Valuation Effects of Overconfident CEOs on Corporate Diversification and Refocusing Decisions

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Abstract

This study presents a theoretical model that links chief executive officer (CEO) overconfidence to the value loss of corporate diversification. Consistent with the model's prediction, the findings show that diversified firms run by overconfident CEOs experience value loss compared to diversified firms run by their rational counterparts. Empirically, the value loss is economically significant and ranges between 12.5% and 14.1%. In addition, the model predicts heightened corporate refocusing activity by overconfident CEOs who pursued diversified investments in the past once realized returns fail to match initial expectations. The empirical odds of corporate refocusing decisions are 67% to 98% higher when past diversifications are undertaken by overconfident rather than rational CEOs. Another prediction of the model is that overconfident CEOs exhibit preference for diversified investments, especially in the presence of ample internal funds. This prediction is also strongly supported by the data. Overall, this study proposes CEO overconfidence as a unified and consistent explanation of why firms pursue value-destructive corporate diversification policies and later adopt refocusing policies aiming to restore value.

Keywords: CEO overconfidence, diversification, refocusing, diversification discount, firm performance.

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Psychologists are constantly bombarding economists with empirical evidence that individuals do not always make rational decisions under uncertainty.
—Roll (1986, p. 199)

I. Introduction

Recent literature examines how managerial overconfidence affects corporate decision making (e.g. Malmendier and Tate (2005), Aktas et al. (2011), Hirshleifer et al. (2012), Ben-David et al. (2013)). This literature builds on the biased tendency of overconfident individuals to overestimate their own judgment, ability, and knowledge when comparing themselves to their rational peers (e.g. Langer (1975), Svenson (1981), Larrick (1993), Alicke et al. (1995), Moore and Cain (2007), Moore et al. (2008)). Overconfidence induces chief executive officer (CEOs) to overrate the added value of new investment projects and to underrate the likelihood of failure. Overconfident CEOs therefore tend to overinvest relative to the first–best choice, especially when they are not constrained by internal funds and thus drive firm size above the optimal level, a decision that can have adverse valuation implications for their firms (Camerer and Lovallo (1999), Malmendier and Tate (2008)). This study builds on prior literature and expands on the theoretical model of Malmendier and Tate (2005; MT hereafter) to offer a CEO overconfidence–based explanation of why firms initially pursue value-destructive corporate diversification policies followed later by corporate refocusing decisions, which aim to restore value.

While prior literature has examined the benefits and costs arising from corporate diversification, no consensus has emerged despite the different theories that have been developed to explain the puzzling evidence that diversified corporations trade at lower valuations relative to a portfolio of focused corporations (Lang and Stulz (1994), Berger and Ofek (1995)).[1] A sizable strand of the literature suggests that distorted investment decisions in the form of corporate diversifications could be the result of misalignment of managerial and shareholder interests (Jensen and Meckling (1976)). Diversified firms destroy value because they appear to incubate entrenched managers who diversify at the expense of shareholders to reap private benefits, such as perks and compensation (Jensen and Murphy (1990)), power and prestige (Jensen (1986), Villalonga (2000)), and better career prospects

[1] For an insightful review of the conflicting value-related findings of corporate diversification, see Martin and Sayrak (2003), Stein (2003), and Maksimovic and Phillips (2007).

(Shleifer and Vishny (1989), Stulz (1990)), and to reduce their own employment risks (Amihud and Lev (1981)).[2,3] Given these explanations, diversified firms appear to have lower valuations (i.e. exhibit a diversification discount) because their managers either overinvest and grow their firms beyond the optimal size (e.g. Aggarwal and Samwick (2003)) or because they pursue the creation of an internal capital market, which is not necessarily efficient or beneficial (e.g. Rajan et al. (2000), Scharfstein and Stein (2000), Ozbas and Scharfstein (2010)).[4] Although they offer a variety of important insights, these theoretical arguments mainly focus on agency problems that arise from (rational) managers' self-interested strategies. Fundamentally, however, they do not consider that the benefits and costs of diversification could depend on biases, such as overconfidence, that vary with the psychological characteristics of the CEO.

This study contributes to this literature by proposing CEO overconfidence as an explanation for the relatively lower valuations of diversified firms. We argue that the so-called corporate diversification discount phenomenon is mostly associated with diversified firms run by overconfident CEOs. We support this claim through a theoretical model that builds on the work of MT. Those authors formalize the idea that distortions in corporate investment policies (i.e. overinvestment), given a pre-existing capital structure, are associated with CEO overconfidence. Nevertheless, the MT model elaborates only on the relation between CEO overconfidence and aggregate firm investment activity and does not explicitly allow for the possibility that CEOs can engage in intra-industry (focused) or inter-industry (diversified) investments. We expand the MT model to account for CEOs' desire to invest outside the firm's core business, which arises because the deployment of more capital resources to the firm's focused business leads to diminishing returns. Accordingly, overconfident CEOs exhibit not only excessive willingness to overinvest but also an overly large appetite to diversify to avoid the diminishing

[2] Potential benefits from diversification arise, for instance, from economies of scope (Teece (1980), Teece (1982), Matsusaka (2001)), debt coinsurance effects (Lewellen (1971), Stein (2003)), internal capital markets (Stein (1997)), and fewer failures in product, labor, and financial markets (Khanna and Palepu (2000)).

[3] For the value destruction impact of corporate diversification, see, for instance, Lang and Stulz (1994), Berger and Ofek (1995), Servaes (1996), Lins and Servaes (1999), Rajan et al. (2000), Scharfstein and Stein (2000), and Hoechle et al. (2012).

[4] Recent studies, however, question the presence of the diversification discount and suggest that the lower valuations of diversified firms are illusory and the outcome of methodological problems; see, for instance, Whited (2001), Campa and Kedia (2002), Graham et al. (2002), Mansi and Reeb (2002), Villalonga (2004a, 2004b), Glaser and Müller (2010), and Kuppuswamy and Villalonga (2015).

returns of focused investments. Since overconfident CEOs pursue diversified investments more often than their rational counterparts, our theoretical arguments imply that the investment quality is reduced, which, in turn, results in lower average firm valuations due to excessive and unsuccessful diversified investment activity. In addition, our theoretical framework incorporates other stylized facts of prior studies suggesting that both rational and overconfident CEOs do learn about the prospects of their own firms from the information contained in stock prices (e.g. Aktas et al. (2009, 2011), Dow and Gorton (1997)). In this respect, a novel proposition of our model is that overconfident CEOs are also expected to undertake more corrective actions through corporate refocusing strategies by reversing their past failed diversified investments.

To empirically investigate the value-related implications of our theory, we link CEO overconfidence to the valuation of diversified firms using a time-series econometric approach that enables the comparison of firm value *before* and *after* the first decision to diversify. Hence, this analysis can be considered resilient to both the endogenous nature of the diversification decision (Campa and Kedia (2002)) and potential measurement errors related to the computation of firm value (Villalonga (2004a)). To gauge CEO overconfidence, we use two proxies. Following MT, the first proxy is based on CEOs' personal overinvestment in firm stock and the second is based on the portrayal of the CEO in the news media, following Hirshleifer et al. (2012) and Malmendier and Tate (2008). Consistent with the main prediction of our model, the findings show that overconfident CEOs exhibit a heightened tendency to carry out more corporate diversification decisions than their rational peers, especially in the presence of sufficient internal funds. These decisions destroy value; following the first incidence of diversification, diversified firms run by overconfident CEOs realize economically lower valuations ranging from 12.5% to 14.1% when compared to firms run by rational CEOs.

Our model further posits that overconfident CEOs who pursue diversified investments are more likely to adopt refocusing policies to restore firm value than their rational counterparts.[5] Consistent with this prediction, the results show that the odds of refocusing decisions are 67% to 98% higher when past diversification decisions are made by overconfident rather than rational CEOs.

[5] Prior empirical work (e.g. Berger and Ofek (1999)) considers refocusing decisions to be value-increasing policies, since they largely relate to the unwinding of past value-destructive diversified investments.

This study makes several contributions to the literature. First, it extends the theory of MT to explicitly model the CEO decision making process in the context of corporate diversification. In this regard, it allows for investment activity outside the firm's core business, due to diminishing returns that arise when CEOs deploy excessive capital on existing assets. More importantly, our model relaxes the assumption of CEO risk neutrality, a focal point of MT. By incorporating CEO risk preferences, the model predicts that, compared to rational CEOs who appear to invest at the first-best level and expand to the first-best number of diversified projects, overconfident CEOs engage in more diversified investments that destroy firm value. Furthermore, the model accounts for managerial learning pertaining to the valuation outcome of past corporate decisions. Using such a multi-period setting enable us to assess whether overconfident CEOs acknowledge investors' stock market valuation signals through a dynamic adjustment of corporate policies, that is, by reversing (or not) failed diversified investments made in the past. A prominent implication of this setting is that learning is, nonetheless, unable to eventually turn an overconfident CEO into a rational one, which is a very intriguing outcome, since it aligns well with evidence that considers managerial overconfidence to be habitual (and not transitory) CEO trait.[6] In this respect, our study offers novel insights and complements prior research that has addressed CEO learning in different contexts (e.g. Luo (2005), Chen et al. (2007), Kau et al. (2008), Aktas et al. (2009)).

Second, this study contributes to the empirical literature documenting that diversified firms appear to have, on average, lower valuations compared to a portfolio of standalone firms (Lang and Stulz (1994), Berger and Ofek (1995)) by offering an unconventional explanation based on CEO psychological traits. By documenting that overconfident CEOs show a heightened tendency to undertake more diversification decisions than their rational peers, we point out the underlying channel through which CEO overconfidence destroys firm value. This result, thus supports the conceptual conjectures of Roll (1986) and the laboratory evidence of Camerer and Lovallo (1999) using realistic conditions whereby overconfident and rational CEOs have certain risk preferences. Furthermore, the proposed explanation for corporate diversification activity complements other prominent explanations

[6] See, for instance, the seminal work of Malmendier and Tate (2005, p. 2672), whose overconfidence CEO measures target the *permanent* rather than *transitory* CEO overconfidence effect.

that rely on suboptimal decision making, such as agency problems (Stein (1997), Villalonga (2000), Aggarwal and Samwick (2003), Stein (2003)). Finally, although many recent studies have investigated the implications of overconfident CEOs on firms' policies and organizational outcomes (e.g. Campbell et al. (2011), Gervais et al., (2011), Hirshleifer et al. (2012)), this study primarily links CEO overconfidence to the value of diversified firms.

Third, the theoretical propositions and empirical evidence support the idea that CEO overconfidence can serve as a unified and consistent explanation for two strands of the literature that investigate, mostly independently, the questions of *why firms diversify* (e.g. Lewellen (1971), Stein (1997), Villalonga (2000), Matsusaka (2001), Aggarwal and Samwick (2003), Stein (2003)) and *why firms refocus* (e.g. Comment and Jarrel (1995), John and Ofek (1995), Berger and Ofek (1996, 1999)). In particular, the finding that corporate refocusing decisions relate to past diversification decisions made by overconfident CEOs implies that corporate refocusing decisions are motivated by the value losses from poor past diversified investment decisions.

Finally, this study relates to the growing strand of behavioural corporate finance literature by empirically connecting CEO overconfidence to value-decreasing investments through corporate diversification decisions and to value-increasing disinvestments through corporate refocusing actions. Our findings shed empirical light on theoretical arguments according to which sufficiently high managerial overconfidence generates overinvestment that subsequently decreases firm value (Goel and Thakor (2008)). Moreover, the study complements that of Malmendier and Tate (2008), who provide evidence that CEO overconfidence increases merger frequency and induces weaker short-term market reactions to merger announcements, especially diversifying acquisitions. While Malmendier and Tate (2008) use diversifying acquisitions as a proxy for value destruction, this study, instead, relies on realized corporate diversification decisions and the subsequent value destruction associated with this policy.

The study proceeds as follows. Section II describes the model. Section III describes the data and measures. Section IV discusses the empirical results. Section V concludes the paper.

II. The Model

This study proposes a two-period model that shows the impact of overconfidence on the type and effectiveness of corporate investments in an efficient capital market. The model is an extension to MT and aims to demonstrate the investment distortion effect of overconfidence on corporate diversification and to link this effect to subsequent corporate refocusing. We assume that the CEO maximizes current shareholder wealth. Initially, the only friction in the model arises from a CEO's inflated perception of the true returns from investment. Then, we also allow the CEO to be optimistic about the return on the firm's assets. Further, we allow the CEO to have certain risk preferences (i.e. we relax the risk-neutral assumption).

Consider a firm with assets A, initial cash holdings C, and s shares outstanding. There is a continuum of differentiated projects $i \in [0,1]$ a producer can undertake. Unlike the model of MT, the CEO's decision is twofold. The CEO jointly decides on the number of projects N to launch and the amount to invest in each sector I_i. For simplicity, we assume that each project has the same return on investment and the CEO therefore chooses the same investment level for all projects, allowing us to drop the subscript i.[7] Further, we assume that the projects' returns are initially identical.

The return on each investment project, $R(I)$, is increasing in the investment level ($R'(I) > 0$) and exhibits diminishing returns ($R''(I) < 0$). Assuming that $E(.)$ is the expectations operator, the perceived return on each project for a firm's CEO is $ER(I) = R(I)(1 + \Delta)$. The difference between rational and overconfident CEOs is that $\Delta = 0$ for rational CEOs, implying that overconfident managers overestimate the true return of their projects by a magnitude of $\Delta > 0$.

As in MT, investment costs can be financed through 1) cash c, which can be as large an amount as the firm's initial cash holdings, so that $c \leq C$; 2) risk-free debt d (at an interest rate of one), which is the debt that a firm can accumulate up to an amount D, where debt capacity is restricted by the

[7] If each project's return is a draw from a distribution, this will not affect the results because this does not change the ranking of the relative investment responses of overconfident and rational CEOs. Heterogeneity in investment projects would imply heterogeneous investments in each project. However, what we are concerned about is that, for each project, the overconfident CEO overinvests compared to the rational CEO. Therefore, we could just as well assume that all projects are the same for this experiment.

collateral value of a firm's assets and, therefore, $A > D$; and 3) a new shares issue, which implies that the amount of internal cash and debt together, $c + d$, is not enough to finance the new investment.

Moreover, investing in different sectors (i.e. outside of the firm's core industry) involves an entry cost $F(N)$. This cost can be interpreted as the cost to maintain competitiveness in N businesses that could involve preparation, advertising, legal costs, accounting and auditing costs, input transformation, research and development (R&D), and/or all extra costs necessary to allow a firm to compete in a certain industry. The cost is increasing in the number of projects N and, therefore, $F'(.) > 0$. Further, the marginal cost of additional business expansion is increasing ($F''(.) > 0$), insinuating that rapid expansion to many sectors at once is less appealing. Therefore, the total cost of investment each period is $NI + F(N)$.[8]

The CEO solves the following constrained optimization problem:

$$\max_{\{I,s',c,d,N\}} \frac{s}{s+s'}[A + C + NR(I)(1+\Delta) - c - d] \tag{1}$$

$$s.t. \quad \frac{s'}{s+s'}[A + C + NR(I) - c - d] = NI + F(N) - c - d \tag{2}$$

$$c \leq C, \qquad d \leq D, \qquad c + d \leq NI + F(N) \tag{3}$$

$$c \geq 0, \qquad d \geq 0, \qquad N \geq 0 \tag{4}$$

where s and s' are the numbers of current shares and shares next period, respectively. The first constraint, equation (2), simply states that the amount financed through a new shares issue (left-hand side) should be equal to the value of the firm that belongs to the new shareholders (right-hand side). In the objective function, equation (1), of the overconfident CEO, the returns are exaggerated by Δ. However, the first constraint, equation (2), reveals that the CEO understands that outside investors do not share the same confidence regarding the firm's expansion. The return in the constraint is the true

[8] We treat both investment *I* and sectors *N* is as if they were sunk costs. We treat *I* as the cost of variable inputs necessary to implement a project and *N* as those variable inputs necessary to maintain competitiveness in *N* different sectors. Alternatively, if we assume that these variables can be accumulated, the model would treat *I* and *N* as state variables and their initial values would also be necessary for the solution. The accumulated investment would then increase asset holdings A_{t+1} next period. However, since our concern is the comparison between overconfident and rational managers, this formulation adds nothing different from our benchmark specification. Therefore, for the rest of the model and without loss of generality, we assume that the firm starts with a zero investment level and initially operates in a measure of zero sectors/projects, that is, $N_0 = 0$.

return ($\Delta = 0$), which is what the new shareholders expect to receive if they invest in the firm. Therefore, when deciding to use external funds, the CEO should also consider that the new shareholders demand a larger share of the pie than what the CEO deems fair. Constraint set (3) imposes bounds on the control variables and constraint set (4) includes non-negativity constraints.

Definition 1: The (first-best) level of investment I_{FB} satisfies $R'(I_{FB}) = 1$ and the (first-best) number of sectors N_{FB} satisfies $F'(N_{FB}) = R(I_{FB}) - I_{FB}$.

Definition 2: The level of investment $\hat{I}$ satisfies $R'(\hat{I}) = \frac{1}{1+\Delta}$ and the number of sectors $\hat{N}$ satisfies $F'(\hat{N}) = (1+\Delta)R(\hat{I}) - \hat{I}$.

Definition 3: The level of investment $\bar{I}$ satisfies $R'(\bar{I}) = \frac{1}{1+\Delta\Phi}$ and the number of sectors $\bar{N}$ satisfies $F'(\bar{N}) = (1+\Delta\Phi)R(\bar{I}) - \bar{I}$ for some $\Phi > 0$.

The following proposition highlights the relative efficiency of a rational manager's decisions compared to an overconfident one. All proofs are included in Appendix A.

Proposition 1: *If $R(.)$ is concave, $F(.)$ is convex, I^* is the optimal level of investment, and N^* is the optimal number of projects to launch, then a) a rational CEO ($\Delta = 0$) chooses $I^* = I_{FB}$ and $N^* = N_{FB}$ for all C and D and b) an overconfident CEO ($\Delta > 0$) chooses $I^* = \bar{I}$ and $N^* = \bar{N} > N_{FB}$ for all C and D such that $C + D < \hat{N}\hat{I} + F(\hat{N})$, with $I^* = \hat{I} > I_{FB}$ and $N^* = \hat{N} > N_{FB}$ for all C and D such that $C + D \geq \hat{N}\hat{I} + F(\hat{N})$.*

The rational CEO invests in each project at the first-best level and expands to the first-best number of projects, irrespective of initial cash holdings or debt capacity, whereas the overconfident CEO overinvests in both the number of projects and the amount allocated to each individual project. Nevertheless, the overconfident CEO tends to exaggerate investment the higher the firm's stock of cash is, leaving the firm more sensitive to its own cash flow.

Lemma 1: *If $C + D < \hat{N}\hat{I} + F(\hat{N})$, which implies overconfident CEOs are cash constrained, and $R(.)$ is concave and $F(.)$ is convex, then $\hat{I} > \bar{I} > I_{FB}$ and $\hat{N} > \bar{N} > N_{FB}$.*

Lemma 1 claims that cash-constrained overconfident CEOs tend to overinvest, albeit at a lower magnitude than cash-rich ones. On the other hand, overconfident CEOs who can carry out the whole investment plan with their own funds tend to overinvest more heavily. The following proposition demonstrates that cash-constrained overconfident CEOs overinvest more the higher the firm's initial stock of cash is.

Proposition 2: *Let $R(.)$ be concave and $F(.)$ convex. Then a) for a rational CEO ($\Delta = 0$), I^* and N^* are independent of initial cash holdings C for all C and D, and b) for an overconfident CEO ($\Delta > 0$), $I^* = \hat{I}$ and $N^* = \hat{N}$ are independent of initial cash holdings C, for all $C + D \geq \hat{N}\hat{I} + F(\hat{N})$, and is strictly increasing in C for all $C + D < \hat{N}\hat{I} + F(\hat{N})$.*

A rational CEO is not concerned about the financing method, adhering to the Modigliani–Miller theorem. However, overconfident CEOs seeking finance through the capital market face a conflict: solving for s' in constraint (2), that is,

$$s' = s\frac{NI + F(N) - c - d}{A + C + NR(I) - NI - F(N)}$$

This equation shows the number of shares that should be offered to new shareholders for their contribution to the investment undertaken by the firm, which is $NI + F(N) - c - d$. In the eyes of the overconfident manager, the new shares issue to finance the same investment should have been

$$s' = s\frac{NI + F(N) - c - d}{A + C + NR(I)(1 + \Delta) - NI - F(N)} < s'$$

Therefore, the overconfident CEO believes that the shares of the firm are more diluted than necessary. This induces the cash-constrained overconfident manager to use as much cash and debt available (thus $c = C$ and $d = D$) to rely as little as possible on new investor funding. This is basically the reason all individual investment and diversification decisions are increasing in cash holdings C. The greater the cash available to the CEO, the greater the scale of diversification.

This argument also sheds new light on Lemma 1. An overconfident manager who needs external funding would keep the issuance of new shares as moderate as possible, holding diversification to a minimum, whereas an overconfident manager with the ability to undertake the entire new investment through internal funding would be in favour of greater diversification. Thus, equity-dependent firms that consider diversification are more cash sensitive than any other firms.

Next, we investigate the diversification decisions of an overconfident CEO who is optimistic not only about the true return but also about the return on the assets of firm A. This excessive optimism could be exacerbated if the overconfident CEO contributed to the accumulation and management of those assets. We assume that the overconfident CEO estimates the next period's return on the firm's assets to be $A(1 + \Delta_A)$, where A is the true value of the assets. A CEO with insufficient internal funds

needs to rely on new shareholders to fund part or all of the cost of the project; therefore, $C + D < N^*I^* + F(N^*)$.

Lemma 2: *Suppose that an overconfident CEO does not hold sufficient internal funds, that is,* $C + D < N^*I^* + F(N^*)$*, and estimates the return to each project as* $R(I)(1 + \Delta)$ *and the return on assets as* $A(1 + \Delta_A)$*, where* $\Delta > 0$ *and* $\Delta_A > 0$*. Then the CEO overinvests (*$I^* > I_{FB}$*) when* $\Delta > \frac{A}{A-D}\Delta_A$ *and underinvests (*$I^* < I_{FB}$*) when* $\Delta < \frac{A}{A-D}\Delta_A$.

Lemma 2 highlights the behaviour of a CEO with insufficient internal funds. If the CEO overestimates the true returns from investments and diversification, the CEO tends to overinvest, even if part of the cost is funded through a new shares issue, inducing share capital dilution. Nonetheless, if the CEO overestimates both the returns on investment and the return on the firm's assets, then the CEO's behaviour can potentially be reversed. For example, suppose the CEO overestimates the true return on assets and, to a lesser extent, the true investment returns; then the CEO underinvests compared to the rational CEO. In such a case, the CEO is reluctant to hand out as many new shares to the new shareholders, because they are entitled to the firm's assets that the CEO considers to be undervalued. The CEO thus feels that the new shareholders are being overcompensated with an extra return to whose determination they do not contribute at all.

Lemma 3: *If risk is introduced by transforming the return function to* $R(I; z) = zR(I)$*, where* $z \sim N(1, \sigma_r^2)$*, CEOs are risk averse and, if the overconfident CEO either overestimates the return* ($\Delta > 0$) *or underestimates the project's risk* ($\sigma^2 < \sigma_r^2$)*, the results in Propositions 1 and 2 still hold.*

For an overconfident CEO, a lower σ^2 value induces the exact same effect as a higher Δ. If the overconfident CEO differs from the rational CEO by either a positive Δ or a lower σ^2 (since $\sigma^2 < \sigma_r^2$), aversion to external financing works precisely the same way. The difference between cash-rich and cash-poor firms is governed by how CEOs perceive the compensation to outside funding and overconfident CEOs – by either overestimating the mean return or underestimating the variance – believe they should compensate outside investors with a price $P_s > 1$ for each dollar those investors bring in for the firm. Since outside investors perceive greater risk, they demand more generous compensation in shares for every dollar they bring in and thus the overconfident CEO is inclined to rely more on the firm's own funds for investment.

Lemma 4: *If the model is extended for another period and CEOs update their beliefs through an adaptive learning algorithm, corporate refocusing is more likely to relate to past diversifications made by overconfident CEOs.*

Both rational and overconfident CEOs are likely to learn and reduce the degree of diversification by refocusing, if the expansion undertaken is above the optimal level.[9] Therefore, since overconfident CEOs overestimate the expected returns of projects, the feedback they receive from the realized returns is more likely to encourage divestment. In this spirit, we expect that, as CEOs learn from their past diversification mistakes, they most likely attempt to reduce the amount of diversification by refocusing.[10]

III. Data and Measures

A. Sample

To construct our sample, we relied on several data sources. We use the Center for Research in Security Prices to obtain market prices; Standard & Poor's Compustat Industrial Segment and Compustat Industrial Annual databases to obtain segment- and accounting-related information, respectively; S&P's ExecuComp to access information about CEOs, and Factiva to retrieve CEO press characterizations. Following prior corporate diversification literature (Aerger and Ofek (1995), Campa and Kedia (2002)), we exclude firm–years where firms report segments in the financial sector (Standard Industrial Classification codes 6000–6999), with sales of less than $20 million, and where the sum of segment sales is not within 1% of the firm's total sales. We also exclude firm–years missing data on

[9] Learning, for instance through market signals is a reasonable assumption for two main reasons: first, prior literature shows that poor firm performance is a main determinant of CEO turnover (Hermalin and Weisbach (1998), Lehn and Zhao (2006)). Thus, given the well-established negative economic and human capital (personal careers) consequences for non-performing (Eckbo et al. (2016)) and fired CEOs, it is reasonable to assume that CEOs care about firm performance and respond accordingly to restore shareholders' confidence about the firm's prospects through corrective corporate decisions such as refocusing. Second, prior theoretical literature in corporate finance assumes that market signals contain information produced by trades that do not have channels of communication with the firm outside of the trading process (e.g. Grossman and Stiglitz (1980), Subrahmanyam and Titman (1999)). Empirically, Chen et al. (2006) show that this information guides managers when making corporate decisions.

[10] If learning induces the underlying beliefs to move from high to lower returns, CEOs are more likely to refocus if the diversification is undertaken by an overconfident CEO. For the results in this paper to reverse, learning must operate in such a way that, after an episode of overconfidence, beliefs converge to rational beliefs in an oscillatory manner, bouncing from extreme optimism to extreme pessimism along the way. However, the literature on learning expectations reveals that agents tend to approach the true parameter without oscillations.

both the dependent and control variables. In addition, we require data on at least one of our overconfidence measures. Because we use a one-period lag for the overconfidence measures, we also require the same CEO over any two consecutive periods. A description of the CEO overconfidence measures follows and detailed information about the control variables is in Appendix B.

The final sample covers the period from 1993 to 2010. We start our analysis in 1993 instead of 1992, which is the start year for ExecuComp, since we observe that the first year of data of this database is rather incomplete and tends to underrepresent S&P 1500 firms. We end our investigation in 2010 because our analysis includes a press-based CEO overconfidence measure that exploits hand-collected information from financial press articles retrieved using the Factiva database going back to 1980. Collecting this information for a 30-year period is a daunting and very time-consuming process that commanded a great deal of human effort to meticulously complete.

B. CEO Overconfidence Measures

Measuring CEO overconfidence empirically presents a great challenge, since it is a salient feature of CEO behaviour that cannot be observed directly. Our objective is therefore to rely on CEO overconfidence measures that have been successfully applied in previous seminal studies. In that vein, we use a net buyer–based measure of overconfidence following the rationale of MT, as well as a press-based measure of overconfidence following the rationale of Hirshleifer et al. (2012). These measures have been widely used by other important studies, such as those of Malmendier and Tate (2008), Malmendier et al. (2011), Campbell et al., (2011) and Hribar et al. (2015). An important feature of these CEO overconfidence measures is that they are meant to capture the permanent (rather than transitory) overconfidence effect. They are therefore consistent with the notion that CEO overconfidence is a habitual characteristic, as postulated in the seminal works of Roll (1986) and MT, and coincide with the theoretical arguments as predicted by the model presented in this study.

First, we draw upon MT to create the net buyer–based measure of overconfidence (*NET_BUYER_OC*). This measure exploits the tendency of certain CEOs to increase exposure to their firm stock despite their already high exposure to idiosyncratic risk. An increase of exposure to firm

stock occurs when a CEO is a net buyer, that is, the CEO buys more stocks than what sells during a year. Following MT, we classify CEOs as overconfident during their entire tenure if they were net buyers of firm equity during their first five years in our sample, that is, they bought stock on net in more years than they sold on net during their first five sample years. Information about CEO exposure to stocks is obtained from ExecuComp. Using the net buyer proxy of CEO overconfidence, we obtain a final sample of 1,360 firms, with 8,262 firm–year observations.

We do not have specific information on whether changes in the stocks owned by CEOs (excluding options) are driven by stocks that CEOs keep after exercising vested options and/or stocks they buy from the open market. Ofek and Yermack (2000) find that most executives sell stocks acquired through the exercise of vested options. Thus, changes in the percentage of stock owned by CEOs, excluding options, should largely reflect additional purchases of stocks from the open market. To complement our approach, we re-estimate the net buyer measure after subtracting the number of stocks acquired by exercising options during the year. Assuming that CEOs keep rather than sell these stocks, this alternative measure is calculated based on stock purchases from the open market. In additional tests, we also exclude the first five years of CEO tenure. Although this approach mitigates endogeneity concerns, it also substantially reduces sample size. Nonetheless, the results using these alternative definitions of net buyer are qualitatively similar to those reported using the main measure.

Second, following Hirshleifer et al. (2012), we use a press-based measure of CEO overconfidence relying on hand-collected information from financial media press articles (*PRESS_OC*). In particular, we search for articles on Factiva by keywords, using the CEOs' names or variants thereof during their tenure period, in the following financial media: *The New York Times*, *Business Week*, *Financial Times*, *The Times*, *The Wall Street Journal*, *The Economist*, *Fortune*, *Forbes*, *Dow Jones Business News*, and *Dow Jones Online News*. Information about the name and tenure of CEOs is obtained from ExecuComp. For each CEO and year, we record the total number of relevant articles with the following information: (i) articles containing the words *confident* and *confidence* or variants such as *overconfidence* and *over-confident*, (ii) the number of articles containing the words *optimistic* and *optimism* or variants such as *overoptimistic* and *over-optimism*, (iii) the number of articles using *pessimistic* and *pessimism* or variants such as *over-pessimistic*, and (iv) the number of articles using

cautious, *reliable*, *steady*, *practical*, *conservative*, *frugal*, *not confident*, or *not optimistic* or variants such as *non-confident* and *non-optimistic*. Each article was carefully read to verify that the context of confident/optimistic or pessimistic/cautious characterizations was used appropriately and was only relevant to the CEO and firm of interest.

Our financial press–based overconfidence measure classifies a CEO as overconfident if the number of press articles describing the manager as confident/optimistic exceeds the number of articles describing the manager as pessimistic/cautious. In particular, we compare the number of articles that use the confident/optimistic terms as captured by categories (i) and (ii) and articles that use the pessimistic/cautious terms as captured by categories (iii) and (iv) and measure CEO overconfidence for each CEO *i* in year *t* as

$$PRESS\_OC_{it} = \begin{cases} 1 \; if \; \sum_{i=1}^{t} CONF_{ij} > \sum_{q=1}^{t} CAUT_{ij} \\ 0 \; otherwise, \end{cases}$$

where $CONF_{ij}$ is the number of articles using confident terms and $CAUT_{ij}$ is the number of articles using cautious terms. Our press-based measure cumulates articles starting from the first year the CEO is in office. ExecuComp provides data from 1992 and onwards and reports the hiring date of each CEO. From this information, many CEOs in our sample seem to have been in their office well before 1992. Therefore, to avoid any bias due to omitted articles that characterize CEOs prior to 1992, our article searches start from the first date the CEO is hired.[11] When using the press-based proxy of CEO overconfidence, we find a final sample of 1,860 firms, with 10,843 firm–year observations.[12]

As Malmendier and Tate (2008) and Hirshleifer et al. (2012), we always use lagged overconfidence measures relative to the dependent variable. The use of disjoint periods to establish the overconfidence measure in year *t* - 1 and to gauge its effects on corporate diversification valuation and outcomes in year *t* is intended to alleviate endogeneity concerns. Our study reports results using both

[11] Our access to financial articles through Factiva starts in 1980.

[12] We note that this measure allows a CEO to change from being overconfident to rational when the number of articles using cautious terms are greater than the number of articles using the confident terms during a certain year. Nevertheless, consistent with overconfidence being a permanent trait, the classification is highly persistent. For instance, when a CEO is classified as overconfident in period *t*, the CEO will remain overconfident 83% of the time in period *t* + 1 and 82.51% of the time in period *t* + 2.

measures of CEO overconfidence. For convenience, we use the variable *CEO_OC*, which takes the value of one when the CEO is overconfident and zero otherwise. In addition, we use the variable *CEO_NOT_OC*, which takes the value of one when the CEO is not overconfident (i.e. rational) and zero otherwise.

IV. Results

The empirical investigation is on the effect of CEO overconfidence on corporate diversification valuation. Therefore, this study first investigates whether diversified firms managed by overconfident CEOs exhibit lower valuation compared to diversified firms managed by rational CEOs. Subsequently, using an alternative empirical approach, the study further checks for value-destructive diversification investments by exploring whether the average overconfident CEO exhibits a heightened tendency to refocus. Finally, in the spirit of Malmendier and Tate (2008), the study also tests for the presence of a value-destructive channel by investigating whether overconfident CEOs show a pronounced tendency to carry out more diversifying decisions compared to their rational peers. This channel must be present in the data to fully support the value-destructive diversification investment decisions and subsequent heightened refocusing activity associated with overconfident CEOs.

A. Descriptive Statistics

Table 1 reports descriptive statistics for the most important variables, segregated into firm–years where CEOs are classified as either overconfident or rational. The results suggest that overconfident CEOs who either increase their exposure to firm stock or are characterized as confident/optimistic more often than pessimistic/cautious in the press tend to manage larger firms, spend less for capital expenditures, and have higher sensitivity to risk. The latter observation is consistent with the view that overconfident CEOs are willing to accept compensation that is more sensitive to firm risk, since they are inclined to make riskier investments. Further, the results show no material relation between the past year's stock returns and overconfidence, suggesting that neither of these measures relates significantly to past firm performance. Regarding the sample with the press

overconfidence measure, the total number of articles citing CEOs is greater for overconfident CEOs than for rational CEOs. Consistent with Malmendier and Tate (2008), these figures seem to suggest that the financial press covers more positive than negative stories. Regarding corporate policies, evidence suggests that overconfident CEOs exhibit a heightened tendency to making more refocusing and diversification decisions compared to their rational peers.

[Insert Table 1 here]

With respect to the other variables, the relations appear to differ between the two overconfidence measures. Focusing on the sample with the net buyer overconfidence measure, we find overconfident CEOs have a lower delta and tenure and manage firms that appear to be slightly more financially distressed, as indicated by cash holding constraints, and firms that are less profitable and exhibit lower excess values. These relations are generally in the opposite direction when the sample is analysed with the press overconfidence measure. Such conflicting univariate relations between the two samples with net buyer/press measures of overconfidence could relate to the fact that the relations between these variables and overconfidence in panel data are unclear. For instance, given that overconfident CEOs perceive external financing as unduly costly (MT, Malmendier et al. (2011)), they should accumulate cash to finance future investment opportunities; at the same time, however, when they use cash to finance investments, the levels of cash will decrease. Thus, in a panel setting, the relation between cash-poor firms and overconfidence is unclear. Similarly, consistent with evidence on the bright side of overconfidence (Hirshleifer et al. (2012)), tenure should be longer for overconfident CEOs. In contrast, evidence indicates that excessive optimism relates to a greater probability of forced turnover (Campbell et al. (2011)). Similarly, these different perspectives on overconfidence can also confound the panel setting relation between excess value and CEO overconfidence.

B. CEO Overconfidence and the Value of Corporate Diversification

We start our empirical investigation by examining whether diversified firms exhibit lower valuations after diversification, particularly when the diversification was made by an overconfident CEO. Similar to Campa and Kedia (2002), we select the sample of all single-segment firms and all

diversified firms. Diversified firms can diversify once or multiple times. We include all types of such firms, particularly those that diversify once from a single segment to multiple segments, those that diversify once from multiple segments to multiple segments, and those that diversify multiple times. In this analysis, we exclude diversified firms that chose to refocus during the sample period, since they can confound the value implications pertaining to corporate diversification and are therefore investigated separately in Section IV.C.[13]

Campa and Kedia (2002) document that the characteristics of firms that diversify, which make the benefits of diversification greater than the costs of diversification, can also cause firms to be discounted, thus implying a self-selection mechanism behind firms' decisions to diversify (see also Kuppuswamy and Villalonga (2015)). Along this line, Campa and Kedia find a strong negative correlation between a firm's choice to diversify and firm value and argue that the lower valuation of diversified firms documented is not adequate evidence that diversification destroys value per se. Therefore, observing in the cross section that diversified firm–years have lower valuations compared to focused firm–years does not necessarily imply that diversification destroys value. Unlike prior studies that rely on cross-sectional data, ours instead relies on a time-series analysis that alleviates self-selection concerns that would otherwise have complicated the cross-sectional analysis. More specifically, the time-series analysis allows us to segregate firm valuations into two components: (i) the one that applies to the firm's value *before* the decision to diversify, which would also reflect all those elements that could have caused lower valuations in the first place and (endogenously) forced the firm to self-select to diversify, and (ii) the one that applies *after* the firm makes the decision to diversify. Therefore, this econometric approach is suitable for assessing the pure impact of diversification on a firm's value by comparing its valuation *before* and *after* the first incidence of diversification (Andreou et al. (2016)). Furthermore, a time-series approach makes our findings less likely to be biased by methodological problems that can arise during the estimation of excess value (e.g. Whited (2001), Campa and Kedia

[13] Comment and Jarrell (1995), John and Ofek (1995), and Berger and Ofek (1996) provide evidence that refocusing firms experience increases in valuations. To avoid such confounding impacts on the value of corporate diversification, we exclude all refocusing firms, particularly those that refocus once from multiple segments to a single segment, those that refocus once from multiple segments to multiple segments, and those that refocus multiple times. Moreover, we exclude multi-segment firms that do not change their number of segments.

(2002), Villalonga (2004a), Santalo and Becerra (2008)), since methodological or measurement problems should affect firm valuation similarly before and after the decision to diversify. Specifically, we estimate variants of the following linear regression model:

$$EXC\_VAL_{i,t} = \gamma_0 + \beta_1 DIV_{i,t} + \beta_2 AFT\_DIV_{i,t} + \beta_3 CONTROLS + \varepsilon_{i,t} \quad (1)$$

In this analysis, the dependent variable is excess value (EXC_VAL_t), *DIV* is a dummy variable that equals one if the firm diversifies at any point (either before or after diversification) and zero otherwise, and *AFT_DIV* is a post-diversification dummy variable that equals one for all firm–years starting from the first incidence of diversification (i.e. the year of the first diversification event and onwards) and zero otherwise.[14] Therefore, (i) the coefficient estimate of *DIV* represents firm valuation before the decision to diversify, (ii) the coefficient estimate of *AFT_DIV* indicates the change in firm valuation after the decision to diversify relative to valuation before the decision to diversify, and (iii) the sum of the coefficient estimates of *DIV* and *AFT_DIV* show the firm valuation after the decision to diversify.

The control variables are based on the work of Berger and Ofek (1995) and include the ratios of capital expenditures to sales ($INVEST_t$) and of earnings before interest and taxes to sales ($PROFIT_t$) and the natural logarithm of total assets ($SIZE_t$). In addition, consistent with Campa and Kedia (2002), we lag by up to two years firm size ($SIZE_{t-1}$ and $SIZE_{t-2}$), profitability ($PROFIT_{t-1}$ and $PROFIT_{t-2}$), and investments ($INVEST_{t-1}$ and $INVEST_{t-2}$). We also include the ratio of long-term debt to total assets (LEV_t) and control for potential nonlinear effects of firm size on firm value by including firm size squared ($SIZE_t^2$). Finally, we include year fixed effects to control for unobserved year characteristics.

Panel A of Table 2 reports the results using the net buyer measure of overconfidence. Model (1) shows that diversified firms have a valuation of -12.0% (p-value < 0.05) before their first diversification decision is made and a reduction in valuation of -14.1% (p-value < 0.05) due to diversification, implying a valuation of -26.1% (p-value < 0.01) after the first incidence of diversification. These findings are consistent with the self-selection reasoning of Campa and Kedia (2002) regarding the decision to

[14] Note that this estimation does not suffer from the dummy variable trap, since the sample includes focused firms as well.

diversify, since firms that choose to diversify appear to demonstrate profoundly lower valuations before the first incidence of diversification. Self-selection, however, can affect overconfident and rational CEOs differently, because overconfidence affects CEOs' perceptions about their firm's valuation (i.e. overconfident CEOs are more likely to perceive their firm as being undervalued). Accordingly, to estimate the valuation effect of corporate diversification for overconfident and rational CEOs, it is important to interact both diversification and post-diversification dummy variables for overconfident CEOs and rational CEOs. These interaction terms are useful for separately segregating the changes in valuation due to diversification for both overconfident and rational CEOs.[15]

[Insert Table 2 here]

Model (2) of Table 2 presents the results. The results suggest that, before the first decision to diversify, firms with diversifications undertaken by overconfident CEOs exhibit valuations of -14.1% (p-value < 0.05), whereas firms with diversifications by rational CEOs are not discounted at all. After the first decision to diversify, firms with diversifications undertaken by overconfident CEOs show a further drop of -21.4% (p-value < 0.05) in valuation, implying a substantial reduction in valuations totalling -35.5% (p-value < 0.01). Diversifications undertaken by rational CEOs also exhibit lower valuations totalling -17.6% (p-value < 0.05) after the decision to diversify, but the reduction value of -7.3% is not statistically significant. Hence, for these firms, diversification does not appear statistically to be value destructive.

In model (3) of Table 2, we provide a more direct analysis of the impact of managerial overconfidence on diversification performance using only the sample of diversified (multi-segment) firms and investigate the impact of diversification using the post-diversification dummy variable. Consistent with the findings, as in model (1), diversified firms experience a decline in valuations of -9.9%, albeit it is statistically insignificant at conventional levels. In model (4), we segregate the post-diversification valuations between overconfident and rational CEOs. Consistent with the findings in model (2), the results indicate that firms with diversifications undertaken by overconfident CEOs are

[15] We avoid any confounding effects from changes in CEO overconfidence before and after the first incidence of diversification by keeping in our analysis only firms with either overconfident or rational CEOs for the whole period that each firm is in our sample. This approach is necessary so the before and after analyses can capture the pure effects of CEO overconfidence on corporate diversification value.

valued at -19.5% (*p*-value < 0.05). In addition, there is no valuation discount for diversified firms with diversifications undertaken by rational CEOs.

Panel B of Table 2 reports estimates of the relation between excess value, diversification, and CEO overconfidence using the press-based measure. Overall, the results are qualitatively similar with the findings in Panel A, suggesting that firms that choose to diversify exhibit lower valuations after the first incidence of diversification. More importantly, however, it is an empirical fact that the lower valuations seem to be mostly driven by diversifications undertaken by overconfident CEOs. For instance, the results in model (2) in Panel B indicate that, after the first incidence of diversification and compared to diversified firms run by rational CEOs, diversified firms run by overconfident CEOs have valuations that are 12.5% economically lower (-27.2% vs. -14.7%) when the press measure of overconfidence is used instead.

B.1 Robustness Checks

We assess the sensitivity of our results using three robustness checks. First, Graham et al. (2002) argue that the diversification discount provides misleading inferences due to violation of the standard assumption that a firm's segments can be benchmarked against typical standalone firms. The authors argue that the diversification discount arises not because diversification destroys value per se, but because firms acquire already discounted target firms. We control for the possible impact of discounted targets on our findings as follows: first we identify firm–years with change in assets of more than 50% from year *t* - 1 to year *t*. Laeven and Levine (2007) argue that such changes in assets, among others, could reflect large acquisitions. Then, we rerun models (2) and (4) of Table 2 after including a dummy variable that equals one for year *t* and all later years in which a firm potentially experienced large acquisitions and zero otherwise (*POST_ACQUISITION*). In additional tests, we verify that our findings do not change when we redefine the dummy variable to equal one for year *t* - 1 and all later years in which a firm potentially experienced large acquisitions and zero otherwise. The results are reported in models (1) and (3) of Table 3, respectively. Irrespective of the measure of overconfidence used, consistent with Graham et al. (2002), the coefficient estimate of the post-acquisition dummy

variable is negative, albeit only significant when excess value relative to focused firms is compared, as shown in model (1). Most importantly, this control does not affect our main findings. When diversification is carried out by overconfident CEOs, the firm still exhibits much lower valuations.

[Insert Table 3 here]

Second, Mansi and Reeb (2002) and Glaser and Mueller (2010) argue that the diversification discount stems from a risk-reducing effect of corporate diversification, which implies that a diversified firm's market value of debt could trade at a premium relative to the book value of debt. Accordingly, for diversified firms, excess value estimated using the book value of debt, following Berger and Ofek (1995), suffers from a downward bias. To assess the sensitivity of our findings to this issue, we re-estimate excess value using the market value of debt instead of the book value of debt. We estimate the market value of debt using Merton's (1974) bond-pricing model. Following Vassalou and Xing (2004) and Bharath and Shumway (2008), we set the input parameters of the model as the standard deviation of daily stock returns over the past 125 days, the one-year Treasury constant maturity rate, the firm's face value of total debt, and the firm's market capitalization. Time to maturity is set equal to one year. Then, using the new estimates of excess value, we rerun models (2) and (4) of Table 2 and report the new results in models (2) and (4) of Table 3, respectively. The results remain virtually unchanged for both measures of overconfidence: diversifications made by overconfident CEOs still show significantly lower valuations after diversification.

Third, it is possible that the results are affected by time-invariant firm characteristics. Including firm fixed effects could alleviate such concerns; however, due to the sample construction, firm fixed effects would be largely correlated with the CEO overconfidence status. Hence, we rely upon an alternative approach to control for time-invariant firm characteristics, including one- and two-year-lagged excess values as additional controls. The idea is that important time-invariant firm characteristics should largely affect the valuation of the firm on a persistent basis (i.e. should be already incorporated in the two lagged excess values). Such a model specification could alleviate concerns about endogeneity arising from time-invariant firm characteristics. Using this approach, we rerun models (2) and (4) of Table 2 and report the results in models (3) and (6) of Table 3, respectively. Interestingly, as when using firm fixed effects, we find the adjusted R^2 value increases substantially relative to the other models,

attesting that the lagged values of excess value capture a substantial portion of the heterogeneity of the dependent variable. Importantly, the findings on CEO overconfidence remain qualitatively similar.

C. CEO Overconfidence, Past Diversification, and Corporate Refocusing Decisions

In this section, we test the prediction of our theoretical model according to which the overconfident CEO is expected to demonstrate a heightened tendency to refocus when feedback on a project's negative payoff becomes available through stock prices. For this analysis, our sample consists of firms that can potentially refocus and firms that refocus but still have a multi-segment structure or end up as single-segment firms. Specifically, we estimate variants of the following multivariate logistic regression model:

$$REF\_EVENT_{i,t} = \gamma_0 + \beta_1 PAST\_DIV_{i,t-3:t-1} + \beta_2 CONTROLS + \varepsilon_{i,t} \quad (2)$$

The dependent variable is corporate refocusing decision events measured in year t (REF_EVENT_t) and all the control variables are measured in year t - 1. The main variable of interest, $PAST\_DIV_{t-3:t-1}$, is a dummy variable that equals one when the firm diversified at least once in the period from year t - 3 to t - 1 and zero otherwise. In additional untabulated tests, we find that our results do not change when measuring the presence of past diversifications in the period from year t - 5 to year t - 1. The control variables are as in equation (1). In addition, we control for whether the firm is cash constrained, using a dummy variable ($CASH\_POOR_t$) that equals one when the residuals of the corporate cash model of Opler et al. (1999) are negative and zero otherwise.[16] We also control for the possibility that our overconfidence measures are affected by past stock performance (Malmendier et al. (2011)) by using the past year's stock returns (RET_t). Further, we include one-period-lagged excess value (EXC_VAL_{t-1}) to control for omitted variables bias that relates to the decision to refocus (Campa and Kedia (2002)). Consistent with Hirshleifer et al. (2012), we also consider CEO-related controls, including tenure, compensation incentives, and press attention. Tenure is the natural logarithm of one

[16] The coefficient estimates of the cash model of Opler et al. (1999) are available upon request.

plus the number of years the CEO has been in office ($TENURE_t$). The compensation incentives are (i) vega, defined as the natural logarithm of one plus the change in the risk-neutral value of the CEO's portfolio of stock options for a 1% change in the standard deviation of the return of the underlying stock ($VEGA_t$), and (ii) delta, defined as the natural logarithm of the change in the risk-neutral value of the CEO's portfolio of stock and stock options for a 1% change in the price of the return of the underlying stock ($DELTA_t$). Finally, press attention is the number of articles mentioning the CEO ($MENTION_t$) and is relevant only to model specifications that use the press-based measure of overconfidence.

Table 4 presents the logistic regression results with firm random effects and year effects, which are used to control for unobserved firm and year heterogeneity, respectively. Models (1) and (3) present the results for the relation between corporate refocusing and past diversification decisions for the two measures of overconfidence employed in the analysis. The coefficient for past diversifications in model (1) is equal to 0.511 (p-value < 0.05), suggesting that past diversification activity significantly increases the likelihood of refocusing. The corresponding odds ratio of firms with past diversification pursuing refocusing is 1.67 times the odds ratio of the remaining CEOs. A similar result is obtained when the press-related measure of overconfidence is used, since the coefficient in model (3) is 0.49 (p-value < 0.01) and the corresponding odds ratio is 1.63. Overall, consistent with prior refocusing literature, these results suggest that past diversification is a significant determinant of corporate refocusing decisions.

[Insert Table 4 here]

Models (2) and (4) in Table 4 report the results for past diversification(s) undertaken by overconfident CEOs and rational CEOs, respectively. Specifically, we define a dummy variable (*PAST_DIV_CEO_OC*) as equal to one if a firm diversified in the period from year t - 3 to year t - 1 and at least one diversification event was undertaken by an overconfident CEO and zero otherwise. Similarly, we define a dummy variable (*PAST_DIV_CEO_NOT_OC*) that takes the value of one when a firm diversified in the period from year t - 3 to year t - 1 and all prior diversification events were undertaken by a rational CEO and zero otherwise. Interestingly, the results suggest that past diversifications relate to refocusing only when they were undertaken by overconfident CEOs. The coefficients (odds ratios) in models (2) and (4) for prior diversification by overconfident CEOs pursuing at least one diversification decision are 0.721 (2.056) and 0.863 (2.370), respectively (Aoth p-values <

0.01). In contrast, there is only weak evidence of corporate refocusing for past diversification decisions made by rational CEOs and only when the press-related measure is used. This relation, as shown in model (4), is marginally significant at the 10% level.[17] By comparing models (2) and (4), the coefficient values of past diversifications made by overconfident CEOs against those of past diversification made by rational CEOs, we infer that the odds of corporate refocusing decisions are 67% to 98% higher when past diversifications were made by overconfident CEOs rather than rational CEOs. This empirical finding lends credence to the model presented in this study, which predicts heightened corporate refocusing activity by overconfident CEOs who pursued diversified investments in the past once realized returns fail to match initial expectations.

Among the control variables, the results show that firms with high levels of capital expenditures in current operations exhibit a greater likelihood of refocusing, suggesting that overinvestment is associated with sizeable past capital expenditures. In addition, firm size leads to more refocusing, whereas firms with greater profitability (using the net buyer sample) and higher past performance are less likely to refocus. The latter result suggests that refocusing could be a response to market pressure. Vega predicts more refocusing (with the net buyer sample) because, for CEOs with high vega exposure, the refocusing most probably has a great positive impact on stock option compensation. On the contrary, delta predicts less refocusing, since refocusing increases the idiosyncratic risk that CEOs usually try to avoid by pursuing self-interested diversification. Tenure is negatively related to refocusing, consistent with the view that it exacerbates agency problems. Finally, when using the press-related sample, we find only weak evidence to suggest that firms with high past valuations are less likely to refocus. In addition, firms with greater press coverage are less likely to refocus.

[17] Corporate refocusing events can be decomposed into two categories: (i) divestments of segments added in the past as a result of a diversification strategy, which are likely to mirror a failed diversification policy; and (ii) broader restructuring, that is, the divestment of other segments unrelated to past diversification actions. Accordingly, we also examine the relation between past diversifications by overconfident CEOs and past diversifications by rational CEOs with each type of corporate refocusing event. Untabulated analysis results reveal that, compared to past diversifications by rational CEOs, past diversifications by overconfident CEOs are more likely to lead to divestment of the same segment (significant at the 10% level when the press-related measure is used). Additionally, compared to past diversifications by rational CEOs, past diversifications by overconfident CEOs are more likely to lead to divestment of other segments (significant at the 5% level when the net buyer measure is used).

In summary, strong evidence suggests that corporate refocusing decisions mainly relate to diversification decisions undertaken in the past by overconfident CEOs.

C.1 Additional results

Aktas et al. (2013) document that learning in a merger and acquisition setting is more important when there is CEO continuity from deal to deal. Based on this perspective, our findings should remain robust when ensuring that the CEO who made past unsuccessful diversified investments is the same CEO who makes the corporate refocusing decision. We test this perspective by re-estimating models (2) and (4) as in Table 4 after (i) including a dummy variable that equals one when there is a change in a firm's CEO in the year that is contemporaneous with corporate refocusing, as illustrated in models (1) and (3) of Table 5 (including this dummy variable alleviates concerns over potential corrective actions arising from newly hired CEOs and reinforces our inferences about learning for CEOs who likely continue in office) and (ii) requiring the CEOs to remain on board during the three years leading to refocusing, as illustrated in models (2) and (4) of Table 5. Overall, as shown in Table 5, corporate refocusing decisions continue to strongly relate to diversification decisions undertaken in the past by overconfident CEOs. Hence, consistent with the inferences of Aktas et al. (2013), the results of Table 5 imply that learning by the same CEO is a plausible explanation of our findings.

[Insert Table 5 here]

D. CEO Overconfidence and Corporate Diversification Decisions

Our empirical evidence so far demonstrates that diversified firms managed by overconfident CEOs experience substantial shareholder value loss. As discussed, we hypothesize that this happens because of the excessive tendency of overconfident CEOs to make more failed diversification decisions than their rational peers, especially when they are not faced with financial constraints. In light of this reasoning, we test this value destruction channel according to which overconfident CEOs are expected to undertake more diversifying decisions, compared to their rational peers. The seeds of this notion have been advanced by Roll (1986) and validated in the laboratory by Camerer and Lovallo (1999).

We begin the analysis by plotting in Figure 1 the unconditional relation between overconfident CEOs and corporate diversification decisions over time. Based on the net buyer measure, the fraction of overconfident CEOs involved in corporate diversification decisions is higher in most of the years in the sample (10 out of the 17 years). Aggregating over time, we find the odds ratio of an overconfident CEO with at least one diversification decision is 1.30 that of rational CEOs (*p*-value < 0.01). Using the press-related measure, we find that, in 13 out of 17 years in the sample, overconfident CEOs make more diversification decisions. Throughout the sample period, the odds ratio of overconfident CEOs with at least one diversification decision is 1.33 times the odds ratio of the rational CEOs (*p*-value < 0.01). Overall, these findings suggest that CEO overconfidence is associated with a higher probability of diversification events and could be a significant determinant in the decision to make a corporate diversification investment.

[Insert Figure 1 here]

We then validate the robustness of the unconditional patterns in Figure 1 using variants of the following multivariate logistic regression model:

$$DIV\_EVENT_{i,t} = \gamma_0 + \beta_1 CEO\_OC_{i,t-1} + \beta_2 CASH\_POOR_{i,t-1} + \beta_3 CONTROLS + \varepsilon_{i,t} \quad (3)$$

where the dependent variable, corporate diversification decision events (DIV_EVENT_t), is a dummy variable that equals one when the number of segments reported increases relative to the previous year and zero otherwise and $CASH\_POOR_{i,t-1}$ is dummy variable that equals one when the residuals of the corporate cash model of Opler et al. (1999) are negative and zero otherwise. Control variables are as in equation (2). In addition, we include firm random effects and year effects to control for unobserved firm and year heterogeneity, respectively.

Table 6 reports the results. Specifically, models (1) and (3) of Table 6 suggest that overconfident CEOs are generally more likely to diversify, since the coefficient for the net buyer measure is 0.369 (*p*-value < 0.05) and that for the press measure is 0.512 (*p*-value < 0.01). The corresponding odds ratios for overconfident CEOs pursuing at least one diversification equals 1.45 times that for the net buyer measure and 1.67 times that for the press measure relative to the odds ratio of the remaining CEOs.

[Insert Table 6 here]

We then investigate whether overconfident CEOs of cash-rich firms are more likely to diversify. To perform this analysis, we segregate the impact of CEO overconfidence on corporate diversification into the impact observed in cash-rich firms and the impact observed in cash-poor firms, as follows:

$$DIV\_EVENT_{i,t} = \gamma_0 + \beta_1 CASH\_POOR_{i,t-1} + \beta_2 CEO\_OC_{i,t-1} \text{ X } CASH\_RICH_{i,t-1} + \beta_3 CEO\_OC_{i,t-1} \text{ X } CASH\_POOR_{i,t-1} + \beta_4 CONTROLS + \varepsilon_{i,t} \quad (4)$$

where $CASH\_RICH_{i,t-1}$ is a dummy variable that equals one when the residuals of the corporate cash model of Opler et al. (1999) are positive and zero otherwise. The results in models (2) and (4) of Table 6 suggest that overconfident CEOs of cash-rich firms are more likely to diversify, since the coefficient of the interaction of the net buyer measure for cash-rich firms is 0.541 (p-value < 0.01) and that for the press measure is 0.584 (p-value < 0.01). The corresponding odds ratios of overconfident CEOs in cash-rich firms pursuing at least one diversification equals 1.72 for the net buyer measure and 1.79 for the press measure, relative to the odds ratio of rational CEOs. In contrast, there is no evidence to support a significant relation between CEO overconfidence and diversification decisions in cash-poor firms.[18]

Among the control variables, the results show that firms with high levels of capital expenditures in current operations exhibit a lower likelihood of further diversification. Similarly, firms with greater valuation as captured by excess value are less likely to diversify. Finally, when using net buyer sample, we find that firms with high profitability are less likely to seek more diversification. In addition, firm size generally leads to greater diversification.

In summary, the results suggest that overconfident CEOs are more likely to overinvest outside the firm's core business, especially when there are sufficient internal funds to finance such growth.

[18] The relation is marginally positive only when using the press measure with an odds ratio of overconfident CEOs pursuing at least one diversification that equals 1.52 times the odds ratio of rational CEOs (p-value < 0.10). This finding does not contradict those of previous empirical studies regarding the thesis that the investments of overconfident CEOs are significantly more responsive to cash flow when internal funds are abundant (Malmendier and Tate (2005)). This is because an overconfident CEO's decision to diversify depends on the unobserved relation between overestimated expected returns of diversified investments and expected financing costs, which is affected by CEOs' perceptions of their own firm's undervaluation. Accordingly, it is unclear whether CEO overconfidence will have a significant impact on the likelihood to diversify in cash-poor firms.

D.1 Robustness Checks

Since the heighten tendency of overconfident CEOs to make diversifying decisions is significantly linked with shareholder value loss, as exhibited in Table 2, we conduct a battery of sensitivity tests to check the robustness of this relation. First, during 1998, there was a spike in corporate diversification activity. This observation could partly represent noise, since segment information from January 1998 conforms to Statement of Financial Accounting Standards (SFAS) 131, which superseded SFAS 14. In particular, SFAS 14 had been criticized for inconsistent segment definitions and segment underreporting (Villalonga (2004a)). SFAS 131 partially addresses these caveats. Berger and Hann (2003) provide evidence that, following the implementation of SFAS 131, certain firms have reported greater numbers of segments, consistent with the pattern in our sample. Accordingly, some of our corporate diversification transactions during 1998 could be spurious. To investigate the sensitivity of our results to this issue, we exclude the year 1998 from the analysis and re-estimate the unconditional relation in Figure 1 between overconfident CEOs and corporate diversification events. Untabulated univariate results show that the odds ratio of overconfident CEOs with at least one diversification event is 1.23 (1.42) times the odds ratio of rational CEOs when the net buyer measure (press measure) is used (Aoth significant at the 1% level). We also re-estimate the multivariate logistic regressions that control for firm- and CEO-related characteristics and find, as shown in models (1) and (4) of Table 7, that CEO overconfidence still predicts a pronounced tendency towards diversification decisions. Overall, the strong relation between CEO overconfidence and diversification decisions does not depend on the implementation of SFAS 131. Rather, these findings provide additional support suggesting that CEO overconfidence is a significant and invariant determinant of corporate diversification activity.[19]

[Insert Table 7 here]

Second, we investigate whether our findings are robust, using a sample of focused firms and focused firms that diversify. Campa and Kedia (2002) find that the characteristics of single-segment firms are substantially differ from those of multi-segment firms. Accordingly, by concentrating on

[19] Supplementary to this analysis, we also re-estimate models (1) and (4) of Table 6 using information from the period either before or after 1998. Untabulated results for both periods are qualitatively similar to those reported in the study.

focused firms and focused firms that diversify, we ensure a more homogeneous sample that alleviates concerns over potential omitted variable biases. The results in models (2) and (5) of Table 7 show that sample homogeneity does not affect our main findings.

Third, assuming that business segment reporting corresponds to distinct internal business units, as suggested by Rajan et al. (2000), an ordinal regression approach could allow us to better capture the diversified firm scope variation within, relative to the logit approach. Therefore, we also employ ordinal regression analysis using the firm's number of business segments as the dependent variable (NUM_SEGM_t). However, inferences from this approach could be complicated by endogeneity concerns between corporate diversification and CEO overconfidence. For instance, if the boards of diversified firms hire overconfident CEOs more often than rational CEOs, then a relation between corporate diversification and CEO overconfidence could be an artifact of the hiring procedures.[20] To alleviate potential endogeneity concerns, we control for the number of segments during the year the CEO is hired. Such an estimation model becomes a first-difference model of the current number of segments, which is the dependent variable, relative to the number of segments during the year of CEO hiring, which is the independent variable (albeit, the first-difference model where the coefficient estimate of the number of segments during the year of CEO hiring is not constrained to one). The results in models (3) and (6) of Table 7 show that our main findings remain qualitatively unchanged.

Finally, we also examine the sensitivity of the findings to the inclusion of firm fixed effects. To perform this test, each firm must have conducted at least one diversification, belong to either the subsample of cash-rich or cash-poor firm–years, and have at least one overconfident and one rational CEO. This requirement considerably reduces the number of observations (Aetween 107 and 448 firm–year observations, depending on the measure of overconfidence and the subsamples of cash-rich and cash-poor firm–years), rendering the results from such an analysis less reliable. To alleviate this problem, we perform a less strict analysis by running regressions in the spirit of models (1) and (3) of Table 6 after controlling for firm fixed effects. Based on this analysis, we cannot provide inferences

[20] Gervais et al. (2011) argue that, among others, firms can hire overconfident CEOs due to the lower cost of motivating them to undertake riskier projects. In addition, overconfidence commits CEOs to exert effort to learn about projects.

regarding the interaction effect of CEO overconfidence and internal cash availability on corporate diversification. However, the advantage of this test is that we have a larger number of firm–year observations (503 and 999 for the net buyer– and press-based measures of overconfidence, respectively). Most importantly, however, this investigation utilizes within-firm and within-CEO variation, which is useful to control for time-invariant firm effects on corporate diversification. Untabulated results consistent with the findings in Table 6 reveal that the odds ratio of overconfident CEOs pursuing at least one diversification equals 2.464 (3.257) times the odds ratio of rational CEOs (significant at the 10% and 1% levels, respectively). These results provide supplemental support for the view that CEO overconfidence leads to more corporate diversification decisions.

E. Alternative Explanations

In this section, we consider alternative explanations for the link between our CEO overconfidence measures, the value of corporate diversification, and refocusing and diversification activity.

Inside information: In the presence of valuable inside information, CEOs can increase exposure to their firm's risk before market participants have access to such information. If inside information includes growth opportunities that take the form of corporate diversification, then the stock buyer proxy of overconfidence could be linked to diversification decisions. In addition, inside information implies that the firm stock is undervalued and decisions to diversify should therefore be sensitive to the availability of internal funds (Myers and Majluf (1984)).

An inside information explanation, however, should be short-lived whereas our stock buyer proxy is habitual. In addition, an inside information explanation suggests that stock buyers should make better diversification decisions. Instead, our evidence shows the opposite, that stock buyers seem to destroy value through corporate diversification. Finally, the press-based proxy of overconfidence utilizes press information and should not capture inside information.

Risk tolerance: Risk-tolerant CEOs can increase their exposure to firm risk by buying stocks. Similarly, some words in the press-based proxy can also indicate willingness to accept more risk. Such

CEOs could be inclined to undertake more challenging projects that are more difficult to manage, such as corporate diversification investments.

Although greater risk tolerance can induce stock buying, this does not imply that such behaviour is habitual. Most importantly, greater risk tolerance should relate to a lower sensitivity of diversification to internal funds, since more risk-tolerant CEOs could exploit external financing for investment purposes. Our evidence about CEOs' appetite for diversification, especially when a firm has abundant internal funds, is inconsistent with such an explanation. Finally, a risk tolerance explanation cannot be reconciled with our findings on corporate diversification performance.

Board pressure: The board can coerce CEOs to buy additional firm stocks to signal to the market the quality of corporate diversification. If the signal is correct, we would expect the diversification to create value. Instead, we find that corporate refocusing relates to past diversifications and that firms that do not refocus exhibit a diversification discount after they diversify. We also find that these effects are stronger when the diversification is undertaken by stock-buying CEOs.

If the signal is wrong, perhaps due to incorrect beliefs of the board, we would expect a reversal of the corporate diversification, that is, refocusing. While such an explanation is supported by our findings on corporate refocusing, we still find that a portion of firms that do not refocus exhibit a diversification discount. In addition, this explanation is difficult to reconcile with our press-based proxy of overconfidence.

V. Conclusions

Empirical evidence in the 1990s and 2000s has led to active debate among researchers about the valuation effects of corporate diversification. In addition, theoretical and empirical evidence in the last decade has exemplified the impact of managerial overconfidence, one of the most prominent cognitive biases of corporate managers, on firm policies and organizational outcomes. In this study, we present a theoretical model that links CEO overconfidence to the value loss of corporate diversification and the adoption of post-diversification refocusing strategies. This model expands on the theoretical framework of MT by considering corporate diversification investments undertaken by CEOs with risk

preferences who are capable of dynamically adjusting their policies by reversing (or not) failed diversified decisions they made in the past. Consistent with the predictions of our theoretical model, following the first incidence of diversification, our findings show that the valuations of diversified firms run by overconfident CEOs are significantly lower, by 12.5% to 14.1%, compared to their counterparts run by rational CEOs. This study further postulates that managerial overconfidence offers a compelling explanation for why CEOs pursue, in the first place, such value-destructive corporate diversification strategies followed by corrective actions through refocusing and finds evidence in support of this prediction. Specifically, our results show that the odds of corporate refocusing decisions are 67% to 98% higher when past diversification decisions were made by overconfident CEOs.

Overall, our findings identify the adverse consequences of CEO overconfidence on firm value. In that respect, CEO overconfidence provides a prominent alternative explanation to traditional theories that link diversification and firm value to agency problems. Consequently, our findings have implications for contracting practices and organizational design. More refined corporate governance structures that constrain the use of internal funds could be necessary to deter the adverse valuation effects of CEO overconfidence pertaining to distorted investment decisions. In addition, either the board of directors and/or institutional owners may need to be more active to restrain managerial overconfidence.

Appendix A: Theoretical Foundations

Proof of Proposition 1:

Rearrange constraint (2) to solve for the number of new shares:

$$s' = s\frac{NI + F(N) - c - d}{A + C + NR(I) - NI - F(N)}$$

Substitute the above into equation (1), and after some algebra the objective of the CEO becomes:

$$\max_{\{I,s',c,d,N\}} \Big\{ A + C + NR(I)(1+\Delta) - c - d - (NI + F(N) - c - d)\frac{A + C + NR(I)(1+\Delta) - c - d}{A + C + NR(I) - c - d} \Big\}$$

Subject to constraints:

$$c \le C, \qquad d \le D, \qquad c + d \le NI + F(N) \tag{A1}$$

$$c \ge 0, \qquad d \ge 0, \qquad N \ge 0 \tag{A2}$$

Define the Lagrange multipliers for $c \le C, d \le D, c + d \le NI + F(N)$ as λ, μ, v respectively, then the first order conditions to the above optimization problem after some algebra are:

$$NR'(I)(1+\Delta) - N\frac{A + C + NR(I)(1+\Delta) - c - d}{A + C + NR(I) - c - d} - (NI + F(N) - c - d)\frac{\Delta NR'(I)(A + C - c - d)}{[A + C + NR(I) - c - d]^2} + Nv = 0 \tag{A3}$$

$$\frac{A + C + NR(I)(1+\Delta) - c - d}{A + C + NR(I) - c - d} - \frac{\Delta NR(I)[NI + F(N) - c - d]}{[A + C + NR(I) - c - d]^2} - 1 - \lambda - v = 0 \tag{A4}$$

$$\frac{A + C + NR(I)(1+\Delta) - c - d}{A + C + NR(I) - c - d} - \frac{\Delta NR(I)[NI + F(N) - c - d]}{[A + C + NR(I) - c - d]^2} - 1 - \mu - v = 0 \tag{A5}$$

$$R(I)(1+\Delta) - \big(I + F'(N)\big)\frac{A + C + NR(I)(1+\Delta) - c - d}{A + C + NR(I) - c - d} - (NI + F(N) - c - d)\frac{\Delta R(I)(A + C - c - d)}{[A + C + NR(I) - c - d]^2} + \big(I + F'(N)\big) = 0 \tag{A6}$$

Part a: Set $\Delta = 0$ and the first order conditions (FOCs), equations (A3) to (A6) become:

$$NR'(I) - N + v = 0 \tag{A7}$$

$$-\lambda - v = 0 \tag{A8}$$

$$-\mu - v = 0 \tag{A9}$$

$$R(I) - I - F'(N) = 0 \tag{A10}$$

From (A8) and (A9) $\lambda = \mu = v = 0$ implying that none of the constraints in (A1) binds. Therefore, (A7) entails that $R'(I^*) = 1$ and thus from definition 1 $I^* = I_{FB}$. Also (A10) implies $R(I_{FB}) - I_{FB} - F'(N^*) = 0$ which by using definition (1) reduces to $N^* = N_{FB}$.

Part b: Suppose that $\Delta > 0$ and $v = 0$, then from (A4) and (A5)

$$\lambda = \mu = \frac{A + C + NR(I)(1 + \Delta) - c - d}{A + C + NR(I) - c - d} - \frac{\Delta NR(I)[NI + F(N) - c - d]}{[A + C + NR(I) - c - d]^2} - 1$$

After a little bit of algebra:

$$\lambda = \mu = \frac{\Delta NR(I)[A + C + NR(I) - NI - F(N)]}{[A + C + NR(I) - c - d]^2} > 0$$

This implies that the first 2 constraints in (A1) are binding and thus $c = C$ and $d = D$. After some algebra the first FOC, equation (A3), becomes:

$$R'(I) = \frac{1}{1 + \Delta \dfrac{A + C - c - d}{A + C + NR(I)(1 + \Delta) - c - d} \dfrac{A + C + NR(I) - NI - F(N)}{A + C + NR(I) - c - d}}$$

The above can take the following form after substituting in $c = C$ and $d = D$:

$$R'(I) = \frac{1}{1 + \Delta\Phi} \tag{A11}$$

Where

$$\Phi \equiv \frac{A - D}{A + NR(I)(1 + \Delta) - D} \frac{A + C + NR(I) - NI - F(N)}{A + NR(I) + D} \tag{A12}$$

By definition $A > D$ and $NR(I) > NI + F(N)$. Since $\Phi > 0$ and $R(.)$ is concave, the level of investment that satisfies (A11) is $I^* = \bar{I} > I_{FB}$ as definition 3 states.

To determine the optimal number of sectors, combine the last FOC, equation (A6), along with $c = C$ and $d = D$ and $v = 0$ and after some algebra it takes the following form:

$$F'(N) = R(N)(1 + \Delta\Phi) - I$$

By definition (3) the above has a solution $N^* = \bar{N}$

$$F'(\bar{N}) = R(\bar{I})(1 + \Delta\Phi) - \bar{I} \tag{A13}$$

By assumption $F(.)$ is convex thus to check whether $\bar{N} > N_{FB}$ we need to compare $F'(\bar{N})$ from the above equation with the solution to the first-best which is repeated below:

$$F'(N_{FB}) = R(I_{FB}) - I_{FB}$$

We need to show that $F'(\bar{N}) > F'(N_{FB})$. However, on the first hand $R(\bar{I})(1 + \Delta\Phi) > R(I_{FB})$ but on the other hand $\bar{I} > I_{FB}$ therefore it is not trivial which one is larger.

Define the quantity of interest as:

$$\Psi \equiv F'(\bar{N}) - F'(N_{FB}) = R(\bar{I})(1 + \Delta\Phi) - \bar{I} - [R(I_{FB}) - I_{FB}]$$

Use equation (A11) in the above and get:

$$\Psi = \frac{R(\bar{I})}{R'(\bar{I})} - (\bar{I} - I_{FB}) - R(I_{FB}) = \frac{1}{R'(\bar{I})}[R(\bar{I}) - R'(\bar{I})(\bar{I} - I_{FB}) - R'(\bar{I})R(I_{FB})]$$

Add and subtract $R(I_{FB})$ in the above equation, which becomes

$$\Psi = \frac{1}{R'(\bar{I})}\left[R(\bar{I}) - R(I_{FB}) - R'(\bar{I})(\bar{I} - I_{FB}) + R(I_{FB})\left(1 - R'(\bar{I})\right)\right]$$

For the last term in the brackets of the above equation, as long as $\bar{I} > I_{FB}$ and $R(.)$ is concave, then $R'(I) < 1$ and the last term $R(I_{FB})\left(1 - R'(\bar{I})\right) > 0$ is positive. It only remains to prove that $R(\bar{I}) - R(I_{FB}) - R'(\bar{I})(\bar{I} - I_{FB}) \geq 0$.

(The proof is an application of the Rooftop Theorem). From the concavity of $R(.)$ we know that for every $t \in [0,1]$

$$R\big((1-t)\bar{I} + tI_{FB}\big) \geq (1-t)R(\bar{I}) + tR(I_{FB})$$

Gather all t together and rearrange

$$R\big(\bar{I} + t(I_{FB} - \bar{I})\big) - R(\bar{I}) \geq t\big(R(I_{FB}) - R(\bar{I})\big)$$

Divide both sides by t and take the limit

$$\lim_{t\to 0} \frac{R\big(\bar{I} + t(I_{FB} - \bar{I})\big) - R(\bar{I})}{t} \geq \big(R(I_{FB}) - R(\bar{I})\big)$$

To determine the limit use L'Hôpital's rule to get

$$R'(\bar{I})(I_{FB} - \bar{I}) \geq \big(R(I_{FB}) - R(\bar{I})\big)$$

Rearrange and find what we are after. That is

$$R(\bar{I}) - R(I_{FB}) - R'(\bar{I})(\bar{I} - I_{FB}) \geq 0$$

This implies that $\Psi > 0$ as both the terms that we have separated are positive and thus guarantees that $F'(\bar{N}) > F'(N_{FB})$ and given that $F(.)$ is convex $\bar{N} > N_{FB}$.

Case b2: $v > 0$ (thus $c + d = NI + F(N)$). Define the following:

$$X \equiv \frac{A + C + NR(I)(1+\Delta) - c - d}{A + C + NR(I) - c - d} \tag{A14}$$

Using all the above, the first order conditions (A3-A6) are transformed respectively as follows:

$$R'(I)(1+\Delta) - X + v = 0 \tag{A15}$$

$$X - 1 - \lambda - v = 0 \tag{A16}$$

$$X - 1 - \mu - v = 0 \tag{A17}$$

$$R(I)(1+\Delta) - \big(I + F'(N)\big)X + \big(I + F'(N)\big)v = 0 \tag{A18}$$

Case b2.1: Set $\lambda = \mu = v = 0$, which implies $X = 1$ from (A16). Thus (A15) becomes

$$R'(I)(1+\Delta) = 1 \tag{A19}$$

By definition (2) the solution to (A19) is $I^* = \hat{I} > I_{FB}$, where the last inequality holds since $R(.)$ is concave. From $\lambda = \mu = 0$, (A16) and (A19) and definition 2

$$F'(\widehat{N}) = R(\hat{I})(1+\Delta) - \hat{I} \tag{A20}$$

We have already proved that the solution for N when $F'(N) = R(I)(1+\Delta\Phi) - I$ for all $I > I_{FB}$ and for all $\Phi > 0$ is $N^* > N_{FB}$. Since $\hat{I} > I_{FB}$, and $\Phi = 1$ then the solution to (A20) implies also that $\widehat{N} > N_{FB}$.

<u>Case b2.2</u>: Suppose $\lambda = \mu > 0$. This implies that $c = C$ and $d = D$ and therefore (A15) and (A16) entail

$$R'(I)(1+\Delta) = 1 + \lambda \tag{A21}$$

Similarly (A18) becomes

$$F'(N) = R(I)\frac{1+\Delta}{1+\lambda} - I \tag{A22}$$

We need to show that $\lambda < \Delta$ for (A21) and (A22) to guarantee that $I^* > I_{FB}$ and $N^* > N_{FB}$.

Use equation (A14) along with equation (A16) and set also $c = C$ and $d = D$ to get

$$\frac{A + NR(I)(1+\Delta) - D}{A + NR(I) - D} - 1 - \lambda = v > 0$$

Suggesting that

$$1 + \lambda < \frac{A + NR(I)(1+\Delta) - D}{A + NR(I) - D}$$

Expand the brackets on the right-hand side and get

$$1 + \lambda < 1 + \Delta\frac{NR(I)}{A + NR(I) - D} < 1 + \Delta$$

As $A - D > 0$ then $\lambda < \Delta$ which proves that $I^* > I_{FB}$ and $N^* > N_{FB}$.■

Proof of Lemma 1:

Since $C + D \leq NI + F(N)$ equation (A12) suggests that $0 < \Phi < 1$. We have already shown that the solutions of equations (A11) and (A13) are $\hat{I} > I_{FB}$, $\widehat{\mathrm{N}} > \mathrm{N_{FB}}$ for $\Phi = 1$ and $\bar{\mathrm{I}} > \mathrm{I_{FB}}$, $\overline{N} > N_{FB}$, for

$0 < \Phi < 1$. The functions $R(.)$ and $F(.)$ are concave and convex respectively and as shown in the previous proof, as Φ approaches zero, $\bar{I}$ approaches I_{FB} and $\bar{N}$ approaches N_{FB} which implies that $\hat{I} > \bar{I} > I_{FB}$ and $\hat{N} > \bar{N} > N_{FB}$. ■

***Proof of Proposition 2*:**

Part a: It is trivial since the system of equations (A7) – (A10) defines the first best level of investment and diversification and clearly C is absent from the system.

Part b.1: If $C + D \geq NI + F(N)$ then the investment cost is covered through internal finance thus $v \geq 0$ which implies that the solution is characterized by the system (A19) and (A20) when $\lambda = \mu = 0$, which is also independent of C. If $\lambda = \mu > 0$ then $c = C$ and $d = D$ and the solution is generated from the system (A21) and (A22), (A16), (A14). The only equation that involves C is (A14), however, as $c = C$, all C disappear from the equation thus this system is also independent of initial cash flows C.

Part b.2: If $C + D < \hat{N}\hat{I} + F(\hat{N})$ then the solution is characterized by (A11), (A13) and (A12) that I repeat below in the same order:

$$R'(I)(1 + \Delta\Phi) = 1 \tag{A23}$$

$$R(I)(1 + \Delta\Phi) = I + F'(N) \tag{A24}$$

$$\Phi = \Phi(N, I, C) \tag{A25}$$

Differentiate (A23) with respect to C considering that both I and N are functions of C at the optimum:

$$R''(I)(1 + \Delta\Phi)\frac{dI}{dC} + \Delta R'(I)\left(\frac{\partial\Phi}{\partial N}\frac{dN}{dC} + \frac{\partial\Phi}{\partial I}\frac{dI}{dC} + \frac{\partial\Phi}{\partial C}\right) \tag{A26}$$

Differentiate (A24) with respect to C considering that both I and N are functions of C at the optimum:

$$R'(I)(1 + \Delta\Phi)\frac{dI}{dC} + \Delta R(I)\left(\frac{\partial\Phi}{\partial N}\frac{dN}{dC} + \frac{\partial\Phi}{\partial I}\frac{dI}{dC} + \frac{\partial\Phi}{\partial C}\right) = \frac{dI}{dC} + F''(N)\frac{dN}{dC} \tag{A27}$$

Define: $D_\Phi \equiv \frac{\partial\Phi}{\partial N}\frac{dN}{dC} + \frac{\partial\Phi}{\partial I}\frac{dI}{dC} + \frac{\partial\Phi}{\partial C}$ and use (A23) on both (A26) and (A27) to transform this system to:

$$\begin{Bmatrix} \frac{R''(I)}{R'(I)}\frac{dI}{dC} = -\Delta R'(I)D_\Phi \\ \Delta R(I)D_\Phi = F''(N)\frac{dN}{dC} \end{Bmatrix} \tag{A28}$$

Define also: $\Phi_1 \equiv \frac{A-D}{A+NR(I)(1+\Delta)-D}$ and $\Phi_2 \equiv \frac{A+C+NR(I)-NI-F(N)}{A+NR(I)+D}$, which means that from (A12)

$$\Phi = \Phi_1\Phi_2 \tag{A29}$$

Differentiate (A29) with respect to I and define the following objects to reduce the length of the algebraic expression as follows:

$$\frac{\partial \Phi}{\partial I} = \frac{\partial \Phi_1}{\partial I}\Phi_2 + \Phi_1 \frac{\partial \Phi_2}{\partial I} = \Omega_1 + \Omega_2 \tag{A30}$$

Where $\Omega_1 = \frac{-(A-D)NR'(I)(1+\Delta)}{[A+NR(I)(1+\Delta)-D]^2}\Phi_2$ and $\Omega_1 = \Phi_1 \frac{N(R'(I)-1)(A+NR(I)-D)-NR'(I)(A+C+NR(I)-NI-F(N))}{[A+NR(I)-D]^2}$

Use in the above the definitions of Φ_1, $\Phi_2$along with (A30) and (A23) to get:

$$\frac{\partial \Phi}{\partial I} = \Omega_1 + \Omega_2 = -\frac{2NR'(I)(1+\Delta)\Phi}{A+NR(I)(1+\Delta)-D} < 0 \tag{A31}$$

Where the last inequality appears because all terms are positive and $A - D$ is also positive.

Similarly differentiate (A29) with respect to N which by the chain rule is:

$$\frac{\partial \Phi}{\partial N} = \frac{\partial \Phi_1}{\partial N}\Phi_2 + \Phi_1 \frac{\partial \Phi_2}{\partial N} = \Lambda_1 + \Lambda_2$$

Where: $\Lambda_1 \equiv \frac{-(A-D)R(I)(1+\Delta)}{[A+NR(I)(1+\Delta)-D]^2}\Phi_2$ and $\Lambda_2 = \Phi_1 \frac{\left(R(I)-I-F'(I)\right)(A+NR(I)-D)-R(I)(A+C+NR(I)-NI-F(N))}{[A+NR(I)-D]^2}$

Use in the above the definitions of Φ_1 and Φ_2 along with (A29) and (A24) to get:

$$\frac{\partial \Phi}{\partial N} = \Lambda_1 + \Lambda_2 = -\frac{2R(I)(1+\Delta)\Phi}{A+NR(I)(1+\Delta)-D} \tag{A32}$$

Now differentiate (A30) with respect to C

$$\frac{\partial \Phi}{\partial C} = \left(\frac{A-D}{A+NR(I)(1+\Delta)-D}\right)\left(\frac{1}{A+NR(I)-D}\right) > 0 \tag{A33}$$

Put the system (A28) in matrix form:

$$\begin{bmatrix} \frac{R''(I)}{R'(I)} + \Delta R'(I)\frac{\partial \Phi}{\partial I} & \frac{\partial \Phi}{\partial N}\Delta R'(I) \\ \frac{\partial \Phi}{\partial I}\Delta R(I) & \Delta R(I)\frac{\partial \Phi}{\partial N} - F''(N) \end{bmatrix} \begin{bmatrix} \frac{dI}{dC} \\ \frac{dN}{dC} \end{bmatrix} = -\Delta \begin{bmatrix} R'(I) \\ R(I) \end{bmatrix} \frac{\partial \Phi}{\partial C}$$

The solution of the system depends on the inverse of the first matrix on the left-hand side, call it M, that is

$$\begin{bmatrix} \frac{dI}{dC} \\ \frac{dN}{dC} \end{bmatrix} = -\frac{\Delta}{|M|}\begin{bmatrix} \Delta R(I)\frac{\partial \Phi}{\partial N} - F''(N) & -\frac{\partial \Phi}{\partial N}\Delta R'(I) \\ -\frac{\partial \Phi}{\partial I}\Delta R(I) & \frac{R''(I)}{R'(I)} + \Delta R'(I)\frac{\partial \Phi}{\partial I} \end{bmatrix}\begin{bmatrix} R'(I) \\ R(I) \end{bmatrix}\frac{\partial \Phi}{\partial C}$$

After the matrix multiplication the solution reduces to:

$$\begin{bmatrix} \frac{dI}{dC} \\ \frac{dN}{dC} \end{bmatrix} = \frac{\Delta}{|M|}\begin{bmatrix} R'(I)F''(N) \\ -\frac{R''(I)}{R'(I)}R(I) \end{bmatrix}\frac{\partial \Phi}{\partial C}$$

Apart from the determinant of M, everything else is positive since $R''(I) < 0$. The only thing left to prove is that the determinant is also positive which is true since:

$$|M| = \left(\Delta R(I)\frac{\partial \Phi}{\partial N} - F''(N)\right)\frac{R''(I)}{R'(I)} - F''(N)\Delta R'(I)\frac{\partial \Phi}{\partial I} > 0$$

Which is positive because as we have already shown in (A32) $\frac{\partial \Phi}{\partial N} < 0$, in (A37) $\frac{\partial \Phi}{\partial I} < 0$, in (A32) and by assumption $F''(N) > 0$, $R''(I)$ and $R'(I) > 0$ which proves that $\frac{dI}{dC} > 0$ and $\frac{dN}{dC} > 0$.■

Proof of Lemma 2:

Solve the same optimization problem as in (1)-(4), changing the objective function to $\frac{s}{s+s'}[A(1+\Delta_A) + C + NR(I)(1+\Delta) - c - d]$. Follow the exact same steps as in Proposition 1 to derive the following two equations that determine I and N:

$$R'(I) = \frac{1}{1+\Upsilon} \tag{A34}$$

$$R(I)(1+\Upsilon) = I + F'(N) \tag{A35}$$

Where $\Upsilon \equiv \frac{-\Delta D - A(\Delta_A - \Delta)}{A(1+\Delta_A) + NR(I)(1+\Delta) - D}\frac{A + C + NR(I) - NI - F(N)}{A + NR(I) - D}$

When $\Delta_A > \Delta$ then $\Upsilon < 0$, and using the same logic as in Proposition 1, (A34) implies that the optimal investment is $I^* < I_{FB}$ and diversification $N^* < N_{FB}$. When $\Delta > \frac{A\Delta_A}{A-D}$ then $\Upsilon > 0$ and the optimal investment is $I^* > I_{FB}$ and diversification is$N^* > N_{FB}$. ■

<u>Proof of Lemma 3</u>:

This Lemma is eventually a direct implication of propositions 1 and 2. What we stress in this section is that the introduction of risk actually strengthens the urge of the overconfident CEO to overinvest and not the opposite. In this specification, the return on each project, $R(I;z)$, is a function of the investment level and an exogenous normally distributed productivity parameter (shock) $z \sim N(1,\sigma_r^2)$, that is $R(I;z) = zR(I)$ where $R(I)$ is increasing in the investment level ($R^{'}(I) > 0$) and exhibits diminishing returns ($R^{''}(I) < 0$). Therefore, investing on the same project increases returns although at a diminishing level. Overconfident CEOs have a distorted view of project returns and their perception $\hat{z}$ of the true parameter z is distributed as $\hat{z} \sim N(1+\Delta,\sigma^2)$ where $\Delta > 0$ and $\sigma^2 < \sigma_r^2$. All projects are uncorrelated even though the results still apply to any degree of positively correlated projects suggesting that the perceived return of every project for an overconfident CEO is distributed as $R(I;z) \sim N(R(I)(1+\Delta), R^2(I)\sigma^2)$. Thus, consistent with Graham, Harvey and Puri (2013) the overconfident CEO either overestimate the mean return ($\Delta > 0$) or underestimate the variance of each project (expect lower $\sigma^2 < \sigma_r^2$), or a combination of the two.

The CEO solves the following constrained optimization problem:

$$\max_{\{I,s',c,d,N\}} \frac{s}{s+s'}\left[A + C + NR(I)(1+\Delta) - c - d - \frac{\phi}{2}N[R(I)]^2\sigma^2\right] \tag{A36}$$

$$s.t. \quad \frac{s'}{s+s'}\left[A + C + NR(I) - c - d - \frac{\phi}{2}N[R(I)]^2\sigma_r^2\right] = NI + F(N) - c - d \tag{A37}$$

$$c \le C, \qquad d \le D, \qquad c + d \le NI + F(N) \tag{A38}$$

$$c \ge 0, \qquad d \ge 0, \qquad N \ge 0 \tag{A39}$$

A rational CEO is not concerned about the financing method, adhering to the Modigliani-Miller theorem as before. However, overconfident CEOs seeking finance through the capital market face a conflict. Plug the constraint (A37) in the objective (A36) eliminating the number of shares s to get:

$$\max_{\{I,s',c,d,N\}} \Big\{A + C + NR(I)(1+\Delta) - c - d - \frac{\phi}{2}N[R(I)]^2\sigma^2 - (NI + F(N) - c - d)P_s\Big\} \tag{A40}$$

Where $P_s = \frac{A+C+NR(I)(1+\Delta)-c-d-\frac{\phi}{2}N[R(I)]^2\sigma^2}{A+C+NR(I)-c-d-\frac{\phi}{2}N[R(I)]^2\sigma_r^2}$. The price $P_s \geq 1$ is the price the CEO needs to pay for each dollar of external funding from new shareholders for the amount they provide, $NI + F(N) - c - d$. For a rational CEO ($\Delta = 0, \sigma^2 = \sigma_r^2$), $P_s = 1$ which implies that the financing method is irrelevant, as both c, d drop out of the objective function (A40). However, for an overconfident CEO ($\Delta > 0$, $\sigma^2 < \sigma_r^2$) that needs $NI + F(N) - c - d$ dollars from external investors, the price P_s is greater than 1. The incentive of the overconfident CEO to diversify diminishes by the increase in the perceived cost of external financing. The overconfident CEO then optimally uses all the available cash $c = C$ and thus higher C guarantees that the overconfident CEO depends less on external funding. Thus, the greater the cash available to the CEO, the greater would be the scale of diversification. An overconfident manager that needs external funding would keep issuance of new shares as moderate as possible holding diversification to a minimum while an overconfident manager with the ability of undertaking the entire new investment through internal funding would be in favour of higher diversification. Thus, equity dependent firms that consider diversification are more cash sensitive than any other firm. In the previous sections we demonstrated that an increase in Δ increases P_s which lowers the appetite for external financing and thus induces the Cash Rich firms to diversify more. For an overconfident, lower σ^2 produces the exact same effect on P_s as Δ. Therefore, if the overconfident differs from the rational by either a positive Δ or a lower σ^2 (as $\sigma^2 < \sigma_r^2$), the aversion to external financing works precisely the same way. The difference between cash-rich and cash-poor firms is governed by how CEO's perceive P_s and the overconfident - either by overestimating the mean return or underestimating the variance - believe they compensate outside investors with a price $P_s > 1$ for each dollar they bring in the company.

To conclude, the introduction of risk actually makes the risk neutral case more prominent. Risk can only alter the result if there are constraints on the amount the firm can borrow, and that constraint binds. Only then risk can potentially reverse the result and more details can be also provided upon request.

Proof of Lemma 4:

In this section, we illustrate the effect on diversification a period in advance, when CEOs receive feedback from the investment and diversification decisions of the past. In the second period, the current manager becomes aware of the forecasting mistakes[21], if any, of the previous period and acts accordingly. We assume that there is uncertainty in the model as in Lemma 3 and thus $R_t \sim N(\bar{R}, \sigma^2)$. The overconfident[22] CEO starts the period with a distorted belief about the true return. The current manager is not necessarily the manager that took the diversification decision in the previous period as there is high turnover in CEO positions. However, taking corrective measures for past CEO's investments might be important for the newly hired CEO as there can be pressure from the board for such corrective measures. The CEO[23] is provided with some feedback about the true returns of the project and needs to revise her estimate about the returns of the diversification decisions of the past. We assume that the current manager, overconfident or not, updates her beliefs according to the following recursive algorithm (as in Evans and Honkapohja (2012)):

$$R_{t+1}^e = R_t^e + \gamma_t(R_t - R_t^e) \tag{A41}$$

The variable R_t^e is the expected return for period t given the information up to $t+1$. The above recursive algorithm states that once a diversification decision is made, given the feedback from the true returns, the update of the CEO's forecast R_{t+1}^e is equal to the realized return R_t plus a weight $0 < \gamma_t < 1$ of the difference between the anticipated return the previous period R_t^e and the true return for that period. A direct implication from propositions 1 and 2 is that the lower the expected return is R_t^e, the lower the diversification investment undertaken. Thus, if $R_{t+1}^e < R_t^e$, the company is going to refocus. If the belief in the first period is that the return is $R_t^e = (1-\Delta)\bar{R}$, then from (A41), the probability to refocus is: $\Pr(R_{t+1}^e < R_t^e) = \Phi\left(\frac{\Delta\bar{R}}{\sigma}\right)$, where $\Phi(.)$ is the cumulative distribution function of a standard normal. Clearly, when $\Delta = 0$, $\Pr(R_{t+1}^e < R_t^e) = \Phi(0) = 1/2$. If the CEO in the initial period is

[21] CEOs are forced to react to failed diversifications because of pressure from shareholders for corrective measures as failure to respond can possibly harm their human capital.

[22] Albeit, the refocusing activity for overconfident CEOs should be much higher following the reasoning in Roll (1986) and Camerer and Lovallo (1999), those are the CEOs who have been engaged more intensively into unsuccessful diversification activities in the first place.

[23] albeit CEOs are capable of learning, in real world situations the overconfident CEO would never turn into a rational one. Learning can turn an overconfident CEO into a rational only when time approaches infinity and if the overconfident is fed with projects that are identical to the initial one.

overconfident and thus $\Delta > 0$, then $\Pr(R^e_{t+1} < R^e_t) = \Phi\left(\frac{\Delta\bar{R}}{\sigma}\right) > 1/2$ implying that it is more likely the diversification to be reversed (refocusing) if it was initiated by an overconfident CEO. ■

Appendix B. Definitions and measurement of variables

Variables	Definitions
Dependent variables	
EXC_VAL	Excess value is the natural logarithm of the ratio of the firm's market value to the imputed value. Market value is the sum of the market value of equity and the book value of debt. The imputed value is the sum of the segments' imputed values, obtained by multiplying each segment's sales with the median of the market value-to-sales ratio computed using only single-business firms in the same industry.
REF_EVENT	Corporate refocusing decision is a dummy variable that equals 1 when the number of business segments reported decrease relative to the previous year, and 0 otherwise.
DIV_EVENT	Corporate diversification decision is a dummy variable that equals 1 when the number of segments reported increase relative to the previous year, and 0 otherwise.
NUM_SEGS	The number of business segments.
CEO overconfidence measures	
NET_BUYER_OC	Net buyer CEO overconfidence following Malmendier and Tate (2005): CEOs are classified as overconfident during their entire tenure if they were net buyers of firm equity during their first five years in our sample, that is, if they bought stock on net in more years than they sold on net during their first five sample years.
PRESS_OC	Press portrayal CEO overconfidence following Hirshleifer et al. (2012): hand collected data based on CEO coverage in the business and financial press – CEOs are classified as overconfident when the number of articles that characterize CEOs as confident or optimistic is greater than the number of articles characterizing CEOs as reliable, cautious, conservative, practical, frugal, or steady.
Diversification and firm characteristic variables	
DIV	A dummy variable that equals 1 for a diversified firm, both before and after the diversification, and zero otherwise.
BEF_DIV	A dummy that equals 1 for the years before a firm diversifies for the first time, and zero otherwise.
AFT_DIV	A dummy that equals 1 for all years following the first instance of diversification, and zero otherwise.
PAST_DIV	A dummy variable that equals 1 when a firm makes a diversification at least once in the period *t-3* to *t-1*, and 0 otherwise.
PAST_DIV_CEO_OC	A dummy variable that equals 1 when a firm makes a diversification in the period from year *t-3* to *t-1* and at least one diversification event was made by an overconfident CEO, and 0 otherwise.

PAST_DIV_CEO_NOT_OC	A dummy that equals 1 when a firm makes a diversification in the period from year *t-3* to *t-1* and all past diversification events were made by a rational CEO, and 0 otherwise.
CASH_POOR	A dummy variable that equals 1 when the residuals of the Opler, Pinkowitz, and Williamson (1999) corporate cash model are negative, and zero otherwise.
CASH_RICH	A dummy variable that equals 1 when the residuals of the Opler, Pinkowitz, and Williamson (1999) corporate cash model are positive, and zero otherwise
SIZE	The natural logarithm of total assets.
INVEST	The ratio of capital expenditures to total sales.
PROFIT	The ratio of earnings before interest and taxes to total sales.
LEV	The ratio of long-term debt to total assets.
POST_ACQUISITION	A dummy variable that equals 1 for the years after an acquisition is made, and 0 otherwise.
VEGA	The natural logarithm of one plus the change in the risk-neutral value of the CEO's portfolio of stock options for a 1% change in the standard deviation of the return of the underlying stock.
DELTA	The natural logarithm of the change in the risk-neutral value of the CEO's portfolio of stock and stock options for a 1% change in the price of the return of the underlying stock.
RET	Past one-year stock performance computed from monthly returns.
TENURE	The natural logarithm of one plus the number of years the CEO sits in office.
TOTAL MENTION	The number of articles mentioning the CEO.
NUM_SEGS_HIRING	The number of segments during the year of CEO hiring. For hiring prior to 1960 we use the number of segments of the year 1960.

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TABLE 1

Descriptive Statistics

This table presents descriptive statistics of key variables for overconfident and rational CEO firm-years. The sample covers firm–year observations with non-missing values from 1993 to 2010 and meets sample selection criteria described in the text. All variables are defined in the Appendix. The equality of means (medians) is tested using a t-test (Wilcoxon signed rank statistic). *, ** and *** indicate significance at the 10%, 5%, and 1% level, respectively. Only mean values are reported for dummy variables.

OVERCONFIDENCE MEASURE		NET BUYER (NET_BUYER_OC)			PRESS-BASED (PRESS_OC)		
		Overconfident firm–year observations	Rational firm–year observations	Difference: (Overconfident – Rational)	Overconfident firm–year observations	Rational firm–year observations	Difference: (Overconfident – Rational)
SIZE	Mean	7.211	6.809	0.402***	8.303	6.672	1.630***
	Median	7.060	6.670	0.390***	8.328	6.574	1.754***
INVEST	Mean	0.085	0.100	-0.015***	0.075	0.091	-0.016***
	Median	0.045	0.047	-0.002***	0.048	0.045	0.003**
PROFIT	Mean	0.103	0.097	0.006*	0.081	0.094	-0.013***
	Median	0.095	0.099	-0.004	0.096	0.091	0.005
CASH_POOR	Mean	0.483	0.428	0.055***	0.411	0.455	-0.045***
VEGA	Mean	3.718	3.235	0.483***	4.347	3.152	1.196***
	Median	3.839	3.468	0.371***	4.679	3.359	1.320***
DETLA	Mean	5.154	5.822	-0.668***	6.049	5.063	0.986***
	Median	5.166	5.790	-0.624***	6.063	5.097	0.966***
RET	Mean	-0.028	-0.048	0.019	-0.025	-0.049	0.023
	Median	0.015	-0.009	0.024*	0.015	-0.002	0.017
TENURE	Mean	1.733	2.246	-0.513***	2.018	1.854	0.164***
	Median	1.720	2.303	-0.583***	2.058	1.832	0.226
MENTION	Mean	n.a.	n.a.	n.a.	3.686	0.382	3.304***
	Median				2.000	0.000	2.000***
EXC_VAL	Mean	0.121	0.247	-0.126***	0.197	0.154	0.044***
	Median	0.100	0.205	-0.105***	0.157	0.121	0.036***
REF_EVENT	Mean	0.041	0.026	0.014***	0.044	0.037	0.007
DIV_EVENT	Mean	0.045	0.034	0.011**	0.057	0.040	0.017***
No. of obs.		4,602	3,660		1,822	9,021	

TABLE 2

Analysis of Excess Value on CEO Overconfidence

This table displays regression analysis of the relation between excess value and CEO overconfidence. The sample consists of all single-segment and diversified firms during the period 1993-2010 that meet sample selection criteria as described in the text. All variables are defined in the Appendix. Panels A and B present multivariate regression analysis of excess value on overconfidence using the net buyer (NET_BUYER_OC) and press-based (PRESS_OC) measures, respectively. Standard errors are adjusted for clustering at the firm level. T-statistics are reported in parentheses below the coefficient. *, ** and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Excess Value on CEO Overconfidence based on the net buyer measure ($NET\_BUYER\_OC_{t-1}$)

	Dependent Variable: Excess Value (EXC_VAL_t)			
	Single and Multi-segment Firms		Multi-segment Firms only	
	(1)	(2)	(3)	(4)
Const.	-0.241 (-0.63)	-0.239 (-0.63)	-0.006 (-0.01)	0.086 (0.10)
DIV	-0.120** (-2.30)			
DIV X CEO_OC		-0.141** (-2.13)		
DIV X CEO_NOT_OC		-0.103 (-1.57)		
AFT_DIV	-0.141** (-2.22)		-0.099 (-1.56)	
AFT_DIV X CEO_OC		-0.214** (-2.44)		-0.195** (-2.53)
AFT_DIV X CEO_NOT_OC		-0.073 (-0.91)		-0.011 (-0.15)
$SIZE_t$	0.543*** (4.74)	0.540*** (4.71)	0.244 (0.94)	0.210 (0.80)
$INVEST_t$	0.057 (0.68)	0.056 (0.67)	0.408 (1.23)	0.416 (1.33)
$PROFIT_t$	0.143 (1.19)	0.141 (1.17)	1.311*** (3.85)	1.284*** (3.69)
$SIZE_{t-1}$	-0.244*** (-5.08)	-0.244*** (-5.05)	-0.194 (-1.46)	-0.192 (-1.43)
$INVEST_{t-1}$	-0.123* (-1.81)	-0.123* (-1.81)	0.551 (1.44)	0.561 (1.47)
$PROFIT_{t-1}$	-0.020** (-2.17)	-0.020** (-2.18)	-0.267 (-0.88)	-0.275 (-0.92)
$SIZE_{t-2}$	-0.198*** (-5.08)	-0.197*** (-5.03)	-0.129 (-1.30)	-0.124 (-1.23)
$INVEST_{t-2}$	0.001 (0.01)	-0.001 (-0.01)	0.717** (2.39)	0.707** (2.37)
$PROFIT_{t-2}$	-0.035 (-1.26)	-0.034 (-1.25)	0.055 (0.19)	0.052 (0.18)
LEV_t	-0.238** (-2.38)	-0.229** (-2.29)	-0.149 (-0.69)	-0.092 (-0.43)
$SIZE_t^2$	-0.004 (-0.57)	-0.004 (-0.55)	0.009 (0.54)	0.011 (0.65)
Year fixed effects	Yes	Yes	Yes	Yes
No. of firms	569	569	139	139
No. of obs.	3,717	3,717	711	711
Adj-R^2	0.1056	0.1076	0.1959	0.2056

Panel B: Excess Value on CEO Overconfidence based on the press-based measure ($PRESS\_OC_{t-1}$)

	Dependent Variable: Excess Value (EXC_VAL_t)			
	Single and Multi-segment Firms		Multi-segment Firms only	
	(1)	(2)	(3)	(4)
Const.	-0.326 (-1.04)	-0.332 (-1.06)	-0.445 (-0.64)	-0.444 (-0.63)
DIV	-0.063 (-1.43)			
DIV X CEO_OC		0.002 (0.02)		
DIV X CEO_NOT_OC		-0.075 (-1.60)		
AFT_DIV	-0.162*** (-2.98)		-0.123** (-2.31)	
AFT_DIV X CEO_OC		-0.272*** (-2.79)		-0.178* (-1.96)
AFT_DIV X CEO_NOT_OC		-0.147** (-2.55)		-0.119** (-2.12)
$SIZE_t$	0.562*** (5.87)	0.566*** (5.90)	0.370* (1.67)	0.368* (1.65)
$INVEST_t$	0.060 (0.67)	0.060 (0.68)	0.765** (2.46)	0.764** (2.46)
$PROFIT_t$	0.188* (1.76)	0.188* (1.76)	0.678*** (2.91)	0.676*** (2.91)
$SIZE_{t-1}$	-0.243*** (-5.53)	-0.243*** (-5.54)	-0.276** (-2.38)	-0.274** (-2.37)
$INVEST_{t-1}$	0.027 (0.30)	0.028 (0.31)	0.103 (0.43)	0.099 (0.41)
$PROFIT_{t-1}$	-0.006 (-0.52)	-0.006 (-0.52)	0.267 (1.56)	0.268 (1.57)
$SIZE_{t-2}$	-0.200*** (-6.54)	-0.200*** (-6.55)	-0.059 (-0.78)	-0.060 (-0.80)
$INVEST_{t-2}$	-0.080* (-1.85)	-0.079* (-1.85)	0.351 (1.12)	0.353 (1.13)
$PROFIT_{t-2}$	-0.048** (-2.24)	-0.048** (-2.24)	-0.025 (-0.12)	-0.026 (-0.13)
LEV_t	-0.192** (-2.48)	-0.192** (-2.47)	-0.095 (-0.52)	-0.098 (-0.54)
$SIZE_t^2$	-0.006 (-0.90)	-0.006 (-0.95)	0.001 (0.05)	0.001 (0.06)
Year fixed effects	Yes	Yes	Yes	Yes
No. of firms	884	884	183	183
No. of obs.	5,002	5,002	939	939
Adj-R^2	0.1087	0.109	0.1769	0.1771

TABLE 3

Analysis of Excess Value on CEO Overconfidence: Additional evidence

This table displays additional analysis of the relation between excess value and CEO overconfidence. The sample consists of all single-segment and diversified firms during the period 1993-2010 that meet sample selection criteria as described in the text. All variables are defined in the Appendix. Panels A and B present multivariate regression analysis of excess value on overconfidence using the net buyer (NET_BUYER_OC) and press-based (PRESS_OC) measures, respectively. Standard errors are adjusted for clustering at the firm level. The t-statistics are reported in parentheses below the coefficient. *, ** and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Excess Value on CEO Overconfidence based on the net buyer measure ($NET\_BUYER\_OC_{t-1}$)

	Dependent Variable: Excess Value (EXC_VAL_t)					
	Single and Multi-segment Firms			Multi-segment Firms only		
	Berger and Ofek (1995)	Mansi and Reeb (2002)	Campa and Kedia (2002)	Berger and Ofek (1995)	Mansi and Reeb (2002)	Campa and Kedia (2002)
	(1)	(2)	(3)	(4)	(5)	(6)
Const.	-0.270	-0.138	-0.094	0.086	0.944	0.376
	(-0.7)	(-0.34)	(-0.59)	(0.10)	(1.22)	(0.55)
DIV X CEO_OC	-0.133**	-0.158**	-0.020			
	(-1.99)	(-2.13)	(-0.62)			
DIV X CEO_NOT_OC	-0.098	-0.086	-0.028			
	(-1.48)	(-1.27)	(-0.85)			
AFT_DIV X CEO_OC	-0.211**	-0.158**	-0.111**	-0.196**	-0.289***	-0.112**
	(-2.42)	(-2.13)	(-2.43)	(-2.54)	(-3.48)	(-2.52)
AFT_DIV X CEO_NOT_OC	-0.063	-0.086	-0.047	-0.012	-0.037	-0.034
	(-0.78)	(-1.27)	(-0.84)	(-0.16)	(-0.42)	(-0.63)
$SIZE_t$	0.567***	0.526***	0.339***	0.209	0.121	0.134
	(4.90)	(4.16)	(5.63)	(0.79)	(0.52)	(0.51)
$INVEST_t$	0.052	0.139	0.043	0.419	0.192	0.144
	(0.63)	(1.56)	(0.86)	(1.32)	(0.58)	(0.41)
$PROFIT_t$	0.142	0.138	0.016	1.285***	1.436***	0.363
	(1.16)	(0.93)	(0.27)	(3.72)	(3.99)	(0.99)
$SIZE_{t-1}$	-0.244***	-0.296***	-0.522***	-0.192	-0.246*	-0.687***
	(-5.10)	(-5.74)	(-8.77)	(-1.43)	(-1.71)	(-3.20)
$INVEST_{t-1}$	-0.128*	-0.146*	-0.092*	0.562	0.786**	-0.289
	(-1.91)	(-1.88)	(-1.8)	(1.48)	(2.00)	(-0.66)
$PROFIT_{t-1}$	-0.020**	-0.023*	0.042	-0.277	-0.492	0.157
	(-2.28)	(-1.78)	(0.59)	(-0.94)	(-1.48)	(0.48)
$SIZE_{t-2}$	-0.202***	-0.177***	0.204***	-0.124	-0.199*	0.397***
	(-5.19)	(-4.41)	(5.93)	(-1.23)	(-1.71)	(4.16)
$INVEST_{t-2}$	-0.006	0.087	-0.008	0.708**	0.978***	0.432
	(-0.1)	(1.30)	(-0.18)	(2.37)	(2.84)	(1.36)
$PROFIT_{t-2}$	-0.032	-0.024	0.012	0.052	0.358	-0.045
	(-1.19)	(-0.49)	(0.39)	(0.18)	(1.04)	(-0.18)
LEV_t	-0.202**	-0.482***	-0.033	-0.095	-0.400	0.125
	(-2.02)	(-3.93)	(-0.71)	(-0.44)	(-1.55)	(0.96)
$SIZE_t^2$	-0.005	0.000	-0.001	0.011	0.025*	0.011
	(-0.71)	(0.06)	(-0.16)	(0.66)	(1.79)	(0.65)
POST_ACQUISITION	-0.068*			0.005		
	(-1.75)			(0.07)		
HHI			-0.362*			-0.833*
			(-1.8)			(-1.74)
EXC_VAL_{t-1}			0.507***			0.546***
			(18.38)			(9.75)
EXC_VAL_{t-2}			0.189***			0.139***
			(9.64)			(2.73)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of firms	569	562	410	139	136	92
No. of obs.	3,717	3,653	2,870	711	689	480
Adj-R^2	0.118	0.124	0.603	0.206	0.254	0.581

Panel B: Excess Value on CEO Overconfidence based on the press-based measure ($PRESS\_OC_{t-1}$)

	Dependent Variable: Excess Value (EXC_VAL_t)					
	Single and Multi-segment Firms			Multi-segment Firms only		
	Berger and Ofek (1995)	Mansi and Reeb (2002)	Kampa and Kedia (2002)	Berger and Ofek (1995)	Mansi and Reeb (2002)	Kampa and Kedia (2002)
	(1)	(2)	(3)	(4)	(5)	(6)
Const.	-0.376	-0.215	-0.202	-0.439	-0.032	-0.067
	(-1.20)	(-0.66)	(-1.50)	(-0.62)	(-0.05)	(-0.15)
DIV X CEO_OC	-0.002	-0.062	-0.058			
	(-0.02)	(-0.84)	(-1.13)			
DIV X CEO_NOT_OC	-0.068	-0.064	-0.014			
	(-1.44)	(-1.26)	(-0.63)			
AFT_DIV X CEO_OC	-0.270***	-0.251***	-0.064*	-0.179*	-0.188*	-0.069
	(-2.69)	(-2.62)	(-1.95)	(-1.95)	(-1.90)	(-1.05)
AFT_DIV X CEO_NOT_OC	-0.141**	-0.195***	-0.020	-0.117**	-0.159**	-0.048
	(-2.45)	(-2.89)	(-0.30)	(-2.09)	(-2.36)	(-1.43)
$SIZE_t$	0.603***	0.518***	0.356***	0.375*	0.309	0.276
	(6.29)	(5.07)	(7.13)	(1.68)	(1.41)	(1.6)
$INVEST_t$	0.053	0.152*	0.118**	0.744**	0.597	0.189
	(0.60)	(1.70)	(2.32)	(2.37)	(1.56)	(0.6)
$PROFIT_t$	0.183*	0.213	0.057	0.669***	0.899***	0.188
	(1.70)	(1.63)	(1.10)	(2.90)	(2.87)	(1.03)
$SIZE_{t-1}$	-0.246***	-0.259***	-0.517***	-0.276**	-0.274**	-0.550***
	(-5.62)	(-5.29)	(-9.92)	(-2.38)	(-2.10)	(4.11)
$INVEST_{t-1}$	0.025	0.045	-0.114**	0.101	0.285	-0.671*
	(0.27)	(0.50)	(2.27)	(0.41)	(1.16)	(-1.94)
$PROFIT_{t-1}$	-0.006	-0.006	0.006	0.269	0.260	0.199
	(-0.54)	(-0.45)	(0.08)	(1.59)	(1.06)	(1.26)
$SIZE_{t-2}$	-0.208***	-0.190***	0.211***	-0.062	-0.117	0.225***
	(-6.84)	(-5.90)	(7.48)	(-0.81)	(-1.34)	(3.36)
$INVEST_{t-2}$	-0.088**	-0.063	-0.040	0.355	0.613*	0.527**
	(-2.05)	(-1.22)	(-1.22)	(1.14)	(1.74)	(1.99)
$PROFIT_{t-2}$	-0.047**	-0.042	0.069	-0.025	-0.020	-0.152
	(-2.16)	(-1.36)	(1.24)	(-0.12)	(-0.08)	(-1.00)
LEV_t	-0.168**	-0.456***	-0.026	-0.088	-0.416*	0.012
	(-2.16)	(-4.88)	(-0.8)	(-0.47)	(-1.93)	(0.11)
$SIZE_t^2$	-0.008	-0.001	-0.002	0.001	0.008	0.004
	(-1.21)	(-0.14)	(-0.94)	(0.04)	(0.65)	(0.40)
POST_ACQUISITION	-0.080**			-0.024		
	(-2.50)			(-0.38)		
HHI	-0.080**		-0.174	-0.024		-0.370
	(-2.50)		(-1.01)	(-0.38)		(-0.83)
EXC_VAL_{t-1}	-0.080**		0.508***	-0.024		0.500***
	(-2.50)		(24.02)	(-0.38)		(8.62)
EXC_VAL_{t-2}	-0.080**		0.170***	-0.024		0.137***
	(-2.50)		(11.11)	(-0.38)		(3.44)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of firms	884	869	814	183	179	161
No. of obs.	5,002	4,894	4,470	939	907	770
Adj-R^2	0.113	0.120	0.583	0.1775	0.207	0.5528

TABLE 4

Analysis of Corporate Refocusing Decision and Past Diversification Decisions

This table displays logistic regression analysis of the relation between corporate refocusing decisions and past diversification decisions. The sample consists of all multi-segment firms (i.e. firms that potentially could refocus) and firms that refocused either to multi-segment firm or to single segment firm included in both Compustat Industrial Segment and Compustat Industrial Annual databases during the period 1993-2010 that meet sample selection criteria as described in the text. All variables are defined in the Appendix. T-statistics are reported in parentheses below the coefficient. *, ** and *** indicates 10%, 5%, and 1% level of significance, respectively.

	Dependent Variable: Corporate Refocusing Decision (REF_EVENT_t)			
OVERCONFIDENCE MEASURE	NET BUYER ($NET\_BUYER\_OC_{t-1}$)		PRESS-BASED ($PRESS\_OC_{t-1}$)	
	(1)	(2)	(3)	(4)
CONSTANT	-3.104***	-3.139***	-3.281***	-3.068***
	(-4.20)	(-4.24)	(-5.30)	(-4.83)
PAST_DIV	0.511**		0.490***	
	(2.55)		(2.95)	
PAST_DIV_CEO_OC		0.721***		0.863***
		(3.34)		(3.42)
PAST_DIV_CEO_NOT_OC		0.037		0.350*
		(0.13)		(1.91)
$CASH\_POOR_{t-1}$	-0.050	-0.061	-0.099	-0.059
	(-0.26)	(-0.31)	(-0.60)	(-0.36)
$INVEST_{t-1}$	1.639*	1.836*	1.940**	1.972**
	(1.72)	(1.93)	(2.18)	(2.23)
$PROFIT_{t-1}$	-1.177*	-1.369*	-0.770	-0.715
	(-1.67)	(-1.93)	(-1.39)	(-1.29)
$SIZE_{t-1}$	0.179**	0.158*	0.251***	0.234***
	(2.02)	(1.78)	(3.19)	(2.94)
$VEGA_{t-1}$	0.136*	0.121	0.087	0.076
	(1.70)	(1.52)	(1.26)	(1.10)
$DELTA_{t-1}$	-0.151*	-0.097	-0.185**	-0.186**
	(-1.73)	(-1.09)	(-2.50)	(-2.53)
RET_{t-1}	-0.382**	-0.408**	-0.336**	-0.337**
	(-2.31)	(-2.42)	(-2.49)	(-2.51)
$TENURE_{t-1}$	-0.334**	-0.316**	-0.230**	-0.245**
	(-2.40)	(-2.26)	(-2.13)	(-2.27)
EXC_VAL_{t-1}	0.023	0.020	-0.092*	-0.097
	(0.13)	(0.12)	(-1.73)	(-0.67)
$TOTAL\ MENTION_{t-1}$			-0.063*	-0.084**
			(-1.73)	(-2.17)
Year fixed effects	Yes	Yes	Yes	Yes
Firm Random effects	Yes	Yes	Yes	Yes
TEST I: PAST_DIV X CEO_OC - PAST_DIV X CEO_NOT_OC		-0.684**		-0.513*
		(-2.38)		(-1.92)
No. of firms	392	392	569	569
No. of obs.	1,195	1,195	1,690	1,690
-2 Log L	846.5	840.5	1179.5	1176.1

TABLE 5

Analysis of Corporate Refocusing Decision and Past Diversification Decisions: Additional evidence

This table displays logistic regression analysis of the relation between corporate refocusing decisions and past diversification decisions. The sample consists of all multi-segment firms (i.e. firms that potentially could refocus) and firms that refocused either to multi-segment firm or to single segment firm included in both Compustat Industrial Segment and Compustat Industrial Annual databases during the period 1993-2010 that meet sample selection criteria as described in the text. All variables are defined in the Appendix. T-statistics are reported in parentheses below the coefficient. *, ** and *** indicates 10%, 5%, and 1% level of significance, respectively.

	Dependent Variable: Corporate Refocusing Decision (REF_EVENT_t)			
OVERCONFIDENCE MEASURE	NET BUYER ($NET\_BUYER\_OC_{t-1}$)		PRESS-BASED ($PRESS\_OC_{t-1}$)	
	(1)	(2)	(3)	(4)
CONSTANT	-3.132***	-3.223***	-3.169***	-3.083***
	(-4.23)	(-3.41)	(-4.95)	(-3.40)
PAST_DIV_CEO_OC	0.720***	0.572**	0.876***	0.947***
	(3.33)	(2.20)	(3.47)	(2.69)
PAST_DIV_CEO_NOT_OC	0.037	-0.096	0.345	0.025
	(0.13)	(-0.27)	(1.39)	(0.51)
$CASH\_POOR_{t-1}$	-0.061	0.046	-0.062	0.121
	(-0.31)	(0.19)	(-0.38)	(0.54)
$INVEST_{t-1}$	1.829*	1.278	2.043**	1.458
	(1.92)	(1.12)	(2.29)	(1.23)
$PROFIT_{t-1}$	-1.368*	-1.358	-0.720	-1.028
	(-1.93)	(-1.45)	(-1.30)	(-1.20)
$SIZE_{t-1}$	0.158*	0.155	0.231***	0.198*
	(1.78)	(1.41)	(2.89)	(1.76)
$VEGA_{t-1}$	0.121	0.200*	0.078	0.212**
	(1.51)	(1.94)	(1.14)	(2.02)
$DELTA_{t-1}$	-0.098	-0.112	-0.174**	-0.150
	(-1.09)	(-0.97)	(-2.36)	(-1.35)
RET_{t-1}	-0.408**	-0.375*	-0.327**	-0.236
	(-2.41)	(-1.80)	(-2.44)	(-1.25)
$TENURE_{t-1}$	-0.315**	-0.279	-0.245**	-0.406**
	(-2.26)	(-1.31)	(-2.31)	(-2.19)
EXC_VAL_{t-1}	0.019	-0.229	-0.085	0.021
	(0.11)	(-1.02)	(-0.59)	(0.10)
$TOTAL\ MENTION_{t-1}$			-0.087**	-0.131**
			(-2.21)	(-2.29)
CEO_CHANGE_{t-1}	-0.051		0.291	
	(-0.18)		(1.58)	
Year fixed effects	Yes	Yes	Yes	Yes
Firm Random effects	Yes	Yes	Yes	Yes
TEST I: PAST_DIV X CEO_OC - PAST_DIV X CEO_NOT_OC	-0.683**	-0.668*	-0.531**	-0.922**
	(-2.37)	(-1.85)	(-1.99)	(-2.34)
No. of firms	392	340	569	433
No. of obs.	1,195	916	1,690	1123
-2 Log L	840.5	601.6	1174.0	707.1

TABLE 6

CEO Overconfidence and Corporate Diversification Decisions

This table presents logistic regression coefficient estimates of the relation between corporate diversification decisions and CEO overconfidence. The sample consists of firms included in both Compustat Industrial Segment and Compustat Industrial Annual databases during the period 1993-2010 that meet sample selection criteria as described in the text. All variables are defined in the Appendix. T-statistics are reported in parentheses below the coefficient. *, ** and *** indicate 10%, 5%, and 1% level of significance, respectively.

	Dependent Variable: Corporate Diversification Decision (DIV_EVENT_t)			
OVERCONFIDENCE MEASURE	NET BUYER ($NET\_BUYER\_OC_{t-1}$)		PRESS-BASED ($PRESS\_OC_{t-1}$)	
	(1)	(2)	(3)	(4)
CONSTANT	-5.511***	-5.628***	-5.373***	-5.384***
	(-9.51)	(-9.55)	(-9.83)	(-9.84)
CEO_OC	0.369**		0.512***	
	(2.45)		(3.09)	
CASH_POOR	0.051	0.259	-0.083	-0.043
	(0.38)	(1.23)	(-0.75)	(-0.34)
CEO_OC X CASH RICH		0.541***		0.584***
		(2.65)		(2.93)
CEO_OC X CASH POOR		0.196		0.420*
		(1.01)		(1.88)
$INVEST_{t-1}$	-1.577**	-1.576**	-1.767***	-1.789***
	(-2.53)	(-2.53)	(-3.06)	(-3.09)
$PROFIT_{t-1}$	-0.682*	-0.682*	-0.112	-0.109
	(-1.94)	(-1.93)	(-0.31)	(-0.30)
$SIZE_{t-1}$	0.110*	0.112*	0.065	0.064
	(1.88)	(1.92)	(1.25)	(1.23)
$VEGA_{t-1}$	0.033	0.034	0.055	0.056
	(0.66)	(0.67)	(1.33)	(1.35)
$DELTA_{t-1}$	-0.005	-0.006	-0.024	-0.025
	(-0.08)	(-0.10)	(-0.52)	(-0.54)
RET_{t-1}	-0.091	-0.101	-0.083	-0.082
	(-0.78)	(-0.86)	(-0.87)	(-0.86)
$TENURE_{t-1}$	0.032	0.036	-0.001	0.000
	(0.34)	(0.38)	(-0.01)	(0.000)
EXC_VAL_{t-1}	-0.404***	-0.405***	-0.357***	-0.353***
	(-3.42)	(-3.43)	(-3.63)	(-3.58)
$TOTAL\ MENTION_{t-1}$			-0.016	-0.015
			(-0.56)	(-0.55)
Year fixed effects	Yes	Yes	Yes	Yes
Firm Random effects	Yes	Yes	Yes	Yes
No. of firms	1,360	1,360	1,860	1,860
No. of obs.	8,262	8,262	10,843	10,843
-2 Log L	2,197.8	2,196.3	3,179.9	3,179.6

TABLE 7

CEO Overconfidence and Corporate Diversification Decisions: Additional evidence

This table presents logistic regression coefficient estimates of the relation between corporate diversification decisions and CEO overconfidence. The sample consists of firms included in both Compustat Industrial Segment and Compustat Industrial Annual databases during the period 1993-2010 that meet sample selection criteria as described in the text. All variables are defined in the Appendix. T-statistics are reported in parentheses below the coefficient. *, ** and *** indicate 10%, 5%, and 1% level of significance, respectively.

	Dependent Variable					
	Corporate Diversification Decision (DIV_EVENT_t)		Number of Segments (NUM_SEGS_t)	Corporate Diversification Decision (DIV_EVENT_t)		Number of Segments (NUM_SEGS_t)
OVERCONFIDENCE MEASURE	NET BUYER ($NET\_BUYER\_OC_{t-1}$)			PRESS-BASED ($PRESS\_OC_{t-1}$)		
	(1)	(2)	(3)	(4)	(5)	(6)
Data/Model treatments	Excluding year 1998	Single segment firms and diversification incidences from single segment firm status	Ordinal regression with Number of Segments as dependent variable	Excluding year 1998	Single segment firms and diversification incidences from single segment firm status	Ordinal regression with Number of Segments as dependent variable
CONSTANT/S	-5.027***	-5.985***	YES	-5.126***	-6.183***	YES
	(-7.21)	(-7.55)		(-8.17)	(-7.33)	
CEO_OC	0.470*	0.213	0.030	-0.119	0.063	-0.043
	(1.75)	(0.83)	(0.34)	(-0.73)	(0.42)	(-0.77)
CASH_POOR	0.603**	0.525**	0.406***	0.803***	0.616**	0.248***
	(2.31)	(2.03)	(4.92)	(3.33)	(2.39)	(2.61)
CEO_OC X CASH RICH	0.027	0.352	0.259***	0.807***	0.204	-0.092
	(0.10)	(1.45)	(2.94)	(2.81)	(0.68)	(-0.83)
CEO_OC X CASH POOR	-1.522*	-2.174**	-2.098	-1.955**	-2.628***	-2.381***
	(-1.88)	(-2.21)	(-7.33)	(-2.40)	(-2.95)	(-8.67)
$INVEST_{t-1}$	-0.697*	-0.646	-0.594***	-0.135	-0.014	-0.388**
	(-1.76)	(-1.58)	(-3.29)	(-0.32)	(-0.03)	(-2.34)
$PROFIT_{t-1}$	0.016	0.122*	0.061**	-0.003	0.078	0.092***
	(0.22)	(1.68)	(2.48)	(-0.05)	(1.24)	(3.94)
$SIZE_{t-1}$	0.009	-0.004	-0.047**	0.064	0.030	-0.027
	(0.14)	(-0.06)	(-2.36)	(1.17)	(0.60)	(-1.54)
$VEGA_{t-1}$	0.042	-0.001	0.065***	-0.028	-0.043	0.029
	(0.58)	(-0.01)	(2.79)	(-0.48)	(-0.79)	(1.45)
$DELTA_{t-1}$	-0.227	-0.264*	-0.127**	-0.127	-0.219*	-0.092*
	(-1.51)	(-1.71)	(-2.13)	(-1.03)	(-1.80)	(-1.84)
RET_{t-1}	-0.042	0.134	0.314***	-0.019	0.146	0.273***
	(-0.35)	(1.07)	(7.50)	(-0.19)	(1.53)	(7.73)
$TENURE_{t-1}$	-0.497***	-0.412***	-0.306***	-0.403***	-0.265**	-0.254***
	(-3.46)	(-2.75)	(-5.84)	(-3.31)	(-2.20)	(-5.53)
EXC_VAL_{t-1}				-0.045	-0.035	-0.017
				(-1.15)	(-0.90)	(-1.36)
NUM_SEGS_HIRING			1.133***			1.227***
			(38.92)			(47.85)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Random effects	Yes	Yes	No	Yes	Yes	No
No. of firms	1,343	1,117	1,356	1,838	1,554	1,855
No. of obs.	7,691	6,477	8,246	10,099	8,483	10,790
-2 Log L	1,553.0	1,264.7	9,389.94	2,321.0	1,821.6	12,629.29

FIGURE 1

Unconditional Probabilities of Corporate Diversification Decisions and CEO Overconfidence

The figures provide evidence about the unconditional relation between corporate diversification decisions and CEO overconfidence. The year-by-year frequencies are calculated separately for the group of overconfident and rational CEOs as the number of CEOs who pursue a corporate diversification decision divided by the total number of CEOs in each group in a given year.