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Workplace safety accident, employee treatment, and firm value: Evidence from China

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ABSTRACT

Workplace safety has become a key priority in China. However, the impact of workplace safety accidents on firm value remains unexplored. In this paper, using a dataset of 249 workplace safety accidents that occurred between 2007 and 2020, we find that workplace safety accidents result in a significant average drop of 2.5% of firm value (over $80 million) within 10 trading days. Firms with superior employee treatment will suffer lower financial market penalties, confirming the insurance effect of CSR activities. The moderating effect is also present in the overall CSR as well as in the stakeholder-related CSR dimensions. In addition, firms with workplace safety accidents will experience a greater decline in employee productivity and market valuation. Overall, the above findings emphasize the important role played by workplace safety and employee treatment for firm value and can provide policy implications for government, regulators, and corporate managers in emerging markets.

1. Introduction

With increasing values attached to human capital, and considering employees are one of the most valuable assets, meeting and maintaining high workplace safety standards are becoming increasingly important. Firms choose the optimal level of workplace safety investments by balancing their marginal costs and benefits (Filer and Golbe, 2003). The costs of safety-related activities include direct expenditures invested on tangible assets with better safety features as well as activities that impact safety, such as safety training, supervision, and cultivating a safety culture (Cohn and Wardlaw, 2016). Correspondingly, the benefits of increased safety may include reduced accidents costs, such as a decrease in the level of damages for injured workers and penalties for regulators, as well as lower wages when assuming firms with hazardous workplace conditions should pay quality-of-life compensation premium to attract same-quality employees (Filer and Golbe, 2003; Deng and Gao, 2013). If the benefits of workplace safety investments exceed the costs, firms will engage in improving safety. Otherwise, firms are incentivized to compromise the safety of the work environment, which may lead to workplace accidents, and a physical cost to employees with pain, injury, disability, and even in extreme cases, death (Caskey and Ozel, 2017).

There have been many substandard working conditions that have turned into major workplace safety accidents or even national crises across a range of Chinese industries. For example, huge explosions in China's Tianjin Port in 2015 resulted from the illegal storage of large numbers of hazardous chemicals at the station, which killed over 170 citizens, injured hundreds of people in the surrounding residential area, and resulted in an estimated 9 billion dollars of losses in the supply chain disruption.[1] Companies such as Alibaba emphasize safety in the workplace in their code of ethics.[2] China subsequently passed a new Workplace Safety Law in 2014, which imposed significantly harsher penalties on firms and also enhanced the supervisory power of occupational safety watchdogs and local governments.[3] Thus, both companies and government officials are paying greater attention to workplace safety.

Workplace safety accidents are negative and unexpected events that exert significant consequences on associated firms and employees. On one hand, they directly affect firm performance by disturbing the production schedule, damaging fixed assets, inventories, raw materials, finished products, and imposing penalties, lawsuits, and health insurance costs on accident firms (Capelle-Blancard and Laguna, 2010; Cohn and

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Wardlaw, 2016). On the other hand, employees injured on-the-job and their families are subjected to unavoidable health deterioration, a decline in their practical skills, and lower current income, which may lead to a long-term reduction in wealth and consumption (Galizzi and Zagorsky, 2009). Overall, this may lead to lower job satisfaction, and thus an increase in employee resignations (Caskey and Ozel, 2017). Although there are several ways to evaluate the real effects of workplace safety accidents, the stock market value of the accident firms could provide essential information; currently, this avenue of thought is not given enough attention.

We investigate the impact of workplace safety accidents on firm value in China, which is an ideal setting for three reasons. First, China has been one of the world's most populous countries and the leading manufacturing hub of the world (Wang et al., 2021). As the added industrial value of the Chinese manufacturing sector grew from 16.98 trillion yuan in 2012 to 26.6 trillion yuan in 2020, the Chinese manufacturing sector has topped the world for 11 consecutive years since 2010. However, with China's development policy shifting to high-quality development, it is important for enterprises to improve the employee relations and the quality of the workforce, and to consider whether and how the employee treatment can affect firm value. Second, from the workplace safety accidents announcements released by the listed firm in China, we can distinguish the different types of accidents, and investigate the heterogeneity effects of such negative accidents on firm value. Third, China has been making legal and policy adjustments in the protection of labor rights and interests, such as the Labor Protection Law. Moreover, China's revised Workplace Safety Law, which imposes significantly harsher penalties on offenders, took effect on Dec. 1, 2014. Thus, it provides us an opportunity to investigate how the investor reacts to the negative accidents after the adjustment of the new law.

Therefore, we formally use public disclosures on workplace safety accident events within Chinese listed firms to analyze how the capital market reacts to workplace safety accidents. We manually collect a unique and comprehensive dataset of 249 workplace safety accidents between 2007 and 2020. By employing an event study and propensity score matching (PSM) procedure used to control the systematic difference between the accident firms and non-accident firms, we find that workplace safety accidents result in a significant average drop of 2.5% (over $80 million) within 10 trading days of the study commencing, compared with control firms. The results suggest that workplace safety accidents are perceived adversely by investors, and cause market penalties to the equity of the associated firm.[4]

To differentiate the possible effects of firm CSR activities, we further investigate how employee treatment will moderate the negative effect of workplace safety accidents. The results show that firms with more caring about employee well-being, will suffer fewer financial market penalties in response to workplace safety accidents. Thus, the results imply that investors perceive firms with high employee treatment as more trustworthy during abnormal times, and firms can also employ such CSR activities to insure against stock price risk, protecting themselves against unexpected events.[5]

The heterogeneity tests show that workplace fires and explosions result in more serious losses in shareholder wealth than other accident types. In addition, the capital market will more heavily penalize firms that occurred accidents after the adoption of the new Workplace Safety Law in 2014. The long-term economic consequence we identified is that firms with workplace safety accidents will experience a greater decline in employee productivity and market valuation. Our results are robust along with different measures and specifications.

This paper contributes to existing studies in at least three ways. Firstly, our findings add to the flourishing stream of literature concerning workplace safety, which is closely related to employee well-being, and has attracted growing attention from the public and academics interested in further studying its determinants and consequences. Given that related studies in China mostly concentrate on firms in the coal mining industry (Nie et al., 2013; Nie and Zhao, 2013; Jia and Nie, 2017), we adopt a large sample of Chinese listed firms, and attempt to provide more general evidence of market reactions on overall workplace safety accidents in an emerging market. Moreover, as workplace safety accidents can bring firms heavy value losses (over $80 million within 10 trading days), our results can prompt firms to pay more attention, and prevent the occurrence of workplace accidents; they can also help managers and regulators implement effective crisis management strategies, design optimal welfare policies, and improve employee safety.

Secondly, previous studies have examined the economic consequences of employee well-being. For example, Krekel et al. (2019) conducted a meta-analysis and exhibited that firms with better employee well-being outperform other firms in the field of productivity and operating performance. By introducing a value-weighted portfolio of the “100 Best Companies to Work for in America”, Edmans (2011, 2012) suggested that firms with a high number of satisfied employees achieved higher stock returns than the industry average. Workplace safety accidents will have both direct and indirect negative impacts on employee well-being, such as safety, satisfaction, and other benefits. We find these accidents responsible for a long-term decline in firm productivity and market valuation. Thus, our results emphasize the importance of employee well-being, which can be a supplement to existing literature.

Thirdly, debates persist over the role played by firm CSR engagement. On the one hand, as noted by Lins et al. (2017), CSR activities can insure against the general economy or market crises, thus firms with superior CSR ratings may experience cushioned market reactions to the negative workplace safety accidents. On the other hand, regarding perceived CSR reputation, those firms with superior CSR ratings should suffer greater capital market penalties when workplace safety accidents occur due to falling short of expectations (Liu et al., 2020). Our results support the first view, indicating that high-CSR firms have fewer negative impacts on firm value in response to workplace safety accidents. This suggests the “insurance effect” of CSR engagement, and highlights the significance of employee treatment on companies.

We note that Kabir et al. (2018) and Amin et al. (2021) both find that negative workplace safety events can deeply impact the financial performance of a firm, which is closely related to our study. However, to distinguish our study from their studies, we further exploit the propensity score matching (PSM) procedure to mitigate the potential influence between the accident firms and non-accident firms. Thus, our approach may provide a more rigorous comparison, and helps to better understand the negative impact of workplace safety accidents on firm value compared to those similar but non-accident firms. Moreover, we propose two competing hypotheses to discuss the role played by employee treatment, then provide empirical evidence and find that firms with a superior ex-ante employee treatment will suffer fewer financial market penalties in response to the negative workplace safety accidents. We also provide

[4] For example, in our sample, a wholly-owned subsidiary of the listed company Guanfu Holdings CO., Ltd. (002102. SZ) suffered an explosion in a wastewater collection tank on Apr 16, 2017, then the stock price dropped 4.5% on the first trading day after the accident. While for a matched company CNNC Hua Yuan Titanium Dioxide Co., Ltd. (002145. SZ), the stock price dropped about 1.1% on the first trading day after Apr 16, 2017. Thus, compared with a matched firm, the accident firm experienced a greater fall in stock price.

[5] For example, a fire broke out in one of the production plants of the listed company Shandong Rike Chemical Co., Ltd. (300214. SZ) on Dec 20, 2017. Due to the worse employee treatment provided by the company (the score of employee relation from Hexun is only 1.23), the stock price dropped 9.9% on the first trading day after the accident. While, for the listed company Guanfu Holding Co., Ltd. (002102. SZ), the stock price dropped 4.5% on the first trading day after the accident. This is a relatively small drop, which may be caused by a higher employee relation (the score of employee relation from Hexun is 7.54) provided by Guanfu Holding Co., Ltd. Thus, a firm with superior employee relations may suffer less from adverse reactions from the financial market in comparison to another firm with workplace safety accidents and inferior employee relations.

more evidence considering the different types of accidents and examine the long-term impact of workplace safety accidents.[6]

We organize the remainder of this paper as follows: Section 2 reviews important related studies and proposes the research hypothesis; Section 3 describes the data, variables, and empirical strategy; Section 4 discusses the empirical results; Section 5 presents further analyses and finally, Section 6 concludes the paper.

2. Literature review and hypothesis development

2.1. Financial effects of workplace safety accident

The academic attention given to workplace safety accidents has generally focused on individual workers, and the negative outcomes for the economy as a whole (Danna and Griffin, 1999). Only a few studies have investigated the issues from the perspective of firms, and so, the empirical evidence often concentrates on particular large-scale catastrophes, or within specific industries, such as gas leaks, oil spills, nuclear accidents, petrochemical explosions, and aviation accidents (Herbst et al., 1996; Hill and Schneeweis, 1983; Capelle-Blancard and Laguna, 2010; Lee and Garza-Gomez, 2012; Ho et al., 2013; Mama and Bassen, 2013). Workplace safety accidents inevitably hamper employee well-being. Additionally, employee relations are regarded as one of the most important stakeholder relationships affecting a firm's value-enhancing (Jiao, 2010; Amin et al., 2021), stock returns (Faleye and Trahan, 2011; Edmans, 2011, 2012; Green et al., 2019), capital structure (Bae et al., 2011; Verwijmeren and Derwall., 2010), productivity (Krekel et al., 2019) and innovation output (Chen et al., 2016; Mao and Weathers, 2019). For example, Amin et al. (2021) find that workplace accidents are negatively associated with firm performance. Kabir et al. (2018) examine the impact of negative workplace safety announcements on firm performance using 227 events between 1970 and 2010 in U.S. public companies. They find that negative workplace safety events can deeply impact the financial performance of a firm, and the magnitude of the impact is much greater today. Greory et al. (2014) find that markets would positively value most aspects of CSR, and high CSR firms could have a higher expected growth rate in their abnormal earnings. Thus, we consider that a plausible link appears to exist between workplace safety accidents and firm value.

In the spirit of earlier studies, we investigate a portfolio of Chinese workplace safety accidents rather than focusing on individual events, or only those within certain industries. We expect workplace safety events to threaten not only employee health, but also the market value of associated firms. Assuming the capital market is efficient, the equity price should reflect the present value of future cash flow expected by the investors of the firms. Negative information regarding a firm's safety accidents could be adverse signs of future performance in the capital market, thus violating the confidence of investors and causing them to reassess their financial prospects and risk profile. When the public perceive a severe risk, investors may very negatively evaluate the value of the firm, resulting in abnormal fluctuations in stock price (Capelle--Blancard and Laguna, 2010; Corbet et al., 2020). Although some firms try to carry insurance against part of those losses, such as obvious costs imposing on fixed assets damage, business interruption as well as medical visits for injured employees, the decline in firm value should be largely attributed to the uninsured or barely insurable costs: reputational damage; heavy media coverage; loss of customers and suppliers; pessimistic forecasts and sentiments by analysts and investors; greater advertising investments to improve public image, and also the expectation of future tighter government regulations (Carpentier and Suret, 2015; Corbet et al., 2020). These expected negative outcomes will jointly decrease cash flows of safety accident firms, implying a significant drop in the demand for stock, and thus in market value. Accordingly, this leads to our Hypothesis 1 as follows:

Hypothesis 1. Ceteris paribus, firms with workplace safety accidents are associated with negative impacts on firm value.

2.2. Employee treatment and the market valuation of workplace safety accident

During the recent decades, a growing number of firms have tended to exhibit greater concern for social responsibility by engaging in CSR activities (Ho et al., 2022). We consider it advantageous for investors to incorporate CSR information into the valuation process because in the event of an accident, the CSR activities affect accident firm value.

On the one hand, the crises arising from workplace safety accidents highlight the importance of a firm's social capital to rebuild stakeholder trust. Both corporate managers and practitioners typically believe that spending on CSR contributes to accumulating a firm's social capital, increasing its cash flows and reducing risk, ultimately enhancing the valuation of the firm (PricewaterhouseCoopers, 2013, 2014; Sacconi and Degli Antoni, 2010; Albuquerque et al., 2019; Boubaker et al., 2020; Dai et al., 2020; Yuan et al., 2022). When suffering a crisis of trust such as workplace safety accidents, the CSR experience of associated firms can also function as an ex-ante valuable insurance-like mechanism, and thus mitigate negative reactions from investors towards adverse events (Lins et al., 2017; Jia et al., 2020; Ding et al., 2021).

Although workplace safety accidents damage brand image and negatively influence the perceived quality of the firm's outcome, equity investors may still assign a premium to high-employee treatment accident firms when making investment decisions; this is because the CSR engagement such as employee treatment tends to send positive signals to assure shareholders and other stakeholders of the firm's strength and prospects (Chen et al., 2016; Mao and Weathers, 2019; Zhang et al., 2020; Wang et al., 2021). Therefore, it implies that CSR activities can be thought of as ex-ante insurance premiums paid by companies to avoid or reduce the potential loss of firm value during unexpected abnormal periods (Shiu and Yang, 2017). We thus posit the following Hypothesis 2A based on the above discussion:

Hypothesis 2A. Ceteris paribus, firms with superior employee treatment show fewer negative impacts on firm value in response to workplace safety accidents.

On the other hand, a workplace safety accident can reveal the reputational gap between a firm's perceived reputation and actual employee safety performance, as captured by the disclosed employee treatment and actual safety accident events respectively. Because the CSR reputation has been positively valued by equity investors (Ramchander et al., 2012; Fernando et al., 2017), any deviation between a firm's perceived CSR reputation and actual workplace safety misconduct, will lead to negative market updating. Therefore, high-employee treatment firms may conversely suffer a greater loss in shareholder value if accused of safety-violating behaviors due to their lower-than-expected performance. Consistent with this standpoint, Liu et al. (2020) empirically indicate that when encountering environmental lawsuit filings, investors react negatively and more sensitively to firms previously regarded as environmentally responsible by the general public. Accordingly, we apply similar logic to workplace safety accidents and posit competing Hypothesis 2B as follows:

Hypothesis 2B. Ceteris paribus, firms with superior employee treatment show greater negative impacts on firm value in response to workplace safety accidents.

3. Data, variables, and methodology

3.1. Data

Our initial sample covers all Chinese non-financial firms listed on the

[6] Thanks for reviewer's suggestion.

Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE). Data used in this study are derived from several resources. Firstly, we manually collect firm workplace safety accident announcements and their event dates (January 2007 to June 2020) from the Cninfo website,[7] an official website authorized by the China Securities Regulatory Commission (CSRC), which discloses announcements and reports of all listed firms. This process yields 249 workplace safety accidents during our sample period. Secondly, we employ employee treatment score from the Hexun CSR evaluation system, and supplement it with employee treatment subcategory data from Chinese Research Data Services (CNRDS). Finally, other stock returns and firm financial data are obtained from the China Stock Market & Accounting Research (CSMAR) database, which is widely applied to studies concerning China. To mitigate the potential effect of outliers, we winsorize all continuous variables at the 1st and 99th percentiles.

3.2. Variable construction

3.2.1. Cumulative abnormal return (CAR)

We typically calculate CARs by using the event study approach, a classical but prevailing methodology, to investigate how the stock market reacts to workplace safety accidents. It assumes the following efficient capital market condition: the difference between a firm's actual return and the expected return (referred to as abnormal return) around the date of an exogenous event, can be considered an effective indicator to gauge the firm value variation derived from the specific event. Recent works in China have discussed the value relevance of anti-corruption reform, USA-China trade war, donations, and new environmental enforcement policy (Lin et al., 2016; Huang et al., 2018; Hoi et al., 2020; Hou and Li, 2020; Sam and Zhang, 2020); the validity of the market model for Chinese data has also been confirmed by Liu et al. (2019), thus further ensuring the applicability of the event study approach in the context of China.

We firstly define event day (T_0) as the date when a firm suffers a sudden workplace safety accident (if the accident date is a trading day), or the next trading day following the occurrence of a workplace safety accident (if the accident date is a non-trading day). To obtain abnormal returns of target firms, we employ the market model to estimate the extent to which a stock normally relates to the market over estimation window [T_0 -180, T_0 -30], which is from 180 days to 30 days before the accident:

$$R_{i,t} = \alpha_i + \beta_i \times R_{m,t} + \varepsilon_{i,t} \tag{1}$$

whereby $R_{i,t}$ denotes the firm's observed daily return, and $R_{m,t}$ denotes the corresponding market return. The estimated parameters $\widehat{\alpha_i}$ and $\widehat{\beta_i}$ are obtained from Eq. (1). Then we incorporate $\widehat{\alpha_i}$ and $\widehat{\beta_i}$ into Eq. (2), and calculate the daily abnormal returns (*AR*) for each firm over the event window:

$$AR_{i,t} = R_{i,t} - \overline{R_{i,t}} = R_{i,t} - (\widehat{\alpha_i} + \widehat{\beta_i} \times R_{m,t}) \tag{2}$$

whereby $\overline{R_{i,t}}$ denotes the firm's expected return, and $AR_{i,t}$ denotes its daily abnormal returns. Lastly, the firm's cumulative abnormal returns (*CAR*) for each workplace safety accident event results, form the aggregate of daily abnormal returns within the event window $[T_1, T_2]$:

$$CAR_i = \sum_{T_1}^{T_2} AR_{i,t} \tag{3}$$

where T_1 and T_2 refer to the starting and ending days of the event windows, respectively. In this paper, we specifically employ three event windows to adequately capture the market announcement response, that is, [T_0 -1, T_0 +1], [T_0 -2, T_0 +2], [T_0 -5, T_0 +5], which are typical short-term event windows in practice because a longer window will confuse the issue with other market noises, or uncorrelated events. Particularly, the average effect of workplace safety accidents can be calculated by the mean value of CAR_i over *N* accident firms in our sample:

$$CAAR[T_1, T_2] = \frac{1}{N} \sum_{i=1}^{N} CAR_i[T_1, T_2] \tag{4}$$

where *N* represents the total number of workplace safety accident firms. The *CAAR* reflects the firm value fluctuation during an event window [T_1, T_2] on average.

3.2.2. Employee treatment (ET)

Our *ET* variables first come from the Hexun CSR evaluation system. The Hexun.com is represented the first vertical financial portal website and one of the biggest financial information service providers in China, which has been releasing CSR ratings for listed firms since 2010. Considering that other CSR ratings, such as Rankins CSR rating (RKS), include only firms with self-disclosed CSR reports, we suggest that one critical advantage of using Hexun CSR rating data is that it covers all Chinese listed firms based on their CSR reports, as well as annual financial reports, rendering it less subjected to the sample selection bias (Cheng et al., 2020). Hexun's rating formally evaluates firm CSR performance from five primary categories: (1) shareholders; (2) employee relations; (3) suppliers, customers, and consumer rights; (4) environment, and (5) community, involving a total of 13 secondary and 37 tertiary indicators.[8] Although Hexun does not disclose the exact algorithm used to generate the indicator ratings, Cheng et al. (2020) conduct several detailed analyses of some sub-components for which the data can be obtained from annual reports to verify its validity, confirming that the rating is a linear transformation of the original values of the specific item and is re-scaled every year. Thus, the CSR scores disclosed by Hexun are considered one of the major measurements of social responsibility for Chinese listed firms (Wen and Song, 2017; Shi et al., 2018; Zhao and Xiao, 2019; Cheng et al., 2020).

In order to formally measure the engagement of firms in employee treatment, we specifically adopt the important sub-component of Hexun's CSR rating, employee relations score, which is evaluated based on employee income and training opportunities, work safety, and caring for employees. Accordingly, the full marks for Hexun's employee relations score are 15 points (10 points for the consumer products industry); a higher score indicates a more employee-friendly firm.

3.2.3. Control variables

We introduce a vector of firm characteristics that prior studies have found to relate to firm value (Kong et al., 2019; Sam and Zhang, 2020). We control for the following variables: firm size (*Size*), proxied as the natural logarithm of a firm's total assets; leverage ratio (*Leverage*), captured as the ratio of a firm's total liabilities to its total assets; market-to-book value (*MB*), referred to as a firm's current market value relative to its book value; profitability (*ROA*), measured as the ratio of a firm's net income to its total assets; current ratio (*Current*), operationalized as a firm's current assets relative to its current liabilities; operating cash flow ratio (*OCF*), measured as the ratio of a firm's operating cash flow to its total assets; tangible assets (*Tangible*), defined as the ratio of a firm's net property, plant, and equipment to its total assets; turnover rate (*Turnover*), proxied as a firm's total sales scaled by its total assets, and finally the dummy variable equity ownership (*SOE*), which takes the value of 1 for state-owned firms, and 0 otherwise. We present detailed variable definitions in Appendix A.

[7] www.cninfo.com.cn.

[8] Detailed description of the Hexun's CSR ratings can be seen from, http://stock.hexun.com/2013/gsshzr/index.html (in Chinese).

3.3. Model

Although the event study approach offers a directly effective test for the unexpected workplace safety accident on firm value, the sample restricted to accident firms will be potentially subject to sample selection bias. For this purpose, we further use a multivariate regression model to alleviate the impact of other confounding factors on the stock price. Our baseline model is specified as follows to test Hypothesis 1:

$$CAR_{i,t} = \beta_0 + \beta_1 Safety\ accident_{i,t} + \sum_{j=1}^{n} \alpha_j Controls_{i,t-1} + Year\ FE + Industry\ FE + \varepsilon_{i,t} \quad (5)$$

where i denotes firms, t denotes years, and $\varepsilon_{i,t}$ denotes the random error term. The dependent variable, $CAR_{i,t}$ is a firm's cumulative abnormal return over the event window $[T_1,T_2]$ in year t. $Safety\ accident_{i,t}$ is an indicator variable that equals 1 if the firm suffers at least one workplace safety accident in fiscal year t and 0 otherwise. The vector $Controls_{i,t-1}$ denotes a series of aforementioned control variables, which are lagged by one year. Finally, we incorporate industry and year fixed effects to control for unobservable time-invariant industry-specific factors and common time trends. Robust standard errors are adopted in all regressions. We expect the coefficient β_1 to be negative and significant if Hypothesis 1 holds.

For Hypothesis 2, we then adopt the following specification to further examine how the CSR investment affects investor reaction to workplace safety accidents within the event period:

$$CAR_{i,t} = \beta_0 + \beta_1 Safety\ accident_{i,t} + \beta_2 ET_{i,t-1} + \beta_3 Safety\ accident_{i,t} \times ET_{i,t-1} + \sum_{j=1}^{n} \alpha_j Controls_{i,t-1} + Year\ FE + Industry\ FE + \varepsilon_{i,t} \quad (6)$$

where $ET_{i,t-1}$ refers to the firm's engagement in employee treatment in year t-1. $Safety\ accident_{i,t} \times ET_{i,t-1}$ is the interaction between $Safety\ accident_{i,t}$ and $ET_{i,t-1}$. All the variables are defined as before. We mainly focus on the coefficient β_3 because it captures the moderating effects of employee treatment, and we expect it to be significantly positive if Hypothesis 2A holds. Otherwise, β_3 is expected to be negative and significant if Hypothesis 2B holds.

Considering that there may exist a systematic difference between the accident firm and non-accident firms, we will utilize the PSM procedure to construct a matched control sample (i.e., firms without workplace safety accidents) for each treatment firm (i.e., firms with workplace safety accidents) by using a one-to-three nearest-neighbor matching algorithm with replacement, and assign them with the same pseudo-event date, assuming these newly matched controlling firms also suffer a workplace safety accident exactly on the same day; this did not happen in reality. Then, we use the PSM sample to test our hypotheses.

4. Empirical results

4.1. Summary statistics

Table 1 provides the distribution results of overall workplace safety accidents for Chinese listed firms by industry and year, from January 2007 to June 2020. The industry classification is based on the Guidelines for Industry Classification of Listed Companies (2012) announced by the China Securities Regulatory Commission (CSRC), and we list manufacturing firms according to the CSRC's three-digit classification, and nonmanufacturing firms according to the one-digit classification. During the sample period, we observe that a total of 249 workplace safety accident events occurred, and they were mostly concentrated in the mining and chemical materials manufacturing industries. The greatest number of workplace safety accidents occurred in 2017 (31), 2018 (33),

Table 1
The distribution of workplace safety accidents during 2007.01–2020.06 This table presents the distribution of overall workplace safety accidents for Chinese listed firms by industry and year, from January 2007 to June 2020.

Industry Code	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
A-Agriculture	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2
B-Mining	0	0	0	2	1	5	4	6	1	0	6	4	6	1	36
C13-Agricultural processing	0	1	0	0	1	0	0	1	0	0	0	0	0	0	3
C14-Food production	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2
C17-Textile manufacturing	0	1	0	0	1	1	0	1	0	0	0	0	0	0	4
C18-Apparel manufacturing	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2
C21-Furniture manufacturing	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
C22-Paper production	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
C25-Petroleum processing	0	0	0	0	1	0	0	1	0	1	1	0	0	0	4
C26-Chemical materials manufacturing	1	2	3	5	10	5	6	4	5	8	9	7	6	2	73
C27-Pharmaceutical manufacturing	0	0	0	1	0	2	1	1	0	0	5	6	2	0	18
C28-Chemical fiber manufacturing	0	0	0	0	0	1	0	0	1	1	0	0	2	0	5
C29-Rubber and plastic production	0	0	0	0	2	1	0	0	0	0	0	1	1	0	5
C30-Nonmetallic mineral production	0	0	0	1	0	0	0	0	0	0	0	3	1	0	5
C31-Ferrous metal smelting	0	1	0	0	0	2	2	0	0	2	1	0	1	1	10
C32-Nonferrous metal smelting	0	0	1	0	0	1	1	1	0	1	3	2	1	0	11
C33-Metal product manufacturing	0	0	0	0	1	0	0	0	0	1	0	1	0	0	3
C34-General equipment manufacturing	0	0	0	0	0	0	0	1	0	0	1	0	2	0	4
C35-Special equipment manufacturing	0	0	0	0	1	1	2	2	3	1	1	2	0	1	14
C36-Automotive manufacturing	0	0	0	0	0	0	0	0	1	0	0	2	0	0	3
C38-Electrical machinery and equipment	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
C39-Computers and communications equipment	0	0	0	1	1	0	0	1	1	1	0	2	2	1	10
C41-Other manufacturing	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
D-Electronic and energy supply	0	0	0	1	1	1	0	0	1	1	0	1	0	0	6
E-Construction	0	0	0	0	0	0	3	1	0	2	1	0	0	0	7
F-Retail and wholesale	0	0	0	0	0	0	1	0	1	0	1	1	0	1	5
G-Transportation	0	0	0	0	0	1	0	0	2	0	0	0	0	2	5
I-Information technology	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
K-Real estate	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
N-Public facility management	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
S-Comprehensive	0	0	0	0	0	1	1	0	0	0	0	0	0	1	3
Total	1	5	4	13	21	23	24	22	16	19	31	33	26	11	249

Table 2
Summary statistics (firm-year level) This table presents the descriptive statistics at the firm-year level, which reports the means and medians of the control variables for the sample of firms with workplace safety accidents versus firms with none. The difference tests of means and medians are based on the *t*-test and the Wilcoxon rank-sum test, respectively. All of the continuous variables are winsorized at the 1% and 99% levels.

variable	*Safety accident*$_t = 1$		*Safety accident*$_t = 0$		T-test	Wilcoxon test
	Mean	Median	Mean	Median	*p*-value	*p*-value
$Size_{t-1}$	22.487	22.363	21.983	21.803	0.000	0.000
$Leverage_{t-1}$	0.486	0.479	0.438	0.435	0.000	0.001
MB_{t-1}	2.232	1.812	2.608	1.995	0.002	0.003
ROA_{t-1}	0.040	0.038	0.037	0.037	0.563	0.762
$Current_{t-1}$	1.809	1.130	2.449	1.576	0.000	0.000
OCF_{t-1}	0.060	0.057	0.044	0.044	0.001	0.001
$Tangible_{t-1}$	0.319	0.314	0.227	0.193	0.000	0.000
$Turnover_{t-1}$	0.649	0.571	0.630	0.528	0.505	0.039
SOE_{t-1}	0.426	0.000	0.390	0.000	0.260	0.260

and 2019 (26), and were more frequent in industries such as chemical materials manufacturing (73), mining (36), pharmaceutical manufacturing (18), indicating that firms need to focus on workplace safety.

To illustrate the puzzle of why workplace safety accidents occur in some firms but not others, we investigate the determinants of safety accidents; such an analysis is also important for the later analysis of the market reaction to workplace safety accidents. Table 2 provides the univariate comparison results between the control variables of accident firms and non-accident firms, suggesting a significant difference between these two groups regarding several characteristics. Table 3 further presents the probit regression results for the determinant analysis. The dependent variable is an indicator for workplace safety accident, *Safety accident*$_{i,t}$, which takes the value of 1 if the firm experiences at least one workplace safety accident within the current year, and 0 otherwise. We display results by controlling for covariates in Column (1), and further add industry and year fixed effects in Column (2). Taking the results in Column (2) as an example, we find that workplace safety accidents are more likely to occur when the firm is larger, with more debts and tangible assets, and in non-SOE firms, which are similar to between-group analysis results of control variables shown in Table 2. Overall, Tables 2 and 3 both indicate that firms with and without workplace safety accidents may differ systematically from each other in many firm-level fundamentals.

Accordingly, we formally adopt the PSM procedure to further control the systematic difference between the accident firms and non-accident firms. The primary benefit of using the PSM procedure is that any observed variation in stock price could be attributed to the occurrence of workplace safety accidents, rather than to the fundamental characteristics of firms that are related to the occurrence of workplace safety accidents. Specifically, we first employ a logit model to estimate the propensity score of occurring workplace safety accidents for each firm. Several firm characteristics are included as matching variables, and we also control industry and year dummies in the first stage of PSM. Then for each treatment firm (i.e., firms with workplace safety accidents), we construct a new matched control sample (i.e. firms without workplace safety accidents) by using a one-to-three[9] nearest-neighbor matching algorithm with replacement, and assign them with the same pseudo-event date, assuming these newly matched controlling firms also suffer a workplace safety accident exactly on the same day; this did not happen in reality. To ensure our PSM is satisfactory, Panel A of Appendix B presents the covariate balance check of PSM, and indicates that no significant difference exists in the mean values of any covariates within these two groups, therefore revealing the many similarities between the

[9] We also assign each treatment firm with one or five matched control firms with the closest propensity for robust checking, and both the results still hold.

Table 3
The determinants of workplace safety accidents This table presents the probit regression results to investigate the determinants of workplace safety accidents. The dependent variable is an indicator for workplace safety accident, *Safety accident*$_{i,t}$, which equals 1 if the firm experiences at least one workplace safety accident in the current year, and 0 otherwise. *t*-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	Safety accident$_t$	
	(1)	(2)
$Size_{t-1}$	0.080***	0.064**
	(3.643)	(2.390)
$Leverage_{t-1}$	0.201	0.442**
	(1.136)	(2.230)
MB_{t-1}	−0.004	−0.022
	(-0.206)	(-1.039)
ROA_{t-1}	0.720	0.673
	(1.362)	(1.157)
$Current_{t-1}$	−0.001	−0.005
	(-0.102)	(-0.330)
OCF_{t-1}	0.274	0.643
	(0.679)	(1.467)
$Tangible_{t-1}$	1.010***	0.871***
	(6.826)	(4.740)
$Turnover_{t-1}$	0.011	−0.039
	(0.188)	(-0.550)
SOE_{t-1}	−0.143***	−0.159***
	(-2.616)	(-2.588)
Intercept	−4.549***	−5.300***
	(-9.252)	(-7.724)
Year FE	No	Yes
Industry FE	No	Yes
Obs	31,427	31,427
Pseudo R^2	0.035	0.103

PSM control sample and treatment firms. The determinant model is shown in Panel B of Appendix B also implies it impossible that the occurrence of workplace safety accidents could be influenced by firm characteristics in the PSM sample. Collectively, these findings suggest that our matching process has successfully taken out meaningful observable differences between the treatment and control groups. Therefore, we adopt the PSM sample to address the remaining analysis in the following sections. Lastly, based on pseudo-event dates, we also calculate corresponding CARs for each firm in the PSM control group, and finally obtain 643 controlling observations.

Table 4 contains the descriptive statistics of the main variables for workplace safety accident firms (see Panel A) and PSM controlling firms (see Panel B). Compared with the controlling firms whose average *CAR* [-1, 1], *CAR*[-2, 2] and *CAR*[-5, 5] are 0.3%, 0.5% and 0.4% respectively, the corresponding average *CAR* in [T_0 -1, T_0 +1], [T_0 -2, T_0 +2], [T_0 -5, T_0 +5] of the workplace safety accident firms are reduced by 1.4%, 1.9% and 2.2% respectively.

4.2. Univariate analysis

We first examine the difference in CARs between the workplace safety accident firms and PSM controlling firms. The results in Table 5 indicate that the differences between the two groups for each event window are all significant at the 1% level both in the parametric and non-parametric tests. Thus, we determine that workplace safety accidents can negatively impact firm value.

Fig. 1 depicts the variations of firm value during the event window [T_0 -10, T_0 +10] to capture the market reaction over a relatively long period. The *X*-axis denotes the number of trading days around the safety accident events, whereas the *Y*-axis denotes *CAAR*, the average CAR for workplace safety accident firms, and controlling firms. As noted in Fig. 1, after the occurrence of workplace safety accidents, there is a stark drop in market return for accident firms whilst that of controlling firms illustrates an opposite pattern. This is possibly a reflection of market participants

Table 4
Summary statistics: CAR-level This table presents the summary statistics at the CAR-level. Panel A reports the descriptive statistics of the main variables for workplace safety accident firms (Panel A) and PSM controlling firms (Panel B). All the continuous variables are winsorized at the 1% and 99% levels.

Variable	Obs	Mean	Std. dev	Min	P25	Median	P75	Max
Panel A: Safety accident firms								
CAR[-1, 1]	249	−0.014	0.048	−0.156	−0.038	−0.017	0.010	0.171
CAR[-2, 2]	249	−0.019	0.062	−0.197	−0.051	−0.018	0.010	0.223
CAR[-5, 5]	249	−0.022	0.095	−0.301	−0.069	−0.017	0.027	0.362
$Size_{t-1}$	249	22.511	1.410	19.964	21.485	22.363	23.327	27.269
$Leverage_{t-1}$	249	0.491	0.215	0.050	0.341	0.479	0.664	0.979
MB_{t-1}	249	2.205	1.360	0.852	1.275	1.812	2.554	8.349
ROA_{t-1}	249	0.040	0.061	−0.252	0.013	0.038	0.068	0.212
$Current_{t-1}$	249	1.738	1.899	0.206	0.730	1.100	1.891	13.007
OCF_{t-1}	249	0.060	0.060	−0.099	0.021	0.058	0.095	0.260
$Tangible_{t-1}$	249	0.325	0.165	0.004	0.194	0.325	0.444	0.735
$Turnover_{t-1}$	249	0.639	0.377	0.097	0.414	0.564	0.738	2.270
SOE_{t-1}	249	0.438	0.497	0.000	0.000	0.000	1.000	1.000
Panel B: Controlling firms								
CAR[-1, 1]	643	0.003	0.046	−0.156	−0.018	−0.001	0.021	0.184
CAR[-2, 2]	643	0.005	0.062	−0.197	−0.024	0.001	0.029	0.261
CAR[-5, 5]	643	0.004	0.089	−0.301	−0.037	0.000	0.035	0.362
$Size_{t-1}$	643	22.695	1.467	19.964	21.705	22.511	23.551	27.269
$Leverage_{t-1}$	643	0.498	0.201	0.050	0.366	0.507	0.637	0.979
MB_{t-1}	643	2.096	1.294	0.852	1.228	1.693	2.465	8.349
ROA_{t-1}	643	0.034	0.060	−0.252	0.010	0.033	0.061	0.212
$Current_{t-1}$	643	1.748	1.899	0.206	0.849	1.188	1.837	13.007
OCF_{t-1}	643	0.056	0.072	−0.161	0.016	0.058	0.095	0.260
$Tangible_{t-1}$	643	0.304	0.178	0.004	0.170	0.280	0.442	0.735
$Turnover_{t-1}$	643	0.642	0.392	0.097	0.378	0.558	0.822	2.270
SOE_{t-1}	643	0.502	0.500	0.000	0.000	1.000	1.000	1.000

Table 5
Univariate analysis This table reports the differences of CARs between the two groups both in the parametric and non-parametric tests.

	CAR[-1, 1]	*CAR*[-2, 2]	*CAR*[-5, 5]
Group A: *Safety accident* = 0	0.003	0.005	0.004
Group B: *Safety accident* = 1	−0.014	−0.019	−0.022
Difference (Group B-Group A)	−0.017	−0.024	−0.025
p-value of T-test	0.000	0.000	0.000
p-value of Wilcoxon test	0.000	0.000	0.000

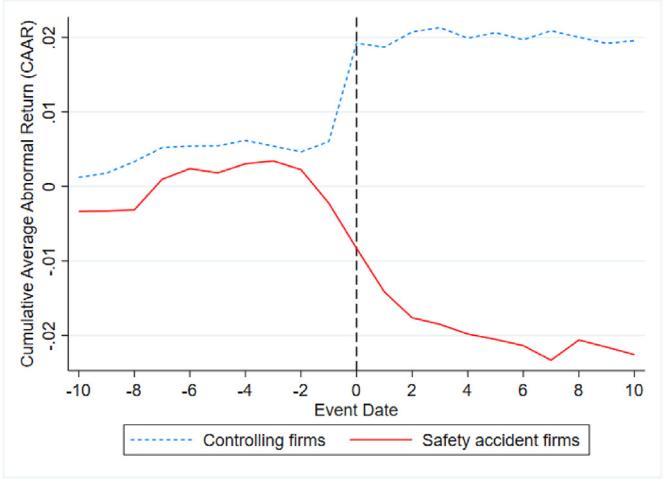

Fig. 1. CAAR for safety accident firms and controlling firms.
This figure depicts the fluctuation of average CAR over the event window [T_0 -10, T_0 +10] for workplace safety accident firms and controlling firms. The *X*-axis denotes the number of trading days around the safety accident events, whereas the *Y*-axis denotes *CAAR*, the average CAR for workplace safety accident firms, and controlling firms.

rebalancing, and transforming from safety accident firms to non-accident firms. We infer this diversity originates from the start of safety accidents because almost no significant difference appears between the two types of firms before the event. The average CAR for accident firms is about −2% up to 10 trading days, and the decline in market value implies that the workplace safety accidents exert negative signals to market participants, and are perceived as imposing additional regulatory costs and reputation penalties on accident firms.[10]

4.3. Multivariate regression analysis of market reaction to workplace safety accidents

Table 6 presents the regression results employing *CAR*[-1, 1], *CAR*[-2, 2], and *CAR*[-5, 5] as the dependent variables to ascertain whether the occurrence of workplace safety accidents is associated with the market reaction. Without controlling for any covariates, as shown in Column (1), the coefficient of $Safety\ accident_{i,t}$ is −0.018, which is significantly negative at the 1% significance level, demonstrating that the market value of safety accident firms is 1.8% lower than that of non-accident firms.[11] Our results still hold after controlling for various firm characteristics and altering event window widths, as shown in Columns (2), (3), and (4), thereby further supporting our Hypothesis 1 that workplace safety accidents are regarded by investors as increasing costs to firms, yielding a dropped market value in a significant way. These coefficients are also economically significant. For instance, our results in Column (4) show that the estimated CARs in [−5, 5] are lower by 2.5% than that of non-accident firms, which experienced a significant decline of over $80 million in shareholder value.[12] Furthermore, we observe that signs of estimated control variables are mostly consistent with our expectations. It shows that firms with higher ROA, leverage, and turnover rate, seem to

[10] Although the accidents are mostly abrupt and unexpected, the widening gap from two days before the event date between safety accident firms and control firms may be explained by the information leakage before the announcements are released by firms due to the time lag between accidents and announcements. Thanks for one reviewer raising the point.

[11] The results remain if we cluster the standard error by the firm, year, or event date. We thank a reviewer for raising the point.

[12] The average market capitalization of sample firms at the beginning of the year when workplace safety accidents occurred is about $3.25 billion.

Table 6
Regression of CARs on workplace safety accident This table presents the regression results of cumulative abnormal returns (CARs) on workplace safety accidents. *t*-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	*CAR*[-1, 1]	*CAR*[-1, 1]	*CAR*[-2, 2]	*CAR*[-5, 5]
$Safety\ accident_t$	−0.018***	−0.017***	−0.024***	−0.025***
	(-5.055)	(-4.914)	(-5.109)	(-3.585)
$Size_{t-1}$		−0.001	−0.001	0.000
		(-0.401)	(-0.724)	(0.018)
$Leverage_{t-1}$		0.008	0.010	0.017
		(0.677)	(0.619)	(0.622)
MB_{t-1}		−0.001	−0.002	−0.004
		(-0.288)	(-0.693)	(-1.122)
ROA_{t-1}		0.008	0.032	−0.014
		(0.196)	(0.538)	(-0.161)
$Current_{t-1}$		0.001	0.001	0.001
		(0.986)	(0.428)	(0.541)
OCF_{t-1}		−0.015	−0.013	−0.017
		(-0.509)	(-0.323)	(-0.316)
$Tangible_{t-1}$		−0.004	−0.012	−0.027
		(-0.348)	(-0.850)	(-1.133)
$Turnover_{t-1}$		0.007	0.009	0.021**
		(1.485)	(1.370)	(2.153)
SOE_{t-1}		0.002	0.001	−0.005
		(0.443)	(0.170)	(-0.718)
Intercept	−0.003	0.005	0.086	0.082
	(-0.094)	(0.114)	(1.633)	(0.911)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Obs	892	892	892	892
Adj. R^2	0.019	0.013	0.016	0.005
VIFs	1.00	1.50	1.50	1.50

enjoy a higher market valuation. Moreover, firms with higher market-to-book ratios, operating cash flow ratio, and tangible assets, appear to have a relatively lower market valuation.

4.4. The moderating effects of employee treatment

We then investigate the impact of a firm's ex-ante employee treatment on firm value in response to workplace safety accidents. On the one hand, CSR investment, such as employee treatment, can be viewed as an insurance policy during a crisis of trust and serves as a buffer to protect firms against problems and uncertainties (Lins et al., 2017; Ding et al., 2021). Hypothesis 2A thus predicts that firms with a high level of employee treatment would mitigate the negative market reaction to workplace safety accidents. On the other hand, based on the competing view of Hypothesis 2B, conditional on the fact that CSR has been positively priced by capital markets (Fernando et al., 2017), any deviation between a firm's perceived CSR reputation and actual workplace safety misconduct will result in a more adverse market response (Liu et al., 2020). Therefore, Table 7 provides empirical evidence to investigate in depth the compound effect of employee treatment.

We still use *CAR*[-1, 1], *CAR*[-2, 2], and *CAR*[-5, 5] as the dependent variables to measure firm value. Given that the safety of a firm's workplace is closely related to employee welfare, we specifically study how employee treatment, an important component of CSR, could impact the market reactions to workplace safety accidents. We first employ Hexun's employee relations score as the proxy employee-friendly measure. Then we introduce the interaction term of $Safety\ accident_{i,t}$ with $Employee\ Score\ Hexun_{i,t-1}$ to further check its moderating effect. Table 6 reports the results. The coefficients of the interaction terms are all significantly positive in event windows [−1, 1], [−2, 2], and [−5, 5], suggesting that superior employee treatment strategies are conducive to alleviating the loss of firm value, and could recover damaged reputation when suffering adverse events.

We then refer to the CNRDS to provide supplementary detailed information on the subcategory treatment of employees by firms, thereby allowing us to display the separate effect of employee treatment on the relationship between workplace safety accidents and firm value. CNRDS rates a firm's employee treatment based on their CSR report on seven strengths categories: safety management system; safety production training plan; professional safety certification; on-the-job training; employee stock ownership plan (ESOP); employee communication channels, and strong retirement benefits. We then classify the strength items into two types, and correspondingly construct two indicator variables. The first type is $Employee\ safety\ strength_{i,t-1}$, which equals 1 if at least one particular strength is present for a specific firm in the given year, involving safety management system, safety production training plan, professional safety certification, and 0 otherwise. The second type is $Employee\ welfare\ strength_{i,t-1}$, which equals 1 if at least one of the remaining four strengths is present for a specific firm in the given year, and 0 otherwise. In Table 7, we find the coefficients of the interaction terms between $Safety\ accident_{i,t}$ and $Employee\ safety\ strength_{i,t-1}$ or $Employee\ welfare\ strength_{i,t-1}$ are all positive and significant within different event windows, thus providing strong evidence that the insurance effect of favorable employee treatment can reduce capital market penalties in the post-negative-event period. Collectively, our findings are further consistent with Hypothesis 2A that the market initially expected firms with ex-ante superior employee treatment to be relatively shielded from the negative impacts of workplace safety accidents.

4.5. The moderating effects of overall CSR and other dimensions of CSR

In this section, we further investigate the potential moderating effects of overall CSR and other dimensions of CSR. We mainly report the results using the *CAR*[-2, 2] as the dependent variable. The results using *CAR*[-1, 1] and *CAR*[-5, 5] as the dependent variables are similar and consistent.

We first introduce the interaction between *Safety accident* and the general CSR, measured as the Hexun's overall CSR score (*Overall CSR*), the results in Column (1) of Table 8 show the coefficient on the interaction term between $Safety\ accident_{i,t}$ and $Overall\ CSR_{i,t-1}$ is positive and significant, which confirm that the investors tend to be less sensitive to negative shocks on socially responsible firms when they perceive firms to be trustworthy.

Then, we examine whether other dimensions of CSR can mitigate the negative reaction to accidents. Specifically, we introduce the interaction between *Safety accident* and other categories of CSR score released by Hexun, including (1) shareholders; (2) suppliers, customers, and consumer rights; (3) environment, and (4) community. The results in Table 8 show that only the coefficients of the interaction terms between $Safety\ accident_{i,t}$, and $Supplier\_Customer_{i,t-1}$ or $Environment_{i,t-1}$ are positive and significant, which may also indicate that other dimensions of CSR, especially those related to the stakeholders, can enhance the stakeholder trust and thus have a mitigating effect on the negative reaction of accidents.[13]

5. Further analysis

5.1. Heterogeneity

In this sub-section, we conduct additional analyses to further explore whether there is a cross-sectional variation in our main findings. Specifically, we consider the different nature of workplace safety accidents, including event types, casualties, property loss, accident history,[14] and the adoption of the new Workplace Safety Law in 2014. We mainly report the results using the *CAR*[-2, 2] as the dependent variable. The results

[13] We thank a reviewer for raising the point.

[14] The distribution of safety accident events based on event types, whether the event cause casualties or property loss, and whether the events happen for the first time or not is presented in Appendix C.

Table 7
The moderating effect of employee treatment This table presents the regression results of the moderating effect of employee treatment, an important component of firm CSR, on the market reaction to workplace safety accidents. We introduce the interaction term of *Safety accident*$_{i,t}$ with *Employee Score Hexun*$_{i,t-1}$ to investigate its moderating effect. *t*-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	*CAR*[-1, 1]			*CAR*[-2, 2]			*CAR*[-5, 5]		
		(1)	(2)		(3)	(4)		(5)	(6)
Safety accident$_t$	−0.024***	−0.023***	−0.023***	−0.033***	−0.032***	−0.032***	−0.036***	−0.039***	−0.037***
	(-4.561)	(-4.598)	(-4.826)	(-4.652)	(-4.668)	(-4.905)	(-3.530)	(-3.934)	(-3.995)
Employee Score Hexun$_{t-1}$	−0.000			−0.001			−0.000		
	(-0.898)			(-1.444)			(-0.298)		
Safety accident$_t$ × *Employee Score Hexun*$_{t-1}$	0.002**			0.003***			0.004**		
	(2.186)			(2.614)			(2.220)		
Employee welfare strength$_{t-1}$		−0.005			−0.008			−0.007	
		(-1.145)			(-1.400)			(-0.837)	
Safety accident$_t$ × *Employee welfare strength*$_{t-1}$		0.015**			0.020**			0.037***	
		(2.019)			(2.174)			(2.619)	
Employee safety strength$_{t-1}$			−0.006			−0.009*			−0.006
			(-1.494)			(-1.724)			(-0.798)
Safety accident$_t$ × *Employee safety strength*$_{t-1}$			0.017**			0.023**			0.038***
			(2.228)			(2.488)			(2.615)
Size$_{t-1}$	−0.002	−0.001	−0.000	−0.002	−0.001	−0.001	−0.001	−0.000	−0.000
	(-1.097)	(-0.313)	(-0.249)	(-1.055)	(-0.446)	(-0.422)	(-0.255)	(-0.121)	(-0.128)
Leverage$_{t-1}$	0.012	0.009	0.009	0.014	0.014	0.013	0.022	0.027	0.028
	(0.932)	(0.690)	(0.674)	(0.770)	(0.778)	(0.763)	(0.789)	(0.991)	(0.999)
MB$_{t-1}$	−0.001	−0.001	−0.001	−0.002	−0.002	−0.002	−0.003	−0.003	−0.003
	(-0.592)	(-0.477)	(-0.485)	(-0.765)	(-0.705)	(-0.720)	(-0.868)	(-0.850)	(-0.863)
ROA$_{t-1}$	0.024	0.016	0.016	0.048	0.052	0.052	−0.002	0.009	0.010
	(0.524)	(0.361)	(0.365)	(0.732)	(0.837)	(0.840)	(-0.017)	(0.102)	(0.113)
Current$_{t-1}$	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(1.023)	(0.918)	(0.926)	(0.467)	(0.454)	(0.461)	(0.613)	(0.567)	(0.594)
OCF$_{t-1}$	−0.020	−0.009	−0.008	−0.020	−0.013	−0.011	−0.034	−0.025	−0.025
	(-0.621)	(-0.295)	(-0.259)	(-0.468)	(-0.320)	(-0.278)	(-0.577)	(-0.443)	(-0.440)
Tangible$_{t-1}$	−0.002	−0.011	−0.010	−0.007	−0.017	−0.016	−0.015	−0.036	−0.035
	(-0.130)	(-0.958)	(-0.907)	(-0.450)	(-1.100)	(-1.044)	(-0.591)	(-1.454)	(-1.399)
Turnover$_{t-1}$	0.006	0.008	0.008	0.007	0.010	0.010	0.020**	0.020**	0.020**
	(1.187)	(1.557)	(1.531)	(1.144)	(1.461)	(1.437)	(2.029)	(2.009)	(1.986)
SOE$_{t-1}$	0.001	0.001	0.001	−0.001	−0.000	0.000	−0.009	−0.007	−0.007
	(0.248)	(0.291)	(0.340)	(-0.147)	(-0.013)	(0.027)	(-1.140)	(-0.929)	(-0.872)
Intercept	0.028	0.014	0.012	0.022	0.087	0.086	−0.012	0.108	0.106
	(0.634)	(0.307)	(0.262)	(0.370)	(1.556)	(1.550)	(-0.148)	(1.121)	(1.116)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	830	849	849	830	849	849	830	849	849
Adj. R^2	0.013	0.014	0.015	0.013	0.021	0.022	0.000	0.010	0.009
VIFs	1.64	1.62	1.59	1.64	1.62	1.59	1.64	1.62	1.59

using *CAR*[-1, 1] and *CAR*[-5, 5] as the dependent variables are similar and consistent.

We consider that different types of workplace safety accidents may cause different consequences, and distinguish them into five categories: leakage; fire; explosion; collapse, and others. We do the subsample analysis based on the different types of accidents. Our results are reported in Panel A of Table 9. The results show that workplace fire and explosion accident events may result in a more serious loss in shareholder wealth compared to other accident types.

According to the severity of workplace safety accidents, we provide results based on casualties and property loss, respectively. We first do the subsample analysis based on whether there is at least one casualty in a workplace safety accident and perform the test of coefficient difference. The results in Panel B of Table 9 show that the negative effects of workplace safety accidents on firm value are significant in both the casualty group and no-casualty group, and there is no significant difference between these two groups.

Then, we do the subsample analysis based on whether there is property loss in workplace safety accidents. We also perform the test of coefficient difference. The results in Panel C of Table 9 show that the negative effects of workplace safety accidents on firm value are significant in both the property loss group and no-property loss group, and the negative effect is greater when the accident with property loss.

We also report the results based on accident history in Panel D of Table 9. We do the subsample analysis based on whether the firm suffers a workplace safety accident in the given year for the first time and perform the test of coefficient difference. The results show that the negative effects of workplace safety accidents on firm value are significant in both the first group and the no-first group, and there is no significant difference between these two groups.

Lastly, the revised Workplace Safety Law took effect on 1 December 2014 and imposed significantly harsher penalties. Thus, we do the subsample analysis before and after the revised Workplace Safety Law in 2014 and perform the test of coefficient difference. The results in Panel E of Table 9 show that the negative effects of workplace safety accidents on firm value are significant both before and after the new workplace safety law group. However, the results indicate the negative effect is stronger after the revised Workplace Safety Law was passed. The revision of the law significantly strengthens the PRC government's regulation and control over workplace safety, which effectively promotes the prevention of workplace accidents in China; results imply that the capital market will penalize firms more heavily for accidents that occur under the new strict laws.

5.2. Economic consequence

Our results suggest that investors respond negatively to workplace safety accidents in the short event windows. However, it is still doubtful that safety accidents will lead to substantial changes in subsequent employee productivity and valuation in the long term. Thus, in the

Table 8
The moderating effect of overall CSR and other dimensions of CSR This table presents the regression results of the moderating effect of overall CSR and other dimensions of CSR, on the market reaction to workplace safety accidents. t-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	*CAR*[-2, 2]				
	(1)	(2)	(3)	(4)	(5)
Safety accident$_t$	−0.040***	−0.031**	−0.030***	−0.029***	−0.028***
	(-4.182)	(-2.367)	(-5.038)	(-5.028)	(-3.105)
Overall CSR$_{t-1}$	−0.000				
	(-1.463)				
Safety accident$_t$ × *Overall CSR*$_{t-1}$	0.001**				
	(2.510)				
Shareholder		0.000			
		(0.247)			
safety_accident × *Shareholder*		0.001			
		(0.635)			
Supplier_Customer			−0.001**		
			(-2.180)		
safety_accident × *Supplier_Customer*			0.002***		
			(2.949)		
Environment				−0.001*	
				(-1.665)	
safety_accident × *Environment*				0.002***	
				(3.113)	
Community					−0.000
					(-0.315)
safety_accident × *Community*					0.001
					(0.622)
Control variable	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	830	830	830	830	830
Adj. R^2	0.012	0.009	0.016	0.015	0.009
VIFs	1.88	2.57	1.54	1.54	1.76

following section, we try to shed light on the long-term effect of workplace safety accidents, and conduct the test by estimating variations of the following regression:

$$TFP \Big/ TobinQ = \beta_0 + \beta_1 Safety\ accident_{i,t} + \sum_{j=1}^{n} \alpha_j Controls_{i,t-1} + Year\ FE + Industry\ FE + \varepsilon \quad (7)$$

The dependent variables are employee productivity, measured by total factor productivity (*TFP*) and market valuation (*TobinQ*), respectively. We specifically follow Giannetti et al. (2015) to estimate the firm's TFP, which addresses the firm's growth, and does not directly relate to the amount of capital, labor, and materials input.

$$Y_{ijt} = \alpha_{jt} + \beta_{jt} K_{ijt} + \gamma_{jt} L_{ijt} + \delta_{jt} M_{ijt} + \varepsilon_{ijt} \quad (8)$$

where Y_{ijt} denotes the logarithm of the sales of firm i belonging to industry j in the year t, K_{ijt} denotes the logarithm of the firm's total assets in the given year, L_{ijt} denotes the logarithm of the firm's number of workers in the given year, and M_{ijt} denotes the logarithm of the firm's amount of material and other inputs in the given year. We estimate E.q. (8) by industry and year, and finally obtain our estimated TFP, which denotes the residuals of the regression, and captures the firm's deviation from the expected total factor productivity within the same industry and year. Table 10 shows that the coefficients on β_1 are both negative and statistically significant. We conclude that a firm's workplace safety accidents not only decrease stock price during event periods, but are also significantly associated with lower productivity and firm value in the long term.

5.3. Robustness tests

We conduct a battery of additional tests to ensure the robustness of our findings.

First, A potential concern raised is that the cumulative abnormal returns may involve other factors that are priced during the sample period. To provide a more robust check, we replicate our main results on market reactions by adopting the Fama-French three-factor model to mitigate the influence of anomalous factors, which is also commonly used for the event study approach. In addition to the market factor, Fama and French (1993) also proposed size and book-to-market factors.

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + s_i SMB_t + h_i HML_t + \varepsilon_{i,t} \quad (9)$$

where $R_{i,t}$ denotes a firm's daily return on a given date, $R_{m,t}$ denotes the corresponding market return on a given date, SMB_t and HML_t are the returns to the small-minus-big (SMB) and high-minus-low (HML) portfolios that capture the size and book-to-market effects on a given date. For each firm in our sample, we estimate the parameters in the three-factor model over the 150 days in the pre-event period [T_0 -180, T_0 -30]. Then we use the three-factor model to obtain three-factor adjusted cumulative abnormal returns.

Table 11 presents the regression results, choosing *FF3 CAR*[-1, 1] as the dependent variable. Our results from the three-factor model are essentially similar to those found using the market model. We also find

Table 9
Additional tests. This table presents the results of cross-sectional heterogeneity in the relationship between workplace safety accidents and firm value. Panel A reports results based on five event types: leakage, fire, explosion, collapse, and others. Panel B reports results based on casualties. Panel C reports results based on property loss. Panel D reports results based on accident history. Panel E reports results based on the adoption of the new Workplace Safety Law in 2014. *t*-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Results based on event types

VARIABLES	CAR[-2, 2]				
	(1) Leakage	(2) Fire	(3) Explosion	(4) Collapse	(5) Other
Safety accident$_t$	−0.010	−0.028***	−0.037***	−0.012	−0.021**
	(-0.855)	(-3.875)	(-3.711)	(-0.947)	(-2.298)
Control variable	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	673	735	688	671	697
Adj. R^2	−0.011	0.000	0.007	−0.018	0.001
VIF	1.48	1.50	1.48	1.47	1.48

Panel B: Results based on casualties

VARIABLES	CAR[-2, 2]	
	(1) With casualty	(2) Without casualty
Safety accident$_t$	−0.023***	−0.026***
	(-4.020)	(-3.653)
Control variable	Yes	Yes
Intercept	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Coefficients difference in *Safety accident* (*p*-value)	0.687	
Observations	800	735
Adj. R^2	0.009	0.002
VIF	1.49	1.49

Panel C: Results based on property loss

VARIABLES	CAR[-2, 2]	
	(1) With property loss	(2) Without property loss
Safety accident$_t$	−0.042***	−0.014**
	(-5.818)	(-2.514)
Control variable	Yes	Yes
Intercept	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Coefficients difference in *Safety accident* (*p*-value)	0.001	
Observations	731	804
Adj. R^2	0.009	0.002
VIF	1.49	1.49

Panel D: Results based on accident history

VARIABLES	CAR[-2, 2]	
	(1) First	(2) No First
Safety accident$_t$	−0.022***	−0.030***
	(-4.390)	(-2.975)
Control variable	Yes	Yes
Intercept	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Coefficients difference in *Safety accident* (*p*-value)	0.527	
Observations	845	690
Adj. R^2	0.006	0.001
VIF	1.50	1.48

Panel E: Results based on the new workplace safety law

VARIABLES	CAR[-2, 2]	
	(1) Before	(2) After
Safety accident$_t$	−0.014**	−0.032***
	(-2.193)	(-4.628)
Control variable	Yes	Yes
Intercept	Yes	Yes

(*continued on next page*)

Table 9 (*continued*)

Panel E: Results based on the new workplace safety law		
VARIABLES	CAR[-2, 2]	
	(1) Before	(2) After
Year FE	Yes	Yes
Industry FE	Yes	Yes
Coefficients difference in *Safety accident* (*p*-value)	0.039	
Observations	379	513
Adj. R^2	0.0220	0.0249
VIF	1.50	1.59

Table 10
Economic consequence This table presents the results of the effect of workplace safety accidents on firm employee productivity and long-term valuation. t-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	TFP_t	TFP_{t+1}	$TobinQ_t$	$TobinQ_{t+1}$
$Safety\ accident_t$	−0.049***	−0.035*	−0.213***	−0.141**
	(-2.588)	(-1.656)	(-3.307)	(-2.566)
$Size_{t-1}$	0.029***	0.027***	−0.365***	−0.296***
	(3.621)	(3.291)	(-8.338)	(-11.079)
$Leverage_{t-1}$	0.005	0.073	0.698*	0.025
	(0.067)	(0.890)	(1.777)	(0.091)
ROA_{t-1}	0.630***	0.711***	0.461	1.320
	(3.211)	(2.691)	(0.373)	(1.581)
$Current_{t-1}$	−0.004	0.003	0.084*	0.008
	(-0.621)	(0.454)	(1.902)	(0.255)
OCF_{t-1}	0.169	0.261	2.044**	1.452***
	(0.977)	(1.413)	(2.442)	(3.119)
$Tangible_{t-1}$	−0.263***	−0.218**	−1.090***	−0.543***
	(-3.526)	(-2.581)	(-3.536)	(-2.778)
$Turnover_{t-1}$	0.124***	0.105***	0.260	0.035
	(4.284)	(3.796)	(1.638)	(0.469)
SOE_{t-1}	−0.021	−0.032	0.050	0.066
	(-0.980)	(-1.335)	(0.625)	(0.891)
Intercept	−0.738***	−0.813***	8.683***	8.292***
	(-2.996)	(-3.160)	(9.021)	(13.231)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Obs	884	841	892	876
Adj. R^2	0.105	0.0802	0.290	0.349
VIFs	1.45	1.46	1.45	1.45

qualitatively similar results when adopting three-factor CARs over the [−2, 2] and [−5, 5] windows as alternative dependent variables, and therefore not reported. Overall, it proves the insensitivity of the estimated model choice for CARs in this study.

Second, following Bereskin et al. (2018), we address potential sample selection bias coming from the likelihood of workplace safety accidents. In the first stage, we estimate a probit model of the probability that a firm would experience a workplace safety accident (i.e., similar to Column 2 in Table 3). Then, in the second stage, we include the inverse Mills ratio from the first-stage probit as an explanatory variable in the regressions. The results are consistent with our findings, indicating that our results are robust to potential sample-selection bias.

Third, considering the potential information leakage before the announcements are released by firms due to the time lag between accidents and announcements, we choose alternative event windows to calculate the CARs (e.g., [0, +1], [0, +2], and [0, +5]), and the results are consistent with our findings.

Fourth, to alleviate the influence of other firm-level critical announcements on our results, we manually check all the announcements released by the firm in the 7 trading days before and after the workplace safety incident and exclude the samples if the accident firms were involved in other critical events. Specifically, we exclude the samples if the firms were involved in the following events: (1) lawsuit; (2) departure of executives; (3) bonds issued were on the watch list; (4) asset restructuring. We also check and exclude the matched non-accident firms if there were other critical announcements in the 7 trading days before and after the corresponding event dates. The results still indicate that workplace safety accidents will induce a significant negative market reaction compared to non-accident firms.

Table 11
Robustness tests This table presents the robustness tests. Panel A reports the regression results of CARs on workplace safety accidents based on the Fama-French three-factor model. Panel B reports the regression results of the moderating effect of firm CSR based on the Fama-French three-factor model. *t*-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	*FF3 CAR*[-1, 1]			
$Safety\ accident_t$	−0.018***	−0.027***	−0.026***	−0.025***
	(-4.921)	(-5.092)	(-5.022)	(-5.061)
$Employee\ Score\ Hexun_{t-1}$		−0.001		
		(-1.438)		
$Safety\ accident_t \times Employee\ Score\ Hexun_{t-1}$		0.002***		
		(2.765)		
$Employee\ welfare\ strength_{t-1}$			−0.008*	
			(-1.728)	
$Safety\ accident_t \times Employee\ welfare\ strength_{t-1}$			0.021***	
			(2.618)	
$Employee\ safety\ strength_{t-1}$				−0.009**
				(-2.201)
$Safety\ accident_t \times Employee\ safety\ strength_{t-1}$				0.020**
				(2.522)
$Size_{t-1}$	0.000	−0.001	0.001	0.001
	(0.040)	(-0.761)	(0.293)	(0.444)
$Leverage_{t-1}$	0.002	0.005	0.001	0.001
	(0.124)	(0.402)	(0.100)	(0.063)
MB_{t-1}	−0.001	−0.002	−0.001	−0.001
	(-0.568)	(-0.884)	(-0.683)	(-0.696)
ROA_{t-1}	−0.005	0.012	0.002	0.002
	(-0.122)	(0.247)	(0.044)	(0.044)
$Current_{t-1}$	0.001	0.001	0.000	0.000
	(0.525)	(0.541)	(0.333)	(0.332)
OCF_{t-1}	−0.018	−0.022	−0.009	−0.007
	(-0.576)	(-0.673)	(-0.287)	(-0.218)
$Tangible_{t-1}$	−0.007	−0.006	−0.014	−0.013
	(-0.614)	(-0.503)	(-1.213)	(-1.134)
$Turnover_{t-1}$	0.011**	0.010*	0.011**	0.011**
	(2.077)	(1.897)	(2.027)	(1.971)
SOE_{t-1}	0.002	0.002	0.001	0.001
	(0.529)	(0.382)	(0.259)	(0.327)
Intercept	0.038	0.030	0.043	0.037
	(0.867)	(0.637)	(0.925)	(0.811)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Obs	892	830	849	849
Adj. R^2	0.025	0.024	0.030	0.030
VIFs	1.50	1.64	1.62	1.59

Fifth, to confirm our results are not affected by accidents that occurred in the mining and chemical material manufacturing industries. We exclude the samples in corresponding industries. The results still hold.

Sixth, we further control the property loss and casualties caused by accidents, as well as if the accidents are covered by insurance. We find that a higher amount of property loss would lead to a more severe impact on firm value. However, after controlling the damages to assets and employees, as well as the insurance, the results are consistent with our findings.

Lastly, we also add the overall CSR score, measured as the Hexun's overall CSR score as the control variable, and the results are still consistent with our findings.[15]

6. Conclusion

This study investigates the market reaction to a portfolio of workplace safety accidents in the context of China and discusses the role of corporate employee treatment in protecting firm value against negative accident events. Using a hand-collected sample of workplace safety accidents amongst public firms from January 2007 to June 2020, we document findings that investors respond significantly negatively to workplace safety accidents, and firms with a superior ex-ante employee treatment or other stakeholder-related CSR will suffer fewer financial market penalties in response to unexpected and adverse events. Therefore, we provide evidence that workplace safety is a crucial factor attached to stock performance, and firms with higher employee well-being or stakeholder benefit will enjoy more insurance-like protection on firm valuation, at a time when trust in firms has largely eroded.

This paper offers important policy implications. Given that workplace safety accidents would be penalized by financial markets and result in substantial losses, government and supervisors should enact stricter laws and regulations on labor safety, and strengthen the intensity of monitoring to ensure workplace safety. Human capital is one of the most important factors determining a firm's competitive success; it may improve the workforce's quality of life, promote a firm's long-term development, and reduce unexpected fluctuations in equity. We also provide another way for the Chinese government and firms to prevent the occurrence of negative consequences, by improving firm CSR engagement. Participating in CSR activities for listed firms provides insurance-like benefits during abnormal times; managers can even employ CSR as a potential risk management tool for creating values for shareholders (Shiu and Yang, 2017) when implementing business strategic management. Other than China, we are also interested in studying developing countries where workplace safety is also a severe issue, and we expect to conduct further analyses concerning the well-being of employees.

Conflicts of interest

No conflict of interest exists in the submission of this manuscript, and the manuscript is approved by all authors for publication.

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Appendix A. Variable definition

Variable	Definition
CAR[-1, 1]	Cumulative abnormal return within the event window [T_0 -1, T_0+1].
CAR[-2, 2]	Cumulative abnormal return within the event window [T_0 -2, T_0+2].
CAR[-5, 5]	Cumulative abnormal return within the event window [T_0 -5, T_0+5].
FF3 CAR[-1, 1]	Cumulative abnormal return within the event window [T_0 -1, T_0+1] calculated by the Fama-French three-factor model.
FF3 CAR[-2, 2]	Cumulative abnormal return within the event window [T_0 -2, T_0+2] calculated by the Fama-French three-factor model.
FF3 CAR[-5, 5]	Cumulative abnormal return within the event window [T_0 -5, T_0+5] calculated by the Fama-French three-factor model.
Safety accident	Indicator variable, which equals 1 if a firm suffers at least one workplace safety accident in the given year, and 0 otherwise.
Size	The natural logarithm of a firm's total assets.
Leverage	The ratio of a firm's total liabilities to its total assets.
MB	Market-to-book ratio, calculated as a firm's current market value relative to its book value.
ROA	Return on assets, measured as the ratio of a firm's net income to its total assets.
Current	The ratio of a firm's current assets to its current liabilities.
OCF	The ratio of a firm's operating cash flow to its total assets.
Tangible	The ratio of a firm's net property, plant, and equipment to its total assets.
Turnover	Total sales scaled by total assets.
SOE	Indicator variable, which equals 1 for stated-owned firms, and 0 otherwise.
TFP	The firm's total factor productivity, captured the firm growth that cannot be directly related to the amount of capital, labor and materials input (Giannetti et al., 2015).
Tobin's Q	The ratio of a firm's market value to its book value of total assets.
Employee Score Hexun	Employee relations score, an important sub-component of Hexun's CSR rating, to measure firms' engagement in employee treatment. The full marks are 15 points (10 points for the consumer products industry), and a higher score in employee relations indicates a more employee-friendly firm.
Employee safety strength	Indicator variable, which equals 1 if at least a particular safety strength is present for a firm in the given year, involving safety management system, safety production training plan, professional safety certification, and 0 otherwise.

(*continued on next page*)

[15] We do not report tables here for brevity, full results are available upon request. Thanks for reviewers' suggestion.

(*continued*)

Variable	Definition
Employee welfare strength	Indicator variable, which equals 1 if at least a particular welfare strength is present for a firm in the given year, involving on-the-job training, employee stock ownership plan (ESOP), employee communication channels, strong retirement benefits, and 0 otherwise.
Overall CSR	The overall CSR score released by Hexun's CSR rating, to measure firms' engagement in CSR activities. The full marks are 100 points, and a higher CSR score implies more socially responsible corporate investment.
Shareholder	Shareholder score released by Hexun's CSR rating, to measure firms' engagement in employee treatment. A higher score in shareholders indicates greater CSR engagement in shareholders.
Supplier_Customer	Suppliers, customers, and consumer rights score released by Hexun's CSR rating, to measure firms' engagement with suppliers, customers, and consumers. A higher score indicates greater CSR engagement in suppliers, customers, and consumer rights.
Environment	Environment score released by Hexun's CSR rating, to measure firms' engagement in the environment. A higher score in the environment indicates greater CSR engagement in the environment.
Community	Community score released by Hexun's CSR rating, to measure firms' engagement in the community. A higher score in the community indicates greater CSR engagement in the community.

Appendix B. Validation of PSM

This table presents the validation of the propensity-score matched (PSM) procedure. Panel A reports the results from a balance test on control variables measured as the post-matching diagnosis. Panel B reports the probit regression results for the determinant analysis by using the PSM sample. *t*-statistics are adjusted by robust standard errors. *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

Panel A
Post-matching diagnosis: Comparison between the treatment and control groups

Variable	Treated	Control	%Bias	T-value	*p*-value
$Size_{t-1}$	22.49	22.49	−0.40	−0.05	0.96
$Leverage_{t-1}$	0.49	0.49	−2.60	−0.29	0.77
MB_{t-1}	2.23	2.28	−2.50	−0.30	0.76
ROA_{t-1}	0.04	0.04	3.40	0.36	0.72
$Current_{t-1}$	1.81	1.70	4.50	0.61	0.54
OCF_{t-1}	0.06	0.06	0.20	0.02	0.99
$Tangible_{t-1}$	0.32	0.32	−0.10	−0.01	0.99
$Turnover_{t-1}$	0.65	0.63	4.20	0.49	0.63
SOE_{t-1}	0.43	0.45	−4.00	−0.43	0.67

Panel B
Determinant model results in the PSM sample

VARIABLES	$Safety\ accident_t$
$Size_{t-1}$	−0.007
	(-0.137)
$Leverage_{t-1}$	0.258
	(0.707)
MB_{t-1}	−0.038
	(-0.965)
ROA_{t-1}	0.626
	(0.629)
$Current_{t-1}$	0.033
	(1.025)
OCF_{t-1}	−0.068
	(-0.084)
$Tangible_{t-1}$	−0.052
	(-0.152)
$Turnover_{t-1}$	0.060
	(0.460)
SOE_{t-1}	−0.045
	(-0.409)
Intercept	0.146
	(0.103)
Year FE	Yes
Industry FE	Yes
OBS	914
Pseudo R^2	0.010

Appendix C. Safety accident events classification

This table presents the different groups of safety accident events based on event types, whether the events cause casualties or property loss, and whether the events happen for the first time or not.

Panel A: Safety accident events in different types	
Leakage	30
Fire	92
Explosion	45
Collapse	28
Other	54
Panel B: Whether the safety accident events cause casualties	
Yes	157
No	92
Panel C: Whether the safety accident events cause property loss	
Yes	86
No	163
Panel D: Whether the safety accident events happen for the first time	
Yes	202
No	47
Total	249

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