Terrorist Attacks and Corporate Investment: The beneficial value of CEO overconfidence

Seongjae Mun[1], Hyeong Joon Kim[2], Kyumin Cho[3], Seung Hun Han[4,*]

[1] School of Business and Technology Management, College of Business, Korea Advanced Institute of Science and Technology, 291, Daehak-ro, Yuseong-gu, Daejeon, Republic of Korea, phone: +82-42-350-6309, fax: +82-42-350-6348, e-mail: forbelld@kaist.ac.kr

[2] School of Business and Technology Management, College of Business, Korea Advanced Institute of Science and Technology, 291, Daehak-ro, Yuseong-gu, Daejeon, Republic of Korea, phone: +82-42-350-6309, fax: +82-42-350-6348, e-mail: creatinghj@kaist.ac.kr

[3] School of Business and Technology Management, College of Business, Korea Advanced Institute of Science and Technology, 291, Daehak-ro, Yuseong-gu, Daejeon, Republic of Korea, phone: +82-42-350-6309, fax: +82-42-350-6348, e-mail: koc5251@kaist.ac.kr

[4] School of Business and Technology Management, College of Business, Korea Advanced Institute of Science and Technology, 291, Daehak-ro, Yuseong-gu, Daejeon, Republic of Korea, phone: +82-42-350-6309, fax: +82-42-350-6348, e-mail: synosia@kaist.ac.kr
*Corresponding author

Declaration of interest

Author Seongjae Mun declares that he has no conflict of interest.
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Abstract

This study examines the impact of terrorist attacks on investment, firm value, and corporate productivity. We show that terrorist attacks reduce firm-level productivity using measures of terrorist attack proximity in the U.S. However, since overconfident CEOs overestimate the returns on their investment, the underinvestment problem caused by the terrorist attacks can be mitigated for firms with overconfident CEOs. We find that firms with non-overconfident CEOs that are located nearby terrorist attacks significantly decrease their investment, relative to firms with overconfident CEOs and firms that are located far from attacks. Consequently, the impact of terrorist attacks on firm value varies between firms with overconfident and non-overconfident CEOs. Overall, this study suggests that CEO overconfidence can be beneficial for shareholders wealth under the certain condition such as terrorist attacks.

Keywords: Terrorist attacks; Productivity; Investment; CEO overconfidence; Firm value
JEL Classification: G31, G41, D91, H56

1. Introduction

In recent years, the frequency of terrorist attacks has increased, and victims and monetary damage have been accumulating. Terrorist attacks affect society as a whole, that is, the political, cultural, religious, and even individual units (Shrivastava 2005). In the U.S., terrorism in a specific area causes extreme fears and anxieties of individuals in the area, and also of individuals living close to the location of terror attacks (Schlenger et al. 2002). People who experienced terrorist attacks may suffer post-traumatic stress disorder (PTSD), which reminds them of the terror attacks and its consequences (Association 2013).[1] These symptoms last for more than several months after the event.[2] In addition, they may experience temporary difficulty in performing their jobs and maintaining relationships with colleagues. Further, employees exposed to the trauma of terrorist events are unwilling to work in unsafe workplace environments, and will require higher compensation for unsafe working conditions. Eventually, as a consequence of terrorist attacks, corporate productivity would decrease. Prior literature has documented through survey-based research that perceived threats of terrorism increase employees' stress and emotional exhaustion, ultimately reducing job performance (De Clercq et al. 2017; Raja et al. 2020).

From a macroeconomic perspective, prior studies have also demonstrated that terrorist attacks (as external shocks) cause either a direct or an indirect economic loss. Eckstein and Tsiddon (2004) recognize that terror has a significant negative macroeconomic effect through declining overall countrywide investment and consumption. Llussá and Tavares (2011) find that private consumption investment is negatively affected by the terror attack. Besides, Brounen and Derwall (2010) reveal that industries experience increased systematic risk after terrorist attacks, due to the

[1] The American Psychiatric Association suggested that people directly or indirectly affected by a terrorist attack suffer from the symptoms of not only physical injuries, but also mental disease such as post-traumatic stress disorder (PTSD).

[2] The National Institute of Mental Health presented the Post-Traumatic Stress Disorder Symptoms and defined that symptoms last at least one month; while some people recover within 6 months, others have symptoms that last much longer, and for some, the condition of PTSD may become chronic.

investment contractions that result from negative investor price effects. They also indicated that the effects of terror on stock markets is greater than the damage of natural disasters of similar size.

Previous studies have demonstrated the economic impact of terrorism empirically. For instance, Bader and Berg (2013) show that terrorism-related stressors of employees significantly increase personal stress levels, which in turn leads to deterioration in work performance. Tingbani et al. (2019) also reveal, through a global empirical approach, that frequent terrorist activities are more likely to contribute to high business failure rates; however, the association between terrorism and business failure is not significant in developed countries.

Moreover, several studies have focused on direct relationships between terrorist attacks and firm-level strategy or performance. Wang and Young (2020) find that investors' risk aversion is related to terrorist attacks, and that their investment portfolio composition varies with the number of attacks. Aslam and Kang (2015) show that the impact of terrorist attacks on stock market return varied across locations and types of attack. Also, Abadie and Gardeazabal (2008) reveal that terrorism affects the allocation of productive capital across countries, increases uncertainty, and reduces the expected return on investment. Recently, Dai et al. (2020) find that terrorist attacks affect the amount and structure of the CEO compensation.

In general, the CEO adopts a decision-making strategy to maximize the company's value; however, according to the Upper Echelons Theory (UET) proposed by Hambrick and Mason (1984), the CEO's decision also depends on his or her personal risk-taking tendency. Eventually, firm performance is affected by the corporate strategy, which is influenced by the CEO's background and personal traits. Malmendier and Tate (2005) present empirical evidence that confident CEOs increase corporate investment, because managerial overconfidence leads managers to overestimate the expected returns on their investment. On the other hand, previous studies show that the effect of CEO overconfidence on corporate investment and firm performance is differently shown by external factors such as the passage of the Sarbanes-Oxley-Act (SOX) or economic uncertainty (Banerjee et

al. 2015; Kang et al. 2018). Following previous studies on CEO overconfidence with UET, we examine how corporate investment policies are developed, according to CEO overconfidence, when terrorism strikes, and how performance is differently valued.

Given the threats of direct or indirect experiences of terrorism, the financial strategy and performance of the company that are nearly located from such terrorism may greatly be influenced. Therefore, main purpose of this study is to investigate how the impact of terror attacks under exogenous shocks on investment and performance differs, based on the CEO's overconfidence level. Few studies have investigated how the impact of terrorism varies according to individual characteristics. Psychological reactions and perspective-taking behaviors to terrorism are expressed differently according to individual-level characteristics or their personal traits (Schlenger et al. 2002; Yum and Schenck-Hamlin 2005; Zeidner 2006). Therefore, a CEO's terrorism perception would differ depending on his or her level of overconfidence.

We employed difference-in-difference (hearafter, DiD) tests to investigate our prediction that firms with overconfident CEOs invest more and perform better than those with non-overconfident CEOs, when firms are affected by terrorist attacks. In addition, it is necessary to examine whether the terrorist attack increases firm-level cost and hinders corporate productivity. To identify the mechanisms of terrorism’s impact on corporate investment and firm value, we identify the statistically significant impact of a terrorist attack on corporate productivity as an external factor that affects the corporate investment policy and firm value by increasing firm-level cost.

While many previous studies have revealed the economic consequences of terrorism at the country or industry level, few studies have investigated the firm-level effect of terrorist attacks. To the best of our knowledge, this study is the first to empirically analyze the relationship of CEO overconfidence to corporate investment and firm performance under the condition of terrorist attacks. By revealing the relationship, which differs by external shocks of terrorist attacks, we contribute empirical evidence to corporate investment-related literature.

The rest of this paper is organized as follows. Section 2 summarizes the development of our study's hypotheses based on a literature review. Section 3 explains the data, variables, and empirical models used to examine the impact of terror attacks on corporate investment and firm performance depending on the level of CEO optimism. Section 4 explains the empirical results. Finally, Section 5 concludes.

2. Literature review and hypothesis development

2.1. Terrorist Attacks, CEO overconfidence, and corporate investment

According to agency theory, shareholders appoint CEOs who are capable of aligning the goals of the firm with shareholder wealth maximization. CEOs are expected to make strategic decisions to maximize shareholders' wealth and have a strong incentive to maximize firm performance in order to secure their position. Therefore, a corporate investment policy is determined by firm-inside information and its internal financial position.

Nevertheless, recent studies suggest external determinants for corporate investment by empirically analyzing the effect of exogenous factors on corporate investment policies. For example, Kim and Kung (2017) show that firms tend to decrease their corporate investment after an increase in uncertainty. Similarly, Duchin et al. (2010) identify the negative effect of the financial crisis on corporate investment.

In addition, previous studies analyzed whether exogenous changes such as the adoption of the Sarbanes-Oxley Act (SOX) and the Statement of Financial Accounting Standards (SFAS) No. 123R affect corporate investment. They argue that the passage of SOX mitigates the agency problem, thereby reducing capital investment (Lu and Wang 2015), while SFAS 123R obliges the disclosure of employee stock options, thereby reducing underinvestment problems and ultimately increasing corporate investment (Dou et al. 2019).

Previous studies have shown that a terror event reduces not only individual investment but also overall national investment (Eckstein and Tsiddon 2004; Llussá and Tavares 2011). Terrorist

attacks have an impact on the level of risk aversion, as risk aversion increases when individual wealth decreases (Barberis and Huang 2001; Wang and Young 2020). In the stock market, terrorism causes a stock price crash and an increase in stocks' time-varying risk (Choudhry 2005; Brounen and Derwall 2010). Therefore, as the risk of corporate investment becomes more pronounced for companies affected by terrorism, the post-terror effect will diminish corporate willingness to invest.

In addition to external factors, corporate investment policy is also determined by the managers' level of optimism (Malmendier and Tate 2005; Banerjee et al. 2015). As the CEO's optimism tends to overestimate the company's future returns, companies with relatively more optimistic CEOs will invest more than other companies (Malmendier and Tate 2005; Campbell et al. 2011). Besides, Campbell et al. (2011) showed that CEO optimism alleviates risk-averse CEOs' underinvestment problem, as proposed by Pratt (1964). More specifically, Goel and Thakor (2008) and Campbell et al. (2011) find that an optimal level of CEO overconfidence can lead a risk-averse CEO to choose value-enhancing projects that maximize shareholder value, as the association of firm value with CEO overconfidence level is concave.

If the corporate cost is predicted to increase due to a sudden terrorist attack, the risk-averse CEO would revise the corporate investment plan and further reduce the amount of corporate investment compared to the previous year (or will not increase the amount of corporate investment). On the other hand, overconfident CEOs underestimate the losses from terrorism, and hence do not change investment plans significantly, invest more than non-overconfident CEOs, or increase the amount of corporate investment.

A terrorist attack is an exogenous shock, thus it represents a quasi-natural experimental setting, since no one can predict a terrorist attack in advance. We consider the impact of terrorism on firm-level investment policy and, at the same time, propose the following hypothesis to examine how the impacts of terrorism on corporate investment are differently recognized by CEO overconfidence.

H1. *The impact of terrorist attacks on corporate investment differs between firms with overconfident and non-overconfident CEOs*

2.2. Terrorist Attacks, CEO overconfidence, and shareholder value

According to Campbell et al. (2011), corporate investment by an overconfident CEO may be closer to the optimal level of investment for shareholders' wealth maximization, or may deviate significantly from the appropriate investment level through excessive overinvestment. Therefore, the impact of corporate investment on firm value increases positively and proportionally to a certain level; when CEO optimism exceeds a certainty equivalent point, a decline in firm value results from overinvestment (Campbell et al. 2011). If terrorism exerts an exogenous shock on firm productivity, the corporate investment by an overconfident CEO is more likely to be close to the appropriate level of investment than that of the non-overconfident CEO.

Evidence from several prior studies suggest that overconfident CEOs adopt a riskier corporate policy, while the relationship between CEO overconfidence and firm value is not clearly defined due to the two sides of CEO overconfidence. In general, Malmendier and Tate (2008) find that managerial overconfidence has a negative effect on acquisition performance. In addition, Ho et al. (2016) argue that banks with overconfident CEOs are likely to experience a greater increase in default risk and a greater reduction in their performance during the crisis period than banks with non-overconfident CEOs.

In contrast, previous studies have identified factors that moderate or reverse the negative effect of CEO overconfidence. Banerjee et al. (2015) show that the effect of CEO overconfidence on firm value is different before and after the passage of SOX. In particular, they find that the passage of the SOX enhances the benefits of overconfident CEOs on firm value and market reaction in an acquisition. Hirshleifer et al. (2012) suggest, as benefits of managerial overconfidence, that firms with overconfident CEOs tend to achieve greater innovative performance; further, the benefits of

CEO overconfidence are enhanced when firms have strong internal innovative opportunities. Recently, Kang et al. (2018) examined the investment policies of firms with overconfident CEOs and how their performance changed under high economic uncertainty. They find that overconfident CEOs perform better during periods of high economic uncertainty, because the investment-oriented policies of overconfident CEOs mitigate value destruction due to underinvestment when the economy is highly uncertain. Prior research suggests that the relationship between CEO overconfidence and firm value needs to be examined by considering external or internal factors.

Further, investors would be more reluctant to invest in companies exposed to terrorism because they recognize that the company may implement risk-averse investment policies due to increased external environmental risk (such as terrorist attacks). Wang and Young (2020) provide empirical evidence that mutual fund investors have increased the weight in safer assets such as government bond funds, while reducing their investment in equity funds, after they have suffered terrorism. In addition, Cuculiza et al. (2020) reveal that the more analysis is done in the period shortly after the terrorist activity, the more negatively and pessimistically the company earnings forecast is evaluated.

Many empirical studies have shown that, depending on the level of CEO overconfidence, market reactions or analyst forecasts for a company's financial policy vary (Malmendier and Tate 2008; Wong and Zhang 2014; Nguyen et al. 2018). Thus, when an external shock such as a terrorist attack occurs, investors would appreciate differently the value of investment policy, depending on the confidence level of managers. Despite the terrorist attacks, the increase in corporate investments with overconfident CEOs may send a positive signal to investors who are unwilling to invest in the stock market. Finally, we propose the following hypothesis to verify the different values (effects) of corporate investment policy on firm value, depending on CEO overconfidence.

H2. *The positive effect of CEO overconfidence on firm value is more pronounced when terrorist attacks have occurred.*

3. Data and Sample selection

3.1 Variables

We collect terrorist attack data from the Global Terrorism Database (GTD) at the National Consortium for the Study of Terrorism and Response to Terrorism (START). The GTD provides detailed information on the date and location of terrorist attacks. The study sample period encompasses 1992 to 2017. We calculate the difference in time (reflected by date) and distance between terrorist attack events to measure whether a company is affected by the terrorist event obtained from the GTD. According to the GTD definition of terrorism and inclusion criteria from START, each terrorism event must be intentional and entail some level of violence or immediate threat of violence by a non-state actor. We employ the location of the firm's headquarters from EDGAR to measure the distance from the attack.[3] Following Dai et al. (2020), we define the terrorist attack dummy as the headquarter of a firm that is located within a 100-mile (or 50-mile) radius of terrorist attacks that occurred within the past three years. Out of 27,586 firm-year observations, we confirm that about 31.39% was affected by terrorist attacks.

We measure CEO overconfidence from Execucomp, which provides detailed information on CEOs since 1992, including their compensation. Following the measure of Malmendier and Tate (2005) and Campbell et al. (2011), we set a stock option-based indicator, CEO overconfidence, to

[3] In addition to this, START defines events that satisfy two of the following three conditions as terrorism: 1) The act must be aimed at attaining a political, economic, religious, or social goal; 2) There must be evidence of an intention to coerce, intimidate, or convey some other message to a larger audience (or audiences) than the immediate victims; and 3) The action must be outside the context of legitimate warfare activities. Related information can be found at https://www.start.umd.edu/gtd/downloads/Codebook.pdf

one if the CEO postponed the exercise of vested options that were more than 67% in the money for two or more years, and to zero otherwise.

We collect financial information data from Compustat. We exclude both the financial industry (Standard Industry Classification (SIC) codes between 6000 and 6999) and the utility industry (SIC codes between 4900 and 4999). We then consider the firm's average change of investment, *ΔInvestment*, as measured by the difference in capital expenditure in the fiscal year and prior year, normalized by firm's total assets. We also consider *Investment* as the firm's capital expenditures normalized by its total assets. In addition, firm value in our analysis is measured by *Industry adjusted Tobin's Q*, which is *Tobin's Q* minus its annual median value among the firm's industry (based on three-digit SIC code), where *Tobin's Q* is defined as the market value of equity plus the book value of assets minus the sum of the book value of common equity and deferred taxes, all divided by the book value of assets. We also account for firm-specific characteristics in our empirical model, including *Assets*, *Tobin's Q*, *Leverage*, *Cash*, *ROA*, *Tangibility*, *Investment*, *R&D*, *CEO Total pay*, *Cash compensation*, and *CEO Tenure*. Detailed definitions of variables are described in Appendix A.

Furthermore, we estimate total factor productivity (TFP) for a given year to capture firm productivity, following the approach of other studies (Ackerberg et al. 2015; Bennett et al. 2020). We employ data on both the price index for the gross domestic product (GDP) deflator and private fixed investment as a deflator for investment and capital from the U.S. Bureau of Economic Analysis (BEA). The detailed estimation of productivity is explained in Appendix B.

3.2 Descriptive statistics

Table 1 reports the descriptive statistics for our sample from 1992 to 2017. In order to reduce the effect of possible spurious outliers, all variables are winsorized at the 1% and 99% levels.

Our final sample consisted of 2,530 firms with 27,586 firm-year observations after eliminating observations with missing variables.

Table 1 shows that 31.4% of firms were affected by terrorist attacks, and approximately 47% of CEOs were classified as overconfident CEOs. In addition, the mean value of investment change of firms is 0.49%, confirming that the tendency towards corporate investment in our sample is growing on average. The mean (median) value of *Tobin's Q* as a measure of firm value is 2.0241 (1.6273), suggesting that our sample firms are overvalued in terms of worth by more than the cost of its assets. Finally, the mean value of productivity as measured by TFP is 3.18, which is similar to Bennett et al. (2020).

[Insert Table 1 here]

4. Empirical Results

4.1. The effect of terrorist attacks on corporate investment

This study aims to examine how companies respond to investment policies when terrorist attacks occur as an external shock. In addition to the impact of terrorist attacks on corporate investment, we consider how CEOs' investment policies vary by their personal overconfidence levels. We adopt the following Equation (1) to examine whether the effect of terrorist attacks on investment change differs between firms with overconfident and non-overconfident CEOs.

Following the DiD regression model of Dai et al. (2020), we first set the treatment group as firms that affected by terrorist attacks (within 100 or 50 miles from the terrorist attack location) within three years since the last attack. At the same time, we set the control group as the treated firms before the attack and all the remaining firms.[4] We include the firm and year fixed effects to control

[4] To compare the treatment effect between firms with an overconfident and non-overconfident CEO, we employ an interaction term of *Terrorist Attack* and *CEO overconfidence*. Also, we exclude an overconfidence variable in our DiD regression model since we try to verify the treatment effect on firms led by overconfident and non-overconfident CEOs, compare with the control group.

time-invariant firm-level factors that might affect corporate investment, as well as time variation in investment change. The standard errors are clustered by firm and year (Bertrand and Mullainathan 2003; Dai et al. 2020).

$$\begin{aligned}\Delta\text{Investment}_{it} &= \beta_0 + \beta_1 \text{Terror Attack}_{it} \\ &+ \beta_2(\text{Terror Attack}_{it} \times \text{CEO overconfidence}_{it}) \\ &+ \theta' \text{Control variables}_{it} + \delta_i + \delta_t + \varepsilon_{it}\end{aligned} \quad (1)$$

where *i* and *t* represent the firm and fiscal year, respectively. $\text{Terror Attack}_{it}$ is a time-variant indicator for firms affected by the terrorist attacks, so that β_1 is our main DiD estimator. Control variables are the time-variant firm characteristics and CEO characteristics, as follows: *Assets*, *Tobin's Q*, *Leverage*, *Cash*, *ROA*, *Tangibility*, *CEO Total pay*, *Cash compensation*, and *CEO Tenure*. Since $\text{Terror Attack}_{it}$ is the time-variant indicator for firms affected by terrorist attacks, β_1 is the DiD estimator (the effect of terrorist attacks on investment change) for non-overconfident CEO firms, and β_2 is the difference in the DiD estimator between overconfident and non-overconfident CEO firms.[5] We expect that $\beta_1 < 0$ and $\beta_2 > 0$, because an overconfident CEO overestimates the firm's return thus is less likely to reduce investment than a non-overconfident CEO after a sudden terrorist attack

Table 2 shows the effect of terrorist attacks on change in investment for overconfident and non-overconfident CEO firms. In Panel A, we tabulate the result of the univariate test on the amount of change in investment, depending on the terrorist effect or the CEO's overconfidence level. In Models (1) to (3), we set the cutoff proximity to a terrorist event that affects firms as 100 miles. Among the companies not affected by terrorism in Model (1), the average value of the change in investment for firms with overconfident and non-overconfident CEOs is 0.72 and 0.22 percentage

[5] Consequently, the sum of β_1 and β_2 indicates the DiD estimator for overconfident CEO firms.

points, respectively, and the difference between firms by CEO overconfidence is statistically significant. In Model (2), we compared the changes in investments of companies affected by terrorism between firms with overconfident and non-overconfident CEOs. Likewise, we confirmed that, for firms affected by terrorism, the investments of firms with overconfident CEOs are significantly greater. The results of Models (1) and (2) consist thereof Malmendier and Tate (2005) that overconfident CEOs are more active in corporate investment on average, regardless of the occurrence of terrorism. Model (3) indicates whether there is a significant difference in the investment change of each firm with overconfident and non-overconfident CEOs, depending on the impact of terrorism. Models (4)–(6) show the results of the univariate test when we set the criteria of the proximity to terrorist attacks as 50 miles. The results in Models (4) and (5) are consistent with previous results in Models (1) and (2). Overall, we find that overconfident CEOs further increase their investments, while non-overconfident CEOs reduce their investment when firms are affected by terrorist attacks.

Panel B of Table 2 shows the effect of terrorist attacks on change in investment for firms with overconfident and non-overconfident CEOs by multivariate analysis. In Model (1), the terror attack does not significantly affect corporate investment after controlling firm and CEO characteristics, and firm and year fixed effects, consistent with the results in Dai et al. (2020). However, when we include the interaction term of overconfidence and terror attack in Model (2), we find that both the terror attack dummy and the interaction term significantly influence corporate investment. Considering that the coefficient of terror dummy and interaction term are –0.1798 and 0.3664, respectively, we confirm that firms affected by terrorism reduce their investments by about –0.18% of their assets, while firms with overconfident CEOs increase their investment ratio to 0.19%. These results are consistent, even when the proximity cutoff criterium of a terrorist attack is 50 miles in Models (3) and (4). To sum up, terrorism experiences overall reduce corporate investments

particularly for firms with non-overconfident CEOs, whereas overconfident CEOs are less likely to affected by terrorism and further increase their firm's investment.

We also confirm a negative association of change in investment with the firm leverage (*Leverage*), cash asset (*Cash*), tangible assets (*Tangibility*). On the other hand, we find that high profitability (*ROA*) and high market performance (*Tobin's Q*) are likely to increase corporate investment. However, we confirm firm-size (*Assets*) is not significantly related to the change in investment. In addition, in CEO-related controls, CEO total compensation (*CEO Total pa*y) is positively related to corporate investment while the ratio of cash compensation is not significantly related. Although the statistical significance level is weak, *CEO Tenure* is positively associated to change in investment.

In Models (1) and (3), the impact of terror on investment is insignificant, and when Models (2) to (4) include the significant interaction term, the overconfidence level of the CEO plays the role of moderator between terrorist attacks and corporate investment policy. These empirical results seem to support the results of survey-based studies, which show that people react differently to a terrorist attack, according to their characteristics (Zeidner 2006). Collectively, when terrorism affects firms, we find that different investment policies are selected by the CEO overconfidence level, confirming that H1 is supported by our empirical evidence.

[Insert Table 2 here]

4.2. The effect of terrorist attacks on firm value

In this subsection, we investigated how the firm's stock market value changes when a terrorist attack occurs. Likewise, when a company is affected by a terrorist attack, we examined the relationship between the CEO overconfidence level and firm value by considering how investors evaluate the firm value differently according to the CEO's confidence level. We tested our H2 by replacing the dependent variable in Equation (1) with the firm value measure (*Industry adjusted*

Tobin's Q). In Table 3, we included control variables as follows: *Assets*, *Leverage*, *Cash*, *ROA*, *Tangibility*, *Investment*, *R&D*, *CEO Total pay*, *Cash compensation*, and *CEO Tenure*. As done previously, we analyzed the relationship between CEO overconfidence and firm value responding to the terror attack through a DiD analysis.

Table 3 shows the results for the univariate and multivariate tests in Panel A and Panel B, respectively. Model (1) of Panel A reports the results of comparing the values of firms not affected by terrorism and those affected by terrorism according to the CEO overconfidence level. Regardless of the occurrence of terrorism, firms with overconfident CEOs have a statistically higher firm value than firms with non-overconfident CEOs. Model (3) shows the difference in firm value between the firms with overconfident CEOs and firms with non-overconfident CEOs, depending on the impact of terrorist attacks on the firm. We find that when firms are affected by terrorist attacks, the average firm value (as measure by *Industry adjusted Tobin's Q*) is as high as 0.06 in firms with overconfident CEOs, and as low as 0.02 in firms with non-overconfident CEOs. These results are consistent in direction and significance, even if we reduce the proximity criterium for determining the impact of terrorist attacks to 50 miles in Models (4) to (6).

Panel B of Table 3 reports the results of the multivariate test that examines the effect of terrorist attacks on firm value for overconfident and non-overconfident CEO firms by employing the DiD test. Model (1) of Panel B presents the result of the impact of terrorist attack proximity on firm value. Since the coefficient of *Terror Attack* is insignificant It seems that the terror attack itself does not significantly affect firm value. However, in Model (2), when we include the interaction term of the terror attack and CEO overconfidence, we confirm that terrorist attacks have a negative effect on firm value, and that the interaction effect between terrorist attacks and CEO overconfidence positively affects firm value. In addition, considering that the coefficient of the interaction term is larger than the coefficient of the terror attack, we find that firms with overconfident CEOs are more

highly evaluated when they are affected by terrorism. These results are consistent with Models (3) and (4), where the cutoff criterium of proximity to a terrorist attack is set to 50 miles.

The coefficient estimates of the control variables statistically significant and their signs are generally consistent with prior research. Both performance-related variable (*ROA*) and investment-related variables (*CAPEX* and R&D) are strongly and positively related to firm value. In addition, we find that firms with high cash assets receive a high evaluation in the stock market, while firms with high tangible assets are low valued in the market. In addition, in CEO-related controls, we confirm positive associations of firm value with the CEOs' compensation and their tenure.

We verify through the DiD test how firm value changes according to CEO overconfidence when a terrorist attack affects companies. If a company is to be affected by terrorism, it seems that terrorism itself does not directly affect firm value when firms are not distinguished by CEO overconfidence. In other words, in line with UET, CEO overconfidence significantly affects the corporate policies and performance (in our study, investment change and firm value, respectively), thus it should be accounted in empirical analysis. Specifically, our results overall suggest that overconfident CEOs can be beneficial for shareholders wealth when the uncertainty exogenously arise (in this study, we employ terrorist attacks), supporting our H2.

[Insert Table 3 here]

4.3. The Cost of Terrorist Attacks

So far, we investigate whether terrorism, as an external shock, results in a cost of change in corporate investment and firm value that differs according to the CEO confidence level. In this section, we examine that terrorist attacks reduce firm-level productivity empirically. If so, it is possible that terrorism experiences increase the external costs and uncertainty for companies near the terrorist attacks, and eventually cause the underinvestment problem due to the managers' risk-aversion.

We adopt DiD test examining the effect of terrorist attacks on corporate productivity. Similar to Equation (1), we include the firm and year fixed effects to control time-invariant firm-level factors that might affect productivity, as well as time variation in productivity, for all firms in the sample (Bertrand and Mullainathan 2003; Dai et al. 2020). Specifically, we adopted the following estimation:

$$\text{Productivity}_{it} = \beta_0 + \beta_1 \text{Terror Attack}_{it} + \theta' \text{Control variables}_{it} + \delta_i + \delta_t + \varepsilon_{it} \quad (2)$$

where *i*, and *t* represent the firm and fiscal year, respectively. $\text{Terror Attack}_{it}$ is the time-variant indicator for firms affected by terrorist attacks, so that β_1 is our main DiD estimator where we expect $\beta_1 < 0$. Control variables are the time-variant firm characteristics and CEO characteristics, as follows: *Assets*, *Tobin's Q*, *Leverage*, *Cash*, *ROA*, *Tangibility*, *Investment*, *R&D*, *CEO Total pay*, *Cash compensation*, and *CEO Tenure*.

Table 4 reports the results of Equation (2). We use the proximity cutoff criterium for terror-affected firms as 100 and 50 miles, in Models (1) and (2), respectively. We note that the impact of terrorism events is likely to be stronger when firms are located closer to the terrorist attack (Aslam and Kang 2015). Further, the more extreme the disaster and its effects, the greater the psychological distress reported by victims (Toukmanian et al. 2000). Therefore, we also construct the distance variable to capture the effect of terrorist attacks on corporate productivity. *Distance* represents the distance of the firm's location to the nearest terrorist attack in the fiscal year (Dai et al. 2020).

Model (1) in Table 4 shows that the coefficient of the terror attack proximity dummy is negative and significant, suggesting that the productivity of companies affected by the terrorist attack is relatively low compared to other untreated firms. It is consistent with prior survey-based studies (Schlenger et al. 2002; Yum and Schenck-Hamlin 2005; Frey et al. 2007), which show that terrorism increases workers' stress and causes economic losses. Model (2) in Table 4 shows the result of reducing the proximity cutoff for companies affected by terrorist attacks to 50 miles. Similar to the

results of Model (1), we confirm that the effect of terrorist attacks on productivity during the current and subsequent period is significantly negative, even when the proximity cut-off is set at 50 miles. In Models (3) and (4) in Table 4, we find that distance and productivity are positively related. This result can be seen in the increase in productivity as the distance from terror increases. In other words, we confirmed that the farther the distance from terrorist attacks, the less the deterioration of corporate productivity. Similar to previous results, these results are supported consistently (Toukmanian et al. 2000; Aslam and Kang 2015).

We find most coefficient estimates of the control variables statistically significant except *CEO Tenure*. We find a positive association of corporate productivity with total assets and firm leverage. In addition, we confirm both performance variables such as *Tobin's Q* and *ROA* and controls related CEO compensation (*CEO Total pay* and *Cash compensation*) are positively related to corporate productivity. We find that among the controls related to corporate investment, capital expenditure generally improves corporate productivity, whereas R&D investment and high accumulation of cash assets reduces corporate productivity.

We find empirical evidence that a loss of a company's productivity result in the company's economic losses. In particular, by revealing that productivity increased as the distance from the attack increased, it was confirmed that productivity varies according to the degree as well as the impact of terrorism. These results show that a terrorist attack is an exogenous shock that induces changes in corporate investment policies and firm value due to increasing firm-level cost.

[Insert Table 4 here]

4.4. Robustness test

In addition, we outline three robustness tests to support our main results. First, we replace the dependent variable in Equation (1) by several measures of investment intensity, rather than by the change of investment. Accounts related to the measurement of corporate investments include

investments for R&D and acquisitions, as well as existing investment costs. Therefore, we expand the scope of corporate investment in Table 5, and examine whether the effect of terrorist attacks on investment between overconfident and non-overconfident CEO firms is still consistent with our main results.

From Models (1)–(3) in Table 5, the direction and significance of the coefficient of the interaction term between terror attacks and CEO overconfidence are consistent with the results of Table 2, even though we extended the scope of corporate investment. In Models (4) to (6), we reduced the proximity criterion of the terrorist attack to 50 miles, and the significance of the terror attack disappeared in some models. Nevertheless, since the coefficient of the interaction term is positively significant in all models, we argue that the results in Table 5 are not sensitive to the expansion of the scope of corporate investment.

[Insert Table 5 here]

Second, to examine how the terrorist attacks affect firms over time, we follow the spirit of Bertrand and Mullainathan (2003) and thus separate seven indicators in the Equations (3): *Before_3*, *Before_2*, *Before_1*, *Current*, *After_1*, *After_2*, and *After_3*$^{+}$. *Current* is an indicator that equals one for firm-year observations for affected firms in the year when a terrorist attack has occurred, and *Before_t* (*After_t*) correspond to year – *t* (+ *t*), and zero otherwise. *After_3*$^{+}$ is an indicator that equals one if a firm-year observation is at least three years after the attack, and zero otherwise. We perform the dynamic analysis between firms with overconfident and non-overconfident CEOs. By including different revelation times before and after the terrorist attack in our model, we analyze whether the interaction effect of the terror attack and CEO overconfidence appeared.

$$
\begin{aligned}
&\text{Investment}_{it} \text{ or Firm value}_{it} \\
&= \beta_1 \text{Before\_3}_{it} + \beta_2(\text{Before\_3}_{it} \times \text{CEO overconfidence}_{it}) \\
&+ \beta_3 \text{Before\_2}_{it} + \beta_4(\text{Before\_2}_{it} \times \text{CEO overconfidence}_{it}) \\
&+ \beta_5 \text{Before\_1}_{it} + \beta_6(\text{Before\_1}_{it} \times \text{CEO overconfidence}_{it}) \\
&+ \beta_7 \text{Current}_{it} + \beta_8(\text{Current}_{it} \times \text{CEO overconfidence}_{it}) \\
&+ \beta_9 \text{After\_1}_{it} + \beta_{10}(\text{After\_1}_{it} \times \text{CEO overconfidence}_{it}) \\
&+ \beta_{11} \text{After\_2}_{it} + \beta_{12}(\text{After\_2}_{it} \times \text{CEO overconfidence}_{it}) \\
&+ \beta_{13} \text{After\_3}^{+}_{it} + \beta_{14}(\text{After\_3}^{+}_{it} \times \text{CEO overconfidence}_{it}) \\
&+ \beta_0 + \theta' \text{Control variables}_{it} + \delta_i + \delta_t + \varepsilon_{it}
\end{aligned} \tag{3}
$$

Table 6 reports the results of dynamic analysis for the robustness test. We estimate the coefficients of each interaction term by employing the dummy variables before and after three years of the terrorist attacks. In Models (1)–(4) in Table 6, we examine whether the impact of terrorism on various corporate investment measures differs by CEO overconfidence, whereas Model (5) focuses on firm value (*Industry adjusted Tobin's Q*).

In Models (1)–(4), *Current*, which is an indicator for firm-year observations affected in the fiscal year when a terrorist attack has occurred, tend to negatively affect corporate investment. Meanwhile, *Before_t* indicators, which are one for firm-year observations that were affected *t* years before the terrorist attack, are all insignificant. In other words, we confirm the causality, that is, the firm's corporate investment is immediately reduced when a terrorist attack affects a firm. Most importantly, the interaction effect with terrorist attack and CEO overconfidence is typically positively significant (except for Model (1)) at *Current* and *After_t*, where *After_t* indicates firm-year observations affected *t* years after a terrorist attack. Although firms tend to choose a policy to reduce their investment immediately after the terrorist attacks, their investment policies are eventually chosen differently, according to CEO overconfidence.

Similarly, in Model (5) of Table 6, we present the interaction effect between CEO overconfidence and terror attacks on the firm value through dynamic analysis as a robustness test. However, the interaction effect is not clearly distinguished before and after the terrorist attack. Nevertheless, as the coefficient of the time of terrorism and the coefficient of the interaction term are rapidly increasing on the basis of *Current*, we thus argue that firms managed by overconfident rather than non-overconfident CEOs have higher firm values after terrorism experiences.

[Insert Table 6 here]

Finally, we use alternative measures for CEO overconfidence. Following Campbell et al. (2011), we account for three CEO groups based on optimism, namely low-, moderate-, and high-optimism CEOs, where *CEO high optimism* is an indicator that equals one for CEOs who had vested options that were valued above the 100% moneyness at least twice during our sample period, and *CEO low optimism* is an indicator that equals one for CEOs who exercised vested options that were valued below the 30% moneyness and did not hold other vested options that were valued above the 30% moneyness. As a result, we classify CEOs as being of moderate optimism if they held and/or exercised options that were valued between 30% and 100% moneyness. With this classification of three CEO groups, we were unable to classify some CEO observations, such as CEOs who have no options at all. As suggested by Campbell et al. (2011), we also exclude the unclassified CEOs from the sample (thus, our sample size in Table 7 reduces to 22,773), whereas we included these unclassified CEOs as non-overconfident CEOs in our main results.

Table 7 reports the results of DiD test for firms conditional on these three CEO groups. We show the coefficients on the two relevant variables – the interaction of the terror attack with high CEO optimism from Model (1), and interactions of the terror attack with high CEO and low CEO optimism from Model (2). In Models (1) and (2), the coefficients of terror attack proximity are insignificant; however, the interaction of terror attack with high CEO optimism is positively significant. In addition, the interaction term between terror attack and low CEO optimism is not

significant, confirming that only CEOs with high optimism tend to increase corporate investment in response to terrorism.

In Models (3) and (4) in Table 7, we investigate the interaction effect on firm value according to CEO optimism level with terrorist attacks. We first confirm that firm value destruction occurs when a terrorist attack affects a firm. In particular, Model (4) shows that the interactions of high and low CEO optimism are positively and negatively significant, respectively. Therefore, we argue that a CEO with low optimism has more severe value destruction and the higher the CEO optimism, the higher the firm value. The evidence in Models (1)–(4) are robust to setting the proximity cutoff criteria for the terror attack as 50 miles (see, Models (5)–(8)). Overall, the results in Table 7 are consistent with Campbell et al. (2011), namely that value destruction due to terrorism is exacerbated by firms with low-optimism CEOs.

[Insert Table 7 here]

The hypotheses proposed in Section 2 have been tested robustly in many ways. We demonstrated that, when an external terrorism-related shock occurs, firms choose different corporate investment policies depending on whether the CEO is overconfident, and thus shareholders value firms differently. Our proposed hypotheses are not sensitive to various further analyses, and thus are supported.

5. Conclusion

Campbell et al. (2011) argue that the optimal level of CEO overconfidence can lead a risk-averse CEO to choose value-enhancing projects that maximize shareholder value, as firm value is concave in CEO overconfidence level. Extending this line of thought, we examine the effect of CEO overconfidence when terrorist attacks occur, in the context of corporate policy and firm value.

Using the sample of U.S. terrorist attacks, we find several empirical evidence and implications. First, we find that the negative impact of terrorist attacks on the nearly located firm's

productivity, confirming the economic cost of terrorism. Nevertheless, we find that, when affected by terrorist attacks, firms with overconfident CEOs are less likely to decrease corporate investment (or further increase), while non-overconfident CEOs reduce it. Since overconfident CEOs generally overestimate the return on their investment, we argue that firms with such CEOs are less likely to be excessively risk-averse even they observe terrorist attacks in areas close to them. Lastly, we find that firms with overconfident CEOs may be highly evaluated in the market when terrorist attacks occur. This would be a consequence of larger investment by overconfident CEOs, and that leads firms with such CEOs closer to optimal investment for firm value maximization, as suggested by Campbell et al. (2011). Overall, our results suggest the beneficial effect of overconfident CEOs when companies are exposed to external shocks such as terrorist attacks.

Our empirical results emphasize the importance of considering the CEO overconfidence in the relationship among an external shock (in our study, terrorist attacks), corporate investment, and firm value. In particular, by showing the impact of fading terrorist attacks when not considering CEO overconfidence, we provide the implication that future terrorist studies may be approached in a multidimensional way, considering both internal and external factors. Therefore, we expect to contribute to the broad horizon of literature, in that the relationship among terrorist attacks, corporate investment policy, and firm value has been revealed by considering the role of CEO overconfidence.

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Table 1. Summary statistics

This table presents the descriptive statistics of our sample from 1993 to 2017. We exclude the regulated industries (Standard Industrial Classification (SIC) codes 4900–4999 and 6000–6999). We winsorize all continuous variables at the 1st and 99th percentiles. N, SD, p25, and p75 denote the number of observations, standard deviations, and 25th and 75th percentiles, respectively. Variables definitions are in Appendix A.

Variables	N	Mean	SD	p25	p50	p75
Terror Attack	27,586	0.3139	0.4641	0.0000	0.0000	1.0000
CEO overconfidence	27,586	0.4707	0.4991	0.0000	0.0000	1.0000
Productivity	27,586	3.1800	0.6200	2.8159	3.1235	3.5298
ΔInvestment	27,586	0.4858	3.3786	-0.6443	0.1728	1.2695
Assets	27,586	7.3581	1.5495	6.2395	7.2328	8.3544
Tobin's Q	27,586	2.0241	1.2569	1.2367	1.6273	2.3242
Industry adjusted Tobin's Q	27,586	-0.0546	1.0659	-0.5775	-0.1390	0.2553
Leverage	27,586	0.2249	0.1879	0.0579	0.2082	0.3381
Cash	27,586	0.1497	0.1608	0.0282	0.0889	0.2183
ROA	27,586	0.0425	0.0984	0.0156	0.0522	0.0901
Tangibility	27,586	0.2703	0.2163	0.1025	0.2066	0.3817
Investment	27,586	0.0531	0.0495	0.0206	0.0377	0.0675
R&D	27,586	0.0307	0.0509	0.0000	0.0030	0.0414
CEO Total pay	27,586	1.4780	0.7470	0.8833	1.4070	1.9805
Cash compensation	27,586	0.3904	0.2808	0.1638	0.3044	0.5589
CEO Tenure	27,586	1.6984	0.9241	1.0986	1.7918	2.3979

Table 2. The effect of terrorist attacks on change in investment for overconfident and non-overconfident CEO firms: Difference-in-Difference (DiD) test

This table presents the results for ΔInvestment. Panel A reports the results of univariate test for the differences of ΔInvestment between affected and non-affected periods by terrorist attacks, based on *t*-test and *Wilcoxon*-test for mean and median, respectively. In Panel A, median values are reported in parentheses. Panel B reports the estimation of difference-in-difference (DiD) test results for overconfident and non-overconfident CEO firms, where the dependent variable is ΔInvestment. Variables definitions are in Appendix A. The *t*-statistics in parentheses are based on robust standard errors adjusted for heteroscedasticity and clustered by firm and year level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable = ΔInvestment

Panel A: Univariate test

	Cutoff criteria = 100 miles			Cutoff criteria = 50 miles		
	Terror Attack = 0	Terror Attack = 1	Difference: (2)–(1)	Terror Attack = 0	Terror Attack = 1	Difference: (5)–(4)
	(1)	(2)	(3)	(4)	(5)	(6)
Overconfident CEO: a	0.72%	0.96%	0.23%***	0.75%	0.91%	0.16%**
	(0.27%)	(0.37%)	(0.10%***)	(0.29%)	(0.33%)	(0.04%*)
Non-Overconfident CEO: b	0.22%	0.19%	-0.03%	0.24%	0.14%	-0.10%*
	(0.07%)	(0.04%)	(-0.03%)	(0.09%)	(0.00%)	(-0.09%***)
Difference: a–b	0.50%***	0.76%***		0.51%***	0.77%***	
	(0.20%***)	(0.33%***)		(0.20%***)	(0.33%***)	

Panel B: Multivariate test

	Cutoff criteria = 100 miles		Cutoff criteria = 50 miles	
	Pooled	Overconfident CEO vs. Non-Overconfident CEO	Pooled	Overconfident CEO vs. Non-Overconfident CEO
	(1)	(2)	(3)	(4)
Terror Attack	-0.0098	-0.1798***	0.0082	-0.1392**
	(-0.204)	(-2.968)	(0.173)	(-2.267)
Terror Attack × CEO overconfidence		0.3664***		0.3179***
		(4.215)		(3.587)

Assets	0.0696	0.0719	0.0698	0.0680
	(1.119)	(1.155)	(1.122)	(1.092)
Tobin's Q	0.4954***	0.4853***	0.4952***	0.4867***
	(14.606)	(14.267)	(14.598)	(14.319)
Leverage	-0.6057***	-0.5989***	-0.6055***	-0.5970***
	(-2.692)	(-2.662)	(-2.691)	(-2.654)
Cash	-2.1681***	-2.1477***	-2.1686***	-2.1632***
	(-8.306)	(-8.235)	(-8.308)	(-8.291)
ROA	4.3954***	4.3551***	4.3953***	4.3553***
	(14.380)	(14.250)	(14.380)	(14.234)
Tangibility	-2.8417***	-2.8068***	-2.8414***	-2.8305***
	(-5.771)	(-5.698)	(-5.770)	(-5.748)
CEO Total pay	0.2900***	0.2887***	0.2899***	0.2912***
	(4.153)	(4.136)	(4.151)	(4.171)
Cash compensation	0.0846	0.0914	0.0842	0.0910
	(0.550)	(0.595)	(0.548)	(0.592)
CEO Tenure	0.0531*	0.0384	0.0531*	0.0404
	(1.786)	(1.283)	(1.787)	(1.350)
Intercept	Yes	Yes	Yes	Yes
Year and Firm Fixed Effect	Yes	Yes	Yes	Yes
N	27,586	27,586	27,586	27,586
Adjusted R2	0.102	0.103	0.102	0.103

Table 3. The effect of terrorist attacks on firm value for overconfident and non-overconfident CEO firms: Difference-in-Difference (DiD) test

This table presents the results for industry adjusted Tobin's Q. Panel A reports the results of univariate test for the differences of industry-adjusted Tobin's Q between affected and non-affected periods by terrorist attacks, based on *t*-test and *Wilcoxon*-test for mean and median, respectively. In Panel A, median values are reported in parentheses. Panel B reports the estimation of difference-in-difference (DiD) test results for overconfident and non-overconfident CEO firms, where the dependent variable is industry adjusted Tobin's Q. Variables definitions are in Appendix A. The *t*-statistics in parentheses are based on robust standard errors adjusted for heteroscedasticity and clustered by firm and year level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable = Industry adjusted Tobin's Q

Panel A: Univariate test

	Cutoff criteria = 100 miles			Cutoff criteria = 50 miles		
	Terror Attack = 0	Terror Attack = 1	Difference: (2)–(1)	Terror Attack = 0	Terror Attack = 1	Difference: (5)–(4)
	(1)	(2)	(3)	(4)	(5)	(6)
Overconfident CEO: a	0.10	0.16	0.06***	0.09	0.18	0.09***
	(-0.03)	(-0.02)	(0.01)	(-0.03)	(-0.01)	(0.02*)
Non-Overconfident CEO: b	-0.20	-0.22	-0.02	-0.20	-0.22	-0.02
	(-0.22)	(-0.24)	(-0.02**)	(-0.22)	(-0.25)	(-0.03**)
Difference: a–b	0.30***	0.38***		0.29***	0.40***	
	(0.19***)	(0.22***)		(0.19***)	(0.24***)	

Panel B: Multivariate test

	Cutoff criteria = 100 miles		Cutoff criteria = 50 miles	
	Pooled	Overconfident CEO vs. Non-Overconfident CEO	Pooled	Overconfident CEO vs. Non-Overconfident CEO
	(1)	(2)	(3)	(4)
Terror Attack	-0.0005	-0.0657***	0.0138	-0.0589***
	(-0.046)	(-4.926)	(1.217)	(-4.321)
Terror Attack × CEO overconfidence		0.1403***		0.1565***
		(6.962)		(7.436)

Assets	-0.3664***	-0.3636***	-0.3662***	-0.3649***
	(-24.907)	(-24.744)	(-24.888)	(-24.842)
Leverage	0.1031*	0.1055**	0.1033*	0.1075**
	(1.918)	(1.967)	(1.922)	(2.006)
Cash	0.9348***	0.9384***	0.9346***	0.9328***
	(11.491)	(11.581)	(11.489)	(11.529)
ROA	1.9229***	1.9011***	1.9225***	1.8964***
	(23.730)	(23.517)	(23.728)	(23.486)
Tangibility	-0.3156***	-0.2940***	-0.3154***	-0.3014***
	(-3.859)	(-3.603)	(-3.860)	(-3.700)
Investment	2.3517***	2.2922***	2.3521***	2.2878***
	(12.285)	(11.985)	(12.292)	(11.976)
R&D	1.7592***	1.7953***	1.7591***	1.8111***
	(3.915)	(4.006)	(3.915)	(4.043)
CEO Total pay	0.2482***	0.2464***	0.2481***	0.2473***
	(13.068)	(12.980)	(13.064)	(13.035)
Cash compensation	0.2022***	0.2036***	0.2019***	0.2039***
	(6.128)	(6.176)	(6.119)	(6.188)
CEO Tenure	0.0313***	0.0256***	0.0313***	0.0250***
	(4.816)	(3.944)	(4.819)	(3.855)
Intercept	Yes	Yes	Yes	Yes
Year and Firm Fixed Effect	Yes	Yes	Yes	Yes
N	27,586	27,586	27,586	27,586
Adjusted R2	0.580	0.581	0.580	0.582

Table 4. The effect of terrorist attacks on the corporate productivity: Difference-in-Difference (DiD) test

This table presents the estimation of difference-in-difference (DiD) test results where the dependent variable is productivity. In Columns (1) and (2), *Terror Attack* is an indicator based on the cutoff criteria as 100 and 50 miles, respectively. In Column (3), *Distance-to-Terror* is the natural logarithm of a minimum distance in miles between corporate headquarter location (firm-year observation) and terrorist attacks in fiscal year. In Column (4), *Distance-to-Terror* is the natural logarithm of a minimum distance to terrorist attacks in miles with maximum value as the natural logarithm of 100. Variables definitions are in Appendix A. The *t*-statistics in parentheses are based on robust standard errors adjusted for heteroscedasticity and clustered by firm and year level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable = Productivity				
	Cutoff criteria = 100 miles (1)	Cutoff criteria = 50 miles (2)	Distance measure (3)	Distance measure (truncated) (4)
Terror Attack	-0.0159***	-0.0139**		
	(-2.891)	(-2.418)		
Distance-to-Terror			0.0048**	0.0055*
			(2.384)	(1.699)
Assets	0.0736***	0.0736***	0.0737***	0.0737***
	(9.206)	(9.217)	(9.233)	(9.222)
Tobin's Q	0.0410***	0.0409***	0.0408***	0.0409***
	(11.379)	(11.362)	(11.335)	(11.350)
Leverage	0.0882***	0.0881***	0.0882***	0.0886***
	(3.179)	(3.175)	(3.181)	(3.194)
Cash	-0.2755***	-0.2761***	-0.2749***	-0.2758***
	(-7.640)	(-7.653)	(-7.627)	(-7.649)
ROA	1.4384***	1.4386***	1.4382***	1.4378***
	(28.139)	(28.142)	(28.136)	(28.143)
Tangibility	-0.9851***	-0.9850***	-0.9838***	-0.9846***
	(-19.612)	(-19.608)	(-19.582)	(-19.602)
Investment	0.6061***	0.6056***	0.6051***	0.6055***
	(5.787)	(5.780)	(5.774)	(5.779)
R&D	-1.2705***	-1.2704***	-1.2720***	-1.2727***
	(-6.697)	(-6.696)	(-6.706)	(-6.711)
CEO Total pay	0.0491***	0.0491***	0.0492***	0.0492***
	(5.710)	(5.703)	(5.728)	(5.719)
Cash compensation	0.0904***	0.0902***	0.0905***	0.0902***
	(5.293)	(5.283)	(5.298)	(5.284)
CEO Tenure	-0.0009	-0.0009	-0.0009	-0.0009
	(-0.272)	(-0.274)	(-0.287)	(-0.271)
Intercept	Yes	Yes	Yes	Yes
Year and Firm Fixed Effect	Yes	Yes	Yes	Yes
N	27,586	27,586	27,586	27,586
Adjusted R2	0.691	0.691	0.691	0.691

Table 5. Robustness test: Difference-in-Difference (DiD) test for the effect of terrorist attacks on investment between overconfident and non-overconfident CEO firms

This table presents the estimation of difference-in-difference (DiD) test results for overconfident and non-overconfident CEO firms, where the dependent variable is investment measures expressed as a percentage. In models (2) and (5), the dependent variables are the sum of *Investment* and *R&D*. In models (3) and (6), the dependent variables are the sum of *Investment*, *R&D* and *Acquisition*, where *Acquisition* is the expense for acquisition (aqc in Compustat). Control variables indicate *Assets, Tobin's Q, Leverage, Cash, ROA, Tangibility, CEO Total pay, Cash compensation,* and *CEO Tenure.* Variables definitions are in Appendix A. The *t*-statistics in parentheses are based on robust standard errors adjusted for heteroscedasticity and clustered by firm and year level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	Investment	Investment + R&D	Investment + R&D + Acq	Investment	Investment + R&D	Investment + R&D + Acq
	Cutoff criteria = 100 miles			Cutoff criteria = 50 miles		
	(1)	(2)	(3)	(4)	(5)	(6)
Terror Attack	-0.1789***	-0.1205*	-0.2465**	-0.2030***	-0.1001	-0.1530
	(-3.611)	(-1.923)	(-1.979)	(-4.078)	(-1.524)	(-1.186)
Terror Attack × CEO overconfidence	0.3692***	0.2076**	0.6074***	0.3898***	0.1636*	0.4505**
	(5.337)	(2.357)	(3.436)	(5.523)	(1.782)	(2.450)
Intercept	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year and Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	27,586	27,586	27,586	27,586	27,586	27,586
Adjusted R2	0.736	0.775	0.469	0.736	0.775	0.469

Table 6. Robustness test: Dynamic analysis

This table presents the results of dynamic analysis. *Current* is an indicator that equals to one for firm-year observations for affected firms at the year when a terrorist attack has occurred, and *Before_t* (*After_t*) correspond year – t (+ t), and zero otherwise. *After_3*$^{+}$ is an indicator that equals one if a firm-year observation is at least three years after the attack, and zero otherwise. Control variables indicate as follows: *Assets, Tobin's Q, Leverage, Cash, ROA, Tangibility, CEO Total pay, Cash compensation,* and *CEO Tenure* in models (1)–(4), and *Assets, Leverage, Cash, ROA, Tangibility, Investment, R&D, CEO Total pay, Cash compensation,* and *CEO Tenure* in model (5). Variables definitions are in Appendix A. The *t*-statistics in parentheses are based on robust standard errors adjusted for heteroscedasticity and clustered by firm and year level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	ΔInvestment	Investment	Investment + R&D	Investment + R&D + Acq	Industry adjusted Tobin's Q
	(1)	(2)	(3)	(4)	(5)
Before_3	0.0932	0.0085	0.1088	0.2358	-0.0400*
	(0.781)	(0.094)	(0.926)	(0.984)	(-1.763)
Before_3 × CEO overconfidence	0.1970	-0.0346	-0.2198	-0.0887	0.0721**
	(1.074)	(-0.240)	(-1.248)	(-0.245)	(2.112)
Before_2	-0.1549	-0.1067	-0.1127	0.1355	-0.0185
	(-1.313)	(-1.131)	(-0.962)	(0.571)	(-0.863)
Before_2 × CEO overconfidence	0.1344	-0.1022	-0.1425	-0.0549	0.0601*
	(0.810)	(-0.766)	(-0.863)	(-0.160)	(1.839)
Before_1	-0.0425	-0.0312	0.0592	-0.3648	-0.0379*
	(-0.383)	(-0.330)	(0.506)	(-1.557)	(-1.789)
Before_1 × CEO overconfidence	0.4635***	0.0388	-0.1874	0.1492	0.0698**
	(2.916)	(0.297)	(-1.163)	(0.466)	(2.136)
Current	-0.4291***	-0.5108***	-0.3663***	-0.9225***	-0.1520***
	(-2.938)	(-4.339)	(-2.626)	(-3.278)	(-5.598)
Current × CEO overconfidence	0.4363***	0.2771**	0.1356	0.7650***	0.1950***
	(3.038)	(2.412)	(0.952)	(2.659)	(6.074)
After_1	-0.4809***	-0.6361***	-0.5013***	-0.7868***	-0.1729***
	(-3.397)	(-5.560)	(-3.563)	(-2.809)	(-6.254)
After_1 × CEO overconfidence	0.3280**	0.4334***	0.2314*	0.4158	0.2323***
	(2.415)	(4.080)	(1.689)	(1.536)	(7.173)
After_2	-0.5859***	-0.7202***	-0.5470***	-1.3415***	-0.1552***
	(-4.073)	(-6.097)	(-3.783)	(-4.821)	(-5.597)
After_2 × CEO overconfidence	0.3842***	0.5961***	0.3618**	1.2221***	0.1952***
	(2.809)	(5.406)	(2.569)	(4.394)	(6.308)

After_3^{+}	-0.4073***	-0.6073***	-0.4842***	-1.0718***	-0.1664***
	(-3.272)	(-5.980)	(-3.877)	(-4.368)	(-6.974)
After_3^{+} × CEO overconfidence	-0.0570	0.2255***	0.1808**	0.5251***	0.1833***
	(-0.818)	(3.930)	(2.402)	(3.403)	(10.604)
Intercept	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes
Year and Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes
N	27,586	27,586	27,586	27,586	27,586
Adjusted R2	0.104	0.736	0.776	0.470	0.584

Table 7. Robustness test: CEOs with low, moderate, high optimism

This table presents the estimation of difference-in-difference (DiD) test results for firms conditional on CEO optimism. Following the Campbell et al. (2011), we account three CEO groups based on the optimism: low-, moderate-, high-optimism CEOs. We exclude the unclassified CEOs and define two indicators as follows: *CEO high optimism* equals to one for CEOs who had vested options that were valued above the 100% moneyness at least twice during our sample period, and *CEO low optimism* equals to one for CEOs who exercised vested options that were valued below the 30% moneyness and did not hold other vested options that were valued above the 30% moneyness. Control variables indicate as follows: *Assets, Tobin's Q, Leverage, Cash, ROA, Tangibility, CEO Total pay, Cash compensation,* and *CEO Tenure* in models (1), (2), (5) and (6), and *Assets, Leverage, Cash, ROA, Tangibility, Investment, R&D, CEO Total pay, Cash compensation,* and *CEO Tenure* in models (3), (4), (7) and (8). Variables definitions are in Appendix A. The *t*-statistics in parentheses are based on robust standard errors adjusted for heteroscedasticity and clustered by firm and year level. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	ΔInvestment	ΔInvestment	Industry adjusted Tobin's Q	Industry adjusted Tobin's Q	ΔInvestment	ΔInvestment	Industry adjusted Tobin's Q	Industry adjusted Tobin's Q
	Cutoff criteria = 100 miles				Cutoff criteria = 50 miles			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Terror Attack	-0.0622	-0.0647	-0.0710***	-0.0659***	-0.0124	-0.0064	-0.0649***	-0.0605***
	(-0.998)	(-1.028)	(-5.331)	(-4.846)	(-0.199)	(-0.102)	(-4.719)	(-4.326)
Terror Attack × CEO high optimism	0.3242***	0.3249***	0.1919***	0.1904***	0.2733***	0.2731***	0.2134***	0.2131***
	(3.207)	(3.217)	(8.197)	(8.135)	(2.693)	(2.691)	(8.826)	(8.819)
Terror Attack × CEO low optimism		0.0455		-0.0897**		-0.1213		-0.0884**
		(0.230)		(-2.228)		(-0.595)		(-2.138)
Intercept	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	22,773	22,773	22,773	22,773	22,773	22,773	22,773	22,773
Adjusted R2	0.097	0.097	0.587	0.587	0.097	0.097	0.588	0.588

Appendix A. Variables definitions

This table presents the detailed definitions for variables.

Variable name	Definition
Terror Attack	Indicator equals to one for firm-year observations for affected firms at the year when a terrorist attack has occurred and the following three years, under the assumption that the impact of a terrorist attack continues for three years; Otherwise, zero. The affected firms are within 100 miles and at least three years have elapsed since the last attack (Dai et al. 2020), where the data for terrorist attacks are from the Global Terrorism Database (GTD) compiled by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland.
CEO Overconfidence	Indicator equals to one for CEOs who had vested options that were valued above the 67% moneyness at least twice during our sample period; Otherwise, zero.
Productivity	Total factor productivity estimated by the method of Ackerberg et al. (2015).
ΔInvestment	(Capital expenditure – Lagged capital expenditure) / Lagged total assets, expressed as a percentage.
Assets	Natural logarithm of Total assets.
Tobin's Q	(Total assets + Market value of equity – Book value of equity) / Total assets
Industry adjusted Tobin's Q	Tobin's Q minus annual industry mean value of Tobin's Q based on the first 3-digit SIC code.
Leverage	Total debts / Total assets
Cash	Cash and short-term investments / Total assets
ROA	Net income / Total assets
Tangibility	Property, plant and equipment / Total assets
Investment	Capital expenditure / Total assets
R&D	R&D expenses / Total assets, where missing R&D expenses (xrd *in Compustat*) are coded as zero
CEO total pay	Natural logarithm of (1 + tdc1 *in Execucomp*)
Cash compensation	(Salary + Bonus) / tdc1
CEO tenure	Natural logarithm of (1 + year become CEO *in Execucomp* – fiscal year)

Appendix B: The estimation of productivity

In this section, we provide our calculation to estimate total factor productivity (TFP). TFP is the firm's portion of output that does not explained by the inputs in production. We first consider Cobb-Douglas production function.

$$Y = f(K, L) = AK^{\alpha}L^{\beta} \quad \text{(A.1)}$$

where *Y* is the output, *K* is capital, *L* is labor, and *A* is productivity (which is the variable of our interest).

To estimate productivity *A*, we construct the following specification.

$$\ln(Y) = \text{Intercept} + \alpha \ln(K) + \beta \ln(L) + \varepsilon \quad \text{(A.2)}$$

where ε is the error term. From Equation (A.1), we have

$$\ln(A) = \text{Intercept} + \varepsilon \quad \text{(A.3)}$$

We construct the firm-level specification to estimate firm-level TFP as follows.

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \varepsilon_{it} \quad \text{(A.4)}$$

where y_{it}, k_{it} and l_{it} are the natural logarithm of the value added, value of capital, and value of labor of firm *i* at year *t*, respectively.

We obtain data from Compustat and U.S. Bureau of Economic Analysis (BEA). First, value added is sales (*revt* in Compustat) minus materials (*revt – oibdp – xlr* in Compustat), adjusted by the GDP deflator. Due to the large number of observations with missing data for labor expenses (*xlr* in Compustat), we replace these missing values as the multiplication of the number of employees (*emp* in Compustat) and the annual industry wage per employee (average of *xlr* / *emp* in Compustat based on Fama-French 12 industry classification for each fiscal year). Second, capital is gross plant, property, and equipment (*ppegt* in Compustat), adjusted by the deflator for investment. For this adjustment, we account the average age of the capital stock (Hall 1990; Brynjolfsson and Hitt 2003; Bennett et al. 2019). Third, labor is the number of employees (*emp* in Compustat).

However, OLS estimation for Equation (A.4) can be biased, thus we employ the estimation method in Ackerberg et al. (2015) for our sample period. Finally, our estimation of firm-level TFP is described in Equation (A.5) as follows.

$$\widehat{TFP_{it}} = y_{it} - \widehat{\beta_k}\, k_{it} - \widehat{\beta_l}\, l_{it} \qquad \text{(A.5)}$$