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The impact of directors' and officers' liability insurance on firm's investment efficiency: evidence from China

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Abstract

Purpose – The purpose of this paper is to examine the impact of directors' and officers' liability insurance (D&O insurance hereafter) on corporate governance and firm performance, with a specific focus on investment efficiency.

Design/methodology/approach – Using a sample of Chinese A-share listed firms from the period 2007 to 2020, this study uses Ordinary Least Squares regressions to investigate the research questions, as well as moderating and mediating effects. Additionally, alternative measures of investment efficiency are used, and the Heckman two-stage model and propensity score matching model are used to demonstrate the consistency of the findings and to mitigate the risk of endogeneity.

Findings – The findings of this study suggest that purchasing D&O insurance has a detrimental impact on corporate investment efficiency, particularly in the context of over-investment activities; robust internal governance mechanisms, exemplified by a higher shareholding ratio of the top shareholder and enhanced internal control quality, alleviate this negative effect; and financing constraints act as a mediating factor in the association between D&O insurance and investment efficiency.

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Originality/value – Corporate investment efficiency is of significant importance for both national macroeconomic growth and micro-enterprise development. Notably, the prevalence of D&O insurance among Chinese firms is progressively increasing, thus exerting a growing influence. This study contributes to the existing literature on D&O insurance and corporate investment efficiency, providing valuable insights into the economic impact of D&O insurance on Chinese firms. The empirical evidence presented herein facilitates future reforms and adjustments.

Keywords Directors' and officers' liability insurance, Investment efficiency, Internal control mechanism

Paper type Research paper

1. Introduction

China's economy is undergoing continuous development and transformation. In the current "new normal" phase, enhancing economic development efficiency has become a top national priority. The 19th National Congress of the Communist Party of China acknowledges that the Chinese economy has shifted from a stage of high-speed growth to one of high-quality development. However, several issues and contradictions have emerged, such as investment bubbles, high leverage ratios and income inequality, which act as barriers to achieving economic growth. With the overall return on investment diminishing, it is imperative for the Chinese business sector to redirect its growth momentum from driving investment volume to enhancing investment efficiency to achieve high-quality economic development in the future.

Directors' and officers' liability insurance (D&O insurance hereafter) is an insurance mechanism designed to protect corporate directors and officers from legal liability arising from decisions and actions performed within their regular duties (Lin *et al.*, 2011). Specifically, D&O insurance covers the personal liability of insured directors and senior managers resulting from misconduct or wrongdoing during the execution of their managerial responsibilities. The insurance provider covers the costs of defense and civil liability arising from legal actions brought by stakeholders such as investors and creditors. In common-law jurisdictions, the purchase of D&O insurance is a common practice among listed firms (Zou *et al.*, 2008). For instance, D&O insurance coverage is present in 97% of US firms, 86% in Canada, 60%–70% in Hong Kong SAR, China (Yuan *et al.*, 2016) and approximately 55% in Taiwan, China (Chiang and Chang, 2022; Li and Liao, 2014). However, by the end of 2019, only 9% of firms in Mainland China had obtained D&O insurance coverage (Jiang *et al.*, 2022). This is surprising considering China's position as the world's second-largest insurance industry, yet D&O insurance adoption among Chinese listed firms remains relatively low (Hu and Fang, 2022; Jia *et al.*, 2019).

According to China's *Securities Law* (revised in 2005 and 2019), directors and officers (D&Os) of firms can be held jointly liable with the issuer for compensation if they are found to have provided false information in corporate documents, such as periodic reports, resulting in losses to investors in securities transactions. Consequently, D&Os face significant personal legal and financial risks unless they can prove their innocence (Jia and Tang, 2018). Over the past two decades, several listed firms and their D&Os have faced lawsuits and penalties because of their failure to fulfill their oversight duties (Jia *et al.*, 2019). [1] The attention toward D&O insurance in China began in 2002 when Chinese insurance companies and listed firms started recognizing the need for such coverage. In anticipation of civil lawsuits against D&Os, Chinese-listed firms were allowed to purchase liability insurance for their D&Os. The launch of the D&O insurance market in China can be traced back to the issuance of the first D&O insurance policy to Vanke Group by Ping An Insurance Company and the Chubb Insurance

Group. Over the years, the Chinese Government has made significant efforts to promote the development of the D&O insurance industry in China [2].

In addition to the late introduction of D&O insurance, Wang *et al.* (2020) suggest that the lack of standardized insurance policy formats, an imperfect litigation system and a low litigation rate have hindered the development of D&O insurance in China. For instance, many Chinese D&O insurance policies are simply replications and translations of foreign policies, which may not align with the unique characteristics of the Chinese context in certain cases. Consequently, Chinese firms' willingness to purchase D&O insurance is constrained by the high cost of obtaining relevant information and shareholders' misconceptions about the purpose and benefits of such insurance (Li *et al.*, 2022b). However, the increasing attention from regulatory authorities and recent D&O insurance claims, such as the claim made by Luckin against Ping An Insurance Company, have motivated Chinese-listed firms to procure D&O insurance. This is evidenced by a tenfold increase in D&O insurance purchases from 2002 to 2019 (Jiang *et al.*, 2022) and a subsequent increase of over 40% from 2019 to 2020 (Li *et al.*, 2022b).

Despite the rapid growth of D&O insurance in China, there is a relative scarcity of literature examining the determinants and consequences of D&O insurance using Chinese data compared to studies from North America and Europe. Furthermore, the existing literature on the consequences of D&O insurance presents inconclusive findings. Proponents argue that acquiring D&O insurance brings the insurance company (i.e. insurer) into the insured firms as an external monitor, thereby reducing opportunistic behaviors by D&Os (Griffith, 2006; Holderness, 1990; O'Sullivan, 1997). Additionally, the protection provided by D&O insurance can assist firms in attracting and retaining talented D&Os (Boyer and Stern, 2014; O'Sullivan, 1997; Priest, 1987), encouraging covered D&Os to act in the best interests of shareholders and enhance firm value.

Opponents, however, argue that the decision to purchase D&O insurance results in excessive protection for D&O activities, leading to lower costs associated with opportunistic behavior and thereby exacerbating the agency problem related to moral hazard, ultimately reducing firm value (Boyer and Tennyson, 2015; Chen *et al.*, 2016; Jia and Tang, 2018; Lin *et al.*, 2011, 2013). Previous studies investigating the determinants of investment efficiency primarily focus on the impact of information transparency and financial reporting quality (Roychowdhury *et al.*, 2019). It has been observed that investment decisions are more efficient when information asymmetry is low and financial reporting quality is high. On one hand, the acquisition of D&O insurance could have a positive effect on information transparency and financial reporting quality through its monitoring and governance-enhancing effects, consequently enhancing investment efficiency. On the other hand, obtaining such insurance may have a negative impact on information transparency and financial reporting quality because of the moral hazard effect, thus diminishing investment efficiency. Given these conflicting perspectives, it is imperative to empirically investigate the association between the purchase of D&O insurance and investment efficiency in Chinese listed firms.

In this paper, we examine the impact of D&O insurance on investment efficiency in Chinese firms. As investment efficiency plays a crucial role in driving economic development in China, this study is of interest to regulators, insurance companies and other stakeholders in the capital market. Using a sample of 27,213 firm-year observations spanning the period from 2007 to 2020, our findings indicate that D&Os from firms with D&O insurance coverage are more likely to make inefficient investment decisions, particularly in the form of over-investing. The coefficients reported in our regression analyses suggest that the purchase of D&O insurance reduces overall investment efficiency

by approximately 7.96% and/or increases over-investment activities by around 8.97%. We attribute this outcome to the moral hazard effect associated with D&O insurance, which outweighs the monitoring and governance-enhancing effects in Chinese listed firms. Furthermore, we find that a sound corporate internal governance mechanism, as indicated by the shareholding ratio of the largest shareholders and the internal control quality index, can alleviate the negative relationship between D&O insurance and investment efficiency. Through our mediation tests, we establish that financing constraints serve as a channel through which D&O insurance can impact investment efficiency.

To ensure the robustness of our main findings, we conduct several additional tests. First, we use two alternative measures of investment efficiency widely used in the literature (Gao and Yu, 2020; Goodman *et al.*, 2014) to assess the presence of measurement errors. Second, we use the Tobit model in our baseline regressions to address concerns that coefficients estimated using Ordinary Least Squares (OLS) regressions may be biased when dependent variables are truncated at zero. Additionally, we use Heckman two-stage regressions and the propensity score matching (PSM) method to mitigate potential endogeneity issues arising from selection bias and differences in observable variables. All of these robustness and endogeneity tests yield results consistent with our main findings.

This study contributes to the existing literature in several significant ways. First, while Chen *et al.* (2015) have also examined the relationship between D&O insurance and investment efficiency, our study differentiates itself in two key aspects. First, Chen *et al.* (2015) relied on manually collected data regarding D&O insurance, which introduces the possibility of measurement errors in constructing the D&O insurance coverage measure. This possibility is evident in the descriptive statistics of their study and acknowledged in their discussions. In contrast, we use a commercial database that provides more reliable D&O insurance data, which has gained increased usage in recent years (Jiang *et al.*, 2022; Wang *et al.*, 2022). [3] Our results to some extent confirm the findings of Chen *et al.* (2015). Second, while Chen *et al.* (2015) did not find a direct association between D&O insurance and investment efficiency, instead focusing on the exacerbation of over-investment when companies face serious agency problems, we establish direct evidence linking D&O insurance coverage to general investment efficiency in this paper.

Second, our study delves into issues surrounding corporate capital investment efficiency, as opposed to corporate labor investment (Wang *et al.*, 2022). Wang *et al.* (2022) find that D&Os engage in empire-building activities through excessive hiring when covered by liability insurance. Our study complements theirs by discovering that D&Os also make inefficient capital investments, particularly in the form of over-investment, when covered by liability insurance. Overall, D&O insurance coverage exhibits a negative association with both internal (labor) and external (capital) investments.

Third, our paper stands apart from the existing literature that investigates the relationship between D&O insurance coverage and investment efficiency in jurisdictions with relatively mature D&O insurance markets (Li and Liao, 2014). Li and Liao (2014) present similar research findings based on D&O coverage limit data in the Taiwanese market, where over 50% of firms have purchased D&O insurance. In contrast, Mainland China has a relatively new D&O insurance market, with only 6% of firms purchasing such insurance. Our results align with those of Li and Liao (2014), suggesting that the detrimental effects of D&O insurance on corporate investment efficiency are not solely driven by the initial set of companies choosing to purchase D&O insurance (i.e. adverse selection problem). Instead, both our studies support the moral hazard effects brought about by D&O insurance. This issue is pervasive in the insurance industry and highlights the need for

policymakers, regulators and other stakeholders to effectively monitor and manage D&O insurance.

Finally, our study contributes to the existing literature by exploring several internal corporate governance mechanisms that can mitigate the adverse effects of D&O insurance on investment efficiency. Specifically, we examine the moderating effects of internal corporate governance characteristics, proxied by equity concentration and internal control quality. Our findings indicate that a robust internal corporate structure can better monitor opportunistic behavior by D&Os, thus alleviating the moral hazard effects of D&O insurance. Therefore, our study suggests possible avenues for monitoring the effectiveness of D&O insurance in situations where external governance mechanisms are limited or absent.

The rest of this paper is organized as follows. Section 2 provides a summary of the literature and the development of our hypotheses. Section 3 outlines the sample characteristics and research methods used. Sections 4 and 5 present the results of our empirical analysis and robustness tests, respectively. Section 6 presents the results of our mediation tests, and finally, Section 7 offers concluding remarks.

2. Literature review and hypothesis development

2.1 Directors' and officers' insurance

2.1.1 Determinants of purchasing directors' and officers' insurance. D&O insurance is specifically designed and acquired to provide protection to D&Os against legal liability arising from their professional activities on behalf of the company. As a result, the key factors influencing the decision to purchase D&O insurance are the actual or perceived litigation risks faced by D&Os (Core, 1997; Jiang *et al.*, 2022; Kao *et al.*, 2020; Park, 2018; Zou *et al.*, 2008). Kao *et al.* (2020) find that conservative and risk-averse D&Os opt to purchase D&O insurance to mitigate litigation risks during initial public offerings. Similarly, Adams *et al.* (2011) find that D&Os' concern for job security is positively associated with decisions to purchase D&O insurance. However, overconfident D&Os may underestimate actual litigation risks, leading to lower demand for D&O insurance (Lai and Tai, 2019). Park (2018) and Zou *et al.* (2008) find that firms experiencing severe agency conflicts between controlling and minority shareholders, as well as between shareholders and management, tend to purchase more D&O insurance and increase insurance coverage. Jia *et al.* (2019) demonstrate a decline in demand for D&O insurance in politically connected firms in China, suggesting a substitution effect between political connections and D&O insurance in protecting D&Os from legal liability.

Li *et al.* (2022a) find that firms' incentives to procure D&O insurance are primarily driven by economic factors in recent years. Supporting this argument, Jiang *et al.* (2022) find that firms are more likely to purchase D&O insurance when operating in an external environment characterized by high economic policy uncertainty, which may lead to increased negative consequences for D&Os. A recent study by Hu and Fang (2022) reveals that the likelihood of a listed firm purchasing D&O insurance increases with the purchase behavior of peer firms.

2.1.2 Consequences of purchasing directors' and officers' insurance. As previously discussed, the primary objective of D&O insurance is to provide protection to D&Os from legal liabilities. Chalmers *et al.* (2002) argue that D&O insurance has a significant impact on corporate governance issues, as it alters the liability risk profile of company directors and managers, thereby influencing their incentives in business decisions. Consequently, the question of whether D&O insurance is beneficial to businesses has been a contentious issue worldwide. The impact of D&O insurance on directors' and managers' decision-making is

primarily analyzed through the lens of agency theory. Advocates contend that D&O insurance benefits insured firms in two ways. First, it facilitates the recruitment and retention of talented D&Os (Boyer and Stern, 2014; O'Sullivan, 1997; Priest, 1987) by transferring occupational risks to the insurer, thereby alleviating risk-averse behaviors among D&Os (Core, 1997). This protection can motivate D&Os to engage in activities that enhance firm value. Second, D&O insurance is expected to play a monitoring role within insured firms, ensuring that D&Os act in the best interests of shareholders. Consequently, D&O insurance can mitigate opportunistic behaviors by D&Os, promote responsible conduct and deter wrongdoing (Holderness, 1990; O'Sullivan, 1997). Conversely, opponents argue that excessive protection provided by D&O insurance reduces the cost of opportunistic behavior for D&Os, leading to a severe agency conflict related to moral hazard and subsequently decreasing firm value (Boyer and Tennyson, 2015; Chen *et al.*, 2016; Jia and Tang, 2018; Lin *et al.*, 2011, 2013). Chang *et al.* (2018) reconcile these contrasting views by suggesting that D&O insurance has both positive and negative effects, with the overall outcome often being a trade-off between the two. They show that the monitoring or governance enhancing effect dominates when firms have high-quality information that can be used to monitor D&Os, whereas the moral hazard effect dominates when firms have asymmetric information and D&Os are not well informed.

Empirical studies present mixed results in both developed and emerging markets. One stream of research investigates the *direct* effect of D&O insurance on D&Os' behavior using D&O-related data. Li *et al.* (2022a) find that the purchase of D&O insurance promotes director dissent in board meeting proposals, particularly among independent directors, supporting the benefits of D&O insurance. However, Jia and Tang (2018) find that independent directors become less diligent in fulfilling their duties when covered by D&O insurance, as evidenced by reduced in-person board meeting attendance, lower levels of diligence and an increased incidence of holding multiple directorships, supporting the detrimental effect of D&O insurance on corporate governance.

Another line of research examines the *indirect* effects of D&O insurance by investigating its associations with firm-level outcomes and stakeholders' perceptions. Studies supporting the benefits of D&O insurance find that firms purchasing D&O insurance are more inclined to undertake risky projects with positive net present value (Cortenraad, 2000), engage in innovation (Wang *et al.*, 2020), avoid costly real earnings management (Chang and Chen, 2018), exhibit more conservative earnings (Liao *et al.*, 2016), have a lower likelihood of restating financial statements and are more likely to disclose separate corporate social responsibility reports, thereby reducing stock price crash risk (Yuan *et al.*, 2016). Li *et al.* (2022b) find that Chinese debt holders perceive D&O insurance coverage positively, as evidenced by charging lower bond credit spreads to firms purchasing such insurance.

A significant portion of the literature supports the moral hazard effects associated with D&O insurance. The purchase of D&O insurance may increase the likelihood of internal control weaknesses (Chen and Keung, 2018), encourage aggressive financial and tax reporting policies, resulting in less conservative earnings (Chung and Wynn, 2008), and lead to more frequent financial restatements (Weng *et al.*, 2017) and tax avoidance (Zeng, 2017). Furthermore, D&O insurance has been found to weaken the sensitivity of directors' compensation to firm performance (Wang and Chen, 2016). As a potential consequence, D&Os may engage in aggressive and irrational behaviors, such as over-hiring activities (Wang *et al.*, 2022), over-investing activities (Chiang and Chang, 2022; Li and Liao, 2014) and paying higher M&A premiums (Lin *et al.*, 2011). Capital market participants perceive the coverage of D&O insurance as an additional risk factor. In response to increased risks associated with opportunistic behavior by D&Os, auditors tend to charge higher audit fees

(Chung and Wynn, 2014; Chung *et al.*, 2015; O'Sullivan, 2009) and disclose more key audit matters (Lin *et al.*, 2020a). Moreover, both debt and equity capital providers are more likely to demand a higher return for firms with D&O insurance (Chen *et al.*, 2016; Lin *et al.*, 2013). Gillan and Panasian (2015) find that firms with D&O insurance face a higher probability of lawsuits, and this probability increases with increased insurance coverage. Boubakri and Bouslimi (2016) show that financial analysts provide less optimistic future earnings forecasts for firms with D&O insurance.

2.2 Investment efficiency

Investment is a critical determinant of both economic growth and firm success, and previous literature has extensively explored the factors influencing investment efficiency over the past decades. Roychowdhury *et al.* (2019) provide a comprehensive review of prior literature examining the effects of financial reporting on corporate investment decisions. Information asymmetry has been identified as a factor that hinders firms from making optimal investment decisions (Hubbard, 1998a; Stein, 2003). Roychowdhury *et al.* (2019) demonstrate that financial reporting can reduce (increase) information asymmetry and, consequently, enhance (diminish) investment efficiency through two channels. The first channel is the *adverse selection* channel, which suggests that accounting information can reduce information asymmetry between the firm and new investors, as well as among investors themselves, thereby increasing stock liquidity and facilitating access to capital (Leuz and Verrecchia, 2000; Myers and Majluf, 1984). Early studies provide supporting evidence for both public firms (Biddle and Hilary, 2006; Biddle *et al.*, 2009) and private firms (Chen *et al.*, 2011).

The second channel is the *moral hazard* channel. Moral hazard issues arise because of severe agency conflicts between D&Os and shareholders (principals), as their goals may not be aligned with each other (Jensen and Meckling, 1976). Consequently, D&Os may exploit their informational advantage to pursue personal goals at the expense of shareholders. For example, D&Os may engage in over-investment activities aimed at expanding the firm's size (i.e. empire-building) without generating commensurate benefits (Jensen, 1986). Conversely, some D&Os may exhibit a reluctance to exert additional efforts, prefer a "quiet life" and/or be risk-averse, leading to under-investment of the firm's capital (Bertrand and Mullainathan, 2003; Gormley and Matsa, 2016). High (low) financial reporting quality reduces (increases) information asymmetry between D&Os and shareholders, thereby facilitating (impeding) better monitoring of D&Os' investment decisions. For instance, using the adoption of SFAS 131 as an indication of reduced disclosure requirements for foreign operations and, consequently, lower financial reporting quality, Hope and Thomas (2008) find that D&Os are more likely to engage in empire-building activities following such adoption.

Financial reporting may also play a distorting role in corporate investment decisions because of D&Os' myopia (another form of moral hazard) (Roychowdhury *et al.*, 2019). D&Os may prioritize short-term benefits (e.g. higher compensation and stock price) at the expense of long-term growth (e.g. investment opportunities). Previous studies have demonstrated that D&Os can use investment decisions to achieve desired financial reporting objectives. Such investment decisions include, for example, research and development expenditures (Bushee, 1998), selling, general and administrative expenditures (Roychowdhury, 2006) and labor-related costs (Dierynck *et al.*, 2012), which can result in under-investment in assets that are difficult to measure. Fellow literature exploring the associations between investment efficiency and firm-specific factors such as board characteristics (Ullah *et al.*, 2020a, 2020b), auditor characteristics (Elaoud and Jarboui, 2017)

and corporate social responsibility reporting (Erhemjamts *et al.*, 2013) essentially investigates internal and external factors that can monitor D&O behavior, reduce information asymmetry and improve financial reporting quality.

2.3 Hypothesis development

As discussed in the previous section, the purchase of D&O insurance can have both positive and negative effects on D&Os' behavior and, consequently, firm-level outcomes. According to the monitoring or governance-enhancing effect, D&Os from firms with liability insurance coverage may be motivated or able to make better investment decisions, leading to improved investment efficiency. On the other hand, according to the moral hazard effects, D&Os from firms with liability insurance coverage may engage in or be perceived as engaging in opportunistic behavior, ultimately reducing investment efficiency. There are two contrasting scenarios that can arise. First, firms with D&O insurance may face higher costs of capital (Chen *et al.*, 2016; Lin *et al.*, 2013), leading to financial constraints that hinder their ability to invest in value-added projects (i.e. under-investment). Second, insured D&Os may not be held accountable for their own misconduct, which may result in irrational investments (i.e. over-investment).

Chang *et al.* (2018) suggest that the final effect of D&O insurance is a trade-off between these positive and negative aspects. In the Chinese context, we predict that the moral hazard effect outweighs the monitoring or governance-enhancing effect. As a civil-law socialist country with relatively weak investor protection, higher information asymmetry and concentrated ownership, China's capital and insurance markets are less developed compared to those in the USA and Europe. Even in jurisdictions with developed insurance markets, Weterings (2015) notes that insurers have not adequately addressed the moral hazard effect despite using various methods to mitigate it. Kim (2015) suggests that markets with relatively poor legal and regulatory environments impose lenient penalties for D&Os' violations of duties, and the sense of responsibility among D&Os is relatively weak. Thus, we posit that Chinese D&Os in firms with liability insurance can be considered as being "over-insured," potentially amplifying the moral hazard effect and increasing the likelihood of inefficient investment. Based on these arguments, we propose the following hypothesis:

H1. The purchase of directors' and officers' insurance reduces investment efficiency.

It is crucial to further understand the factors that influence the extent to which D&O insurance undermines investment efficiency. If D&O insurance does undermine investment efficiency because of the moral hazard effect, then it is essential to identify strategies for mitigating the associated risks. As discussed in Sections 2.2 and 2.3, information asymmetry plays a key role in influencing investment efficiency (Roychowdhury *et al.*, 2019), and D&O insurance amplifies the moral hazard effect when information asymmetry is high (Chang *et al.*, 2018). We argue that the internal governance mechanisms of a firm can effectively reduce information asymmetry, enhance financial reporting quality and, consequently, restrict D&Os' opportunistic behaviors (Ge *et al.*, 2021). In this paper, we consider the shareholding of the top shareholder and a robust internal control system as two proxies for a stronger internal governance mechanism.

From an agency theory perspective, controlling shareholders have the incentive to monitor management's behavior to maximize profits. China's listed firms often exhibit a highly concentrated ownership structure, with a dominant large shareholder (often state-owned) (Jiang and Kim, 2020). Consequently, D&Os in Chinese-listed firms face heightened monitoring by large shareholders. Previous studies have also demonstrated that both overall internal control regulations and firm-level internal control quality improve financial

reporting quality (Altamuro and Beatty, 2010; Ge *et al.*, 2021). Moreover, Lai *et al.* (2020) find that managers in firms with weak internal control over financial reporting are more likely to make inefficient investments. Collectively, prior literature supports the potential moderating effects of both ownership concentration and internal control quality. Therefore, we propose the following hypotheses:

H2. The adverse impact of directors' and officers' insurance on firms' investment efficiency will be reduced by an increase in the shareholding ratio of the top shareholder.

H3. The adverse impact of directors' and officers' insurance on firms' investment efficiency will be reduced by the presence of a sound internal control system.

3. Research design

3.1 Sample

We collected data on the purchase of D&O insurance from the Chinese Research Data Services platform. Chinese Research Data Services gathers D&O information from various sources, including annual reports, minutes of board and shareholders' meetings and media reports. We obtained firm-level financial data from the China Stock Market and Accounting Research database. Our sample comprises Chinese A-share firms for the period 2007–2020. We selected 2007 as the starting year for our sample because it marks the effective convergence between Chinese Accounting Standards and International Financial Reporting Standards (Peng and Smith, 2010). In our analyses, we used lagged D&O insurance data. To exclude the effect of the significant increase in D&O insurance purchases in 2020 following the Luckin's claim against Ping An Insurance Company and other insurance firms (Li *et al.*, 2022b), we set 2019 as the final year for D&O insurance data and, consequently, 2020 as the final year for investment efficiency measures.

We excluded special treatment (*ST) firms, particular transfer (*PT) firms and firms from the financial industry from our sample. These firms have distinct corporate structures, regulatory environments and reporting rules, and their motivations for purchasing D&O insurance may differ from those of other firms. We also removed firm-year observations with missing data. Our final sample consists of 27,213 firm-year observations from 3,433 unique firms. To mitigate the influence of outliers, we winsorized all continuous variables at the 1% level.

3.2 Measurement of investment efficiency

According to Richardson (2006), we first estimate the expected investment level of the corporation using the following model:

$$\begin{aligned} INVEST_{i,t} = {} & \alpha_0 + \alpha_1 GROWTH_{i,t-1} + \alpha_2 LEV_{i,t-1} + \alpha_3 CASH_{i,t-1} + \alpha_4 AGE_{i,t-1} \\ & + \alpha_5 SIZE_{i,t-1} + \alpha_6 RETURN_{i,t-1} + \alpha_7 INVEST_{i,t-1} + \sum YEAR \\ & + \sum INDUSTRY + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where $INVEST_{i,t}$ represents the new capital expenditure in the current year. We selected a cash flow-based measure of capital expenditure for our analysis. Specifically, *INVEST* is calculated as the cash paid for acquiring and constructing fixed assets, intangible assets and other long-term assets, minus the cash received from disposing of such assets, divided by total assets. All explanatory variables are lagged by one year.

GROWTH denotes the growth rate of sales revenue; *LEV* represents the leverage ratio, calculated as the ratio of total liabilities to total assets; *CASH* signifies the ratio of cash holdings to total assets; *AGE* corresponds to the natural logarithm of the number of years the firm has been listed plus one; *SIZE* denotes the firm size, measured as the natural logarithm of total assets; and *RETURN* indicates the annualized stock return. *GROWTH* and *RETURN* are included to capture growth opportunities, while the remaining variables (*LEV*, *CASH*, *AGE* and *SIZE*) are included to account for financial constraints, which have been found to be associated with new investment decisions (Hubbard, 1998b; Lamont, 2000; Richardson, 2006). *YEAR* and *INDUSTRY* are also included to control for business cycle effects and industry-specific effects (Chiang and Chang, 2022). The residual value obtained from Model (1) reflects the deviation between expected and actual new investment expenditure. We use the absolute values of these residuals to measure the levels of investment inefficiency (*INEFFICIENCY*). In addition, *OVERINV* represents the degree of over-investment (when the residual is greater than zero), while *UNDERINV* represents the degree of under-investment (when the residual is less than zero). We use the absolute value of the residual when measuring *UNDERINV* to facilitate interpretation. Higher (lower) values of *INEFFICIENCY*, *OVERINV* and *UNDERINV* indicate lower (higher) levels of investment efficiency.

3.3 Model specification

We use the following OLS model to examine the association between the purchase of D&O insurance and corporate investment efficiency:

$$\begin{aligned} INEFFICIENCY_{i,t} = {} & \beta_0 + \beta_1 INSURANCE_{i,t-1} + \beta_2 AGE_{i,t-1} + \beta_3 SIZE_{i,t-1} \\ & + \beta_4 SOE_{i,t-1} + \beta_5 ROA_{i,t-1} + \beta_6 CFO_{i,t-1} + \beta_7 LEV_{i,t-1} \\ & + \beta_8 GROWTH_{i,t-1} + \beta_9 BZ_{i,t-1} + \beta_{10} IDP_{i,t-1} + \sum YEAR \\ & + \sum INDUSTRY + \varepsilon_{i,t} \end{aligned} \tag{2}$$

Our explanatory variable is the purchase of D&O insurance (*INSURANCE*). Consistent with prior studies using Chinese data (Jia *et al.*, 2019; Yuan *et al.*, 2016; Zou *et al.*, 2008), we code *INSURANCE* as a binary variable, taking a value of 1 if a firm purchases D&O insurance in year t-1 and 0 otherwise. Our *H1* predicts a significant and positive coefficient β_1 for *INSURANCE*, indicating that the purchase of D&O insurance leads to increased (decreased) investment inefficiency (efficiency). Following existing literature (Wu *et al.*, 2022), we include several control variables in Model (2): *AGE*, *SIZE*, *SOE*, *ROA*, *CFO*, *LEV*, *GROWTH*, *BZ* and *IDP*. *SOE* is a dummy variable coded as 1 if a firm is a state-owned enterprise and 0 otherwise. *ROA* represents the return on assets, calculated as net income divided by total assets. *CFO* denotes operating cash flow scaled by total assets. *IDP* captures board independence, measured as the percentage of independent directors on the board. *BZ* reflects board size, measured as the natural logarithm of the number of directors on the board. Other variables are defined as in Model (1). *AGE*, *SIZE*, *ROA*, *CFO*, *LEV* and *GROWTH* have been previously found to be associated with investment efficiency (Biddle *et al.*, 2009; Cheng *et al.*, 2013). We include *SOE* in the model to account for the distinctive behavior of Chinese SOEs compared to non-SOEs (Lin *et al.*, 2020b; Jiang and Kim, 2020). Board-related characteristics have also been linked to investment efficiency (Nor *et al.*, 2017;

Ullah *et al.*, 2020a, 2020b); thus, we control for *BZ* and *IDP* in our model. All firm-level control variables are lagged by one year. Furthermore, we control for time-invariant unobserved characteristics at the year and industry levels by including fixed effects for *YEAR* and *INDUSTRY*. Throughout this paper, standard errors are clustered by firm. Definitions of the variables are provided in Appendix 1.

4. Empirical results

4.1 Descriptive statistics

Table 1 presents the descriptive statistics of the variables included in our regressions. Over the sample period from 2007 to 2019, approximately 6% of Chinese listed firms purchased D&O insurance, which aligns with recent literature (Jiang *et al.*, 2022; Wang *et al.*, 2022). While the proportion of firms with D&O insurance coverage is small, Table 2 Panel A demonstrates a gradual increase in the number of firms purchasing D&O insurance over time. Consequently, the percentage of firms with D&O insurance rose from 4.53% in 2007 to 7.64% in 2019. Regarding industry distribution, Table 2 Panel B indicates that firms in the *Transportation* industry (20.02%) are more inclined to purchase D&O insurance, followed by firms in the *Mining* (13.91%) and *Real Estate* (9.98%) industries. Conversely, there were no instances of D&O insurance purchase in the *Accommodation and Catering* and *Resident, Repair and Other Services* industries throughout the sample period. Compared to other industries, the *Manufacturing* industry accounts for approximately 49.17% (803 of 1,633) of total D&O insurance purchases.

Table 1 also reveals that among inefficient investments, under-investment activities are more prevalent than over-investment activities. However, the degree of over-investment (mean *OVERINV* of 5.975%) is significantly higher than the degree of under-investment (mean *UNDERINV* of 3.43%). The mean values of *SIZE* (22.103) and *GROWTH* (19.6%) indicate that the sample firms are characterized by large size and valuable growth opportunities. Additionally, the average firm is profitable (mean *ROA* of 3.9%). Approximately 42% of sample firms are state-owned enterprises, and the average leverage ratio is 43.7%. The average board size is around 10 (mean *BZ* of 2.282), with 37.8% of directors classified as independent directors.

Variables	*N*	SD	Mean	p25	p50	p75
INEFFICIENCY	27,213	5.150	4.299	1.310	2.787	5.123
OVERINV	9,951	7.889	5.975	1.136	3.091	7.361
UNDERINV	17,262	3.037	3.430	1.403	2.688	4.494
INSURANCE	27,213	0.238	0.060	0	0	0
AGE	27,213	0.91	1.978	1.386	2.197	2.708
SIZE	27,213	1.271	22.103	21.185	21.926	22.828
SOE	27,213	0.493	0.420	0	0	1
ROA	27,213	0.055	0.039	0.014	0.036	0.065
CFO	27,213	0.122	0.159	0.073	0.124	0.208
LEV	27,213	0.202	0.437	0.277	0.434	0.592
GROWTH	27,213	0.472	0.196	−0.012	0.116	0.283
BZ	27,213	0.245	2.282	2.197	2.197	2.398
IDP	27,213	0.070	0.378	0.333	0.364	0.429

Table 1.
Descriptive statistics

Notes: This table reports the descriptive statistics of all variables included in the baseline regression. Variable definitions are provided in Appendix 1
Source: Authors' own creation

Year	Firms with a D&O insurance	Total firms	%
Panel A: Year distribution			
2007	51	1,127	4.53
2008	69	1,253	5.51
2009	78	1,318	5.92
2010	84	1,418	5.92
2011	93	1,761	5.28
2012	106	2,074	5.11
2013	123	2,247	5.47
2014	130	2,234	5.82
2015	143	2,329	6.14
2016	146	2,519	5.8
2017	173	2,729	6.34
2018	200	3,100	6.45
2019	237	3,104	7.64

Panel B: Industry distribution				
CODE	Industry	Firms with a D&O insurance	Total firms	%
A	Agriculture, Forestry, Livestock, Fishery	16	429	3.73
B	Mining	96	690	13.91
C	Manufacturing	803	17,299	4.64
D	Utilities	85	980	8.67
E	Construction	37	736	5.03
F	Wholesale and Retail	147	1,587	9.26
G	Transportation	178	889	20.02
H	Accommodation and Catering	0	105	0
I	Information Transmission, Software, and Information Technology Services	44	1,538	2.86
K	Real Estate	134	1,343	9.98
L	Leasing and Commercial Services	20	334	5.99
M	Scientific Research and Technical Services	6	200	3
N	Environment and Public Facilities	30	300	10
O	Resident, Repair and Other Services	0	34	0
P	Education	1	17	5.88
Q	Health and Social Work	3	56	5.36
R	Culture, Sports, and Entertainment	20	319	6.27
S	Comprehensive	13	357	3.64

Notes: This table presents the sample distribution statistics. Panel A shows the distribution of firms with and without D&O insurance coverage by year. Panel B reports the distribution of firms with and without D&O insurance coverage by industry. The industry classification follows the Guidelines for the Industry Classification of Listed Companies issued by the China Securities Regulatory Commission
Source: Authors' own creation

Table 2.
Sample distribution

4.2 Correlation matrix

Table 3 displays the Pearson correlation coefficients among the variables. The correlation between the purchase of D&O insurance (*INSURANCE*) and investment inefficiency (*INEFFICIENCY*) is significantly negative, with a coefficient of −0.024. This finding contradicts our hypothesis. However, it is important to note that this correlation coefficient only captures the association between *INSURANCE* and *INEFFICIENCY* without considering other relevant variables. Thus, any inferences based on it will be less reliable than regression evidence. The coefficients for the control variables indicate that larger firms, more mature firms, SOEs, firms with lower leverage and firms with a greater number of

Table 3.
Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
INEFFICIENCY	1										
INSURANCE	−0.024***	1									
SIZE	−0.153***	0.228***	1								
AGE	−0.129***	0.144***	0.361***	1							
SOE	−0.105***	0.145***	0.316***	0.407***	1						
ROA	0.037***	−0.028***	−0.009	−0.171***	−0.070***	1					
CFO	0.056***	−0.049***	−0.229***	−0.231***	−0.073***	0.255***	1				
LEV	−0.103***	0.114***	0.485***	0.347***	0.289***	−0.322***	−0.390***	1			
GROWTH	0.072***	−0.013**	0.050***	−0.036***	−0.058***	0.177***	0.008	0.050***	1		
BZ	−0.022***	0.072***	0.237***	0.140***	0.223***	−0.048***	−0.059***	0.142***	0.013**	1	
IDP	0.023***	−0.017***	−0.027***	−0.098***	−0.139***	0.030***	0.019***	−0.065***	0.003	−0.161***	1

Notes: This table shows the Pearson correlation coefficients for the variables included in our Model (2). The sample size is 27,213 firm-year observations. ***, ** and *indicate significance at the 1, 5 and 10% level, respectively
Source: Authors' own creation

directors on the board are less likely to exhibit investment inefficiency. Conversely, firms with higher returns, greater operating cash flows and more growth opportunities are more likely to engage in inefficient investments. Moreover, the purchase of D&O insurance is more common among larger firms, more mature firms, SOEs, firms with higher leverage and firms with a greater number of directors. Conversely, profitable firms, firms with higher operating cash flows, growth-oriented firms and firms with a higher proportion of independent directors are less likely to purchase D&O insurance. The highest correlation coefficient of 0.485 is observed between *SIZE* and *LEV*, indicating that multicollinearity is not a concern in this study.

4.3 Baseline regression results

We report the regression results for our *H1* in Table 4. In Column (1), we examine the association between the purchase of D&O insurance and overall investment efficiency. The coefficient of *INSURANCE* is positive and statistically significant at the 5% level, providing support for our *H1* that the purchase of D&O insurance reduces investment efficiency among Chinese firms. The explanatory power of our models, as indicated by the R-squared values, is comparable to previous studies (Chen *et al.*, 2017; Ullah *et al.*, 2020a, 2020b). Our findings suggest that the moral hazard effects of D&O insurance outweigh the monitoring or governance-enhancing effect. In other words, D&O insurance in China increases the risk of moral hazard and leads to greater investment inefficiency. In terms of control variables, our results indicate that firm age (*AGE*), firm size (*SIZE*) and state ownership (*SOE*) are negatively associated with inefficient investments, while operating cash flows (*CFO*) and growth opportunities (*GROWTH*) are positively associated with inefficient investments. These findings align with previous research.

In the subsample analysis for over-investment and under-investment, the coefficient of *INSURANCE* is positive and statistically significant at the 10% level in the over-investment

Variables	(1) *INEFFICIENCY*	(2) *OVERINV*	(3) *UNDERINV*
INSURANCE	0.342** (2.093)	0.536* (1.735)	0.088 (0.803)
AGE	−0.378*** (−7.099)	−0.285** (−2.405)	−0.394*** (−11.354)
SIZE	−0.431*** (−9.177)	−0.994*** (−9.104)	−0.170*** (−5.903)
SOE	−0.762*** (−7.750)	−1.056*** (−4.854)	−0.476*** (−7.907)
ROA	−0.665 (−0.876)	0.843 (0.407)	−5.271*** (−10.616)
CFO	0.967*** (2.725)	2.676*** (2.805)	0.555** (2.536)
LEV	−0.014 (−0.049)	0.352 (0.503)	−0.827*** (−4.428)
GROWTH	0.780*** (9.466)	0.055 (0.294)	1.065*** (12.448)
BZ	0.221 (1.453)	0.655* (1.787)	−0.020 (−0.203)
IDP	0.467 (0.929)	1.653 (1.377)	−0.337 (−1.019)
Year effect	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Constant	13.904*** (14.003)	26.252*** (11.133)	8.597*** (14.248)
Observations	27,213	9,951	17,262
Adjusted R^2	0.065	0.077	0.113

Notes: This table shows the regression results for the association between the purchase of D&O insurance and investment efficiency. Standard errors are clustered at the firm-level and *t*-statistics are reported in parentheses. See Appendix 1 for variable definitions. ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$
Source: Authors' own creation

Table 4.
Baseline regression results

subsample, but it is positive and insignificant in the under-investment subsample. These results suggest that D&Os of Chinese firms are more likely to over-invest in capital expenditures when they face reduced legal liability risks. Our findings are consistent with Li and Liao (2014), who investigate the relationship between D&O insurance coverage and investment efficiency using data from Taiwan. Furthermore, our results complement the findings of Wang *et al.* (2022), indicating that D&O insurance increases the propensity of D&Os to engage in empire-building activities through over-hiring. We extend these findings by demonstrating that D&Os with liability insurance coverage are also more prone to over-invest in capital expenditures. In terms of economic significance, the coefficient reported in Column (1) suggests that the purchase of D&O insurance reduces investment efficiency by 7.96%: 0.342 (coefficient on *INSURANCE*) divided by 4.299 (mean value of *INEFFICIENCY*). The coefficient presented in Column (2) indicates that D&Os covered by liability insurance engage in 8.97% more over-investment activities: 0.536 (coefficient on *INSURANCE*) divided by 5.975 (mean value of *OVERINV*). Therefore, the effects of D&O insurance on investment efficiency are both statistically and economically significant.

4.4 The moderating effects of internal governance

In this section, we examine the moderating effects of internal governance mechanisms on the association between the purchase of D&O insurance and investment efficiency. Specifically, we use ownership concentration and internal control quality as proxies for internal governance mechanisms. Our hypothesis posits that a robust internal governance mechanism improves financial reporting quality, reduces information asymmetry and, consequently, mitigates the moral hazard effects of D&O insurance on investment efficiency. We test our *H2* and *H3* using the following models:

$$\begin{aligned} INEFFICIENCY_{i,t} = {} & \beta_0 + \beta_1 INSURANCE_{i,t-1} + \beta_2 TOP1_{i,t-1} * INSURANCE_{i,t-1} \\ & + \beta_3 TOP1_{i,t-1} + \sum CONTROL + \sum YEAR \\ & + \sum INDUSTRY + \varepsilon_{i,t} \end{aligned} \tag{3}$$

$$\begin{aligned} INEFFICIENCY_{i,t} = {} & \beta_0 + \beta_1 INSURANCE_{i,t-1} + \beta_2 IC_{i,t-1} * INSURANCE_{i,t-1} \\ & + \beta_3 IC_{i,t-1} + \sum CONTROL + \sum YEAR \\ & + \sum INDUSTRY + \varepsilon_{i,t} \end{aligned} \tag{4}$$

Ownership concentration is measured as the percentage of shareholdings held by the largest investor (*TOP1*). We use the internal control quality index (*IC*) developed by DIB Company to assess the internal control quality of Chinese firms (Chen *et al.*, 2019; Liu *et al.*, 2022). [4] To examine the effects of internal governance mechanisms, we include *TOP1* and *IC* as well as their interactive terms with *INSURANCE* in Models (3) and (4), respectively. Based on *H2*, we anticipate negative and significant coefficients for *TOP1* * *INSURANCE* because the D&O insurance could lead to directors' moral hazard, and it is suggested D&O insurers should take various measures in an attempt to mitigate the moral hazard (Weterings, 2015). However, when the shareholding ratio of the top shareholder is higher, the major shareholder possesses stronger monitoring capabilities over the board, thereby weakening the moral hazard and improving firm performance (Nguyen *et al.*, 2015; Wang *et al.*, 2019).

Similarly, according to *H3*, we predict negative and significant coefficients for *IC* * *INSURANCE* as a stronger internal control system reduces the opportunities for D&Os to engage in opportunistic behavior, thereby mitigating the moral hazard effect of D&O insurance. All other variables remain the same as in Model (2). The regression results are presented in Table 5. The coefficients on *INSURANCE* are statistically positive in five of the six columns, aligning with our main findings that the purchase of D&O insurance reduces investment efficiency. Furthermore, the results reveal statistically negative coefficients for *TOP1* * *INSURANCE* and *IC* * *INSURANCE*, indicating that the adverse effects of D&O insurance on investment efficiency are alleviated by a firm's internal governance mechanisms. Thus, both *H2* and *H3* are supported.

5. Robustness and endogeneity tests

5.1 Alternative measurement of investment efficiency

To check the robustness of our main findings, we replaced our original measure of investment inefficiency (*INEFFICIENCY*) with two alternative measures used in previous literature. Gao and Yu (2020) provide a comprehensive review of investment efficiency measurement methods. First, we substituted the sales growth rate (*GROWTH*) with Tobin's Q (*TOBINQ*) and re-estimated Model (1). *TOBINQ* is computed as the sum of the market value of equity and the amount of debt, divided by total assets. We refer to this alternative measure as *INEFFICIENCY_A1*. Second, we adopted the investment efficiency measure developed by Goodman *et al.* (2014), which focuses on investment in response to investment opportunities. Model (5) was used to estimate the expected investment level:

$$INVEST_{i,t} = \alpha_0 + \alpha_1 ASSET\_GROWTH_{i,t-1} + \alpha_2 TOBINQ_{i,t-1} + \alpha_3 CFO_{i,t-1} + \alpha_4 INVEST_{i,t-1} + \varepsilon_{i,t} \quad (5)$$

where *ASSET_GROWTH* represents the growth rate of total assets. All other variables were defined previously, and all explanatory variables were lagged by one year. Similar to the main investment inefficiency measure, we used the absolute value of residuals generated from Model (5) to quantify our second alternative measure, denoted as *INEFFICIENCY_A2*. The results using the alternative measures of investment efficiency are presented in Table 6 Panel A. We still find positive and significant coefficients on our independent variable (i.e. *INSURANCE*), which are consistent with the main findings. Thus, our results remain robust and are not influenced by measurement errors.

5.2 Tobit regression

Our dependent variables (*INEFFICIENCY*, *OVERINV* and *UNDERINV*) are truncated at 0, which suggests that OLS regressions may yield biased coefficients. To address this concern, we used Tobit regressions to examine the robustness of our results. The findings are presented in Table 6 Panel B. Consistent with our main results, we continue to observe the adverse effects of D&O insurance coverage on investment efficiency, indicating that D&Os covered by liability insurance are less inclined to make optimal investment decisions.

5.3 Endogeneity – Heckman two-stage test and propensity score matching

5.3.1 Heckman two-stage regressions. As the decision to purchase D&O insurance may not be random, there is a possibility that unobservable factors influencing this decision are also related to investment efficiency. Thus, we ran further tests to address any remaining concerns about endogeneity. First, we used Heckman's (1979) two-stage regressions to

Table 5.
Moderating effect of internal governance mechanisms

Variables	(1) *INEFFICIENCY*	(2) *OVERINV*	(3) *UNDERINV*	(4) *INEFFICIENCY*	(5) *OVERINV*	(6) *UNDERINV*
INSURANCE	1.302*** (3.184)	2.264*** (2.967)	0.654** (2.080)	1.915** (2.358)	2.045 (1.193)	1.512** (1.970)
TOP1 * *INSURANCE*	−0.026*** (−2.783)	−0.046*** (−2.600)	−0.015** (−2.168)			
TOP1	0.004 (1.479)	0.015** (2.158)	0.000 (0.255)			
IC * *INSURANCE*				−0.002** (−2.021)	−0.002 (−0.905)	−0.002* (−1.952)
IC				0.000 (0.790)	0.001 (1.359)	−0.001** (−2.184)
AGE	−0.367*** (−6.630)	−0.240* (−1.955)	−0.396*** (−11.064)	−0.378*** (−7.078)	−0.273** (−2.292)	−0.401*** (−11.563)
SIZE	−0.432*** (−8.996)	−1.014*** (−9.190)	−0.165*** (−5.587)	−0.429*** (−9.018)	−1.012*** (−9.057)	−0.153*** (−5.228)
SOE	−0.783*** (−7.673)	−1.126*** (−5.029)	−0.474*** (−7.687)	−0.766*** (−7.772)	−1.067*** (−4.888)	−0.472*** (−7.842)
ROA	−0.755 (−0.998)	0.456 (0.220)	−5.270*** (−10.597)	−0.743 (−0.951)	0.286 (0.134)	−4.867*** (−9.491)
CFO	0.937*** (2.650)	2.595*** (2.735)	0.546** (2.495)	0.965*** (2.723)	2.677*** (2.807)	0.551** (2.519)
LEV	−0.043 (−0.156)	0.304 (0.435)	−0.845*** (−4.511)	−0.014 (−0.049)	0.350 (0.500)	−0.839*** (−4.499)
GROWTH	0.777*** (9.441)	0.062 (0.333)	1.062*** (12.418)	0.776*** (9.424)	0.043 (0.228)	1.067*** (12.507)
BZ	0.241 (1.577)	0.727** (1.978)	−0.018 (−0.179)	0.226 (1.478)	0.670* (1.823)	−0.032 (−0.327)
IDP	0.464 (0.922)	1.644 (1.370)	−0.330 (−0.999)	0.472 (0.936)	1.597 (1.328)	−0.287 (−0.868)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes
Constant	13.746*** (13.742)	25.996*** (11.021)	8.462*** (13.948)	13.697*** (13.699)	25.929*** (10.877)	8.563*** (14.022)
Observations	27,213	9,951	17,262	27,212	9,951	17,261
Adjusted R^2	0.065	0.078	0.114	0.065	0.077	0.114

Notes: This table presents the effect of internal governance mechanisms. Internal governance mechanisms are proxied by the shareholding ratio of the largest shareholders (i.e. *TOP1*) and internal control quality index (i.e. *IC*). We add *TOP1* and *TOP1***INSURANCE* in Columns (1)–(3) and *IC* and *IC** *INSURANCE* in Columns (4)–(6). Standard errors are clustered at the firm level and *t*-statistics are reported in parentheses. See Appendix 1 for variable definitions. ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$

Source: Authors' own creation

	(1) *INEFFICIENCY_A1*	(3) *INEFFICIENCY_A2*
Panel A: Alternative investment inefficiency measures		
INSURANCE	0.323* (1.655)	0.076*** (4.396)
Controls	Yes	Yes
Year effect	Yes	Yes
Industry effect	Yes	Yes
Constant	14.976*** (13.103)	3.236*** (11.806)
Observations	22,490	23,497
Adjusted R^2	0.055	0.052

Panel B: Tobit regression

	(1) *INEFFICIENCY*	(2) *OVERINV*	(3) *UNDERINV*
INSURANCE	0.429*** (3.228)	0.713** (2.231)	0.167* (1.669)
Controls	Yes	Yes	Yes
Year effect	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Constant	14.621*** (21.900)	26.884*** (15.962)	9.335*** (19.190)
Observations	27,213	9,951	17,262
Pseudo R^2	0.0063	0.0069	0.0147

Notes: This table shows the results of the robustness tests. Panel A presents the results of using two alternative investment efficiency measures, and Panel B shows the results from Tobit regression. Standard errors are clustered at the firm level and *t*-statistics are reported in parentheses. See Appendix 1 for variable definitions. ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$
Source: Authors' own creation

Table 6.
Robustness tests

address potential endogeneity resulting from selection bias. In the first step, we estimated a Probit regression model for the D&O insurance purchase decision. Subsequently, we included the inverse Mills ratio (*IMR*) generated from the first step as an additional control variable in the second-stage regression. Consistent with prior studies (Hu and Fang, 2022; Wang *et al.*, 2022; Yuan *et al.*, 2016), we used the industry average coverage of D&O insurance, excluding the focal firm (*IND_INSURANCE*), as the exclusion variable that may affect the firms' decision to purchase D&O insurance but is unlikely to affect firms' investment efficiency. We argue that firms are more likely to purchase D&O insurance when their industry peers do so, and therefore, we expect a positive association between *IND_INSURANCE* and our primary variable of interest (*INSURANCE*).

Table 7 Panel A shows the results of the Heckman two-stage regressions. Consistent with our expectations, we find a positive and significant coefficient on *IND_INSURANCE*. The coefficients on other control variables align with the results of our correlation analysis. Importantly, we observe that the coefficients on *INSURANCE* remain positive and statistically significant in Columns (2) and (3) even after incorporating *IMR* as an additional control variable. Thus, the endogeneity concern is mitigated in our results.

5.3.2 Propensity score matching method. We also used the PSM approach to address selection bias arising from observable factors. PSM creates treatment and control groups that are comparable in terms of those observable factors, relaxing assumptions about the functional form of variable relations (Shipman *et al.*, 2017). By using the PSM approach, we can attribute the observed effects of D&O insurance to the insurance itself, rather than to the influence of those observable covariates. Following Yuan *et al.* (2016), we first estimated a

	(1) *INSURANCE*	(2) *INEFFICIENCY*	(3) *OVERINV*	(4) *UNDERINV*
Panel A: Heckman two-stage model				
IND_INSURANCE	0.007*** (7.116)			
INSURANCE		0.339** (2.074)	0.516* (1.667)	0.089 (0.811)
IMR		0.583 (1.257)	2.746** (2.512)	−0.512 (−1.541)
Controls	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Constant	−8.217*** (−25.313)	9.272** (2.532)	4.656 (0.537)	12.498*** (4.828)
Observations	26,884	26,884	9,862	17,022
Pseudo/Adjusted R^2	0.142	0.065	0.077	0.112

Panel B: Propensity Score Matching (PSM) model

	(1) *INEFFICIENCY*	(2) *OVERINV*	(3) *UNDERINV*
INSURANCE	0.363*** (2.733)	0.717** (2.485)	0.151 (1.494)
Controls	YES	Yes	Yes
Year effect	YES	Yes	Yes
Industry effect	YES	Yes	Yes
Constant	10.964*** (9.836)	15.823*** (6.313)	7.573*** (8.977)
Observations	6,445	2,547	3,934
Adjusted R^2	0.040	0.057	0.075

Notes: This table reports the results of the endogeneity tests. We use Heckman two-stage model and PSM model in Panels A and B, respectively. Standard errors are clustered at the firm level and *t*-statistics are reported in parentheses. See Appendix 1 for variable definitions. ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$
Source: Authors' own creation

Table 7.
Endogeneity tests

Probit model (similar to the model used in Section 5.3.1, but excluding *IND_INSURANCE*) using the pooled sample. Subsequently, we estimated a propensity score for each firm and conducted a 1:4 matching with replacement based on the nearest neighbor technique as part of the PSM procedure. This approach enables more successful matches and, consequently, increases the sample size (Shipman *et al.*, 2017). Our matched sample comprises 6,445 firm-year observations, including 1,633 observations with D&O insurance and 4,812 observations without D&O insurance coverage.

We tested the effectiveness of the PSM procedure by comparing the distribution of observable covariates between the treatment and control groups. In the propensity-matched sample, the absence of systematic differences in mean values indicates that the PSM model is appropriately specified (Austin, 2011). As depicted in Appendix 2, none of the included variables exhibit significant differences between the treatment and control groups in the pooled sample, the over-investment subsample and the under-investment subsample.

Table 7 Panel B presents the results of the PSM analysis. In Column (1), the coefficient of *INSURANCE* is positive and significant at the 1% level, while in Column (2), it is significant at the 5% level, which supports our main findings. In conclusion, the results from the PSM analysis further reinforce our main findings that D&Os with liability insurance coverage tend to engage in inefficient investments, particularly in the case of over-investment activities.

6. Additional test: Mediation effects of financing constraints

Thus far, we have obtained robust evidence indicating that D&O insurance coverage has a negative effect on investment efficiency because of the moral hazard effect. However, we

have not yet identified the specific channel(s) through which D&O insurance coverage reduces investment efficiency. In this section, we propose financing constraints as one such possible channel. Previous studies have found that firms with D&O insurance coverage are perceived as having higher risks by capital market participants because of the moral hazard effect, poor information quality and/or increased risk-taking activities. As a result, these firms face higher costs of equity capital and debt capital (Chen *et al.*, 2016; Lin *et al.*, 2013), leading to more severe financing constraints (Gulen and Ion, 2016). On the other hand, Campello *et al.* (2010) find that firms facing financing constraints tend to postpone or abandon investment opportunities, thereby reducing investment efficiency. We use the SA_INDEX developed by Hadlock and Pierce (2010) to measure financing constraints, where the financing constraints are a function of firm size and age (See Model A1 in Appendix). The higher the SA_INDEX, the more serious the financing constraints.

Following the approach of Baron and Kenny (1986) and Jollineau and Bowen (2022), we use Models (6A)–(6C) to conduct our mediation analyses:

$$INEFFICIENCY_{i,t} = \alpha_0 + \alpha_1 INSURANCE_{i,t-1} + \sum CONTROL + \sum YEAR + \sum INDUSTRY + \varepsilon_{i,t} \quad (6A)$$

$$SA\_INDEX_{i,t} = \beta_0 + \beta_1 INSURANCE_{i,t-1} + \sum CONTROL + \sum YEAR + \sum INDUSTRY + \varepsilon_{i,t} \quad (6B)$$

$$INEFFICIENCY_{i,t} = \gamma_0 + \gamma_1 INSURANCE_{i,t-1} + \gamma_2 SA\_INDEX_{i,t} + \sum CONTROL + \sum YEAR + \sum INDUSTRY + \varepsilon_{i,t} \quad (6C)$$

where the mediator is *SA_INDEX*. The total effect of *INSURANCE* on *INEFFICIENCY* (i.e. α_1 from Model 6A) can be decomposed into a direct effect and an indirect effect (through the mediator *SA_INDEX*). The direct effect is γ_1 from Model (6C), whereas the indirect effect is $\beta_1 * \gamma_2$ for *SA_INDEX*. We use the OLS regressions to perform the causal step regressions.

Table 8 Panel A presents the results of our mediation tests. In Column (1), we observe a positive and significant coefficient on D&O insurance coverage (*INSURANCE*) when running the regression without the mediator. This finding aligns with our main results presented in Table 4, suggesting that the purchase of D&O insurance reduces the overall investment efficiency of Chinese firms. In Column (2), we find a weak positive and significant association between *INSURANCE* and *SA_INDEX* (coefficient of 0.025 and $p < 0.1$), indicating that firms face more severe financing constraints when their D&Os are covered by liability insurance. In Column (3), where we include *SA_INDEX* as an additional control variable, we still find a positive and significant coefficient on *INSURANCE*. However, the significance level decreases (coefficients decline from 0.342 to 0.325 and *t*-statistics drop from 2.093 to 1.979), confirming a partial mediation effect of *SA_INDEX*. We also conduct a Sobel test to verify the robustness of our mediation results, and the significant Z-score of the Sobel test supports our findings, as shown in Table 8 Panel B. Nevertheless, we also find that the direct effect accounts for the majority of the total effect (approximately 91%). Overall, these results suggest that financing constraints partially mediate the relationship between D&O insurance coverage and investment efficiency.

	(1) *INEFFICIENCY*	(2) *SA_INDEX*	(3) *INEFFICIENCY*
Panel A: Baron and Kenny's (1986) causal step regression results			
INSURANCE	0.342** (2.093)	0.025* (1.712)	0.325** (1.979)
SA_INDEX			0.680*** (3.004)
Controls	Yes	Yes	Yes
Year effect	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Constant	13.904*** (14.003)	−4.241*** (−48.943)	16.786*** (11.705)
Observations	27,213	27,213	27,213
Adjusted R^2	0.065	0.424	0.066
Panel B: Sobel test results			
Indirect effect			0.0388
Direct effect			0.3906
Total effect			0.4295
Indirect/Total			0.0903
Z-Score			4.56
p-value			0.0000

Notes: This table reports the results of the mediation tests. We use a financing constraints measure (*SA_INDEX*) as the mediator. Column (1) shows the effect of *INSURANCE* on *INEFFICIENCY* without the *SA_INDEX*. Column (2) presents the effect of *INSURANCE* on *SA_INDEX*, while Column (3) shows the results with both *INSURANCE* and *SA_INDEX*. Standard errors are clustered at the firm level and *t*-statistics are reported in parentheses. See Appendix 1 for variable definitions. ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$

Source: Authors' own creation

Table 8.
Additional test – mediation effect

7. Conclusions

Corporate investment efficiency holds significant importance for both macroeconomic growth and micro-enterprise development. The adoption of D&O insurance as a means to mitigate risks in business decision-making by directors and executives has been increasingly prevalent among Chinese firms. However, the impact of D&O insurance on investment efficiency in Chinese firms remains largely unexplored in the literature. This study aims to address this gap by empirically examining the relationship between D&O insurance and investment efficiency using a sample of China's A-share listed firms from 2007 to 2020.

The key findings of this study are as follows. First, the purchase of D&O insurance has a significantly negative effect on corporate investment efficiency in both the pooled sample and the over-investment sample. In other words, Chinese firms' investment efficiency declines significantly after obtaining D&O insurance coverage. Second, by considering the moderating effect of firms' internal governance mechanisms, we find that the adverse effects of D&O insurance on investment efficiency are mitigated by the shareholding ratios of the top shareholder and the quality of internal control systems. This suggests that stronger control by the top shareholder and robust internal control systems have a greater monitoring effect, which effectively offsets the potential moral hazard risks associated with D&O insurance. Finally, our study reveals that financing constraints mediate the relationship between D&O insurance and investment efficiency. Firms with D&O insurance coverage are more likely to encounter financing constraints, leading to inefficient investment decisions.

This paper contributes to the existing literature on corporate investment efficiency and corporate governance in China. It also has practical implications for enterprises, insurance companies and policymakers in China. The findings suggest that D&O insurance in China

does not improve corporate investment efficiency but rather increases the likelihood of moral hazard and opportunistic behaviors, resulting in inefficient investment. Therefore, it is recommended that listed firms carefully consider their specific circumstances and characteristics when selecting D&O insurance. For insurance companies, it is advised to design liability insurance policies that align with the institutional environment and firms' characteristics in China. Only through the collaborative efforts of insurers and insured firms can D&O insurance effectively fulfill its intended role in enhancing the monitoring of listed firms and protecting the interests of minority shareholders.

Notes

1. For instance, in 2008, the chairman of Zoje Sewing Machine Co., Ltd (present name: Zoje Resources Investment Co., Ltd.) was named as a defendant in a lawsuit brought by investors for the misrepresentation of financial statements, making the beginning of securities lawsuits targeting D&Os in China (Chen *et al.*, 2015). Another example is that, in 2021, Kangmei Pharmaceutical Co., Ltd and its D&Os were ordered to pay nearly 2.45bn RMB to compensate investors' losses.
2. Relevant regulatory documents include "Article 39 of the Code of Corporate Governance for Listed Companies (Article 24 in the 2018 revised version)", "Notice on the Relevant Issues concerning the Acceptance of Cases of Disputes over Civil Tort Arising from False Statement in the Securities Market" and "Opinions on Accelerating the Development of Modern Insurance Service Industry".
3. Specifically, Chen *et al.* (2015) show that only 1.41% of total sample firms purchased D&O insurance during the period from 2002 to 2012. The corresponding figures in this study are 5.37% for the period of 2007–2012 and 6% for the whole sample period (2007–2019).
4. A total of 63 indicators across five areas (i.e. internal environment, risk assessment, controlling activity, information and communication and internal monitoring) constitute the internal control quality index. Each indicator equals a score of 1 if a firm disclosed that it met the requirement specified by that indicator and a score of 0 otherwise. The index is the sum of all scores from these 63 indicators; thereby, a higher internal control index indicates better quality of a firm's internal control system.

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Appendix 1

Variable	Definition
Dependent variable	
INEFFICIENCY	Investment inefficiency, measured by the absolute value of residuals generated from Model (1) according to Richardson (2006)
INEFFICIENCY_A1	Alternative measure of investment inefficiency, measured by the absolute value of residuals generated from Model (1) after replacing *GROWTH* with Tobin's Q
INEFFICIENCY_A2	Alternative measure of investment inefficiency, measured by the absolute value of residuals generated from Model (5) according to Goodman *et al.* (2014)
OVERINV	The level of over-investment, measured by the positive residuals generated from Model (1)
UNDERINV	The level of under-investment, measured by the absolute value of negative residuals generated from Model (1)
Independent variable	
INSURANCE	An indicator variable coded as 1 for firm purchasing D&O insurance in year t-1, 0 otherwise
Variables to calculate investment efficiency	
AGE	Firm age, measured by natural log of listing years plus one
ASSET_GROWTH	The growth rate of total assets
CASH	The cash holdings divided by total assets
CFO	Operating cash flow scaled by total assets
GROWTH	Growth opportunities, measured by the growth rate of sales revenue
INVEST	Total new capital expenditure, defined as cash paid for acquisition and construction of fixed assets, intangible assets, and other long-term assets less cash received from the disposal of fixed assets, intangible assets, and other long-term assets, divided by total assets
LEV	Leverage ratio, measured by the ratio of total liabilities and total assets
RETURN	Annual stock returns
SIZE	Firm size, measured by natural log of total assets
TOBINQ	The sum of market value of equity and the amount of debt, divided by total asset
Other firm-level variables	
BZ	Board size, measured by the natural log of the number of directors
IDP	Board independence, measured by the percentage of independent directors on the board of directors
IND_INSURANCE	Industry-average coverage of D&O insurance
ROA	Return on assets, measured by net income divided by total assets
SOE	An indicator variable that equals 1 for state-owned enterprises, and 0 for non-state-owned enterprises
SA	Financing constraint measure developed by Hadlock and Pierce (2010) using the following model: $SA_{i,t} = -0.737*SIZE_{i,t} + 0.043*(SIZE_{i,t})^2 - 0.040*AGE_{i,t}$ (A1)
TOP1	Ownership concentration, measured by the percentage of shareholdings held by the largest investor
IC	Internal control quality index. A total of 63 indicators across five areas (i.e. internal environment, risk assessment, controlling activity, information and communication and internal monitoring) constitute the internal control quality index. Each indicator equals a score of 1 if a firm disclosed that it met the requirement specified by that indicator and a score of 0 otherwise. The index is the sum of all scores from these 63 indicators

Table A1.
Variable definitions

Source: Authors' own creation

Appendix 2

Table A2. Mean-difference tests for PSM matching covariates

	Observations	Treated	Observations	Control	*t*-statistics
Panel A: Overall investment inefficiency sample					
AGE	1,633	2.496	4,812	2.488	0.380
SIZE	1,633	23.245	4,812	23.269	−0.430
SOE	1,633	0.702	4,812	0.689	0.790
ROA	1,633	0.033	4,812	0.034	−0.260
LEV	1,633	0.528	4,812	0.528	0.030
CFO	1,633	0.135	4,812	0.137	−0.500
GROWTH	1,633	0.172	4,812	0.180	−0.460
IDP	1,633	0.374	4,812	0.372	0.550
BZ	1,633	2.353	4,812	2.350	0.260
Panel B: Over-investment subsample					
AGE	672	2.571	1,875	2.582	−0.340
SIZE	672	23.370	1,875	23.375	−0.070
SOE	672	0.709	1,875	0.694	0.580
ROA	672	0.039	1,875	0.039	0.330
LEV	672	0.546	1,875	0.552	−0.560
CFO	672	0.135	1,875	0.133	0.340
GROWTH	672	0.187	1,875	0.179	0.350
IDP	672	0.373	1,875	0.376	−0.620
BZ	672	2.355	1,875	2.353	0.160
Panel C: Under-investment subsample					
AGE	961	2.443	2,973	2.438	0.180
SIZE	961	23.156	2,973	23.152	0.050
SOE	961	0.697	2,973	0.703	−0.290
ROA	961	0.029	2,973	0.030	−0.220
LEV	961	0.515	2,973	0.511	0.370
CFO	961	0.135	2,973	0.137	−0.250
GROWTH	961	0.162	2,973	0.154	0.380
IDP	961	0.374	2,973	0.375	−0.210
BZ	961	2.350	2,973	2.353	−0.270

Source: Authors' own creation

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