International Review of Financial Analysis 79 (2022) 101964

Contents lists available at ScienceDirect

International Review of Financial Analysis

journal homepage: www.elsevier.com/locate/irfa

A new method for measuring CEO overconfidence: Evidence from acquisitions

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ARTICLE INFO

JEL classification:
G14
G30
G34

Keywords:
CEO overconfidence
Synergies forecast error
Hubris
Mergers and acquisitions
Takeover premium
Abnormal returns

ABSTRACT

This study proposes a new direct method of measuring managerial overconfidence using an acquisition setting. CEOs with significantly higher synergies forecast error (SFE), measured as the deviation between acquisition forecasted operating synergies and actual realized operating synergies, are more likely to exhibit traits of overconfidence. In support of this view, we find that synergies forecast error is positively related to takeover premium and negatively related to acquirer returns. Additionally, validation tests confirm that high SFE firms conduct more diversifying acquisitions. Reflecting, as well, the ex-ante power of the overconfidence measure in other settings, high SFE firms have a positive relation with capital expenditures, leverage, and innovation, and negative relation with equity issues.

1. Introduction

Roll's (1986) hubris hypothesis refers to the tendency of decision makers to overestimate their own abilities when engaged in merger and acquisition (M&A) decisions. Since his seminal work, it has been widely held that managerial overconfidence is one of the most important motives in explaining M&As. Within this framework of CEOs with idiosyncratic biases but efficient markets,[1] a vast literature analyzes the impact of CEO overconfidence on merger activity and acquirer shareholders' wealth, and points to excessive acquisitiveness and significant value destruction for acquisitions initiated by overconfidence [See, e.g., Roll, 1986, Hayward & Hambrick, 1997, Doukas & Petmezas, 2007, Malmendier & Tate, 2008, Billett & Qian, 2008, and Ferris, Jayaraman, & Sabherwal, 2013]. Measuring a behavioral trait, such as CEO overconfidence, however, is not trivial. In this paper, we propose and empirically test a new method for measuring managerial overconfidence that is *directly* linked to each acquisition. In particular, we estimate overconfidence as the deviation of CEO forecasted operating synergies prior to an acquisition deal from acquiring firm actual realized operating synergies after the deal.

Given the limitations of direct measurement when collecting data from executives [Hambrick & Mason, 1984], and the lack of a validated instrument for use in direct inquiries [Hayward & Hambrick, 1997; Hiller & Hambrick, 2005], researchers have developed several measures from secondary data to assess executive overconfidence (mainly takeover premium paid to target firms and time of exercise of CEO stock options). While these proxies offer useful tools to measure overconfidence, the objective of this study is to complement their work by responding to Roll's (1986) call to precisely quantify the magnitude of CEO overconfidence in a *specific deal*. The fact that we can construct a measure that captures directly CEO overconfidence can be important not only to individuals wishing to invest in stocks but also to financial advisors or analysts when evaluating managerial decisions and their effect on firm value.

Consistent with Roll's hubris hypothesis, we propose a measure of CEO overconfidence directly related to the event in question (i.e., acquisitions) which makes a direct comparison between a forecast (i.e., CEO forecasted acquisition operating synergies prior to the deal) and a

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[1] For papers using a similar research framework, see for example, Benos (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), Gervais and Odean (2001), [Malmendier and Tate 2005, 2008], Doukas and Petmezas (2007), Chen, Podolski, Rhee, and Veeraraghavan (2014), Aktas et al. (2019), and Sauerwald and Su (2019). In contrast, another strand of literature focuses on rational agents operating in irrational markets [see for example, Ikenberry et al., 1995; Loughran & Ritter, 1995; Shleifer & Vishny, 2003, and Baker & Wurgler, 2004].

https://doi.org/10.1016/j.irfa.2021.101964
Received 11 May 2021; Received in revised form 1 September 2021; Accepted 11 October 2021
Available online 30 November 2021

realized outcome (i.e., actual realized operating synergies after the acquisition deal). Our measure of overconfidence is in the spirit of Roll's argument in which bidders pay more for the targets when their forecasts are more optimistic than the realized synergies.

Whilst our overconfidence measure could be applied to a more general framework (e.g., overall corporate performance), we consider M&As as the ideal testing platform for the following reasons. First, acquisitions are risky projects with uncertain net present value outcome, relative to capital expenditures, for instance, which are characterized by lower uncertainty [see, e.g., Harford & Li, 2007]. Prior literature has shown that people tend to be more overconfident about their performance on hard rather than easy tasks [Hirshleifer, Low, & Teoh, 2012; Griffin & Tversky, 1992]. Therefore, we expect relatively overconfident CEOs to be especially enthusiastic about risky and challenging corporate decisions such as M&As. Second, acquisitions are the largest and most important corporate investments in the entire life of a firm [Harford & Li, 2007], which are often associated with significant losses [particularly in public deals [Moeller, Schlingemann, and Stulz (2004)]; CEO overconfidence has been established as one of the most common explanations behind value destruction in acquisitions. Third, M&As allow for a direct assessment of overconfidence because our measure can be regressed against outcome variables such as takeover premium and acquirer announcement stock abnormal return, with easily identifiable predictable hypotheses (i.e., positive relation with takeover premium and negative relation with acquirer announcement cumulative abnormal returns (CARs)).

We base our analysis on the two most common reflections of managerial overconfidence in M&As: these are cross-sectional regressions in which takeover premium and acquirer CAR are the main outcome variables. As expected, we find that SFE has a positive relation with takeover premium. Economically, a one unit increase in SFE leads to 8.07% higher takeover premium. Additionally, acquirers with higher SFE are related with 2.86% lower announcement 5-day CAR, translating into $294.29 million value destruction for the average acquirer in the sample. Collectively, these results are consistent with the theoretical predictions of Roll's (1986) hubris theory and empirically support that our proxy captures CEO overconfidence.

Next, we attempt to rule out other potential explanations regarding what our proxy captures. We control for corporate governance [as in Bebchuk, Cohen, & Ferrell, 2009] since bad corporate governance firms may not monitor their CEOs adequately, for managerial ability [Demerjian, Lev, & McVay, 2012] in case our proxy captures ability rather than overconfidence, and litigation risk as CEOs might underestimate forecasted synergies to reduce litigation risk. Further, our results hold when we control for acquirer or target sigma. Additionally, our main models already control for acquirer market-to-book, so growth prospects do not seem to be a plausible story for the relationships we uncover. Overall, in all cases above, we find that synergies forecast error has a positive association with takeover premium and negative relation with acquirer CARs with coefficients of similar magnitude to the ones of the baseline models, which rules out that any of the above interpretations is hidden behind our proposed measure of overconfidence.

Next, to further validate that our measure proxies for overconfidence we do the following test. Malmendier and Tate (2008) provide evidence that overconfident CEOs do more diversifying acquisitions, and that the effect of overconfidence on diversifying deals is more pronounced within cash-rich firms. We show that synergies forecast error has a positive relation with diversifying deals, while the effect is more pronounced within cash-rich than non-cash-rich firms.

More importantly, we assess the *ex-ante* power of our proxy as a measure of managerial overconfidence. Whereas an important part of our measure is the *ex-post* synergies element, it is still a useful tool for the *ex-ante* assessment of CEO's overconfidence status. This is due to the fact that once a CEO is characterized as overconfident based on our measure in M&A deals, then this characterization can be used for the assessment of later corporate decisions, indicating its value as an *ex-ante* measure. That is, once a CEO is characterized as overconfident based on our measure in an M&A setting, then our measure can be assessed against other subsequent corporate actions. This test will also serve as an additional validation test of our overconfidence measure. In particular, prior literature has provided evidence that overconfident CEOs are related with higher capital expenditures [Malmendier & Tate, 2005], more leverage [Malmendier, Tate, & Yan, 2011], less equity issues [Malmendier et al., 2011], and higher levels of innovation [Hirshleifer et al., 2012]. We, therefore, run tests to examine the relation between CEO overconfidence based on the M&As synergies forecast error and outcome variables based on the above literature related with subsequent (to M&As) corporate actions. We find significant relations with the predicted sign. These validation results further reinforce our baseline empirical evidence that our measure captures CEO overconfidence.

Ideally, we would like to examine whether our measure has the predicted relation with acquisition outcomes for multiple acquirers. In particular, if a CEO is involved in serial acquisitions, then one could investigate whether firms with CEOs classified as overconfident in the first deal have higher synergies forecast error in the deals, which is accompanied by higher takeover premium and lower acquirer announcement return. Unfortunately, there are very few multiple acquirers in our sample to allow for any meaningful results. Nevertheless, as previously argued, our measure of overconfidence can be used beyond acquisitions allowing to examine other corporate actions.

Finally, we perform a few tests to alleviate any concerns regarding sample selection and endogenous matching between the CEO and firm characteristics. Regarding the former, it is possible that our results are driven by sample selection bias since not all firms choose to disclose their synergy forecasts. The two-stage Heckman model suggests that our sample does not suffer from sample selection bias, corroborating our baseline results. In addition, one may argue that certain firms choose specific CEOs to carry out their policies and as a consequence leading to spurious results. We follow Hirshleifer et al. (2012) and Aktas, Louca, and Petmezas (2019) and re-run the main analysis after excluding recently appointed CEOs (i.e., CEO with tenure being less than one year or less than three years). These are the cases, which most likely relate to the appointment decision, and could, thus, potentially cause a spurious relationship. We obtain quantitatively similar results, which alleviates endogeneity concerns.

Our paper's main contribution lies in the construction of a new measure of CEO overconfidence. Existing literature has primarily used CEO stock options and business press as measures of overconfidence focusing, among others, on investment [Malmendier & Tate, 2005; Malmendier & Tate, 2008], and financing [Malmendier et al., 2011]. More recent studies have examined CEO overconfidence based on machine-readable data [e.g., Kolasinski and Li, 2013] which mitigates the problem of costly hand collected data and sample size but does not constitute a direct measure of CEO overconfidence. Our study focuses on M&As and offers a direct– as we believe – measurement method of CEO overconfidence which has the following advantages: i) it is directly linked to the corporate decision in question as in the spirit of Roll (1986); ii) it is constructed based on CEO's *himself* estimations of synergies toward a specific deal, rather than on outsiders' views (for instance, business press, which reflects the – perhaps – biased views of journalists or analysts); iii) the forecasted operating synergies are subsequently assessed against the actual realized operating synergies; in other words, generated synergies approve or disapprove estimated-forecasted synergies. In fact, this measure could directly assess whether overconfident CEOs destroy firm value instead of relying on less direct measures.

Our paper also contributes to several strands of literature. Particularly, it contributes overall to the burgeoning literature on the effects of managerial characteristics on corporate policies and performance [see for instance, Bertrand & Schoar, 2003, Graham, Li, & Qiu, 2012, and Sauerwald & Su, 2019, Lai, Li, & Chan, 2021]. In terms of individual characteristics our paper adds to the literature that shows a relation

between CEO's ability and execution skills with corporate performance [Kaplan, Klebanov, & Sorensen, 2012], managerial skills and pay [Custodio, Ferreira, & Matos, 2013], executives' gender and their investment decisions [Huang & Kisgen, 2013], CEO age and acquisitiveness [Yim, 2013], CEOs raised during the Great Depression and leverage [Malmendier et al., 2011], CEOs' behavioral traits and corporate financial policies and compensation structure [Graham, Harvey, & Puri, 2013], CEO power and risk taking [Lewellyn & Muller-Kahle, 2012], and CEO characteristics and internal control quality in response to the disclosure requirements mandated by the SOX 404 [Lin, Wang, Chiou, & Huang, 2014].

Additionally, we contribute to research on the motives behind M&As. Several studies suggest that synergies or efficiency gains lie behind M&As [see for instance, Jensen & Ruback, 1983 and Servaes, 1991], which should be associated with value increasing effects. On the contrary, there are studies which suggest value decreasing effects of M&As attributing this result to different motives such as empire building/agency reasons [e.g., Jensen, 1986; Harford, 1999] or managerial overconfidence [e.g., Roll, 1986; Malmendier & Tate, 2008].

The paper also contributes to the literature of behavioral corporate finance looking at the effects of biased managers in efficient markets [Barberis & Thaler, 2003; Baker, Ruback, & Wurgler, 2007, and Aktas et al., 2019], and more specifically, to the literature on managerial overconfidence. Consequently, our study separates itself from studies that examine, for example, market timing [Ikenberry, Lakonishok, & Vermaelen, 1995; Loughran & Ritter, 1995], investor catering [Cooper, Khorana, Osobov, Patel, & Rau, 2005; Baker & Wurgler, 2004], and stock market valuation as merger motive [Shleifer & Vishny, 2003; Rhodes-Kropf & Viswanathan, 2004], in which agents are rational but are operating in inefficient markets. Seemingly, our study also partly distinguishes itself from the neoclassical theory of mergers such as Jensen (1993), Mitchell and Mulherin (1996), Jovanovic and Rousseau (2002), and Harford (2005), in which agents are rational and markets are efficient.

The remainder of the study proceeds as follows. Section 2 provides a literature review of the existing measures of overconfidence. Section 3 describes the sample, our measure of CEO overconfidence, and the variables used in the empirical analysis. Section 4 examines the effect of CEO overconfidence on: i) takeover premium; ii) acquirer CARs; iii) considers alternative explanations; and iv) examines the *ex-ante* power of our overconfidence measure in other corporate finance settings. Section 5 conducts endogeneity checks and performs some further tests. Finally, Section 6 concludes the paper.

2. Related literature and critical review of existing measures of CEO overconfidence in M&As

2.1. CEO stock options

The most commonly used measure of managerial overconfidence was proposed by Malmendier and Tate [Malmendier and Tate, 2005, Malmendier and Tate, 2008]. This measure is based on the notion that CEOs prefer not to exercise stock options timely, as would typically be optimal for risk-averse undiversified executives, though they are sufficiently in the money [Hall & Murphy, 2002]. In particular, Malmendier and Tate (2008) use the following proxies related to option exercising behavior: i) *Longholder,* if the CEOs holds an option though it is at least 40% in-the-money entering its final year; and ii) *Holder 67*, which relaxes the requirement that CEOs hold their options all the way until expiration but focuses on the exercise decision in the fifth year prior to expiration. In this framework, overconfident is the CEO who fails to exercise options with five years remaining duration despite a 67% increase in stock price (or more) since the grant date. Though the stock-option based measure has its own benefits, there are a number of important shortcomings.

First, CEO option exercise behavior may reflect various constructs or contextual factors [Hill, Kern, & White, 2014] and be related to other factors (for instance, industry mispricing and growth opportunities [Cao, 2009], or CEOs risk tolerance [Aktas, Louca, & Petmezas, 2018]). Second, limited information might create selection bias [Hill et al., 2014]; in fact, Malmendier and Tate (2008) acknowledge as shortcoming of the longholder measure its lack of power, since only 42% of their sample observations fall into the longholder category capturing only 74 mergers. Third, since option exercising is a market-based measure, it might suffer from endogeneity bias, i.e., option exercising behavior might be driven by increased stock performance, which should then affect M&A decisions. Fourth, the stock options holding measure is somewhat diffuse as it measures inaction – it is impossible to identify the moment when the decision to do nothing is taken, which, together with the fact that data on CEO stock options holding is annual, implies that the link between the non-exercise of stock options and important strategic decisions is difficult to establish precisely. The non-exercise of stock options might also reflect a situation in which the CEO needs to reassure the board and investors about their commitment to the firm's future, irrespective of overconfidence. Fifth, if a CEO is identified as overconfident by this measure, he remains so for the rest of the sample period; however, the same CEO might have not had the same option exercising behavior in later years but still being included in the overconfident CEOs sample altering the conclusions generated. Finally, while CEO longholder measure has been established as a measure of overconfidence, it not entirely obvious that it does not ultimately capture the opposite, i.e., *under*confidence. In particular, non-option exercising behavior might reflect (apart from overestimation of expected profitability from undertaking of new projects) underestimation of stock return volatility. Underestimation of risk implies overvaluing the stock, which should discourage a CEO from exercising and selling. However, no-arbitrage option pricing theory implies that volatility increases the value of the option feature. As discussed by Malmendier et al. (2011), underestimation of risk could encourage overconfident managers to exercise options early instead of late. If so, the options-based measure could alternatively proxy for *under*confidence.

2.2. Business press

The second conventional overconfidence measure is the financial press-based measure, which classifies a CEO as overconfident if the number of press articles in leading business publications describing the manager as “confident/optimistic”, or words of similar nature, exceeds the number of articles describing the manager as “pessimistic/cautious”, or with similar words [Malmendier & Tate, 2008; Hirshleifer et al., 2012].[2] Despite the fact that this is not a market-based measure, since it relies on how CEOs are perceived by outsiders, it is a “necessarily noisy and less precise measure” [Malmendier & Tate, 2008, p.38]; particularly, media comments may lack objectivity because of media bias or the perceptional biases associated with the author of the article portraying the executive [Hill et al., 2014]. Additionally, limited information might – like the option-based measure – create selection bias. Finally, as Malmendier and Tate (2008) state, press coverage suffers from an important endogeneity problem: mergers may change the tenor of press coverage. The press may perceive acquiring CEOs as more confident, or managers may try to convey confidence during acquisition bids. In particular, CEOs might leak stories about forthcoming acquisitions and say that they are “confident” about these projects imposing endogeneity bias.

[2] Hayward and Hambrick (1997) have also used media press to determine overconfident CEOs, without however, providing specific terms for the choice of words used to characterize CEOs as overconfident/non-overconfident.

2.3. Net buyer

The third measure employed by Malmendier and Tate (2005) – and other studies later – is the net buyer. Like the option-based measure, this is again a market-based proxy, and it is determined by the tendency of some CEOs to buy additional firm stock regardless of their already high exposure to firm risk, i.e., if they bought stock on net in more years than they sold on net during their first five sample years (excluding the first five years of their tenure). Nevertheless, this measure might also capture managers' expectations about strong future stock performance or CEOs risk tolerance. Additionally, it might suffer from endogeneity bias, i.e., buying stocks might be driven by prior stock performance, which should then, in turn, affect acquisition investment decisions.

2.4. Other proxies of managerial overconfidence

Finally, the extant literature provides further measures of managerial overconfidence, though less commonly used. These are i) the relative compensation, i.e., CEOs who believe they have far superior abilities than other executives and require this to be manifested in a much higher cash compensation than the next highest paid executive [Hayward & Hambrick, 1997]. However, this measure is rather noisy, as compensation could proxy for several other factors [for instance, lower risk aversion Guay, 1999 or entrenchment Berger, Ofek, & Yermack, 1997], and also suffers from endogeneity bias (i.e., the decision of the compensation package offered to the CEO might be correlated with other factors that affect investment choices); ii) recent organizational performance, i.e., recent organizational success is likely to foster CEO hubris [Hayward and Hambrick, 1997]. However, using such a measure, gives rise to serious endogeneity issues (i.e., reverse causality); iii) frequent acquirers, as in Doukas and Petmezas (2007) and Billett and Qian (2008). In particular, these studies suggest that acquirers involved in serial deals in a very short period of time are affected by overconfidence, sourced by self-attribution bias, leading to value-destruction in later M&A deals. However, there are studies, which provide opposite evidence, i.e., higher returns for frequent acquirers, attributing this finding to the "learning by doing" concept, i.e., CEOs gain experience from every deal, which makes them take better decisions in later deals [Aktas, de Bodt, & Roll, 2009]. Additionally, self-selection bias might arise in CEO decisions to engage into M&A deals. Finally, though this measure is directly related to acquisition, it does not precisely quantify the magnitude of CEO overconfidence in each specific deal.

3. Sample, data, and measure of CEO overconfidence

3.1. Sample and data

We collect the acquisition sample from the Thomson Reuters SDC M&As Database. The sample deals involve completed acquisitions of US publicly listed targets by US listed acquirers announced over the period between January 1st, 1993 and December 31st, 2013. Filtering follows standard procedures as in the M&A literature [Ang, Daher, and Ismail, 2019 and Ismail, Khalil, Safieddine, and Titman, 2019]. Share price data are from the Centre for Research in Security Prices (CRSP) database and accounting information is from COMPUSTAT for the period. We exclude financial and utility firms (SIC 6000–6999 and 4900–4949, respectively). To ensure we include only economically meaningful deals, we require the transaction value to be at least $1 million. Additionally, we require the acquirer to own more than 50% of the target firm shares after the deal.

To be included in the sample we also require acquiring firms to have data on forecasted synergies, which are manually collected from the SEC. The sample period ranges from 1993 to 2016 (three-year forecasts) or 2018 (five-year forecasts). Forecasted synergies represent the after-tax present value of the forecasted incremental cash flows for each acquisition as in Houston, James, and Ryngaert (2001), Ismail (2011), and Dutordoir, Roosenboom, and Vasconcelos (2014). The incremental cash flows are disclosed by the management of the acquiring firm and consist of forecasts related to cost savings and revenue enhancement, in addition to other merger costs, such as restructuring costs and financial advisors' fees. To obtain incremental cash flows, we manually search and hand-collect projections released during press conferences, and forecasts reported in 8-K filings and proxy statements DEF14, DEFM14A, and S-4 filed with the SEC. The sample of deals with available incremental cash flow forecasts consists of 607 completed deals. However, we further restrict the sample to deals with enough data to estimate an appropriate discount rate. Therefore, our final sample consists of 497 deals for which we are able to calculate the present value of forecasted synergies.

We make a note at this point. We acknowledge that a limitation of our study is that the use of forecasted synergies is not greatly populated. However, this is in line with prior studies, which show that forecasted synergies are confined to relatively small samples. For instance, Houston et al. (2001) employ a sample of 41 large bank mergers, Dutordoir et al. (2014) show that the fraction of deals with disclosed synergy forecasts (341 deals) represents around 17.34% of their sample of completed deals between 1995 and 2008, whereas Ismail et al. (2019) report that nearly 19.5% of the deals in their sample were accompanied with forecasted synergies. It is important to highlight, however, that the frequency of voluntarily disclosing incremental cash flow forecasts around merger announcements has increased considerably over time, particularly among larger deals accounting for more than 40% of the entire sample (i.e., forecast and no-forecast subsamples) in the last ten years of the sample period. Additionally, while prior studies document that forecast versus no-forecast subsamples exhibit different acquirer, target, and deal characteristics [Dutordoir et al., 2014; Ismail et al., 2019], in our sample, the total deal volume of the synergy forecast sample is more than 78% of the deal volume of the no-forecast sample ($986 billion vs. $1261.5 billion, respectively). Thus, it is apparent that sample representativeness is not a serious concern in this study.

Finally, since synergy forecasts are not available for all M&A deals, we run a two-step Heckman regression model to alleviate any concerns that our results are driven by sample selection bias and we find this not to be the case (see discussion in Section 5.1).

3.2. Calculation of forecasted synergies and actual synergies

The calculation of the present value of forecasted synergies follows a procedure similar to Kaplan and Ruback (1995), Gilson, Hotchkiss, and Ruback (2000), Houston et al. (2001), Ruback (2002), Devos, Kadapakkam, and Krishnamurthy (2009), Ismail (2011), and Dutordoir et al. (2014).

In certain cases, the management does not report projections with defined timelines, thus we follow Houston et al. (2001), Dutordoir et al. (2014) and Bernile & Lyandres (2019) and interpose cash flows for the intermediate years by assuming they grow linearly over those years. In most cases (approximately 91%), the management projects synergies to be realized within a three- to four-year window. In very rare cases, though, synergies are projected to be realized in less than three years. We assume that cash flows become perpetual after the last year of projection as declared by the management and we use a flat tax rate of 36% similar to Bernile and Lyandres (2019) and slightly less than Houston et al. (2001) who apply the federal tax rate plus 3 percentage points as most banks face also state tax in addition to the federal tax rate. We calculate the present value of forecasted synergies by discounting back the projected after-tax cash flows to the announcement date as follows:

$$PV\ (Forecasted\ Synergies) = \sum_{t=i}^{T} \frac{(1-0.36)CF_t}{(1+R_e)^t} + \frac{(1-0.36)CF_{i+T}}{R_e(1+R_e)^{i+T}} \quad (1)$$

Whereby $i = 1 +$ (days to completion/365). We account for the period between the announcement date and the completion date

because cash flows are forecasted to be generated in future years relative to the completion date. We use as a discount rate (R_e), the weighted average cost of equity capital of the acquiring and target firms as calculated using the Capital Asset Pricing Model (CAPM).[3]

We define the actual synergies as the present value of the annual changes in actual Equity Cash Flows or Free Cash flow to Equity (FCFE) from the pre-merger year to the three-year post-merger period (+1, +2, +3)[4] as follows:

$$PV\ (Actual\ Synergies) = \sum_{t=1}^{3} \frac{\Delta FCFE_t}{(1+R_e)^t} + \frac{\Delta FCFE_{t+1}}{R_e(1+R_e)^{t+1}} \quad (2)$$

In terms of cash flow timing, similar to our assumption in calculating the forecasted synergy, we also assume that actual incremental cash flows become perpetual beyond year 3.

Where we define annual change in cash flow (ΔFCFE) as:

$$\Delta FCFE_t = FCFE_t - Combined\ FCFE_{pre\ merger} \quad (3)$$

In measuring actual synergies, we aim to be consistent with the notion and the spirit of the literature that usually examines operating performance improvement after corporate events. For instance, the M&As literature uses the change in operating cash flows from pre- to post-acquisition years after adjusting for industry averages as a measure of performance improvement [Healy, Palepu, & Ruback, 1992; Ghosh, 2001; Linn & Switzer, 2001, and Carline, Linn, & Yadav, 2009]. The latter paper clearly uses the change in operating cash flow return as merger-related performance improvement measure.

Moreover, we tried to depart from the notion of estimating forecasted synergy as reported in the literature and as defined by theory and by practitioners. That is, synergy results mainly from cost savings and revenue enhancements. We applied this principle for estimating forecasted and actual synergies as in prior research [Houston et al., 2001; Devos et al., 2009; Ismail, 2011; Dutordoir et al., 2014; Bernile & Lyandres, 2019]. Moreover, our methodology is more closely consistent with Devos et al. (2009) who define operating synergies as arising from changes in cash flow related to operations such as increased operating profits and savings from reductions in investments.

Overall, actual cost savings, revenue enhancements, and reductions in investments are captured by changes in cash flows; therefore, we adopt the procedures and notions of the aforementioned studies to estimate the present value of actual synergies.

Thus, pre-merger equity cash flows (Combined ECF_{t-1}) are the pro-forma cash flows of the target and acquiring firms. To discount the annual changes in actual cash flows (ΔECF_{t+1}), we also follow a similar procedure to calculating the present value of forecasted synergies, by using the same discount rate and assuming that changes in cash flows beyond year three become perpetual. We scale both the forecasted and actual synergies by the combined equity value of the target and acquiring firms in the pre-merger year. Alternatively, we calculate the actual synergies by discounting the annual changes in actual Equity Cash Flows (ECF) from the pre-merger year to three post-merger years only followed by perpetual cash flows. The results we obtain are similar.

We note that it is also possible that CFOs, rather than the CEOs, are actively involved in the process of synergies forecasting in M&As. Undoubtedly, however, it is the CEO who has the final say in this decision, since it is he who is open to public scrutiny if forecasts are not met. The fact that the CEO may delegate responsibilities does not imply he will accept any forecasts without any reservations. It, therefore, seems more probable for the average CEO in a public firm to evaluate, revise, and finalize such forecasts on major firm events rather than merely be only the announcer of these.

3.3. Measure of CEO overconfidence

Our proposed measure of CEO overconfidence, labelled as *synergies forecast error*, is a continuous variable defined as the difference between the forecasted and actual operating synergies. The higher the forecasted synergies relative to the actual synergies the more overconfident the CEO is. We find that out of 497 deals, 182 deals (i.e., 36.62%) have higher forecasted synergies than actual synergies. Even though the construction of our measure allows a CEO's overconfidence to change across acquisition deals, we note that most of the CEOs in our sample have only one deal. While on average forecasted synergies are lower than actual synergies (11.68% versus 35.27%, significant at the 1% level), in the cases where forecasted synergies are higher than actual synergies, the mean difference is 18.08% (statistically significant at the 1% level). We expect that the largest part of CEO overconfidence variation lies within firms with high difference between forecasted and actual synergies. Additionally, the proportion of overconfident relative to non-overconfident CEOs obtained with our measure of overconfidence follows the patterns of previously used measures of overconfidence which identify that the majority of CEOs is not necessarily overconfident [see, for example, Malmendier & Tate 2005, 2008].

In addition, we also examine the correlation of SFE with other measures of overconfidence. As Malmendier and Tate (2008) find, the magnitudes of some of the overconfidence measures are low. The reason provided by the authors is the fact that managerial traits (e.g., overconfidence) are not directly observable while also constructed from different data sources and as a result, they can be noisy. We, nevertheless, construct the overconfidence measure Holder 67 as in Malmendier and Tate (2008) using data from Compustat's Execucomp. Similar to Malmendier and Tate (2008), we find a low correlation between our measure of overconfidence and Holder 67. This is not surprising as our measure is constructed using data from press releases and SEC filings, which is different to the proxies used in the literature.

3.4. Descriptive statistics

In Table 1, we report sample statistics for the merging parties and for deal characteristics. In order to reduce the effect of possible outliers, we winsorize variables at the 5% and 95% levels, except the premium, values below 0% or above 200% are truncated following Officer (2003). The table reveals these acquisitions are settled with pure shares (pure cash) payment in 25.96% (30.18%) of the cases and 68.81% of them are within the same industry (based on 2-digit SIC). As for size, these transactions involve both large acquirer and target firms; for instance, the mean (median) acquirer size (*ASize*), measured by the market value of assets, is $15.74 billion ($4.29 billion). Similarly, target size (*TSize*) has a mean (median) of $2.12 billion ($1.18 billion). Additionally, the market-to-book ratio of the acquirer (*AM/B*) is quite large compared to target firms (*TM/B*), with mean (median) of 3.50 (2.37) vs. 2.75 (2.10). In terms of performance, we notice that both merger parties have quite high operating cash flow ratios. Namely, the mean (median) ratio for the acquirer (*AOCF*) is 7.48% (7.55%) while the corresponding value for the

[3] The weights are the relative equity values of the target and acquiring firms two months prior to the announcement date. We use the cost of equity to discount cash flows assuming that these cost savings and revenue enhancement accrue to shareholders only, which is consistent with Houston et al. (2001) and Weston, Siu, and Johnson (2001). We calculate CAPM betas by regressing daily firm stock returns against CRSP value-weighted returns from 230 to 41 trading days prior to the announcement date. We use a market risk premium of 7.5% per annum, in line with prior relevant studies [e.g., Houston et al., 2001 and Devos et al., 2009 use market risk premium of 7%, and Gilson et al., 2000 use 7.4%]. We employ the 10-year U.S. government bond yield to proxy for the risk-free rate. If we obtain a negative beta, we replace it by the sample average beta, which is 1.034 for acquirers and 0.997 for targets.

[4] Equity cash flow is defined, based on Compustat items, as follows: (SALE – COGS – XSGA – TXT – WCAPCH – CAPX – XINT), where SALE represents total Sales, COGS is Cost of Goods Sold, XSGA is Selling, General and Administrative Expenses, TXT is the Total Income Taxes, WCAPCH is Total Working Capital Change, CAPX is Capital Expenditures and XINT is Total Interest and Related Expense at the end of the fiscal year.

Table 1
Sample statistics.

Variables	Observations	Mean	Median	Std	Min	Max
Panel A: Deal Characteristics						
Takeover Premium	475	0.4161	0.3497	0.3753	0.0000	2.0000
Synergies Forecast Error	497	−0.2107	−0.0915	0.4852	−1.6205	0.4497
Forecasted Synergy	497	0.1168	0.0699	0.1331	0.0065	0.5401
Actual Synergy	497	0.4012	0.2058	0.6049	−0.2867	2.1543
Pure Shares	497	0.2596	0.0000	0.4388	0.0000	1.0000
Pure Cash	497	0.3018	0.0000	0.4595	0.0000	1.0000
Industry Relatedness	497	0.6881	1.0000	0.4637	0.0000	1.0000
Toehold	497	0.0201	0.0000	0.1406	0.0000	1.0000
Hostile	497	0.0282	0.0000	0.1656	0.0000	1.0000
Competed	497	0.0402	0.0000	0.1967	0.0000	1.0000
Tender Offer	496	0.1512	0.0000	0.3586	0.0000	1.0000
M&A Liquidity	496	0.0331	0.0188	0.0534	0.0001	0.3885
Panel B: Acquirer Characteristics						
ASize	495	15,741.47	4293.94	26,227.62	46.94	102,145.75
AM/B	495	3.5005	2.3705	3.1985	0.6014	14.8606
ADebt	494	0.3385	0.3058	0.1868	0.0262	0.6760
AOCF	495	0.0748	0.0755	0.0489	−0.0798	0.1539
Net Equity Issues	480	0.0011	0.0000	0.0414	−0.0945	0.2110
ARunup	485	0.0333	0.0267	0.1584	−0.3195	0.4222
AHHI	496	0.0610	0.0421	0.0606	0.0079	0.4635
CARs	485	−0.0218	−0.0157	0.0843	−0.1855	0.1413
AEindex	340	2.3441	2.0000	1.2512	0.0000	5.0000
Ama_score	470	0.0321	−0.0076	0.1710	−0.2950	0.5887
ALitigation	497	0.1710	0.0000	0.3769	0.0000	1.0000
ASigma	491	0.0248	0.0213	0.0160	0.0056	0.2262
Panel C: Target Firm Characteristics						
TSize	493	2118.79	1175.50	2141.45	13.74	5839.18
TM/B	493	2.7490	2.1027	2.2732	0.1486	10.1649
TDebt	492	0.3813	0.3658	0.2154	0.0312	0.7958
TOCF	493	0.0621	0.0787	0.0858	−0.2965	0.1691
TRunup	484	0.0701	0.0594	0.1885	−0.3438	0.5978
TIlliquidity	482	0.0003	0.0000	0.0009	0.0000	0.0127
TEindex	248	2.4677	2.0000	1.3160	0.0000	5.0000
TSigma	481	0.0304	0.0259	0.0156	0.0080	0.0923

The table presents summary sample statistics for acquirer, target firm, and deal characteristics for which there is information on synergies forecast error. The sample includes acquisitions announced by US acquirers between January 1993 and December 2013 as reported by the SDC, where the acquirer completes a deal and gains control of a public target firm. We exclude financial companies (Standard Industrial Classification (SIC) codes 6000–6999) and utilities (SIC codes 4900–4949) from the sample. All acquirer and target firm characteristics are at the end of the fiscal year prior to the acquisition. Variables definitions are in the Appendix. Dollar values are in $ millions.

target firm (*TOCF*) has a mean (median) of 6.21% (7.87%). Finally, acquiring firms appear to be less levered than target firms with the mean (median) acquirers' debt ratio (*ADebt*) being 33.85% (30.58%), whereas the mean (median) ratio of the target firms is 38.13% (36.58%).

4. Results

4.1. Synergies forecast error and takeover premium

We begin our main analysis by examining the relation between the *synergies forecast error* and acquisition premium. The first hypothesis states that overconfident managers tend to overestimate their own abilities to create value and therefore end up offering higher takeover premium [Roll, 1986].

Table 2 presents the results of this analysis. The dependent variable is the acquisition premium calculated as the difference between the offer price and the target firm's stock price 4 weeks prior to the acquisition announcement divided by the latter. The main variable of interest is the *synergies forecast error* - our direct measure of managerial overconfidence - which is regressed against the acquisition premium offered in M&A deals. In all specifications, we control for various deal, acquirer, target firm, and industry characteristics that have been shown to affect takeover premium [see for example, Betton, Eckbo, & Thorburn, 2009; Alexandridis, Fuller, Terhaar, & Travlos, 2013].

At the deal level, we control for the method of payment (*pure cash* and *pure shares*) used in the transaction, *industry relatedness*, *toehold* held in the target firm, the target firm's response on the initial bid (*hostile*), the presence of multiple bidders (*competed*), and tender offers (*tender offer*). In addition, we control for various acquirer and target firm characteristics that affect takeover premium. More specifically, we account for the market value (*ASize and TSize*), market-to-book value (*AM/B* and *TM/B*), leverage (*ADebt* and *TDebt*), operating cash flows (*AOCF* and *TOCF*), and stock price run-up (*ARunup* and *TRunup*). We also include the target firm's Amihud illiquidity ratio (*TIlliquidity*) to account for the liquidity in the target firm's stock price. Finally, we include industry characteristics such as the liquidity in the M&A market (*M&A liquidity*) and the Herfindahl-Hirschman industry concentration index (*HHI*). All acquirer and target characteristics are taken at the end of the fiscal year prior to the acquisition.

Column (1) shows the estimates of the OLS regression without fixed effects. Consistent with our expectations, the *synergies forecast error* is positive and statistically significant at 5% level suggesting that overconfident managers offer higher premiums (compared to non-overconfident managers) when bidding for target firms. The sign and significance of the control variables are also consistent with prior literature. For example, paying for with shares or acquiring a larger target has a negative relation with takeover premium while an unsolicited bid, a tender offer, acquirer size, M&A liquidity, and target firm's stock runup are positively associated with takeover premium.

Columns (2) and (3) include year-fixed effects, and industry- and year-fixed effects, respectively to account for variations across industry and time that may affect takeover premium [see e.g., Alexandridis,

Table 2
Takeover premium.

	(1)	(2)	(3)
Intercept	0.5140***	0.525	0.415
	(0.090)	(0.327)	(0.489)
Synergies Forecast Error	0.1150**	0.132**	0.127**
	(0.056)	(0.063)	(0.064)
Pure Shares	−0.0561*	−0.0562	−0.0496
	(0.034)	(0.038)	(0.040)
Pure Cash	−0.0449	−0.0297	−0.0128
	(0.036)	(0.041)	(0.044)
Industry Relatedness	0.0341	0.042	0.0425
	(0.029)	(0.033)	(0.034)
Toehold	−0.0904	−0.0793	−0.0619
	(0.104)	(0.112)	(0.117)
Hostile	0.1810**	0.162*	0.159*
	(0.082)	(0.091)	(0.095)
Competed	0.0622	0.0804	0.116
	(0.070)	(0.075)	(0.078)
Tender Offer	0.0952**	0.0664	0.033
	(0.041)	(0.046)	(0.048)
M&A Liquidity	0.4810*	0.551*	0.536
	(0.284)	(0.325)	(0.356)
ASize	0.0359***	0.0326**	0.0274*
	(0.012)	(0.014)	(0.014)
AM/B	0.0041	0.00213	−0.0005
	(0.005)	(0.005)	(0.006)
ADebt	0.0163	0.0423	0.0157
	(0.092)	(0.107)	(0.110)
AOCF	0.5560	0.695*	0.648
	(0.382)	(0.418)	(0.428)
ARunup	0.1560*	0.133	0.138
	(0.094)	(0.103)	(0.105)
AHHI	−0.3270	−0.375	−0.466
	(0.252)	(0.432)	(0.453)
TSize	−0.0763***	−0.0752***	−0.0720***
	(0.016)	(0.018)	(0.018)
TM/B	−0.0103	−0.00991	−0.00813
	(0.007)	(0.008)	(0.008)
TDebt	0.0006	0.0279	−0.0137
	(0.080)	(0.090)	(0.092)
TOCF	−0.4830**	−0.392*	−0.347
	(0.214)	(0.236)	(0.250)
TRunup	0.957***	0.979***	0.961***
	(0.080)	(0.088)	(0.093)
TIlliquidity	21.49	21.85	17.96
	(17.83)	(20.47)	(20.91)
Year Fixed Effects	NO	NO	YES
Industry Fixed Effects	NO	YES	YES
Observations	461	461	461
Adjusted R^2	0.399	0.369	0.375

The table presents OLS regressions of the acquisition premium offered on synergies forecast error and other control variables. The dependent variable is the merger premium calculated as the final offer price relative to the target firm's share price on day −40 prior to the acquisition announcement. The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors (in parentheses) are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% statistical significance, respectively.

Mavrovitis, & Travlos, 2012]. Adding fixed effects increases the significance of our main variable of interest. In particular, *synergies forecast error* is positive and statistically significant at the 1% level in both specifications. In economic terms, a one-unit increase in *synergies forecast error* leads to 8.07% higher takeover premium (specification (3)). Overall, the results of this analysis uncover a positive relation between synergies forecast error and takeover premium, in line with hubris hypothesis [Roll, 1986].

4.2. Synergies forecast error and acquirer CAR

In this section, we examine the relation between our measure of overconfidence and the acquiring firm's stock price response to the announcement of takeover bids. According to hubris hypothesis, we expect a negative relation between *synergies forecast error* and acquirer's announcement stock abnormal returns.

Table 3 presents the results. We use the same control variables and specifications as in Table 2. The dependent variable is the acquirer's cumulative abnormal return (CAR) over a five-day (−2, +2) window around the acquisition announcement. The abnormal returns are calculated using market-adjusted returns, where the CRSP value-weighted index return is the market return. Consistent with the prediction, the coefficient of our main variable of interest is negative and statistically significant at conventional levels across all specifications. For model with industry- and year-fixed effects (specification (3)), our

Table 3
Acquirer CAR.

	(1)	(2)	(3)
Intercept	−0.0689***	−0.0952	−0.0835
	(0.025)	(0.089)	(0.131)
Synergies Forecast Error	−0.0374**	−0.0558***	−0.0479***
	(0.016)	(0.017)	(0.017)
Pure Shares	−0.0097	−0.0083	−0.0052
	(0.010)	(0.010)	(0.011)
Pure Cash	0.0395***	0.0331***	0.0264**
	(0.010)	(0.011)	(0.012)
Industry Relatedness	0.0030	0.0099	0.0082
	(0.008)	(0.009)	(0.009)
Toehold	0.0211	0.0261	0.0339
	(0.029)	(0.031)	(0.031)
Hostile	0.0230	0.0211	0.0296
	(0.023)	(0.025)	(0.025)
Competed	−0.0060	−0.0006	−0.0067
	(0.020)	(0.020)	(0.021)
Tender Offer	0.0044	0.0046	0.0113
	(0.011)	(0.012)	(0.013)
M&A Liquidity	0.0065	−0.0205	0.0169
	(0.079)	(0.088)	(0.095)
ASize	0.0038	0.0033	0.0031
	(0.003)	(0.004)	(0.004)
AM/B	−0.0006	−0.0006	−0.0001
	(0.001)	(0.002)	(0.002)
ADebt	0.0318	0.0186	0.0033
	(0.026)	(0.029)	(0.030)
AOCF	0.128	0.130	0.154
	(0.105)	(0.111)	(0.113)
ARunup	0.0193	0.0487*	0.0351
	(0.026)	(0.028)	(0.028)
AHHI	0.180**	0.210*	0.143
	(0.070)	(0.117)	(0.122)
TSize	−0.0048	−0.0032	−0.0038
	(0.005)	(0.005)	(0.005)
TM/B	−0.0027	−0.0015	−0.0012
	(0.0020)	(0.002)	(0.002)
TDebt	0.00425	0.0196	0.0263
	(0.022)	(0.024)	(0.025)
TOCF	0.1090*	0.0647	0.0553
	(0.059)	(0.063)	(0.067)
TRunup	0.0169	0.0066	−0.0042
	(0.022)	(0.024)	(0.025)
TIlliquidity	6.132	5.877	7.286
	(4.977)	(5.533)	(5.606)
	NO	NO	YES
Year Fixed Effects			
Industry Fixed Effects	NO	YES	YES
Observations	467	467	467
Adjusted R^2	0.131	0.143	0.164

The table presents OLS regressions of the acquirer five-day cumulative announcement abnormal returns CAR (−2, +2) on synergies forecast error and other control variables. The dependent variable is the five-day cumulative abnormal stock return CAR (−2, +2) of the acquirer. The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% significance, respectively.

main variable of interest is statistically significant at the 1% level. In economic terms, a one-unit increase in *synergies forecast error* is associated with 2.86% lower announcement five-day stock abnormal returns. This decrease in the firm's stock price translates into $294.29 million value destruction for the mean-size acquiring firm of our sample.

In sum, the results of this analysis show a negative relation between synergies forecast error and acquirer announcement abnormal returns.[5]

4.3. Synergies forecast error, target CARs, and excess offer price

The results in the previous sections show that the more overconfident the CEO the higher the takeover premium and the lower the acquirer's CAR. Consequently, if our measure captures CEO overconfidence, we would expect that target shareholders would gain more in acquisitions when acquired by CEOs with higher synergies forecast error.

In order to test this conjecture, we regress the target CARs on SFE (similar to Table 3) and present the results in the Appendix Table A.1. As expected, the results show that the relation between SFE and target CARs to be positive and significant suggesting that the more overconfident the CEO the higher the return to target firms. This shows evidence of wealth transfer to target shareholders which sources from the higher takeover premiums paid by more overconfident CEOs.

Even though we show that more overconfident acquirers offer higher premiums, we perform an additional test to establish whether more overconfident acquirers offer premiums above expectations. In Table 4, we regress our measure of overconfidence on the Ang and Ismail (2015) measure of excess offer price (merger offer price above a reference point that the authors empirically estimate) and find a positive and significant relation. This indicates that overconfident CEOs are more likely to offer a price for the target firm above the reference point, that is, a price that exceeds a reference price that is determined by the 52-week high and low prices of the target, and the mean past offer price in the industry. This implies that more overconfident CEOs – as indicated by our measure - are more likely to overpay in acquisitions and exceed target firm's expectations.

4.4. Other explanations

The main results in the previous sections suggest that high synergies forecast error CEOs pay on average higher premium and destroy more shareholder value than their counterparts. In this section, we run a set of different tests in order to rule out other potential explanations that could be driving our main results. Panel A of Table 5 reports the premium results, while Panel B shows the CAR results. All specifications in Table 5 use the full model (3) of Table 2.

4.4.1. Corporate governance

Firm corporate governance can influence CEO decisions [Masulis, Wang, & Xie, 2007]. For example, CEOs that operate in firms with more antitakeover provisions are generally less likely to be dismissed from their position and, as a result, they may make unrealistic predictions about the forecasted deal synergies at the shareholders' expense. In addition, Kolasinski and Li (2013) find that better governed firms mitigate the effect of CEO overconfidence. In column (1) of Table 5, we add the entrenchment index as in Bebchuk et al. (2009) to control for the acquirers and target firm's corporate governance. The entrenchment index is the sum of binary variables concerning the following provisions: i) classified boards; ii) limitations to shareholders' ability to amend the bylaws; iii) supermajority voting for business combinations; iv) supermajority requirements for charter amendments; v) poison pills; and vi) golden parachutes. A high entrenchment index value represents strong managerial power (i.e., bad corporate governance). The synergies forecast error coefficient (both in Panel A and Panel B) remains highly statistically significant at conventional levels exhibiting a positive (negative) relation with takeover premium (CAR).

4.4.2. Managerial ability

Column (2) controls for the acquirer's managerial ability. The low realized operating synergies relative to the forecasted operating synergies could be due to low managerial ability rather than CEO overconfidence. We add the acquirer's managerial ability score (*Ama_score*) which is based on the index developed by Demerjian et al. (2012). This index is based on managers' efficiency in generating revenues. We find that the synergies forecast error coefficient remains statistically significant in both panels at the 1% level with the expected positive (negative) sign in premium (CAR) regressions. We have also used the measure suggested by Falato, Li, and Milbourne (2015) who argue that more talented individuals will need less time on the corporate ladder to become CEOs. We obtain qualitatively similar results.

4.4.3. Litigation risk

Johnson, Kasznik, and Nelson [2000, 2001] find that a firm's legal exposure to litigation risk increases the propensity of voluntarily disclosing of forward-looking information such as earnings and sales forecasts. In fact, such firms issue forecasts that contain more quantitative as well as qualitative information. Hence, a potential argument could be that our measure captures the inverse effect of litigation risk, as CEOs might underestimate forecasted synergies to reduce litigation risk. Column (3) controls for litigation risk in the acquiring firm, which is defined, as in Johnson et al. (2001), by whether the bidder belongs to the computer hardware (SIC codes 3570–3577), computer software (SIC codes 7371–7379), or pharmaceuticals (SIC codes 2833–2836) industries. We find that the coefficient of the synergies forecast error continues to be statistically significant at the 1% level, carrying the expected positive (negative) sign in premium (CAR) regressions.

4.4.4. Inside information

Further, our proxy of overconfidence may be capturing inside information that CEOs may have regarding a specific deal. Even though, this would be at odds with our results so far given the significant value destruction we have uncovered, we, nevertheless, control for acquirer's sigma (i.e., idiosyncratic volatility). Contrary to this argument, our proxy may also be capturing the uncertainty about the target firm's value; in this respect, difficult-to-value firms increase the likelihood in the error between forecasted and realized synergies. We therefore control for target firm's sigma to capture such an error. Columns (4) and (5) present the estimates controlling for the aforementioned explanations. In both Panels A and B the coefficient of our synergies forecast error continues to hold statistically significant coefficients at better than 5% level with the predicted signs.

4.4.5. Merger waves and financial advisors

Our results could be driven by the fact that economic activity comes in cycles. For example, merger activity has not only been shown to occur in waves [see e.g., Andrade, Mitchell, & Stafford, 2001; Harford, 2005] but also be driven by different motives and comprised of acquirers that exhibit different characteristics. Along these lines, Alexandridis et al. (2012) show that acquiring firms paid significantly less premiums in the sixth compared to the fifth merger wave. Therefore, it is plausible that the CEOs in our sample pay high premiums when there is optimism in

[5] At this point, we ask the reader to recall that this paper investigates the research questions under the premise of irrational CEOs and efficient markets. This is to distinguish our research framework from that of rational CEOs and efficient markets in which the relation of CARs and SFE could be negative by construction. One needs only to assume that synergies are known to investors and markets are competitive (or that the Grossman and Hart, 1980 free riding mechanism is at play) such that synergies accrue to target shareholders. However, the results in the remainder of the paper (as well as the preceding section) suggest that this is less likely to be the case and more likely that our measure captures overconfidence.

Table 4
Reference point.

	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.2730**	−0.1340	−0.0265	0.3460**	0.7510***	0.7670**
	(0.078)	(0.252)	(0.411)	(0.080)	(0.266)	(0.390)
Synergies Forecast Error	0.0453*	0.0593**	0.0557*	0.0747**	0.0821**	0.0776**
	(0.026)	(0.027)	(0.029)	(0.028)	(0.029)	(0.031)
Control Variables	YES	YES	YES	YES	YES	YES
Year Fixed Effects	NO	YES	YES	NO	YES	YES
Industry Fixed Effects	NO	NO	YES	NO	NO	YES
Observations	461	461	461	423	423	423
Adjusted R^2	0.333	0.358	0.331	0.356	0.359	0.335

The table reports OLS regressions of two measures of overpayment as in Ang and Ismail (2015) on synergies forecast error and other control variables. The dependent variable is the Final Offer Price Minus the Reference Point (models 1,2 and 3) and the Initial Offer Price Minus the Reference Point (models 4, 5 and 6). The reference point is estimated in Ang and Ismail (2015) empirically and is determined by the 52-week high and low prices of the target, and the mean past offer price in the industry. All specifications contain the same control variables as in Table 3. The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% statistical significance, respectively.

the markets, but subsequently the initially planned synergies fail to materialize. Our results are presented in the Appendix Table A.2 (Panel A) and show that the *synergies forecast error* variable remains significant for both premium and CARs.

The role of financial advisors in mergers and acquisitions has received significant attention in the literature and has been shown to be pertinent when deals are more complex or bidders have low acquisition experience [Servaes & Zenner, 1996]. Financial advisors have also been associated with bidder returns and synergy gains [Kale, Kini, & Ryan, 2003] and more specifically for public acquisitions where advisors' reputation is at stake and more skill or effort is required [Golubov, Petmezas, & Travlos, 2012]. In the Appendix Table A.2 (Panel B), we control for the existence of a financial advisor advising the acquirer on the deal and find our main variable of interest, *synergies forecast error*, to remain significant for both premium and CARs.

4.5. Validation analysis

In this section, we present a validation analysis of our measure of overconfidence using it in various contexts that have previously been found to be affected by CEO overconfidence.

4.5.1. Synergies forecast error and diversifying acquisitions

In this part, we examine the relation between overconfident CEOs and diversifying acquisitions. Prior research has shown that overconfident CEOs are more likely to make more diversifying acquisitions [see e.g., Malmendier & Tate, 2008]. Additionally, Malmendier and Tate (2008) provide evidence that the effect of overconfidence on diversifying deals is more pronounced within cash-rich firms.

Table 6 examines the relation between diversifying acquisitions and *synergies forecast error* using logit regressions. The dependent variable in this table is a dummy variable that takes the value of one if the target and acquirer do not share the same 2-digit SIC code, and zero otherwise. The control variables are the same as the ones reported in the previous tables (excluding *industry relatedness*). In addition, we also examine the probability to diversify between cash-rich and non-cash-rich firms. We identify cash-rich firms as the ones that have cash-to-assets ratio above the sample average.

Columns (1) to (3) and (4) to (6) of Table 6 report the full model with industry-fixed effects and with industry- and year-fixed effects, respectively. In all specifications (except (5)), our main variable of interest, *synergies forecast error*, is positive and statistically significant at conventional levels suggesting that overconfident CEOs are more likely to be making diversifying acquisitions. In fact, the coefficient of our proxy is very similar in terms of economic magnitude (between 0.798 and 1.887) to the ones reported in Malmendier and Tate (2008) (between 1.781 and 2.5376). Consistent with Malmendier and Tate (2008), we find that diversifying deals are more pronounced within cash-rich firms.

4.5.2. Other corporate actions

In this part, we assess whether our overconfidence measure has the predictive relationships against various corporate actions such as capital expenditures, leverage, equity issues, and innovation. More specifically, prior literature has shown that overconfident CEOs are related with higher capital expenditures [Malmendier & Tate, 2005], more leverage, less equity issues [Malmendier et al., 2011], and higher levels of innovation [Hirshleifer et al., 2012]. Therefore, if our measure captures indeed overconfidence then we would expect to find relationships according to these predictions.

Table 7 presents the results of this analysis using feasible generalized least squares panel regressions. This procedure allows for regression estimation in the presence of autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels. In column (1), we run a regression on capital expenditures while controlling for all firm-level observations as in Table 3 including year-fixed effects. In this table, we control for firm-specific characteristics, since the merger-specific characteristics used in the previous tables are not relevant for this test.

The result from Table 7 suggests that overconfident CEOs conduct more capital expenditures than other CEOs. Malmendier et al. (2011) show that overconfident CEOs use more leverage and make less net equity issues compared to their predecessors or successors. In column (2), we use the acquiring firm's leverage as a dependent variable and show that our measure of overconfidence – synergies forecast error – is positive and statistically significant at the 5% level. In column (3), we use the net equity issues of the acquiring firm and show that overconfident CEOs make significantly less issues compared to their counterparts. Finally, in column (4), we use a proxy for innovation as dependent variable from the dataset of Kogan, Papanikolaou, Seru, and Stoffman (2017). The dependent variable is the number of patents applied during one year after the acquisition. The coefficient of our overconfidence measure is 0.192 positive and significant suggesting that a one-unit change in *synergies forecast error* leads to a change in patents applied by 21%.

Overall, the results in this section show that our proposed measure of overconfidence predicts also subsequent corporate actions indicating its value as an *ex-ante* measure of overconfidence as well.

5. Endogeneity checks and further tests

In this section, we perform some tests to address endogeneity concerns and conduct some additional tests to assess the synergies forecast error as measure of overconfidence.

Table 5
Controlling for other factors.

Panel A: Merger Premium	(1)	(2)	(3)	(4)	(5)
Intercept	0.8370**	0.4660	0.4790	0.4230	0.4180
	(0.395)	(0.492)	(0.486)	(0.494)	(0.487)
Synergies Forecast Error	0.1230**	0.1180***	0.0988***	0.0946***	0.0988***
	(0.055)	(0.037)	(0.035)	(0.035)	(0.035)
AEindex	0.0147				
	(0.017)				
TEindex	0.0150				
	(0.016)				
Ama_score		−0.0762			
		(0.112)			
ALitigation			−0.0602		
			(0.065)		
Asigma				1.1780	
				(1.839)	
Tsigma					2.6790*
					(1.614)
Control Variables	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES	YES
Observations	187	436	461	461	461
Adjusted R^2	0.34	0.376	0.381	0.381	0.385

Panel B: Acquirer CAR (−2, +2)	(1)	(2)	(3)	(4)	(5)
Intercept	−0.0165	−0.1050	−0.0829	−0.0468	−0.0895
	(0.148)	(0.132)	(0.131)	(0.133)	(0.132)
Synergies Forecast Error	−0.0685**	−0.0487***	−0.0462***	−0.0434**	−0.0472***
	(0.034)	(0.018)	(0.017)	(0.017)	(0.017)
AEindex	−0.0049				
	(0.005)				
TEindex	−0.0107**				
	(0.005)				
Ama_score		−0.0328			
		(0.030)			
ALitigation			−0.0251		
			(0.018)		
Asigma				−0.8580*	
				(0.494)	
Tsigma					0.2550
					(0.435)
Control Variables	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES	YES
Observations	189	441	467	467	467
Adjusted R^2	0.233	0.152	0.166	0.168	0.162

The table presents OLS regressions after controlling for various factors. In Panel A, we report results of the regressions whereby the dependent variable is the merger premium calculated as the final offer price relative to the target firm's share price on day −40 prior to the acquisition announcement. In Panel B, the dependent variable is the acquirer five-day cumulative abnormal stock return CAR (−2, +2) surrounding the acquisition announcement. In column (1) of both panels, we control for corporate governance, whereby we employ the entrenchment index of the acquirer and the target firm as our measure of governance as in Bebchuk et al. (2009). In column (2), we control for managerial ability using the acquirer managerial ability score (Ama_score) as in Demerjian et al. (2012). In column (3) we control for litigation risk using a dummy for deal with high litigation risk as in Johnson, Kasznik, and Nelson [2000, 2001]. In column (4) we control for inside information using the acquirer sigma. In column (5) we control for the uncertainty regarding the target firm's value using the target firm's sigma. All specifications contain the same control variables as in Tables 2 (Panel A) and 3 (Panel B). The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% significance, respectively.

5.1. Sample selection

The sample used in the analysis is relatively small as not all acquiring firms disclose their forecasts of merger-related synergies. As a result, the sample may be subject to selection bias. Although we do not impose any additional refinement criteria on the synergy sample, we aim to alleviate any concerns of lack of sample representativeness; in other words, we account for the possibility that the results may be driven by sample selection bias since the synergy forecasts are not necessarily available for all M&A deals. To that end, we use a two-step Heckman model [Heckman, 1979] for the whole sample of disclosing and non-disclosing bidders, whereby in the first step, we model the probability of disclosing synergy forecasts. In the Appendix Table A.3, we report the Heckman regressions and find our results to corroborate the findings of the OLS regressions in Tables 2 and 3, while alleviating any concerns on sample selection bias.

5.2. Endogenous CEO-firm matching

It is not unreasonable to assume that firms might wish to hire overconfident CEOs to pursue certain strategies. For example, Hirshleifer et al. (2012) show that innovative firms are more likely to hire overconfident managers to undertake risky and challenging projects. Therefore, firm-CEO matching effects are likely to be important in the early years of the CEO in the helm of the firm rather than later in his tenure, and as a result can cause a spurious relationship.

Following, Hirshleifer et al. (2012) and Aktas et al. (2019), we re-run our baseline analysis for both takeover premium and CAR for a subset of

Table 6
Diversifying acquisitions.

	All	Cash-Rich	Non-Cash Rich	All	Cash-Rich	Non-Cash-Rich
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.104	−8.346***	0.238	−0.971	−23.06**	−1.198
	(1.716)	(2.840)	(2.006)	(2.036)	(10.030)	(2.473)
Synergies Forecast Error	1.226**	4.435**	1.949**	1.310*	22.10**	2.407**
	(0.613)	(1.857)	(0.891)	(0.669)	(8.737)	(1.013)
Pure Shares	0.249	−0.268	0.137	0.286	−3.421*	0.0476
	(0.353)	(0.924)	(0.487)	(0.389)	(2.010)	(0.556)
Pure Cash	0.514	1.364	0.184	0.604	5.285*	0.215
	(0.376)	(0.963)	(0.493)	(0.423)	(2.954)	(0.603)
Toehold	2.944***	0	3.997**	5.020***	0	5.515**
	(1.075)	(.)	(1.759)	(1.890)	(.)	(2.347)
Hostile	0.24	0	1.657*	−0.0977	0	1.881*
	(0.796)	(.)	(0.958)	(0.887)	(.)	(1.094)
Competed	−0.879	0	−0.613	−0.574	0	−0.19
	(0.723)	(.)	(0.849)	(0.782)	(.)	(0.966)
Tender Offer	0.123	−0.605	−0.272	0.29	0.286	−0.103
	(0.395)	(1.095)	(0.524)	(0.445)	(2.464)	(0.632)
M&A Liquidity	1.263	5.115	−3.171	0.459	−28.01	−8.119
	(3.143)	(6.496)	(5.670)	(3.904)	(59.230)	(6.945)
ASize	0.375***	0.324	0.599***	0.437***	1.584	0.708***
	(0.130)	(0.302)	(0.185)	(0.148)	(0.991)	(0.207)
AM/B	−0.0626	−0.0674	−0.105	−0.0375	−0.733	−0.0783
	(0.051)	(0.129)	(0.070)	(0.054)	(0.473)	(0.081)
ADebt	0.709	2.109	0.616	1.331	21.37**	0.559
	(1.001)	(2.605)	(1.326)	(1.095)	(10.200)	(1.491)
AOCF	−2.83	−0.534	−2.586	−1.664	−21.68	−6.294
	(4.004)	(7.643)	(6.249)	(4.439)	(19.590)	(7.114)
ARunup	1.09	2.453	0.47	1.535	8.403*	1.501
	(0.970)	(1.991)	(1.423)	(1.085)	(4.757)	(1.699)
AHHI	−4.605	66.76*	−5.829	0.858	250.4**	1.22
	(4.346)	(34.190)	(6.620)	(4.696)	(122.500)	(7.293)
TTize	−0.315*	0.174	−0.808***	−0.364*	−0.626	−0.906***
	(0.180)	(0.445)	(0.263)	(0.193)	(1.267)	(0.293)
TM/B	−0.0512	−0.262	−0.0246	−0.0443	−0.379	−0.0307
	(0.070)	(0.210)	(0.088)	(0.076)	(0.499)	(0.093)
TDebt	−1.001	−0.263	−2.675**	−0.798	−6.798	−2.908**
	(0.825)	(1.902)	(1.147)	(0.885)	(6.011)	(1.303)
TOCF	−1.178	−3.735	0.746	−0.138	31.87	2.531
	(2.186)	(3.988)	(3.948)	(2.627)	(20.000)	(4.462)
TRunup	1.582**	−0.657	3.436***	1.226	1.051	3.300**
	(0.801)	(1.848)	(1.233)	(0.921)	(4.140)	(1.437)
TIlliquidity	−556.7	162.7	−1119.4	−642.8	2162.6	−1322.6*
	(381.400)	(558.900)	(694.300)	(399.600)	(1332.700)	(773.300)
Year Fixed Effects	NO	NO	NO	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES	YES	YES
Observations	414	108	270	404	80	255
Pseudo R^2	0.167	0.327	0.232	0.219	0.566	0.281

The table reports logit regressions of the probability of making diversifying acquisitions on synergies forecast error and other control variables. The dependent variable is a dummy that takes the value of 1 if the target firm and the acquirer do not share the same 2-digit SIC code, and 0 otherwise. We replicate regressions for two subsamples of cash-rich and non-cash-rich acquirers, respectively, whereby we define cash-rich (non-cash-rich) acquirers as those that have cash-to-assets ratio above (below) the sample average. The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% statistical significance, respectively.

firms that exclude newly appointed CEOs; namely excluding CEOs with tenure of less than one year or less than three years. Results are reported in Table 8.

Columns (1) and (2) show the results for takeover premium excluding tenures of less than one and less than three years, respectively. Our main independent variable, *synergies forecast error*, remains positive and statistically significant at 5% even after removing CEOs with relatively low tenures. Columns (3) and (4) report results for acquirer CAR for the one- and three-year minimum tenures confirming the negative relation with our proxy of overconfidence and, therefore, alleviating endogeneity concerns.

5.3. Causality

One may argue that the direction of causality between SFE and takeover premium could be in reverse order to what we have so far assumed. For example, the CEO of the bidding firm may knowingly announce unrealistic synergies to increase the probability of acquiring the target by justifying a high premium. Following this line of thought, it is possible that premiums can be driving the forecasted synergies and as a result, SFE. However, we argue that this is not probable. Under Rule 10b-5 of the U.S. Security Exchange Act of 1934, it is unlawful not to disclose material information or to make any untrue or misleading statements of a material fact, like for instance disclosing false information regarding forecasted synergies. In addition, the Regulation Fair Disclosure passed in October 2000, prevents firms from making selective disclosures to securities market professionals and shareholders. As a result, firms in the past had to demonstrate how they provided their estimated synergies (see for example, the merger between Hewlett-Packard and Compaq). The possibility of incurring litigation costs for providing misleading or selective information should act as a deterrent and force CEOs to provide as accurate forecasted synergies as possible.

Table 7
CEO overconfidence and other corporate actions.

	(1)	(2)	(3)	(4)
	Capital Expenditures	ADebt	Net Equity Issues	Log (1 + Patents)
Intercept	0.0184***	0.4840***	0.0198***	1.6740***
	(0.004)	(0.033)	(0.005)	(0.176)
Synergies Forecast Error	0.0018**	0.0314***	−0.0017*	0.3540***
	(0.001)	(0.010)	(0.001)	(0.044)
AM/B	−0.0003***	-0.0005	0.0003*	(0.009)
	(0.000)	(0.001)	(0.000)	(0.007)
ADebt	0.0007		0.0108***	−0.0069
	(0.001)		(0.002)	(0.059)
AOCF	0.0437***	-0.0433	-0.0243***	0.1150
	(0.007)	(0.044)	(0.009)	(0.343)
ASize	0.0007***	−0.0030**	−0.0022***	0.1320***
	(0.000)	(0.001)	(0.000)	(0.010)
Year Fixed Effects	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES
Observations	2495	2505	2504	835
Wald Chi2	3141.13***	1563.75***	566.64***	11,555.26***

The table reports panel data regressions of the effect of CEO overconfidence on various corporate actions using feasible generalized least squares, which allows estimation in the presence of autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels. The panel data are taken for the entire sample period from 1993 to 2013 whereby dependent variables are in year *t* and independent variable are in year *t*-1. In column (1) the dependent variable is the capital expenditure scaled by market value of assets of the acquiring firm. In column (2) the dependent variable is the leverage of the acquiring firm (Debt ratio). In column (3) the dependent variable is the net equity issues scaled by market value of assets of the acquiring. In column (4), the dependent variable is the number of patents applied during 1 year after the acquisition. Both variables are extracted from the dataset of Kogan et al. (2017) . The definitions of all variables are provided in the Appendix. Year-fixed effects, whose coefficients are suppressed, are based on calendar year dummies. Standard errors are in parentheses and are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% statistical significance, respectively.

At the very least, this should be the case for the average CEO in a public firm.

5.4. Synergies forecast error and acquirer's operating performance

Even though, the procedure followed in the paper is closely related to many previous studies including the ones cited above, we acknowledge that the present value calculation is subject to various assumptions about the discount rates and its related parameters.

Yet, in order to alleviate any further concerns that our synergies measure does not capture merger-related improvement in performance (thus contaminating the SFE measure), we regress post-merger cash flow on pre-merger cash flow to estimate the abnormal post-merger performance as in previous studies [e.g., Healy et al., 1992; Ghosh, 2001; Linn & Switzer, 2001, and Carline et al., 2009]. The abnormal post-merger performance is captured by the intercept of the regression. Results are presented in the Appendix Table A.4. Column (2) indicates that for overconfident CEO (i.e., positive SFE) the abnormal post-merger performance is significantly negative (negative intercept), while for non-overconfident CEO (column (3)), the abnormal post-merger performance is significantly positive (positive intercept).

5.5. Synergies forecast error using a five-year window

Even though our empirical analysis (and more specifically our synergies measure) is a based on established methodologies as highlighted in previous sections, we understand that one may have some concerns about the underlying methodological assumptions. In order to provide further reassurance, we have relaxed one of the main assumptions in the model to assess the robustness of our main results. More specifically, we have re-defined the actual synergies measure using a five-year window (instead of the three-year window). This new set of results on premiums and acquirer CARs are consistent with our baseline results. These results are presented in the Appendix Tables A.5 (premiums) and A.6 (acquirer's CARs).

Table 8
Non-random CEO-firm matching.

	Takeover Premium		Acquirer CAR	
	Tenure > 1 Year (1)	Tenure > 3 Years (2)	Tenure > 1 Year (3)	Tenure > 3 Years (4)
Intercept	0.4520	0.6560	−0.0915	−0.0401
	(0.505)	(0.576)	(0.133)	(0.147)
Synergies Forecast Error	0.0912**	0.0976**	−0.0445**	−0.0460**
	(0.038)	(0.044)	(0.019)	(0.021)
Control Variables	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES
Industry Fixed Effects	YES	YES	YES	YES
Observations	386	314	392	318
Adjusted R^2	0.388	0.377	0.165	0.176

The table reports OLS regressions by subsamples of CEO tenure. Specifications (1) and (3) require CEO tenure greater than 1 year, specifications (2) and (4) greater than 3 years. In columns (1) and (2) the dependent variable is the takeover premium calculated as the final offer price relative to the target firm's share price on day −40 prior to the acquisition announcement. In columns (3) and (4) the dependent variable is the five-day cumulative abnormal stock return CAR (−2, +2) of the acquirer. All specifications contain the same control variables as in Tables 2 (specifications (1) and (2)) and 3 (specifications (3) and (4)). The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% statistical significance, respectively.

6. Conclusion

In this paper, we propose an alternative method to measure CEO overconfidence using information from M&As. More specifically, we use operating synergies that the CEOs forecast prior to the acquisition and compare these to the actual synergies realized from the deal in order to create our proposed synergies forecast error measure.

As expected, consistent with Roll's (1986) hubris hypothesis, we find that our measure of overconfidence is positively associated with takeover premium and negatively related with acquirer's announcement stock abnormal returns. These results are statistically and economically significant; a one unit increase in synergies forecast error leads to 8.07% higher premium while it decreases acquirer's abnormal returns by 2.86%.

We also conduct various tests to rule out other possible explanations that our proxy may capture. Our baseline results hold after controlling for corporate governance, managerial ability, litigation risk, inside information, and uncertainty about target firm value. In addition, we show that our proxy of overconfidence continues to remain significant for risky (diversifying) acquisitions and that it is more pronounced within cash-rich firms than other firms.

To deal with non-random CEO-firm matching, we re-run the baseline analysis by excluding CEOs whose tenure is less than a year or less than three years. *Synergies forecast error* remains statistically significant having the predicted relation with both takeover premium and acquirer abnormal returns alleviating endogeneity concerns.

Finally, we assess our proxy of overconfidence against other,

subsequent to the M&A, corporate actions in which overconfidence has been found to play a role. We examine the relation of *synergies forecast error* with capital expenditures, leverage, innovation, and net equity issues. We find our proxy to be significant with the predicted sign providing further support that our measure captures CEO overconfidence. These results also highlight the *ex-ante* power of our measure which can prove as a useful tool to researchers to identify overconfident CEOs based on a direct measure that gauges this personal attribute but also to investors and financial advisors when evaluating CEO overconfidence status and its implied effect on corporate decisions.

Declaration of Competing Interest

None.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We would like to thank Yakov Amihud, Erik Devos, Feng Dong, Xiang Long, Fabian Silbereis, Nick Travlos, Robert Vishny, Jeffrey Wurgler and particularly Dimitris Petmezas, as well as conference participants at the 2020 Financial Management Association Annual Meeting, 2021 Financial Management Association Europe, and 2021 European Financial Management Association for useful comments and suggestions. All remaining errors are our own.

Appendix A. Variable definitions

Variable	Definition
Panel A: Dependent Variables	
Takeover Premium	The difference between the offer price and the target firm's stock price 4 weeks prior to the acquisition announcement dividend by the latter. Values below 0% or above 200% are winsorized following Officer (2003).
CARs (−2,+2)	The acquiring firm's 5-day cumulative abnormal returns estimated using the market adjusted model as actual return minus benchmark return using the CRSP value-weighted index returns as the benchmark.
Capital Expenditures	The mean capital expenditure scaled by market value of assets of the acquiring firm for the three years post-merger.
ADebt	The book debt over market value of assets (as defined above). Book debt is total assets (Item AT) minus book equity. Book equity is Total Assets (Item AT) minus liabilities (Item LT) plus balance sheet deferred taxes and investment tax credit (Item TXDITC) minus preferred stock.
Net Equity Issues	Sale of common and preferred stock (SSTK) minus purchase of common and preferred stock (PRSTKC), scaled by market value of assets.
Log (1 + Patents)	The number of patents applied during 1 year after the acquisition. Patents are extracted from the dataset of Kogan et al. (2017).
Final Offer Price minus the reference point	The difference between the Final offer price and the estimated reference point (Final Price minus Ref. Point) as empirically estimated in Ang and Ismail (2015). The reference price is empirically determined by the 52-week high and low prices of the target, and the mean past offer price in the industry.
Initial Offer Price minus the reference point	The difference between the Initial offer price and the estimated reference point (Initial Price minus Ref. Point) as empirically estimated in Ang and Ismail (2015). The reference price is empirically determined by the 52-week high and low prices of the target, and the mean past offer price in the industry.
Panel B: Deal Characteristics	
Synergies Forecast Error	The forecasted synergies minus actual synergies.
Actual Synergy	The present value of the annual changes in actual equity cash flows (ECF) from the pre-merger year to the five-year post-merger period.
Pure Shares	Dummy equal to one if the method of payment is pure share, 0 otherwise.
Pure Cash	Dummy equal to one if the method of payment is pure cash, 0 otherwise.
Industry Relatedness	Dummy equal to one if the acquisition is between firms with the same 2-digit SIC code, 0 otherwise.
Toehold	Dummy equal one for deals where the acquirer had at least 5% ownership in the target firm prior to the acquisition, 0 otherwise.
Hostile	Dummy equal to one if an acquisition is hostile or unsolicited, 0 otherwise.
Competed	Dummy equal to one if there was a competing bidder for the target firm as reported in Thomson Financial SDC, 0 otherwise.
Tender Offer	Dummy equal to one if the deal type is tender offer as reported in Thomson Financial SDC, 0 otherwise.
M&A Liquidity	The sum of acquisition deal value per year and 2-digit SIC industry divided by the total assets of all firms in the Compustat dataset in the same year and industry.
Panel C: Acquirer Characteristics	
ASize	The market value of assets defined as liabilities (Item LT) minus balance sheet deferred taxes and investment tax credit (Item TXDITC) plus preferred stock (Item PSTKL) plus market equity (Item CSHO×Item PRCC_F).
AM/B	Market to Book ratio: market value of equity calculated as share price multiplied by number of shares outstanding divided by book value of shareholders equity.
ADebt	The book debt over market value of assets (as defined above). Book debt is total assets (Item AT) minus book equity. Book equity is Total Assets (Item AT) minus liabilities (Item LT) plus balance sheet deferred taxes and investment tax credit (Item TXDITC) minus preferred stock.
AOCF	Operating cash flows to MV of assets ratio. The operating cash flow is sales minus cost of goods sold, selling and general administrative expenses, and working capital change, items (SALE−COGS−XSGA−WCAPCH).
ARunup	The market-adjusted buy-and-hold returns of the acquiring firm over the (−205, −6) window prior to the acquisition announcement.
AHHI	Sum of squares of the market shares of all firms sharing the same 2-digit SIC, where market share is defined as sales of the firm to the aggregated sales of the industry.
AEindex	The acquirer entrenchment index is the sum of binary variables concerning the following provisions: i) classified boards; ii) limitations to shareholders' ability to amend the bylaws; iii) supermajority voting for business combinations; iv) supermajority requirements for charter amendments; v) poison pills; and vi) golden parachutes.
Ama_score	The acquirer managerial ability score that is calculated as the fitted value of manager-fixed effects on firm efficiency as in Demerjian et al. (2012).
ALitigation	Dummy variable equal to one if the bidder belongs to the computer hardware (SIC codes 3570–3577), computer software (SIC codes 7371–7379), or pharmaceuticals (SIC codes 2833–2836) industries.
ASigma	The standard deviation of the market-adjusted daily returns of the acquiring firm over the (−205, −6) window prior to the acquisition announcement.
Panel D: Target Firm Characteristics	
TDebt	

(*continued on next page*)

(*continued*)

Variable	Definition
	The book debt over market value of assets. The market value of assets is defined as liabilities (Item LT) minus balance sheet deferred taxes and investment tax credit (Item TXDITC) plus preferred stock (Item PSTKL) plus market value of equity (Item CSHO×Item PRCC_F). Book debt is total Assets (Item AT) minus book equity. Book equity is total assets (Item AT) minus liabilities (Item LT) plus balance sheet deferred taxes and investment tax credit (Item TXDITC) minus preferred stock.
TOCF	Operating cash flows to market value of assets ratio. Operating cash flows are sales minus cost of goods sold, selling and general administrative expenses, and working capital change, items (SALE−COGS−XSGA−WCAPCH).
TM/B	Market to book ratio: Market value of Equity calculated as share price multiplied by number of shares outstanding divided by the book value of shareholders' equity.
TRunup	The market-adjusted buy-and-hold returns of the target firm over the (−205, −6) window prior to the acquisition announcement.
Tlliquidity	This is similar to the Amihud (2002) illiquidity measure.
TEindex	The target entrenchment index is the sum of binary variables concerning the following provisions: i) classified boards; ii) limitations to shareholders' ability to amend the bylaws; iii) supermajority voting for business combinations; iv) supermajority requirements for charter amendments; v) poison pills; and vi) golden parachutes.
TSigma	The standard deviation of the market-adjusted daily returns of the target firm over the (−205, −6) window prior to the acquisition announcement.

Table A.1
Target CARs.

	(1)	(2)	(3)
Intercept	0.281***	0.224	0.26
	(0.0457)	(0.1630)	(0.2460)
Synergies Forecast Error	0.0442***	0.0425**	0.0450**
	(0.0154)	(0.0170)	(0.0176)
Pure Shares	−0.0532***	−0.0506***	−0.0500**
	(0.0171)	(0.0187)	(0.0202)
Pure Cash	0.0274	0.0429**	0.0402*
	(0.0177)	(0.0202)	(0.0221)
Industry Relatedness	0.00601	0.0133	0.013
	(0.0147)	(0.0164)	(0.0170)
Toehold	−0.0465	−0.0305	−0.0199
	(0.0524)	(0.0558)	(0.0585)
Hostile	0.0552	0.0446	0.0535
	(0.0410)	(0.0451)	(0.0476)
Competed	−0.0233	−0.019	−0.014
	(0.0350)	(0.0373)	(0.0390)
Tender Offer	0.0541***	0.0349	0.0334
	(0.0205)	(0.0227)	(0.0242)
M&A Liquidity	0.0678	0.149	0.272
	(0.1430)	(0.1610)	(0.1790)
ASize	0.0261***	0.0250***	0.0228***
	(0.0061)	(0.0068)	(0.0070)
AM/B	0.000422	0.000269	−0.00039
	(0.0025)	(0.0027)	(0.0028)
ADebt	−0.0034	0.0359	0.0259
	(0.0458)	(0.0528)	(0.0555)
AOCF	0.0624	0.141	0.0975
	(0.1910)	(0.2060)	(0.2140)
ARunup	0.0809*	0.0741	0.0691
	(0.0469)	(0.0509)	(0.0524)
AHHI	−0.206	−0.248	−0.312
	(0.1260)	(0.2150)	(0.2280)
TSize	−0.0439***	−0.0458***	−0.0446***
	(0.0080)	(0.0087)	(0.0091)
TM/B	−0.00837**	−0.00710*	−0.00587
	(0.0034)	(0.0037)	(0.0038)
TDebt	0.042	0.0665	0.0534
	(0.0399)	(0.0441)	(0.0459)
TOCF	−0.0307	0.00394	0.0295
	(0.1080)	(0.1170)	(0.1250)
TRunup	−0.156***	−0.153***	−0.156***
	(0.0401)	(0.0435)	(0.0466)
TIlliquidity	17.43*	15.41	14.4
	(8.9500)	(10.1600)	(10.5000)
Year Fixed Effects	NO	NO	YES
Industry Fixed Effects	NO	YES	YES
Observations	467	467	467
Adjusted R^2	0.215	0.192	0.18

The table presents OLS regressions of the target five-day cumulative announcement abnormal returns CAR (−2, +2) on synergies forecast error and other control variables. The dependent variable is the five-day cumulative abnormal stock return CAR (−2, +2) of the target. The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for

heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% significance, respectively.

Table A.2
Controlling for merger waves and financial advisors.

	Panel A		Panel B	
	(1)	(2)	(3)	(4)
	Premium	CAR	Premium	CAR
Intercept	0.588*	−0.104	0.443	−0.073
	(0.3280)	(0.0891)	(0.4910)	(0.1320)
Synergies Forecast Error	0.138**	−0.0565***	0.0982***	−0.0472***
	(0.0623)	(0.0169)	(0.0349)	(0.0172)
Wave6	−0.0631*	0.00843		
	(0.0338)	(0.0091)		
AAdvisor			0.0452	−0.0143
			(0.0799)	(0.0215)
Controls	YES	YES	YES	YES
Year Fixed Effects	NO	NO	YES	YES
Industry Fixed Effects	YES	YES	YES	YES
Observations	461	467	461	467
Adjusted R^2	0.373	0.142	0.381	0.163

The table presents OLS regressions after controlling for merger waves and for employing a financial advisor by the acquiring firm. In Panel A, we control for mergers waves whereby the dependent variable in column 1 is the merger premium calculated as the final offer price relative to the target firm's share price on day −40 prior to the acquisition announcement. In column 2, the dependent variable is the acquirer five-day cumulative abnormal stock return CAR (−2, +2) surrounding the acquisition announcement. We introduce one dummy variable to account for the sixth merger wave, Wave6, which takes the value of one if the deal was announced between 2003 and 2007, zero otherwise, as in Alexandridis et al. (2012). In Panel B, we control for the existence of an investment bank (financial advisor) advising the acquirer on the deal by adding a dummy variable for that effect. The dependent variable in column 3 is the merger premium calculated as the final offer price relative to the target firm's share price on day −40 prior to the acquisition announcement. In column 4, the dependent variable is the acquirer five-day cumulative abnormal stock return CAR (−2, +2) surrounding the acquisition announcement. Controls are the same control variables as in Tables 2 (Panel A) and 3 (Panel B). The definitions of all variables are provided in the Appendix. Year and industry fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% significance, respectively.

Table A.3
Adjusting for potential self-selection.

	First Step	(1)	First Step	(2)
	Synergy Dummy	Premium	Synergy Dummy	CAR
Intercept	−2.607***	1.233	−2.531***	−0.113
	(0.2160)	(0.8130)	(0.2140)	(0.2070)
Synergies Forecast Error		0.128**		−0.0480***
		(0.0570)		(0.0153)
Pure Shares	−0.305***	0.01	−0.334***	−0.00752
	(0.0919)	(0.0635)	(0.0913)	(0.0168)
Pure Cash	−0.0769	0.000973	−0.1	0.0258**
	(0.0985)	(0.0453)	(0.0976)	(0.0113)
Industry Relatedness	0.104	0.0205	0.0918	0.00888
	(0.0764)	(0.0382)	(0.0758)	(0.0090)
Toehold	−0.475**	0.0441	−0.490**	0.03
	(0.2210)	(0.1400)	(0.2210)	(0.0364)
Hostile	0.167	0.136	0.174	0.0305
	(0.2630)	(0.1010)	(0.2630)	(0.0234)
Competed	0.0622	0.102	0.0558	−0.00628
	(0.1860)	(0.0790)	(0.1860)	(0.0188)
Tender Offer	−0.282***	0.0885	−0.296***	0.0092
	(0.1050)	(0.0656)	(0.1050)	(0.0170)
M&A Liquidity	−0.784	0.705*	−0.797	0.0105
	(0.6690)	(0.3640)	(0.6680)	(0.0930)
ASize	−0.168***	0.0627*	−0.167***	0.00184
	(0.0283)	(0.0322)	(0.0281)	(0.0082)
AM/B	−0.0294**	0.00573	−0.0311**	−0.000383
	(0.0127)	(0.0075)	(0.0126)	(0.0019)
ADebt	0.266	−0.0352	0.267	0.00517
	(0.2410)	(0.1160)	(0.2400)	(0.0286)
AOCF	−0.25	0.743*	−0.0449	0.153
	(0.8890)	(0.4220)	(0.8800)	(0.1010)
ARunup	0.0191	0.146	0.0396	0.0349
	(0.2230)	(0.1020)	(0.2220)	(0.0250)
AHHI	0.0132	−0.485	−0.00597	0.143
	(0.6480)	(0.4160)	(0.6460)	(0.1090)
TSize	0.569***	−0.188*	0.562***	0.000344
	(0.0372)	(0.0969)	(0.0369)	(0.0246)
TM/B	−0.027	−0.00256	−0.0243	−0.00139

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Table A.3 (*continued*)

	First Step	(1)	First Step	(2)
	Synergy Dummy	Premium	Synergy Dummy	CAR
	(0.0181)	(0.0089)	(0.0179)	(0.0021)
TDebt	1.050***	−0.217	1.009***	0.0334
	(0.2050)	(0.1910)	(0.2030)	(0.0469)
TOCF	−1.011**	−0.169	−1.106**	0.0479
	(0.4550)	(0.2760)	(0.4500)	(0.0732)
TRunup	−0.16	0.988***	−0.183	−0.00544
	(0.1800)	(0.0919)	(0.1790)	(0.0233)
TIlliquidity	−15.86	30.4	−16.79	6.825
	(16.9700)	(19.5400)	(17.1800)	(5.6720)
Year Fixed Effects		YES		YES
Industry Fixed Effects		YES		YES
Inverse Mills Lambda		−0.3		0.011
		(0.244)		(0.0639)
N	2088		2094	
Pseudo Rsq.	0.2599		0.257	
N Uncensored		461		467
Wald Chi-sq.		336.5		231.9

The table reports Heckman model regressions to adjust for potential self-selection following Heckman (1979) and replicates the results of the OLS regressions presented earlier in Tables 2 and 3 of the premium and CAR on the Synergy Forecast Error and other control variables. In the first step Heckman we model the likelihood of disclosing synergy forecasts. The definitions of all variables are provided in the Appendix. Year and industry fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% significance, respectively.

Table A.4
Abnormal post-merger performance.

	(1)	(2)	(3)
	Post-Merger OCF Return	Post-Merger OCF Return	Post-Merger OCF Return
	ALL	Overconfident CEO	Non-Overconfident CEO
Intercept	0.0030*	−0.0068**	0.0074***
	(0.002)	(0.003)	(0.002)
Pre-Merger OCF return	0.369***	0.606***	0.345***
	(0.034)	(0.092)	(0.033)
N	441	160	281
adj. R-sq	0.2130	0.2100	0.2790

The table presents OLS regressions of the Median Post-Merger Operating Cash Flow Return on the Pre-Merger Operating Cash Flow Return. Operating Cash Flow Return is calculated following previous studies [e.g. Healy et al., 1992; Ghosh, 2001; Linn & Switzer, 2001; Carline et al., 2009] as sales minus cost of goods sold, selling and general administrative expenses, and working capital change, items (SALE−COGS−XSGA−WCAPCH) scaled by market value of assets. The post-merger period extends to three years after merger while year −1 stands for the pre-merger period. The pre-merger OCF is the proforma value for target and acquirer firms. The definitions of all variables are provided in the Appendix. Year and industry fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% significance, respectively.

Table A.5
Takeover premium – 5-year actual synergies.

	(1)	(2)	(3)
Intercept	0.537***	0.314	0.449
	(0.0910)	(0.2960)	(0.4870)
Synergies Forecast Error	0.0601**	0.0737***	0.0807***
	(0.0268)	(0.0273)	(0.0311)
Pure Shares	−0.0591*	−0.0491	−0.0577
	(0.0341)	(0.0359)	(0.0404)
Pure Cash	−0.0492	−0.0395	−0.0139
	(0.0355)	(0.0381)	(0.0440)
Industry Relatedness	0.0375	0.0327	0.0503
	(0.0294)	(0.0298)	(0.0340)
Toehold	−0.0877	−0.096	−0.0554
	(0.1040)	(0.1070)	(0.1160)
Hostile	0.187**	0.184**	0.169*
	(0.0816)	(0.0835)	(0.0944)
Competed	0.0614	0.106	0.117
	(0.0696)	(0.0711)	(0.0771)
Tender Offer	0.0918**	0.0634	0.0229
	(0.0409)	(0.0425)	(0.0480)
M&A Liquidity	0.497*	0.534*	0.551
	(0.2840)	(0.2990)	(0.3550)
ASize	0.0342***	0.0308**	0.0251*

(*continued on next page*)

Table A.5 (*continued*)

	(1)	(2)	(3)
	(0.0121)	(0.0122)	(0.0139)
AM/B	0.0035	0.0002	−0.0011
	(0.0049)	(0.0050)	(0.0055)
ADebt	0.0202	0.0006	0.0259
	(0.0918)	(0.0942)	(0.1100)
AOCF	0.525	0.448	0.577
	(0.3830)	(0.3880)	(0.4280)
ARunup	0.159*	0.144	0.145
	(0.0937)	(0.0949)	(0.1040)
AHHI	−0.363	−0.281	−0.48
	(0.2520)	(0.2570)	(0.4520)
TSize	−0.0751***	−0.0758***	−0.0726***
	(0.0161)	(0.0163)	(0.0181)
TM/B	−0.0101	−0.0081	−0.0078
	(0.0069)	(0.0069)	(0.0075)
TDebt	0.0233	−0.0208	0.0031
	(0.0801)	(0.0819)	(0.0916)
TOCF	−0.550**	−0.446*	−0.421*
	(0.2170)	(0.2290)	(0.2500)
TRunup	0.957***	0.951***	0.963***
	(0.0799)	(0.0836)	(0.0927)
TIlliquidity	19.36	15.39	13.75
	(17.82)	(18.07)	(20.84)
Year Fixed Effects	NO	NO	YES
Industry Fixed Effects	NO	YES	YES
Observations	461	461	461
Adjusted R^2	0.40	0.412	0.38

The table presents OLS regressions of the acquisition premium offered on synergies forecast error and other control variables. The dependent variable is the merger premium calculated as the final offer price relative to the target firm's share price on day −40 prior to the acquisition announcement. The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors (in parentheses) are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% statistical significance, respectively.

Table A.6
Acquirer CAR - 5-year actual synergies.

	(1)	(2)	(3)
Intercept	−0.0939***	−0.141	−0.106
	(0.0325)	(0.1050)	(0.1700)
Synergies Forecast Error	−0.0186*	−0.0196**	−0.0286***
	(0.0096)	(0.0096)	(0.0109)
Pure Shares	−0.00983	−0.00487	−0.00111
	(0.0122)	(0.0126)	(0.0140)
Pure Cash	0.0497***	0.0372***	0.0369**
	(0.0127)	(0.0134)	(0.0153)
Industry Relatedness	0.0104	0.00955	0.0132
	(0.0105)	(0.0104)	(0.0118)
Toehold	0.0356	0.0441	0.0588
	(0.0375)	(0.0379)	(0.0406)
Hostile	0.0241	0.0354	0.0336
	(0.0294)	(0.0295)	(0.0330)
Competed	−0.00922	−0.0166	−0.00788
	(0.0250)	(0.0252)	(0.0270)
Tender Offer	0.00213	0.0128	0.0104
	(0.0147)	(0.0150)	(0.0168)
M&A Liquidity	0.066	0.103	0.114
	(0.1020)	(0.1060)	(0.1240)
ASize	0.00507	0.00525	0.00433
	(0.0043)	(0.0043)	(0.0049)
AM/B	−0.00197	−0.00141	−0.0012
	(0.0018)	(0.0018)	(0.0019)
ADebt	0.0547*	0.0306	0.00804
	(0.0328)	(0.0332)	(0.0384)
AOCF	0.05	0.107	0.144
	(0.1360)	(0.1360)	(0.1470)
ARunup	0.0186	0.00699	0.0345
	(0.0335)	(0.0334)	(0.0362)
AHHI	0.167*	0.105	0.0886
	(0.0904)	(0.0909)	(0.1580)
TSize	−0.00575	−0.00521	−0.00401
	(0.0058)	(0.0057)	(0.0063)
TM/B	−0.00266	−0.00229	−0.000991

(*continued on next page*)

Table A.6 (*continued*)

	(1)	(2)	(3)
	(0.0024)	(0.0024)	(0.0026)
TDebt	0.00235	0.0163	0.0279
	(0.0286)	(0.0287)	(0.0318)
TOCF	0.192**	0.189**	0.146*
	(0.0770)	(0.0800)	(0.0869)
TRunup	0.0236	0.000541	−0.0175
	(0.0286)	(0.0295)	(0.0322)
TIlliquidity	5.135	8.651	9.039
	(6.4000)	(6.3910)	(7.7290)
Year Fixed Effects	NO	NO	YES
Industry Fixed Effects	NO	YES	YES
Observations	467	467	467
Adjusted R^2	0.106	0.152	0.124

The table presents OLS regressions of the acquirer five-day cumulative announcement abnormal returns CAR (−2, +2) on synergies forecast error and other control variables. The dependent variable is the five-day cumulative abnormal stock return CAR (−2, +2) of the acquirer. The definitions of all variables are provided in the Appendix. Year- and industry-fixed effects, whose coefficients are suppressed, are based on calendar year dummies and 2-digit SIC industries classification dummies, respectively. Standard errors, which are in parentheses, are adjusted for heteroscedasticity. *, **, and *** represent 10%, 5%, and 1% significance, respectively.

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