WARWICK
THE UNIVERSITY OF WARWICK

Manuscript version: Author's Accepted Manuscript
The version presented in WRAP is the author's accepted manuscript and may differ from the published version or Version of Record.

Persistent WRAP URL:
http://wrap.warwick.ac.uk/150604

How to cite:
Please refer to published version for the most recent bibliographic citation information. If a published version is known of, the repository item page linked to above, will contain details on accessing it.

Copyright and reuse:
The Warwick Research Archive Portal (WRAP) makes this work by researchers of the University of Warwick available open access under the following conditions.

© 2021 Elsevier. Licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International http://creativecommons.org/licenses/by-nc-nd/4.0/.

Publisher's statement:
Please refer to the repository item page, publisher's statement section, for further information.

For more information, please contact the WRAP Team at: wrap@warwick.ac.uk.

warwick.ac.uk/lib-publications

The Impact of Shareholder Intervention on Overinvestment of Free Cash Flow by Overconfident CEOs

Sewon Kwon
College of Business Administration, Ewha Womans University, 03760, South Korea
Jae Hwan Ahn*
Lancaster University Management School, Lancaster University, LA1 4YX, U.K.
Gi H. Kim
Warwick Business School, University of Warwick, CV4 7AL, U.K.

ABSTRACT

This paper examines the impact of shareholder intervention on investment distortions, which we capture using overinvestment of free cash flow by overconfident CEOs. Using this definition and U.S. data for 1996–2014, our fixed effects and difference-in-difference matching estimation results provide consistent evidence that the threat of potential intervention of shareholders can curb overinvestment by overconfident CEOs. Specifically, firms with greater voting premium and hedge fund activism experience less overinvestment and exhibit lower sensitivity of free cash flow to investment. Such disciplining effects are stronger for firms managed by overconfident CEOs. Overall, our results suggest that shareholder intervention is particularly effective at mitigating overinvestment that is more likely to be distorted.

Keywords: investment-cash flow sensitivity; CEO overconfidence; free cash flow; investment distortion; shareholder intervention
JEL Classification: G3, M4

* Corresponding author.
Email: j.h.ahn@lancaster.ac.uk (J. Ahn), gi.kim@wbs.ac.uk (G. Kim), k4js1@ewha.ac.kr (S. Kwon)

1. INTRODUCTION

We examine the impact of shareholder intervention on investment distortions, which we capture using overinvestment of free cash flow (FCF) by overconfident CEOs. While positive investment-cash flow sensitivity (henceforth ICFS) is often considered to represent investment distortions (Jensen, 1986), Malmendier and Tate (2005) argue that the ICFS of firms managed by overconfident CEOs is more likely to constitute investment distortions. This is because positive ICFS can be observed even when incentives are perfectly aligned between shareholders and CEOs and, in such cases, overinvestment of FCF does not necessarily capture investment distortions.[1] However, positive ICFS of firms with overconfident CEOs suggests distorted investment due to managers' systematic bias. Despite the large volume of literature on shareholder governance with respect to overinvestment, virtually no literature has focused on its impact on investment decisions by overconfident CEOs, per se.[2] Our paper fills this gap.

In order to address potentially different impacts on overinvestment, we divide our sample into four distinct subsamples with different levels of CEO overconfidence and FCF: 1) overconfident CEO–positive FCF, 2) non-overconfident CEO–positive FCF, 3) overconfident CEO–negative FCF, and 4) non-overconfident CEO–negative FCF. Then, for each subsample, we examine the relationship between shareholder intervention and overinvestment. In doing so, we employ two variables as proxies for the threat of shareholder intervention, namely, voting premium and hedge fund activism, and the overinvestment measure proposed by Richardson (2006).[3] Our primary focus is subsample (1), dubbed the *distorted investment* subsample.

The choice of shareholder intervention measures is critical in this type of study. Early studies in the literature used the mere presence of influential and/or sophisticated shareholders as a proxy for shareholder voices (e.g., Graves, 1988; Bushee, 1998). However, more recent studies have suggested relatively less noisy and more direct measures. For example, Kalay et al. (2014) propose the market value of voting premium measure. Voting premium is estimated by taking the difference between a stock price with voting rights and the synthetic stock price without voting rights. The difference represents the price shareholders would be willing to pay to exercise their voting rights, and it captures shareholders' active involvement in the voting process. According to Kalay et al. (2014) and Lin et al. (2018), there are time series and cross-

[1] "Under asymmetric information, the managers themselves (who act in the interest of shareholders) restrict external financing in order to avoid diluting the (undervalued) shares of their company. In this case, cash flow increases investment, but reduces the distortions" (Malmendier and Tate, 2005, p. 2662).

[2] Huang et al. (2011) is an exception. Using Chinese data, the authors argue that the ICFS associated with overconfident CEOs is caused primarily by agency problems.

[3] Abnormal change in new investment after excluding depreciation and amortization.

sectional variations in the voting premium. It is larger when shareholders are about to exercise their voting rights (e.g., around shareholder meetings or during control contests), and it varies systematically across firms. In our analysis, variations in the voting premium imply that shareholders across firms do not value their voting rights equally. The magnitude of the variation is essentially a measure of a firm's active shareholder involvement.

We also employ hedge fund activism as an alternative measure of shareholder intervention. Brav et al. (2008) propose hedge fund activism as a proxy for active and informed shareholder monitoring. The authors manually collected all Schedule 13Ds filed by hedge fund activists who explicitly seek to influence control at target firms,[4] excluding cases where other passive or non-hedge fund investors hold more than 5% of shares. Their explicit declarations to influence target firms indicate that hedge fund activists have a stronger incentive to take a more active role in monitoring firm investments.

We construct our empirical predictions based on the efficient market and disciplinary threat hypotheses. These theories assume that shareholders intervene effectively to reduce suboptimal investment by processing *all* relevant information, and that managers consider shareholder voices to be a credible threat to engage the firm in a costly proxy contest. We thus hypothesize that if all else remains equal, a larger voting premium is negatively associated with investment distortions, and that investment distortions will decrease with the arrival of hedge fund activists. However, we do not predict similar effects of shareholder intervention when overinvestment is not a manifestation of investment distortion because, in this case, CEOs will not feel threatened by shareholder voices.

To test our disciplining hypothesis, we use two different samples. The first comprises a merged file of Compustat, Execucomp, CRSP, and OptionMetrics, which results in 8,346 firm-year observations for the 1996–2014 period after excluding missing values (henceforth, the voting premium sample). We choose this sample to estimate the voting premium by using derivative trading data from OptionMetrics. The second is the merged file of Compustat, Execucomp, CRSP, and 13D filings compiled by Brav et al. (2018).[5] In this sample, we do not use the voting premium variable, and so do not require that firms be included in OptionMetrics because this requirement reduces our sample size. Instead, to reduce any systematic differences in observable firm characteristics between activist targets and non-targets, we select 354 matched pairs (2,173 firm-year observations) for 1996–2014 based on the ex ante probability

[4] In the U.S., the SEC requires investors to file a Schedule 13D when their shareholding exceeds 5% of any class of shares in a public company, and when they seek to influence control at a target company (Brav et al., 2008).
[5] We thank Alon Brav for generously sharing their data on 13D filings with us.

of 13D filings (henceforth, the hedge fund activism sample). In all analyses, we capture overinvestment, FCF, and CEO overconfidence by adopting the frameworks proposed by Richardson (2006) and Malmendier and Tate (2005).

Using the voting premium sample and a fixed effects estimator, we show that voting premium reduces investment distortion by overconfident CEOs. First, when we regress overinvestment on the interaction term between FCF and voting premium, it carries a significantly negative coefficient only for the overconfident CEO subsample, suggesting reduced ICFS for such firms. Alternatively, using the four aforementioned classifications of the sample, we find that voting premium is negatively associated with overinvestment only in the distorted investment subsample. As the mean value of overinvestment in this subsample is positive, the results imply that shareholder intervention effectively mitigates the extent of overinvestment of firms with positive FCF and overconfident CEOs. Interestingly, and consistent with the disciplinary threat hypothesis, this deterrent effect persists even after we explicitly exclude the effects of actual voting events, control contests, and shareholder litigation.

Using the hedge fund activism sample and a difference-in-differences (DID) matching estimator, we also show that investment distortion by overconfident CEOs diminishes when the firm is under threat of hedge fund activism. Specifically, we find a negative coefficient for our triple interaction term (among hedge fund activism, "post" variable, and FCF), which essentially suggests a reduction in ICFS subsequent to hedge fund activism (i.e., 13D filings), only for the overconfident CEO subsample. Alternatively, using the four aforementioned classifications of the sample, we find a significantly negative coefficient for our double interaction term (between hedge fund activism and post variable), which captures a reduction in overinvestment post 13D filings. This relationship is also observed only in the distorted investment subsample.

Next, we seek to attenuate concerns over our assumption that the ICFS of firms managed by overconfident CEOs captures potential investment distortions. If firms in the distorted investment subsample generate good ex post financial performance (e.g., ROA), shareholders will not need to curb such overinvestments, and we may not be able to define this subsample as potential investment distortions. However, using the system generalized method of moments (GMM) and Fama-MacBeth regression approaches, we find that overinvestment is negatively associated with firm performance both in the short and long run, but mostly in our distorted investment subsample. In contrast, overinvestments in other subsamples do not lead to poor performance in a consistent manner. These findings lend support to our classification of potential investment distortions.

Overall, we interpret our findings as implying that shareholder intervention does not uniformly deter all types of overinvestment, but it is particularly effective at alleviating investment distortions, i.e., overinvestment due to CEO overconfidence. We also show that the effects of shareholder intervention acting as a credible threat to CEOs are significantly incremental to those of actual voting events, control contests, and shareholder litigation.

Our study makes distinct contributions to the existing literature. First, it builds on research exploring the causes (e.g., Fazzari et al., 1988; Kaplan & Zingales, 1997) and mitigating factors (e.g., Pawlina & Renneboog, 2005; Richardson, 2006) of ICFS. As noted earlier, traditional ICFS does not necessarily capture investment distortions, but that of firms managed by overconfident CEOs is more likely to do so. However, since Malmendier and Tate (2005), virtually no studies have focused on this unique ICFS type.[6] To the best of our knowledge, this paper is the first to explicitly explore the mitigating factors of Malmendier and Tate's (2005) investment distortions. In particular, while Richardson (2006) provides some evidence that activist shareholders mitigate overinvestment using traditional ICFS, this study complements his finding by documenting that shareholder intervention is most effective at deterring overinvestment caused by overconfident CEOs.

Second, this paper adds to the literature that explores the role of shareholder intervention in curbing investment distortions. Empirical evidence on this topic and its interpretation have been mixed, at least partly because of ambiguity over the definition of investment distortions. For example, one strand of research suggests that informed shareholder monitoring is effective for mitigating the problems of suboptimal investment (e.g., Bushee, 1998; Hansen & Hill, 1991; Baysinger et al., 1991; Schnatterly et al., 2008; Aghion et al., 2013). Others argue that the deterrent role of shareholders is ineffective due to their short-term investment horizon (e.g., Graves, 1988; Porter, 1992; Greenwood & Schor, 2009). In this paper, we show that shareholder intervention does not uniformly deter all overinvestments. We believe that the adoption of Malmendier and Tate's (2005) approach to capture potential investment distortions may help to resolve the mixed results and interpretations in the literature.

[6] Instead, studies have investigated CEO overconfidence in other contexts. For example, studies after Malmendier and Tate (2005) have analyzed the impact of CEO overconfidence on firm performance (Hsu et al., 2017), stock price crash risk (Kim et al., 2016), CEO turnover (Campbell et al., 2011), and earnings quality (Schrand and Zechman, 2012; Ahmed and Duellman, 2013; Hsieh et al., 2014).

In the remainder of this paper, Section 2 summarizes previous literature and our hypothesis development, and Section 3 describes our data and research method. Sections 4 and 5 present our empirical results and robustness checks, and Section 6 draws some conclusions.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

This study investigates the deterrent role of shareholder intervention in mitigating investment distortions, captured using overinvestment of FCF by overconfident CEOs. The next subsections briefly review relevant literature (summarized in Table 1) and present our hypotheses.

2.1 Agency costs of FCF and CEO overconfidence

Despite intense research, controversy remains over the interpretation of ICFS. Theoretical and empirical studies suggest that positive ICFS does not necessarily translate into investment distortions. Jensen (1986) argues that FCF causes investment inefficiencies, because managers whose interests are *not aligned* with those of shareholders will direct FCF to non-value-maximizing projects rather than paying dividends to shareholders. Here, FCF is defined as excess cash flow after funding all positive-NPV projects. A considerable volume of literature explores the agency costs of FCF in terms of their causes (e.g., Fazzari et al., 1988) [7] and mitigating factors (e.g., Pawlina & Renneboog, 2005). For example, Richardson (2006) interprets a positive association between abnormal investment and FCF as reflecting investment distortions or the agency costs associated with overinvestment of FCF.

On the other hand, a strand of studies suggests that positive ICFS may also be a result of underinvestment if driven by information asymmetries (Stiglitz & Weiss, 1981; Myers & Majluf, 1984; Pawlina & Renneboog, 2005). These studies argue that CEOs whose interests are *aligned* with shareholders rely heavily on internal funds rather than raising costly external funds, and will thus lose potentially positive-NPV projects.

Heaton (2002) turns to the behavioural aspects of managers to explain investment inefficiencies. Specifically, he argues that *optimistic* managers are more likely to make excessive investments in negative-NPV projects, even without agency problems, because they systematically overvalue investment options. Furthermore, Malmendier and Tate (2005) note that FCF does not necessarily cause investment distortions if driven by information asymmetries, in which case CEOs will rely more on internal funds to avoid diluting their firms'

[7] Fazzari et al. (1988) argue further that ICFS is an indicator of financing constraints caused by market imperfections, while Kaplan and Zingales (1997) attribute it (at least partially) to managerial conservatism.

undervalued securities. Positive ICFS may therefore represent overinvestment, but not necessarily investment distortions. Instead, Malmendier and Tate (2005) argue that overconfident CEOs will invariably cause investment distortions because their optimistic nature makes them more likely to be misled by rosy evaluations of investment opportunities. CEO overconfidence therefore positively moderates the link between firm investment and FCF.

In this paper, we employ Malmendier and Tate's (2005) unique type of ICFS and the overinvestment measure proposed by Richardson (2006) to capture investment distortions, i.e., overinvestment of FCF by overconfident CEOs, enabling us to better capture the agency costs associated with overinvestment.

2.2 Shareholder intervention

Given potential investment distortions, shareholders may seek to limit the self-interested activities of CEOs by incurring monitoring costs (Jensen & Meckling, 1976). Despite mixed findings in the literature (e.g., Graves, 1988; Bushee, 1998), a majority of studies listed in Table 1 find evidence for the effectiveness of shareholder intervention in boosting promising projects but curbing potential investment distortions. For example, Baysinger et al. (1991) and Brav et al. (2018) find that institutional investors' shareholding and hedge fund activism are positively associated with R&D investment and corporate innovations (e.g., citations), respectively. Pawlina and Renneboog (2005) and Richardson (2006) also provide evidence that shareholder intervention, captured using blockholder shareholding and the presence of activist shareholders, effectively mitigates the agency costs of FCF. As previously noted, unlike these studies, we employ Malmendier and Tate's (2005) ICFS type to revisit the analysis of whether shareholder intervention curbs investment distortions.

The main argument supporting the deterrent role of shareholders is the *efficient market hypothesis*, which posits that shareholders are able to process *all* relevant information (Hansen & Hill, 1991) and thus optimize firm investment.[8] Nevertheless, shareholders' active involvement in the voting process or their informed monitoring does not give them direct power over firms' investment decisions. Even when shareholders could intervene directly to deter investment distortions (e.g., by altering investment-distorting CEOs), a proxy battle is very costly for both shareholders and managers. Therefore, shareholder voices are most likely to be effective when they pose a more credible threat of engaging the firm in a costly proxy contest.

[8] In contrast, others argue that performance pressures give institutional investment managers a short-term perspective (Hansen & Hill, 1991; Greenwood & Schor, 2009), and that these managers lack sufficient sophistication and ability to probe complex firm investments (Franco et al., 2015; Barth et al., 2017).

We refer to this as the *disciplinary threat hypothesis* (see also Francis & Smith, 1995; Klein & Zur, 2006; and Brav et al., 2018).

For example, shareholders may legitimately demand that firms reduce investment distortions. If incumbent CEOs do not conform, they will feel threatened by shareholder intervention for fear of facing dismissal (Campbell et al., 2011) or enhancing governance controls (e.g., amendments to corporate charters, alterations to board composition). Consequently, if all else remains equal, we predict that CEOs will decrease investment distortions when shareholders are more likely to actively exercise their voting rights, which we capture using higher levels of the voting premium (Kalay et al., 2014). However, we do *not* predict similar effects when overinvestment is not necessarily distorted because, in this case, CEOs will not feel threatened by shareholder voices.

H1: Voting premium is negatively associated with investment distortions.

Previous studies indicate that certain types of shareholders have greater ability and incentives to facilitate disciplining mechanisms (Shleifer & Vishny, 1986). For example, institutional investors are more able to reduce information asymmetries because their firm ownership tends to be sufficiently concentrated (Schnatterly et al., 2008), and their diversified portfolios may give them a longer-term perspective, leading them to support risky but promising investments (Baysinger et al., 1991).

In particular, Brav et al. (2008) compare hedge funds with institutional investors and other fund types (e.g., mutual funds), and find that hedge funds are ideally positioned to act as informed and active monitors. They suggest that this is because hedge funds are operated by highly incentivized managers, and tend to hold relatively concentrated positions in a small number of firms. This implies that hedge fund activists are likely to have stronger incentives and be better positioned to take a more active role in monitoring firm investments. We thus predict that investment distortions will decrease with the arrival of hedge fund activists.

H2: Investment distortions decrease following the entrance of hedge fund activists.

[Insert Table 1 here]

2.3 Institutional context

While ICFS has been explored globally (e.g., Huang et al., 2011 for China), we conduct this research in the context of a single country, the U.S., for two main reasons. First, the U.S. is a common-law country (La Porta et al., 2000) with relatively strong investor protection. Although shareholder activism took root in the mid-1980s in the U.S., early institutions relating to shareholder protection, such as shareholder proposals, were initiated as early as the Securities and Exchange Act 1934 (Denes et al., 2017). Against this background, U.S. shareholders are more able to intervene to curb investment distortions through proxy battles, hedge fund activism, takeover, and litigation. This favorable context for shareholders provides an ideal setting for research to test the effectiveness of shareholder voices. Second, a single-country analysis of the U.S. facilitates our access to relevant data. For example, data to construct overconfidence and voting premium measures are readily available from Execucomp and OptionMetrics. We are also able to utilize hedge fund activism data compiled by Brav et al. (2018). These are unlikely to be available for a cross-country analysis.

2.4 Conceptual framework

Figure 1 summarizes how shareholder intervention affects overinvestment of FCF by overconfident CEOs, which we adopt as a proxy for investment distortions. We use this measure because overinvestment of FCF (Richardson, 2006) does not necessarily capture investment distortions. Specifically, while overinvestment of FCF driven by *agency problems* is more likely to constitute investment distortions, FCF associated with *information asymmetries* may increase investment but reduce distortions (Malmendier & Tate, 2005). In contrast, according to Malmendier and Tate (2005), overinvestment of FCF by overconfident CEOs invariably causes investment distortions, because overconfident CEOs' optimism leads them to undertake negative-NPV projects more frequently.

Using this definition of investment distortions, we test the effectiveness of shareholder intervention in curbing suboptimal investment. Specifically, based on the *efficient market hypothesis*, we assume that shareholders in general, and hedge fund activists in particular, have incentives and ability to optimize firm investment. Based on the *disciplinary threat hypothesis*, we then predict that CEOs will consider shareholder voices as a credible threat, and will thus adjust their investment levels accordingly, but only when these are causing investment distortions.

[Insert Figure 1 here]

3. DATA AND METHOD

3.1 Sample and data

We use two samples to test for the deterrent role of shareholder interventions in mitigating investment distortion: the *voting premium sample,* and the *hedge fund activism sample*. We describe both in more detail in the following subsections.

3.1.1. Voting premium sample

We begin the sample selection process by merging observations from OptionMetrics, Compustat, Execucomp, and CRSP. After excluding financial institutions and observations without sufficient data, we are left with 12,066 firm-years for the 1996–2014 period.[9] The sample to estimate the voting premium (*VP*) starts in 1996, because the OptionMetrics data begin in that year. It ends in 2014, in order to match the period of our second sample. We follow Malmendier and Tate (2005) and Campbell et al. (2011), who propose an option-based CEO overconfidence measure, and require CEOs to exhibit overconfident behavior (i.e., not exercising stock options that are more than 67% in the money) at least twice during their tenure in order to be included in our sample. Accordingly, the observations in our sample have an approximately equal chance of being classified as overconfident. As a result of applying these requirements, our voting premium sample comprises 8,346 firm-years.

To capture the potential investment distortions proposed by Malmendier and Tate (2005), we then split this pooled sample by levels of CEO overconfidence and FCF: 1) overconfidence–positive FCF (N = 3,434), 2) non-overconfidence–positive FCF (N = 2,453), 3) overconfidence–negative FCF (N = 1,349), and 4) non-overconfidence–negative FCF (N = 1,110). Our main analyses focus on subsample (1), which we call investment distortions, or the ICFS of overconfident CEOs.

3.1.2 Hedge fund activism sample

To analyze hedge fund activism, we use a second data set. We begin with the merged file of Compustat, Execucomp, CRSP, and 13D filings by hedge funds compiled by Brav et al. (2018). As in the voting premium sample, we also exclusively include CEOs who exhibit overconfident behavior at least twice during their tenure. This merging process results in 10,726 firm-year observations for 1996–2014 after excluding missing values.

[9] Following Richardson (2006), we exclude financial institutions from our analysis. This is because, in the financial industry, demarcations among the three cash flow classifications are unclear, and some crucial components required to calculate new investments (e.g., R&D expenditure) are not available.

To test for the effect of hedge fund activism on investment distortions, we use propensity score matching. This approach facilitates causal inference in a non-experimental setting by identifying counterfactuals of which the ex ante probability of treatment is similar to *actual* treatment observations. Because a firm can be a target (*Targets*) in one year and a non-target (*Non-targets*) in another, we limit potential control firms to those for which hedge funds did not file a Schedule 13D at any point during our sample period. We then estimate the propensity of 13D filings by hedge fund activists using a probit model (Eq. (1)), where we regress hedge fund activism (*Targets*) on agency costs (*CEO_own*) and information asymmetry (*Spread*) after controlling for the number of existing 13D blockholders (*Num_5pct*)[10] and CEO equity-based incentives (*CEO_delta*).

Following Brav et al. (2018), *Targets* is an indicator variable that equals 1 for specific firm-years when hedge fund activists filed a Schedule 13D with the SEC, and 0 otherwise. This model is based on agency theory (Jensen & Meckling, 1976), which states that ownership structure is determined by the extent of agency costs and information asymmetry. In this model, we include additional variables relating to the main financial (*Size*, *ROA*, and *Leverage*) and market (*Turn*, *Stock return*, and *Volatility*) characteristics suggested in prior literature that relate to ownership structure and equity investment risk (e.g., Rogers & Stocken, 2005; Kim & Lu, 2011). In the interest of brevity, detailed variable definitions are in Appendix 2.

Finally, we use the propensity scores, which represent the ex ante probability of 13D filings, to select matched pairs of *Targets* and *Non-Targets* without replacement for the propensity score caliper of 0.05. Subsequently, for 1996–2014, we are left with 354 matched firms (177 *Targets* and 177 *Non-targets*), or 2,173 firm-year observations.[11]

$$Pr(Targets_t) = \alpha_0 + \alpha_1 CEO\_own_t + \alpha_2 Spread_t + \alpha_3 Num\_5pct_t + \alpha_4 CEO\_delta_t + \Sigma\ Financial\ characteristics + \Sigma\ Market\ characteristics + \varepsilon \quad (1)$$

[10] Blockholder ownership data come from *Thomson Reuters 13F Institutional Holdings*. Among the available quarterly 13F data, we use blockholder information for the final quarter. Specifically, if a firm files a Form 13F in the third quarter, but not in the fourth, we consider the third quarter information to be the annual observation. Given that all institutional investment managers with more than $100 million in assets under management are required to file Form 13F with the SEC, we replace remaining missing values with zero.

[11] Brav et al.'s (2018) original data set consists of 3,242 firm-year 13D filings by hedge fund activists for 1994–2014. We drop 41 observations in order to ensure this sample period matches our voting premium sample (i.e., 1996–2014). By merging with the files of Compustat, Execucomp, and CRSP, we lose 2,996 cases that are not listed (primarily on Execucomp). After excluding a further 25 cases for which we could not find matched non-targets, we are left with 177 13D filings. Note that this decrease in observations is inevitable to analyze overconfident CEOs.

3.2 Empirical specification

3.2.1 Voting premium

To test for the voting premium mechanism using the voting premium sample, we construct a firm investment model as in Eq. (2). Our dependent variable, overinvestment (*Dist_invest*), comprises the residuals from Richardson's (2006) differencing model, wherein we regress *new investment* after excluding depreciation and amortization on a vector of control variables (i.e., growth opportunity, leverage, asset size, firm age, cash, prior-year new investment, and stock returns) (see Eq. (6) in Appendix 1). By incorporating the first differencing of new investment, this model attenuates the problem of unobserved firm heterogeneities that are time-invariant.

Note that Eq. (2) does not include the covariates originally considered in the differencing model, because *Dist_invest* is orthogonal to those variables. Instead, we incorporate additional control variables that were not considered in the model but may confound the link between *VP* and *Dist_invest.* For example, shareholders do not necessarily pay more to exercise their voting rights when the internal governance mechanism is working properly (e.g., *Out_director*).

Our main variable of interest in Eq. (2), *VP*, is the market value of the voting premium, as proposed by Kalay et al. (2014). We calculate *VP* by taking the difference between a synthetic stock price without voting rights, estimated from the put-call parity equation (Eq. (9) in Appendix 1), and the stock price with voting rights. The resulting difference represents the extent of *shareholders' active involvement in the voting process*.

We adopt an option-based measure of CEO overconfidence (*CEO_over*) and its variations (Malmendier & Tate, 2005; Hsu et al., 2017). It is an indicator variable that equals 1 for firms with CEOs holding stock options that are more than 67% in the money,[12] and 0 otherwise. This measure is based on the assumption that overconfidence on the part of CEOs is a relatively permanent trait. We therefore classify CEOs as overconfident from the first year onward if they fail to exercise deep-in-the-money stock options (unless they consistently exhibit the opposite behavior (Hsu et al., 2017)). However, to test the sensitivity of our analyses, we use variations of *CEO_over* after changing the assumption (i.e., CEO optimism as a transitory trait) and cutoff levels (i.e., 67%, 100%, or 150% of moneyness). We summarize the results in subsection 5.3.

Following Richardson (2006), we define *FCF* as free cash flow from existing assets less expected new investments. Expected new investment is the predicted value from Richardson's (2006) differencing model. We provide further details of the estimation methods of our main variables in Appendix 1.

---

[12] Malmendier and Tate (2005) set a 67% threshold following Hall and Murphy's (2002) calibration.

As additional control variables, we use CEO stock ownership (*CEO_own*), because equity holdings are likely to incentivize CEOs to overinvest in order to increase their private wealth (Ghosh et al., 2007; Ju et al., 2014). In contrast, stock ownership may capture CEOs' aligned interests with shareholders (Pawlina & Renneboog, 2005). We also include the proportion of outside directors on the board (*Out_director*), because CEOs under weak board monitoring are less vulnerable to shareholder voices (Aktas et al., 2018). And we include the Kaplan and Zingales index (*KZ_index*) as a proxy for financing constraints, because limited access to capital markets will have a real effect on investment decisions. Contrary to the leverage variable included in the differencing model, *KZ_index* considers firms' reliance on *both* debt and equity markets. Finally, we include year dummies to control for economic conditions that may affect *Dist_invest* and *VP* over time, and industry dummies (Fama-French industry groups) to address time-invariant industry heterogeneities.

We run Eq. (2) using the four subsamples described in subsection 3.1.1, but with our primary focus on the overconfidence–positive FCF subsample, i.e., the distorted investment subsample. The coefficient on *VP* (β_1) in this subsample captures the moderating effect of *VP* on the ICFS of firms managed by overconfident CEOs.

$$Dist\_invest_t = \beta_0 + \beta_1 VP_{t-1} + \Sigma\, Controls_{t-1} + \Sigma \text{ Year fixed effect} + \Sigma \text{ Industry fixed effect} + \zeta \qquad (2)$$

For the purpose of the sensitivity tests presented in 5.3, we adopt an alternative investment model (Eq. (3)) proposed by Malmendier and Tate (2005). For dependent variables, this model includes two alternative specifications of overinvestment (*Alt_dist (I)* and *Alt_dist (II)*) suggested by previous studies. Contrary to *Dist_invst*, *Alt_dist (I)* (*Alt_dist (II)*) is the abnormal total (new) investment that is not explained by the prior-year sales growth level (Biddle et al., 2009). For independent variables other than *VP*, it incorporates growth opportunity (*Q*), cash flow (*FCF*), CEO equity incentives (*CEO_own* and *CEO_delta*), size effect (*Size*), and corporate governance (*Duality*).

$$Alt\_dist\,(I)_t\ (Alt\_dist\,(II)_t) = \gamma_0 + \gamma_1 VP_{t-1} + \Sigma\, Controls_{t-1} + \Sigma \text{ Year fixed effect} + \Sigma \text{ Industry fixed effect} + \eta \qquad (3)$$

3.2.2 Hedge fund activism

Next, we employ a DID model (Eq. (4)) to test for the effect of hedge fund activism on investment distortions using the matched pairs of the hedge fund activism sample. Our dependent variable is again firm overinvestment (*Dist_invest*), which we use in Eq. (2).

However, in the matching model (Eq. (1)), *Targets* was an indicator variable that equaled 1 for *specific* firm-years when hedge fund activists filed a Schedule 13D with the SEC, and 0 otherwise. Here, it now represents *all* firm-years of firms for which a Schedule 13D was filed at least once during the sample period. We set *Post_activism* equal to 1 for all firm-years since the first year of 13D filings for *Targets* and since the matched years for *Non-targets*, and 0 otherwise. Therefore, the coefficient on *Targets* × *Post_activism* (δ_3) captures the effect of hedge fund activism on firm overinvestment relative to *Non-targets*. Finally, we include industry and year fixed effects to control for variations in *Targets* and *Non-targets* across industry and time, respectively.

$$Dist\_invest_t = \delta_0 + \delta_1 Targets_t + \delta_2 Post\_activism_t + \delta_3 Targets_t \times Post\_activism_t + \Sigma \text{ Year fixed effect} + \Sigma \text{ Industry fixed effect} + \theta \quad (4)$$

3.2.3 Endogeneity concerns

While analyzing hedge fund activism using the DID matching estimator may be less susceptible to potential endogeneity concerns, analysis of the voting premium is not. Specifically, we are concerned that any association between the voting premium and investment distortions might be driven by reverse causality from overinvestment to shareholder control rights, and/or confounded by correlated omitted variables (see, e.g., Bhagat & Jefferis, 2002). To attenuate this concern, we adopt an IV approach (Ullah et al., 2020), which allows us to better isolate the average direct effect of the voting premium on overinvestment, which may not relate to the aforementioned endogeneity concerns.

Specifically, we instrument the voting premium using the exercise price of the market option (*X*), which appears to affect overinvestment *only through* the voting premium. On the one hand, exercise price mechanically affects the voting premium because it is one of the input variables used to construct the voting premium variable (Eq. (9) in Appendix 1). On the other hand, to the best of our knowledge, the strike price of a market option does not necessarily affect firm investment. This is because strike price was pre-determined by derivative market participants, not by firms. Given that there are various option investors with differing degrees of risk tolerance, it is hard to imagine that CEOs make firm investment decisions in the exclusive interest of particular option investors. We believe that this reasonably satisfies the exclusion restriction condition.

However, we acknowledge that it may be contentious to assume that exercise price is randomly assigned to a firm because it may pick up the effect of stock price on firm investment.[13] Nonetheless, the fact that a higher stock price does not necessarily lead to a higher voting premium (because the voting premium is the difference between stock price and implied stock price) gives us some comfort in adopting the exercise price as an instrumental variable.

4. RESULTS

4.1 Descriptive statistics of the voting premium sample

Table 2, Panel A, presents summary statistics for the variables in the voting premium analysis (Eq. (2)). The mean (median) of *Dist_invest* is virtually zero, since it represents residuals that are not explained by the covariates in the differencing model. Average *VP* is 0.320, which means that shareholders in our sample pay, on average, 0.320% of the current stock price to acquire voting rights. These statistics are broadly consistent with those of Richardson (2006) and Kalay et al. (2014).

In contrast, the means (medians) of *CEO_over* and *FCF* are 0.573 (1.000) and 0.036 (0.038), respectively. The large value of *CEO_over* results from our sampling strategy that exclusively selects CEOs exhibiting overconfident behavior at least twice during their tenure (Malmendier & Tate, 2005). The firm-year observations in the voting premium sample have a similar chance of being classified as overconfident. The positive median value of *FCF* indicates that OptionMetrics includes firms with relatively sufficient free cash flow.

Panel B reports the characteristics of higher and lower *VP* firms classified at the median of *VP*. Firms with higher *VP* have significantly more overconfident CEOs (the mean difference in *CEO_over* = 0.135 in column (3)), and hold more positive FCF (the mean difference in *FCF* = 0.011 in column (3)). These univariate analysis results hint at potential joint effects between *VP* and, respectively, *CEO_over* and *FCF*.

Panel C compares the firm characteristics of the four subsamples: overconfidence–positive FCF (column (1)), non-overconfidence–positive FCF (column (2)), overconfidence–negative FCF (column (3)), and non-overconfidence–negative FCF (column (4)). Again, our focus here is on the potentially distorted investment subsample in column (1) that combines overconfident CEOs and positive FCF. Compared to column (2), where firms hold positive FCF but are not managed by overconfident CEOs, column (1) includes firms for which *VP* and *Dist_invest* are

[13] A strand of literature indicates that the stock price contains information that managers may not be able to acquire, so managers will rely on market information when making investment decisions (e.g., Morck et al., 1990; Chen et al., 2007).

significantly higher (mean differences of 0.323 and 0.006, respectively; standard errors for these differences are reported in column (5)). Larger firm investment in itself does not necessarily signal distorted investment, but it suggests potential for distortions.

The univariate analyses reveal further that the *distorted investment subsample* is comprised of firms with relatively good performance, measured as ROA (mean *ROA* = 0.098 in column (1)) relative to other subsamples. This preliminary finding is inconsistent with our prediction that column (1) includes potential investment distortions. Therefore, using a system GMM and Fama-MacBeth approach in the following analyses, we estimate the financial performance of the distorted investment subsample again.

Finally, in Panel D, we examine the Spearman correlation for the main variables in Eq. (2). As in previous studies (e.g., Malmendier & Tate, 2005; Richardson, 2006), there are positive and significant associations between *Dist_invest* and, respectively, *CEO_over* and *FCF*. In the following subsections, we explore these associations with regard to our research question: *whether shareholder intervention mitigates investment distortions*. Specifically, we explore the association between *VP* and *Dist_invest* in the subsample where CEOs are overconfident and firms hold positive FCF, which is equivalent to the moderating effect of *VP* on the ICFS of firms managed by overconfident CEOs.

Descriptive statistics for the hedge fund activism sample are in Table 4, along with the DID analysis results.

[Insert Table 2 here]

4.2 Main results

4.2.1 Voting premium

Table 3 presents the key results from the estimation of the relation between voting premium and investment distortion, obtained using the fixed effects estimator (Eq. (2)). Specifically, we use the voting premium sample summarized in Table 2 (N = 8,346) and regress *Dist_invest* on *VP* after controlling for financing constraints.

We begin our analysis by estimating the well-known positive ICFS. To this end, following Richardson (2006), we use two piecewise variables that divide FCF into positive and negative values (i.e., *FCF (positive)* and *FCF (negative)*). In column (1), the positive coefficient on *FCF (positive)* is significant and greater than *FCF (negative)*, i.e., 0.100 (p-value < 0.01) vs 0.020

(p-value > 0.10).[14] This asymmetry of ICFS is consistent with Richardson (2006) and affirms the presence of positive ICFS in our sample. To test for the deterrent effect of *VP* on this ICFS, in column (2), we interact *VP* with *FCF (positive)* and *FCF (negative)*. Although the coefficients on the interaction terms are not significant at the conventional level, we find that they have opposite signs: negative for *FCF (positive)* and positive for *FCF (negative)*. This hints at ICFS being attenuated when *VP* is high and when firms have positive free cash flow. To examine whether CEO overconfidence moderates the relation between *VP* and ICFS, we then use two subsamples where CEOs are overconfident (column (3)) and non-overconfident (column (4)). The positive and significant coefficient on *FCF (positive)* (-0.079 with a p-value < 0.05) in column (3) indicates that shareholder intervention weakens ICFS when CEOs are overconfident. In contrast, in column (4), the positive and insignificant coefficient on *FCF (negative)* suggests that shareholder intervention does not necessarily weaken ICFS when CEOs are not overconfident.

In columns (5)–(8), we conduct our main analyses to understand the source of this deterrent effect using the four subsamples presented in Panel C of Table 2. Here, column (5) represents the distorted investment subsample where CEOs are overconfident and firms hold positive FCF (N = 3,434). The negative and significant coefficient on *VP* (-0.008) means that a 1-standard deviation (0.779) increase in *VP* corresponds to an approximately $4.275 million decrease in *Dist_invst*. Insignificant control variables affirm that *Dist_invest* is already orthogonal to most traditional determinants of firm investment.[15] Therefore, the highly significant coefficient on *VP* indicates that shareholder intervention has an *incremental* effect on *Dist_invst*, supporting *H1*. We interpret this as suggesting the deterrent effect of *VP* on ICFS in firms run by overconfident CEOs.

In contrast, in column (6), the segment of interest is *VP* in firms with non-overconfident CEOs but positive FCF (N = 2,453). The positive and insignificant coefficient on *VP* (0.004 with a p-value > 0.10) indicates that the strength of ICFS is not necessarily muted for firms with positive FCF if CEOs are not overconfident. In columns (7) and (8), *VP* is not significant at the conventional level.

[14] Note that the relatively low explanatory power of our main analyses (e.g., 1.5% in column (1)) may be attributable to the fact that *Dist_invest* is already filtered by a wide range of covariates in the differencing model (Eq. (6) in Appendix 1). Thus, the model already explains 24.8% of *New_invest* (unreported). Similarly, the R^2 of regression models in studies employing the abnormal investment variable is also generally low (e.g., 1.8% in the case of Richardson, 2006).

[15] Unlike Richardson (2006), we include year and industry fixed effects. However, the exclusion of fixed effects does not alter the results, because those effects have already been absorbed in the calculation of *Dist_invest*.

It is informative to note that the negative coefficients for *FCF (positive)* × *VP* in column (3) and for *VP* in column (5) may suggest a decrease in new investment below the "optimal" levels, i.e., underinvestment. However, the negative coefficients are more likely to represent *less overinvestment* (rather than more underinvestment) as the mean values of *Dist_invest* for the subsamples used in both columns are positive.[16]

[Insert Table 3 here]

4.2.2 Hedge fund activism

In Table 4, we examine the effect of hedge fund activism on overinvestment using the hedge fund activism sample ($N = 2{,}173$) and the DID matching estimator (Eq. (4)). Specifically, we regress *Dist_invest* on the interaction term *Targets* × *Post_activism* (δ_3), which captures the dynamic multi-period change in firm overinvestment in *Targets* post-hedge fund intervention relative to that for *Non-targets*.

To capture investment distortions, we again divide the sample into four CEO overconfidence–FCF subsamples. Here, columns (3) of Panels B and C are the potentially distorted investment subsample, where CEOs are overconfident and firms hold positive FCF simultaneously. In contrast, columns (4)–(6) do not necessarily represent investment distortions.

Panel A summarizes the covariate balance of *Targets* and *Non-targets* identified with Eq. (1). This equation is a hedge fund activism model, where we regress 13D filings by hedge fund activists on ten potential determinants. Columns (3) and (4) report the mean differences and standard errors for the differences between *Targets* and *Non-targets*. The test results show that the ten variables used in the matching process are not significantly different between matched pairs at the conventional level. The balanced covariates ensure that any change in overinvestment after the arrival of hedge fund activists may be reasonably attributed to shareholder activism rather than other observable firm characteristics.

Using two subsamples where CEOs are overconfident and non-overconfident, we first run the DID model in columns (1) and (2) of Panels B and C. Here, each panel includes observations within five- and one-year windows subsequent to the entrance of hedge fund activists. The results indicate that, though not significant, the coefficients on our triple interaction term, *Targets* × *Post_activism* × *FCF,* are opposite: negative in the overconfident CEO subsample (a range from -0.330 to -0.215) and positive in the non-overconfident CEO subsample (a range from 0.052 to 0.063). Essentially, the coefficient on this term will capture

[16] *Dist_invest* in around 75% of firm-years in these subsamples have positive FCF.

the change in ICFS when the firm is under threat of hedge fund activism. A negative coefficient on this term would suggest a reduction in ICFS, which we only observe for firms with overconfident CEOs.

The results in columns (3)–(6) reveal the source of this contrast. Using the four subsamples constructed based on different levels of CEO overconfidence and FCF (N = 160 to 753), we find that the coefficients on *Targets* × *Post_activism* are negative and significant only in column (3) of both panels. This negative association suggests that, relative to matched *Non-targets*, *Targets* experience a significant drop in overinvestment after the entrance of hedge fund activists. The results support *H2* and affirm that the contrast shown in columns (1) and (2) is driven by the dynamic reduction in overinvestment of firms with simultaneously positive FCF and overconfident CEOs. However, in contrast to column (3), we do not find any similar results in any other subsamples (columns (4)–(6)).

We also conduct an untabulated placebo test, in which we falsely assume that hedge fund activists filed a Schedule 13D at time $t - 1$. We find an insignificant coefficient for the DID estimator. This supports the parallel trend assumption.

Overall, using Malmendier and Tate's (2005) approach to capture potential investment distortions, our analysis suggests that shareholder intervention does not uniformly curb overinvestment but is particularly effective at mitigating overinvestment that is more likely to be distorted. These results add to Brav et al.'s (2018) finding that hedge fund activists facilitate firm innovation by providing additional evidence of their role in optimizing firm investment.

[Insert Table 4 here]

5. FURTHER ANALYSIS

The tests we presented in the previous section establish an association between shareholder intervention and potential investment distortions as measured by the ICFS of firms managed by overconfident CEOs (Malmendier & Tate, 2005). However, we have not examined the validity of our assumption that the ICFS of overconfident CEOs captures potential investment distortions. We have also not sufficiently addressed concerns over the potential endogeneity and noisy nature of the voting premium variable. In this section, we examine these issues, in addition to conducting sensitivity checks on our main test results.

5.1 Performance of the investment distortion subsample

The tests in Table 5 examine the financial performance of our four subsamples by using system GMM (Blundell & Bond, 1998; Ullah et al., 2018) and Fama-MacBeth regression (Fama & MacBeth, 1973) estimators. We adopt system GMM to mitigate potential endogeneity concerns in our dynamic panel data where current-year firm performance is affected by pervious performance. Both approaches are commonly useful to correct for the potential correlation between independent variables and the error term, in which case the exogeneity assumption underlying conventional OLS estimators is violated. To weaken these concerns, system GMM uses the lag of the dependent variable as an instrument, and the Fama-MacBeth regression uses time-series averages of regressions run each year.

For the GMM estimation, we regress financial performance, measured as ROA, [17] on *Dist_invest* (and the lag of *Dist_invest*) after controlling for lagged *ROA*, leverage, size effect, growth opportunity, and year fixed effects. In all columns, Hansen statistics for overidentifying restrictions are insignificant, indicating valid instruments. The tests for second-order autocorrelation in the error term (i.e., AR(2)) are also insignificant, which implies that the lag of *ROA* and other instrumental variables are reasonably exogenous.

In columns (1)–(8), we first report the long-run GMM coefficients. While GMM coefficients represent immediate effects, long-run coefficients capture the responsiveness of ROA to overinvestment after an infinite number of years.[18] Specifically, in the distorted investment subsamples (i.e., columns (1) and (5)), the negative and significant coefficients (a range from -0.260 to -0.181) suggest a detrimental impact of overinvestment on firm performance in the long run. The short-run effects are similar. The estimated coefficient on *Dist_invest* is negative and significant (a range from -0.141 to -0.095), suggesting that investment distortions generate poor performance in the short run as well. The comparison of short- and long-run coefficients in columns (1) and (5) indicates a greater impact of overinvestment on firm performance in the long run (e.g., -0.181 with a p-value < 0.05 in column (1)) than in the short run (e.g., -0.095 with a p-value < 0.05 in column (1)). The results do not alter even when we include lagged *Dist_invest* (*Lag_Dist_invest*) in the estimation model (column (5)). In contrast, in columns (2)–(4) and (6)–(8), where overinvestment is not

[17] We use income before extraordinary items to construct ROA because operating ROA does not pass the AR(2) test. Except for this serial correlation in the error term, the estimation results using operating income are qualitatively similar to those using income before extraordinary items (untabulated).
[18] We calculate long-run GMM coefficients using the "*nlcom*" command in Stata 15.

necessarily distorted, the estimated coefficients on *Dist_invest* are mostly smaller than those in the distorted subsamples and/or insignificant.

The results are also qualitatively similar even when we adopt Fama-MacBeth regression (columns (9)–(12)). Here, we explicitly use future ROA instead of long-run GMM coefficients. Following Fu (2010), we adopt the 5-year median of future ROA as a dependent variable and *Dist_invest* as the main variable of interest. We also control for all the variables used in the GMM estimation. Although the performance deteriorates most when CEOs are overconfident and FCF is negative (-0.075 with a p-value < 0.01 in column (11)), we find that, if FCF is positive, future performance is poorer when CEOs are overconfident (-0.050 with a p-value < 0.01 in column (9) vs -0.009 with a p-value > 0.10 in column (10)).

Our results complement those of Fu (2010), who interprets a negative association between investment and future firm performance as implying overinvestment, by demonstrating that overconfident CEOs mostly drive the detrimental impact of overinvestment on firm performance.

[Insert Table 5 here]

5.2 Endogeneity concerns

5.2.1 Instrumental variables analysis

To attenuate the concern that the negative association between the voting premium and investment distortions (column (5) in Table 3) may be confounded by endogeneity, we consider an IV strategy. As previously noted, we instrument the voting premium (*VP*) using the exercise price of the market option (*X*), which relates mechanically to *VP* (Kalay et al., 2014) but does not necessarily affect overinvestment.

Formal diagnostic tests reported in column (1) of Table 6, where we regress *VP* on *X* and the controls included in Eq. (2), indicate that our IV is reliable. Specifically, the Kleibergen-Paap RK Lagrange multiplier statistic (59.67; p-value = 0.000) and the Cragg-Donald Wald F statistic (75.03; threshold proposed by Stock and Yogo, 2005 at the 10% bias level is 16.38) suggest that our model and IV are neither under-identified nor weak.

The estimation results reported in columns (2)–(5), where we regress *Dist_invest* on *VP_Pred* (i.e., predicted values estimated from column (1)) and the controls, confirm the robustness our findings. The negative association between *VP_Pred* and *Dist_invest* is only observed in column (2), where simultaneously CEOs are overconfident and firms hold positive FCF. We find no significant and/or negative coefficients of *VP_Pred* in columns (3)–(5).

[Insert Table 6 here]

5.2.2 Control contests and voting events

We note that *not all* voting premiums aim to reshape firm investment. For example, regardless of the level of investment distortion, the voting premium can become larger due to control contests, such as, e.g., M&A (Kalay et al., 2014). Similarly, even when shareholders are paying voting premiums to alter incumbent CEOs, this may not be due to their investment distortions. Therefore, a larger voting premium does not necessarily represent shareholders' exclusive intentions or actual actions to influence firm investment. One way to reduce concerns about the voting premium variable is to remove potentially confounding effects as much as possible (e.g., control contests and actual voting events), and gauge whether there is any surviving effect on overinvestment. Any remaining effect is closer to the *disciplinary threats* of shareholder control rights that prior studies have assumed in this research area (e.g., Francis & Smith, 1995; Brav et al., 2018).

To this end, we adopt a two-stage methodology. First, we regress *VP* on the aforementioned potentially confounding effects after controlling for industry/year fixed effects and an exogenous variable (Eq. (5)). As noted earlier, M&A (*Pr*(*Takeover*)) and a change of CEO (*Pr*(*CEO_turnover*)) constitute a typical control contest and voting event, respectively. We also include shareholder litigation (*Pr*(*Litigation*)), because filing lawsuits is a last resort for shareholders. Again, *X* serves as an exogenous variable here. We use the residual component from this regression to capture the incremental effect of *VP* beyond that of M&A, CEO dismissal, and shareholder litigation (*VP_resid*).

Table 7, Panel A, reports the estimation results of Eq. (5). Although not significant, the coefficients of *Pr*(*Takeover*) and *Pr*(*CEO_turnover*) are positive, which is consistent with Kalay et al. (2014). On the other hand, *VP* significantly and negatively relates to *Pr*(*Litigation*), because shareholders will not pay premiums to exercise voting rights if costly and time-consuming lawsuits have been filed. *VP_resid* estimated from Eq. (5) is orthogonal to the effects of these three events.

$$VP_t = \lambda_0 + \lambda_1 X_t + \lambda_2 Pr(Takeover_t) + \lambda_3 Pr(CEO\_turnover_t) + \lambda_4 Pr(Litigation_t) + \Sigma \text{ Year fixed effect} + \Sigma \text{ Industry fixed effect} + v \quad (5)$$

Second, we run our main model, Eq. (2), after substituting *VP_resid* for *VP*. Panel B presents the results from the estimation of the relation between *VP_resid* and firm overinvestment, which we obtain using the fixed effects estimator. Consistent with the results in Table 3, the residual component of a voting premium is also negatively and significantly associated with firm overinvestment only in the potentially distorted investment subsample (column (1)). The coefficients for *VP_resid* in the other subsamples are insignificant (columns (2)-(4)). These results suggest that our main findings in Table 3 are not significantly confounded by the effects of actual voting events, control contests, and shareholder litigation, and lend support to the disciplinary threat hypothesis.

[Insert Table 7 here]

5.3 Sensitivity tests

Lastly, we conduct sensitivity analyses by changing the specifications of our main variables (*Dist_invest* and *CEO_over*) and the investment model (Eq. (2)). Table 8, Panel A, gives the results for alternative specifications of *CEO_over*. Specifically, from the estimation results of our base model in column (1), we modify the cutoff from 67% to 100% and 150%, respectively (columns (2) and (3)). In column (4), we then measure CEO overconfidence based on an alternative assumption that CEO optimism may be a transitory trait that changes every year. Therefore, *CEO_over* equals 1 only in those years when CEOs do not exercise stock options that are more than 67% in the money. As consistently shown in columns (1)–(4), our results are robust to these variations in the *CEO_over* variable.

To test the sensitivity of our results to alternative model specifications, we adopt the investment model proposed by Malmendier and Tate (2005, Eq. (3)), and the two different overinvestment definitions from prior studies (*Alt_dist (I)* and *Alt_dist (II)*). As explained in Eq. (8) of Appendix 1, we use Biddle et al.'s (2009) sales growth model to estimate abnormal levels of investment. Panel B confirms that our findings are not susceptible to alternative model specifications or estimation methods of abnormal investment.

[Insert Table 8 here]

6. CONCLUSION

In contrast to prior studies that have explored firm investment and shareholder intervention, we capture potential investment distortions by using the ICFS of firms managed by overconfident CEOs. This unique ICFS type allows us to examine the impact of shareholder voices on overinvestments that are more likely to be distorted.

Using a range of 2,173 to 8,346 U.S. firm-year observations for the 1996–2014 period, we provide consistent evidence that shareholder interventions, as measured by the voting premium and hedge fund activism, are effective in curbing investment distortions. However, we do not find similar effects in any other types of overinvestment that are not necessarily distorted. The effects of shareholder intervention acting as a credible threat to CEOs are significantly incremental to those of actual voting events, control contests, and shareholder litigation, supporting the disciplinary threat hypothesis.

While a strand of studies indicates that shareholder intervention effectively addresses the agency costs of FCF, our study adds to the literature by documenting that shareholder intervention does not uniformly deter all overinvestments, but is particularly effective at alleviating investment distortions caused by both overconfident CEOs and surplus cash flow simultaneously.

As with most research of this type, the results should be interpreted with some caveats. An important concern is measurement error. Given that we use proxies for unobservable abnormal investment and shareholder interventions, our variables may inevitably fail to capture what they set out to represent. To mitigate this concern, we adopt complementary variables for overinvestment (i.e., abnormal investment defined by Richardson, 2006 and Biddle at al., 2009) and shareholder interventions (i.e., voting premium and hedge fund activism).

With this caveat in mind, our results raise important policy implications for the controversial debate over how much power to allocate to shareholders and to the board (Bebchuk, 2005). On the one hand, enhancing shareholder control rights may serve to protect shareholder value; on the other hand, increased shareholder power may cause expropriation by entrenched shareholders (Luo & Jackson, 2012), create managerial myopia, and hinder effective and appropriate board functioning (Burns & Minnick, 2013). In this regard, our results provide insights into the value of shareholder interventions in a context of potential investment distortions.

Future studies could analyze more specific mechanisms of shareholder intervention through proxy contests, and might also investigate whether shareholder intervention plays different roles depending on firms' industry membership (Hirshleifer et al., 2012), the level of managerial discretion, and the presence of management protection provisions. Such research would broaden our understanding of the role of shareholder voices in optimizing firm investment.

REFERENCES

Aghion, P., Van Reenen, J., & Zingales, L. (2013). Innovation and institutional ownership. *American Economic Review*, *103*(1), 277–304. https://doi.org/10.1257/aer.103.1.277

Ahmed, A. S., & Duellman, S. (2013). Managerial overconfidence and accounting conservatism. *Journal of Accounting Research*, *51*(1), 1–30. https://doi.org/10.1111/j.1475-679X.2012.00467.x

Aktas, N., Andreou, P. C., Karasamani, I., & Philip, D. (2018). CEO duality, agency costs, and internal capital allocation efficiency. *British Journal of Management*, *30*(2), 473–493. https://doi.org/10.1111/1467-8551.12277

Barone-Adesi, G., & Whaley, R. E. (1987). Efficient analytic approximation of American option values. *The Journal of Finance*, *42*(2), 301–320. https://doi.org/10.1111/j.1540-6261.1987.tb02569.x

Barth, M. E., Cahan, S. F., Chen, L., & Venter, E. R. (2017). The economic consequences associated with integrated report quality: Capital market and real effects. *Accounting, Organizations and Society*, *62*, 43–64. https://doi.org/10.1016/j.aos.2017.08.005

Baysinger, B. D., Kosnik, R. D., & Turk, T. A. (1991). Effects of board and ownership structure on corporate R&D strategy. *Academy of Management Journal*, *34*(1), 205–214. https://doi.org/10.5465/256308

Bebchuk, L. A. (2005). The case for increasing shareholder power. *Harvard Law Review*, *118*(3), 833–914.

Bhagat, S., & Jefferis, R. (2002). *The Econometrics of Corporate Governance Studies*. Cambridge, MA: MIT Press.

Biddle, G. C., Hilary, G., & Verdi, R. S. (2009). How does financial reporting quality relate to investment efficiency? *Journal of Accounting and Economics*, *48*(2-3), 112–131. https://doi.org/10.1016/j.jacceco.2009.09.001

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Brav, A., Jiang, W., Ma, S., & Tian, X. (2018). How does hedge fund activism reshape corporate innovation? *Journal of Financial Economics*, *130*(2), 237–264. https://doi.org/10.1016/j.jfineco.2018.06.012

Brav, A., Jiang, W., Partnoy, F., & Thomas, R. (2008). Hedge fund activism, corporate governance, and firm performance. *The Journal of Finance*, *63*(4), 1729–1775. https://doi.org/10.1111/j.1540-6261.2008.01373.x

Burns, N., & Minnick, K. (2013). Does say-on-pay matter? Evidence from say-on-pay proposals in the United States. *Financial Review*, *48*(2), 233–258. https://doi.org/10.1111/fire.12002

Bushee, B. J. (1998). The influence of institutional investors on myopic R&D investment behavior. *Accounting Review*, *73*(3), 305–333. https://doi.org/10.1504/IJAAPE.2008.020195

Campbell, T. C., Gallmeyer, M., Johnson, S. A., Rutherford, J., & Stanley, B. W. (2011). CEO optimism and forced turnover. *Journal of Financial Economics*, *101*(3), 695–712. https://doi.org/10.1016/j.jfineco.2011.03.004

Cella, C. (2020). Institutional investors and corporate investment. *Finance Research Letters*, *32*, 1–6. https://doi.org/10.1016/j.frl.2019.04.026

Chen, Q., Goldstein, I., & Jiang, W. (2007). Price informativeness and investment sensitivity to stock price. *The Review of Financial Studies*, *20*(3), 619–650. https://doi.org/10.1093/rfs/hhl024

Coles, J. L., Daniel, N. D., & Naveen, L. (2006). Managerial incentives and risk-taking. *Journal of Financial Economics*, *79*(2), 431–468. https://doi.org/10.1016/j.jfineco.2004.09.004

Cornett, M. M.. Marcus, A. J., Saunders, A., & Tehranian, H. (2007). The impact of institutional ownership on corporate operating performance. *Journal of Banking & Finance*, *31*(6), 1771–1794. https://doi.org/10.1016/j.jbankfin.2006.08.006

Cremers, K. M., Nair, V. B., & John, K. (2008). Takeovers and the cross-section of returns. *Review of Financial Studies*, *22*(4), 1409–1445. https://doi.org/10.1093/rfs/hhn032

Denes, M. R., Karpoff, J. M., & McWilliams, V. B. (2017). Thirty years of shareholder activism: A survey of empirical research. *Journal of Corporate Finance*, *44*, 405–424. https://doi.org/10.1016/j.jcorpfin.2016.03.005

Fama, E. F., & MacBeth, J. D. (1973). Risk, rerurn, and equillibrium: Empircial tests. *Journal of Political Economy*, 81(3), 607-636. https://doi.org/10.1086/260061

Fazzari, S. M., Hubbard, R. G., Petersen, B. C., Blinder, A. S., & Poterba, J. M. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, *1988*(1), 141–206. https://doi.org/10.2307/2534426

Francis, J., & Smith, A. (1995). Agency costs and innovation: Some empirical evidence. *Journal of Accounting and Economics*, *19*(2-3), 383–409. https://doi.org/10.1016/0165-4101(94)00389-M

Franco, G., Hope, O. K., Vyas, D., & Zhou, Y. (2015). Analyst report readability. *Contemporary Accounting Research*, *32*(1), 76–104. https://doi.org/10.1111/1911-3846.12062

Fu, F. (2010). Overinvestment and the operating performance of SEO firms. *Financial Management*, *39*(1), 249–272. https://doi.org/10.1111/j.1755-053X.2010.01072.x

García Lara, J. M., García Osma, B., & Penalva, F. (2016). Accounting conservatism and firm investment efficiency. *Journal of Accounting and Economics*, *61*(1), 221–238. https://doi.org/10.1016/j.jacceco.2015.07.003

Ghosh, A., Moon, D., & Tandon, K. (2007). CEO ownership and discretionary investments. *Journal of Business Finance & Accounting*, *34*(5-6), 819–839. https://doi.org/10.1111/j.1468-5957.2007.02011.x

Graves, S. B. (1988). Institutional ownership and corporate R&D in the computer industry. *Academy of Management Journal*, *31*(2), 417–428. https://doi.org/10.2307/256557

Greenwood, R., & Schor, M. (2009). Investor activism and takeovers. *Journal of Financial Economics*, *92*(3), 362–375. https://doi.org/10.1016/j.jfineco.2008.05.005

Hall, B. J., & Murphy, K. J. (2002). Stock options for undiversified executives. *Journal of Accounting and Economics*, *33*(1), 3–42. https://doi.org/10.1016/S0165-4101(01)00050-7

Hansen, G. S., & Hill, C. W. (1991). Are institutional investors myopic? A time-series study of four technology-driven industries. *Strategic Management Journal*, *12*(1), 1–16. https://doi.org/10.1002/smj.4250120102

Heaton, J. B. (2002). Managerial optimism and corporate finance. *Financial Management*, *31*(2), 33–45. https://doi.org/10.2307/3666221

Hirshleifer, D., Low, A., & Teoh, S. H. (2012). Are overconfident CEOs better innovators? *The Journal of Finance*, *67*(4), 1457–1498. https://doi.org/10.1111/j.1540-6261.2012.01753.x

Hsieh, T. S., Bedard, J. C., & Johnstone, K. M. (2014). CEO overconfidence and earnings management during shifting regulatory regimes. *Journal of Business Finance & Accounting*, *41*(9-10), 1243–1268. https://doi.org/10.1111/jbfa.12089

Hsu, C., Novoselov, K. E., & Rencheng, W. (2017). Does accounting conservatism mitigate the shortcomings of CEO overconfidence? *Accounting Review*, *92*(6), 77–101. https://doi.org/10.2308/accr-51718

Huang, W., Jiang, F., Liu, Z., & Zhang, M. (2011). Agency cost, top executives' overconfidence, and investment–cash flow sensitivity: Evidence from listed companies in China. *Pacific-Basin Finance Journal*, *19*(3), 261–277. https://doi.org/10.1016/j.pacfin.2010.12.001

Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, *76*(2), 323–329.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X

Jenter, D., & Kanaan, F. (2015). CEO turnover and relative performance evaluation. *The Journal of Finance*, *70*(5), 2155–2184. https://doi.org/10.1111/jofi.12282

Ju, N., Leland, H., & Senbet, L. W. (2014). Options, option repricing in managerial compensation: Their effects on corporate investment risk. *Journal of Corporate Finance*, *29*, 628–643. https://doi.org/10.1016/j.jcorpfin.2013.11.003

Kalay, A., Karakaş, O., & Pant, S. (2014). The market value of corporate votes: Theory and evidence from option prices. *The Journal of Finance*, *69*(3), 1235–1271. https://doi.org/10.1111/jofi.12132

Kaplan, S. N., & Zingales, L. (1997). Do investment–cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics*, *112*(1), 169–215. https://doi.org/10.1162/003355397555163

Kim, E. H., & Lu, Y. (2011). CEO ownership, external governance, and risk-taking. *Journal of Financial Economics*, *102*(2), 272–292. https://doi.org/10.1016/j.jfineco.2011.07.002

Kim, J. B., Wang, Z., & Zhang, L. (2016). CEO overconfidence and stock price crash risk. *Contemporary Accounting Research*, *33*(4), 1720–1749. https://doi.org/10.1111/1911-3846.12217

Klein, A., & Zur, E. (2006). Hedge fund activism. ECGI Working Paper No. 140/2006, European Corporate Governance Institute, Brussels, Belgium. http://ssrn.com/abstract_id=913362.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (2000). Investor protection and corporate governance. *Journal of Financial Economics*, *58*(1), 3–27. https://doi.org/10.1016/S0304-405X(00)00065-9

Lin, C. Y., Tsai, W. C., Hasan, I., & Tuan, L. Q. (2018). Private benefits of control and bank loan contracts. *Journal of Corporate Finance*, *49*, 324–343. https://doi.org/10.1016/j.jcorpfin.2018.01.006

Luo, Y., & Jackson, D. O. (2012). CEO compensation, expropriation, and the balance of power among large shareholders. *Advances in Financial Economics*, *15*, 195–238. https://doi.org/10.1108/S1569-3732(2012)0000015010

Malmendier, U., & Tate, G. (2005). CEO overconfidence and corporate investment. *The Journal of Finance*, *60*(6), 2661–2700. https://doi.org/10.1111/j.1540-6261.2005.00813.x

Morck, R., Shleifer, A., Vishny, R. W., Shapiro, M., & Poterba, J. M. (1990). The stock market and investment: Is the market a sideshow? *Brookings Papers on Economic Activity*, *1990*(2), 157–215.

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, *13*(2), 187–221. https://doi.org/10.1016/0304-405X(84)90023-0

Pawlina, G., & Renneboog, L. (2005). Is investment–cash flow sensitivity caused by agency costs or asymmetric information? Evidence from the UK. *European Financial Management*, *11*(4), 483–513. https://doi.org/10.1111/j.1354-7798.2005.00294.x

Porter, M. E. (1992). Capital choices: Changing the way America invests in industry. *Journal of Applied Corporate Finance*, *5*(2), 4–16. https://doi.org/10.1111/j.1745-6622.1992.tb00485.x

Richardson, S. (2006). Over-investment of free cash flow. *Review of Accounting Studies*, *11*(2-3), 159–189. https://doi.org/10.1007/s11142-006-9012-1

Rogers, J. L., & Stocken, P. C. (2005). Credibility of management forecasts. *Accounting Review*, *80*(4), 1233–1260. https://doi.org/10.2308/accr.2005.80.4.1233

Schnatterly, K., Shaw, K. W., & Jennings, W. W. (2008). Information advantages of large institutional owners. *Strategic Management Journal*, *29*(2), 219–227. https://doi.org/10.1002/smj.654

Schrand, C. M., & Zechman, S. L. (2012). Executive overconfidence and the slippery slope to financial misreporting. *Journal of Accounting and Economics*, *53*(1), 311–329. https://doi.org/10.1016/j.jacceco.2011.09.001

Shleifer, A., & Vishny, R. W. (1986). Large shareholders and corporate control. *The Journal of Political Economy*, *94*(3), 461–488. https://doi.org/10.1086/261385

Stiglitz, J. E., & Weiss, A. (1981). Credit rationing in markets with imperfect information. *The American Economic Review*, *71*(3), 393–410.

Stock, J. H., & Yogo, M. (2005). Testing for weak instruments in linear IV regression. In D. W. K. Andrews & J. H. Stock (Eds.), *Identification and Inference for Econometric Models: Essays in Honor of Thomas J. Rothenberg* (pp. 80–108). Cambridge, UK: Cambridge University Press.

Tribo, J. A., Berrone, P., & Surroca, J. (2007). Do the type and number of blockholders influence R&D investments? New evidence from Spain. *Corporate Governance: An International Review*, *15*(5), 828–842. https://doi.org/10.1111/j.1467-8683.2007.00622.x

Ullah, S., Akhtar, P., & Zaefarian, G. (2018). Dealing with endogeneity bias: The generalized method of moments (GMM) for panel data. *Industrial Marketing Management*, *71*, 69–78. https://doi.org/10.1016/j.indmarman.2017.11.010

Ullah, S., Zaefarian, G., & Ullah, F. (2020). How to use instrumental variables in addressing endogeneity? A step-by-step procedure for non-specialists. *Industrial Marketing Management* [online]. https://doi.org/10.1016/j.indmarman.2020.03.006

APPENDIX 1. ESTIMATION OF MAIN VARIABLES

1. Overinvestment

We estimate overinvestment (*Dist_invest*) with the residuals from Richardson's (2006) differencing model. Adopting *new* investment as a dependent variable in Eq. (6) has the advantage of excluding the effect of the ordinary maintenance of existing investment (i.e., depreciation and amortization) from *total* investment (Eq. (7)). This model assumes that firms' new investment decisions are affected by their growth opportunities (*Growth opportunities*), as well as by financial characteristics such as leverage (*Leverage*), firm size (*Size*), firm age (*Age*), cash investment (*Cash*), and stock returns (*Stock returns*). In particular, the model addresses unobserved firm heterogeneities by incorporating the first differencing of investment levels. Variable definitions are in Appendix 2.

$$New\_invest_t = \alpha_0 + \alpha_1 Growth\ opportunities_{t-1} + \alpha_2 Leverage_{t-1} + \alpha_3 Size_{t-1} + \alpha_4 Age_{t-1} + \alpha_5 Cash_{t-1} + \alpha_6 Stock\ returns_{t-1} + \alpha_7 New\ investments_{t-1} + \Sigma \text{ Year fixed effect} + \Sigma \text{ Industry fixed effect} + \varepsilon \quad (6)$$

$$Total\_invest_t = \alpha_0 + \alpha_1 Maint\_invest_t + \alpha_2 New\_invest_t \quad (7)$$

2. Alternative specifications of overinvestment

To reduce measurement bias, we construct two alternative specifications of overinvestment adopted by previous studies: total overinvestment (Biddle et al., 2009), and new overinvestment (Richardson, 2006). Total overinvestment is the sum of new and maintenance investment.[19]

To test the sensitivity of our main results, we also alternatively adopt Biddle et al.'s (2009) sales growth model (Eq. (8)). This model assumes that abnormal investment consists of what the previous year's sales growth (*Sales growth*) cannot explain. The residuals from this model, estimated for each Fama-French classification-year grouping (i.e., *Alt_dist (I)* and *Alt_dist (II)*), are taken as firm overinvestment.

$$Investment_t = \alpha_0 + \alpha_1 Sales\ growth_{t-1} + \varepsilon \quad (8)$$

3. Voting premium

To reduce endogeneity concerns about the percentage of ownership measures as a proxy for shareholder control rights (Cornett et al., 2007), we use the market value of the voting premium, as proposed by Kalay et al. (2014). The voting premium is calculated by deducting

[19] Consistent with Malmendier and Tate (2005), all investment measures are deflated by net PP&E (*ppent*).

the price of a synthetic stock without voting rights ($\hat{S}(T)$), estimated by the put-call parity in Eq. (9), from its current stock market price with voting rights (*S*). Since the difference represents the price that shareholders would pay to exercise their voting rights, it ideally captures the magnitude of *shareholder control rights* in general, and *the willingness to exercise voting rights* in particular. We then scale the voting premium by the market price (*S*) to normalize and average it for one year (VP) (Lin et al., 2018).[20]

$$\hat{S}(T) = C - P + PV(X) + PV(Div) - EEP_{call} + EEP_{put} \tag{9}$$

where

$\hat{S}(T)$	=	price of a synthetic stock implied in the put-call parity with maturity *T*;
C	=	premiums of call options;
P	=	premiums of put options;
PV(X)	=	present value of a bond with par value *X*;
PV(Div)	=	present value of dividend payments;
EEP_{call}	=	early exercise premiums for call options;
EEP_{put}	=	early exercise premiums for put options.

4. CEO overconfidence

As a proxy for CEO overconfidence, we adopt the option-based measure (*CEO_over*) proposed by Malmendier and Tate (2005) and its variations. Investment-based overconfidence measures (see, e.g., Schrand & Zechman, 2012; and Ahmed & Duellman, 2013) are inappropriate for our analyses, because our dependent variable is also an overinvestment measure (*Dist_invest*). *CEO_over* is an indicator variable that equals 1 for a CEO holding stock options that are more than 67% in the money without exercising them (Malmendier & Tate, 2005; Campbell et al., 2011; Hsu et al., 2017).[21] Because risk-averse CEOs with undiversified portfolios are likely to exercise stock options once they are vested and reasonably in the money, postponing these options implies that these CEOs have strong optimism about future firm performance.

Consistent with Malmendier and Tate (2005), we classify CEOs as overconfident from the first year *onward* if they fail to exercise stock options that are more than 67% in the money,

[20] Consistent with Kalay et al. (2014), we adopt pairs of American-style call and put options with identical strike prices and maturities. We then exclude options with maturities exceeding 90 days, with locked or crossed quotes, with missing volume and implied volatility data, or with moneyness between 0.1 and -0.1. Finally, we require that these pairs have at least ten observations in each year. We estimate the early exercise premium of American options using Barone-Adesi and Whaley's (1987) approximations.
[21] To calculate the moneyness of stock options, we follow Campbell et al.'s (2011) method, which uses Execucomp data.

and exhibit overconfident behavior, at least twice during their tenure. However, following Hsu et al. (2017), we allow CEOs to be reclassified as non-overconfident in years when they exhibit the opposite behavior (i.e., exercising stock options that are less than 67% in the money) at least twice after they have been classified as overconfident. This enables us to avoid the potential problem that a CEO who becomes “unbiased” will still be identified as overconfident, while maintaining the advantage of capturing relatively *permanent* rather than *transitory* effects of optimism (see Malmendier & Tate, 2005).

5. Free cash flow (FCF)

To obtain a clean measure of FCF, we follow Richardson’s (2006) Eq. (10)). This measure deducts expected new investment (New_invest^*) – the fitted value of Eq. (6) – from the cash flow from operating activities (*CFO*) to capture net sources of FCF in excess of those required to fund all potentially positive-NPV projects (Jensen, 1986).

$$FCF = CFO - Maint\_invest + R\&D - New\_invest^* \quad (10)$$

APPENDIX 2. VARIABLE DEFINITIONS

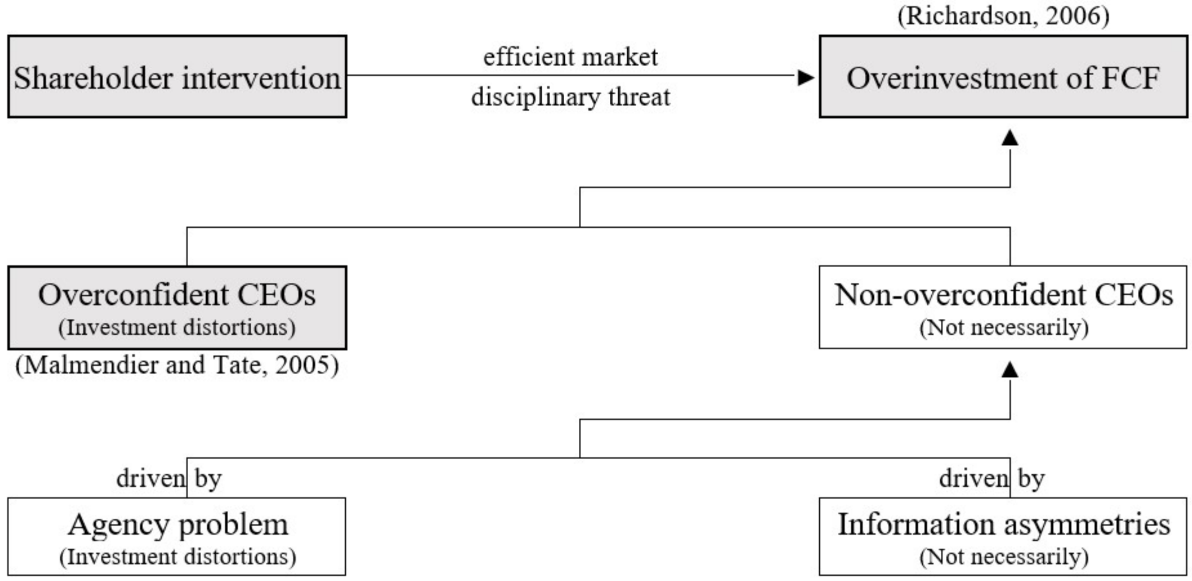
Variable	Definition	Data source
Dependent variables		
Dist_invest	Residuals (ε) from $New\_invest_t = \alpha_0 + \alpha_1 Growth\ opportunities_{t-1} + \alpha_2 Leverage_{t-1} + \alpha_3 Size_{t-1} + \alpha_4 Age + \alpha_5 Cash_{t-1} + \alpha_6 Stock\ returns_{t-1} + \alpha_7 New\ investments_{t-1}$ + Σ Year fixed effect + Σ Industry fixed effect + ε, where *New_invest* is the ratio of the sum of capital expenditure (*capx*), R&D expenditure (*xrd*), acquisitions (*aqc*), sale of PP&E (-*sppe*), and amortization and depreciation (-*dpc*) to average total assets (*at*) (Richardson, 2006).	Compustat
Alt_dist (I)	Residuals from $Total\_invest_t = \alpha_0 + \alpha_1 Sales\ growth_{t-1} + \varepsilon$, where *Total_invest* is the ratio of the sum of capital expenditure (*capx*), R&D expenditure (*xrd*), acquisitions (*aqc*), and sale of PP&E (-*sppe*) to net PP&E (*ppent*) (Biddle et al., 2009).	Compustat
Alt_dist (II)	Residuals from $New\_invest_t = \alpha_0 + \alpha_1 Sales\ growth_{t-1} + \varepsilon$, where *New_invest* is the ratio of the sum of capital expenditure (*capx*), R&D expenditure (*xrd*), acquisitions (*aqc*), sale of PP&E (-*sppe*), and amortization and depreciation (-*dpc*) to net PP&E (*ppent*) (Richardson, 2006).	Compustat
Variables of interest		
VP	Value of voting rights, estimated as the difference between the market price of a stock with voting rights and the price of non-voting synthetic stock implied in put-call parity. The value is then normalized by the stock price and annualized over one year (Kalay et al., 2014).	OptionMetrics
Targets	Indicator variable that equals 1 for firms for which hedge fund activists filed a Schedule 13D, and 0 otherwise.	Barv et al. (2018)
CEO_over	Indicator variable that equals 1 for firms with CEOs holding stock options that are more than 67% in the money, and 0 otherwise (Malmendier & Tate, 2005; Hsu et al., 2017).	Execucomp
FCF	Free cash flow from existing assets less expected new investments (Richardson, 2006).	Compustat
Financial and market ratios		
Size	Natural logarithm of total assets (*at*).	Compustat
ROA	Ratio of income before extraordinary items (*ib*) to average total assets (*at*).	Compustat
Q	Ratio of the sum of the market value of equity (*mktval*) and the book value of liability (*lt*) to total assets (*at*) (Malmendier & Tate, 2005).	Compustat
Growth opportunity	Ratio of firm value (V) to the market value of firm equity. V is estimated as $V_{AIP} = (1–\alpha\times12\%) \times ceq + \alpha(1+12\%) \times oiadp – \alpha \times 12\% \times dvc$, where $\alpha = (0.62/(1+12\%–0.62))$ (Richardson, 2006).	Compustat

Leverage	Ratio of the sum of debt in current liabilities (*dlc*) and long-term debt (*dltt*) to the sum of total liabilities (*lt*) and the book value of common equity (*ceq*).	Compustat
KZ_index	Quartile rank of the Kaplan and Zingales index estimated by *KZ index* = -1.001909 × (*Cash flow*$_t$ / *Total capital*$_{t-1}$) ((*ib*+*dp*) / (*ppent*)) + 0.2826389 × *Tobin's Q*$_t$ ((*lse*+*csho* × *prcc_f* – *ceq* – *txdb*) / *lse*) + 3.139193 × *Leverage*$_t$ ((*dlc*+*dltt*) / (*dlc*+*dltt*+*seq*) – 39.3678 × (*Dividend*$_t$ / *Total capital*$_{t-1}$) ((*dvc*+*dvp*) / (*ppent*)) - 1.314759 × (*Cash*$_t$ / *Total capital*$_{t-1}$) (*che* / *ppent*) (Kaplan & Zingales, 1997).	Compustat
Cash	Ratio of cash and short-term investment (*che*) to lagged total assets (*at*).	Compustat
Sales growth	Percentage change in sales from *t-1* to *t*.	Compustat
Stock returns	Annual buy-and-hold stock returns.	CRSP
Volatility	Yearly mean of standard deviation of daily stock returns over a rolling window of 120 days by CRSP id (i.e., *permno*).	CRSP
Turn	Ratio of average share volume to average shares outstanding.	CRSP
Spread	Yearly median of the difference between bid and ask prices divided by their midpoint price.	CRSP
Age	Natural logarithm of years since first CRSP date.	CRSP
X	Natural logarithm of the exercise price of market option.	OptionMetrics
CEO equity incentives		
CEO_own	Shares held by a CEO excluding stock options divided by total shares.	Execucomp
CEO_delta	Sum of the sensitivities of stock options to a 1% change in stock price (https://sites.temple.edu/lnaveen/data/).	Coles et al. (2006)
Governance control and CEO discretion		
Out_director	Ratio of outside directors on the board to total number of directors.	Riskmetrics, IRRC
Duality	Indicator variable that equals 1 for firms with a CEO who is also a chairman of the board, and 0 otherwise.	Execucomp
Num_5pct	Number of institutional blockholders who own more than 5% of shares.	Thomson Reuters 13F Institutional Holdings
Exercise of control rights		
Pr(CEO_turnover)	Fitted value of *Pr*(CEO_turnover$_t$) = $\alpha_0 + \alpha_1\hat{r}_{t-1} + \alpha_2\hat{e}_{t-1} + \alpha_3\hat{r}_{t-2} + \alpha_4\hat{e}_{t-2} + \alpha_5 Ownership_t + \sum$ Firm fixed effect + ε, where $\hat{r}_{t-1}$ and $\hat{e}_{t-1}$ are the fitted value and residuals of $\hat{r}_{t-1} = \alpha_0 + \alpha_1 r_{peer\ group,t-1} + \zeta_{t-1}$, respectively (Jenter & Kanaan, 2015); *CEO_turnover* is an indicator variable that equals 1 if a CEO leaves the firm under the age of 60, and 0 otherwise. *Ownership* is an indicator variable that equals 1 for firms with CEOs holding more than 5% of shares.	Execucomp
Pr(Litigation)	Fitted value of *Pr*(Litigation$_t$) = $\alpha_0 + \alpha_1 Size_t + \alpha_2$*Stock*	Stanford Law

	$turnover_t + \alpha_3 Beta_t + \alpha_4 Stock\ returns_t + \alpha_5 Volatility_t + \alpha_6 Skewness_t + \alpha_7 Minimum\ Returns_t + \alpha_8 High\ risk\ industries_t + \varepsilon$ (Rogers & Stocken, 2005); *Litigation* is an indicator variable that equals 1 for firms for which securities class action lawsuits have been filed by investors, and 0 otherwise.	School
Pr(Takeover)	Fitted value of $Pr(Takeover_t) = \alpha_0 + \alpha_1 ROA_{t-1} + \alpha_2 Leverage_{t-1} + \alpha_3 Ln(Assets)_{t-1} + \alpha_4 Tobin's\ Q_{t-1} + \alpha_5 Asset\ structure_{t-1} + \alpha_6 Blockholder\ ownership_{t-1} + \sum$ Year fixed effect + $\sum$ Industry fixed effect + ε (Cremers et al., 2008); *Takeover* is an indicator variable that equals 1 for takeover target firms, and 0 otherwise.	Thomson One Banker-Deals

* Compustat mnemonics in parentheses.

Figure 1
Impact of shareholder intervention on overinvestment



This figure summarizes how shareholder intervention affects overinvestment of FCF by overconfident CEOs. While overinvestment of FCF by non-overconfident CEOs does not necessarily constitute investment distortions, overinvestment of FCF by overconfident CEOs is more likely to do so. We argue that shareholder intervention effectively curbs investment distortions, but not other types of overinvestment.

Table 1
Summary of previous literature

Study	Dependent variable	Shareholder intervention	Cash flow	Sample	Observed association
Fazzari et al. (1988)	Investment		Cash flow	422 firms, 1970–1984	Positive
Graves (1988)	R&D	Institutional shareholding		112 firm-years, 1976–1985 (computer industry)	Negative
Hansen and Hill (1991)	R&D	Institutional shareholding		129 firms, 1977–1987 (technology industries)	Positive
Baysinger et al. (1991)	R&D	Institutional shareholding		176 firms, 1981–1983	Positive
Francis and Smith (1995)	Patent, R&D per patent	Insider ownership Outsider ownership		262 firms, 1980–1989	Positive (negative) between patent (R&D per patent) and insider ownership/outsider ownership
Kaplan and Zingales (1997)	Investment		Cash flow	719 firm-years, 1970–1984	Positive, but the effect is greater when firms are not financially constrained
Bushee (1998)	Decrease in R&D	Institutional shareholding	FCF	13,944 firm-years, 1983–1994	Negative between decrease in R&D and institutional shareholding
Pawlina and Renneboog (2005)	Investment	Blockholder shareholding × cash flow	Cash flow	3,445 firm-years, 1992–1998 (UK)	Positive (negative) between cash flow (cash flow × blockholder shareholding) and investment
Malmendier and Tate (2005)	Investment		CEO overconfidence × cash flow	1,058 firm-years, 1980–1994	Positive

Richardson (2006)	Overinvestment	Governance control (e.g., activist shareholders)	FCF	58,053 firm-years, 1988–2002	Positive between FCF and overinvestment Negative between governance control and overinvestment in the positive FCF subsample
Tribo et al. (2007)	R&D	Bank ownership Corporate ownership (types of blockholders)		3,638 firm, 1996–2000 (Spain)	Negative (positive) between bank ownership (corporate ownership) and R&D
Biddle et al. (2009)	Investment		Financial reporting quality × cash and leverage	34,791 firm-years, 1993–2005	Negative
Aghion et al. (2013)	Citation	Institutional shareholding Institutional shareholding × product market competition		6,208 firm-years, 1991–1999	Positive between citation, and institutional shareholding and institutional shareholding × product market competition
García Lara et al. (2016)	Investment		Conservatism × Underinvestment Volatility of cash flow	41,626 firm-years, 1990–2007	Positive (negative) between conservatism × underinvestment (volatility of cash flow) and investment
Brav et al. (2018)	R&D, patents, citations	Hedge fund activism		1,106 firm-years, 1994–2007	Negative (positive) between hedge fund activism and R&D (patents and citations)
Cella (2020)	Investment	Long-term institutional shareholding × Overinvestment	Cash flow	40,155 firm-years, 1980–2006	Negative between long-term institutional shareholding × overinvestment and investment

Table 2
Summary statistics of the voting premium sample

Panel A: Summary statistics

Variable	N	Mean	Std Dev	Q1	Median	Q3
$Dist\_invest_{t+1}$	8,346	0.000	0.106	-0.031	-0.001	0.035
Alt_dist (I) $_{t+1}$	8,346	0.000	0.110	-0.057	-0.017	0.035
Alt_dist (II)$_{t+1}$	8,346	0.000	0.111	-0.049	-0.012	0.035
VP	8,346	0.320	0.856	-0.129	0.335	0.800
CEO_over	8,346	0.573	0.495	0.000	1.000	1.000
FCF	8,346	0.036	0.107	-0.012	0.038	0.092
CEO_own	8,346	0.020	0.050	0.001	0.004	0.014
Out_director	7,077	0.802	0.143	0.750	0.846	0.889
KZ_index	8,346	-5.808	22.455	-6.192	-1.526	0.557
ROA	8,341	0.062	0.104	0.032	0.067	0.108
Size	8,346	7.596	1.521	6.528	7.523	8.587
Duality	8,343	0.568	0.495	0.000	1.000	1.000

Panel B: Firm characteristics by VP level (N = 8,346)

VP	Lower	Higher	Higher–Lower	SE for (1) – (2)
	(1)	(2)	(3)	(4)
Mean ($Dist\_invest_{t+1}$)	0.008	0.009	0.002	0.002
Mean (CEO_over)	0.506	0.641	0.135	0.011***
Mean (FCF)	0.030	0.042	0.011	0.002***
Mean (CEO_own)	0.022	0.018	-0.020	0.113***
Mean (Out_director)	0.796	0.808	0.013	0.003***
Mean (KZ_index)	-5.833	-5.782	0.051	0.492
Mean (Size)	7.597	7.802	0.205	0.000***
Mean (ROA)	0.052	0.072	-0.020	0.002***
N (Max)	4,180	4,166		

Panel C: Firm characteristics by four ICFS subsamples (N = 8,346)

Overconfidence	Yes	No	Yes	No	SE
FCF	Positive	Positive	Negative	Negative	for (1) – (2)
	(1)	(2)	(3)	(4)	(5)
Mean (VP)	0.481	0.158	0.431	0.044	0.021***
Std Dev (VP)	0.779	0.857	0.873	0.926	
Mean ($Dist\_invest_{t+1}$)	0.016	0.010	0.003	-0.010	0.003**
Std Dev ($Dist\ \_invest_{t+1}$)	0.114	0.081	0.127	0.098	
Mean (CEO_own)	0.021	0.020	0.020	0.019	0.000
Mean (Out_director)	0.802	0.807	0.778	0.781	-0.004
Mean (KZ_index)	-6.635	-5.939	-5.438	-3.407	-0.482
Mean (Size)	7.630	8.022	7.424	7.537	-0.041***
Mean (ROA)	0.098	0.063	0.028	-0.013	0.036***
N (Max)	3,434	2,453	1,349	1,110	

Panel D: Spearman correlation matrix

Variable	1	2	3	4	5	6	7
1. $Dist\_invest_{t+1}$	1.000						
2. VP	0.005	1.000					
3. CEO_over	0.040***	0.199***	1.000				
4. FCF	0.076***	0.038***	0.051***	1.000			
5. CEO_own	-0.004	-0.038***	0.010	0.009	1.000		
6. Out_director	0.017	0.033***	-0.011	0.032***	-0.155***	1.000	
7. KZ_index	0.005	0.005	-0.025**	-0.081***	-0.009	0.022*	1.000

The voting premium sample is comprised of 8,346 firm-years for the 1996–2014 period, in which we require that CEOs show overconfident behavior at least twice during their tenure in order to be included in the sample. The investment distortion subsample (column (1) in Panel C) comprises 3,434 firm-years for the same period, in which CEOs are overconfident and firms hold positive FCF.

Panel A presents summary statistics for the variables analyzed here. Panel B reports firm characteristics of the higher and lower *VP* subsamples, in which *VP* is the shareholder voting premium estimated by taking the difference between a synthetic stock price without voting rights and the stock price with voting rights. Panel C compares the firm characteristics of the four subsamples classified based on CEO overconfidence and FCF levels. In particular, column (1) includes observations that are potential investment distortions, which we capture by the investment-cash flow sensitivity (ICFS) of firms managed by overconfident CEOs. Panel D examines Spearman correlations for the main variables analyzed here.

Columns 3 and 4 (the "SE" columns) in Panels B and C, respectively, report standard errors for two-tailed paired Wilcoxon signed rank tests of the difference in mean values in columns (1) and (2).

Dist_invest is the abnormal change in *new* investment after excluding depreciation and amortization, obtained from Richardson's (2006) differencing model. *CEO_over* is an indicator variable that equals 1 for firms with CEOs who fail to exercise stock options that are more than 67% in the money, and 0 otherwise. *FCF* is free cash flow from existing assets less expected new investment. See Appendix 2 for all other variable definitions. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 3
Voting premium

DV =	Dist_invest							
Overconfidence:			Yes	No	Yes	No	Yes	No
FCF:					Positive	Positive	Negative	Negative
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VP	-0.001	0.002	0.000	0.003	-0.008***	0.004	-0.000	-0.000
	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.004)
FCF (positive)	0.100***	0.114***	0.127***	0.130***				
	(0.025)	(0.023)	(0.024)	(0.034)				
FCF (negative)	0.020	0.010	-0.039	0.099				
	(0.057)	(0.065)	(0.057)	(0.080)				
FCF (positive) × VP		-0.040	-0.079**	0.026				
		(0.027)	(0.038)	(0.034)				
FCF (negative) × VP		0.035	0.034	0.055*				
		(0.038)	(0.044)	(0.027)				
Overconfidence	0.008***	0.008***						
	(0.003)	(0.003)						
CEO_own	-0.017	-0.017	-0.015	-0.017	0.019	-0.020	-0.169***	-0.035
	(0.023)	(0.023)	(0.031)	(0.020)	(0.043)	(0.023)	(0.047)	(0.061)
Out_director	0.015*	0.015*	0.007	0.022**	-0.003	0.018*	0.013	0.019
	(0.007)	(0.008)	(0.011)	(0.010)	(0.013)	(0.009)	(0.018)	(0.018)
Out_director_dum	0.010	0.010	0.001	0.021*	-0.018*	0.019**	0.033**	0.013
	(0.007)	(0.007)	(0.009)	(0.011)	(0.010)	(0.009)	(0.015)	(0.019)
KZ_index	-0.000	-0.000	-0.000	0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.019**	0.018**	0.023**	0.023	0.028**	0.036***	0.031***	0.005
	(0.008)	(0.008)	(0.009)	(0.015)	(0.013)	(0.010)	(0.009)	(0.029)
Year dummy	Included	Included	Included	Included	Included	Included	Included	Included
Industry dummy	Included	Included	Included	Included	Included	Included	Included	Included
Observations	8,346	8,346	4,783	3,563	3,434	2,453	1,349	1,110
Adjusted R^2	0.015	0.016	0.013	0.028	0.006	0.018	0.026	0.000

The voting premium sample is comprised of 8,346 firm-years for the 1996–2014 period. For the purpose of analyzing investment distortions, we classify four subsamples based on CEO overconfidence (*CEO_over*) and FCF (*FCF*) levels (columns (3)–(8)). In particular, column (5) comprises 3,434 firm-years of potential investment distortions, in which CEOs are overconfident and firms hold positive FCF.
The dependent variable is *Dist_invest* in all columns. *Dist_invest* is the abnormal change in *new* investment after excluding depreciation and amortization, obtained from Richardson's (2006) differencing model. The variable of interest, *VP*, is the shareholder voting premium, estimated by taking the difference between a synthetic stock price without voting rights and the stock price with voting rights. *FCF (positive)* equals FCF if FCF is greater than or equal 0, and 0 otherwise. *FCF (negative)* equals FCF if FCF is smaller than 0, and 0 otherwise. *Out_director* is the ratio of outside directors on the board to total number of directors. *Out_director_dum* is an indicator variable that equals 1 for firms where *Out_director* is missing, and 0 otherwise. After controlling for this dummy variable, we replace missing *Out_director* values with zeros. See Appendix 2 for all other variable definitions.
All specifications are estimated using the fixed effects estimator. Two values are reported for each covariate: the coefficient estimate, and industry-clustered standard errors (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 4
Hedge fund activism

Panel A: Covariate balance

Variable	Targets (treatment) (1)	Non-targets (control) (2)	Targets – Non-targets (3)	SE for (3) (4)
CEO_own	2.180	1.860	0.320	0.475
Spread	0.000	0.000	0.000	0.000
Num_5pct	3.270	3.380	-0.110	0.186
CEO_delta	0.210	0.190	0.020	0.031
ROA	0.120	0.120	0.010	0.012
Size	7.320	7.120	0.200	0.165
Leverage	0.230	0.230	-0.010	0.022
Turn	11.740	11.530	0.210	0.896
Stock returns	0.180	0.150	0.040	0.064
Volatility	0.030	0.030	0.000	0.001
Firm observations	177	177	354	
(Firm-year observations)	(1,167)	(1,006)	(2,173)	

Panel B: Difference-in-differences tests (*t* -5 to *t* +5 with *Treatment* at *t* = 0; *N* = 2,173)

DV =	Dist_invest					
Overconfidence:	Yes	No	Yes	No	Yes	No
FCF:			Positive	Positive	Negative	Negative
	(1)	(2)	(3)	(4)	(5)	(6)
Targets	0.001	-0.006	0.014*	-0.001	-0.045	-0.005
	(0.011)	(0.014)	(0.008)	(0.009)	(0.030)	(0.025)
Post_activism	0.011	-0.014	0.009	-0.016*	0.002	-0.009
	(0.013)	(0.009)	(0.010)	(0.009)	(0.027)	(0.016)
Targets × Post_activism	-0.015	0.008	-0.031**	0.005	0.023	0.004
	(0.017)	(0.012)	(0.012)	(0.009)	(0.045)	(0.024)
Targets × Post_activism × FCF	-0.215	0.063				
	(0.181)	(0.148)				
FCF	0.206**	0.297*				
	(0.091)	(0.170)				
Post_activism × FCF	-0.033	-0.084				
	(0.095)	(0.115)				
Targets × FCF	0.199	0.058				
	(0.126)	(0.165)				
Constant	0.059	-0.028**	-0.010	-0.039**	0.125**	-0.009
	(0.051)	(0.011)	(0.023)	(0.019)	(0.048)	(0.032)
Year dummy	Included	Included	Included	Included	Included	Included
Industry dummy	Included	Included	Included	Included	Included	Included
Observations	1,025	1,148	696	753	329	395
Adjusted R^2	0.091	0.089	0.008	0.006	0.148	0.003

Panel C: Difference-in-differences tests (*t* -1 to *t* +1 with *Treatment* at *t* = 0; *N* = 856)

DV =	Dist_invest					
Overconfidence:			Yes	No	Yes	No
FCF:	Positive	Negative	Positive	Positive	Negative	Negative
	(1)	(2)	(3)	(4)	(5)	(6)
Targets	-0.006	-0.025*	0.033	-0.021	-0.082	-0.003
	(0.021)	(0.014)	(0.019)	(0.023)	(0.052)	(0.017)
Post_activism	0.008	-0.034**	0.030	-0.043*	-0.055	0.003
	(0.022)	(0.016)	(0.024)	(0.024)	(0.050)	(0.021)

Targets × Post_activism	-0.020	0.032*	-0.060**	0.033	0.084	-0.004
	(0.025)	(0.017)	(0.027)	(0.028)	(0.070)	(0.028)
Targets × Post_activism × FCF	-0.330	0.052				
	(0.211)	(0.237)				
FCF	0.089	0.165				
	(0.121)	(0.285)				
Post_activism × FCF	0.116	0.032				
	(0.145)	(0.212)				
Targets × FCF	0.313**	0.146				
	(0.118)	(0.258)				
Constant	0.128***	0.021	0.029	0.210	0.144***	0.032
	(0.019)	(0.025)	(0.048)	(0.034)	(0.052)	(0.057)
Year dummy	Included	Included	Included	Included	Included	Included
Industry dummy	Included	Included	Included	Included	Included	Included
Observations	389	467	229	293	160	174
Adjusted R^2	0.140	0.047	0.000	0.000	0.355	0.000

The hedge fund activism sample is comprised of 2,173 firm-years for the 1996–2014 period. For the purpose of analyzing investment distortions, we classify four subsamples based on CEO overconfidence and FCF levels (columns (3)–(6) in Panels B and C). In particular, columns (3) in Panels B and C comprise 229 to 696 firm-years of potential investment distortions, in which CEOs are overconfident and firms hold positive FCF.

Panel A summarizes the covariate balance between the treatment (13D filing) and control (non-filing) groups at *t* = 0. Panels B and C report results for whether hedge fund activism influences firm overinvestment, where the dependent variable is *Dist_invest*. *Dist_invest* is the abnormal change in *new* investment after excluding depreciation and amortization, obtained from Richardson's (2006) differencing model. *Targets* equals 1 for firm-year observations for which hedge fund activists filed a Schedule 13D, and 0 for matched control firm observations. *Post_activism* equals 1 for periods after a Schedule 13D filing for *Targets* and corresponding control firms, and 0 otherwise. Consequently, the coefficient for *Targets* × *Post_activism* reflects the difference-in-differences estimator of the effect of the 13D filing on firm overinvestment between the *Target* and control firms. *FCF* is free cash flow from existing assets less expected new investment. See Appendix 2 for all other variable definitions.

All specifications are estimated using the fixed effects (FE) estimator. Two values are reported for each covariate: the coefficient estimate, and industry-clustered standard errors (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5
Financial performance

DV =	ROA								ROA (5-year median)			
Model:	System GMM								Fama-MacBeth regression			
Overconfidence:	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
FCF:	Positive	Positive	Negative	Negative	Positive	Positive	Negative	Negative	Positive	Positive	Negative	Negative
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Long-run GMM coefficient												
Dist_invest	-0.181**	-0.056**	-0.018	-0.113*	-0.260***	-0.079*	-0.080*	-0.140				
	(0.091)	(0.028)	(0.030)	(0.064)	(0.092)	(0.042)	(0.042)	(0.103)				
Lag_Dist_invest					-0.280**	-0.099	-0.073	-0.045				
					(0.111)	(0.118)	(0.056)	(0.094)				
Lag_ROA	0.470***	0.330***	0.159**	0.296***	0.456***	0.331***	0.148*	0.291***	0.387***	0.326***	0.484***	0.609***
	(0.084)	(0.046)	(0.081)	(0.104)	(0.057)	(0.046)	(0.076)	(0.105)	(0.034)	(0.055)	(0.064)	(0.111)
Dist_invest	-0.095**	-0.037**	-0.015	-0.079**	-0.141***	-0.053*	-0.067*	-0.099	-0.050***	-0.009	-0.075***	-0.132
	(0.040)	(0.018)	(0.024)	(0.040)	(0.042)	(0.027)	(0.035)	(0.070)	(0.016)	(0.022)	(0.019)	(0.121)
Lag_Dist_invest					-0.152***	-0.066	-0.063	-0.032				
					(0.055)	(0.079)	(0.048)	(0.067)				
Leverage	-0.006	-0.002	-0.019	0.051	-0.009	-0.002	-0.007	0.056*	-0.007	0.006	-0.028*	-0.030
	(0.016)	(0.009)	(0.020)	(0.032)	(0.015)	(0.010)	(0.020)	(0.029)	(0.006)	(0.009)	(0.015)	(0.022)
Size	0.006	-0.002	0.017	0.009	0.015*	-0.001	0.017	0.008	0.006***	0.004***	0.009***	0.015***
	(0.007)	(0.007)	(0.012)	(0.018)	(0.008)	(0.007)	(0.024)	(0.017)	(0.001)	(0.001)	(0.003)	(0.005)
Q	0.010***	0.032***	0.019***	0.008	0.012***	0.032***	0.021***	0.009	0.012***	0.024***	0.003	0.021**
	(0.002)	(0.003)	(0.005)	(0.007)	(0.002)	(0.003)	(0.006)	(0.007)	(0.002)	(0.004)	(0.004)	(0.009)
Constant									-0.121***	-0.085***	-0.176***	-0.344***
									(0.020)	(0.023)	(0.058)	(0.088)
Year dummy	Included	Included	Included	Included	Included	Included	Included	Included				
Observations	2,065	1,770	711	722	2,065	1,770	711	722	3,434	2,453	1,349	1,110
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
AR (2) (Prob > chi2)	0.839	0.922	0.169	0.267	0.920	0.766	0.177	0.333				
Hansen Statistics (Prob > chi2)	0.326	0.101	0.174	0.207	0.320	0.100	0.620	0.242				
Adjusted R^2									0.376	0.452	0.396	0.437

The voting premium sample is comprised of 8,346 firm-years for the 1996–2014 period. For the purpose of analyzing investment distortions, we classify four columns based on CEO overconfidence and FCF levels. In particular, columns (1) and (5) comprise 3,434 firm-years of potential investment distortions in which CEOs are overconfident and firms hold positive FCF. However, through the two-stage estimation process of system GMM, we lose 3,078 observations.

In columns (1)–(8), the dependent variable is *ROA*, or the ratio of income before extraordinary items to average total assets. In columns (9)–(12), the dependent variable is the 5-year median of future ROAs. The variable of interest, *Dist_invest*, is the abnormal change in *new* investment after excluding depreciation and amortization, obtained from Richardson's (2006) differencing model. The long-run GMM coefficients are calculated using the "*nlcom*" command in Stata 15. See Appendix 2 for all other variable definitions.

Specifications are estimated using system GMM estimation in columns (1)–(8) and Fama-MacBeth regression in columns (9)–(12). Two values are reported for each covariate: the coefficient estimate, and robust (Fama-MacBeth) standard errors (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 6
Instrumental variables analysis

DV =	VP	Dist_invest			
Overconfidence:	Yes	Yes	No	Yes	No
FCF:	Positive	Positive	Positive	Negative	Negative
Model:	1st stage	2nd stage			
	(1)	(2)	(3)	(4)	(5)
VP_Pred		-0.040**	0.023*	0.023	0.001
		(0.020)	(0.013)	(0.020)	(0.020)
X	0.200***				
	(0.025)				
Controls	Included	Included	Included	Included	Included
Constant	-0.383	0.039	0.015	0.020	0.004
	(0.239)	(0.022)	(0.022)	(0.036)	(0.033)
Year dummy	Included	Included	Included	Included	Included
Industry dummy	Included	Included	Included	Included	Included
Observations	3,434	3,434	2,453	1,349	1,110
Under identification test:					
Kleibergen-Paap RK LM statistic (Chi-sq(1))	59.67***				
Weak identification tests:					
Cragg-Donald Wald F statistic	75.03				
Stock-Yogo weak ID test critical value (bias < 10%)	16.38				
Adjusted R^2	0.110				
Uncentered R^2		-0.000	0.020	0.051	0.054

The voting premium sample is comprised of 8,346 firm-years for the 1996–2014 period. For the purpose of analyzing investment distortions, we classify four columns based on CEO overconfidence and FCF levels. In particular, columns (1) and (2) comprise 3,434 firm-years of potential investment distortions in which CEOs are overconfident and firms hold positive FCF.

The dependent variables are *VP* and *Dist_invest* in columns (1) and (2)–(5), respectively. *Dist_invest* is the abnormal change in *new* investment after excluding depreciation and amortization, obtained from Richardson's (2006) differencing model. *VP* is the shareholder voting premium, estimated by taking the difference between a synthetic stock price without voting rights and the stock price with voting rights, whereas *VP_Pred* is the predicted values estimated from column (1). The endogenous variable is *VP* and the instrumental variable is *X*. *X* is the natural logarithm of the exercise price of market option. Control variables are the same as in Eq. (2) and are explained in Appendix 2.

All specifications are estimated using the instrumental variables estimator. Two values are reported for each covariate: the coefficient estimate, and robust standard errors (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 7
Control contests and voting events

Panel A: Residual model	
DV =	VP
X	0.263***
	(0.019)
Pr(Takeover)	0.014
	(0.157)
Pr(CEO_turnover)	0.589
	(0.359)
Pr(Litigation)	-0.405***
	(0.103)
Pr(Takeover)_dum	0.154
	(0.153)
Pr(CEO_turnover)_dum	0.093*
	(0.047)
Constant	-0.470***
	(0.107)
Year dummy	Included
Industry dummy	Included
Observations	8,346
Adjusted R^2	0.116

Panel B: Overinvestment model				
DV at t + 1 =	Dist_invest			
Overconfidence:	Yes	No	Yes	No
FCF:	Positive	Positive	Negative	Negative
	(1)	(2)	(3)	(4)
VP_resid	-0.006***	0.003	-0.001	-0.000
	(0.002)	(0.002)	(0.004)	(0.004)
Controls	Included	Included	Included	Included
Constant	0.024	0.039***	0.031	0.004
	(0.013)	(0.010)	(0.007)	(0.030)
Year dummy	Included	Included	Included	Included
Industry dummy	Included	Included	Included	Included
Observations	3,434	2,453	1,349	1,110
Adjusted R^2	0.005	0.018	0.026	0.000

The voting premium sample is comprised of 8,346 firm-years for the 1996–2014 period. For the purpose of analyzing investment distortions, we classify four subsamples based on CEO overconfidence and FCF levels. In particular, column (1) of Panel B comprises 3,434 firm-years of potential investment distortions in which CEOs are overconfident and firms hold positive FCF.

In Panel A, the dependent variable is *VP*, which is the shareholder voting premium estimated by taking the difference between a synthetic stock price without voting rights and the stock price with voting rights. For variables capturing the ex ante probability of exercising shareholder control rights, we include *Pr*(CEO_turnover), *Pr*(*Litigation*), and *Pr*(*Takeover*). *Pr*(CEO_turnover) is the fitted value of $Pr(\text{CEO\_turnover}_t) = \alpha_0 + \alpha_1\hat{r}_{t-1} + \alpha_2\hat{e}_{t-1} + \alpha_3\hat{r}_{t-2} + \alpha_4\hat{e}_{t-2} + \alpha_5 Ownership_t + \sum$ Firm fixed effect $+ \varepsilon$, where $\hat{r}_{t-1}$ and $\hat{e}_{t-1}$ are the fitted values and residuals of $\hat{r}_{t-1} = \alpha_0 + \alpha_1 r_{peer\ group,t-1} + \zeta_{t-1}$, respectively (Jenter & Kanaan, 2015). *Pr*(*Litigation*) is the fitted value of $Pr(\text{Litigation}_t) = \alpha_0 + \alpha_1 Size_t + \alpha_2 Stock\ turnover_t + \alpha_3 Beta_t + \alpha_4 Stock\ returns_t + \alpha_5 Volatility_t + \alpha_6 Skewness_t + \alpha_7 Minimum\ Returns_t + \alpha_8 High\ risk\ industries_t + \varepsilon$ (Rogers & Stocken, 2005). *Pr*(*Takeover*) is the fitted value of $Pr(Takeover_t) = \alpha_0 + \alpha_1 ROA_{t-1} + \alpha_2 Leverage_{t-1} + \alpha_3 Ln(Assets)_{t-1} + \alpha_4 Tobin's\ Q_{t-1} + \alpha_5 Asset\ structure_{t-1} + \alpha_6 Blockholder\ ownership_{t-1} + \sum$ Year fixed effect $+ \sum$ Industry fixed effect $+ \varepsilon$ (Cremers et al., 2008). *Pr*(CEO_turnover)*_dum* and *Pr*(*Takeover*)*_dum* are indicator variables that equal 1 for firms where *Pr*(CEO_turnover) and *Pr*(*Takeover*) are missing, and 0 otherwise, respectively. After controlling for these dummy variables, we replace missing *Pr*(CEO_turnover) and *Pr*(*Takeover*) values with zeros. *X* is the natural logarithm of the exercise price of market option

In Panel B, the dependent variable is *Dist_invest* in all columns. *Dist_invest* is the abnormal change in *new* investment after excluding depreciation and amortization, obtained from Richardson's (2006) differencing model. The variable of interest, *VP_resid*, is the residuals taken from Eq. (5), in which we regress *VP* on the variables capturing the actual exercise of shareholder control rights. Control variables are the same as in Eq. (2), and are explained in Appendix 2.

All specifications are estimated using the fixed effects estimator. Two values are reported for each covariate: the coefficient estimate, and industry-clustered standard errors (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 8
Alternative specifications

Panel A: Overconfidence

DV at t + 1 =	Dist_invest			
Assumption	Permanent	Permanent	Permanent	Transitory
Pseudo-mating	Yes	Yes	Yes	No
In-the-money threshold	67%	100%	150%	67%
	(1)	(2)	(3)	(4)
VP	-0.008***	-0.008**	-0.010**	-0.008**
	(0.003)	(0.003)	(0.004)	(0.003)
Controls	Included	Included	Included	Included
Constant	0.028**	0.032**	0.012	0.031
	(0.013)	(0.015)	(0.016)	(0.013)
Year dummy	Included	Included	Included	Included
Industry dummy	Included	Included	Included	Included
Observations	3,434	2,314	1,387	3,336
Adjusted R^2	0.006	0.000	0.020	0.006

Panel B: Overinvestment measure and model specification

DV at t + 1 =	Dist_invest	Alt_dist (I)	Alt_dist (II)
	(1)	(2)	(3)
VP	-0.007**	-0.007**	-0.006**
	(0.003)	(0.002)	(0.003)
Q	0.001	0.004**	0.003
	(0.002)	(0.002)	(0.002)
CEO_own	-0.003	-0.009	-0.021
	(0.040)	(0.044)	(0.042)
CEO_delta	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Size	-0.003*	-0.016***	-0.014***
	(0.002)	(0.003)	(0.002)
Duality	0.001	-0.005	-0.005
	(0.004)	(0.005)	(0.005)
Duality_dum	0.008	0.007	0.020
	(0.019)	(0.038)	(0.022)
Constant	0.047***	0.152***	0.132***
	(0.017)	(0.020)	(0.020)
Year dummy	Included	Included	Included
Industry dummy	Included	Included	Included
Observations	3,432	3,432	3,432
Adjusted R^2	0.004	0.082	0.063

The voting premium sample is comprised of 8,346 firm-years for the 1996-2014 period. For the purpose of analyzing investment distortions, we use the investment distortion subsample, which comprises 3,434 firm-years in which CEOs are overconfident and firms hold positive FCF. In Panel B, we analyze 3,432 firm-years due to the missing values of *CEO_delta*.

In Panel A, the dependent variable is *Dist_invest* in all columns. *Dist_invest* is the abnormal change in *new* investment after excluding depreciation and amortization, obtained from Richardson's (2006) differencing model. The variable of interest, *VP*, is the shareholder voting premium, estimated by taking the difference between a synthetic stock price without voting rights and the stock price with voting rights. Control variables are the same as in Eq. (2). See Appendix 2 for all other variable definitions.

In this analysis, column (1) matches our main definition of CEO overconfidence as reported in Table 3. In column (2), we change the 67% cutoff to 100%, while keeping all other conditions the same as in column (1). In column (3), we set the cutoff to 150%. Finally, in column (4), we assume that CEO overconfidence is a transitory trait, and thus CEOs do not retain their overconfidence classification onward.

In Panel B, the dependent variables are *Dist_invest*, *Alt_dist (I)*, and *Alt_dist (II)* in columns 1, 2, and 3, respectively. *Alt_dist (I)* is abnormal *total* investment, obtained from Biddle et al.'s (2009) sales growth model. *Alt_dist (II)* is abnormal *new* investment after excluding depreciation and amortization, obtained from Biddle et al.'s (2009) sales growth model. The variable of interest, *VP*, is the shareholder voting premium, estimated by taking the difference between a synthetic stock price without voting rights and the stock price with voting rights. *Duality_dum* is an indicator variable that equals 1 for firms where *Duality* is missing, and 0 otherwise. After controlling for this dummy variable, we replace missing *Duality* values with zeros. Control variables are consistent with those proposed by Malmendier and Tate (2005), and are explained in Appendix 2.

All specifications are estimated using the fixed effects (FE) estimator. Two values are reported for each covariate: the coefficient estimate, and industry-clustered standard errors (in parentheses). *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.