is significantly positive at the 10% level. In columns (2) and (4), where *Tobin's* Q_{it} is the dependent variable, the interaction of CEO organizational identification and cash holdings is significantly positive at the 1% level. Notably, the coefficients on *OI* are significantly positive in columns (2)

Table 8
CEO organizational identification, cash holdings, and firm value.

VARIABLE	(1) *ROA*	(2) *Tobin's Q*	(3) *ROA*	(4) *Tobin's Q*
OI	−0.0002	0.4770***	0.0039	0.4780***
	(−0.0475)	(2.7537)	(0.9419)	(2.7569)
Cash	−0.0718	0.8880***		
	(−1.5811)	(5.8566)		
OI × *Cash*	0.0250*	0.0125***		
	(1.7785)	(2.6507)		
INDCash			−0.0717	0.7468***
			(−1.5051)	(5.1977)
OI × *INDCash*			0.0245*	0.0122**
			(1.6588)	(2.5729)
LEV	−0.1223***	−0.2392	−0.1230***	−0.3007*
	(−32.2066)	(−1.4186)	(−32.5162)	(−1.7963)
SIZE	0.0118***	−0.9965***	0.0118***	−0.9989***
	(17.9884)	(−34.8205)	(17.9368)	(−34.8916)
FIRST	0.0184***	0.2989	0.0186***	0.3085
	(3.8493)	(1.4472)	(3.8854)	(1.4924)
SOE	−0.0111***	−0.3043***	−0.0112***	−0.3017***
	(−7.1873)	(−4.5554)	(−7.1950)	(−4.5138)
SALE	0.0211***	0.3888***	0.0211***	0.3880***
	(18.3128)	(7.6414)	(18.2924)	(7.6187)
Constant	−0.2036***	24.4246***	−0.2148***	24.6263***
	(−9.2223)	(29.3318)	(−11.0526)	(29.6462)
F	98.76***	165.07***	98.49***	164.45***
Observations	5,118	5,118	5,118	5,118
Adj-R²	0.2761	0.4024	0.2756	0.4015

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

and (4), indicating that firms with higher CEO organizational identification perform better in the market. These results suggest that CEO organizational identification can alleviate agency problems, improve the value of cash holdings, and promote firm value in the long term.

7. Robustness and endogeneity tests

Considering that the CFO may also play a significant role in a firm's financial decision making, we control the effect of CFO organizational identification (*CFO_OI*) in Table 4 to regress Model (1); the measurement is consistent with CEO organizational identification. As shown in Table 9, the coefficients on CFO organizational identification (*CFO_OI*) are positive but insignificant in both regression models. The core variable that we focus on, CEO organizational identity (*OI*), is still significantly negative at the 5% level, suggesting that our

Table 9
Robustness test adding CFO organizational identification.

VARIABLE	(1) *Cash*	(2) *INDCash*
OI	−0.0441**	−0.0417**
	(−2.4093)	(−2.2655)
CFO_OI	0.0028	0.0013
	(0.2279)	(0.1070)
$Cash_{t-1}$	0.6137***	
	(78.2872)	
$INDCash_{t-1}$		0.6114***
		(77.7877)
LEV	−0.1836***	−0.1856***
	(−10.4470)	(−10.5165)
CF	0.1376***	0.1341***
	(4.9753)	(4.8259)
AGE	−0.0011	−0.0056
	(−0.2396)	(−1.1816)
NWC	−0.1536***	−0.1545***
	(−9.8668)	(−9.8794)
CAPEX	−0.0874*	−0.0788*
	(−1.9077)	(−1.7112)
SIZE	−0.0081***	−0.0088***
	(−2.9540)	(−3.1870)
DSD	−0.2220***	−0.2225***
	(−6.3870)	(−6.3717)
CFVOL	0.0023***	0.0019***
	(5.5797)	(4.6960)
BM	0.0037	0.0034
	(1.0466)	(0.9626)
DIV	0.0070	0.0081
	(1.1391)	(1.3012)
LOSS	0.0163**	0.0162**
	(2.2849)	(2.2545)
SOE	0.0152***	0.0162***
	(2.6822)	(2.8478)
FIRST	0.0176	0.0169
	(1.0893)	(1.0389)
IND	YES	YES
YEAR	YES	YES
Constant	0.4165***	0.3870***
	(5.1077)	(4.7335)
F	281.06***	248.89***
Observations	4,985	4,985
Adj-R^2	0.6810	0.6540

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

result is not influenced by CFO organizational identification. In addition, when CFO organization identification (*CFO_OI*) is included in Tables 5 and 6, the results remain unchanged (untabulated).

Since there is some homogeneity in the 6-item scale of organizational identification, we directly sum the scores to measure CEO organizational identification. To obtain more robust results, we adopt the principal component analysis method to construct CEO organizational identification. Through dimensionality reduction, principal component analysis can transform multiple variables into a few comprehensive indicators through linear transformation, in which each principal component reflects most of the information from the original variables. Table 10 shows the results of using CEO organizational identification constructed by the first principal component. We find that CEO organizational identification is still significantly negative at the 5% level, which is consistent with Table 4.

In the hypothesis development section, our preliminary theoretical argument concerning CEO organizational identification and firm cash holdings relied on the principal-agent theory. To make our results more robust, we incorporate five typical corporate governance variables in Model (1), including duality (*DUAL*,

Table 10
CEO organizational identification constructed by principal component analysis.

VARIABLE	(1) *Cash*	(2) *INDCash*
OI	−0.0026**	−0.0025**
	(−2.2870)	(−2.1637)
$Cash_{t-1}$	0.6231***	
	(80.6498)	
$INDCash_{t-1}$		0.6206***
		(80.1244)
LEV	−0.1833***	−0.1853***
	(−10.4752)	(−10.5546)
CF	0.1488***	0.1452***
	(5.4148)	(5.2615)
AGE	−0.0007	−0.0052
	(−0.1517)	(−1.1013)
NWC	−0.1540***	−0.1549***
	(−9.9393)	(−9.9567)
CAPEX	−0.1034**	−0.0942**
	(−2.2682)	(−2.0587)
SIZE	−0.0079***	−0.0086***
	(−2.8994)	(−3.1530)
DSD	−0.2203***	−0.2207***
	(−6.3662)	(−6.3539)
CFVOL	0.0022***	0.0019***
	(5.4941)	(4.6012)
BM	0.0040	0.0037
	(1.1322)	(1.0577)
DIV	0.0061	0.0071
	(0.9929)	(1.1525)
LOSS	0.0163**	0.0161**
	(2.2913)	(2.2522)
SOE	0.0152***	0.0163***
	(2.6993)	(2.8724)
FIRST	0.0150	0.0144
	(0.9336)	(0.8877)
IND	YES	YES
YEAR	YES	YES
Constant	0.2774***	0.2533***
	(4.6746)	(4.2679)
F	305.62***	270.88***
Observations	5,081	5,081
Adj-R^2	0.6893	0.6628

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

defined as 1 if the chairman and CEO are the same person, and otherwise 0), board size (*BDSIZE*, defined as the natural logarithm of the number of directors), ratio of independent directors (*INDEPENDENT,* defined as the ratio of the number of independent directors to the number of board directors), management shareholding (*MNGHLD*, defined as 1 if the management holds shares, and otherwise 0), and CEO compensation (*CEO-*

Table 11
Regression results after controlling corporate governance factors.

VARIABLE	(1) *Cash*	(2) *INDCash*
OI	−0.0267**	−0.0401**
	(−2.0946)	(−2.1791)
$Cash_{t-1}$	0.6239***	
	(25.3276)	
$INDCash_{t-1}$		0.6213***
		(24.9537)
LEV	−0.1832***	−0.1859***
	(−8.2295)	(−8.2999)
CF	0.1511***	0.1474***
	(3.4871)	(3.3893)
AGE	−0.0004	−0.0048
	(−0.0584)	(−0.7707)
NWC	−0.1548***	−0.1560***
	(−8.5885)	(−8.6070)
CAPEX	−0.1087*	−0.0977
	(−1.7607)	(−1.5679)
SIZE	−0.0080**	−0.0089**
	(−2.0960)	(−2.3054)
DSD	−0.2168***	−0.2174***
	(−6.2850)	(−6.2898)
CFVOL	0.0022***	0.0019**
	(2.9554)	(2.4784)
BM	0.0040	0.0038
	(1.4373)	(1.3579)
DIV	0.0050	0.0060
	(0.7363)	(0.8922)
LOSS	0.0159**	0.0157**
	(2.3869)	(2.3563)
SOE	0.0154***	0.0169***
	(2.7523)	(3.0482)
FIRST	0.0121	0.0113
	(0.7293)	(0.6843)
DUAL	0.0068	0.0077
	(1.1205)	(1.2562)
BDSIZE	0.0028	0.0040
	(0.2135)	(0.3007)
INDEPENDENT	0.0153	0.0227
	(0.3468)	(0.5148)
MNGHLD	−0.0093*	−0.0086*
	(−1.7941)	(−1.6611)
CEOPAY	0.0027*	0.0028*
	(1.8292)	(1.8675)
IND	YES	YES
YEAR	YES	YES
Constant	0.3268***	0.3435***
	(3.5644)	(3.3335)
F	65.73***	57.85***
Observations	5,049	5,049
Adj-R^2	0.6922	0.6661

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

PAY, defined as the natural logarithm of CEO compensation). As shown in Table 11, the coefficient on CEO organizational identification (*OI*) remains significantly negative. It is worth noting that only the coefficients on *MNGHLD* and *CEOPAY* are significant at the 10% level, while the coefficients on other corporate governance variables are insignificant, indicating that when management holds shares, they tend to pay more attention to the firm's long-term development and consequently engage in more investment. Conversely, when he/she has high vested interest, a CEO with higher compensation perhaps lacks the incentive to pay attention to the firm's future development, leading to higher cash holdings, which is partly consistent with the findings in Dittmar et al. (2003) and Xin and Xu (2006). One possible explanation for why the other three corporate governance variables are insignificant is that corporate governance is an integral concept, and different sub-indicators of corporate governance need to be integrated to achieve better corporate governance effects. Another possible explanation is that CEO organizational identification has a certain corporate governance function, and some of the governance effects of sub-indicators are substituted by CEO organizational identification.

One important assumption in this paper is that CEO organizational identification does not change over a short period of time, as this would probably lead to an overestimation of the T-value of *OI*. To exclude the

Table 12
Regression results using only the sample from 2014.

VARIABLE	(1) *Cash*	(2) *INDCash*
OI	−0.0495**	−0.0519**
	(−2.5141)	(−2.1616)
$Cash_{t-1}$	0.5801***	
	(41.6510)	
$INDCash_{t-1}$		0.5780***
		(41.6150)
LEV	−0.0834***	−0.0843***
	(−3.2648)	(−3.3031)
CF	0.3868***	0.3820***
	(9.5109)	(9.4719)
AGE	0.0025	0.0068
	(0.3704)	(1.0121)
NWC	−0.0905***	−0.0908***
	(−3.9849)	(−3.9689)
CAPEX	−0.4084***	−0.4014***
	(−6.1045)	(−6.0442)
SIZE	0.0117***	0.0108***
	(3.0072)	(2.7841)
DSD	0.0061	0.0064
	(0.1220)	(0.1290)
CFVOL	0.1621	−0.0136**
	(1.5659)	(−2.4146)
BM	−0.0142**	−0.0122**
	(−2.4109)	(−2.0816)
DIV	−0.0007	0.0001
	(−0.0801)	(0.0101)
LOSS	0.0161	0.0181*
	(1.5349)	(1.7411)
SOE	0.0033	0.0024
	(0.4082)	(0.2910)
FIRST	−0.0084	−0.0078
	(−0.3593)	(−0.3341)
IND	YES	YES
Constant	−0.0002	−0.0257
	(−0.0022)	(−0.2250)
F	108.16***	76.67***
Observations	1767	1767
Adj-R^2	0.6120	0.5930

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

possible impact of the sample period, we use the sample in 2014 to re-regress Model (1). As shown in Table 12, the coefficient on *OI* is still significantly negative at the 5% level, indicating that the results of our paper are relatively robust.

As there may be endogeneity between CEO organizational identification and firm cash holdings, we apply the instrumental variable method to eliminate endogeneity concerns. According to the principles of econometrics, the instrumental variable should be related to the endogenous variable, and unrelated to the *OLS* regression residual items. Accordingly, we use a dummy variable indicating whether the CEO's first job was with the current firm as the instrumental variable (*FIRSTJOB*). More specifically, if the CEO's first job was with the current firm, *FIRSTJOB* is defined as 1, and otherwise 0. If the CEO's first job was with the current firm, he/she may have a stronger organizational identification, and the independent variable (*OI*) and instrumental variable (*FIRSTJOB*) are significantly and positively correlated. As shown in Table 13, the coefficients on

Table 13
Endogeneity test.

VARIABLES	(1) *OI*	(2) *Cash*	(3) *OI*	(4) *INDCash*
OI (IV = FIRSTJOB)		−0.5609*		−0.5696*
		(−1.8614)		(−1.8441)
$Cash_{t-1}$	0.0005	0.4653***		
	(0.0739)	(31.6500)		
$INDCash_{t-1}$			−0.0007	0.4958***
			(−0.1232)	(30.5536)
LEV	−0.0458***	−0.2064***	−0.0466	−0.2150***
	(−3.0558)	(−8.3103)	(−3.2486)	(−8.1604)
CF	−0.0033	0.1193***	−0.0030	0.1295***
	(−0.1351)	(3.4806)	(−0.1291)	(3.6318)
AGE	−0.0039	−0.0105*	−0.0040	−0.0153***
	(−1.0035)	(−1.9143)	(−1.0439)	(−2.6681)
NWC	−0.0197	−0.1088***	−0.0201	−0.1366***
	(−1.5154)	(−6.3568)	(−1.5809)	(−7.5709)
CAPEX	0.0107	−0.0197	0.0109	−0.0329
	(0.2805)	(−0.4001)	(0.2873)	(−0.6281)
SIZE	0.0007	−0.0072**	0.0007	−0.0085***
	(0.2875)	(−2.4037)	(0.2879)	(−2.7548)
DSD	0.0184	−0.1692***	0.0188	−0.1972***
	(0.6310)	(−4.7479)	(0.6541)	(−5.3422)
CFVOL	0.0002	0.0007	0.0002	0.0008
	(0.6394)	(1.2842)	(0.7036)	(1.2602)
BM	0.0032	0.0003	0.0032	0.0039
	(1.0719)	(0.1050)	(1.1325)	(1.2960)
DIV	−0.0063	0.0070	−0.0063	0.0066
	(−1.1984)	(1.1177)	(−1.2312)	(1.0162)
LOSS	−0.0078	0.0126*	−0.0078	0.0137**
	(−1.3384)	(1.8611)	(−1.3216)	(1.9709)
SOE	−0.0002	0.0204***	−0.0002	0.0195***
	(−0.0443)	(4.0421)	(−0.0428)	(3.7731)
FIRST	−0.0205	0.0117	−0.0203	0.0112
	(−1.5438)	(0.7616)	(−1.5249)	(0.7083)
FIRSTJOB	0.0133***		0.0133***	
	(3.2674)		(3.1993)	
IND	YES	YES	YES	YES
YEAR	YES	YES	YES	YES
Constant	3.2691	2.1428**	3.2676	2.1422**
	(63.4038)	(2.1801)	(69.3832)	(2.1267)
F	2.63***	133.20***	2.39***	125.59***
Observations	5,081	5,081	5,081	5,081
Adj-R^2	0.0073	0.5743	0.0073	0.5562

Notes: *T* statistics are in parentheses. Significance is indicated at the ***0.01, **0.05, and *0.1 levels.

OI are significantly negative at the 10% level, indicating that CEO organizational identification is still significantly negatively associated with cash holdings after using the instrumental variable to eliminate endogeneity concerns.

8. Conclusion

Executives' psychological characteristics have a crucial impact on firms' financial decision-making behavior. Using survey data from listed firms in China, this paper investigates the association between CEO organizational identification and firm cash holdings. The empirical results show that CEO organizational identification is significantly negatively associated with cash holdings, suggesting that it can mitigate the agency problem. We then examine two different factors, financial development and economic policy uncertainty. We find that financial development strengthens the negative association between CEO organizational identification and firm cash holdings, greater financial development makes it more convenient for the firm to obtain financing, and CEOs with higher organizational identification are more likely to make long-term plans for the firm, increasing its investments and thus holding less cash. Therefore, in regions with higher financial development, CEOs with stronger organizational identification hold less cash. In contrast, economic policy uncertainty mitigates the negative association between CEO organizational identification and firm cash holdings, demonstrating the defensive incentive effect of cash holdings. Under higher economic policy uncertainty, CEOs tend to increase their cash holdings to avoid problems such as financial distress. Further analysis reveals a significant positive association between CEO organizational identification and R&D investment and capital expenditure, which indirectly supports our main conclusion that the decrease in cash holding may be caused by greater spending on investments. In addition, we find that CEO organizational identification promotes the value of cash holdings. In a robustness test, because the CFO will also exert a major impact on the firm's financial decisions, we add CFO organizational identification to the regression model, and the results remain unchanged. Principal component analysis is also applied to construct CEO organizational identification, and the results still remain unchanged. We also incorporate typical corporate governance variables in our model, and the results remain the same. Our research demonstrates the effect of executive psychological characteristics on corporate financial decision-making behaviors.

This paper has several critical policy implications. According to the theory of organizational identification, when the characteristics of individuals' self-concept are similar to the organizational characteristics, a sense of organizational identification is reinforced. Therefore, when a firm hires a new CEO, it can check the consistency of his or her work methods, goals, beliefs, and values with the organization's, and inquire about his/her views on the organization's culture. In addition, firms can enhance executives and employees' awareness of the firm's mission and vision, and promote their sense of ownership and corporate identification in various ways, including staff training and promoting the unique culture of the organization. However, one shortcoming of this paper is that the cost of investigating the most important variable, CEO organizational identification, is very high, and a second similar investigation cannot be conducted. Thus, this paper can only use cross-sectional data for an empirical test but cannot test the causal inference that is prevalent in the financial field.

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.

Acknowledgements

We appreciate the financial support from the National Natural Science Foundation of China (Grant No. 71862017; 71802199; 71972152), China Postdoctoral Science Foundation (Grant No. 2018M642587), Shenzhen "Peacock Project" High-level Talents Research Foundation, Shenzhen Key Research Base of Humanities and Social Science, China (Xi'an) Institute for Silk Road Research Program (Grant No. 2019YA03), and Education Department of Shaanxi Province Key Research Base of Philosophy and Social Science (Grant No. 20JZ053).

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China Journal of Accounting Research 14 (2021) 207–230

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Examining export trade and corporate innovation: A multiphase difference-in-differences method

Donghua Zhou *, Jianfei Peng, Xue Gao

School of Accountancy, Jiangxi University of Finance and Economics, China

ARTICLE INFO

Article history:
Received 15 June 2020
Accepted 26 January 2021
Available online 23 March 2021

Keywords:
Export trade
Technological innovation
Economies of scale
Risk-taking

ABSTRACT

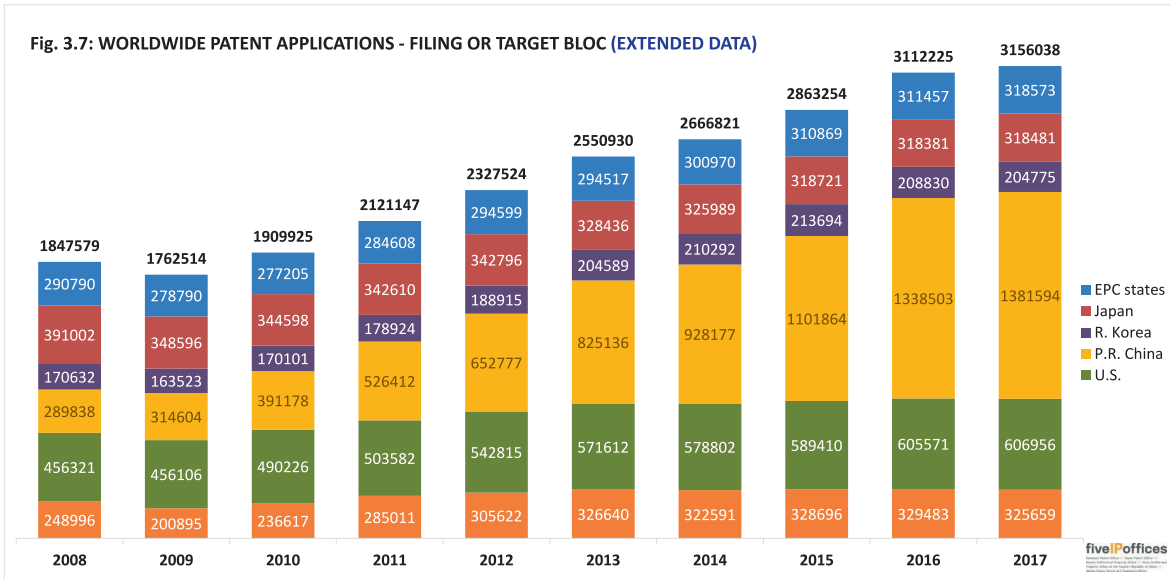
Using a multiphase difference-in-differences model, this study investigates the relationship between export trade and the corporate technological innovation of listed companies. It reveals that engaging in export trade increases corporate innovation input and output. In terms of patent output, export trade greatly promotes the output of invention patents and utility model patents with a high technological content. These conclusions remain valid after a series of robustness and endogeneity tests. Regarding the mechanisms of the observed relationships, export trade stimulates corporate technological innovation mainly by realizing economies of scale and increasing risk-taking. The positive correlation between export trade and corporate technological innovation is strongest among state-owned enterprises, non-high-tech enterprises, enterprises based in central and eastern China, enterprises engaged in general trade, and enterprises exporting to developed economies. Given the growing trade frictions ongoing at the time of writing, the conclusions of this study provide vital practical guidance and empirical evidence for a national strategy of innovation-driven development.

1. Introduction

According to the 2017 Statistics Report[1] released by IP5, a coalition of the world's five largest patent offices, the number of patent applications filed by China in 2017 reached 1.381 million, which is 3% higher than in 2016. As shown in Fig. 1, of the five countries and regions with the most patent filings (which also

* Corresponding author.
☆ The authors acknowledge financial support from the National Natural Science Foundation of China (No. 71972091). We are also grateful for the helpful comments made by Minggui Yu and participants in the CJAR Summer Research Workshop in 2020.
[1] www.fiveipoffices.org/statistics.html.

https://doi.org/10.1016/j.cjar.2021.01.002
1755-3091/



Filing bloc	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EPC states	283030	284595	287014	296238	290790	278790	277205	284608	294599	294517	300970	310869	311457	318573
Japan	423081	427078	408674	396291	391002	348596	344598	342610	342796	328436	325989	318721	318381	318481
R. Korea	140115	160921	166189	172469	170632	163523	170101	178924	188915	204589	210292	213694	208830	204775
P.R. China	130384	173327	210501	245161	289838	314604	391178	526412	652777	825136	928177	1101864	1338503	1381594
U.S.	356943	390733	425967	456154	456321	456106	490226	503582	542815	571612	578802	589410	605571	606956
Others	173904	190721	227270	184518	248996	200895	236617	285011	305622	326640	322591	328696	329483	325659
Total	1507457	1627375	1725615	1750831	1847579	1762514	1909925	2121147	2327524	2550930	2666821	2863254	3112225	3156038

Fig. 1. Patent applications of the five countries and regions with the most patent filings from 2013 to 2017, The related data are available at https://www.fiveipoffices.org/wcm/connect/fiveipoffices/8c519416-173d-4b32-99ed-5387045c46a2/IP5+Statistics+Report+2018_2012 2019_full.pdf?MOD=AJPERES&CVID= (p. 40 Fig. 3.7).

include the European Union, the U.S., Japan, and South Korea), China accounts for the largest proportion of the total number of patent applications worldwide, and its share is increasing.

However, lacking core technologies and proprietary brands, most locally operating Chinese enterprises are still merely processors of medium- and low-end products in the global value chain (Tao et al., 2020). Facing growing Sino–U.S. trade frictions and the increasingly stringent restrictions on technology transfer imposed by the U.S. government, Chinese enterprises, which generally lack high-end core technologies, are suffering under constraints imposed by Europe, the U.S., and other countries and regions producing technology spillover effects (Zhang et al., 2018). To overcome its technological dependence on U.S.-led developed countries in the West, China must improve its technological innovation. At the New Economy Forum held in Beijing on November 22, 2019, China's General Secretary Xi Jinping stated: "Innovation is a great challenge of our time. The world is undergoing major and unprecedented changes this century, and a new round of technological change and industrial revolution is in the ascendant."[2] According to Keller (2010), the technological innovation of most countries is attributable to technology spillovers produced by trade. Therefore, whether export trade can effectively promote corporate innovation is an issue of great practical significance.

Most studies of corporate innovation have focused on the roles of national policies, corporate governance, and other non-trade factors. Relevant national policies include juridical protection (Pan et al., 2015), industrial policies (Li and Zheng, 2016; Yu et al., 2016a; 2016b; Howell, 2017), government subsidies (Yang et al., 2015; Mao and Xu, 2015; Guo, 2018), and tax reforms (Lin et al., 2013; Li and Wang, 2017; Sun, 2017). Relevant corporate governance factors comprise mainly ownership structure (La Porta et al., 1999; Li and Yu,

[2] http://www.xinhuanet.com/politics/leaders/2019–11/22/c_1125264342.htm.

2015; Chen et al., 2019), employee motivation (Meng et al., 2019; Zhou et al., 2019), business assessment (Yu et al., 2016a; 2016b; Li et al., 2018), and executive characteristics (Yu et al., 2018a; 2018b; He et al., 2019).

Since the start of its economic reforms and liberalization, China has experienced rapid economic growth and strengthened its trade connections with other countries, becoming a trading power with global influence (He et al., 2020). The rapid growth of export trade greatly increases innovation activities (Li et al., 2016). When enterprises start exporting, they encounter more intense competition in a broader market, which encourages them to innovate. For example, technology spillovers from the advanced products of developed countries have enabled Chinese enterprises to learn from and absorb new technologies (Li and Zhu, 2006; Tao et al., 2020). Increased trade demands also generate more profits for enterprises, thus enhancing their culture of and capacity for innovation. In this sense, export trade is an important factor influencing corporate innovation. Unfortunately, however, the relationship between export trade and corporate innovation has rarely been explored.

In terms of input, enterprises engage in export trade naturally increase their input of production factors because the demand for their products is increasing overseas. In addition, the increased output scale in a broader market lowers average production costs and realizes economies of scale. From the perspective of technology spillovers, exporting enterprises greatly increase their risk-taking by learning from advanced production technologies, technological processes, and organizational management (Xu et al., 2015). Economies of scale and risk-taking and can foster corporate innovation (Lileeva and Trefler, 2010; Zhou et al., 2019). This study seeks to answer the following two questions. How do economies of scale influence the relationship between export trade and corporate innovation? How does the level of risk-taking influence the relationship between export trade and corporate innovation?

To answer these questions, we empirically examine the relationship between export trade and the corporate innovation of listed companies. We find that engaging in export trade promotes corporate innovation in terms of both input and output. Our conclusions remain valid following a series of tests for robustness and endogeneity. Export trade stimulates corporate technological innovation mainly through economies of scale and increased levels of risk-taking. The stimulating effects of export trade are observed mainly in state-owned enterprises, non-high-tech enterprises, enterprises based in central and eastern China, and enterprises that engage in general trade and export to developed countries.

This study makes two contributions to the field. First, related studies have rarely examined listed companies; most have used data on small and medium-sized enterprises (SMEs) from the China Industry Business Performance Database to explore the relationship between export trade and corporate technological innovation (Li et al., 2016). According to the Schumpeterian hypothesis, larger enterprises usually have a stronger and more independent capacity for innovation (Schumpeter, 1942). SMEs generally engage in superficial, application-oriented innovation activities, such as the pure imitation or refinement of existing technologies. In contrast, listed companies have a fundamental and radical potential for technological innovation, such as revolutionizing existing technologies or pioneering explorations of unknown fields (Chi, 2002). They generally engage in high-end innovation activities that erect long-lasting technological barriers and accurately reflect their country's level of technological innovation. Thus, by examining the relationship between listed companies' export trade and corporate innovation, this study serves as an important supplement to the literature in this field. The second contribution made by this study is to clarify the mechanism by which export trade influences corporate innovation from the perspectives of risk-taking and economies of scale. In light of the Sino–U.S. trade frictions ongoing at the time of writing, this study offers vital practical guidance for Chinese enterprises on maintaining their export trade, improving their innovation ability, abandoning their heavy dependence on U.S. science and technology, and contributing to China's transformation into an innovation-driven nation.

Part II of this paper presents the literature review and hypotheses. Part III describes the design of the study. Part IV discusses the empirical results. Part V presents the conclusions and offers recommendations to Chinese enterprises to improve their innovation capacity under the background of Sino–U.S. trade frictions.

2. Literature review and hypotheses

2.1. Literature review

In the field of international trade, two key hypotheses have been proposed regarding the relationship between export trade and corporate technological innovation. The first relates to "self-selection" effects and the second concerns "learning by exporting" effects. The first hypothesis states that export barriers (specifically the costs of transportation, distribution and marketing, and adapting products to meet foreign standards) allow only enterprises with high productivity to overcome the impact of sunk costs and enter the export market. Hence, according to this hypothesis, corporate technological innovation affects exports. In contrast, the hypothesis regarding learning by exporting effects states that exporting enterprises can acquire new technological knowledge from competitors, partners, and customers. Hence, the hypothesis suggests that export trade affects corporate technological innovation (De Loecker, 2007; Zhao and Li, 2007; Qian et al., 2011; Li et al., 2016; Zhang et al., 2016).

2.1.1. Self-selection effects

The concept of self-selection effects is first proposed by Clerides et al. (1998), who state that innovation increases enterprises' productivity and affects their export decisions. In a study of U.S. enterprises, Bernard and Jensen (1999; 2004b) find that even new entrants into the export market are more productive than non-exporting enterprises are. Examining manufacturing data from South Korea, Aw et al. (2000) discover self-selection effects among newly exporting enterprises. Using a trade model with heterogeneous enterprises, Melitz (2003) explains the relationship between enterprise differences and export behaviors and shows that trade openness increases the productivity of an entire industry through the self-selection effects produced by enterprises' exporting behaviors. Studies in this field have also discovered self-selection effects among British enterprises (Girma et al., 2004), German enterprises (Wagner, 2002; Arnold and Hussinger, 2005), and Chinese enterprises (Qian et al., 2011; Yi and Fu, 2011; Qiu et al., 2012). However, other scholars note that the productivity of exporting Chinese enterprises is lower than that of non-exporting enterprises, i.e., the "productivity paradox." They argue that the large number of processing trade enterprises in China has dragged down the average productivity of exporting enterprises, thereby negating self-selection effects (Li, 2010; Lu et al., 2010).

2.1.2. Learning by exporting effects

According to the learning by exporting hypothesis, exporting enterprises in a broad and competitive market learn advanced production technologies that further strengthen their ability to learn (Xiang and Ma, 2013). Long a hotspot issue in the field of international trade, learning by exporting effects have been extensively studied by scholars both in China and abroad, but no unanimous conclusions have been reached. As indicated by the levels of economic development in exporting countries, learning by exporting effects do not arise in the majority of developed countries (Bernard and Jensen, 2004a; Wagner, 2002; Greenaway and Yu, 2004). However, such effects have been observed in newly industrializing economies and developing countries (Clerides et al., 1998; Aw et al., 2000; Alvarez and Lopez, 2005). By taking part in international competition, newly industrializing economies and developing countries are able to learn from and absorb advanced technologies from developed countries, thus improving their independent innovation ability (Aw et al., 2000; De Loecker, 2007; Alvarez and Lopez, 2005). However, from the perspective of industry characteristics, learning by exporting effects are diminished or negated in industries with large numbers of foreign-funded enterprises (Greenaway and Kneller, 2007).

In recent years, extensive efforts have been made to explore learning by exporting effects in samples of Chinese enterprises. Focusing on modes of trade, Zhang et al. (2008), Li and Zhao (2010), Fan and Feng (2013), and Bao et al. (2014) find few or no long-term learning by exporting effects among Chinese enterprises. They conclude that significant learning by exporting effects exist among general trade enterprises but not processing trade enterprises, which account for the majority of Chinese enterprises. Studies show that processing trade enterprises are locked into labor-intensive links with low technological content (Bao et al., 2014). Such enterprises are reliant on low-end manufacturing, exogenous export trade intermediaries, and sufficiently cheap

labor, and lack the pressure and motivation to increase their efficiency (Jing et al., 2012). Unlike general trade enterprises, processing trade enterprises enter the international market by joining the global value chains of multinational corporations. They neither directly compete with other enterprises nor enter into direct contact with the ultimate purchasers in the international market, so they do not experience the learning by exporting effects observed among general trade enterprises (Lv et al., 2016). However, some scholars take the opposite view. Using microdata from China, Dai and Yu (2012) find that enterprises exporting for the first time see a productivity increase of 2% in their first year of exporting, but no significant increases in the following years. Examining survey data released by the World Bank, Wang et al. (2011) observe learning by exporting effects among Chinese enterprises. Using the propensity score matching (PSM) difference-in-differences (DID) (PSM-DID) method, Qiu et al. (2012) perform a two-sided test of the causality between the export behaviors and productivity of Chinese manufacturing enterprises. They conclude that significant learning by exporting effects exist among Chinese manufacturing enterprises and that these effects gradually increase over time. Exploring the relationship between enterprises' engagement in export trade and independent innovation, Li et al. (2016) report that the effects of exportation on corporate technological innovation show an inverted "U" shape, with an initial increase followed by a decrease.

2.2. Theoretical analysis and hypotheses

Export trade can promote the technological innovation of a country (Wagner, 2007). When an enterprise begins to export, it must conduct technological innovation to stay competitive in the international arena by meeting the demands of new customers and markets. Compared with non-exporting enterprises, exporting enterprises are more productive (Melitz, 2003; Wagner, 2007) and more competitive (Mao and Sheng, 2014). In pursuit of development, exporting enterprises tend to seek business expansion in the international market after meeting domestic demands (Mao and Wang, 2006). However, an expanded market brings more intense competition, and to earn a place in the highly competitive international market, exporting enterprises must either provide better products or charge lower prices. Both options require technological innovation, either to upgrade product quality (Faruq, 2010) or to reduce costs, leading to lower prices (Chen, 2002).

According to the learning by exporting hypothesis, export trade offers developing countries an important means of acquiring technology spillovers from developed countries and accessing advanced technological knowledge. Within an industry, technology spillovers from new foreign customers and competitors help enterprises to strengthen their technological innovation. Across industries, export trade promotes mutual integration, exchange, and cooperation through the global division of labor. Technology spillovers also facilitate the sharing of innovation-related resources, thus promoting technological innovation among exporting enterprises. Moreover, export trade leads to "induced innovation", as exporting enterprises can improve their technological innovation by "learning during exporting"[3] (Li et al., 2016). By competing in the broader international market, enterprises can strengthen their ability to solve new problems using their existing resources, enhance their technological innovation through the knowledge they have gained from abroad, draw inspiration from different markets and cultures, and improve their ability to innovate (Salomon and Shaver, 2005).

Beyond encouraging enterprises to engage in technological innovation and innovative learning, competition and technology spillovers offer crucial mature conditions and resources that enable enterprises to raise their level of innovation. For exporting enterprises, the domestic market is no longer the sole concern; a broader international export market is bound to create more demand. By meeting both international and domestic demand, exporting enterprises are able to gain more trade profits and engage in more innovative activities (Li, 2002). Considering the effects of export demand, we propose our first hypothesis, as follows.

H1: Other conditions being equal, export trade promotes corporate technological innovation.

Domestic market fragmentation, high credit costs, the absence of intellectual property protection, and other distortions in the institutional environment prevent local Chinese enterprises from using their domestic

[3] Li et al. (2016) suggest that exporting enterprises can improve their technological innovation by "learning during exporting", i.e., "induced innovation" (p. 76).

market capacity to realize economies of scale and achieve rapid growth. Instead, export trade becomes an important means by which Chinese enterprises can realize economies of scale (Zhang et al., 2009). As mentioned above, a broader international market creates more demand, which drives exporting enterprises to expand the scale of their production, increase their input of the factors of production, launch mass production, and realize economies of scale. These outcomes in turn play vital roles in stimulating corporate innovation (Lileeva and Trefler, 2010). The theory of Marshallian externalities stresses the importance of economies of scale and various externalities in promoting innovation (Han and Ke, 2012). When manufacturing a product earns a company increasing returns to scale, the company obtains a cost advantage due to the expanded scale of production and reduced cost per unit product (Krugman, 1980). In addition, economies of scale promote industrial expansion and strengthen industrial competitiveness, which further motivate continuous innovation (Florida, 1994). Therefore, realizing economies of scale helps exporting enterprises to reduce their production costs, increase their profits, and lower their innovation risks while motivating them to engage in technological innovation. Considering the effects of economies of scale, we propose our second hypothesis, as follows.

H2: Other conditions being equal, engaging in export trade motivates enterprises to engage in technological innovation by increasing their economies of scale.

Enterprise innovation is key to gaining a competitive advantage (Teece et al., 1997; Baer, 2012), improving corporate performance, and increasing shareholder wealth. However, innovation also requires investments of time, energy, and resources (such as expenditure on R&D and management of innovation) that have very uncertain returns (Wu et al., 2005; Ling et al., 2008). Enterprises that take more risks usually have a higher tolerance of innovation-related risks and uncertainties, as well as greater confidence in innovation projects with high levels of risk and uncertainty (Faccio et al., 2011). In turn, these firms' higher levels of tolerance and confidence increase their innovation performance.

Exporting enterprises that seek to compete in the international market must guarantee product quality. To meet consumers' demands, newly exporting enterprises must improve their technological processes and standards, upgrade their machinery and equipment, and organize training for their employees to lay a solid foundation for increased risk-taking (Gereffi et al., 2005). Due to learning by exporting effects, enterprises with better production methods, capital equipment, product design, and organizational management are better able to capitalize on risky investment opportunities (Grossman and Helpman, 1990). Moreover, enterprises that enjoy lower average production costs and higher productivity from increased outputs are more motivated and better able to engage in promising and profitable investment activities. This in turn promotes their risk-taking (Xu et al., 2015) and innovation. Considering the importance of technological innovation to risk-taking, we propose our third hypothesis, as follows.

H3: Other conditions being equal, export trade motivates enterprises to conduct technological innovation by increasing their risk-taking.

3. Research design

3.1. Sample selection and data source

As the China customs database currently only contains export trade data on Chinese enterprises for the period 2000–2015, our sample period is 2000–2015. Most related studies have used industrial data on SMEs to study the effect of export trade on innovation. However, unlike listed companies, SMEs engage mainly in imitative and low-end innovation activities (Chi, 2002), which do not fully reflect China's strengths in innovation. Hence, we take companies listed on the Shanghai and Shenzhen A-share stock markets as our sample.

We obtain data on the financial and other characteristics of the enterprises from the China Stock Market and Accounting Research Database, which collects all of the relevant financial indicators of listed companies. We eliminate companies that met any of the following criteria. (1) Contained "ST" (indicating special treatment firms) or "PT" (indicating particular transfer firms) in their abbreviations. The financial data of such listed companies are processed before release and cannot reflect their financial statuses truthfully. (2) Asset–liability ratios above 1. The business conditions of these listed companies are abnormal and have no referential value. (3) Classified as financial or insurance companies. Such firms adopt differential financial accounting systems, which may compromise data consistency. (4) Appeared no more than three times during

the sample period. Each sampled company is required to have at least two years of observed values before and after starting to export, so that the continuous effects of export trade on corporate innovation could be seen more clearly. (5) Listed or delisted in the same year as beginning to export. (6) Missing substantial amounts of data. To better study the effects of export trade on corporate innovation, we classified the sampled companies into three categories: non-exporting (non-export) enterprises, existing exporting enterprises, and newly exporting (new-export) enterprises (Dai and Yu, 2012; Qiu et al., 2012; Li et al., 2016).[4] After eliminating existing exporting enterprises, we obtain data on 1507 listed companies and 13,666 company-year observed values (4960 for new-export enterprises and 8706 for non-export enterprises). To avoid the effects of extreme values, we winsorize the main variables at the upper and lower 1%.

3.2. Model design and variable definitions

To explore the effects of engaging in export trade on the technological innovation of our sampled listed companies, we introduce a multi-stage difference-in-differences (multi-DID) model for testing. Following studies of export trade (De Loecker, 2007; Qiu et al., 2012; Li et al., 2016; Zhang et al., 2016) and corporate technological innovation (Li et al., 2016; Zhou et al., 2019), we control for corporate financial variables and corporate governance variables, as well as the corporate fixed effect (*Firm*) and the annual fixed effect (*Year*):

$$Innovi,t = \alpha 0 + \alpha 1 Treati \times Postt + \sum Controls + \sum Firm + \sum Year + \varepsilon i,t \quad (1)$$

where corporate innovation ($Innov_{i,\ t}$) is the explained variable, measured in terms of innovation input and innovation output. Innovation input is measured by corporate R&D intensity, which is defined as the ratio of total R&D inputs to total assets. Listed companies may transfer their innovation activities to their subsidiaries or affiliated companies (Yu et al., 2016a; 2016b). In the above model, innovation output is measured by the natural logarithms of total number of patent applications (*Total*), number of invention patent applications (*Invent*), number of utility model patent applications (*Utility*), and number of appearance design patent applications (*Design*) after adding 1 to them. These variables cover the innovation activities of a listed company and its subsidiaries, associated companies, and joint venture partners. $Treat_i$ is a dummy variable introduced to distinguish the treatment group from the control group, set to 1 for new-export enterprises and 0 for non-export enterprises. $Post_t$ is a dummy variable for enterprise export time, set to 1 for the first and subsequent years of exporting but to 0 for the previous years. $Treat_i \times Post_t$ is a core explanatory variable set to 1 for the first and subsequent years of exporting but to 0 for the previous years. Calculated by the DID method, the coefficient of this variable measures the effects of export trade on the technological innovations of the listed companies, i.e., the average change in the level of corporate innovation of new-export enterprises relative to non-export enterprises.

To test the heterogeneity of the listed companies, we also introduce a series of firm characteristic variables, such as ownership nature (*Soe*), technological level (*Tech*), district (*District*), export destination country type (*Country*), and mode of export trade (*Tradetype*). If a listed company is state-owned, *Soe* is set to 1; otherwise, it is set to 0. Following Gu et al. (2018), we classify the listed companies as high-tech enterprises or non-high-tech enterprises. If a listed company is a high-tech enterprise, *Tech* is set to 1; otherwise, it is set to 0. In terms of regional distribution, if a company is located in western China, *District* is set to 0, but for central and eastern China, it is set to 1. Following Nielsen (2013) and the Human Development Index[5], we classify the export destination country types of the listed companies as developed or developing. If a listed company predominantly exports to developed countries, *Country* is set as 1; otherwise, it is set to 0. Finally, following Li et al. (2016), we classify the modes of export trade of the listed companies as either general trade or processing and mixed trade. If the volume of the processing trade of a listed company account for less than 25% of its total export trade volume, the listed company is deemed as mainly engaged in general trade, so *Tradetype*

[4] A non-export enterprise is defined as an enterprise that do not export during the sample period. An existing exporting enterprise is defined as an enterprise that export throughout the sample period. A new-export enterprise is defined as an enterprise that begin exporting a year after having been listed during the sample period.

[5] Human Development Index is available at http://hdr.undp.org/sites/default/files/hdr2019.pdf. (p. 300–311).

Table 1
Definitions of variables.

Variables	Name	Sign	Definition
Dependent Variables	R&D intensity	*RD*	R&D expenditure/total assets
	Total number of patent applications	*Total*	ln(total number of patent applications + 1)
	Number of invention patent applications	*Invent*	ln(number of invention patent applications + 1)
	Number of utility model patent applications	*Utility*	ln(number of utility model patent applications + 1)
	Number of appearance design patent applications	*Design*	ln(number of appearance design patent applications + 1)
Independent Variables	Export type dummy variable	$Treat_i$	1 for new-export enterprises, 0 for non-export enterprises
	Export time dummy variable	$Post_t$	1 for export year and after, otherwise 0
	Export dummy variable	$Treat_i \times Post_t$	Interaction term of $Treat_i$ and $Post_t$
Moderating Variables	Nature of ownership	*Soe*	1 for state-owned enterprises, otherwise 0
	Technology level	*Tech*	1 for high-tech enterprises, 0 for non-high-tech enterprises
	Location	*District*	1 for enterprises in central and eastern China, 0 for enterprises in western China
	Export destination country type	*Country*	1 for enterprises with developed export destination countries, 0 for enterprises with developing export destination countries
	Export trade type	*Tradetype*	1 for general trade, otherwise 0
Control Variables	Total factor productivity	*Tfp*	Productivity, measured by Levinsohn- Petrin (2003) method
	Company size	*Size*	ln(total assets)
	Financial leverage ratio	*Lev*	Total liabilities/total assets
	Return on assets	*Roa*	Net profits/total assets
	Company growth	*Growth*	(current operating income - last operating income)/last operating income
	Capital stock per capita	*Ak*	Fixed assets/number of employees at the end of the period
	Tangible asset ratio	*Tangibility*	Tangible assets/total assets
	Cash level	*Cash*	Cash and cash equivalents/total assets
	Company listed age	*Age*	ln(company listed age + 1)
	Financial constraints	*KZ*	KZ index. The larger the KZ index, the greater the financial constraints of a listed company
	Board size	*Board*	ln(number of board members)
	Independent director ratio	*Indep*	Number of independent directors/number of board members
	Management shareholding ratio	*Share*	Number of shares held by management/total number of shares in the company
	Chairperson–CEO duality	*Dual*	1 for chairperson–CEO duality, otherwise 0

is assigned a value of 1. Otherwise, the company is deemed as mainly engaged in processing and mixed trade, so *Tradetype* is assigned a value of 0.

The control variables (*Controls*) are as follows: total factor productivity (*Tfp*), company size (*Size*), financial leverage ratio (*Lev*), return on assets (*Roa*), company growth (*Growth*), capital stock per capita (*Ak*), tangible asset ratio (*Tangibility*), cash level (*Cash*), company listing age (*Age*), financial constraints (*KZ*), board size (*Board*), independent director ratio (*Indep*), management shareholding ratio (*Share*), and chairperson–CEO duality (*Dual*). Further, to control for the ownership, industry, and regional characteristics of the enterprise, we add nature of ownership (*Soe*), technology level (*Tech*), and location (*District*) to the model.[6] Specific variable definitions can be found in Table 1.

4. Empirical results

4.1. Summary statistics

Table 2 reports the summary statistics for the main variables. Column (1) presents the statistical characteristics of the full sample; columns (2) and (3) present the mean performance for the main variables of

[6] We thank an anonymous referee for several valuable comments on the control variables that helped to greatly improve the paper.

Table 2
Summary statistics for the variables.

Variables	(1)					(2)	(3)	(4)
	Full sample					*New-export*	*Non-export*	*T-test of (2)-(3)*
	Mean	*Std. Dev.*	*Min*	*Median*	*Max*	*Mean*	*Mean*	
RD	0.0068	0.0161	0.0000	0.0000	0.3272	0.0115	0.0069	0.0046***
Total	1.3925	1.6371	0.0000	0.6931	6.2710	2.2612	1.2466	1.0147***
Invent	0.8880	1.2996	0.0000	0.0000	5.3327	1.5186	0.8001	0.7185***
Utility	0.9379	1.3785	0.0000	0.0000	5.5491	1.6017	0.8113	0.7905***
Design	0.3607	0.8246	0.0000	0.0000	3.8067	0.5723	0.3176	0.2547***
Tfp	14.8667	1.1028	12.2938	14.8104	17.7377	15.1231	14.9649	0.1582***
Size	21.8455	1.2258	19.6026	21.6692	25.4099	21.9490	22.0341	−0.0851***
Lev	0.4748	0.1937	0.0599	0.4865	0.8676	0.4891	0.4747	0.0144***
Roa	0.0354	0.0557	−0.1735	0.0329	0.1982	0.0345	0.0382	−0.0037***
Growth	0.1926	0.4496	−0.5930	0.1212	2.8698	0.1748	0.1912	−0.0164*
Ak	12.5642	1.1882	9.7451	12.4656	15.8661	12.5143	12.6358	−0.1215***
Tangibility	0.9467	0.0700	0.6258	0.9697	1.0000	0.9503	0.9386	0.0117***
Cash	0.1650	0.1193	0.0097	0.1345	0.5990	0.1655	0.1694	−0.0039
Age	2.1620	0.5745	1.0986	2.1972	3.0910	2.2406	2.2619	−0.0212*
KZ	0.2211	1.5458	−4.6660	0.4145	3.6985	0.2856	0.1971	0.0884***
Board	2.2021	0.2220	1.6094	2.1972	2.7081	2.1784	2.2026	−0.0242***
Indep	0.3301	0.1080	0.0000	0.3333	0.5556	0.3611	0.3586	0.0025*
Share	0.0482	0.1360	0.0000	0.0001	0.6300	0.0594	0.0567	0.0027
Dual	0.1634	0.3697	0.0000	0.0000	1.0000	0.1691	0.1579	0.0112
Soe	0.6466	0.4781	0.0000	1.0000	1.0000	0.5992	0.6120	−0.0128
Tech	0.2405	0.4274	0.0000	0.0000	1.0000	0.3445	0.1915	0.1530***
Distract	0.7634	0.4250	0.0000	1.0000	1.0000	0.8085	0.7577	0.0508***

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

new-export enterprises and non-export enterprises, respectively; and column (4) shows the results of univariate comparisons of firm characteristics between new-export enterprises and non-export enterprises. As shown in the full sample statistics in column (1), the mean and standard deviation of R&D intensity (*RD*) of the listed companies are 0.0068 and 0.0161 respectively; the minimum, median, and maximum values are 0, 0, and 0.3272, respectively; the mean and standard deviation of the logarithms of the total number of patent applications (*Total*) of the listed companies are 1.3925 and 1.6371, respectively; and the minimum, median, and maximum values are 0, 0.6931, and 6.2710, respectively. These results indicate that the overall levels of innovation input and output of listed companies in China are low, and require further improvement. In terms of the three types of patents, the average logarithms of invention patents (*Invent*), utility model patents (*Utility*), and appearance design patents (*Design*) are 0.8880, 0.9379, and 0.3607, respectively. This indicates that the main types of patent applications filed by listed companies in China are invention and utility model patent applications. The results of the inter-group mean test in columns (2)-(4) reveal significant differences between the new-export enterprises and non-export enterprises. In particular, compared with the non-export enterprises, the new-export enterprises have a significantly higher innovation level. We can initially conclude that export trade promotes the technological innovation of Chinese listed companies. Finally, from the perspective of enterprise characteristics, the productivity, asset–liability ratio, tangible asset ratio, and financial constraints of the new-export enterprises are significantly higher than those of the non-export enterprises. In addition, significantly more of the new-export enterprises than the non-export enterprises are high-tech enterprises. Most of the new-export enterprises are located in central or eastern China.

4.2. Baseline regression results

Using a multi-DID model, we empirically examine the relationship between export trade and the technological innovation of listed companies. The regression results are shown in Table 3. Column (1) shows the regression results for the export dummy variable ($Treat_i \times Post_t$) and R&D intensity (*RD*), and columns

Table 3
Export trade and corporate innovation.

Variables	(1) $RD_{i,t}$	(2) $Total_{i,t}$	(3) $Invent_{i,t}$	(4) $Utility_{i,t}$	(5) $Design_{i,t}$
$Treat_i \times Post_t$	0.0047***	0.4178***	0.4539***	0.3166***	0.0288
	(3.763)	(4.248)	(4.930)	(3.713)	(0.536)
Tfp	0.0010**	0.1098**	0.0444	0.1090**	−0.0071
	(2.051)	(2.141)	(1.008)	(2.387)	(−0.276)
Size	−0.0015***	0.2694***	0.2354***	0.2182***	0.1047***
	(−3.077)	(4.408)	(4.281)	(4.136)	(3.577)
Lev	−0.0043**	−0.2388	−0.2168	−0.3705**	0.0061
	(−2.363)	(−1.350)	(−1.377)	(−2.413)	(0.062)
Roa	0.0159***	−0.3223	−0.1347	−0.6807**	0.1705
	(2.944)	(−0.943)	(−0.457)	(−2.320)	(0.789)
Growth	0.0000	−0.0895***	−0.0667***	−0.0683***	0.0025
	(0.048)	(−3.215)	(−2.892)	(−2.755)	(0.156)
Ak	−0.0006	0.0242	0.0280	0.0303	−0.0317***
	(−0.977)	(0.901)	(1.285)	(1.297)	(−2.643)
Tangibility	0.0086**	−0.5971*	−0.3378	−0.3366	−0.0426
	(2.551)	(−1.770)	(−1.096)	(−1.187)	(−0.233)
Cash	−0.0069*	−0.3067	−0.3885**	−0.3434**	−0.0833
	(−1.734)	(−1.570)	(−2.267)	(−2.001)	(−0.708)
Age	0.0024	0.5588***	0.3243***	0.4761***	0.1985**
	(1.332)	(4.253)	(2.754)	(4.045)	(2.491)
KZ	0.0002	0.0032	−0.0061	−0.0085	−0.0015
	(0.781)	(0.260)	(−0.570)	(−0.785)	(−0.194)
Board	−0.0005	0.1864	0.1392	0.1806	−0.0052
	(−0.221)	(1.332)	(1.228)	(1.484)	(−0.068)
Indep	−0.0057	0.3333	0.0275	0.4079	0.0207
	(−1.579)	(0.816)	(0.077)	(1.123)	(0.106)
Share	−0.0001	0.4720	0.0650	0.3585	−0.1278
	(−0.012)	(1.424)	(0.203)	(1.176)	(−0.585)
Dual	−0.0012**	−0.0209	0.0032	−0.0207	−0.0219
	(−2.131)	(−0.340)	(0.060)	(−0.358)	(−0.593)
Soe	0.0015*	−0.0112	−0.0625	0.0270	0.0303
	(1.875)	(−0.103)	(−0.695)	(0.339)	(0.613)
Tech	0.0027**	0.1661	0.1030	0.0881	0.0550
	(2.321)	(1.470)	(0.976)	(1.011)	(0.929)
Distract	−0.0023	−0.0669	−0.1018	−0.0610	0.0070
	(−1.395)	(−0.234)	(−0.543)	(−0.270)	(0.057)
Constant	0.0209*	−7.0631***	−5.5281***	−6.3667***	−1.7879***
	(1.899)	(−5.495)	(−4.805)	(−5.596)	(−2.678)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
N	9827	9827	9827	9827	9827
Adj R^2	0.136	0.271	0.264	0.246	0.027

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

(2)-(5) show the results of regressing the export dummy variable ($Treat_i \times Post_t$) on the total number of patent applications (Total) and the number of each of three types of patent applications: invention (*Invent*), utility model (*Utility*), and appearance design (*Design*). First, as shown in column (1) and column (2), the coefficients of $Treat_i \times Post_t$ are 0.0047 and 0.4178 respectively, and both are significantly positive at the 1% level. This indicates that export trade increases not only the innovation input but also the innovation output of Chinese listed companies, significantly promoting their technological innovation. The results in columns (3)-(5) show that export trade has a significant positive impact on invention and utility model patents with high technical content, but has no significant impact on design patents. This is basically consistent with the conclusions of the literature (Li et al., 2016).

4.3. Parallel-trend tests

The most important premise of the DID model is that the parallel-trend assumption must be satisfied; that is, the treatment group and the control group must have the same trend before the policy shock. In the field of international trade, studies provide considerable evidence that enterprises with stronger innovation capabilities and higher productivity are more likely to enter the export market (Bernard and Jensen,1999). Therefore, the innovation trend of new-export enterprises may be different from that of non-export enterprises before they engage in export behavior. If so, the results of this paper may be biased. To test whether the sampled new-export enterprises and non-export enterprises satisfied the parallel-trend hypothesis before engagement in export trade, we construct the following regression model:

$$\text{Innovi}, t = \beta 0 + \sum_{n=-4}^{4} [\beta n * (I_{i,t}^{n} \times Treati)] + \sum \text{Controls} + \sum Firm + \sum Year + \varepsilon i, t \quad (2)$$

In model (2), I is a dummy variable. If the gap between the year of observations and the year of the export shock is n, I equals 1; otherwise, it equals 0. $n = -1$ denotes the one-year period before the export shock; $n = 1$ denotes the one-year period after the export shock. The range of n is [−15,15]. To ensure that the number of enterprises is balanced across years, the range of n is merged into [−4,4]. As mentioned above, $Treat_i$ is an indicator variable used to identify the treatment group and the control group, taking a value of 1 if firm i is a new-export enterprise and 0 if firm i is a non-export enterprise.

We take the one-year period before the export shock (*D_1*) as the benchmark group, enabling us to observe the differences in innovation between new-export enterprises and non-export enterprises compared with the benchmark group. The regression results are shown in Table 4, in which column (1) reports the results of the parallel-trend test for R&D intensity (*RD*) and columns (2)-(5) show the results of parallel-trend tests for the total number of patent applications (*Total*) and the number of each of the three types of patent applications: invention (*Invent*), utility model (*Utility*), and appearance design (*Design*). According to the regression results in Table 4, the coefficient estimates for the two-year period (*D_2*), three-year period (*D_3*), and four-year period (*D_4*) before export trade are not significant, indicating that new-export listed companies and

Table 4
Parallel-trend tests and long-term effects of exporting.

Variables	(1) $RD_{i,t}$	(2) $Total_{i,t}$	(3) $Invent_{i,t}$	(4) $Utility_{i,t}$	(5) $Design_{i,t}$
D_4	0.0012	−0.0884	−0.0245	−0.1405	−0.0707
	(0.711)	(−0.580)	(−0.176)	(−0.978)	(−0.555)
D_3	−0.0000	−0.0286	−0.0387	−0.0999	−0.0573
	(−0.026)	(−0.215)	(−0.308)	(−0.913)	(−0.552)
D_2	0.0017	−0.0822	0.0205	−0.1116	−0.0592
	(1.317)	(−0.764)	(0.202)	(−1.069)	(−0.822)
Current	0.0040***	0.2818***	0.3287***	0.1008	0.0068
	(3.054)	(3.035)	(3.348)	(1.287)	(0.123)
D1	0.0046***	0.2708**	0.3474***	0.1346	−0.0159
	(3.419)	(2.574)	(3.389)	(1.459)	(−0.277)
D2	0.0044***	0.4127***	0.4507***	0.3259***	−0.0107
	(3.190)	(3.611)	(4.235)	(3.327)	(−0.169)
D3	0.0044***	0.4146***	0.5086***	0.3107***	0.0203
	(3.008)	(3.369)	(4.447)	(2.944)	(0.307)
D4	0.0086***	0.6413***	0.7172***	0.5807***	0.0147
	(5.545)	(5.037)	(6.116)	(5.258)	(0.220)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
N	9827	9827	9827	9827	9827
Adj R^2	0.142	0.275	0.271	0.255	0.027

Note: (1) Control variables are included in all of the above models; (2) T-statistics based on robust standard errors clustered at the firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

non-export listed companies show the same trends in innovation input and innovation output before engaging in export trade. In addition, the coefficient estimates for the current year and the first, second, third, and fourth years of a firm's export behavior (*Current*, *D1*, *D2*, *D3*, and *D4*, respectively) for R&D intensity, the total number of patent applications, and the number of invention patent applications (but not the number of design patent applications) are significantly positive. The coefficient estimates for the second and following years for utility model patent applications are also significantly positive. These results indicate that export trade significantly promotes the technological innovation of listed companies in the long term.

4.4. Robustness tests

4.4.1. Innovation measured at years t + 1 to t + 3

According to Holmstrom (1989), enterprise innovation is a complex, long-term, and multi-stage process. Therefore, we use the innovation input and innovation output variables measured at years $t+1$ to $t+3$ as proxies for enterprise innovation, to further explore the relationship between export trade and the technological innovation of the sampled listed companies. Table 5 reports the estimation results. First, Panel A and

Table 5
Robustness tests: Innovation measured at years $t+1$ to $t+3$.

Panel A: *R&D intensity*			
	$RD_{i,t+1}$	$RD_{i,t+2}$	$RD_{i,t+3}$
$Treat_i \times Post_t$	0.0033***	0.0026**	0.0024**
	(2.819)	(2.277)	(1.988)
N	8,412	7,101	5,856
Adj R^2	0.125	0.122	0.138
Panel B: *Total number of patent applications*			
	$Total_{i,t+1}$	$Total_{i,t+2}$	$Total_{i,t+3}$
$Treat_i \times Post_t$	0.3174***	0.2887***	0.2002**
	(3.174)	(3.056)	(2.130)
N	8412	7101	5856
Adj R^2	0.249	0.225	0.196
Panel C: Number of invention patent applications			
	$Invent_{i,t+1}$	$Invent_{i,t+2}$	$Invent_{i,t+3}$
$Treat_i \times Post_t$	0.3597***	0.3004***	0.3009***
	(3.923)	(3.705)	(3.608)
N	8,412	7,101	5,856
Adj R^2	0.245	0.226	0.201
Panel D: *Number of utility model patent applications*			
	$Utility_{i,t+1}$	$Utility_{i,t+2}$	$Utility_{i,t+3}$
$Treat_i \times Post_t$	0.3062***	0.3324***	0.2124**
	(3.479)	(3.926)	(2.536)
N	8412	7101	5,856
Adj R^2	0.228	0.207	0.174
Panel E: *Number of appearance design patent applications*			
	$Design_{i,t+1}$	$Design_{i,t+2}$	$Design_{i,t+3}$
$Treat_i \times Post_t$	−0.0129	0.0095	−0.0429
	(−0.241)	(0.163)	(−0.653)
N	8,412	7,101	5,856
Adj R^2	0.020	0.012	0.010

Note: (1) Control variables are included in all of the above models; firm fixed effects and year fixed effects are controlled for. (2) T-statistics based on robust standard errors clustered at the firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel B show that the coefficient estimates of $Treat_i \times Post_t$ are significantly positive at the 1%, 5%, or 10% level, indicating that export trade promotes the technological innovation of listed companies and this effect occurs in the long term. Second, Panel C to Panel E of Table 5 show that export trade has no significant positive effect on design patent applications but significantly promotes invention patent and utility model patent applications. Therefore, compared with the baseline regression results, the results are unchanged and the research conclusions above are robust.

4.4.2. Remeasurement of innovation variables

In addition to using R&D investment scaled by firm assets and the logarithm of patent applications to proxy for innovation input and innovation output, we use R&D investment scaled by sales and the number of patents obtained by listed companies as alternative proxy variables for enterprise innovation. Specifically, we take the ratio of R&D investment to sales, the total number of patents, the number of invention patents, the number of utility model patents, and the number of appearance design patents obtained by the listed companies plus 1 and then use their natural logarithms to measure enterprise innovation. In addition, to increase the robustness of our results, we use the proxy variables at year $t + 1$. The regression results in Table 6 again indicate that export trade promotes the technological innovation of listed companies.

4.4.3. Redefining the treatment group and control group

We define a new-export enterprise as a listed company for which the first year of exporting is later than the year in which the company first appear in the sample period. However, some enterprises withdraw from the export market after exporting (Li et al., 2016) and the failure to maintain exports may bias measurements of the impact of export trade (Zhang et al., 2009). Therefore, following Li et al. (2016), we exclude listed companies that exported but then withdrew from the export market as a robustness test. The regression results are shown in Table 7. The results show that export trade promotes the technological innovation of listed companies. Further, our results remain unchanged after using the proxy variables of innovation measured at years $t + 1$ to $t + 3$, indicating that the regression results reported in this paper are relatively robust.

Table 6
Robustness tests: Remeasurement of innovation variables.

Panel A: *Innovation measured at year* t					
Variables	(1)	(2)	(3)	(4)	(5)
	$RD_{i,t}$	$Total_{i,t}$	$Invent_{i,t}$	$Utility_{i,t}$	$Design_{i,t}$
$Treat_i \times Post_t$	0.0085***	0.*5179***	0.4349***	0.4482***	0.1192**
	(4.089)	(5.313)	(5.192)	(4.570)	(2.118)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
N	9827	9,827	9,827	9,827	9,827
Adj R^2	0.082	0.301	0.245	0.271	0.043
Panel B:Innovation measured at year t + *1*					
Variables	(1)	(2)	(3)	(4)	(5)
	$RD_{i,t+1}$	$Total_{i,t+1}$	$Invent_{i,t+1}$	$Utility_{i,t+1}$	$Design_{i,t+1}$
$Treat_i \times Post_t$	0.0047**	0.4123***	0.3829***	0.3556***	0.0673
	(2.176)	(4.024)	(4.264)	(3.643)	(0.981)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
N	8412	8412	8412	8412	8412
Adj R^2	0.072	0.294	0.247	0.262	0.037

Note: (1) Control variables are included in all of the above models. (2) T-statistics based on robust standard errors clustered at the firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7
. Robustness tests: Redefining the treatment group and control group.

Panel A: *R&D intensity*			
	$RD_{i,t+1}$	$RD_{i,t+2}$	$RD_{i,t+3}$
$Treat_i \times Post_t$	0.0067**	0.0077***	0.0075***
	(2.467)	(2.995)	(3.007)
N	6051	5072	4170
Adj R^2	0.089	0.086	0.107
Panel B: *Total number of patent applications*			
	$Total_{i,t+1}$	$Total_{i,t+2}$	$Total_{i,t+3}$
$Treat_i \times Post_t$	0.4243**	0.4754***	0.3640***
	(2.480)	(3.547)	(2.783)
N	6051	5072	4170
Adj R^2	0.226	0.205	0.185
Panel C: *Number of invention patent applications*			
	$Invent_{i,t+1}$	$Invent_{i,t+2}$	$Invent_{i,t+3}$
$Treat_i \times Post_t$	0.5503***	0.6201***	0.6441***
	(3.222)	(4.510)	(4.398)
N	6051	5072	4170
Adj R^2	0.218	0.203	0.185
Panel D: *Number of utility model patent applications*			
	$Utility_{i,t+1}$	$Utility_{i,t+2}$	$Utility_{i,t+3}$
$Treat_i \times Post_t$	0.4745***	0.5879***	0.2964**
	(2.800)	(4.247)	(2.412)
N	6051	5072	4170
Adj R^2	0.198	0.180	0.158
Panel E: *Number of appearance design patent applications*			
	$Design_{i,t+1}$	$Design_{i,t+2}$	$Design_{i,t+3}$
$Treat_i \times Post_t$	−0.0531	−0.0212	−0.0408
	(−0.563)	(−0.183)	(−0.298)
N	6051	5072	4170
Adj R^2	0.024	0.017	0.019

Note: (1) Control variables are included in all of the above models; (2) T-statistics based on robust standard errors clustered at the firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.4.4. Discussion of endogenous problems

Using the multivariate DID model with appropriate control variables and conducting a series of alternative tests yielded regression results that confirm the positive correlation between export trade and enterprise innovation. However, it remains unclear whether the results are affected by problems of endogeneity that may lead to estimation bias, such as sample self-selection, two-way causality, and the non-randomness (endogeneity) of export policy. To increase the reliability of the conclusions of this paper, we discuss the endogeneity problem of causal identification in this section. Due to limitations on space and consideration of importance, in this section and the following content we focus on the relationship between export trade ($Treat_i \times Post_t$.) and R&D intensity (*RD*), the total number of patent applications (*Total*), and the number of invention patent applications (*Invent*).

(1) Endogeneity problems caused by sample self-selection

Many scholars in China and abroad have identified a self-selection effect among new-export enterprises (Aw et al., 2000; Melitz, 2003; Qian et al., 2011; Yi and Fu, 2011; Qiu et al., 2012). Therefore, although the baseline regression results indicate that export trade promotes the technological innovation of listed

enterprises, the issue of inherent selection bias cannot be ignored. To increase the robustness of the results above, we further use the PSM method to explore the relationship between export trade and the technological innovation of listed companies. Specifically, we first estimate a logit regression to predict the export probability of the listed companies with all of the control variables mentioned above. Next, we select samples of non-export enterprises that are similar to those of new-export enterprises by one-to-five nearest neighbor PSM to eliminate significant differences between the treatment group and the control group before the export shock. This reduces the bias caused by the self-selection effect of listed companies before and after exporting. Finally, we re-estimate the multi-DID model using the matched sample to explore the net average impact of export trade on the technological innovation of listed companies. The estimation results are shown in Table 8. The coefficient estimates of $Treat_i \times Post_t$ are all significantly positive at the 1% level for R&D intensity (*RD*), the total number of patent applications (*Total*), and the number of invention patent applications (*Invent*), indicating that export trade promotes the technological innovation of listed companies. Our estimation results are consistent with the baseline results.

(2) Endogeneity problems caused by two-way causality and non-random policies

Although the DID method is an appropriate tool to evaluate the effect of export trade policy, its effectiveness depends on the randomness (exogeneity) of the policy variables. If an enterprise's export behavior is related to its innovation capabilities, the explanatory variable of exporting is endogenous. To solve the problems of two-way causality and policy endogeneity in the model, we implement two main measures. One is to add the lag term of the explained variable to the regression model to control factors that vary between enterprises and across time to eliminate the impact of enterprise innovation on export trade. The second is to find an exogenous instrumental variable (IV).

(1) Adding the lag term of the explained variable to the model

As indicated above, we address potential endogeneity problems in the model by adding the lag term of the explained variables to the model. However, this brings new endogeneity problems due to dynamic panel deviation. To solve the latter problems, we follow Zhang and Zheng (2013) and Feng and Liu (2017) in using the two-stage system generalized method of moments (GMM) method for the regression and adding year dummy variables to the model to control the time trend.

The regression results are shown in Table 9. Columns (1)-(3) report the estimation results of our dynamic panel models for the R&D intensity (*RD*), total number of patent applications (*Total*), and number of

Table 8
Treatment of endogeneity problems: propensity score matching test.

Variables	(1) $RD_{i,t}$	(2) $Total_{i,t}$	(3) $Invent_{i,t}$
$Treat_i \times Post_t$	0.0042***	0.4033***	0.4318***
	(3.303)	(3.456)	(3.956)
Constant	0.0340**	−6.3203***	−5.2824***
	(2.407)	(−4.139)	(−3.849)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	7541	7541	7541
Adj R^2	0.143	0.290	0.284

Note: (1) As export trade and innovation may have an industry cluster effect, our matching process is treated by industry.[We thank an anonymous referee for several valuable comments on conducting PSM by industry that helped to greatly improve the paper.] In addition, our industry division method follows the classification method used in the mainstream literature; that is, the manufacturing industry is divided according to the CSRC 2012 Industry Classification and all other industries are divided according to the CSRC 2012 Industry Classification. (2) Control variables are included in all of the above models; (3) T-statistics based on robust standard errors clustered at the firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9
Treatment of endogeneity problems: two-stage system generalized method of moments.

Variables	(1)	(2)	(3)
	$RD_{i,t}$	$Total_{i,t}$	$Invent_{i,t}$
$RD_{i,t-1}$	0.2350*		
	(1.811)		
$Total_{i,t-1}$		0.2447***	
		(4.496)	
$Invent_{i,t-1}$			0.2526***
			(4.461)
$Treat_i \times Post_t$	0.0193*	3.4028***	2.7499***
	(1.875)	(5.094)	(6.125)
Constant	0.0344	−23.5889***	−22.9229***
	(0.254)	(−3.221)	(−2.813)
AR(1)	0.022	0.000	0.000
AR(2)	0.426	0.284	0.606
Hansen	0.352	0.258	0.147
Year fixed effects	Yes	Yes	Yes
N	9,005	9,005	9,005

Note: (1) Control variables are included in all of the above models; (2) T-statistics based on robust standard errors clustered at firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

invention patent applications (*Invent*) of the listed companies. The results of the Hansen test and the residual sequence correlation test support the validity of the instrumental variable in the model, the residual first-order sequence correlation (*AR (1)*), and the second-order sequence correlation (*AR (2)*).

In addition, Table 9 shows that after controlling the explained variables of the lagging period and using two-stage system GMM to solve problems of endogeneity, the coefficient estimates of $Treat_i \times Post_t$ are still significantly positive at the 1% or 5% level. This again indicates that export trade promotes the innovation activities of listed companies in terms of both innovation input and innovation output.

(2) Instrumental variable method

Next, we address the endogeneity problem associated with trade policy to improve the reliability of the conclusions of this paper. We use the IV method as the final robustness estimation, taking the lag term of enterprise export trade volume as the IV.

Specifically, we first take the natural logarithm of export trade volume and then take the lag term of the logarithmic export trade volume as the IV (*IV*). Generally, the export behavior of Chinese enterprises is characterized by persistence (Chen et al., 2012; Dai and Zheng, 2015). The larger an enterprise's export trade volume in the previous year, the higher the probability of the enterprise's engaging in export behavior in the current year. Therefore, the lag term of enterprise export trade volume, selected as the IV of export trade, satisfies the correlation hypothesis. In addition, to satisfy the exclusivity hypothesis of the IV approach, there must be no direct correlation between the export trade volume of the previous period and enterprise innovation in the current period. That is, the technological innovation level of the enterprise in the current period must not affect its export trade volume in the previous period. In sum, our IV is valid.

The regression results are shown in Table 10, in which column (1) presents the results of the first stage of the IV regression and columns (2)-(4) report the results of the second stage of the instrumental variable regression. First, the estimation results of the first stage show that the greater the export trade volume of listed companies in the previous period, the more willing enterprises are to export in the current period. The estimation results of the second stage show that after the use of the IV, export trade still significantly improves the innovation input and output of listed companies. Therefore, the results after addressing endogeneity problems again support the conclusions of this paper.

Table 10
Treatment of endogeneity problems: instrumental variable regression.

	First stage	*Second stage*		
Variables	(1)	(2)	(3)	(4)
	$Treat_i \times Post_t$	$RD_{i,t}$	$Total_{i,t}$	$Invent_{i,t}$
$Treat_i \times Post_t$		0.0079**	0.9245***	1.0550***
		(2.411)	(2.886)	(3.726)
IV	0.0142***			
	(11.023)			
Constant	−0.3797**	0.0240*	−7.2671***	−5.1453***
	(−2.154)	(1.951)	(−5.182)	(−4.135)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	9005	9005	9005	9005

Note: (1) Control variables are included in all of the above models; (2) T-statistics based on robust standard errors clustered at the firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.5. Additional analysis

4.5.1. Mechanism analysis

The results above indicate that engaging in export trade promotes the technological innovation of listed companies. It is also important to explore the paths and mechanisms of this effect. According to the theoretical analysis for economies of scale and of risk-taking, first, an increase in market demand leads enterprises to expand their production scale and increase their input of production factors to achieve economies of scale, thus promoting enterprise innovation. Second, competition and learning effects by exporting significantly improve enterprise management, production technology, and product process and increase enterprises' risk-taking, thereby enhancing their technological innovation. Based on this, we estimate the following models:

$$Yi,t = \gamma 0 + \gamma 1 Treati \times Postt + \sum Controls + \sum Firm + \sum Year + \varepsilon i,t \tag{3}$$

$$RiskTi,t = \eta 0 + \eta 1 Treati \times Postt + \sum Controls + \sum Firm + \sum Year + \varepsilon i,t \tag{4}$$

In model (3), the explained variable $Y_{i,t}$ represents economies of scale, measured by the logarithm of the number of employees, intermediate product input, operating income, and profits (He et al., 2020). In model (4), $RiskT_{i,t}$ represents the risk-taking level of an enterprise. Referring to John et al. (2008), Boubakri et al. (2013), and Yu et al. (2013), we choose as our primary measure of corporate risk-taking ($RiskT_{i,t}$) the volatility of a firm's industry-adjusted return on assets ($ADJ\_ROA_{i,t}$) over three-year overlapping periods (i.e., $t-1$, t, $t+1$). The calculation process is as follows:

$$RiskTi,t = \sqrt{\frac{1}{N}\sum_{t=1}^{N}(ADJ\_ROAi,t - \frac{1}{N}\sum_{t=1}^{N} ADJ\_ROAi,t)^2} \mid N = 3 \tag{5}$$

$$ADJ\_ROAi,t = \frac{EBITDAi,t}{ASSETSi,t} - \frac{1}{X}\sum_{t=1}^{X}\frac{EBITDAi,t}{ASSETSi,t} \tag{6}$$

where $EBITDA_{i,t}$ is the earnings before interest, taxes, depreciation, and amortization of firm i in year t, and $ASSETS_{i,t}$ denotes the total assets of the enterprise at the end of the period. Table 11 reports the estimation results of the mechanism test. First, export trade significantly increases the number of employees, input of intermediate products, operating income and profits of the listed companies, expanding the scale of their production and sales in terms of input and output. This realizes economies of scale, reduces unit product costs, obtains cost advantages, and improves enterprise competitiveness, thereby promoting enterprise innovation. Second, export trade significantly increases enterprises' risk-taking, reducing the risk associated with R&D investment and increasing technological innovation.

Table 11
Export trade and corporate innovation: mechanism test.

Variables	(1)				(2)
	Employee	*MI*	*Sales*	*Profit*	*RiskT*
$Treat_i \times Post_t$	0.0737**	0.0631**	0.0430*	0.0865*	0.0058***
	(2.109)	(2.297)	(1.762)	(1.952)	(2.704)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
N	9799	9557	9827	8836	8798
Adj R^2	0.504	0.890	0.924	0.725	0.715

Note: (1) Control variables are included in all of the above models; (2) T-statistics based on robust standard errors clustered at the firm levels are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.5.2. Heterogeneity analysis

In recent years, numerous scholars have studied heterogeneous trade theory, according to which a company's type affects its export trade behavior (Jing et al., 2013; Li et al., 2016; Liu and Tong, 2017). Accordingly, we further examine the relationship between export trade and the technological innovation of the sampled listed companies with reference to the nature of ownership, technology level, location, export destination country type, and export trade type.

The regression results are shown in Table 12. Panel A shows that export trade plays a key role in promoting the innovation of state-owned enterprises but does not significantly promote the innovation of private enterprises, and even has a significant inhibitory effect on the appearance design patent applications of private enterprises. This indicates that compared with private enterprises, state-owned enterprises have lower production efficiency and innovation efficiency (Wu, 2012; Dong et al., 2014), leaving more room to improve their export learning (Jing et al., 2013). Second, state-owned enterprises show a significantly lower level of risk-taking (Li and Yu, 2012) than private enterprises do. Therefore, after state-owned enterprises start exporting, they take significantly more risks. Finally, because of their large scale and protection by the government (Yu et al., 2019), state-owned enterprises are more likely than private enterprises are to obtain economies of scale, making them better able to compete in the international market. Therefore, engaging in export trade has a greater positive effect on innovation ability for state-owned listed companies than their private counterparts.

The innovation behavior of enterprises may be affected by industry differences. Previous studies have shown that export trade promotes technological innovation mainly for enterprises in high-tech industries and medium–high-tech industries. It has no significant positive effect—and may even have a negative effect—on the technological innovation behavior of enterprises in low-tech industries (Li et al., 2016). Following previous studies, based on the High-tech Industry (Manufacturing) Classification (2017) and High-tech Industry (Service Industry) Classification (2018)[7,8,9] issued by China's National Bureau of Statistics, we classify the sampled enterprises as high-tech or non-high-tech to explore the impact of export trade on the technological innovation of listed companies from the perspective of technological development level. The regression results are shown in Table 12, Panel B. The estimation results show that export trade has a significant positive impact on the technological innovation of non-high-tech listed companies. The possible reasons are as follows. First, non-high-tech enterprises have a lower technological starting point than high-tech enterprises do and thus more room for improvement. Second, compared with non-high-tech enterprises, high-tech enterprises engaging in export trade are more vulnerable to technological blockades by Western developed countries. Third, high-tech enterprises need to invest heavily in R&D to support their high-tech activities. Providing protection for high-risk R&D activities itself incurs considerable risk. Therefore, the effect of export trade on high-tech enterprises' level of risk-taking is not pronounced. Fourth, because of their high technical level, high-tech

[7] The relevant documents are available from the National Bureau of Statistics.
[8] The High-tech Industry (Manufacturing) Classification (2017) is available at http://www.stats.gov.cn/tjsj/tjbz/201812/t20181218_1640081.html.
[9] The High-tech Industry (Service Industry) Classification (2018) is available at http://www.stats.gov.cn/tjsj/tjbz/201805/t20180509_1598315.html.

enterprises can establish certain technical barriers in the domestic market to obtain economies of scale and reduce the marginal cost of their products. Therefore, as high-tech enterprises already have a certain degree of economies of scale, engaging in export trade has little substantial impact on their economies of scale. Based on these points, export trade is particularly beneficial to non-high-tech enterprises in enhancing their innovation ability.

In addition, regions are often heterogeneous in their level of export trade and/or level of enterprise innovation. Therefore, according to the regions in which they are located, we classify the listed companies as either enterprises in eastern China or enterprises in central or western China. The regression results are shown in

Table 12
Export trade and corporate innovation: heterogeneity test.

Panel A:From the perspective of nature of ownership						
Variables	*State-owned*			*Non-state-owned*		
	(1) $RD_{i,t}$	(2) $Total_{i,t}$	(3) $Invent_{i,t}$	(4) $RD_{i,t}$	(5) $Total_{i,t}$	(6) $Invent_{i,t}$
$Treat_i \times Post_t$	0.0075**	0.8660***	0.8365***	0.0049	0.0783	0.3187
	(2.217)	(3.293)	(3.497)	(1.272)	(0.267)	(1.203)
Constant	0.0331*	−8.7731***	−6.3988***	−0.0108	−4.5509*	−4.9028**
	(1.789)	(−3.133)	(−2.692)	(−0.275)	(−1.729)	(−2.082)
N	3240	3240	3240	2039	2039	2039
Adj R^2	0.124	0.322	0.299	0.133	0.190	0.216
Panel B:From the perspective of technology level						
Variables	*High-tech*			*Non-high-tech*		
	(1) $RD_{i,t}$	(2) $Total_{i,t}$	(3) $Invent_{i,t}$	(4) $RD_{i,t}$	(5) $Total_{i,t}$	(6) $Invent_{i,t}$
$Treat_i \times Post_t$	0.0059	−0.2443	0.0801	0.0065***	0.8495***	0.8649***
	(0.919)	(−0.907)	(0.289)	(3.277)	(3.292)	(3.840)
Constant	0.0459	−10.8588***	−13.2561***	0.0192	−4.8308**	−3.6171**
	(0.668)	(−2.714)	(−3.505)	(1.557)	(−2.561)	(−2.406)
N	1295	1295	1295	4106	4106	4106
Adj R^2	0.254	0.374	0.363	0.082	0.251	0.240
Panel C: From the perspective of location						
Variables	*Central/eastern region*			*Western region*		
	(1) $RD_{i,t}$	(2) $Total_{i,t}$	(3) $Invent_{i,t}$	(4) $RD_{i,t}$	(5) $Total_{i,t}$	(6) $Invent_{i,t}$
$Treat_i \times Post_t$	0.0083***	0.6483***	0.7295***	0.0006	0.1591	0.4126
	(3.091)	(2.768)	(3.572)	(0.186)	(0.334)	(0.897)
Constant	0.0083	−6.6887***	−5.3947***	0.0325*	−6.3458*	−5.1467*
	(0.435)	(−2.932)	(−2.658)	(1.654)	(−1.830)	(−1.695)
N	4297	4297	4297	1104	1104	1104
Adj R^2	0.111	0.268	0.259	0.229	0.288	0.263
Panel D:From the perspective of export destination country type						
Variables	*Developed countries*			*Developing countries*		
	(1) $RD_{i,t}$	(2) $Total_{i,t}$	(3) $Invent_{i,t}$	(4) $RD_{i,t}$	(5) $Total_{i,t}$	(6) $Invent_{i,t}$
$Treat_i \times Post_t$	0.0141**	0.7506	0.8168*	0.0065***	0.6153***	0.7120***
	(2.053)	(1.326)	(1.753)	(2.968)	(3.053)	(4.025)
Constant	0.0229	−5.2135***	−4.1470**	0.0156	−5.7330***	−4.7335***
	(1.452)	(−2.585)	(−2.356)	(0.990)	(−2.997)	(−2.810)
N	4887	4887	4887	5493	5493	5493
Adj R^2	0.086	0.232	0.218	0.111	0.259	0.248

Panel E: From the perspective of export trade type

Variables	*General trade*			*Processing and mixed trade*		
	(1) $RD_{i,t}$	*(2)* $Total_{i,t}$	*(3)* $Invent_{i,t}$	*(4)* $RD_{i,t}$	*(5)* $Total_{i,t}$	*(6)* $Invent_{i,t}$
$Treat_i \times Post_t$	0.0087***	0.4736***	0.6013***	0.0135	0.5030	0.5881
	(2.769)	(2.909)	(3.984)	(1.386)	(1.278)	(1.640)
Constant	0.0078	−6.4110***	−4.6439***	0.0252	−5.4628**	−4.8340**
	(0.572)	(−3.839)	(−3.172)	(1.217)	(−2.254)	(−2.315)
N	6318	6318	6318	3895	3895	3895
Adj R^2	0.103	0.231	0.222	0.064	0.170	0.161

(1) To improve the robustness of the results, the samples used in the above models were PSM paired after excluding listed companies that export but then exit the export market. (2) Control variables are included in all of the above models. (3) T-statistics based on robust standard errors clustered at the firm level are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 12, Panel C. The estimation results show that export trade mainly promotes the technological innovation of enterprises in central and eastern China; it does not significantly promote the technological innovation of enterprises in western China. This indicates, first, that the development of modern industry in the western region is slow, lacking precision production equipment, an appropriate financial environment, and scientific and technological human resources. Therefore, after engaging in export trade, even if western Chinese enterprises have learned from international advanced technology, the transformation efficiency of their innovation achievements is relatively low because they lack the environment and human resources conducive to innovation. Second, because western China is geographically far from the main export markets of Europe and the U. S., the cost of entering these export markets is highest for western Chinese enterprises (Tong and Liu, 2014). Therefore, the export costs incurred by these enterprises are relatively high and their resulting export profits are relatively low, resulting in relatively little investment in innovation.

Furthermore, previous studies have shown that newly industrialized economies and developing countries can improve their independent innovation capability (Aw et al., 2000; De Loecker, 2007; Alvarez and Lopez, 2005) by participating in international competition to learn from and absorb advanced technology from developed countries. However, this effect has not been confirmed in the vast majority of developed industrialized countries (Bernard and Jensen, 1999; 2004a; Wagner, 2002; Greenaway and Yu, 2004). Therefore, the role of export trade in promoting corporate innovation may vary between countries based on their export destination type.[10] Therefore, according to the division of the Human Development Index[11], we classify the export destination countries of the sampled listed companies as developed or developing economies to conduct comparative analysis. As shown in Table 12, Panel D, export trade significantly promotes the innovation level of enterprises in developed countries but only slightly promotes the innovation output of enterprises in developing countries. This indicates that export trade has a significant positive effect on the innovation level of enterprises that export to developed countries, but only slightly promotes the innovation output of enterprises that export to developing countries. The more developed an enterprise's export destination country, the higher the enterprise's degree of innovation knowledge, resulting in higher enterprise innovation.

Finally, according to Dai et al. (2014), processing trade with low technological content is the main reason for the productivity paradox observed among Chinese enterprises. Processing trade enterprises may not experience learning by exporting effects (Xiang and Ma, 2013). Therefore, the promoting effect of export trade on enterprise innovation may vary with the mode of export trade. Therefore, following Li et al. (2016), we distinguish between modes of trade for further analysis.[12] The regression results are shown in Table 12, Panel E. First, export trade significantly promotes the innovation of enterprises that are mainly engaged in general

[10] We thank an anonymous referee for several valuable comments on heterogeneity analysis that helped to greatly improve the paper.
[11] Human Development Index is available at http://hdr.undp.org/sites/default/files/hdr2019.pdf. (p. 300–311).
[12] Following Li et al. (2016), if the proportion of processing trade of their total export trade is less than 25%, we classify exporting enterprises as mainly engaged in general trade. If the proportion of processing trade of their total export trade is more than 75%, we classify exporting enterprises as mainly engaged in processing trade. We classify the others as mainly engaged in mixed trade.

trade, but has no significant impact on the innovation level of enterprises mainly engaged in processing and mixed trade. This indicates that, unlike enterprises mainly engaged in general trade, enterprises mainly engaged in processing and mixed trade do not experience the export learning effect, consistent with previous findings.

5. Conclusion

The performance of export trade at the micro level of enterprises has long been a hot topic of research on international trade. Based on data on Shanghai and Shenzhen A-share listed companies from 2000 to 2015, we use a multi-DID model to study the relationship between export trade and technological innovation. The findings indicate that export trade promotes the technological innovation of listed companies in terms of both innovation input and innovation output. From the perspective of patent output, export trade significantly promotes listed companies' applications for invention patents and utility model patents with a high technical content. The conclusions report in this paper remain robust after a series of robustness tests. Export trade behavior generally leads enterprises to expand their production scale, increase their input of production factors to achieve economies of scale, and increase their risk-taking, thereby raising their level of technological innovation. In terms of enterprise heterogeneity, export trade mainly promotes the technological innovation of state-owned enterprises, non-high-tech enterprises, enterprises in central and eastern China, enterprises that export to developed economies, and enterprises that are mainly engaged in general trade.

At the time of writing, the trade negotiations resulting from Sino–U.S. trade frictions have reached an impasse. The U.S. launches a trade war against China primarily to restrain the development of China's high-tech enterprises by imposing punitive tariffs to curb China's scientific and technological innovation (Huang et al., 2018a; 2018b). Given the U.S.'s zero-sum thinking, i.e., seeking to maintain its status as a great power while curbing China's development, the trade conflict is complex and likely to be long-lasting (Yu et al., 2018a; 2018b). Since the U.S.'s announcement of tariffs against China Sino-US trade friction on March 22, 2018[13], Chinese enterprises' volume of export trade to the U.S. has decreased significantly, and the value-innovation chain of Chinese export enterprises has been damaged (Young, 1991; Gibbon et al., 2008). Today, with rapid economic globalization, national strength is ultimately measured by the capacity for innovation. At present, China is on the brink of entering the ranks of the world's most innovative countries. The conclusions of this paper are of practical significance for Chinese enterprises seeking to strengthen their export trade and improve their scientific and technological innovation against the background of Sino–U.S. trade frictions. This may in turn help China to emerge as an innovative country by breaking down the scientific and technological blockade erected by the U.S. and eliminating its high-tech dependence on the U.S.

Declaration of Competing Interest

The author declare that there is no conflict of interest.

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[13] On March 22, 2018, the U.S. government plans to impose tariffs of up to 25% on China's imports of US $50 billion, which is regarded as the beginning of Sino-US trade friction (Huang et al., 2018).

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