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# Does CEO bias escalate repurchase activity?☆

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ABSTRACT

We propose and test the hypothesis that overconfident-CEOs, with upwardly-biased estimates of own firm-value, are more predisposed to repurchasing stock. An implication is that the stock-market, recognizing overconfident-CEO behavior, will react less positively to repurchase announcements. The hypothesis is strongly supported: Overconfident managers repurchase stock at lower levels of cash holdings, and respond more to stock-price declines. Entrenchment exacerbates this behavior. Interestingly, institutional investors appear to encourage repurchases, perhaps to curb excessive investment. Overconfident-CEOs are also more likely to substitute repurchases for dividends or capital expenditure. Consistent with our hypothesis, the stock-market reaction to these share repurchase announcements is less positive.

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*"Companies are spending record amounts on buying back their own shares. Investors should be worried."* ~ The Economist (2014a)

## 1. Introduction

Companies repurchased around USD 500 billion of shares in 2013, raising concerns in some quarters as to whether the repurchases were motivated by short-term price considerations, possibly at the cost of longer-term investments (The Economist, 2014a,b). The notion that firms repurchase shares in response to stock price movements or to affect their stock prices is well developed and studied.[1] In particular, it has been argued that managers, with better information regarding firm prospects, engage in market-timing i.e., they tend to repurchase when they believe their shares to be undervalued. Such market timing is consistent with survey findings that most financial executives believe that firms repurchase shares when their stocks are valued below 'true' value.[2] Interestingly, however, the empirical evidence on market-timing is inconclusive.[3] In this paper, we offer a somewhat different perspective on the timing of repurchases. Prior studies highlight that CEOs' perceptions of their own capability can distort corporate decision making (Hiller and Hambrick, 2005; Zhu and Chen, 2018; Patel and Cooper, 2014). Subsequently, we examine whether some of the repurchase activity could be driven by managers with biased perceptions. Evidence that some repurchases are induced by biased valuations could help to reconcile CEOs' assertions that they time repurchases with the mixed evidence on the existence of such timing.

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[1] For example, Jagannathan et al. (2000) show that firms repurchase after a stock price run-down.

[2] Brav et al. (2005) find survey evidence that 86.4% financial executives agree or strongly agree with the statement that firms repurchase when their stock is a good value, relative to its true value.

[3] Support for market timing is found in papers such as Baker and Wurgler (2000, 2002), Ikenberry et al. (2000a, 2000b, 1995), and Peyer and Vermaelen (2009), while studies such as Eckbo et al. (2000), Schultz (2003), Butler et al. (2005), and Dittmar and Dittmar (2008) find evidence inconsistent with market timing.

To study whether managerial biases could escalate repurchase activity, we turn to the question precisely which types of CEOs are prone to have upwardly biased valuations. We focus on one especially prominent CEO attribute: overconfidence. The literature suggests that many CEOs are overconfident, over-estimating their own ability and firms' prospects, while under-estimating risks.[4] Because overconfident CEOs believe their firms to be undervalued by the market (see e.g., Deshmukh et al., 2013), they might be more inclined to repurchase equity. In this paper, we analyze the repurchase decisions of overconfident CEOs. An interesting aspect of these repurchases is that, despite being driven by the manager's misperceptions, they can have unintended benefits by, for instance, reducing the resources available for over-investment.

To develop our hypotheses, we start with the observation that, almost by definition, overconfident CEOs are likely to overvalue both the firm's assets in place and its future investment prospects. Consequently, overconfident CEOs will believe that the market undervalues their firms. Of course, the overconfident CEO could use the cash on investments rather than repurchases. But if the perceived undervaluation is larger than the return on the potential investment with positive NPV, then the overconfident manager will go for the repurchase whereas the non-overconfident manager will go for the investment. Thus, overconfident CEOs will be more likely to repurchase stock than non-overconfident CEOs in their effort to create value for shareholders that remain, including themselves.

Several factors might influence the impact of CEO overconfidence. The difference in repurchase likelihood between overconfident and other CEOs is expected to widen following a stock-price decline that increases the overconfident CEOs' perceived degree of undervaluation. Further, we expect overconfident CEOs to be more likely to repurchase at lower levels of cash holdings than other CEOs, and we expect increases in CEO power to facilitate such behaviorally driven repurchases. Nonetheless, we contend that institutional investors might encourage such repurchases: potentially as a means to facilitate their exit from the company, or to reduce the firm's cash position and prevent overconfident CEOs from over-investing. The repurchases can limit the resources available for new investments and to reduce dividend pay-out. Finally, given that overconfident CEOs' repurchases are driven by perceived undervaluation we expect the market to react less positively to share repurchases announcements by overconfident CEOs. We proceed to test these predictions empirically.

Our first tests examine the impact of CEO overconfidence on the likelihood of a repurchase. We rely on both option and press-based measures of CEO confidence and a firm-year panel dataset consisting of around 20,000 observations over the 1992–2011 period. We find strong support for our hypotheses: overconfident managers are significantly more likely to repurchase stock and to allocate substantially more funds towards repurchase activities. Overconfident CEOs are more sensitive to stock-price movements and are more likely than other CEOs to repurchase stock following a decline in stock price. Furthermore, overconfident CEOs are less sensitive to the firm's cash position and tend to repurchase stock at lower levels of cash holdings. These results are consistent with overconfident CEOs believing their firm's stock to be under-valued by the market and repurchasing shares in response.

Governance and institutional investment appears to influence overconfident CEOs' repurchase activities. Li and Tang (2010) argue that CEO hubris and risk-taking increases with managerial discretion, implying that improved governance should mitigate the impact of CEO overconfidence. We find that a CEO with greater power – e.g., one who is also the chairperson or at a company with more anti-takeover provisions – is more likely to engage in frequent repurchases and to spend significantly more funds in doing so. Conversely, institutional investors appear to encourage, or at least tacitly approve, such bias-driven repurchase activities. We posit that institutional investors, concerned about the propensity of these managers to over-invest, might prefer these firms to return cash to shareholders through repurchases. Such repurchases could also enable institutional investors to exit from these companies (at repurchase prices, typically at a premium to market prices).

Our finding is that overconfident CEOs are more likely to substitute repurchases for capital expenditures and dividends. We extend the dividend-substitution framework in Grullon and Michaely (2002) to show that overconfident managers are significantly more likely to reduce "discretionary" dividends than are other managers. This result is consistent with the idea that if overconfident managers decide to pay-out cash to shareholders, they prefer to do so via a repurchase rather than a dividend. Further, we find that overconfident managers are more likely to cut back on capital expenditures in order to fund repurchase activities. Such CAPX-reductions can benefit shareholders if they are associated with a reduction in excessive investment. However, such reductions can harm shareholders if they are associated with a shift from positive-NPV projects towards repurchases motivated by managerial bias.

We next explore the value-implications of overconfident CEOs' repurchases. Specifically, we examine how CEO confidence influences the market's reaction to the announcement of such repurchase decisions. We hypothesize and show, using a sample of around 4000 repurchase announcements, that the market reacts less positively to announcement of repurchases by over-confident CEOs. The less positive reactions are consistent with the market recognizing that these repurchases may be driven by biased perceptions of firm value.

We conduct a series of robustness checks. We use propensity-score and weighting approaches to ensure that the results are not due to systematic differences between overconfident and non-overconfident CEOs. We also ensure the results hold across various model specifications. Additionally, we take steps to ameliorate concerns over endogeneity between the option-based measure of overconfidence and repurchases. A concern is that overconfident CEOs might merely repurchase stock in order to maximize the value of their options before exercising. The press-based measure of overconfidence (which is not based on option holdings) helps to cross-validate the findings in relation to the option-based measure of overconfidence. Further, given that overconfident CEOs' repurchases perform poorly in the post-repurchase period, there appears to be little stock-price benefit for overconfident CEOs from these repurchases. Nonetheless, we verify that the results hold after dropping all firm-years in which the CEO exercises options; this omits CEOs that might be motivated by the desire to increase prices prior to exercising options.[5]

Our results contribute to several strands of the existing literature. First, the results contribute to the literature on managerial overconfidence and its impact on corporate decision making.

[4] Overconfident managers are not necessarily better or worse than non-overconfident managers in terms of firm value. On the plus side, such overconfidence can yield benefits in relation to innovation (Galasso and Simcoe, 2011; Hirshleifer et al., 2012), and lead to greater managerial effort (Hilary et al., 2013; Goel and Thakor, 2008; Pikulina et al., 2013). On the other hand, overconfident managers tend to over-invest and to engage in value destroying acquisitions (Malmendier and Tate, 2008; 2005a; Kolasinski and Li, 2013; Kim, 2013). Indeed, Simon and Houghton (2003) highlight that overconfident managers make riskier investments but those investments are less likely to succeed.

[5] To conserve on the length of paper, some of the less central and ancillary results are provided in an online appendix.

The literature has increasingly highlighted the importance of considering CEOs' personality traits when analyzing their investment decisions.[6] For example, overconfident individuals might be more willing to enter new markets based on their own optimistic perceptions of their capabilities (Hiller and Hambrick, 2005; Moore et al., 2007).[7] In so doing, they are likely to invest more in riskier projects that are potentially less likely to succeed (Simon and Houghton, 2003). Their actions might also expose their firms to increased risks, such as the risk of litigation (Banerjee et al., 2018). Deshmukh et al. (2013) show that the higher investment propensity of these managers, by placing a greater demand on internal funds, can lead to lower dividend payout. We extend the overconfidence literature to show that overconfidence can also shift the manner in which firms pay out excess cash and influence the dividend-repurchase substitution decision. Interestingly, we find that overconfident CEOs do pay out more cash than other CEOs in the form of repurchases, suggesting that their perceived undervaluation of the firm's stock can sometimes override their desire to retain cash internally for investment purposes.

We also contribute to the literature on the timing of repurchases. Brav et al. (2005) report survey findings that most financial executives believe that firms repurchase when their stocks are undervalued in the market. However, the empirical evidence on market-timing is mixed. Some prior studies have found support for market timing (see e.g., Baker and Wurgler, 2000, 2002; Ikenberry et al., 1995; 2000a,b; Peyer and Vermaelen, 2009). However, such support is not universal, with other studies finding limited evidence of market timing (see e.g., Eckbo et al., 2000; Schultz, 2003; Butler et al., 2005; Dittmar and Dittmar, 2008). In our paper we examine whether repurchases are, in part, driven by managers with biased perceptions of firm value. Repurchases that are induced by biased valuations could account for the inconclusive findings from tests of market timing that assume managers to be unbiased in their valuations.

We introduce an additional motive for repurchases: CEO overconfidence. This provides an interesting addition to prior findings that worse-performing repurchases tend to involve worse governed firms (Bonaimè et al., 2014a). Further, we add to the prior findings in relation to the factors that drive the market's reaction to repurchases (see e.g., Lakonishok and Vermaelen, 1990; Ikenberry et al., 1995; Grullon and Michaely, 2004; Peyer and Vermaelen, 2009).[8] We provide an additional explanation for how, and why, the market reacts to repurchase announcements. Namely, that for a sub-set of firms, the perceived under-reaction actually reflects the market discounting the signaling effect of repurchases that are made by overconfident CEOs.

The paper makes an indirect contribution to the governance literature by shedding light on the relationship between managerial entrenchment and CEO overconfidence. The theoretical model in Goel and Thakor (2008) highlights that poor corporate governance can exacerbate the impact of CEO overconfidence. We find support for this prediction, with our results indicating that managerial entrenchment can enable overconfident CEOs to act on their behavioral biases. Additionally, we present evidence to support the idea in Huang and Thakor (2013) that repurchase activity is higher when the level of investor-management agreement is lower. We demonstrate this by showing a positive relationship between repurchase activity and institutional trading as proxied by a measure that connotes governance-through-exit (as per Chang et al., 2013); and thus, shareholder disagreement.

There is prior literature on the relationship between CEO overconfidence and repurchases. For example, Andriosopoulos et al. (2018) use an option-based measure of CEO overconfidence and find that overconfident CEOs are more likely to complete a repurchase plan once initiated. Similarly, Shu et al. (2013) examine overconfident managers in Taiwan using only a media-based measure of overconfidence, find that these managers are more likely to initiate a repurchase. We add to the literature by examining how overconfident CEOs' decisions are influenced by the firm's cash position, stock performance, and governance. We also examine the substitution between dividends, CAPX, and repurchases while analyzing the market's reaction to repurchase decisions. This also enables us to examine whether overconfident CEOs' repurchases, while conveying a weaker signal about the firm's value, may nonetheless benefit shareholders by inhibiting overconfident CEOs' propensity to over-invest.

## 2. Hypotheses

This section presents our hypotheses about the impact of CEO overconfidence on share repurchases. In Appendix A, we present a basic formalization of overconfident CEO's repurchase decisions. Our first hypothesis is that overconfident managers are more likely to repurchase stock and is premised on two prior findings: There exists strong evidence consistent with the idea that managers often repurchase stock to mitigate chronic underpricing (Liljeblom and Pasternack, 2006; Jagannathan et al., 2000; Guthart, 1967). Further, there exists prior evidence that suggests that overconfident managers over-estimate projects' cash flows and under-estimate their risks, thereby over-estimating firm value (Dittrich et al., 2005). Thus, overconfident managers are more likely to believe that their firms are undervalued and hence, are more likely to "invest" in buying back shares they perceive to be undervalued and to use repurchases as a mechanism to boost their stock price. Therefore, we propose, and subsequently test, the following hypothesis:

**Hypothesis 1.** Overconfident managers are more likely to repurchase stock.

We expect that overconfident managers are more likely to be swayed by stock-price movements when making repurchase decisions. Jagannathan et al. (2000) and Chan et al. (2004) show that managers are more likely to repurchase stock after a sustained period of negative stock returns. Chan et al. (2007) suggest that managers attempt to time the market when undertaking share repurchases. Given that overconfident managers are more likely to believe their stock is underpriced in general, we would expect them to react more to any drop in share price.

**Hypothesis 2.** Overconfident managers are more sensitive to stock price movements when taking repurchase decisions.

As argued above, an overconfident CEO is more likely to believe that her company's stock is under-priced. Hence, we conjecture that an overconfident CEO will be less sensitive to the firm's cash/cash-flow position when taking a repurchase decision. That is, if perceived under valuation is large, an overconfident manager may initiate repurchase even when the cash/free cash flow position is not entirely conducive and vice versa. This is because an overconfident CEO uses repurchase as a mechanism to correct her

[6] For example, prior studies have analyzed the role of CEO narcissism in corporate investment activity (see e.g., Petrenko et al., 2018; Zhu and Chen, 2018; Patel and Cooper, 2014).

[7] Cain et al. (2015) qualify this finding by indicating that overconfidence about one's skills *relative* to other people matters more than overconfidence in one's skills per se. Similarly, Simon and Shrader (2012) indicate that overconfidence increases the likelihood of entering highly competitive environments.

[8] The purported under-reaction arises due to findings that the market's initial reaction to the repurchase is small whereas there is a large positive long run post-repurchase drift. However, Bargeron et al. (2013) argue that this long-run drift arises due to contaminating events such as supervening repurchases or takeovers; and thus, that the drift is not conclusive evidence of a market under-reaction. Andriosopoulos and Lasfer (2018) reach similar conclusions using European data, emphasizing the role of supervening repurchases.

perceived under-pricing of the company's stock rather than returning any excess cash to the shareholders; hence, cash holding is not necessarily a critical variable in determining an overconfident CEO's repurchase decision.

A related expectation is that overconfident CEOs are less sensitive to the firm's credit position when making repurchase decisions. A firm with a worse short term credit rating would benefit more from retaining current assets (i.e., cash) to meet its current liabilities. An overconfident CEO is more likely to believe that the company has positive future growth prospects; and thus, that a low credit rating is less harmful. Subsequently, the overconfident CEO is more likely to undertake a repurchase notwithstanding a poor credit rating than is a non-overconfident CEO.

**Hypothesis 3.** An overconfident manager is more likely to repurchase shares at a relatively lower level of cash holdings, or notwithstanding a relatively worse credit rating, than is a non-overconfident CEO.

We also expect that overconfident CEOs that have more power (face less resistance) within the company are more likely to do repurchases. Sub-optimally executed repurchases tend to involve firms with worse corporate governance (Bonaimè et al., 2014a). Further, CEO power exacerbates the impact of CEO hubris, giving hubristic CEOs greater scope to act on their optimistic beliefs (Li and Tang, 2010). Therefore, an overconfident CEO who has more "power" – i.e., an overconfident CEO who is not subject to inside resistance and/or outside scrutiny, is more likely to act on her behavioral biases and indulge in such bias-driven repurchase activities. Prior literature posits that there are two ways to increase CEO-power: insulation from "internal" resistance by, for instance, the CEO also being the chairperson of the board (see e.g., Rechner and Dalton, 1991; Fahlenbrach, 2009) and insulation from "external" or market-based discipline through, for instance, the presence of anti-takeover provisions (see e.g., Gompers et al., 2003; Bebchuk et al., 2009). Thus, CEOs with more power, as evidenced by CEO-Chair duality and/or a preponderance of anti-takeover provisions (ATPs) will be more likely to repurchase stock.

**Hypothesis 4.** Overconfident CEOs with more "power" are more likely to repurchase stock and to spend more on repurchase activities.

We additionally expect institutional investors to influence repurchase-activity. While institutional investors can help to mitigate CEOs' behavioral biases and restrain CEOs' actions, they may seek to encourage these overconfidence driven repurchase activities. The reason is that these institutional investors might be more concerned about potentially value-destroying over-investment; and thus, encourage these overconfident CEOs to return funds rather than undertake investments. There is anecdotal evidence that institutional investors have pushed for such repurchases in order to encourage companies to reduce excess cash holdings (The Economist, 2014c). Also, as documented/argued by the prior literature, these institutional investors could use these repurchases as an avenue to liquidate their holdings (Gallagher et al., 2018; Chang et al., 2013; Edmans, 2009; Edmans et al., 2013; Edmans and Manso, 2011). Indeed, there is anecdotal evidence of boards becoming increasingly willing to repurchase shares from activist investors, both to reduce shareholder activism and as a result of 'hushmail' in order to pay-off a disruptive activist (Gerstein et al., 2014). A repurchase, which often occurs at a premium to the current share price, presents an attractive way for these institutional shareholders to exit the company.

**Hypothesis 5.** Institutional investors encourage overconfident CEOs to initiate/complete repurchase activities.

It is not hard to argue that an overconfident CEO will prefer repurchases over dividends. Prior evidence indicates that overconfident managers prefer not to pay dividends; they prefer to retain cash internally or to undertake bias-driven investments (Deshmukh et al., 2013). However, as will become apparent from our analysis, we find that these overconfident CEOs do not necessarily eliminate existing (or regular) dividends. Rather these overconfident CEOs cut the level of discretionary dividends (or special dividends) – an amount usually over and above the regular dividend. This is important because prior literature has documented that cutting "regular" dividends is construed as an extremely negative signal by the market – something that even these overconfident CEOs are likely to avoid. Therefore, we expect that overconfident CEOs are more likely (than other CEOs) to substitute 'abnormal' dividends with repurchases.

**Hypothesis 6.** Overconfident managers are more likely to substitute 'abnormal' dividends for repurchases.

Prior studies document that overconfident CEOs tend to overinvest in capital expenditure (Malmendier and Tate, 2005a). However, as stated above, overconfident CEOs are also more likely to perceive their stock to be under-priced; and thus, are inclined to repurchase shares to support the share price. Therefore, to an overconfident CEO the choice between CAPX and repurchasing stock is a choice between two positive NPV investments. By contrast, other CEOs, who do not necessarily perceive their stock as perennially underpriced, are less likely to perceive such a substitution decision. Therefore, we expect that overconfident CEOs, as compared with other CEOs, are more likely to reduce CAPX in order to release funds for repurchase activities.

**Hypothesis 7.** Overconfident CEOs are more likely to cut "abnormal" capital expenditures to boost repurchase activities.

Finally, we anticipate that the market will react less strongly to overconfident managers' stock repurchases. The market generally interprets stock repurchases as a positive signal and a reflection of the manager's belief that the firm is underpriced (Ikenberry et al., 1995; Chhachhi and Davidson, 1997; Grullon and Michaely, 2004; Chan et al., 2004). However, Ikenberry et al. (1995) show that the market reaction is more muted for 'glamor' stocks, which are less likely to be underpriced. Further, there is evidence that the market responds less positively to buybacks by managers that are more likely to intentionally use a buyback to mislead the market by conveying a false signal of the firm's profitability (Chan et al., 2010). Given that overconfident managers are more likely to have an excessively positive view of their company's stock (and to falsely believe the company is underpriced when it is not), we expect that the market-response to overconfident managers' repurchases will be more muted.

**Hypothesis 8.** The market-response to overconfident managers' repurchases is more muted.

## 3. Data

For our empirical tests of the above hypotheses we make use of a firm-year panel dataset, other than for market reactions to repurchase announcements.

### 3.1. Data sources

We construct the required dataset by starting with the set of CEOs in *Execucomp* for which we can obtain option data necessary to construct the option-based measure of overconfidence. We obtain a set of control variables that might influence the repurchase decision. The panel data-set contains about 20,000 observations,

with the precise number of observations varying slightly between models based upon the required variables. We collect data from *Compustat* (as per Grullon and Michaely, 2002) on whether the company spends money on repurchasing stock in a given year. This allows us to create a repurchase-indicator and to examine the dollar amount spent on repurchases. In order to examine the substitution between CAPX, dividends, and repurchases, we also collect data on CAPX and dividends. When examining repurchase-dividend substitution , we compute a measure of "unexpected" dividends (as in Grullon and Michaely, 2002), which we describe in Section 4.6.

We examine the market's reaction to repurchases by using a cross-sectional dataset of repurchase announcements from SDC. We exclude any repurchases in which the firm seeks to purchase more than 25% of the outstanding shares since such a repurchase could, for instance, represent a defensive measure in response to an acquisition attempt. We then merge in data on CEO overconfidence (as described below) and other control variables that might influence the market's reaction to the repurchase. The event-study dataset contains around 4000 observations, though the sample size reduces to around 3200 observations when we require all controls. For this data-set, we collect data on the market's reaction to repurchase decisions. We examine longer-run cumulative abnormal returns (as per Peyer and Vermaelen, 2009), focusing on returns from five days before or ten days after the repurchase announcement to 200, 250, or 300 days after the repurchase announcement. We base the abnormal returns on an OLS estimate of the market model, with parameters computed over the previous year.

### 3.2. CEO overconfidence measures

We use two definitions of managerial over-confidence. In robustness tests, we ensure that the results are robust to several alternative measures of overconfidence, including the Holder67 option-based measure of overconfidence. We focus on the confidence of the CEO, as opposed to other executives, due to prior evidence that CEO overconfidence (as opposed to CFO overconfidence) tends to affect non-financial decisions in general (Malmendier and Zheng, 2014).

First, we use option-based measures of overconfidence. The premise behind these measures is that a CEO's human capital is concentrated in their company. Thus, a CEO would rationally exercise and cash-out her stock options when they vest, especially if they are deep in the money. Indeed many CEOs do precisely this (Korczak and Liu, 2014). However, retaining highly in the money options that have vested would indicate a degree of overconfidence. We define managerial overconfidence in a way similar to Malmendier and Tate (2008, 2005a). Specifically, we collect the number of unexercised, but vested, options that a CEO has in year $t$ and the value of those options in year $t$ (both from Execucomp). We then construct the value-per-option by dividing the value of the CEO's vested-but-unexercised option holdings by the number of such options. We then construct the 'Confidence' measure as a measure of how in-the-money the CEO's options are, which we obtain by dividing the value-per-option by the share price at the end of the fiscal year. We use a continuous variable due to prior evidence that many managers are, to some extent, operating under faulty beliefs about the distribution of returns (Ben-David et al., 2013).

Second, we use a press-based measure of managerial overconfidence (similarly to Hirshleifer et al., 2012; Shu et al., 2013; Malmendier and Tate, 2005b).[9] Specifically, for the period 2000–2006, we perform a Factiva search for articles that refer to the manager as confident or not confident and that appear in reputed newspapers and magazines like The New York Times (NYT), Business Week (BW), Financial Times (FT), The Economist, Forbes Magazine, Fortune Magazine. For each CEO and sample year, we record the number of articles containing the words like over confident or over confidence, optimistic or optimism, reliable, cautious, conservative, practical, frugal, steady or visible. We check that these terms are generally used to describe the CEO in question and separate out newspaper articles describing the CEO of interest.

In order to distinguish between "strong" and "weak" positive (negative) articles, we adopt the following strategy: if an article contains more than one positive (or negative) descriptive words, we add 1/3 weights for each additional descriptive word. For example, if any article contains descriptive words like both "visible" and "aggressive" , then we assign a score of 1.33. Similarly, if an article contains both positive and negative descriptive words, but the number of positive (negative) words is greater than negative (positive) words, then we subtract 1/4 weight per negative (positive) word from the positive (negative) score and vice versa. For example, if any single article contains descriptive words like "visible" and "aggressive' and "not confident", then we assign a score of $1.00 + 0.33 - 0.25$ or 1.08. A positive score denotes an overall positive article whereas a negative score denotes an overall negative (or non-confident) article. We next split the set of articles into the positive articles and negative articles and calculate the total positive score and the total negative score for the CEO. Note that in our final sample, we do not consider CEOs, whose total negative descriptive word count exceeds total positive descriptive word count. This is both to enable us to focus on the impact of degrees of confidence rather than on pessimism or a lack of confidence). Further, it helps to avoid 'under-reporting bias' in the results owing to CEOs that made overconfident statements but that the media never noticed (i.e., not because the CEO was not overconfident, but because there was simply a lack of reporting on it).

For the final step of computing a measure of overconfidence, we then calculate the net number of positive references and negative (i.e., not confident) references. Next, we construct the scaled measure, 'Net News'/('Confident News + Non-Confident News'), allowing us to determine the proportion of news that refers to the manager as confident. We then take the natural log of one plus this number.

### 3.3. Other control variables

We collect data on various control variables that might influence the decision to repurchase stock and the market's reaction to these repurchases. The firm-level factors include the firm's size, stock return, stock return standard deviation, stock illiquidity (as proxied by the proportion of days on which there is no trade, as per Lesmond et al., 1999), the firm's cash holdings and free cash flow, its leverage, R&D expenses, and the amount it spends on dividends. We also control for the firm's level of institutional ownership as institutions can influence corporate governance; and thus, the tendency to repurchase stock.

We control for other CEO-level characteristics as well. Both CEO age (Yim, 2018) and CEO tenure (Simsek, 2007; Wu et al., 2005) can influence risk-taking and, thus, possibly the tendency to repurchase stock. The CEO's percentage ownership can also influence risk-taking tendencies, affecting the CEO's incentive to repurchase shares.

### 3.4. Summary statistics

The summary statistics are in Table 1. The proportion of companies that do repurchases in our sample is similar to that in

[9] This measure is similar in focus to the measure in Lee et al. (2018) that focuses on the optimism of CEO language in tweets and conference calls.

**Table 1**
Summary Statistics. This table contains the summary statistics for the sample. The figures are means,medians, standard deviations, or 25th or 75th percentile cut-off points as indicated in the column title. Panel A presents summary statistics for the firm-year panel data. Panel B presents summary statistics for the sample used to conduct an event-study analysis of the market's reaction to repurchase decisions.

| Variable | Mean | Median | Std Dev | 25th Pctile | 75th Pctile |
|---|---|---|---|---|---|
| Panel A: Panel Data Sample | | | | | |
| Repurchases | 0.557 | 1.000 | 0.497 | 0.000 | 1.000 |
| Repurchase Amount | 134 | 1 | 419 | 0 | 52 |
| Confidence Options | 0.309 | 0.268 | 0.277 | 0.062 | 0.496 |
| Confidence News | 0.317 | 0.297 | 0.240 | 0.094 | 0.511 |
| CAPEX/Sales | 0.076 | 0.038 | 0.124 | 0.020 | 0.076 |
| Assets | 8702 | 1593 | 24,983 | 528 | 5389 |
| Stock Return | 0.146 | 0.136 | 0.455 | −0.088 | 0.365 |
| Stock Return Std Dev | 0.028 | 0.024 | 0.015 | 0.018 | 0.034 |
| Prop No Trade Days | 0.000 | 0.000 | 0.008 | 0.000 | 0.000 |
| Toal Dividends/ Assets | 0.010 | 0.002 | 0.016 | 0.000 | 0.015 |
| Cash/Assets | 0.093 | 0.050 | 0.109 | 0.016 | 0.131 |
| Bonus/Salary | 0.726 | 0.359 | 1.163 | 0.000 | 1.002 |
| Tenure (Years) | 6.726 | 5.000 | 7.167 | 2.000 | 9.000 |
| Age (Years) | 55.379 | 55.000 | 7.225 | 51.000 | 60.000 |
| CEO%Own | 0.020 | 0.003 | 0.048 | 0.001 | 0.012 |
| Inst%Own | 0.587 | 0.654 | 1.767 | 0.399 | 0.813 |
| Debt/Assets | 0.192 | 0.170 | 0.168 | 0.038 | 0.299 |
| R&D/Sales | 0.042 | 0.000 | 0.100 | 0.000 | 0.033 |
| FCF/Assets | 0.066 | 0.065 | 0.117 | 0.016 | 0.122 |
| BCF | 2.412 | 2 | 1.331 | 1 | 3 |
| CEO is Chair | 0.405 | 0 | 0.491 | 0 | 1 |
| Panel B: Repurchase Event-Study Sample | | | | | |
| CAR(−5,200) | 0.061 | 0.065 | 0.441 | −0.171 | 0.280 |
| CAR(−5,250) | 0.067 | 0.077 | 0.517 | −0.208 | 0.337 |
| CAR(−5,300) | 0.075 | 0.085 | 0.597 | −0.235 | 0.390 |
| CAR(10,200) | 0.047 | 0.051 | 0.415 | −0.176 | 0.260 |
| CAR(10,250) | 0.054 | 0.063 | 0.491 | −0.212 | 0.315 |
| CAR(10,300) | 0.061 | 0.074 | 0.571 | −0.236 | 0.362 |
| Confidence Options | 0.325 | 0.300 | 0.279 | 0.102 | 0.501 |
| Confidence News | 0.341 | 0.335 | 0.228 | 0.156 | 0.515 |
| CAPEX/Sales | 0.058 | 0.036 | 0.085 | 0.020 | 0.063 |
| Assets | 12,954 | 2117 | 32,587 | 669 | 7977 |
| Stock Return | 0.069 | 0.086 | 0.373 | −0.128 | 0.283 |
| Stock Return Std Dev | 0.025 | 0.022 | 0.012 | 0.017 | 0.030 |
| Prop No Trade Days | 0.000 | 0.000 | 0.004 | 0.000 | 0.000 |
| Toal Dividends/ Assets | 0.012 | 0.005 | 0.017 | 0.000 | 0.018 |
| Cash/Assets | 0.093 | 0.056 | 0.102 | 0.019 | 0.132 |
| Bonus/Salary | 0.779 | 0.375 | 1.256 | 0.000 | 1.068 |
| Tenure (Years) | 6.735 | 5.000 | 7.361 | 2.000 | 9.000 |
| Age (Years) | 55.392 | 56.000 | 6.943 | 51.000 | 60.000 |
| CEO%Own | 0.019 | 0.003 | 0.048 | 0.001 | 0.011 |
| Inst%Own | 0.732 | 0.709 | 4.017 | 0.550 | 0.839 |
| Debt/Assets | 0.167 | 0.139 | 0.154 | 0.027 | 0.258 |
| R&D/Sales | 0.036 | 0.000 | 0.073 | 0.000 | 0.036 |
| FCF/Assets | 0.106 | 0.094 | 0.110 | 0.041 | 0.158 |

Grullon and Michaely (2002). Further, the statistics in Panel A versus Panel B indicate that the sample-composition of the event-study sample is similar to that in the full firm-year panel sample. Fig. 1 indicates the proportion of companies that repurchase stock each year in our sample. The trend towards increasing repurchases is consistent with that documented in Grullon and Michaely (2002).

## 4. Analysis

### 4.1. Are overconfident CEOs more likely to repurchase stock?

We expect that overconfident managers will be both more likely to do a repurchase and to spend more money on repurchases (see Hypothesis 1). We capture this first by using a logit model (Eq. (1)) where the dependent variable is an indicator that equals one if the firm repurchases stock in year $t+1$, as reported in Compustat. Second, we use an OLS regression model to examine whether overconfident managers spend more money on repurchases (see Eq. (2)).

$$\text{Repurchase Indicator}_{i,t+1} = \alpha + \beta\,\text{Confidence}_{i,t} + \theta\,\mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_k \quad (1)$$

$$\ln(\text{Repurchase Dollar Amount}_{i,t+1}) = \alpha + \beta\,\text{Confidence}_{i,t} + \theta\,\mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_k, \quad (2)$$

where "Repurchase" indicates whether firm $i$ repurchases in year $t+1$ and "Repurchase Dollar Amount" is the dollar amount that it spends on repurchases in year $t+1$. "Confidence" is a measure of managerial overconfidence, $\mathbf{x}$ is a vector of control variables, $\lambda_t$ is a set of year fixed effects, and $\delta_{i(j)}$ is a set of SIC two-digit indicators for whether firm $i$ is in industry $j$. We estimate the indicator-variable regressions using logit regressions, and the repurchase-amount regressions using tobit models with a lower bound of zero. All models include year dummies and two-digit SIC industry dummies (as indicated) and use standard errors clustered by firm. We discuss robustness to various model specifications in Section 5.

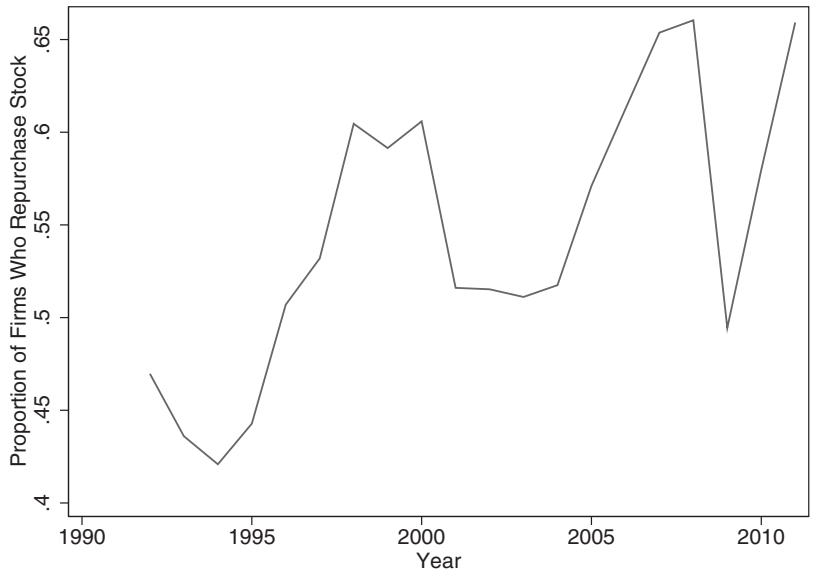



**Fig. 1.** Repurchases by year. This graph plots the proportion of companies who repurchase stock (according to compustat) in a given year between 1992 and 2011.

The results are stated in Table 2. The main finding is that both measures of overconfidence are associated with a significantly greater likelihood of a repurchase and significantly larger dollar amount of repurchases in the following year. This holds in regressions with and without controls for other factors that could influence repurchase expenditure. These results are economically meaningful: a one standard deviation increase in option-based confidence is associated with a 1.2% increase in the likelihood of a repurchase.[10] Further, from Column 7 of Table 2, a one standard deviation increase in *Confidence Options* results in about at 16% increase in the dollar amount spent on repurchases. Given that CEOs often aim to repurchase shares when their firm is 'undervalued' (Bonaimè et al., 2014b; Babenko et al., 2012), this result is consistent with the idea that overconfident CEOs tend to perceive their companies as 'undervalued' by the market. As a robustness check, we re-run the above models using repurchase information collected from the SDC database. Our results (unreported) are qualitatively similar to the above results with Compustat data. To ensure that our results are not driven by small repurchases, we estimate our regression models for larger repurchases, restricting the sample to the Top 25% or Top 50% of the repurchases by dollar amount. Again, our results are qualitatively similar and are not reported for the sake of brevity.

Growth options will influence an overconfident CEO's decision to repurchase shares. We capture growth options by using the firm's intangibles scaled by its total assets. We then analyze whether this moderates the relationship between CEO overconfidence and repurchases. We provide these results in a table titled "Growth options and repurchase activity" in an Online Appendix. The main finding is that overconfidence itself remains positively related to repurchase activity. However, the relationship is weaker in firms with greater growth options (i.e., intangibles). This suggests that while overconfident CEOs generally prefer to repurchase more shares, this preference becomes weaker as the firm's internal growth options improve.

[10] We obtain this as follows. We use the Stata command `mfx` to obtain the marginal effects for Column 3 of Table 2. The marginal effect for *Confidence Options* is 0.044. We then multiply the marginal effect with the standard deviation from Table 1.

The coefficients on the control variables are largely consistent with expectations: Larger companies and companies with more cash or free cash flow are more likely to repurchase stock, suggesting that such companies face fewer financial-constraint-related barriers to buying back stock. Conversely, firms with higher levels of financial leverage are less likely to buy back stock and to buy back smaller amounts, indicating that such firms would prefer not to weaken their financial position by disgorging cash to shareholders as opposed to, say, paying down debt. Firms with a higher stock return are less likely to less likely to repurchase stock, because they are less concerned with valuation of their stock. Firms with a higher stock return standard deviation are less likely to repurchase stock, presumably because such firms tend to be smaller and less liquid. Firms that pay higher dividends are also more likely to repurchase stock and to spend more doing so, consistent with the observation in Grullon and Michaely (2002, p. 1682) that "many firms that have been paying dividends have also started to repurchase shares as well".

### 4.2. Are overconfident CEOs more sensitive to stock returns and cash holdings?

We hypothesize, in Hypothesis 2, that overconfident managers are more sensitive to the firm's stock returns. Overconfident managers tend to over-estimate their company's value and, following a stock-price decrease, are more inclined to believe that it represents a buying opportunity. We capture this by interacting the CEO-overconfidence variables with the firm's stock return over the prior year. The models are of the following form:

$$\begin{aligned}\text{Repurchase Indicator}_{i,t+1} &= \alpha + \beta^{(1)}\text{Confidence}_{i,t} + \beta^{(2)}\text{Return}_{i,t} \\ &\quad + \beta^{(3)}(\text{Confidence}_{i,t} \times \text{Return}_{i,t}) \\ &\quad + \theta \mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_{k,} \qquad (3)\end{aligned}$$

$$\begin{aligned}\ln(\text{Repurchase Dollar Amount}_{i,t+1}) &= \alpha + \beta^{(1)}\text{Confidence}_{i,t} \\ &\quad + \beta^{(2)}\text{Return}_{i,t} \\ &\quad + \beta^{(3)}(\text{Confidence}_{i,t} \\ &\quad \times \text{Return}_{i,t}) + \theta \mathbf{x}_{i,t} \\ &\quad + \lambda_t + \delta_{i(j)} + \varepsilon_k. \qquad (4)\end{aligned}$$

**Table 2**
CEO's Confidence Level & Firm's Repurchase Activities. This table contains regression models that examine the relationship between CEO overconfidence in year $t$ and announcement of new repurchase plans in year $t+1$. The models in Columns 1, 2, 4, and 5 are *logit* regression models, and the models in Columns 3 and 6 are *tobit* models with a lower bound of zero. All models include year dummies and SIC two-digit industry dummies and cluster standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| Dependent Variable<br>Column | Does Repo<br>[1] | Ln[$Repo]<br>[2] | Does Repo<br>[3] | Ln[$Repo]<br>[4] |
|---|---|---|---|---|
| Confidence Options (t) | 0.366*** | 0.868*** | | |
| | [0.000] | [0.000] | | |
| Confidence News (t) | | | 0.445*** | 1.019*** |
| | | | [0.009] | [0.000] |
| Ln[Assets(t)] | 0.169*** | 0.871*** | 0.203*** | 0.918*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Yearly BHR | −0.176*** | −0.186*** | −0.136** | −0.115 |
| | [0.000] | [0.000] | [0.010] | [0.156] |
| Stock Return S.D. (t) | −37.745*** | −64.455*** | −42.276*** | −72.991*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Prop No Trade Days (t) | −4.648 | −4.741 | −0.712 | 0.008 |
| | [0.292] | [0.292] | [0.892] | [0.999] |
| Dividends (t) | 0.078*** | 0.114*** | 0.080*** | 0.116*** |
| | [0.000] | [0.000] | [0.003] | [0.003] |
| Cash/Assets (t) | 1.825*** | 4.013*** | 2.485*** | 4.931*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Ln[Tenure(t)] | 0.021 | 0.003 | 0.065 | 0.084 |
| | [0.512] | [0.954] | [0.172] | [0.232] |
| Ln[CEO Age(t)] | −0.159 | −0.413 | −0.460 | −0.770 |
| | [0.488] | [0.218] | [0.167] | [0.121] |
| CEO%Own | 0.287 | 0.173 | −0.965 | −2.001 |
| | [0.649] | [0.836] | [0.332] | [0.133] |
| Inst%Own | 0.035 | 0.149 | 0.067 | 0.199 |
| | [0.707] | [0.262] | [0.615] | [0.299] |
| Debt/Assets (t) | −1.660*** | −3.226*** | −2.374*** | −4.358*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| R&D/Sales(t) | −0.727** | 0.268 | −0.621 | 0.285 |
| | [0.043] | [0.656] | [0.210] | [0.727] |
| FCF/Assets (t) | 2.353*** | 5.052*** | 2.889*** | 5.732*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Industry FCF/Assets(t) | 1.248 | 1.974* | −1.413 | −1.377 |
| | [0.120] | [0.093] | [0.305] | [0.482] |
| Year FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| Observations | 18,239 | 18,270 | 7030 | 7047 |
| Pseudo R-squared | 0.1373 | 0.1034 | 0.1671 | 0.1144 |

Here, '$\text{Confidence}_{i,t}$' is the measure of the CEO's level of overconfidence at firm $i$, '$\text{Return}_{i,t}$' is the cumulative abnormal stock return over the year $t$, based on an OLS estimation of the market model over the year $t-1$ using an equally weighted CRSP market index, $\mathbf{x}$ is a vector of controls, $\lambda_t$ represents a set of year dummies, and $\delta_{i(j)}$ represents a set of industry dummies. We estimate Eq. (3) using logit and Eq. (4) using a tobit model with a lower bound of zero. All models include year dummies, two-digit SIC industry dummies and use standard errors clustered by firm. We check the p-values for the interaction terms by using the adjustment for interaction terms in non-linear models (as in Ai and Norton, 2003; Norton et al., 2004).[11] Unless otherwise specified the reported results are regression coefficients.

The results are in Table 3 Panel A and are in line with expectations. Model 1 and Model 2 examine the likelihood that a firm repurchases stock (Eq. (3)) and Model 3 and Model 4 examine dollar amount spent on repurchases (Eq. (4)). The main finding is that the coefficient on the interaction terms is significant and negative. The results are economically significant: following a one standard deviation in stock return, highly overconfident CEOs (with option-based confidence in the top quartile) are 3.7% more likely to repurchase stock than are less overconfident CEOs (with option-based confidence in the bottom quartile).[12]

The results are in Table 3 Panel B and supportive of our hypotheses. Models 1 and 2 provide logit estimates of the likelihood that a firm makes a repurchase (Eq. (5)), while Models 3 and 4 analyze the dollar repurchases (Eq. (6)). The main result is that the coefficient on the interaction term (confidence and cash level) is negative and significant. In terms of economic magnitude, a one standard deviation reduction in cash holdings is associated with a 4.3% reduction in the likelihood of a repurchase for highly overconfident managers (i.e., with option-based confidence in the top quartile) compared with a 6.3% reduction for managers whose

[11] Specifically, we operationalize this by using the Stata `inteff` command. The results are qualitatively unchanged when using this adjustment.

[12] We calculate this as follows: We compute $m_{\text{Return}} \times \sigma_{\text{Return}} + m_{\text{Return}\times\text{Confidence}} x_{\text{Confidence}} \sigma_{\text{Return}}$, where $m_{\text{Return}}$ and $m_{\text{Return}\times\text{Confidence}}$ are respectively the marginal effects for the cash holdings variable and the interaction term, $\sigma_{\text{Return}}$ is the standard deviation of the stock returns, and $x_{\text{Confidence}}$ is the relevant percentile cut-off for the option-based confidence measure. We compute marginal effects for interactions using the Stata command `inteff` (per Norton et al., 2004), and `mfx` for the non-interaction variables. We then multiply the marginal effects with the relevant standard deviation and 25th and 75th percentile cut-offs (obtained from Table 1).

**Table 3**
CEO confidence, stock returns, cash holdings, and Repurchase Activities. This table contains regression models that examine the relationship between CEO confidence in year *t*, stock returns in year *t* (in Panel A) and cash holdings (in Panel B) and announcement of new repurchase plans in year $t+1$. The models in Columns 1 and 3 are *logit* regression models, and the models in Columns 2 and 4 are *tobit* models with a lower bound of zero. All models include the controls from the baseline regressions, year dummies and SIC two-digit industry dummies and cluster standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| Dependent Variable<br>Model<br>Column | Does Repo<br>Logit<br>[1] | Ln[$Repo]<br>Tobit<br>[2] | Does Repo<br>Logit<br>[3] | Ln[$Repo]<br>Tobit<br>[4] |
|---|---|---|---|---|
| Panel A | | | | |
| Confidence Options (t) | 0.473*** | 1.046*** | | |
| | [0.000] | [0.000] | | |
| Confidence News (t) | | | 0.558*** | 1.190*** |
| | | | [0.001] | [0.000] |
| Confidence Options (t) x Yearly BHR | −0.455*** | −0.788*** | | |
| | [0.000] | [0.000] | | |
| Confidence News (t) x Yearly BHR | | | −0.546*** | −0.865*** |
| | | | [0.005] | [0.003] |
| Yearly BHR | 0.025 | 0.163** | 0.055 | 0.191 |
| | [0.591] | [0.031] | [0.504] | [0.125] |
| Controls | Yes | Yes | Yes | Yes |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 18,239 | 18,270 | 7030 | 7047 |
| Pseudo R-squared | 0.1384 | 0.1040 | 0.1679 | 0.1147 |
| Panel B | | | | |
| Confidence Options (t) | 0.536*** | 1.108*** | | |
| | [0.000] | [0.000] | | |
| Confidence Options (t) x Cash/Assets | −1.652** | −2.500*** | | |
| | [0.014] | [0.006] | | |
| Confidence News (t) | | | 0.701*** | 1.501*** |
| | | | [0.001] | [0.000] |
| Confidence News (t) x Cash/Assets | | | −2.439* | −4.632*** |
| | | | [0.061] | [0.007] |
| Cash/assets | 2.425*** | 4.941*** | 3.360*** | 6.629*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Controls | Yes | Yes | Yes | Yes |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 18,239 | 18,270 | 7030 | 7047 |
| Pseudo R-squared | 0.1377 | 0.1036 | 0.1677 | 0.1148 |

option-based confidence is in the bottom quartile.[13] This suggests that compared with other CEOs, overconfident CEOs are more willing to undertake a repurchase at a lower level of cash holdings. This supports the notion that overconfident CEOs are more likely to regard a repurchase as a better use of scarce cash resources.

### 4.3. Are overconfident CEOs less sensitive to the firm's credit rating?

Hypothesis 3 states that overconfident CEOs are less sensitive to the firm's cash position and credit rating. For our test, we interact the CEO confidence measures with the value of cash holdings. The regression specifications are as below:

$$\begin{aligned}\text{Repurchase Indicator}_{i,t+1} = {} & \alpha + \beta^{(1)}\text{Confidence}_{i,t} + \beta^{(2)}\text{Cash}_{i,t} \\ & + \beta^{(3)}(\text{Confidence}_{i,t} \times \text{Cash}_{i,t}) \\ & + \theta \mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_{k,} \end{aligned} \quad (5)$$

$$\begin{aligned}\ln(\text{Repurchase Dollar Amount}_{i,t+1}) = {} & \alpha + \beta^{(1)}\text{Confidence}_{i,t} \\ & + \beta^{(2)}\text{Credit Rating}_{i,t} \\ & + \beta^{(3)}(\text{Confidence}_{i,t} \\ & \times \text{Credit Rating}_{i,t}) + \theta \mathbf{x}_{i,t} \\ & + \lambda_t + \delta_{i(j)} + \varepsilon_k. \end{aligned} \quad (6)$$

Here, '$\text{Confidence}_{i,\,t}$' is the measure of the CEO's level of overconfidence, '$\text{Credit Rating}_{i,\,t}$' is the firm's Credit Rating in period *t*, **x** is a vector of controls, $\lambda_t$ represents a set of year dummies, and $\delta_{i(j)}$ represents a set of industry dummies.

We examining the sensitivity of overconfident CEOs to the firm's short term credit rating. A firm with a worse short term credit rating should be more reticent to do a repurchase, since such companies might benefit the most from retaining current assets to meet current liabilities. We capture this by creating a numerical measure of the company's S&P short term credit rating; a higher numerical measure indicates a better rating.[14] We report the results in Table 5. The main finding is that the coefficients on the interaction terms are negative and significant in three of four cases. This suggests that overconfident managers are less sensitive than non-overconfident managers to the company having a lower credit rating or to being unrated.

[13] We get this figure as follows: We compute $m_{\text{Cash}} \times \sigma_{\text{Cash}} + m_{\text{Cash} \times \text{Confidence}} x_{\text{Confidence}} \sigma_{\text{Cash}}$, where $m_{\text{Cash}}$ and $m_{\text{Cash} \times \text{Confidence}}$ are respectively the marginal effects for the cash holdings variable and the interaction term, $\sigma_{\text{Cash}}$ is the standard deviation of cash holdings, and $x_{\text{Confidence}}$ is the relevant percentile cut-off for the option-based confidence measure. We compute marginal effects for interaction terms using the Stata's `inteff` command (per Norton et al., 2004), and `mfx` for the non-interaction variables. We then multiply the marginal effects with the relevant standard deviation and 25th and 75th percentile cut-offs (obtained from Table 1).

[14] S&P credit ratings go from A-1+, A-1, A-2, A-3, B (B-1, B-2, B-3), C, D. We code the ratings from 9 to 1, with 9 being the best.

**Table 4**
CEO's Confidence Level, Firm's Cash Holdings & Repurchase Activities. This table contains regression models that examine the relationship between CEO's confidence in year *t*, cash holdings at year *t* and announcement of new repurchase plans in year $t+1$. The models in Columns 1 and 3 are *logit* regression models, and the models in Columns 2 and 4 are *tobit* models with a lower bound of zero. All models include year dummies and SIC two-digit industry dummies and cluster standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| Dependent variable<br>Model | Does Repo<br>[1] | Ln[$Repo]<br>[2] | Does Repo<br>[3] | Ln[$Repo]<br>[4] |
|---|---|---|---|---|
| Confidence Options (t) | 0.536*** | 1.108*** | | |
| | [0.000] | [0.000] | | |
| Confidence Options (t) x Cash/Assets (t-1) | −1.652** | −2.500*** | | |
| | [0.014] | [0.006] | | |
| Confidence News (t) | | | 0.701*** | 1.501*** |
| | | | [0.001] | [0.000] |
| Confidence News (t) x Cash/Assets (t-1) | | | −2.439* | −4.632*** |
| | | | [0.061] | [0.007] |
| Yearly BHR | −0.170*** | −0.175*** | −0.135** | −0.113 |
| | [0.000] | [0.000] | [0.011] | [0.161] |
| Ln[Assets(t)] | 0.169*** | 0.870*** | 0.203*** | 0.919*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Stock Return S.D. (t) | −37.421*** | −63.970*** | −42.119*** | −72.722*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Prop No Trade Days (t) | −5.094 | −5.325 | −1.203 | −1.674 |
| | [0.279] | [0.256] | [0.818] | [0.819] |
| Dividends (t) | 0.080*** | 0.116*** | 0.081*** | 0.118*** |
| | [0.000] | [0.000] | [0.003] | [0.003] |
| Cash/assets (t) | 2.425*** | 4.941*** | 3.360*** | 6.629*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| ln(Tenure(t)) | 0.022 | 0.005 | 0.071 | 0.095 |
| | [0.490] | [0.912] | [0.137] | [0.178] |
| ln(CEO Age(t)) | −0.165 | −0.428 | −0.495 | −0.840* |
| | [0.474] | [0.202] | [0.138] | [0.090] |
| CEO Ownership (%) | 0.279 | 0.158 | −0.999 | −2.065 |
| | [0.657] | [0.850] | [0.314] | [0.122] |
| Inst%Own | 0.036 | 0.150 | 0.069 | 0.201 |
| | [0.700] | [0.258] | [0.608] | [0.293] |
| Debt/Assets (t) | −1.660*** | −3.227*** | −2.358*** | −4.316*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| R&D/Sales(t) | −0.790** | 0.177 | −0.647 | 0.255 |
| | [0.028] | [0.768] | [0.192] | [0.754] |
| FCF/Assets (t) | 2.344*** | 5.042*** | 2.896*** | 5.736*** |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Industry FCF/Assets(t) | 1.176 | 1.869 | −1.426 | −1.425 |
| | [0.143] | [0.111] | [0.302] | [0.468] |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 18,239 | 18,270 | 7030 | 7047 |
| Pseudo R-squared | 0.1377 | 0.1036 | 0.1677 | 0.1148 |

**Table 5**
CEO's Confidence Level, Firm's Credit Rating and Repurchase Activities. This table contains regression models that examine the relationship between CEO confidence, firm's credit ratings, and repurchase activity. The variable "ST Credit Rating (t)" is the short-term credit ration of the firm in year *t*. All models include the same controls as in Table 2, year dummies and SIC two-digit industry dummies and cluster standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| Dependent Variable | [1]<br>Does Repo | [2]<br>Ln[$ Repo] | [3]<br>Does Repo | [4]<br>Ln[$Repo] |
|---|---|---|---|---|
| Panel A: Short Term Credit Rating | | | | |
| Confidence Options (t) | 4.453** | 10.013***** | | |
| | [0.046] | [0.000] | | |
| Confidence Options (t) x ST Credit Rating (t) | −0.454* | −1.091*** | | |
| | [0.078] | [0.000] | | |
| Confidence Press (t) | | | 6.814*** | 9.649*** |
| | | | [0.008] | [0.001] |
| Confidence Press (t) x ST Credit Rating (t) | | | −0.904*** | −1.158*** |
| | | | [0.006] | [0.003] |
| *Firm-related Controls* | Yes | Yes | Yes | Yes |
| *Market-related Controls* | Yes | Yes | Yes | Yes |
| *CEO-related Controls* | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Industry Fixed Effect | Yes | Yes | Yes | Yes |
| Observations | 4083 | 4129 | 1608 | 1670 |
| R-squared | 0.1958 | 0.1041 | 0.2493 | 0.1265 |

**Table 6**
CEO Confidence, CEO Power & Repurchase Activities. This table contains regression models that examine the relationship between CEO confidence in year *t*, CEO power in year *t* and repurchase activities in year $t+1$. The column title states the dependent variable. The models in Columns 1–4 are *logit* models and the models in Columns 5–8 are *tobit* models with a lower bound of zero. All models include year dummies and SIC two-digit industry dummies and clustered standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| Dependent Variable | Repurchase Indicator | | | | Ln[Dollar Repurchases] | | | |
|---|---|---|---|---|---|---|---|---|
| Model | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] |
| Confidence Options (t) | −0.052 | | −0.081 | | 0.198 | | 0.077 | |
| | [0.648] | | [0.688] | | [0.238] | | [0.753] | |
| Confidence Options (t) × CEO_Chairman | 0.490*** | | | | 0.678*** | | | |
| | [0.003] | | | | [0.004] | | | |
| Confidence Options (t) × BCF (t) | | | 0.201*** | | | | 0.317*** | |
| | | | [0.010] | | | | [0.001] | |
| Confidence Press (t) | | 0.269 | | −0.794** | | 0.811** | | −0.65 |
| | | [0.269] | | [0.034] | | [0.021] | | [0.196] |
| Confidence Press (t) × CEO_Chairman | | 0.137 | | | | 0.103 | | |
| | | [0.644] | | | | [0.805] | | |
| Confidence Press (t) × BCF (t) | | | | 0.525*** | | | | 0.677*** |
| | | | | [0.000] | | | | [0.000] |
| CEO_Chairman | −0.222*** | −0.151 | | | −0.291** | −0.145 | | |
| | [0.007] | [0.268] | | | [0.014] | [0.446] | | |
| BCF (t) | | | −0.05 | −0.126** | | | −0.123*** | −0.208*** |
| | | | [0.150] | [0.022] | | | [0.007] | [0.006] |
| *Firm-related Controls* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Market-related Controls* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *CEO-related Controls* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 18,319 | 7034 | 13,099 | 5623 | 18,329 | 7048 | 13,109 | 5634 |
| R-squared | 13.64% | 16.94% | 14.88% | 18.05% | 10.34% | 11.54% | 10.39% | 11.72% |

### 4.4. Does CEO power facilitate repurchases by overconfident CEOs?

From Hypothesis 4, we expect that overconfident CEOs' that have more power, and more insulated from internal or external discipline, will be more likely to act on their behavioral bias to do more repurchases. We capture insulation from internal discipline by identifying whether a CEO is also the chairperson of the board (as indicated in Execucomp's executive title variable, 'titleann'). We capture insulation from external discipline i.e., the market for corporate control by using the Bebchuk et al. (2009) index of six key anti-takeover provisions ('ATPs'), which we denote 'BCF Index'. While there is some evidence that the 'BCF Index' is not per se associated with a reduction in takeover likelihood, so might not capture 'entrenchment' from *takeovers* (Bates et al., 2008), the attributes that it comprises, such as the presence of a classified board, are symptomatic of problematic governance; and thus, would represent protection from effective oversight (following Guo et al., 2018). We capture the role of such governance factors in the following models.

$$\begin{aligned}\text{Repurchase Indicator}_{i,t+1} = {} & \alpha + \beta^{(1)}\text{Confidence}_{i,t} + \beta^{(2)}g_{i,t} \\ & + \beta^{(3)}\left(\text{Confidence}_{i,t} \times g_{i,t}\right) \\ & + \theta\mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_{k,} \qquad (7)\end{aligned}$$

$$\begin{aligned}\ln(\text{Repurchase Dollar Amount}_{i,t+1}) = {} & \alpha + \beta^{(1)}\text{Confidence}_{i,t} + \beta^{(2)}g_{i,t} \\ & + \beta^{(3)}\left(\text{Confidence}_{i,t} \times g_{i,t}\right) \\ & + \theta\mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_k. \qquad (8)\end{aligned}$$

Here, '$g_{i,t}$' represents the relevant governance provision (i.e., CEO-Chair duality or the Bebchuk et al. (2009) index in year *t*), 'Confidence' represents the two measures of CEO overconfidence, **x** is a vector of controls, $\lambda_t$ represents a set of year dummies, and $\delta_{i(j)}$ denotes a set of industry dummies.

The results are in Table 6. The main finding is that the interaction terms of the confidence measures with the BCF index, or with the CEO-Chair indicator are significant and positive in all models. These results suggest that overconfident CEOs that have more power are more prone to acting on their behavioral biases and repurchasing more stock.[15] This is also consistent with prior evidence that, in other contexts, improved governance could help to reign in overconfident CEOs (see e.g., Banerjee et al., 2015).

### 4.5. Does institutional ownership influence the relationship between CEO overconfidence and repurchases?

We hypothesize that increased institutional holdings might encourage overconfident CEOs to engage in buybacks (following Hypothesis 5). Overconfident CEOs tend to overinvest in underperforming investments (see e.g., Malmendier and Tate, 2005a; 2008). Institutional shareholders would likely oppose such investments. This can influence the likelihood of repurchases for at least two reasons: First, greater investor/manager disagreement could lead to increased repurchases as managers attempt to repurchase stock from investors who disagree; the 'disagreeing' investors will also be more willing to tender their shares (Huang and Thakor, 2013). Second, institutional investors, that often use 'exit' as a way of disciplining managers (Gallagher et al., 2018; Chang et al., 2013), will be more likely to encourage/approve of a repurchase as it would provide a way to sell their shares.

We examine the role of institutional holdings by obtaining the percentage of institutional holdings from the Thomson 13f filings and by constructing the 'reward punishment index' (RPI) proposed in Chang et al. (2013). According to Chang et al. (2013), the RPI is a measure of institutional trading activity and is designed to capture the extent to which institutional investors are willing to trade shares, potentially to discipline managers. They find that RPI is positively associated with firm value and negatively associated

[15] We also estimate models (unreported) in which we include CEO overconfidence interacted with the variables such as cash, stock-return and governance variables in the same regression. The results are largely similar to those obtained when the variables are considered individually.

**Table 7**
CEO Confidence, Institutional Ownership & Repurchase Activities. This table contains regression models that examine the relationship between CEO overconfidence, institutional holdings, and announcement of new repurchase plans and the dollar amount of repurchases. All models include the same controls as in Table 2, year dummies and SIC two-digit industry dummies and cluster standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| ***Panel A***: Repurchase indicator | | | | |
|---|---|---|---|---|
| Model | [1] | [2] | [3] | [4] |
| Confidence Options (t) | −3.218*** | | −0.179 | |
| | [0.005] | | [0.421] | |
| Confidence Press (t) | | −0.407 | | 0.046 |
| | | [0.846] | | [0.923] |
| Confidence Options (t) × RPI | 0.190*** | | | |
| | [0.003] | | | |
| Confidence Press (t) × RPI | | 0.038 | | |
| | | [0.743] | | |
| Confidence Options (t) × Institution%Ownership | | | 0.524* | |
| | | | [0.099] | |
| Confidence Press (t) × Institution%Ownership | | | | 0.404 |
| | | | | [0.535] |
| RPI | 0.051 | 0.147** | | |
| | [0.177] | [0.012] | | |
| Institution%Ownership | | | −0.192 | 0.025 |
| | | | [0.233] | [0.933] |
| Observations | 16,183 | 6312 | 16,183 | 6312 |
| Pseudo R-squared | 0.1425 | 0.1745 | 0.1408 | 0.1724 |
| ***Panel B***: Ln[Dollar Repurchases] | | | | |
| Model | [1] | [2] | [3] | [4] |
| Confidence Options (t) | −4.248*** | | −0.083 | |
| | [0.009] | | [0.794] | |
| Confidence Press (t) | | −0.928 | | 0.643 |
| | | [0.740] | | [0.303] |
| Confidence Options (t) × RPI | 0.262*** | | | |
| | [0.004] | | | |
| Confidence Press (t) × RPI | | 0.088 | | |
| | | [0.563] | | |
| Confidence Options (t) × Institution%Ownership | | | 0.918** | |
| | | | [0.045] | |
| Confidence Press (t) × Institution%Ownership | | | | 0.209 |
| | | | | [0.811] |
| RPI | 0.251*** | 0.373*** | | |
| | [0.000] | [0.000] | | |
| Institution%Ownership | | | −0.192 | 0.198 |
| | | | [0.385] | [0.632] |
| Observations | 16,217 | 6332 | 16,217 | 6332 |
| Pseudo R-squared | 0.1089 | 0.1204 | 0.1068 | 0.1178 |
| *Firm-related Controls* | Yes | Yes | Yes | Yes |
| *Market-related Controls* | Yes | Yes | Yes | Yes |
| *CEO-related Controls* | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes |
| Industry Fixed Effect | Yes | Yes | Yes | Yes |

with measures of empire building. While it is true that the RPI might capture the activities of relatively short-term investors, prior evidence suggests that such 'active' investors are often better informed (Yan and Zhang, 2009), indicating that they would be able to undertake monitoring-through-trading.[16] The RPI is constructed as follows:

$$\mathrm{RPI}_{i,t} = \ln\left(\sum_{q=1}^{4}\sum_{j\in\mathcal{J}}\left|N_{j,i,q} - N_{j,i,q-1}\right|\right), \tag{9}$$

where, $N_{j,\,i,\,q}$ is the number of shares owned by institutional investor $j \in \mathcal{J}$ in quarter $q$ in firm $i$. We calculate this on an yearly basis and include the RPI summed over all four quarters in year $t$, when analyzing repurchases that are made in year $t+1$.

The results are presented in Table 7. RPI (although not the institutional percentage holdings per se) is positively associated with repurchases. The RPI result is consistent with the idea that for companies with greater institutional monitoring, the institutions may use repurchases as a way to exit the company. The interactions of the options-based measure of overconfidence with the two institutional ownership variables (Inst%Own and RPI) are positive and mostly significant, providing some evidence that institutions tend to encourage repurchases in companies run by overconfident managers, likely as a way for them to exit their positions.

### *4.6. Are overconfident CEOs more prone to reducing "discretionary" dividends to do a repurchase?*

We hypothesize (in Hypothesis 6) that overconfident managers would prefer to payout excess cash through a repurchase than through a dividend payment. We analyze this within the dividend substitution framework of Grullon and Michaely (2002). The

[16] It is true that long-term investors may be better suited to engaging in 'governance through voice' and can be beneficial around particular transactions, such as takeovers, where a long-term investor might be beneficial due to the long-horizon nature of integration (Chen et al., 2007). However, the notion of 'governance through trading' differs from the idea of 'governance through voice' and presupposes a willingness to sell low-quality companies.

**Table 8**
CEO Confidence & Dividend-Repurchase Substitution. This table contains regression models that examine the relationship between CEO confidence in year $t$ and dividend-repurchase substitution in year $t+1$. Our dependent variable is "discretionary" (or unanticipated) dividend derived using Eq. (11). The models are OLS regression that include year dummies and SIC two-digit industry dummies and clustered standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| Dependent Variable | Discretionary (Unanticipated) Dividend (t+1) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] |
| Confidence Options (t) | 0.028*** | 0.043*** | 0.028*** | 0.045*** | | | | |
| | [0.000] | [0.000] | [0.000] | [0.000] | | | | |
| Repurchases (t) | −0.001 | 0.008*** | | | | | | |
| | [0.771] | [0.007] | | | | | | |
| Confidence Options (t) × Repurchases (t) | | −0.028*** | | | | | | |
| | | [0.000] | | | | | | |
| Repurchases (t+1) | | | −0.002 | 0.007*** | | | | |
| | | | [0.168] | [0.005] | | | | |
| Confidence Options (t) × Repurchases (t+1) | | | | −0.030*** | | | | |
| | | | | [0.000] | | | | |
| Confidence Press (t) | | | | | 0.044*** | 0.065*** | 0.045*** | 0.068*** |
| | | | | | [0.000] | [0.000] | [0.000] | [0.000] |
| Repurchases (t) | | | | | 0.001 | 0.014*** | | |
| | | | | | [0.674] | [0.006] | | |
| Confidence Press (t) × Repurchases (t) | | | | | | −0.040*** | | |
| | | | | | | [0.002] | | |
| Repurchases (t+1) | | | | | | | −0.002 | 0.011** |
| | | | | | | | [0.277] | [0.012] |
| Confidence Press (t) × Repurchases (t+1) | | | | | | | | −0.042*** |
| | | | | | | | | [0.000] |
| *Firm-related Controls* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Market-related Controls* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *CEO-related Controls* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 18,330 | 18,330 | 18,330 | 18,330 | 7048 | 7048 | 7048 | 7048 |
| Adjusted $R^2$ | 18.60% | 18.70% | 18.60% | 18.70% | 22.80% | 23.00% | 22.80% | 23.00% |

Grullon and Michaely (2002) framework functions by looking at the determinants of 'unexpected' changes in dividends, which are broadly defined as the change in dividends over and above that which a Lintner (1956) based dividend-prediction model would predict. The idea is that dividends can be both 'expected' and 'discretionary'. The 'expected' level of dividends is based upon the company's dividend policy (i.e., as manifested in the lagged level of dividends) and the company's current level of earnings. The 'discretionary' dividends derive from factors other than earnings or the historic dividend policy, and could involve the company disgorging excess cash to shareholders. The Grullon and Michaely (2002) model looks at how managers choose between issuing 'unexpected'/'discretionary' dividends and doing a repurchase. We augment their model by examining the role of overconfidence. Thus, we estimate the following model:

$$\begin{aligned}\text{Unexpected Dividends}_{i,t+1} &= \alpha + \beta^{(1)}\text{Confidence}_{i,t} + \beta^{(2)}\text{Repurchase}_{i,t+1} \\ &+ \beta^{(3)}\left(\text{Confidence}_{i,t} \times \text{Repurchase}_{i,t+1}\right) \\ &+ \theta \mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_k. \end{aligned} \quad (10)$$

Here, we calculate the level of 'unexpected dividends' as in Eq. (11) (see below), 'confidence' is our measure of managerial overconfidence, 'Repurchase' is an indicator for whether the company spends any money repurchasing stock in year $t+1$, as reported in Compustat, $\mathbf{x}$ denotes a vector of control variables, $\delta_{i(j)}$ is a set of SIC two-digit indicators for whether firm $i$ is in industry $j$ and $\lambda_t$ is a set of year fixed effects. The models use standard errors clustered by firm. Following Grullon and Michaely (2002), we calculate the unexpected amount of dividends as follows:

$$\begin{aligned}&\text{Unexpected Dividends}_{i,t} \\ &= \left[\Delta\text{Dividends}_{i,t} - \Delta\text{Dividends}^{*}_{i,t}\right]/\text{Market Capitalization}_{i,t}, \end{aligned} \quad (11)$$

where, $\text{Dividends}^{*}_{i,t}$ is the 'expected' change in dividends and comes from a Lintner (1956) type dividend adjustment model. Specifically, we compute it as the difference between the 'expected' level of dividends for year $t$ and the actual level of dividends in year $t-1$. We compute the expected level of dividends in year $t$ using a Lintner (1956) model which predicts the level of dividends in year $t$ as a function of earnings in year $t$ and the dividends paid in year $t-1$.

The results are in Table 8. The main finding is that the interaction terms of both the options-based and press-based measures of overconfidence with the repurchase variables are negative and significant. That is, overconfident managers that undertake repurchases subsequently decrease dividends by more. This suggests that overconfident managers are more prone to reduce excess dividends and conduct a repurchase than are non-overconfident managers.

One interesting result in Table 8 is that overconfident managers are associated with higher levels of excess dividend payments (as indicated by the positive coefficients on the options-based and press-based measures of overconfidence). This initially appears to contrast with Deshmukh et al. (2013). However, they examine total/raw dividends as opposed to 'excess' dividends and in unreported results we also confirm that both measures of confidence are negatively related to the total dividend variables used in Deshmukh et al. (2013).

### 4.7. Do overconfident CEOs reduce CAPX to repurchase stock?

From Hypothesis 7 we have that overconfident managers may choose to reduce excessive capital expenditure in order to repurchase stock. We expect that repurchases will reduce investment by overconfident CEOs. We capture this in models of the following form:

$$\text{Predicted CAPX/Sales}_{i,t+1} = \alpha + \theta \mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_k \quad (12)$$

**Table 9**
Effect of CEO Overconfidence and Share Repurchase on Abnormal CAPEX. This table contains regression models that examine the relationship between CEO confidence and likelihood of share repurchases on change in capital expenditure. The models are LOGIT/TOBIT regression models that include year dummies and SIC two-digit industry dummies and cluster standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| Dependent | Abnormal CAPEX/Sales (t+1) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Confidence Options (t) | 4.533*** | 4.671*** | | |
| | [0.000] | [0.000] | | |
| Confidence Options (t) × Does Repo (t) | −1.880*** | | | |
| | [0.002] | | | |
| Confidence News (t) | | | 5.897*** | 5.744*** |
| | | | [0.000] | [0.000] |
| Confidence News (t) × Does Repo (t) | | | −1.993* | |
| | | | [0.050] | |
| Confidence Options (t) × Does Repo (t+1) | | −2.146*** | | |
| | | [0.000] | | |
| Confidence News (t) × Does Repo (t+1) | | | | −1.784* |
| | | | | [0.087] |
| Does Repo (t) | 0.668*** | | 0.764** | |
| | [0.007] | | [0.024] | |
| Does Repo (t+1) | | 0.386 | | 0.354 |
| | | [0.118] | | [0.326] |
| Ln[Assets (t)] | 0.013 | 0.039 | 0.083 | 0.103 |
| | [0.904] | [0.731] | [0.578] | [0.497] |
| Yearly BHR | −0.906*** | −0.948*** | −0.571** | −0.572** |
| | [0.000] | [0.000] | [0.026] | [0.024] |
| Stock Return Std. Dev. | 6.480 | 4.607 | 9.300 | 7.299 |
| | [0.443] | [0.591] | [0.534] | [0.628] |
| Prop No Trade Days (t) | 1.807 | 1.076 | −2.534 | −1.963 |
| | [0.476] | [0.781] | [0.483] | [0.662] |
| Dividends (t) | 0.063 | 0.056 | 0.063 | 0.058 |
| | [0.443] | [0.500] | [0.533] | [0.573] |
| Cash/Assets (t) | −0.281 | −0.277 | −0.356 | −0.286 |
| | [0.790] | [0.795] | [0.821] | [0.857] |
| Bonus / Salary (t) | −0.115 | −0.121 | −0.090 | −0.075 |
| | [0.413] | [0.386] | [0.547] | [0.620] |
| Ln[Tenure (t)] | −0.133 | −0.130 | −0.001 | −0.001 |
| | [0.308] | [0.324] | [0.997] | [0.996] |
| Ln[CEO Age (t)] | 0.468 | 0.516 | −0.452 | −0.262 |
| | [0.669] | [0.642] | [0.767] | [0.865] |
| CEO%Own | −0.539 | −0.151 | −0.023 | −0.037 |
| | [0.790] | [0.942] | [0.993] | [0.988] |
| Inst%Own | −0.199 | −0.194 | −0.195 | −0.214 |
| | [0.660] | [0.671] | [0.731] | [0.703] |
| Debt/Assets (t) | 0.260 | −0.056 | 1.076 | 0.837 |
| | [0.776] | [0.951] | [0.361] | [0.481] |
| R&D/Sales(t) | −1.079 | −1.159 | 1.867 | 2.018 |
| | [0.557] | [0.532] | [0.489] | [0.458] |
| FCF/Assets (t) | 1.244 | 1.539 | 3.865*** | 4.486*** |
| | [0.233] | [0.141] | [0.004] | [0.001] |
| Industry FCF/Assets(t) | 0.345 | 1.074 | −1.294 | −0.247 |
| | [0.907] | [0.718] | [0.751] | [0.951] |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 18,721 | 18,313 | 7135 | 7039 |
| R-squared | 0.020 | 0.020 | 0.039 | 0.041 |

$$\begin{aligned}\text{Abnormal CAPX/Sales}_{i,t+1} &= \alpha + \beta^{(1)}\text{Confidence}_{i,t} \\ &+ \beta^{(2)}\text{Repurchase}_{i,t+1} \\ &+ \beta^{(3)}\left(\text{Confidence}_{i,t} \times \text{Repurchase}_{i,t+1}\right) \\ &+ \theta \mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_k. \end{aligned} \quad (13)$$

Here, 'Predicted CAPX/Sales$_{i,t+1}$' is the firm's capital expenditure as predicted by all the firm characteristics (like **x**), $\lambda_t$ represents a set of year dummies and $\delta_{i(j)}$ is a set of two-digit SIC industry dummies. We estimate the models using OLS, with year dummies and two-digit industry dummies and cluster standard errors by firm. Next, we subtract Actual CAPX/Sales$_{i,t+1}$ − Predicted CAPX$_{i,t+1}$ to calculate the Abnormal CAPX/Sales$_{i,t+1}$. Finally, we regress Abnormal CAPX/Sales$_{i,t+1}$ on 'Confidence' is a measure of CEO overconfidence, 'Repo$_{i,t}$' is an indicator for whether the firm did a repurchase (according to Compustat) in year $t$ (similarly for 'Repo$_{i,t+1}$' in year $t+1$), **x** is a vector of control variables, $\lambda_t$ represents a set of year dummies and $\delta_{i(j)}$ is a set of two-digit SIC industry dummies. Again, we estimate the models using OLS, with year dummies and two-digit industry dummies and cluster standard errors by firm.

The results are in Table 9. The results indicate that overconfident CEOs spend more on CAPX (abnormal CAPX is increasing), consistent with prior evidence (Malmendier and Tate, 2005a). Companies that repurchase stock in year $t$ or year $t+1$ also spend more on CAPX in year $t+1$, consistent with the idea that repurchasing firms might be in a better cash position than non-repurchasing firms. However, we find that overconfident managers

**Table 10**
BHRs by CEO confidence. This table contains the average BHR for periods after the repurchase announcement by CEO confidence. We split the sample by whether the CEO's confidence is in the top 50% or bottom 50% of the SDC-sample. Superscripts ***, **, and * denote significant differences in means at 1%, 5%, and 10%, respectively.

| | Cofidence Options | | | Confidence News | | |
|---|---|---|---|---|---|---|
| | Bottom 50% | Top 50% | Difference | Bottom 50% | Top 50% | Difference |
| BHAR(−5,5) | 0.012 | 0.009 | 0.004 | 0.017 | 0.000 | 0.017*** |
| BHAR(−5,250) | 0.075 | 0.019 | 0.056*** | 0.113 | −0.007 | 0.120*** |
| BHAR(−5,500) | 0.140 | −0.034 | 0.174*** | 0.224 | −0.016 | 0.239*** |
| BHAR(−5,1000) | 0.310 | −0.085 | 0.395*** | 0.312 | −0.097 | 0.409*** |
| BHAR(−5,1500) | 0.472 | −0.097 | 0.569*** | 0.474 | −0.106 | 0.581*** |

**Table 11**
Effect of CEO Overconfidence and Buy-Hold Return (BHR) on Share Repurchase. This table contains regression models that examine the relationship between CEO confidence, buy-hold stock return and the likelihood of relatively large repurchases and dollar amount of repurchase. The models are LOGIT/TOBIT regression models that include year dummies and SIC two-digit industry dummies and cluster standard errors by firm. The appendix contains the detailed variable definitions. The significance levels at the 1%, 5%, and 10% are denoted by ***, ** and *, respectively.

| VARIABLES | (1) [−5, 5] | (2) [−5, 250] | (3) [−5, 500] | (4) [−5, 1000] | (5) [−5, 1500] | (6) [−5, 5] | (7) [−5, 250] | (8) [−5, 500] | (9) [−5, 1000] | (10) [−5, 1500] |
|---|---|---|---|---|---|---|---|---|---|---|
| Confidence Options (t) | 0.001 | −0.114** | −0.389*** | −0.914*** | −1.243*** | | | | | |
| | [0.945] | [0.034] | [0.000] | [0.000] | [0.000] | | | | | |
| Confidence News (t) | | | | | | −0.040** | −0.162* | −0.373*** | −0.696*** | −0.997*** |
| | | | | | | [0.013] | [0.055] | [0.009] | [0.002] | [0.001] |
| Past Repurchase Indicator | 0.004 | −0.003 | −0.028 | −0.074 | −0.125** | 0.005 | 0.007 | −0.029 | −0.058 | −0.133 |
| | [0.174] | [0.873] | [0.352] | [0.122] | [0.050] | [0.431] | [0.843] | [0.629] | [0.547] | [0.321] |
| Ln[Assets(t)] | −0.004*** | −0.019** | −0.015 | −0.048** | −0.076*** | −0.006** | −0.003 | −0.004 | −0.009 | −0.043 |
| | [0.004] | [0.014] | [0.250] | [0.019] | [0.004] | [0.039] | [0.834] | [0.863] | [0.824] | [0.412] |
| Dividends (t) | 0.001 | 0.004 | −0.004 | −0.000 | 0.008 | 0.000 | −0.000 | 0.007 | 0.019 | 0.049 |
| | [0.237] | [0.487] | [0.633] | [0.988] | [0.676] | [0.967] | [0.959] | [0.695] | [0.481] | [0.205] |
| Cash/Assets (t) | −0.054*** | −0.201* | −0.236 | −0.553** | −1.057*** | −0.061 | −0.380* | −0.347 | −0.588 | −1.388* |
| | [0.009] | [0.067] | [0.196] | [0.050] | [0.004] | [0.107] | [0.055] | [0.253] | [0.246] | [0.051] |
| CEO Bonus/Salary (t) | −0.001 | −0.013** | −0.024* | −0.021 | −0.022 | −0.001 | −0.001 | −0.022 | −0.016 | −0.003 |
| | [0.288] | [0.037] | [0.055] | [0.272] | [0.384] | [0.712] | [0.887] | [0.237] | [0.593] | [0.946] |
| ln[Tenure(t)] | −0.001 | −0.001 | 0.000 | 0.033 | 0.073* | 0.007* | 0.026 | 0.046 | 0.112* | 0.198** |
| | [0.797] | [0.960] | [0.988] | [0.291] | [0.084] | [0.089] | [0.190] | [0.190] | [0.055] | [0.015] |
| ln[CEO Age(t)] | 0.004 | −0.008 | −0.101 | −0.290 | −0.349 | 0.034 | −0.156 | −0.174 | −0.609 | −1.149** |
| | [0.813] | [0.913] | [0.428] | [0.163] | [0.204] | [0.259] | [0.250] | [0.455] | [0.109] | [0.031] |
| CEO%Own | −0.027 | −0.101 | 0.075 | 0.102 | 0.293 | −0.312*** | −0.165 | −0.019 | 0.250 | 1.035 |
| | [0.487] | [0.662] | [0.861] | [0.886] | [0.755] | [0.010] | [0.783] | [0.985] | [0.870] | [0.648] |
| Inst%Own | −0.012* | −0.018 | 0.048 | 0.077 | 0.103 | −0.051*** | 0.067 | 0.089 | 0.063 | 0.160 |
| | [0.097] | [0.649] | [0.454] | [0.440] | [0.422] | [0.001] | [0.363] | [0.518] | [0.770] | [0.572] |
| Debt/Assets (t) | 0.007 | −0.045 | −0.079 | −0.073 | −0.038 | −0.008 | −0.138 | −0.301 | −0.273 | −0.081 |
| | [0.558] | [0.506] | [0.517] | [0.707] | [0.881] | [0.758] | [0.354] | [0.236] | [0.480] | [0.874] |
| R&D/Sales(t) | −0.029 | 0.020 | −0.035 | 0.209 | 0.368 | −0.158** | −0.255 | −0.625 | −1.218 | −1.371 |
| | [0.363] | [0.915] | [0.908] | [0.688] | [0.561] | [0.014] | [0.399] | [0.175] | [0.128] | [0.159] |
| FCF/Assets (t) | 0.029* | −0.112 | −0.223 | −0.453* | −0.536* | 0.035 | 0.139 | 0.095 | 0.168 | 0.545 |
| | [0.068] | [0.244] | [0.132] | [0.060] | [0.096] | [0.215] | [0.449] | [0.757] | [0.740] | [0.430] |
| Industry FCF/Assets(t) | 0.018 | 0.465 | 0.826 | 1.008 | 1.235 | −0.287* | 0.371 | 1.191 | 1.110 | 1.990 |
| | [0.795] | [0.253] | [0.221] | [0.363] | [0.405] | [0.087] | [0.709] | [0.473] | [0.678] | [0.586] |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 3189 | 3189 | 3189 | 3189 | 3189 | 955 | 955 | 955 | 955 | 955 |
| R-squared | 0.054 | 0.117 | 0.175 | 0.192 | 0.194 | 0.160 | 0.235 | 0.232 | 0.228 | 0.230 |

that repurchase stock spend less on CAPX than do overconfident managers that do not repurchase stock. That is, overconfident managers appear willing to substitute over-investment for a repurchase, highlighting that overconfident managers (more than other managers) are likely to regard their firm as under-priced.

### *4.8. Does the market react less favorably to overconfident CEOs' repurchases?*

Following Hypothesis 8, we expect that the market's reaction to overconfident managers' repurchases will be more muted. We examine this by obtaining a set of repurchase announcement-dates from SDC platinum. We then obtain the cumulative abnormal return ('CAR') and buy and hold abnormal return ('BHAR') surrounding the announcement. Consistent with Peyer and Vermaelen (2009), we focus on long run returns (i.e., from the day of the repurchase announcement to 250, 500, 1000, and 1500 days after the repurchase announcement). We also report short-run returns from five days before the announcement to five days after the announcement. The CARs are based on an OLS estimation of the market model in the pre-event period (a period of 250 days ending 11 days before the repurchase-announcement). The reported BHARs are based on a Carhart (1997) four-factor model estimated over the pre-event period (a period of 250 days ending 11 days before the repurchase-announcement). The results (unreported) are similar if we use a Fama and French (1993) three-factor model. The returns are winsorized at 1%. In Section 5 we also consider whether the results might be impacted by changes in takeover-likelihood, or corporate risk, following the repurchase.

The univariate statistics are in Table 10. The table reports BHARs over various event-horizons split by whether the CEO's confidence is in the top or bottom 50% of the SDC sample. The results in-

dicate that long-run BHARs are significantly lower in companies run by overconfident CEOs. These repurchases are still associated with positive BHARs (consistent with the idea that returning cash to shareholders is generally a positive signal and/or creates value). That overconfident companies' BHARs are less positive suggests that their repurchases generate a weaker signal of firm value.

We next estimate multivariate regressions to control for other factors that might influence the BHARs around the repurchase. We estimate the following regressions.

$$r_{k(i,(\tau_1,\tau_2))} = \alpha + \beta \text{Confidence}_{i,t} + \theta \mathbf{x}_{i,t} + \lambda_t + \delta_{i(j)} + \varepsilon_k, \quad (14)$$

where, $r_{k(\tau_1,\tau_2)}$ is BHAR from $\tau_1$ days before the announcement to $\tau_2$ days after the announcement of repurchase $k$ done by firm $i$, Confidence is the managerial confidence variable, $\mathbf{x}$ is a vector of firm-specific controls, $\lambda_t$ represents a set of year dummies and $\delta_{i(j)}$ represents a set of SIC two-digit industry dummies for whether firm $i$ is in industry $j$. The models are OLS regressions and use standard errors clustered by firm.

The results are in Table 11. The main finding is that both measures of CEO overconfidence are significantly and negatively related to long run returns following the repurchase. However, overconfidence is only weakly related to short run returns and only when using the news-based measure of overconfidence. In terms of economic magnitude, overconfident CEOs' repurchases still create shareholder wealth (as per Table 11). However, they create less value than do non-overconfident CEOs' repurchases. This could be because overconfident CEOs are prone to overvalue their company, so their repurchases convey a weaker signal about the value of the company's shares.

## 5. Additional robustness tests

### 5.1. The 2001 dividend tax cuts and the Sarbanes–Oxley Act of 2002

The results are robust to the impact of the dividend tax cuts in 2001 and the Sarbanes–Oxley Act of 2002 ('SOX'). The 2001 cuts change the relative attractiveness of dividends and repurchases. SOX strengthened corporate governance and could influence the manager's incentives to undertake repurchases. Subsequently, we ensure that the results hold after 2003. We suppress most results for brevity, and report the results that examine dividend-repurchase substitution in Table OA1. The main finding is that even after 2003, overconfident managers are more likely to substitute dividends for repurchases, suggesting that the results do not merely reflect the impact of the 2001 tax cut or SOX.

### 5.2. Contemporaneous market conditions, confidence, and repurchases

One concern is that repurchases are often in response to market conditions, which can also influence measures of overconfidence, potentially leading to spurious correlation. A related concern is that if the firm has a pattern of repurchase-activity, then prior repurchase activity could influence company-performance, which could influence the measures of overconfidence. We mitigate the impact of such market-performance issues by constructing 'residual' measures of overconfidence. For each of the confidence measures, we undertake a first-stage regression of the form $C_{i,t} = r_{i,t} + \varepsilon_{i,t}$, where $C_{i,t}$ represents one of the two measures of overconfidence (the option-based, or news-based, measure), and $r_{i,t}$ represents the return to firm $i$ in year $t$. We then use the residuals from this regression, termed 'Conf Opt Resid' and 'Conf News Resid', as alternative measures of overconfidence.

The results for the 'residual' measures of overconfidence are consistent with the baseline results reported above. The results for the options-residual method are in Table OA@ and the results for the news-residual method are in Table OA3. The main finding is that the interaction terms (and the level terms for the confidence measures) are of qualitatively the same statistical significance as in the main reported models. These results suggest that contemporaneous market-movements, potentially reflecting prior repurchase activity, do not drive the results.

### 5.3. Systematic differences between repurchaser and non-repurchaser

We ensure that the results (in relation to managerial confidence) do not merely reflect systematic differences between repurchasing companies and non-repurchasing companies. We do this by using a propensity score matching procedure. First, we estimate a first stage model to predict the likelihood that a firm undertakes a repurchase in year $t+1$, as per Table 2. This model contains the same control variables as in Table 2. We then obtain the predicted values from this first-stage regression. Further, for the set of companies that do repurchase stock, we construct the distribution of predicted values and find the values that mark the 5th percentile. Finally, we exclude from the sample non-repurchasers whose propensity score is below the 5th percentile. For brevity, we do not report all the results; however, we report a sub-set of the main models in Table OA4. The main takeaway is that the results are robust to restricting the sample in this way.

### 5.4. Additional measures of overconfidence, including Holder67

The results are robust to using different measures of CEO overconfidence. We obtain qualitatively similar results if we use a 'Holder67' measure of CEO overconfidence. The Holder67 measure aims to detect CEOs that are highly overconfident, as evidenced by holding highly in-the-money vested options (Malmendier and Tate, 2005a; 2008). It is a largely time-invariant measure that treats CEO overconfidence as an unvarying behavioral characteristic. We construct the Holder67 measure following the approach in Malmendier et al. (2011). Specifically, we start by constructing a continuous 'in-the-moneyness' (or ITMNESS) variable (defined as the average value of the vested unexercised options over the average strike price).[17] We then determine if this ITMNESS variable is at least 0.67 on at least two years, in which case Holder67 equals one from the first such year and equals zero otherwise. These results are in Table OA5 and are consistent with our main reported results.

The results are also similar if we scale the total value of the CEO's vested but unexercised options by the value of the CEO's salary in that year (Compustat: tdc1), providing a measure for how much the options are worth, compared to what the CEO would ordinarily earn. We report these results for a sub-set of models in Table OA6; the results are qualitatively similar to those in the main regressions.

The results (suppressed for brevity) are qualitatively similar if we measure managerial overconfidence using the number of vested, but unexercised options that the CEO has, or if we use an indicator for whether the option-based measure of confidence is in the top quartile (similarly for the press based measure of overconfidence).

[17] The specific calculation is as follows. ITMNESS = (Average value of vested unexercised options)/(Average Strike Price), the 'Average value of vested unexercised options' is the value of such options scaled by the number of such options. The 'Average Strike Price' follows the basic formula that $X = S - (S - X)$, where $S$ is the stock price and $X$ is the strike price. Thus, the 'Average Strike Price' = 'Stock Price' - 'Average value of vested unexercised options', where the 'Stock Price' is the price at the end of the fiscal year (in CRSP/Compustat: prcc_f).

### 5.5. Alternative explanation: CEOs repurchase to increase value of options prior to exercise

One concern is that the relationship between overconfidence and repurchases arises merely because CEOs with options engage in repurchases to increase the value of those options. This concern follows from prior literature that CEOs might influence repurchase/payout activity for self-interested reasons, including earnings management (Farrell et al., 2014), and compensation-related reasons (Minnick and Rosenthal, 2014; Ching et al., 2018). A repurchase might be less effective at propping up the stock price than (for example) a self-tender or a special dividend. However, to the extent that this is the case, it would count against the notion that CEOs would be engaging in these repurchases to increase prices.

This concern mainly affects the option-based measure of confidence (rather than the press-based measure). Given that the results are similar across both option-based and press-based measures, this alternative explanation does not appear to explain the results. Nonetheless, we ensure that the results are robust to omitting from the sample any firm-year observation in which the CEO exercises options in that year or in the following year. Table OA7 contains the results. We report only some results for brevity; however, we find consistent results in all models. The main conclusion is that the core results are robust to excluding the CEOs that might exercise options in the aftermath of the stock repurchase. This suggests that the results do not merely reflect the desire of option-laden CEOs to repurchase shares to increase their value, followed by exercising options.

### 5.6. Unobserved firm effects, panel regressions and Fama–Macbeth regressions

An issue with corporate finance studies is controlling for unobserved firm effects. The reported models use year dummies and two-digit SIC industry dummies (as per Becker et al., 2011; Cronqvist and Fahlenbrach, 2009). We report some of the results in Tables OA8 and OA9 (for brevity, we only report the main results). OA8 indicates that the results are also robust to using a Fama–Macbeth regression technique. Table OA9 indicates that the results are robust to using firm fixed effects, controlling for (time-invariant) unobserved firm attributes, instead of industry fixed effects.

We also aim to address the issue of unobserved firm effects by examining repurchases following CEO turnovers. In this case, the impact of CEO overconfidence on repurchases would more reflect the impact of the CEO's characteristics than the firm characteristics. To do this, we use regressions similar to those in Healy et al. (1992). In our models, the dependent variable is from year $t+1$. We identify situations where the CEO in year $t$ differs from the CEO in either year $t-1$ or $t-2$. We then analyze how the confidence of the new CEO influences repurchase activity in year $t+1$. We report both models that do (and do not) control for repurchases from before the turnover. The coefficient on CEO overconfidence then represents the impact of the new CEO's overconfidence on changes in repurchase-activity. The results are in Table OA10. The key finding is that both confidence measures are statistically significantly related to repurchase activity after the turnover (even after controlling for the repurchase-expenditure before the turnover). This indicates that newly appointed overconfident CEOs tend to encourage more repurchase activity and suggests that the results do not merely reflect firm-effects.

One issue with the foregoing analysis in Table OA10 is that the change in repurchase-activity after a turnover might arise because the old CEO was removed in order to facilitate a change in corporate policy. Thus, we further analyze the impact of new CEO overconfidence following a 'retirement' type turnover. In a 'retirement' the new CEO's overconfidence, rather than any issue with prior firm characteristics, would influence the change in repurchase activity. We report these results in Table OA11. We look at situations where the old CEO was at least 60 years old (Panel A) or 65 years old (Panel B) at the time of the turnover. In most cases, we find that the overconfidence of the new CEO is significantly and positively related to increases in repurchase activity, with stronger results when analyzing the amount repurchased (rather than just the likelihood of such a repurchase).

### 5.7. Do the repurchase-results merely reflect the impact of other corporate decisions

One possibility is that the tendency to repurchase stock might be a consequence of the CEO's other decisions. That is, the decision to spend more on CAPX and takeovers, or to borrow more, might influence repurchase activity. In the reported regressions, we control for CAPX and R&D expenditure. We also control for financial leverage. In relation to takeovers, it is unlikely that a firm that needs capital to acquire another company would spend that money on a repurchase. Nonetheless, we take further steps to ensure that the results do not reflect M&A activity. Specifically, we find that the results are qualitatively similar if we exclude from the sample any firm that makes an acquisition in the current, prior, or subsequent year. This suggests that the relationship between repurchases and overconfidence is unlikely to be a mere consequence of other corporate decisions.

### 5.8. Outliers

It is conceivable that the sample could contain outlier firms that make significant repurchases. The M&A literature indicates the importance of mitigating the presence of such (potential) outliers (see e.g., Moeller et al., 2005; Fich et al., 2012). The models that examine 'ln($ Repurchase)' largely mitigate this concern by taking the log of the dollar amount spent on repurchases. Nonetheless, the results are sustained in robust regressions.[18] These regressions function by using weighted least squares, in which observations with a higher Cook's D are assigned a lower weight. This is designed to decrease the influence of potentially outlying observations (Verardi and Croux, 2009).

### 5.9. Overconfidence and information

One potential issue is that the managers that hold options have positive private information that (rather than over-confidence), causes them to hold options. This seems unlikely as prior literature suggests that managers who hold options (i.e., as per our overconfidence measure) tend to engage in value-destruction (Malmendier and Tate, 2005a; 2008), suggesting that they do not have positive private information. Nonetheless, the results hold if we exclude from the sample firms for which there is less public information and for which managers are more likely to have private information. We do this (in untabulated results) by excluding from the sample any firm that does not have an analyst covering the company. The results are robust to excluding such firms.

### 5.10. Anti-takeover provisions

The results are robust to controlling for the presence of anti-takeover provisions ('ATPs'). ATPs can enable managers to act self-interestedly (Humphery-Jenner, 2012; Humphery-Jenner and Pow-

[18] Specifically, we use the Stata command `rreg`.

ell, 2011; Masulis et al., 2007; Harford et al., 2012),[19] which may enable managers to adjust payout behavior. Similarly, managers of companies with dual-class share structures might act self-interestedly (see e.g., Masulis et al., 2009), potentially engaging in repurchases to buy-back shares from shareholders that disagree with management (as in Huang and Thakor, 2013). Requiring data on anti-takeover provisions significantly reduces the sample size (by approximately 6000 observations). Consequently, we do not include ATPs in the main models. However, we address the issue of ATPs in Table 6, in which we analyze the interaction of CEO overconfidence with the Bebchuk et al. (2009) index of six ATPs. The results are also robust to simply controlling for the Gompers et al. (2003) index of 24 ATPs, the Bebchuk et al. (2009) index of six ATPs or the presence of a poison pill and/or classified board (on which, see Bebchuk and Cohen, 2005; Bebchuk. et al., 2002).

### 5.11. CEO gender and age

CEO-age can often be associated with CEO-confidence. For example, younger CEOs tend to be more acquisitive (Yim, 2018). The reported models control for the CEO's age. However, the results (unreported) are also robust to splitting the sample into halves based on the CEO's age. Other evidence indicates that gender might influence behavior that could arguably be overconfident/aggressive (Levi et al., 2010; Jia et al., 2013; Barber and Odean, 2001). Nevertheless, our results (unreported) are robust to including a CEO-gender indicator and/or to omitting female CEOs from the sample; female CEOs only account for around 2% of our sample (about 450 observations), making it difficult to obtain reliable regression estimates for the sub-sample of firms run by female CEOs.

### 5.12. CAPX and company growth prospects

One concern is that the CAPX results might exhibit spurious correlation due to poorly performing firms having a lack of profitable investments (thus a lack of CAPX), which would also enable the firms to disgorge more cash to shareholders. We address this by ensuring that the results hold in the sample of companies that are at least able to maintain their level of sales between year $t$ and year $t+1$. The results (unreported for brevity) are qualitatively similar for this sub-sample of companies.

### 5.13. The impact of SFAS 123R

We address the impact of SFAS 123R on the results. SFAS 123R involved a change in how companies account for options. This change influences the accounting for options, effectively making it more expensive for firms to pay options and resulting in a reduction in option-based compensation (Hayes et al., 2012). While prior evidence suggests that SFAS 123R was not associated with significant changes in corporate policy (Hayes et al., 2012), this could influence the construction of the option-based overconfidence measure. This is especially so given that overconfident CEOs might potentially desire incentive-based pay (see e.g., Humphery-Jenner et al., 2016).

However, we argue that this does not qualitatively impact the results. First, the results are robust to using the news-based measure of overconfidence, which the 2006 rule-change would not affect. Second, the models include year fixed effects, which would account for the impact of such time-specific changes. Third, this rule-change would influence all firms in the sample similarly. Finally, we obtain qualitatively similar results if we focus only on the set of observations from before 2006.

### 5.14. Post-repurchase returns and changes in corporate risk

A possible issue with the results related to post-repurchase results is that corporate risk could change after the repurchase, possibly creating issues with the reported analysis. We address this by re-running the analysis using BHARs based on a Carhart (1997) four-factor model computed over the 250-day period from 5 days before to 245 days after the repurchase-announcement. Such a benchmark period would incorporate changes in corporate risk following the repurchase. The results are in Table OA12. Panel A reports results for the option-based measure of overconfidence and Panel B for the press-based measure of overconfidence. The main finding is that the results are of the same sign, and of similar magnitude, to those reported in the baseline results. This suggests that our results are not merely an artifact of changes in corporate risk.

### 5.15. Do the returns results merely reflect the propensity to do repurchases?

One issue is that if the market anticipates a repurchase-announcement, then the reaction will be more muted. Thus, if overconfident CEOs are more likely to repurchase stock, this anticipation might lead to the appearance that the market reacts less positively to overconfident CEO's repurchases. We take steps to address this by re-estimating the returns results and controlling for the firm's propensity to repurchase. We obtain this propensity from Columns 3 and 4 of Table 2. The additional returns results are in Table OA13. The main finding is that the coefficients on the confidence variables are qualitatively similar to those reported in the main models, suggesting that the propensity to repurchase stock does not drive our reported results.

### 5.16. Other robustness tests

A further concern is that the results might be driven by the set of companies that make no payout (either through dividends or repurchases) or that transition from making no payout to conducting repurchases (and thus, those that might not actually be substituting repurchases for dividends). Nonetheless, the results are robust to restricting the sample to the set of companies that make a payout either via dividends or repurchases in year $t+1$ and/or in year $t$.

Also, the results regarding cash holdings (see e.g., Table 4) are robust to the concern that the control variables 'FCF/Assets' and 'Industry FCF/Assets' are collinear with the cash holdings variable. Specifically, the results are qualitatively similar if we omit the free-cash-flow-based control variables. Further, the results are robust to considering whether the CEO is also the founder of the company. A founder-CEO might have different repurchase-incentives from other CEOs. For example, a founder-CEO might repurchase stock in order to dilute the influence of outside shareholders (following Huang and Thakor, 2013). We identify founder-CEOs as CEOs whose tenure starts before the date the company first appears in CRSP (as in Bebchuk et al., 2011). The results are robust to omitting companies with a founder-CEO or to controlling for a dummy that equals one if the CEO is also the founder.

Another issue could be that CARs can be misleading over the longer term, especially if there are large fluctuations in share prices; BHARs are less subject to this concern (Seyhun, 1990). The results are qualitatively similarly if we use BHRs instead of CARs, when examining the market's reaction to the repurchase.

[19] We acknowledge that anti-takeover provisions can, in some specific contexts, have a non-negative impact on value (see e.g., Humphery-Jenner, 2014; Johnson et al., 2015).

The results are robust to the industry definition that we use. The reported results use two-digit SIC industries to construct industry fixed effects. However, the results are robust to using three-digit or four-digit industries. The results are also robust to using the Hoberg and Phillips (2010) industry classifications.

## 6. Conclusion

This paper examines the impact of CEO overconfidence on repurchase decisions and the market's reaction to those decisions. Overconfident CEOs tend to over-estimate the value of their companies, leading to the prediction that overconfident CEOs are more likely to repurchase stock. We also predict that they will be less sensitive to the company's cash position when making repurchase decisions, but more sensitive to a stock-price decline. We hypothesize that the perception of corporate undervaluation will lead overconfident CEOs to substitute repurchases for CAPX. Further, given that overconfident CEOs tend to prefer not to pay dividends (Deshmukh et al., 2013), we expect that overconfident CEOs will substitute stock repurchases for dividends. We additionally anticipate that because overconfident CEOs are more likely to overestimate the value of their companies, their repurchases will convey a weaker signal about the firm's quality.

We use both press-based and option-based measures of overconfidence to test our predictions. We find that overconfident CEOs are more likely to repurchase stock and to spend more money on repurchases; spending up to 16% more on repurchases in a given year. Further, they are less sensitive to the company's cash position but are more sensitive to stock-price declines. Overconfident CEOs with more power (i.e., are also board-chair or in firms with more anti-takeover provisions) are more likely to act on their behavioral biases and engage in repurchases.

An interesting finding is that institutional investors appear to encourage repurchases, suggesting that they may use repurchases as a way to express disagreement with overconfident CEOs and to exit the company at a premium. Additionally, given that overconfident CEOs tend to over-invest in negative NPV projects, the repurchase (and attendant reduction in expenditure) could actually benefit share holders.

Further, consistent with our hypothesis that overconfident CEOs repurchases are driven by their overvaluation of the firm, the market responds less strongly (albeit still positively) to overconfident CEOs' repurchases. This finding helps to shed further light on the impact of behavioral biases on the value-implications of repurchases.

These findings contribute to the literature on repurchases and on CEO overconfidence. There is increasing concern that CEOs are engaging in excessive buybacks, potentially at the expense of long term wealth creation. Our findings suggest that certain types of firms may be especially prone to such repurchase activity. Companies run by overconfident CEOs are more likely to perceive their company as undervalued in the market, causing them to buyback stock. We demonstrate that such behavioral biases account for an appreciable portion of repurchase activity. The results highlight that curbing such behavioral biases, for instance through stronger governance, could be one avenue through which to attenuate excessive repurchase activity.

## Appendix A. Simple model

This section contains a basic formalization of the relation between CEO overconfidence and repurchase decisions. We develop a basic model to analyze the choice between dividends and repurchases from the perspectives of overconfident CEOs and non-overconfident CEOs. In short, we predict that overconfident CEOs will be more likely to repurchase shares and to substitute repurchases for CAPX or dividends.

### *A1. Managerial overconfidence and dividend/repurchase decision*

The set-up is as follows. We consider firms that, from the perspective of non-overconfident investors, have existing investments/assets-in-place denoted by $Z$ as well as 'excess' cash-holdings $C$. The cash-holding is the result of flows from past investment and retention. The firm's manager can be 'non-overconfident' (i.e., value their firm in the similar way as outside investors) or they can be 'overconfident' and believe the value of the firm's assets-in-place to be inflated by a factor $\beta > 1$. There is no disagreement about the value of cash.

In addition to differences in managerial overconfidence, we allow managers to also be asymmetrically informed about their assets-in-place. We assume that while a fraction $\theta$ of firms have assets in place of $Z$, the rest have assets-in-place of $Z + \delta$, where $\delta > 0$. Firms can choose to distribute their cash by paying dividends or by repurchasing their shares. We assume that the firms choose their distribution policies considering that it is costly to retain 'excess' cash that they do not expect they will require in the near term. There are several reasons why excessive cash retention can be costly for shareholders e.g., it may allow unions or managers to extract benefits at the expense of shareholders (Klasa et al., 2009), and may place the firm in a weaker position when negotiating with counter-parties (Hennessey and Livdan, 2009).

We restrict our discussion to the equilibrium in which firms repurchase their shares when they believe that their firms would otherwise be undervalued by the market. Otherwise, they distribute cash by paying dividends. This would be consistent with the managers acting in the interest of the shareholders who remain in the firm after the repurchase or cash distribution. Hence, a dividend distribution of $C$ would be interpreted by outside investors as indicating that the assets in place were worth $Z$, while a repurchase would indicate that the assets-in-place were worth $Z + \delta$. Based on this, the ex-dividend distribution value of the firm would be $Z$ whereas that following a repurchase would be $Z + \delta$. We assume that the market revalues the firm upon hearing whether it pays a dividend or undertakes a repurchase. Irrespective of the manager's decision, the firm's price will converge to its true value over the longer term. We assume that managers have a small preference for having their firms recognized by the market as being more valuable earlier.

In such an equilibrium, if $\delta > 0$, then for the non-overconfident manager we have, in the event of a repurchase: If the fraction of the firm's shares repurchased is $\alpha$ and the firm's share price is $P$, then we have $\alpha P = C$ (i.e., the amount purchased equals the amount of 'excess' cash holdings) and $(1 - \alpha)P = Z + \delta$.[20] This implies $\alpha = \frac{C}{Z+\delta+C}$. Thus, if a non-overconfident manager announces a repurchase, the stock price climbs from $Z + \theta\,\delta + C$ to $Z + \delta + C$, where $\theta$ is likelihood of undervaluation. By contrast if $\delta = 0$, then the non-overconfident manager would never repurchase stock (as the market would interpret it as a signal that $\delta > 0$, rendering the repurchase too expensive).

On the other hand, if $\beta$ is sufficiently large (i.e., the manager's sense of existing assets' valuations is sufficiently inflated), the overconfident manager, will always want to repurchase shares to distribute cash. This would imply that the outside investors do not revalue the shares since the repurchase is not conditional on a firm value of $Z + \delta + C$. Thus, the repurchase does not signal that $\delta > 0$.

[20] This expression follows because the total value of the assets in place after the repurchase is $Z + \delta$, while the number of shares outstanding falls to $1 - \alpha$. Thus, the price becomes $P = (Z + \delta)/(1 - \alpha)$.

In this case, we would have: $\alpha = \frac{C}{Z+\theta\,\delta+C}$. The overconfident manager will want to repurchase, rather than pay dividends, so long as he/she is willing to pay a price of $Z+\delta+C$, even though he/she realizes that the outside investors would value his firm at only $Z+C$. Hence, the condition for the overconfident manager to always repurchase (even if $\delta=0$) is:

$$\beta Z + C \geqslant Z + \theta\,\delta + C, \tag{15}$$

which implies,

$$\beta \geqslant 1 + \frac{\theta\,\delta}{Z}. \tag{16}$$

From the discussion above, it follows that if $\delta>0$, then both the overconfident manager and the non-overconfident manager would find it optimal to repurchase stock. If $\delta=0$, then the non-overconfident manager would not repurchase stock; however, the overconfident manager will repurchase if $\beta > 1+\frac{\theta\,\delta}{Z}$, i.e., if his perceived undervaluation is significantly high. This implies that overconfident managers will on average repurchase more frequently than will non-overconfident managers. Thus, we make the following proposition.

**Claim 1.** *Firms run by overconfident CEOs engage in more repurchases than do other CEOs*

### *A2. Dividend-repurchase substitution*

The foregoing logic further implies that if the firm has excess cash, then the overconfident managers will be more likely to distribute it using repurchases than dividends. The non-overconfident CEO will pay dividends whenever $\delta=0$. By contrast, the overconfident CEO would pay dividends only if $\delta=0$ and the perceived undervaluation parameter, $\beta < 1+\frac{\theta\,\delta}{Z}$ (as indicated above). Put differently, the overconfident CEO would pay dividends only if their perceived over-valuation of the assets in place is below a certain threshold. This creates a substitution from dividends to repurchases in companies run by overconfident CEOs. This implies the following hypothesis.

**Claim 2.** *Firms run by overconfident CEOs will be more likely to choose repurchase over dividends.*

### *A3. Repurchase-investment substitution*

Next, we extend the model to consider an investment opportunity. For simplicity, assume that this project requires one-time investment of $C$ and the NPV of the project is $F>0$. Given this new investment opportunity, firms can choose to distribute their cash through repurchases or dividends, or they can choose to take up the new project.

First, consider the non-overconfident manager who observes $\delta>0$. Since, there is only a small gain from having their firms recognized by the market as being more valuable earlier and because the nature of the investment does not require to sell additional equity to raise additional funds at a lower price, the non-overconfident manager will invest in the new project. As a result the short-term price will be $Z+\theta\delta+F+C$ and in the long run price converges to $Z+\delta+F+C$. Obviously, the non-overconfident manager who observes $\delta=0$ will choose to invest as well and the resulting short term price is equal to the long term price equal to $Z+F+C$.

Now, consider the case of overconfident manager. His/her decision to invest depends on comparing (a) the value of the firm if he/she invests with (b) the value of the remaining shares of the firm if he/she uses the cash to repurchase shares. Consider first the case that when the overconfident manager observes $\delta>0$. Given that overconfident managers may still repurchase even if $\delta=0$, the repurchase would not cause the market to immediately revalue the firm at $P=Z+\delta+F+C$, instead the overconfident CEO will be able to repurchase at $Z+\theta\,\delta+F+C$. Then, he/she repurchases as opposed to invests, if

$$\beta Z + \delta + C \geqslant Z + \theta\,\delta + F + C \tag{17}$$

Rearranging the above expression and simplifying we get

$$\beta_{\delta>0} \geqslant 1 + \frac{F}{Z} - \frac{\theta\,\delta}{Z} \tag{18}$$

All managers with perceived undervaluation of existing assets $\beta \geq \beta_{\delta>0}$ will give up the positive NPV investment and instead pursue share repurchase activity. Note that even if the market does interpret the repurchase as indicating that $\delta>0$, the overconfident manager would still repurchase if $\beta Z+\delta+C \geq Z+\delta+F+C$; i.e., he/she would repurchase if $\beta \geq 1+\frac{F}{Z}$.

Next, consider the case that when the overconfident manager observes $\delta=0$. Then, he/she repurchases, as opposed to invests, if

$$\beta Z + C \geqslant Z + \theta\,\delta + F + C \tag{19}$$

Rearranging the above expression and simplifying we obtain

$$\beta_{\delta=0} \geqslant 1 + \frac{F}{Z} + \frac{\theta\,\delta}{Z} \tag{20}$$

All managers with perceived undervaluation of existing assets $\beta \geqslant \beta_{\delta=0}$ will give up the positive NPV investment and instead pursue share repurchase activity.

Comparing Expressions (18) and (20), we know that $\beta_{\delta>0} < \beta_{\delta=0}$; i.e., the level of overconfidence required to motivate a repurchase instead of an investment is lower if the manager observes a positive $\delta$ rather than a zero $\delta$. The intuition is quite straightforward. When $\delta>0$ and $\beta>1$, there are two sources of market undervaluation and the overconfident manager is more likely to be swayed to pursue share repurchase activity in his effort to capture these "undervaluation" for the remaining shareholders. When the manager observes $\delta=0$, the level perceived undervaluation of the manager, $\beta$ is the only thing that matters; hence, one needs a relatively large overconfidence to justify giving up positive NPV investment opportunities. We state:

**Claim 3.** *A financially constrained and sufficiently overconfident manager at times forgoes positive NPV investments to pursue share repurchase activities.*

## Appendix B. Variable Appendix

| Variable | Definition |
|---|---|
| Repurchases (t) | An indicator that equals one if the firm repurchases stock as indicated by the firm making a positive expenditure on stock repurchases in Compustat (code: prstkc) |
| Repurchase Amount (t) | The amount that the firm spends repurchasing stock in USDm (Compustat: prstkc) |

(*continued on next page*)

| Variable | Definition |
|---|---|
| Confidence Options (t) | A continuous option-based measure of CEO overconfidence. This is the value-per-vested-unexercised option scaled by the share price. The value-per-vested-unexercised option is the total number of options scaled by the value of those options (in Execucomp codes: opt_unex_exer_num/opt_unex_exer_val). The shareprice is from CRSP/Compustat and is measured as at the end of the fiscal year (code: prcc_f) |
| Confidence Press (t) | A press-based measure of overconfidence this is defined as ln(1+ Net News/(Confident News + Non-Confident News)). Here, the 'Confident News' is the news that refers to the CEO as confident, optimistic (etc) whereas the 'Non-Confident News' refers to the CEO as pessimistic, not-confident (etc.). |
| ln[Assets(t)] | The natural log of the firm's total assets (Compustat: at) |
| ln[Total Dividends(t)] | The natural log of the total dividends. This is computed as the total dividends per share multiplied by the number of shares (Compustat: dvpsp_f × csho) |
| Cash/Assets (t) | The firm's cash holdings scaled by its total assets (Compustat: ch/at) |
| Debt/Assets (t) | The firm's long term debt scaled by its assets (Compustat: dltt/at) |
| R&D /Assets (t) | The firm's R&D expense scaled by its assets (Compustat: xrd/at). If the firm has missing R&D, we recode the firm's R&D as equal to zero |
| FCF/Assets (t) | The firm's operating cash flow scaled by its assets (Compustat: oibdp/at) |
| Industry FCF/Assets (t) | The SIC two-digit industry average FCF/Assets in that year |
| Stock return (t) | The firm's stock return over year $t$ |
| Stock return S.D. (t) | The standard deviation of the firm's stock return in year $t$ |
| Prop No Trde Days (t) | The proportion of days on which there are no trades in that year |
| Inst%Own | The percentage of the firm's shares that institutional investors own (as reported from Thomason 13f filings) |
| ln[Tenure(t)] | The natural log of the CEO's tenure as CEO in year $t$ as derived from Execucomp |
| ln[CEO Age (t)] | The natural log of the CEO's age in year $t$ |
| CEO%Own | The CEO's percentage ownership in year $t$ as derived from Execucomp |
| ST Credit Rating (t) | The firm's short term credit rating from S&P. The short term credit rating is a letter grade, which we then convert into a numerical score. A higher score connotes a better credit rating |
| CEO is Chair (t) | An indicator that equals one if the CEO is also the chairperson of the board (as obtained by having regard to the CEO's title in Execucomp) |
| BCF (t) | The firm's (Bebchuk et al., 2009) index of six key ATPs (from IRRC/RiskMetrics). IRRC does not report data in all years. For missing years, we back-fill from the most recent prioryear |
| RPI (t) | The reward-punishment-index (RPI) is based on the approach in Chang et al. (2013) and is: $\mathrm{RPI}_{i,t} = \ln\left(\sum_{q=1}^{4}\sum_{j\in\mathcal{J}}\left\lvert N_{j,i,q} - N_{j,i,q-1}\right\rvert\right)$. Where, $N_{j,i,q}$ is the number of shares owned by institutional investor $j \in \mathcal{J}$ in quarter $q$ in firm $i$. We calculate this on a yearly basis and include the RPI summed over all four quarters in year $t$ when analyzing repurchases that are made in year $t+1$. The data is from the Thomson 13f filings. |

## Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jbankfin.2018.02.003.

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