Out-of-equilibrium CEO Incentives, Dynamic Adjustment and Firm Performance

Robert Bushman
University of North Carolina at Chapel Hill
bushman@unc.edu

Zhonglan Dai
University of Texas at Dallas
zdai@utdallas.edu

Weining Zhang
Cheung Kong Graduate School of Business
wnzhang@ckgsb.edu.cn

November 2018

* We would like to thank John Core, William Cready, Mei Feng, Mark Flannery, Richard Frankel (Discussant), Pingyang Gao, Zhaoyang Gu, Wayne Guay Jin Liu, Jim Omartian, Clair Wang (Discussant), Jieying Zhang, and seminar participants at Chinese University of Hong Kong, Cornell, NYU, Oklahoma University, Tel Aviv University, the 2018 MIT Asia Conference and UNC Kenan-Flagler for helpful discussions and comments.

Out-of-equilibrium CEO Incentives, Dynamic Adjustment and Firm Performance

Abstract

In this paper we investigate whether adjustment cost frictions impede firms from achieving value-maximizing levels of CEO equity incentives and degrade firm performance by sustaining deviations from targeted incentive levels. Specifically, we explore the dynamic adjustment process of CEO incentives and examine implications of speed of adjustment to target for firm performance. Consistent with adjustment frictions sustaining a wedge between target and actual incentives, we find that firm performance decreases in deviations from target incentives, and that firms' active management of incentives towards target only partially closes the gap between target and realized incentives. We then separately consider excess incentives and deficient incentives. We find that while adjustment speed is slower for excess relative to deficient incentives, relative adjustment speed for excess incentives increases significantly for firms with higher monitoring intensity, product competition, and CEO career concerns, and that for such firms performance degradation associated with deviations from target is mitigated. We also provide evidence that when CEOs have greater incentives to voluntarily hold unconstrained equity, excess (deficient) incentives have slower (faster) adjustment speed and greater (lower) negative influence on firm performance. This evidence suggests that CEOs' voluntarily holding of unconstrained equity is a source of adjustment costs.

1. Introduction

A large empirical literature examines relations between CEOs' incentives and outcomes such as firm performance.[1] However, significant challenges hinder interpretations of empirical associations between outcomes and observed CEO incentives. Specifically, such associations can be interpreted as reflecting either an in-equilibrium or out-of-equilibrium phenomena (e.g., Hermalin and Weisbach, 2003). An in-equilibrium perspective assumes that incentives continuously reflect optimal equilibrium choices. In this case there should be no systematic relation between CEO incentives and performance, implying that any empirical association results from correlated omitted variables (e.g., Demsetz, 1983; Himmelberg, Hubbard, and Palia, 1999). In contrast, an out-of-equilibrium interpretation assumes that, for some reason, observed incentives do not reflect value-maximizing levels. In this case empirical associations between observed incentives and performance reflect sub-optimal actions by executives that can be remedied by better incentive alignment. In this paper we seek to distinguish these two interpretations by exploring the processes governing how CEO incentives are managed and adjusted through time.

To the extent that value-maximizing firms seek to continuously optimize CEO incentives, any theory of out-of-equilibrium incentives requires a plausible hypothesis for why misaligned incentives would persist given negative consequences for shareholders. Core et al. (2003) and Core and Larcker (2002) argue that a persistent wedge between observed and optimal incentives can result from the presence of adjustment cost frictions associated with realigning incentives. Such frictions can sustain deviations from optimality, which in turn can negatively influence managerial decisions. In contrast, an equilibrium interpretation assumes that no frictions impede firms' ability to continuously adjust incentives to optimal levels (e.g., Demsetz and Lehn, 1985).

[1] Useful reviews of this literature include Edmans, Gabaix, and Jenter (2017), Armstrong, Jagolinzer, and Larcker (2010), and Core, Guay, and Larcker (2003).

The main objective of this paper is to investigate the plausibility of the out-of-equilibrium perspective by exploring the role of adjustment costs in shaping the dynamic adjustment process governing realignment of CEO incentives and implications of the adjustment process for firm performance. Following Core and Guay (1999) and Core and Larcker (2002), we posit that changes in firm characteristics, CEO characteristics or other aspects of the environment can knock CEO incentives out of optimal alignment. Value maximizing firms are aware of this and seek to restore misaligned incentives to optimal levels. However, the existence of non-trivial adjustment costs inhibits firms' ability to quickly restore target incentives. Resultant deviations between realized and target incentives increase residual agency conflicts which persist until the firm can reset incentives to the new optimal level.

To empirically investigate the out-of-equilibrium perspective, we estimate deviations from target incentives, explicitly model and explore the nature of the dynamic process governing adjustment of CEO incentives towards target, and examine implications of dynamic adjustment for firm performance. Consistent with adjustment costs driving a wedge between actual and target incentives (or out-of-equilibrium incentives), we document that firm value decreases in the magnitude of estimated deviations from target incentives. Further, we find that while firms use future equity grants to actively manage misaligned CEO incentives towards target, they are unable to fully close the current gap between target and actual CEO incentives over the subsequent year.

We then separately examine deviations from target into those that exceed target incentives (excess incentives) and those that are too low relative to target (deficient incentives). We find that excess incentives have a slower speed of adjustment to target level relative to deficient incentives. However, in cross-sectional analysis we find that adjustment speed for excess incentives increases significantly for firms with higher monitoring intensity, product competition, and CEO career concerns, and that for such firms performance degradation associated with deviations from target is mitigated.

We finally investigate underlying sources of incentive adjustment costs. Our analysis builds on Armstrong, Core and Guay (2018) who document that U.S. CEOs hold a significant amount of equity that is not explicitly constrained by ownership guidelines or vesting requirements. We hypothesize that such unconstrained equity holdings, which are presumably optimal from the perspective of the CEO, generate adjustment costs from the perspective of the firm. Consistent with our hypothesis, we provide evidence that when CEOs have greater incentives to voluntarily hold unconstrained equity, excess incentives have a slower speed of adjustment and greater negative influence on firm performance, while in contrast deficient incentives have a faster speed of adjustment and reduced negative influence on firm performance.

To measure deviations from a firm's target incentives, we estimate a model of CEO incentives using an extensive set of time varying firm and CEO characteristics to capture changes in target incentives over time, as well as firm fixed effects to capture time invariant aspects of target incentives.[2] Following Core and Guay (1999) and others, we posit that the incentive gap between predicted incentives from the model and actual observed incentives captures the extent of incentive misalignment.[3] We perform a series of analyses to provide support for the plausibility of this supposition.

First, if firms target CEOs incentives to maximize firm value, then we expect firm performance to decrease in the magnitude of the incentive gap. To examine this proposition, we

[2] We use the terms incentive gap and deviation from target incentives interchangeably throughout. We define incentives as the estimated delta of a CEO's equity portfolio (i.e., change in CEO wealth for a 1% change in firm value). Incentive gap (deviation from target) is the difference between our model estimate of target incentives and actual incentives. Incentives are presumed to be excessive when target incentives < actual incentives.

[3] Papers that have taken related approaches to measuring deviations from optimal incentives include Core and Guay (1999), Burns and Kedia (2006), Tong (2008), Bushman, Dai, and Zhang (2016) and Peng, Röell, and Tang (2016).

estimate the association between future firm performance (i.e., Tobin's Q and ROA) and our estimate of the incentive gap in the current period. To the extent that the estimated incentive gap captures incentive misalignment, we expect performance to be lower when either observed incentives exceed target incentives (excess incentives) or when they are too low relative to target (deficient incentives). We find evidence consistent with this hypothesis.[4]

Building on this result, we take the out-of-equilibrium perspective that when incentives deviate from target, firms will act to quickly realign incentives subject to adjustment costs that inhibit the speed with which firms are able to fully achieve realignment. CEOs' equity incentives can become misaligned due to changes in firm and manager characteristics, periodic rebalancing of equity portfolios by executives, and changes in stock price, price volatility and time to maturity, etc. Consistent with boards readjusting misaligned incentives towards optimality, Core and Guay (1999) find that the incentives reflected in future equity grants are negatively related to estimated deviations from target.

Our point of departure for examining dynamic adjustment of CEO incentives is an extension of Core and Guay (1999) utilizing an augmented model of incentives and a significantly longer sample period. Reaffirming Core and Guay (1999), we find that incentive levels reflected in future equity grants to CEOs are negatively related to estimated incentive gaps. However, while these results suggest active management of incentive towards optimality, these results do not provide insight into the nature of adjustment costs and out-of-equilibrium incentives. Specifically, this specification provides no information on the extent to which optimal incentives are restored or on textured properties of the dynamic adjustment process if they are not.

[4] Tong (2008) and Peng et al. (2016) run related analyses using different specifications.

To address these challenges, we examine the hypothesis that if adjustment costs constrain firm's ability to quickly remedy misaligned incentives, then incentives will only partially adjust back to optimal levels. We empirically isolate the speed of partial adjustment by estimating the proportion of any existing gap between target and actual incentives that is closed over the subsequent year by virtue of changes in incentives deriving from any and all sources.[5] This analysis documents that on average firms close around 43% of the gap between target and actual incentives over the subsequent year. Disaggregating the gap, we find that 50% (37%) of the gap is closed for deficient (excess) incentives, suggesting that it is easier to increase incentives that are too low relative to decreasing incentives that are too high.[6]

Extending our analysis of deficient versus excess incentives, we next hypothesize that speed of adjustment will vary with the extent of (1) monitoring intensity as captured by institutional ownership and equity analyst following; (2) product market competition, as competitive pressure imposes discipline to remove slack; and (3) the tenure of the CEO, as consequences of misaligned incentives may be amplified by career concerns of newer CEOs managing talent perceptions, putting a premium on faster adjustment. Further, note that adjustment speed determines the persistence of deviations from target. Thus, we also expect firm characteristics associated with faster (slower) speed of adjustment to be associated with reduced (magnified) negative consequences of deviations from target. Consistent with both expectations, we find that adjustment speed for excess incentives increases significantly for firms with higher

[5] The process of restoring incentive alignment involves firms' equity granting decisions as well as decisions by CEOs to exercise options and buy or sell shares (Li, 2002). Our approach considers the combined effect of all such decisions on CEO incentives. The technique of partial speed of adjustment has been widely used in the finance literature to examine capital structure adjustments (e.g., Lemmon, Roberts, and Zender, 2008; Flannery and Rangan, 2006).

[6] When target > actual, incentives are deficient and must be increased to meet target, and when target < actual, incentives are excessive and must be decreased to meet target.

monitoring intensity, more competition, and earlier tenured CEOs, and that for such firms performance degradation associated with deviations from target is mitigated.

Finally, while our previous analyses points to existence of adjustment costs that impede incentive realignment and degrade performance, these analyses shed no light on underlying sources of such costs. We explore one potential source by considering that adjustment costs may arise from CEOs voluntarily holding equity above amounts explicitly constrained by ownership guidelines or vesting requirements (Armstrong et al., 2018). While unconstrained holdings are by nature optimal from a CEO's perspective and beyond a firm's control, we hypothesize that these holdings can serve as a source of incentive misalignment from a firm's perspective. Armstrong et al. (2018) posit that CEOs have incentives to hold excess equity when they are overconfident, or when they want to signal private information, or when they have informed trading motivations. We find that speed of adjustment is slower (faster) for excess (deficient) incentives when CEOs are more overconfident and for CEOs with higher signaling incentives. We also find consistent results for firm performance, where firm performance is worse (better) for excess (deficient) incentives for more overconfident CEOs and those with higher signaling incentives. That is, performance is worse (better) in the same settings where speed of adjustment is slower (faster). We find no results for informed trading motivations.

Our explicit analyses of out-of-equilibrium CEO incentives make several substantive contributions to the literature. First, we provide new evidence on the importance of adjustment costs in sustaining divergence between actual and target CEO equity incentives. Specifically, we extend Core and Guay (1999) and Li (2002) by documenting that, not only do firms actively use equity grants to manage shocks to incentives back towards optimality, but that deviations from optimal are negatively associated with firm value. These negative effects on firm value suggest that the active management of incentives we document is unable to fully remedy misaligned incentives.

Building on this observation, we extend the literature by performing an in-depth investigation into the dynamic adjustment of CEO incentive alignment (see e.g., Cheung and Wei, 2006; Tong 2008; Bushman et al., 2016). Our speed of partial adjustment analysis provides novel insights into the trajectory of incentive adjustment over time. First, we provide evidence of asymmetry in the adjustment trajectory, where incentives converge towards target more quickly when target incentives exceed actual, consistent with it being easier to remedy incentives that are too low than too high. Second, our cross-sectional analyses provide new evidence of significant variation in the speed of adjustment associated with differences in monitoring intensity, competitive pressure and CEO career concerns. Third, we provide evidence that speed of adjustment can serve as a mechanism that determines the extent to which deviations from target incentives negatively influence firm performance, as adjustment speed determines the persistence of deviations from target. Finally, we provide novel evidence consistent with adjustment costs emanating from CEOs incentives to voluntarily hold equity in excess of that explicitly constrained by ownership guidelines or vesting requirements

The rest of the paper is organized as follows. Section 2 discusses the conceptual framework of the paper and its relation to the prior literature. Section 3 discusses the out-of-equilibrium incentives and presents the evidence on the nature of the dynamic adjustment process toward the optimal. Section 4 examines the extent to which CEOs' voluntary holdings of unconstrained equity represent a source of adjustment costs. Section 5 concludes.

2. Conceptual Framework, Related Literature and Predictions

Agency theory posits that separation of management from financiers creates agency conflicts in which managers exploit private information to extract personal benefits (e.g., Jensen and Meckling, 1976). While equity incentives are often posited as a solution to agency problems, there is presently no consensus on how CEOs equity incentives affect firm performance. An in-equilibrium perspective posits that value-maximizing firms design optimal incentive structures as a function of exogenous parameters characterizing the firm, manager and economic setting, and that observed incentives continuously reflect optimal levels. In this case there should be no systematic relation between observed CEO incentives and firm performance, conditional on controlling for exogenous determinants of incentives (e.g., Demsetz, 1983; Himmelberg et al., 1999; Demsetz and Villalonga, 2001).[7]

In contrast, an out-of-equilibrium perspective assumes that, for some reason, observed incentives do not reflect value-maximizing levels. In this case, empirical associations between observed incentives and performance reflect sub-optimal managerial actions that can be remedied by better incentive alignment. For example, Morck, Shleifer, and Vishny (1988) argue that, on average, observed CEO equity ownership and incentives are too low relative to optimal. To the extent this is the case, firms could increase firm value by increasing CEO equity incentives. This raises the fundamental question: why would deviations from optimal incentives persist given the negative consequences for firm performance?

As recognized by Hermalin and Weisbach (2003) among others, it is challenging to distinguish in-equilibrium interpretations of empirical associations from out-of-equilibrium interpretations in which persistent non-optimal incentives degrade firm performance. Core et al. (2003) and Core and Larcker (2002) address this challenge by positing that equilibrium and out-

[7] See also Demsetz (1983), Himmelberg et al. (1999), Demsetz and Villalonga (2001), Villalonga and Amit (2006), and Fahlenbrach and Stulz (2009).

of-equilibrium interpretations rest on very different assumptions about the extent of adjustment costs associated with adjusting misaligned incentives towards optimal. When CEO incentives drift out of optimal alignment and adjustment frictions impede firms' ability to immediately re-establish optimality, observed CEO incentives can deviate from optimal levels for some period. In this paper we examine the hypothesis that incentive alignment is a dynamic process in which value maximizing firms actively seek to quickly eliminate deviations from optimality and restore optimal incentive alignment, but they are constrained by adjustment cost frictions.

Our empirical approach for isolating deviations from value-maximizing incentives follows Core and Guay (1999) and Li (2002) who investigate whether observed grants of equity to CEOs are consistent with the theory of optimal contracting. These papers model optimal equity incentives and use residuals from the model to capture deviations from target levels. Consistent with these residuals reflecting deviation from target and firms actively seeking to realign incentives, Core and Guay (1999) document that grants of new incentives from options and restricted stock are negatively related to the residuals. Li (2002) extends this result by recognizing that firms and CEOs jointly correct deviations from these optimal levels through equity grants and CEO portfolio rebalancing, and provides evidence consistent with firms and CEOs coordinating their equity-granting and portfolio-rebalancing decisions to manage optimal CEO incentive levels consistent with economic theory.

We estimate a model of optimal incentives and, following Core and Guay (1999), posit that deviations from predicted incentives estimated from this model represent deviations from target CEO incentives. We then perform a series of analyses to provide evidence that these residuals plausibly reflect deviations from target incentive levels. First, if firms target CEOs incentives to maximize firm value, then we expect firm performance to decrease in the magnitude of the estimated incentive gap. To examine this proposition, we estimate the association between deviations from target incentive levels and both future Tobin's Q and ROA.

Second, if incentives deviate from firms' desired target, value maximizing firms would take actions to quickly realign incentives by actively managing incentives towards target (e.g., Core and Guay, 1999; Li, 2002). To examine this, we first replicate Core and Guay (1999) utilizing an augmented model of optimal incentives and a significantly longer sample period. However, while this analysis provides evidence consistent with incentive misalignment and firms behaving consistent with the theory of optimal contracting, it does not allows us to directly examine whether adjustment frictions result in persistent deviations from target. While Core and Guay (1999) and our extension show that firms actively adjust incentives towards target, it provides no information on whether these adjustments fully restore incentive alignment (i.e., zero adjustment costs) or reflect only partial adjustment (i.e., non-trivial adjustment costs).

If CEO incentives are misaligned and firms' best efforts to restore alignment are hampered by adjustment costs, we would expect to observe only partial adjustment back towards target levels. To explore this, we analyze the speed of partial adjustment by estimating the proportion of the current gap between target and actual CEO incentives that is closed by actual changes in incentives over the subsequent year. While the technique of partial speed of adjustment has been widely used to examine firms' capital structure adjustments (e.g., Lemmon et al., 2008; Flannery and Rangan 2006), several papers have employed it in an executive compensation context (Cheung and Wei, 2006; Tong, 2008; Bushman et al., 2016). Our speed of adjustment specification runs a regression of actual changes in CEO incentives from year t-1 to year t on the estimated gap between target and actual incentives at year t-1. That is, we run

$$Delta_t - Delta_{t-1} = \lambda * (Target\ Delta_{t-1} - Delta_{t-1}) + \varepsilon_t \ . \qquad (1)$$

The left hand side of (1) is the actual change in incentives, and the difference on the right represents the delta gap to be closed to achieve target. The coefficient λ captures the estimated speed of adjustment and $Target\ Delta_{t-1}$ is the target level of CEO incentives estimated using available information at time t-1. A coefficient of $\lambda = 1$ implies that 100% of the incentive gap at t-1 is closed by the choice of actual CEO incentives at t. Consistent with frictions impeding full adjustment, $\lambda < 1$ implies that only a fraction λ of the incentive gap is closed. We also explore whether speed of adjustment is symmetrical for excess and deficient incentives gaps by running:

$$Delta_t - Delta_{t-1} = \alpha + \lambda_1 Deficient\ Delta_{\ t-1} + \lambda_2 Excess\ Delta_{\ t-1} + \varepsilon_t \ . \quad (2)$$

In (2) the coefficients λ_1 and λ_2 capture speed of adjustment when incentives are too low and too high, respectively. *Deficient (Excess) Delta* is set equal to $Delta\ Gap = Target\ Delta_{t-1} - Delta_{t-1}$ when *Delta Gap* is positive (negative), and equals zero otherwise.

To gain further insight into the dynamic incentive adjustment process, we explore cross-sectional differences in the speed of adjustment across firms. This analysis is based on the premise that speed of adjustment results from a tradeoff between benefits of realigning incentives and adjustment costs, where the nature of this trade-off may differ across firms.

First, we conjecture that speed of adjustment will increase in outside monitoring intensity. The idea is that greater disciplinary pressure imposed on firms shifts the cost-benefit trade-off in favor of faster convergence back to optimal incentives levels. Building on existing literature, we proxy for outside monitoring intensity using two variables: institutional ownership, and equity analyst following. With respect to institutional investors, Barber (2007) documents cumulative announcement period gains of over $3 billion associated with targeting of firms by CalPERS, a large activist institutional investor. Chen, Harford, and Li (2007) show that in the context of mergers, withdrawal of bad bids is more likely in firms with independent long-term institutional investors. Bushee (1998) shows that institutional investors serve a monitoring role in preventing a firm's reduction of R&D spending for short term benefit, a form of real earnings management.[8] Healy and Palepu (2001) suggest that information intermediaries such as analysts engage in private information production that helps to detect managers' misbehavior. Jensen and Meckling (1976, page 353) argue that "as security analysis activities reduce the agency costs associated with the separation of ownership and control, they are indeed socially productive". Yu (2008) finds that firms followed by more analysts manage their earnings less.

Second, we conjecture that speed of adjustment will increase in the intensity of product market competition. Economists have long argued that competitive forces act as a disciplining mechanism, exerting pressure on firms to reduce slack and improve efficiency in order to survive (e.g., Scherer, 1980; Fama, 1980). Giroud and Mueller (2011) and Jagannathan and Srinivasan (1999) provide evidence that competition mitigates managerial slack. Third, we hypothesize that speed of adjustment will be faster for CEOs earlier in their tenure with the firm. Because career concerns can lead CEOs early in their tenure to pursue short-term benefits, such as accounting and real earnings management (e.g., Holmstrom, 1999), boards may seek to adjust misalignments faster to prevent impairment of firm value. Ali and Zhang (2015) document that earnings overstatement is relatively higher for CEOs' in their early tenure with the firm, and this relation is less pronounced for firms with greater external and internal monitoring. In this analysis, we run

$$Delta_t - Delta_{t-1} = \alpha + \lambda_1 Deficient\,Delta_{t-1} * CV + \lambda_2 Excess\,Delta_{t-1} * CV + \beta * CV + \varepsilon_t . \quad (3)$$

In (3) *CV* represents one of the cross-sectional variables discussed earlier.

---

[8] The monitoring role played by the institutional investors has also been documented in Hartzell and Starks (2003) where they show a positive relation between CEO's pay-performance-sensitivity and institutional ownership.

The basic premise of our analysis of dynamic incentive adjustment is that adjustment speed reflects the amount of time that deviations from target persist, and that the negative influence of deviations on firm performance should increase with persistence of the deviation. To examine this, we extend the analysis described by equation (3) to examine how the influence of incentive gaps on firm performance varies in the cross-section. Specifically, we run specifications of the form:

$$Firm\,Performance_t = \alpha + \lambda_1 Deficient\,Delta_{t-1} * CV + \lambda_2 Excess\,Delta_{t-1} * CV + \beta * CV + \varepsilon_t . \quad (4)$$

In (4), firm performance is either *Tobin's Q* or *ROA*, and *CV* is one of the cross-sectional variables discussed earlier associated with monitoring intensity, product market competition or career concerns. The objective of estimating equation (4) is to examine whether performance is worse (better) in the same settings where speed of adjustment is slower (faster).

Finally, as discussed in the introduction, we explore the hypothesis that adjustment costs may arise from CEOs voluntarily holding unconstrained equity over and above amounts explicitly constrained by ownership guidelines or vesting requirements. Armstrong et al. (ACG, 2018) provide evidence that CEOs hold significant levels of unconstrained equity. Consistent with these holdings being voluntary rather than explicitly or implicitly required by the firm, they provide evidence that CEOs appear to be less than fully compensated for the risk associated with their total equity holdings. ACG consider several explanations for why CEOs seem to "voluntarily" hold more equity than is required, and for which they are not risk compensated, including CEO overconfidence, incentives to signal, and informed trading motivations.

Overconfident CEOs are willing to hold unconstrained equity because they tend to over-estimate the future returns on their stock. In examining this hypothesis, ACG follow Malmendier and Tate (2005) who argue that overconfident CEOs believe that investors have undervalued their firm's stock, and are therefore reluctant to make investments when the projects must be financed with new stock. Malmendier and Tate (2005) find that overconfident CEOs exhibit greater investment-to-cash-flow sensitivity, presumably because they are less willing to invest in the absence of internal cash flow. Similar to ACG, we estimate CEO overconfidence as the sensitivity of investment to cash flow, γ_i, for each CEO from the following regression:

$$Investment_{i,t+1} = \gamma_0 + \gamma_i Cash\,Flow_{i,t+1} + \gamma_1 Book\text{-}To\text{-}Market_{i,t} + Controls_{i,t} + \varepsilon_{i,t+1}. \quad (5)$$

In (5), *Investment* is annual capital expenditures (Compustat Item CAPX), scaled by beginning-of-the-year capital (PPENT), and *Cash Flow* is earnings before extraordinary items (IB) plus depreciation (DP) scaled by beginning-of-the-year capital.

The signaling hypothesis posits that CEOs may hold unconstrained equity to signal their belief that the firm is fairly valued, or perhaps even undervalued. Following ACG, we use corporate share repurchases as a proxy for the CEO's beliefs about the firm's value, as prior research documents that managers repurchase shares when they believe that the stock is undervalued (e.g., Brav, Graham, Harvey, and Michaely, 2005; Dittmar and Field, 2015). Also, managers' share repurchase decisions and personal portfolio decisions appear to reflect similar information and beliefs about stock valuation (e.g., Core, Guay, Richardson, and Verdi, 2006). We measure stock repurchases as the total value of stock repurchased during the twelve months starting three months after the fiscal year end, as a percentage of beginning-of-year market value of equity.

With respect to informed trading motives, ACG assess whether CEOs alter their unconstrained equity holdings when they have private information about stock under- or over-valuation, or perhaps when they expect to be able to manipulate the stock price, by including future excess returns. We compute these returns as annual buy-and-hold returns excess over equal-weighed market return starting 3 months after the firm's fiscal year t end in t+1.

Analogous to our earlier cross-sectional analysis, we estimate the following two specifications:

$$Delta_t - Delta_{t-1} = \alpha + \lambda_1 Deficient\ Delta_{t-1} * DV + \lambda_2 Excess\ Delta_{t-1} * DV + \beta * DV, \text{ and} \quad (6)$$

$$Firm\ Performance_t = \alpha + \lambda_1 Deficient\ Delta_{t-1} * DV + \lambda_2 Excess\ Delta_{t-1} * DV + \beta * DV. \quad (7)$$

In equations (6) and (7), DV is either CEO overconfidence, share repurchases (overconfidence) or future excess returns (informed trading motivation). Equation (6) is designed to examine whether incentives to hold unconstrained equity are associated with slower speed of adjustment, and the objective of equation (7) is to examine whether performance is worse (better) in the same settings where speed of adjustment is slower (faster).

3. Out-of-Equilibrium Incentives and the Dynamic Adjustment Process

A main objective of this paper is to investigate the extent to which CEO stock and option portfolios reflect out-of-equilibrium incentive levels deriving from adjustment cost frictions, and to examine the properties of the dynamic adjustment process reflecting firms' efforts to restore optimality. In section 3.1 we develop our empirical approach for constructing deviations from a firm's target incentives by estimating a model of CEO incentives. Following Core and Guay (1999) and others, we posit that the incentive gap between predicted incentives from the model and actual observed incentives captures the extent of incentive misalignment. In section 3.2 we examine whether our estimated incentive gap can plausibly be interpreted as deviations from optimal incentives by investigating the relation between the incentive gap and firm performance. Finally, section 3.3 utilizes a speed of adjustment framework to extensively explore characteristics of the dynamic process by which out-of-equilibrium incentives adjust back towards target.

3.1 Estimating optimal CEO incentives and deviations from optimal

In this section, we estimate a model of CEO incentives using an extensive set of time varying firm and CEO characteristics to capture changes in target incentives over time, as well as firm fixed effects to capture time invariant aspects of target incentives. Our compensation data is drawn from the Compustat ExecuComp database for the years 1993 to 2015. We supplement this with firm financial information from Compustat and stock return data from CRSP. We measure incentives based on a CEO's entire portfolio holdings of stock and stock options (exercisable and unexercisable) in the firm. The incentive intensity reflected in an executive's equity portfolio is represented by the *delta* of an executive's equity portfolio, defined as the change in value of the portfolio for a 1% change in the price of the underlying stock. Specifically,

$$delta = (\#of\ Shares + \#of\ Options \times Option\,Delta) \times (Price \times .01). \tag{8}$$

Option deltas are estimated using the methodology of Core and Guay (2002) and price refers to the firm's year-end stock price. Since *delta* is positive and right skewed, we follow the literature and use the natural log of *delta* in all of our specifications.

To estimate deviations from target incentives, we specify a model of a CEO's optimal incentives that builds on the specifications developed in Core and Guay (1999), Armstrong and Vashishtha (2012) and Armstrong et al. (2018). Specifically,

$$\begin{aligned} \log(delta_t) = {} & \beta_0 + \beta_1 \log(MV_{t\text{-}1}) + \beta_2 Book\text{-}to\text{-}Market_{t\text{-}1} + \beta_3 \log(idiosyncratic\,risk_{t\text{-}1}) \\ & + \beta_4 \log(CEO\,tenure_{t\text{-}1}) + \beta_5 \log(CEO\ Cash\ Compensation_{t-1}) \\ & + \beta_6 Cash\ scaled\,by\,total\,assets + \beta_7 Return_{t\text{-}1} + \beta_8 ROA_{t\text{-}1} + \beta_9 Leverage_{t\text{-}1} \\ & + \beta_{10} Capital_{t\text{-}1} + \beta_{11} Free\,Cash\,Flow\,\mathrm{Pr}\,oblem_{t-1} + \beta\ Cumulative\,Returns_{t-1} \\ & + \beta_{13} CEO\,Diversification_{t-1} + firm\ fixed\ effect + year\ fixed\ effect\ + \varepsilon. \end{aligned} \tag{9}$$

Equation (9) incorporates an extensive set of firm and CEO characteristics expected to influence the design of optimal CEO incentives.[9] Firm size, measured as the market value of equity (*MV*), is included based on the premise that larger firms demand more talented CEOs and that CEOs of larger firms tend to be wealthier (Smith and Watts, 1992; Core and Guay, 1999). We expect a positive relationship between firm size and *delta*. Next, it has been argued that it is more difficult to monitor managers of firms with greater investment opportunities, leading firms to shift more intensively towards the use of equity incentives (e.g., Smith and Watts, 1992). We include the *Book-to-Market* ratio to proxy for growth opportunities and expect it to be negatively associated with equity incentives. Idiosyncratic stock return risk can have conflicting influences on CEO incentive intensity. First, less predictable environments have been posited to have higher monitoring costs that require higher incentives (e.g., Demsetz and Lehn, 1985). In contrast, Jin (2002) documents that idiosyncratic risk is negatively related to pay performance-sensitivity, but finds little relation between systematic risk and incentive level. We thus have no prediction on the sign of the relationship between idiosyncratic risk and *delta*. We control for past performance using both lagged stock returns and return on assets as firms may reward managers for their past performance with restricted stock and options (Armstrong and Vashishtha, 2012).

Following Armstrong et al. (2018), we include a proxy for free cash flow defined as operating cash flow minus common and preferred dividends divided by average total assets. We also control for a firm's cash on hand scaled by total assets. Both greater free cash flows and cash balances may be associated with greater agency problems, implying a positive relation with CEO incentives (Jensen, 1986; Stulz, 1990). On the other hand cash-constrained firms may use restricted stock and stock options as substitutes for cash compensation (Core and Guay, 1999).

[9] See the appendix for a detailed description of all variables used in the paper.

Thus, the sign of the relationship of cash levels with equity incentives is ambiguous. CEO tenure captures both CEO career concerns (Gibbons and Murphy, 1992) and potential horizon problems (Dechow and Sloan, 1991). Consistent with prior literature, we predict a positive relationship between CEO tenure and the level of equity incentives.

We include several variables to control for CEOs risk aversion and wealth. First, we follow Armstrong et al. (2018) and include *Cumulative Return* measured as the annual buy-and-hold returns less equal-weighed market return starting from the month after CEO takes the position, and ending in the current fiscal year. The idea here is that firms require wealthier CEOs to hold more equity than less wealthy CEOs. Further, the value of a CEO’s stock and option portfolio, and therefore the proportion of wealth invested in firm equity, fluctuates over time as a function of the firm’s stock price performance. Although CEOs can rebalance their portfolios over time, frictions will likely prevent CEOs from immediately adjusting their holdings back to target levels (Huddart and Lang, 1996; Ofek and Yermack, 2000; Core et al., 2003). *Cumulative Return* is included to capture these effects. The more recent portion of the cumulative return is expected to capture portfolio rebalancing frictions, and the longer-term component is expected to capture variation in CEO wealth. We expect cumulative returns to exhibit a positive relation with CEOs’ incentives. We include the variable *CEO Diversification,* computed as the ratio of a CEO’s firm specific wealth divided by the CEO’s total wealth, where CEO’s non-firm wealth is estimated following Dittmann and Maug (2007). As CEO diversification is decreasing in this measure, we expect it to have a positive relation with CEO incentives. As a second measure of CEO diversification and risk aversion, we include cash compensation following Guay (1999), who argues that CEOs with higher cash compensation are better able to diversify their portfolio and will therefore be less risk-averse. We thus predict a positive relationship between cash compensation and delta.

Finally, we also control for leverage, as discipline from outside creditors may serve as a substitute or complement for equity incentives, PP&E scaled by total assets to control for the tangibility of the asset base (*Capital*), and firm fixed effects to capture time invariant aspects of firms' target equity incentives. Year fixed effects are also included.

In Table 2, we estimate equation (9). Summary statistics for all variables used in this analysis are presented in Table 1, Panel A. To explore the relative influence of economy-wide, time invariant and time varying determinants of target incentives, we run three nested specifications. In column (1) we run an OLS regression that includes only year fixed effects, and document that economy-wide influences explain around 10% of the variation in CEO *delta*. In column (2) we add firm fixed effects, finding that R^2 increases dramatically to 68% from the 10% explained by year fixed effects alone. In column (3), we further include the time varying firm and manager characteristics discussed earlier and see a modest increase in R^2 to 74% from the 68% documented in column (2). Finally in column (4), we substitute industry fixed for firm fixed effects, and find that the R^2 drops to 58% from 74% for firm fixed effects. All results in the paper are robust to using the industry fixed effects specification.

In all analyses to follow, we use predicted incentives from the specification in column (3) of table 2 to proxy for CEO target incentives using information available at time t-1 (i.e., $Target_{t-1}$). Using this estimate of $Target_{t-1}$, we compute deviation from target CEO incentives at t-1 as $Delta\,Gap_{t-1} = Target_{t-1} - Actual\ Delta_{t-1}$.

3.2 Relation between deviations from target incentives and firm performance

In this section we explore whether our estimated deviations from target can plausibly be interpreted as deviations from optimal incentives. The premise of our analysis is that, if target incentives are designed to maximize firm value, then deviations from target sustained through time by adjustment costs should degrade firm value. To examine this, we estimate the association between future performance (*Tobin's Q* or *ROA*) and deviation from target CEO incentives at t-1, $Delta\,Gap_{t-1}$, by running the following specification[10]:

$$\begin{aligned} Tobin's\,Q_{it}\,(ROA_{it}) = \alpha + \delta_1 Deficient\,Delta_{i,t-1} + \delta_2 Excess\,Delta_{i,t-1} + Tobin's\,Q_{i,t-1} \\ + Other\,Controls + Industry\,\&\,Year\,Fixed\,Effects + \varepsilon_{i,t}. \end{aligned} \quad (10)$$

Recall that *Deficient (Excess) Delta* is set equal to $Delta\,Gap = (Target\,Delta_{t-1} - Delta_{t-1})$ when *Delta Gap* is positive (negative), and equals zero otherwise. To the extent that our specification captures deviation from target incentives, we expect *Q* and *ROA* to be lower for both deficient and excess delta. Our firm control variables are comparable to those used in Kale, Reis, and Venkateswaran (2009) and include industry homogeneity, firm size, return volatility, leverage, R&D and advertising expenditures, and dividend yield. In addition, we further control for past performance by including lagged Tobin's Q, lagged ROA and lagged annual stock returns. Finally, we include industry and year fixed effects. Descriptive statistics for all variables are reported in Table 1, Panel B.

Results from running equation (10) are reported in Table 3. We find that *Deficient Delta* (i.e., incentives too low) is negatively and significantly associated with future *Q/ROA*, while *Excess Delta* (i.e., incentives too high) is positively and significantly associated with future *Q/ROA*. These results suggest an inverted U-shaped relationship between estimated incentive gaps

[10] It is important to note that the residual delta variables used in equation (10) are generated regressors from our first stage regression in Table 2, column (3) (Pagan, 1984). So we follow Faulkender, Flannery, Hankins, and Smith (2012) and use Bootstrapped standard errors to account for the generated regressor.

and future firm performance, providing evidence consistent with deviations from target incentives degrading firm value, whether these incentives are either too high or too low. We note that the coefficient on *Excess Delta* is substantially greater in absolute magnitude (.155) than the coefficient on *Deficient Delta* (-.022), suggesting that excessive incentives have a larger negative (more detrimental) impact on firm value than incentives that are too low.

We next empirically investigate the nature of the process by which CEO incentives dynamically adjust back towards target incentives.

3.3 Dynamic adjustment process of misaligned incentives towards optimality

The results in Table 3 just discussed provide evidence consistent with adjustment costs preventing firms from fully restoring target incentives, where the resultant out-of-equilibrium incentives negatively impact firm value. If adjustment costs are indeed the cause of deviations from target, we would expect value maximizing firms' to actively manage incentives towards target incentives. In this section we use two approaches to explore this hypothesis. First, in section 3.3.1 we follow Core and Guay (1999) and examine the extent to which firms use future equity grants to move currently out-of-equilibrium incentives towards target levels. Second, the presence of non-trivial adjustment costs hinder the efforts of value maximizing firms to immediately restore misaligned incentives, which would result in only partial adjustment of incentives towards target. In section 3.3.2 we examine this possibility in a speed of partial adjustment framework. Finally, in section 3.3.3 we examine cross-sectional variation in the speed of partial adjustment, and in section 3.3.4 we examine how the influence of incentive gaps on firm performance varies in the cross-section.

3.3.1 Out-of-equilibrium incentives and future equity grants

If a CEO's incentives drift away from optimal alignment, a natural step firms would take to actively pursue restoration of optimality is to adjust CEO's incentives through its annual equity grants to CEOs. To examine this, we follow Core and Guay (1999) using an extended model of optimal CEO incentives and a substantially longer sample period that extends from 1993-2015. A main innovation in our model of CEO incentives is to include firm fixed effects along with several additional time varying firm and manager characteristics. As reported in table 2, column (3) our model of CEO incentives explains 74% of the variation in CEO delta, where the model in Core and Guay (1999, Table 2) explains about 48% of the variation. This suggests a substantial amount of unobserved firm-level heterogeneity underpinning the incentive choices of firms. We run the following specification:

$$Log(1+NewGrant_{it}) = \alpha + \gamma_1 Delta\ Gap_{i,t-1} + Controls_{i,t-1} + Industry \& Year\ Fixed\ Effects + \varepsilon_{it}, \quad (11)$$

where *New Grant* is computed as the portfolio delta of the subsequent year's grant of stock and options to the CEO, and $Delta\,Gap_{t-1} = Target_{t-1} - Actual\ Delta_{t-1}$. We predict that γ_1 will be negative as firms use equity grants to counteract deviations from target incentives. Our control variables mirror those in Core and Guay (1999), where all of these variables are described in the Appendix and descriptive statistics are reported in Table 1, Panel C.

The results from estimating equation (11) are reported in Table 4. Consistent with Core and Guay (1999), we document that the coefficient on *Delta Gap* is negative and significant using both an OLS and Tobit specification. However, it is key for our purposes to note while these results are consistent with the notion of firms actively managing incentives towards target, it provides no information on whether these adjustments fully restore optimality (i.e., zero adjustment costs) or reflect only partial adjustment (i.e., non-trivial adjustment costs). In the next section we examine this issue more carefully using a partial speed of adjustment framework.

3.3.2 Estimating Partial Speed of Adjustment (SOA) towards target incentives

If shocks push CEO incentives out of alignment, and firms' efforts to counteract these shocks and restore optimality are subject to adjustment costs, we would expect these shocks to only partially dissipate as boards face frictions in managing incentives towards optimality. To explore this, we estimate how much of incentive gap between target delta and actual delta at time t-1 is closed over the subsequent year. Specifically, we use the following specification:

$$CEO\ Delta_t - CEO\ Delta_{t-1} = \alpha + \lambda * (Target\ Delta_{t-1} - Delta_{t-1}) + \varepsilon_t, \quad \text{or} \quad (12a)$$

$$CEO\ Delta_t = \alpha + (1-\lambda) * Delta_{t-1} + \lambda * Target\ Delta_{t-1} + \varepsilon_t, \quad (12b)$$

where $Target\ Delta_{t-1}$ is the estimated target value of *CEO Delta* using data available at time *t*-1 (e.g., equation (9) above). To understand the intuition of this analysis, note that equation (12a) regresses the actual change in *CEO Delta* from *t-1* to *t* on the incentive gap between $Target\ Delta_{t-1}$ and actual *Delta* at *t-1*. The coefficient λ in (12a) is referred to as the speed of adjustment (SOA), and can be interpreted as the proportion of the gap between target and actual CEO incentives at time *t-1* that is closed by the actual change in CEO incentives from year *t-1* to *t* (e.g., Lemmon et al., 2008). Equation (12b) simply rearranges the terms in (12a).

We first adopt the technique developed in Flannery and Rangan (2006) and Lemmon *et al.* (2008) to estimate equation (12b) and examine how much of the incentive gap in year t-1 is closed by the change of incentives from year t-1 to year t. In Panel A of Table 5, we present the results using both OLS regression and system general method of moments (Blundell and Bond, 1998). GMM is used due to potential bias associated with OLS in panel data (Hsiao, 2003). We find that the estimates of SOA using OLS or GMM are close to each other, where SOA is 0.45 (=1-0.547) from OLS and 0.49 (=1-0.51) from GMM. These results provide evidence consistent with the existence of adjustment costs where boards' actively, but only partially, adjust executives' incentives towards the target level.

To facilitate parsimonious presentation of our interaction analyses to follow, we adopt the approach in Faulkender et al. (2012) and use a two-step procedure for estimating speed of adjustment. Specifically, we estimate the specification in equation (12a) using the predicted value of incentives from our estimation of target in Table 2, column (3) to proxy for *Target Delta* at t-1. We again report bootstrapped standard errors to deal with the generated regressor issue. As shown in Table 5, Panel B, we find that estimated SOA (0.453) is similar to the SOA estimates in table 5, Panel A. We next use this two-step specification to explore the properties of the dynamic incentive adjustment process in more depth.

First, we disaggregate the incentive gap and explore whether the speed of adjustment is symmetric for positive and negative gaps. When incentive gap = ($Target\ Delta_{t-1} - CEO\ Delta_{t-1}$) > 0, incentives are deficient and must be increased to meet target and vice versa for excess delta when ($Target\ Delta_{t-1} - CEO\ Delta_{t-1}$) < 0. The results reported in Table 5, Panel C provide evidence that SOA is characterized by asymmetric responses to positive and negative incentives gaps. Specifically, SOA is 0.51 when the gap is positive and 0.39 when the gap is negative, where the difference between these two SOA estimates is statistically significant with p-value of 0.0002 as shown at the bottom of panel C. This suggests that the adjustment is faster when the CEO is under incentivized than when the CEO is over incentivized. It is interesting to compare this result with the analysis in Table 3 which examined the relations between *Deficient* and *Excess Deltas* and firm performance. There we found that the coefficient on *Excess Delta* is substantially greater in absolute magnitude (.155) than the coefficient on *Deficient Delta* (-.022), suggesting that excessive incentives have a larger negative impact on firm value than incentives that are too low.

The relatively greater performance effect of *Excess Delta* is consistent with the relatively slower SOA for *Excess Delta* documented in table 5, panel C.

3.3.3 Cross-sectional variation in Partial Speed of Adjustment (SOA)

In this section we perform cross-sectional analyses to explore whether the partial speed of adjustment is influenced by differences across firms in monitoring intensity, product market competition and CEO tenure. Based on our earlier arguments, we expect SOA to be faster for (1) firms with higher institutional ownership and greater analyst following boards due to greater monitoring discipline associated with these mechanisms; (2) firms facing more intense product market competition due to the discipline of competitive pressure; and (3) firms with CEOs earlier in their tenure as boards seek to adjust misalignments faster to prevent impairment of firm value due to CEO career concerns.

Analyst following is from IBES and institutional ownership is from Reuters 13f. We proxy for product market competition using the total similarity measure from Hoberg and Phillips (2016), which is based on textual analysis of firms'10-K product descriptions. Total similarity is the sum of the pairwise cosine similarities between a given firm's product description and those of all other firms in a given year, where higher values indicate more intense product market competition.[11] CEO tenure is extracted from ExecuComp. Descriptive statistics for these variables are found in Table 1, Panel D. In Panel A of Table 6 we run the following specification:

$$\begin{aligned} Delta_{it} - Delta_{i,t-1} &= \alpha + \lambda * (Target\,Delta_{i,t-1} - Delta_{i,t-1}) \\ &\quad + \lambda_1 (Target\,Delta_{i,t-1} - Delta_{i,t-1}) * CV + \lambda_2 CV + \varepsilon_{it}\,, \end{aligned} \tag{13}$$

where *CV* is one of the cross-sectional variables described above. In table 6, Panel A we find that coefficient λ_1 is positive and statistically significant for all of our cross-sectional variables.

[11] The total similarity data used in our paper was retrieved in July 2017 from the Hoberg-Phillips Data Library (Hoberg and Phillips, 2016.) at http://hobergphillips.usc.edu/industryconcen.htm .

Specifically, we find that SOA is faster when there is higher analyst following and the institutional investor percentage is higher. We also find that SOA is faster when product market is more competitive and when the CEO is in her early tenure with the firm.

In table 6, panel B we refine the cross-sectional analysis by splitting the estimated deviation from target into the components *Deficient* and *Excess Delta*. We run the following specification (previously shown as equation (3)):

$$Delta_t - Delta_{t-1} = \alpha + \lambda_1 Deficient\ Delta_{t-1} * CV + \lambda_2 Excess\ Delta_{t-1} * CV + \beta * CV + \varepsilon_t . \quad (3)$$

Table 6, panel B shows that SOA *Excess Delta* is significantly faster when there is higher analyst following, the institutional investor percentage is higher, product market is more competitive and when the CEO is in her early tenure with the firm. For *Deficient Delta* we find no significant differences in SOA in the cross section.

The analysis in this section documents significant cross-sectional variation in the speed of adjustment. Given that adjustment speed reflects the amount of time that deviations from target persist, we would expect that the negative influence of deviations on firm performance should increase with persistence of the deviation. We examine this in the next section.

3.3.4 Excess versus deficient delta and firm performance: cross sectional variation

In this section, we examine how the influence of incentive gaps on firm performance varies in the cross-section. Specifically, we run specifications of the form (previously shown as equation (4)):

$$Firm\ Performance_t = \alpha + \lambda_1 Deficient\ Delta_{t-1} * CV + \lambda_2 Excess\ Delta_{t-1} * CV + \beta * CV + \varepsilon_t , \quad (4)$$

where firm performance is either *Tobin's Q* or *ROA*. Results are reported in table 7, panels A and B. We find that the negative influence of *Deficient Delta* and *Excess Delta* on firm performance is mitigated for higher analyst following, higher institutional investor percentage, more competitive products markets, and when the CEO is early in her tenure with the firm. This result holds regardless of whether firm performance is measured as *Tobin's Q* or *ROA*. The significant reduction in the negative influence of *Excess Delta* on firm performance is mitigated when there is higher monitoring intensity, competition and career concerns is consistent with our earlier result that SOA is also significantly faster for firms sharing these characteristic. This suggests that the negative influence of deviations from target on firm performance is a function of how long such deviations persist, where persistence decreases in the speed of SOA.

4. Are CEOs' voluntary holdings of unconstrained equity a source of adjustment costs?

In this section, we explore one potential source of adjustment costs that may arise from CEOs voluntarily holding equity above amounts explicitly constrained by ownership guidelines or vesting requirements (Armstrong et al., ACG 2018). While unconstrained holdings are by nature optimal from a CEO's perspective and beyond a firm's control, we hypothesize that these holdings can serve as a source of incentive misalignment from a firm's perspective. As discussed earlier, we follow ACG (2018) who posit that CEOs have incentives to hold excess equity when they are overconfident, when they want to signal private information, and when they have informed trading motivations. Following ACG (2018), we estimate CEO overconfidence as the sensitivity of investment to cash flow, γ_i, for each CEO from the following regression (previously shown as equation (5):

$$Investment_{i,t+1} = \gamma_0 + \gamma_i Cash\,Flow_{i,t+1} + \gamma_1 Book\text{-}To\text{-}Market_{i,t} + Controls_{i,t} + \varepsilon_{i,t+1} \quad . \qquad (5)$$

In (5), Investment is annual capital expenditures (Compustat Item CAPX), scaled by beginning-of-the-year capital (PPENT), and Cash Flow is earnings before extraordinary items (IB) plus depreciation (DP) scaled by beginning-of-the-year capital. We use corporate share repurchases as a proxy for the CEO's beliefs about the firm's value. Finally, we proxy for informed trading motives by future excess returns. All variables are described in detail in the Appendix.

Similar to our earlier cross-sectional analysis, we estimate the following two specifications (previously shown as equations (6) and (7)):

$$Delta_t - Delta_{t-1} = \alpha + \lambda_1 Deficient\ Delta_{t-1} * DV + \lambda_2 Excess\ Delta_{t-1} * DV + \beta * DV, \text{ and} \quad (6)$$

$$Firm\ Performance_t = \alpha + \lambda_1 Deficient\ Delta_{t-1} * DV + \lambda_2 Excess\ Delta_{t-1} * DV + \beta * DV. \quad (7)$$

In equations (6) and (7), DV is the determinant variable of voluntary equity holdings, either investment to cash flow sensitivity (CEO overconfidence), share repurchases (signaling) or future excess returns (informed trading motivation).

Results from running equations (6) and (7) are reported in table 8. Table 8, panel A shows that SOA is slower (faster) for excess (deficient) incentives when CEOs are more overconfident and for CEOs with higher signaling incentives. This result is consistent with the CEOs with greater incentives to hold unconstrained equity being more resistant to reductions in their excess equity holdings, and those with deficient incentives being more eager to build up equity holdings.

To the extent that CEOs holdings of unconstrained equity are not in alignment with the preferences of the firm owners, we hypothesize that the slower (faster) SOA for excess (deficient) incentives related to incentives for holding unconstrained equity would result in excess (deficient) incentives having a more (less) negative influence on firm performance. That is, the more persistent excess holdings will be associated with greater negative performance while the less persistent deficient incentives will be associated with a reduced negative impact. Table 8, panels B and C reports results consistent with the hypothesis. Specifically, we find that firm performance (*Tobin's Q, ROA*) is worse (better) for excess (deficient) incentives for more overconfident CEOs and those with higher signaling incentives. That is performance is worse (better) in the same settings where speed of adjustment is slower (faster). However, we find no results for informed trading motivations.

5. Summary

A common and well accepted view in the academic literature is that incentive contracts are always at optimal equilibrium levels because it is assumed that firms can continuously and completely counteract shocks that cause deviations from optimal (e.g., Demsetz and Lehn, 1985). In contrast, in this paper we investigate whether adjustment cost frictions impede firms from achieving value-maximizing levels of CEO equity incentives and degrade firm performance by sustaining deviations from targeted incentive levels. Specifically, we explore the dynamic adjustment process of CEO incentives and examine implications of speed of adjustment to target for firm performance.

Consistent with adjustment frictions sustaining a wedge between target and actual incentives, we find that firm performance decreases in deviations from target incentives, and that firms' active management of incentives towards target only partially closes the gap between target and realized incentives. We then disaggregate deviations from target into excess and deficient components. We find that while adjustment speed is slower for excess relative to deficient incentives, relative adjustment speed for excess incentives increases significantly for firms with higher monitoring intensity, product competition, and CEO career concerns, and that for such firms performance degradation associated with deviations from target is mitigated.

We also provide evidence that when CEOs have greater incentives to voluntarily hold unconstrained equity, excess (deficient) incentives have slower (faster) adjustment speed and greater (lower) negative influence on firm performance. This evidence suggests that CEOs' voluntarily holding of unconstrained equity is a source of adjustment costs.

References

Ali, A., Zhang, W., 2015. CEO tenure and earnings management. Journal of Accounting and Economics 59, 60-79.

Armstrong, C., Jagolinzer, A., Larcker, D., 2010. Chief executive officer equity incentives and accounting irregularities. Journal of Accounting Research 48, 225–271.

Armstrong, C., Core, J., Guay, W., 2018. Why do CEOs hold equity? Working paper, Wharton and MIT.

Armstrong, C., Vashishtha, R., 2012. Executive stock options, differential risk-taking incentives, and firm value. Journal of Financial Economics 104 (1), 70-88.

Barber, B., 2007. Monitoring the monitor: Evaluating CalPERS' activism. Journal of Investing (Winter), 66-80.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87 (1), 115-143.

Brav, A., Harvey, C., Graham, J., Michaely, R., 2005. Payout policy in the 21st century. Journal of Financial Economics. 77 (3), 483-527.

Bushee, B., 1998. Institutional investors, long term investment, and earnings management. The Accounting Review 73 (3), 305–33.

Bushman, R.M., Dai, Z., Zhang, W., 2016. Management team incentive dispersion and firm performance. Accounting Review 91 (1), 21-45.

Burns, N., Kedia, S., 2006. The impact of performance-based compensation on misreporting. Journal of Financial Economics 79 (1), 35-67.

Chen, X., Harford, J., Li, K., 2007. Monitoring: Which institutions matter? Journal of Financial Economics 86, 279-305.

Cheung, A., Wei, J., 2006. Insider ownership and corporate performance: Evidence from the adjustment cost approach. Journal of Corporate Finance 12, 906-925.

Core, J., Guay, W., 1999. The use of equity grants to manage optimal equity incentive levels. Journal of Accounting and Economics 28, 151-184.

Core, J., Guay, W., 2002. Estimating the value of employee stock option portfolios and the sensitivities to price and volatility. Journal of Accounting Research 40, 613–630.

Core, J., Guay, W., Larcker, D., 2003. Executive equity compensation and incentives: A survey. Economic Policy Review (Apr), 27–50.

Core, J., Guay, W., Richardson, S., Verdi, R., 2006. Stock market anomalies: What can we learn from repurchases and insider trading? Review of Accounting Studies 11 (1), 49-70.

Core, J., Larcker, D., 2002. Performance consequences of mandatory increases in executive stock ownership. Journal of Financial Economics 64 (3), 317-340.

Dechow, P., Sloan, R.G., 1991. Executive incentives and the horizon problem: An empirical investigation. Journal of Accounting and Economics 14 (1), 51-89

Demsetz, H., 1983. The structure of ownership and the theory of the firm. Journal of Law and Economics 26, 375–390.

Demsetz, H., Villalonga, B., 2001. Ownership structure and corporate performance. Journal of Corporate Finance 7, 209–233.

Demsetz, H., Lehn, K., 1985. The structure of corporate ownership: Causes and consequences. Journal of Political Economy, 1155-1177.

Dittmann, I., Maug, E., 2007. Lower Salaries and No Options? On the Optimal Structure of Executive Pay. Journal of Finance LXII (1), 303-343.

Dittmar, A., Field, L., 2001. Can managers time the market? Evidence Using repurchase price data. Journal of Financial Economics 115 (2), 261-282.

Edmans A., Gabaix X., Jenter D., 2017. Executive compensation: A survey of theory and evidence. In Hermalin, B.E.; Weisbach, M.S. (eds.) Handbook of the economics of corporate governance, Volume 1, Elsevier.

Fahlenbrach, R., Stulz, R., 2009. Managerial ownership dynamics and firm value. Journal of Financial Economics 92, 342–361.

Faulkender, M.W., Flannery, M.J., Hankins, K.W., Smith, J.M., 2012. Cash flows and leverage adjustments. Journal of Financial Economics 103, 632–646.

Flannery, M., Ragan, K., 2006. Partial adjustment toward target capital structures. Journal of Financial Economics 79, 469–506.

Fama, E., 1980. Agency problems and the theory of the firm. Journal of Political Economy 88 (2), 288-307.

Gibbons, R., Murphy, K., 1992. Optimal incentive contracts in the presence of career concerns: Theory and evidence. Journal of Political Economy 100, 468-505.

Giroud, X., Mueller, H.M., 2011. Corporate governance, product market competition, and equity prices. Journal of Finance 66 (2), 563–600.

Guay, W., 1999. The sensitivity of CEO wealth to equity risk: an analysis of the magnitude and determinants. Journal of Financial Economics 53 (1), 43-71.

Hartzell, J. C., Starks, L.T. 2003. Institutional investors and executive compensation. Journal of Finance 58 (6), 2351–2374.

Healy, P., Palepu, K., 2001. Information asymmetry, corporate disclosure, and the capital markets: A review of the empirical disclosure literature. Journal of Accounting and Economics 31, 405–440.

Hermalin, B., Weisbach, M., 2003. Boards of directors as an endogenously determined institution: A survey of the economic literature. FRBNY Economic Policy Review (April), 7-26.

Himmelberg, C., Hubbard, R., Palia, D. 1999, Understanding the determinants of managerial ownership and performance, Journal of Financial Economics 53, 333–384.

Hoberg, G., Phillips, G., 2016. Text-based network industries and endogenous product differentiation. Journal of Political Economy 124 (5), 1423-1465.

Holmström, B., 1999. Managerial incentive problems: A dynamic perspective. Review of Economic Studies 66 (1), 169–182.

Hsiao, C., 2003. Analysis of Panel Data. Cambridge University Press.

Huddart, S., Lang, M., 1996. Employee stock option exercises an empirical analysis. Journal of Accounting and Economics 21 (1), 5-43.

Jagannathan, R., Srinivasan, S., 1999. Does product market competition reduce agency costs? The North American Journal of Economics and Finance 10 (2), 387-399.

Jensen, M., 1986. Agency costs of free cash flow, corporate finance, and takeovers. American Economic Review 76, 323-329.

Jensen M., Meckling W., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics 3, 305-360.

Jin, L., 2002. CEO Compensation, diversification, and incentives, Journal of Financial Economics 66, 29-63.

Kale, J., Reis, E., Venkateswaran, A., 2009. Rank-order tournaments and incentive alignment: The effect on firm performance. Journal of Finance 64, 1479-1512.

Lemmon, M.L., Roberts, M.R., Zender, J.F., 2008. Back to the beginning: Persistence and the cross-section of corporate capital structure. Journal of Finance LXIII (4), 1575-1608.

Li, Y., 2002. Maintaining Optimal CEO incentives through equity grants and CEO portfolio rebalancing. Working paper, MIT.

Malmendier, U., Tate, G., 2005. CEO overconfidence and corporate investment. Journal of Finance 60, 2661-2700.

Morck, R., Shleifer, A., Vishny, R. 1988. Management ownership and market valuation: An empirical analysis. Journal of Financial Economics 20, 293–315.

Ofek, E., Yermack, D., 2000. Taking Stock Equity Based Compensation and Evolution of Managerial Compensation. Journal of Finance 58, 1367-1384.

Pagan, A., 1984. Econometric issues in the analysis of regressions with generated regressors. International Economic Review 25, 154–193.

Peng, L., Röell, A., Tang, H., 2016. CEO incentives: Measurement, determinants, and impact on performance. Working paper, Columbia University.

Scherer, F.M., 1980. Industrial market structure and economic performance. Rand McNally College Pub. Co.

Smith, C., Watts, R., 1992. The investment opportunity set and corporate financing, dividends, and compensation policies. Journal of Financial Economics 32, 263-292.

Stulz, R., 1990. Managerial discretion and optimal financing policies. Journal of Financial Economics 26, 3–27.

Tong, Z., 2008. Deviation from optimal CEO ownership and firm value. Journal of Banking and Finance 32, 2462–2470.

Villalong, B., Amit, R., 2006. How do family ownership, control and management affect firm value? Journal of Financial Economics 80 (2), 385-417.

Yu, F., 2008. Analyst coverage and earnings management. Journal of Financial Economics 88, 245-271.

Appendix: Variable Definition and Measurement

Dependent Variables:	
Delta	Natural logarithm of (Delta+1) where Delta is estimated following Core and Guay (1999) model.
New Grants	Delta of the annual grant of stock and options to CEO.
ROA	Return on asset, income before extraordinary items scaled by lagged total asset.
Tobin's Q	Measured as ((Total asset – Book value of equity + Market value of equity)/ Total asset)
Independent Variables:	
Advertising to Capital	Advertising expense divided by Net of PP&E.
Analyst Following	Number of analysts who follow a firm.
BM	Book-to-market ratio of equity.
Capital	Net of PP&E scaled by total asset.
Capital to Sales	Net of PP&E scaled by sales.
Cash	Cash holding scaled by total asset.
Cash Flow Shortfall	Three-year average of [(common and preferred dividends + cash flow from investing - cash flow from operations) / total assets].
CEO Cash Compensation	CEO's cash compensation, including salary and bonus.
CEO Diversification	$\frac{CEO's\ Firm\ specific\ wealth}{CEO's\ Total\ wealth}$, where CEO's non-firm wealth is estimated following Dittmann and Maug (2007).
CEO Tenure	CEO's tenure in a firm.
Cumulative Return	Annual buy-and-hold returns excess over equal-weighed market return starting from the month after CEO takes the position, and ending in fiscal year t.
Delta Gap	Predicted delta using information available at t-1 based on column (3) of Table 2 (i.e., $Target\ Delta_{t-1}$) minus actual Delta at t-1. That is: $Target\ Delta_{t-1} - Actual\ Delta_{t-1}$
Deficient (Excess) Delta	Equal to Delta Gap when Delta Gap > 0 (< 0), and zero otherwise. Deficient (Excess) Delta Gap is posited to capture the extent to which a CEO's Delta is too low (high) relative to target Delta.
Dividend Constraint	Dummy variable that equals to one if the firm is dividend constrained in any of the three years prior to the year the new equity grant is awarded, and zero otherwise. Following Core and Guay (1999), we categorize a firm as dividend constrained if [(retained earnings at year-end cash dividends and stock repurchases during the year)/the prior year's cash dividends and stock repurchases], is less than two. If the denominator is zero for all three years, we also categorize the firm as dividend constrained.
Dividend Yield	The dividends per share ex-date divided by close price for the fiscal year.
Early CEO Tenure	Dummy variable which equals one if it is the first 3 years of CEO tenure with the firm, and zero otherwise.

Excess Return	Annual buy-and-hold returns excess over equal-weighed market return starting 3 months after the firm's fiscal year t end in t+1.
Firm Size	Natural logarithm of market capitalization.
Free Cash Flow Problem	Three-year average of [(cash flow from operations minus common and preferred stock dividends)/total assets], if the firm's book-to-market assets ratio is greater than one; otherwise, it is zero.
High Analyst Following	Dummy variable which equals one if Analyst Following is above median of the sample, and zero otherwise.
High Institution Ownership	Dummy variable which equals one if Institutional Ownership is above median of the sample, and zero otherwise.
Idiosyncratic Risk	Standard deviation of the residual from a market model regression estimated over the fiscal year with daily returns.
Industry Homogeneity	Mean partial correlation between firm's returns and an equally weighted industry index, for all firms in the same two-digit SIC industry code, holding market return constant (see Parrino 1997), estimated based on 60 monthly returns prior to sample year.
Institution Ownership	Percentage of outstanding shares held by the institutional investors.
Investment-to-cash-flow Sensitivity	Following Malmendier and Tate (MT, 2005), we estimate: $Investment_{i,t+1} = \gamma_0 + \gamma_i\ Cash\ Flow_{i,t+1} + \gamma_1\ Book\text{-}to\text{-}market_{i,t} + Controls_{i,t} + \varepsilon_{i,t+1}$ We calculate *Investment* as annual capital expenditures (Compustat Item *CAPX*), scaled by beginning-of-the-year capital (*PPENT*), and *Cash Flow* as earnings before extraordinary items (*IB*) plus depreciation (*DP*) scaled by beginning-of-the-year capital. The model is estimated using a random coefficient regression that allows γ_i to take a different value for each CEO. The estimated coefficient measures cash flow sensitivity (*Investment-to-Cash-Flow Sensitivity*) for each of the sample CEOs. Consistent with MT, the control variables include CEO stock ownership, number of CEO vested options, log of market value, year effect, industry effects, and interaction of cash flow with all above variables.
Leverage	Financial leverage, measured as total liability divided by total asset.
Log (Sales)	Natural logarithm of sales
NOL	Net operating loss, a dummy variable which equals one if operating income after depreciation is negative for any of the previous three years, and zero otherwise.
Product Market Competition	Total similarity measure from Hoberg and Phillips (2016) based on text-based analysis of firms'10-K product descriptions. Computed as the sum of the pairwise cosine similarities between the given firm's product description and those of all other firms in the given year. Higher values of total similarity indicate that a firm faces more intense product market competition in a given year.
R&D to Capital	Research & development expenditure divided by net of PP&E.
Return	Annual buy-and-hold return.
Return Volatility	Variance of 60 monthly returns preceding sample year.
Stock Repurchase	Change of treasury stocks, scaled by market capitalization at the beginning of year t.

Table 1 Summary Statistics

This table reports the summary statistics for all variables used in this study. Depending on the analyses, we have four different samples: panel A is for the sample used in estimating target levels of CEO delta (Table 2); panel B is for the sample used for the analysis of relation between deviations from optimal CEO delta and Tobin's Q/ROA (Table 3); panel C is for the sample used in the dynamic adjustment of CEO incentives analyses (Tables 4 and 5) and panel D is for the sample used in the rest of the tables. The sample period covers 1992 to 2015 for most of the variables except for board independence (1999-2013). All continuous variables are winsorized at 1% and 99%. See Appendix for variable definition and measurement.

Panel A: Sample used to estimate the target levels of CEO delta (Table 2)

	Mean	Std. Dev.	Median	Q1	Q3
CEO PPS (Raw)$_t$	1144.2	10873.7	66.4	180.7	514.7
Log(CEO Delta)$_t$	7.527	1.600	6.408	7.411	8.527
Firm Size$_{t-1}$	7.527	1.600	7.411	6.408	8.527
BM$_{t-1}$	0.542	0.439	0.458	0.284	0.684
Log(idiosyncratic risk)$_{t-1}$	-3.954	0.496	-3.973	-4.318	-3.614
Log (CEO Tenure)$_t$	2.099	0.587	2.079	1.609	2.485
Log (CEO Cash Compensation +1)$_{t-1}$	6.785	0.841	6.779	6.386	7.169
Cash$_{t-1}$	0.136	0.162	0.071	0.022	0.194
Return$_{t-1}$	0.193	0.643	0.121	-0.097	0.356
ROA$_{t-1}$	0.045	0.107	0.047	0.017	0.085
Leverage$_{t-1}$	0.534	0.211	0.547	0.385	0.684
Capital$_{t-1}$	0.269	0.239	0.197	0.076	0.409
Free Cash Flow Problem$_{t-1}$	0.080	0.091	0.077	0.036	0.122
Cumulative_return$_{t-1}$	-0.007	0.114	0.000	0.000	0.000
CEO Diversification$_{t-1}$	-0.582	0.644	-0.430	-0.862	-0.134

Panel B: Analysis of deviations from optimal CEO delta and firm performance (Table 3)

	Mean	Std. Dev.	Median	Q1	Q3
Tobin's Q	1.889	1.277	1.491	1.153	2.137
ROA	0.039	0.105	0.046	0.015	0.083
Deficient Delta$_{t-1}$	0.234	0.519	0.000	0.000	0.286
Excess Delta$_{t-1}$	-0.230	0.390	-0.023	-0.330	0.000
R&D to Capital$_{t-1}$	0.379	2.229	0.000	0.000	0.182
Industry Homogeneity$_{t-1}$	0.214	0.112	0.184	0.126	0.296
Firm Size$_{t-1}$	7.389	1.593	7.295	6.294	8.436
Firm Size$^2_{t-1}$	57.142	24.185	53.211	39.609	71.159
Return Volatility$_{t-1}$	0.018	0.031	0.011	0.006	0.020
Capital to Sales$_{t-1}$	0.453	0.816	0.202	0.108	0.427
Leverage$_{t-1}$	0.212	0.166	0.202	0.063	0.327
Advertising to Capital$_{t-1}$	0.100	0.601	0.000	0.000	0.042
Dividend Yield$_{t-1}$	0.015	0.030	0.008	0.000	0.022
Tobin's Q$_{t-1}$	1.926	1.495	1.500	1.157	2.159
ROA$_{t-1}$	0.044	0.107	0.048	0.018	0.085

Panel C: For the Tables on Dynamic Adjustment of CEO Incentives Adjustment Sample (Tables 4 & 5)

	Mean	Std. Dev.	Median	Q1	Q3
Log (New Grant + 1)	2.788	1.623	3.012	1.778	3.975
Delta Gap_{t-1}	-0.003	0.731	-0.025	-0.338	0.285
Log $(Sales)_{t-1}$	7.368	1.555	7.272	6.272	8.412
BM_{t-1}	0.670	0.263	0.676	0.470	0.872
NOL_{t-1}	0.133	0.339	0.000	0.000	0.000
Cash flow $shortfall_{t-1}$	-0.162	0.116	-0.152	-0.227	-0.090
Dividend $constraint_{t-1}$	0.430	0.495	0.000	0.000	1.000
$Return_{t-1}$	0.150	0.443	0.106	-0.112	0.340

Panel D: For the Rest of Tables

	Mean	Std. Dev.	Median	Q1	Q3
Change of Delta	-0.051	1.046	0.093	-0.255	0.388
Delta Gap	-0.020	0.648	-0.032	-0.333	0.272
Deficient Delta	0.208	0.428	0.000	0.000	0.272
Excess Delta	-0.228	0.376	-0.032	-0.333	0.000
Analyst Following	9.854	7.867	8.000	3.909	14.455
Institution Ownership	0.686	0.261	0.739	0.565	0.865
CEO Tenure	9.607	6.437	8.000	5.000	12.000
Early CEO Tenure	0.050	0.218	0.000	0.000	0.000
Product Market Competition	4.491	7.321	2.147	1.340	4.282
Stock Repurchase	0.007	0.076	0.000	0.000	0.008
Positive Stock Repurchase	0.379	0.485	0.000	0.000	1.000
Investment-to-Cash-Flow Sensitivity	-0.003	0.069	-0.009	-0.041	0.026
Excess Return	0.0047	0.5539	-0.0316	-0.2397	0.1738

Table 2 Estimating Target Levels of CEO Delta

In this table we estimate CEOs' optimal Delta by regressing CEO Delta on lagged determinants of CEO equity incentives. The sample period covers 1992 to 2015. The OLS regressions are estimated clustered by firm. See Appendix for variable definition and measurement.

Dependent Variable =	CEO Delta $_t$							
	(1)		(2)		(3)		(4)	
	estimate	t-value	estimate	t-value	estimate	t-value	estimate	t-value
Intercept					0.573	1.83	-2.600	-8.61
Firm Size$_{t-1}$					0.435	15.73	0.568	31.10
BM$_{t-1}$					0.000	0.01	-0.064	-1.84
Log(idiosyncratic risk)$_{t-1}$					0.133	3.40	0.255	6.30
Log (CEO Tenure)$_t$					0.676	24.63	0.834	29.96
Log (CEO Cash Compensation +1)$_{t-1}$					0.044	1.37	0.061	1.88
Cash$_{t-1}$					0.127	0.90	0.269	1.79
Return$_{t-1}$					0.048	3.68	0.039	2.87
ROA$_{t-1}$					0.122	1.22	0.069	0.66
Leverage$_{t-1}$					-0.049	-0.39	-0.044	-0.42
Capital$_{t-1}$					-0.150	-0.78	-0.346	-3.25
Free Cash Flow Problem$_{t-1}$					0.869	6.33	1.395	9.25
Cumulative_return$_{t-1}$					-0.235	-2.04	-0.213	-1.88
CEO Diversification$_{t-1}$					0.724	29.05	0.775	27.97
Firm fixed effects	No		Yes		Yes		No	
Industry fixed effects	No		No		No		Yes	
Year fixed effects	Yes		Yes		Yes		Yes	
R^2	0.0990		0.6820		0.7397		0.5836	
N	22,616		22,616		22,616		22,616	

Table 3 Delta Gap and Firm Performance

In this we examine whether deficient incentives and excess incentives differentially influence firm performance (Tobin's Q and ROA). Deficient Delta = Delta Gap when Delta Gap > 0 (i.e., $Target_{t-1}$ > Actual $Delta_{t-1}$), and equals zero otherwise. Excess Delta equals Delta Gap when Delta Gap < 0 (i.e., $Target_{t-1}$ < Actual $Delta_{t-1}$), and zero otherwise. Delta Gap = Target $Delta_{t-1}$ minus actual $Delta_{t-1}$, where Target $Delta_{t-1}$ is estimated in column (3) of Table 2 using information available at t-1. The sample period covers 1992-2015. See the appendix for variable definition and measurement. The OLS regressions are estimated clustered by firm. Standard errors are bootstrapped to account for generated regressors.

Dependent =	Tobin's Q_t		ROA_t	
	estimate	t-value	estimate	t-value
Intercept	0.661	3.03	-0.167	-6.51
Deficient $Delta_{t-1}$	-0.022	-1.99	-0.005	-3.38
Excess $Delta_{t-1}$	0.155	7.64	0.005	2.68
R&D to $Capital_{t-1}$	0.005	1.03	-0.001	-1.32
Industry $Homogeneity_{t-1}$	-0.097	-1.33	-0.020	-2.01
Firm $Size_{t-1}$	0.003	0.09	0.044	7.07
Firm $Size^2_{t-1}$	0.000	0.17	-0.002	-6.51
Return $Volatility_{t-1}$	-0.522	-2.20	-0.158	-1.42
Capital to $Sales_{t-1}$	0.022	1.43	-0.006	-3.98
$Leverage_{t-1}$	-0.247	-3.88	-0.033	-4.53
Advertising to $Capital_{t-1}$	0.017	1.89	0.000	0.28
Dividend $Yield_{t-1}$	0.120	0.36	-0.075	-1.10
Tobin's Q_{t-1}	0.600	11.79	0.011	4.51
ROA_{t-1}	0.548	2.34	0.419	12.87
Industry Fixed Effect	Yes		Yes	
Year Fixed Effect	Yes		Yes	
R^2	0.6144		0.3585	
N	19,182		19,182	

Table 4 Firms' Active Management of CEO Incentives: New Equity Grants and Delta Gap

In this table we examine relations between future equity grants to CEOs by boards of directors and Delta Gap. *New Grant* = the delta of the annual grant of stock and options to CEO. Delta Gap = predicted delta using information available at t-1 based on column (3) of Table 2 minus actual delta at t-1. Both columns (1) and (2) replicate the main results in Core and Guay (1999) over a different time frame while column (1) uses OLS and column (2) uses Tobit to take care of truncation problem associated with zero grants. The sample period covers 1992-2015. See appendix for variable definition and measurement. The OLS regressions are estimated clustered by firm. Standard errors are bootstrapped to account for generated regressors.

Dependent Variable =	Log (New Grant + 1)			
	OLS		Tobit	
	(1)		(2)	
	estimate	t-value	estimate	t-value
Intercept	-0.938	-4.34	-0.882	-5.37
Delta Gap_{t-1}	0.056	2.75	0.077	4.90
Log $(Sales)_{t-1}$	0.507	30.82	0.552	66.35
BM_{t-1}	-0.464	-11.36	-1.022	-18.52
NOL_{t-1}	0.133	2.88	0.092	2.45
Cash Flow $shortfall_{t-1}$	-0.369	-2.12	-0.113	-0.97
Dividend $constraint_{t-1}$	0.095	2.63	0.111	4.49
$Return_{t-1}$	0.306	10.96	0.064	2.15
Industry fixed effects	Yes		Yes	
Year fixed effects	Yes		Yes	
Pseudo R^2 / R^2	0.3049		0.0829	
N	20,126		20,126	

Table 5 Dynamic Adjustment of CEO Incentives: Speed of Adjustment

In this table, we examine the dynamic adjustment of the CEO delta by examining speed of adjustment (SOA). Panel A estimates SOA for CEO incentives using both an OLS and a System GMM specifications, where estimated SOA is given by 1 minus the coefficient on CEO Delta; in panel B we follow Faulkender et al. (2012) and estimate SOA with OLS by first computing the gap between target and actual Delta at year t-1 (Delta Gap = Target-Delta Gap) using the predicted value of Delta from Table 2, column 3 to proxy for target Delta at t-1. Estimated SOA is given by the coefficient on Delta Gap. In panel C we use the Faulkender et al. (2012) OLS specification to consider how SOA varies differentially for deficient incentives relative to excess incentives. Deficient Delta = Delta Gap when Delta Gap > 0 (i.e., $Target_{t-1}$ > Actual $Delta_{t-1}$), and equals zero otherwise. Excess Delta equals Delta Gap when Delta Gap < 0 (i.e., $Target_{t-1}$ < Actual $Delta_{t-1}$), and zero otherwise. The sample period covers 1992-2015. See appendix for variable definition and measurement. The OLS regressions are estimated clustered by firm. Standard errors are bootstrapped to account for generated regressors.

Panel A: Speed of adjustment using OLS and System GMM specifications: $Delta_t = (1-\lambda) * Delta_{t-1} + Controls + \varepsilon_t$ *, where* λ *= Speed of Adjustment.*

Dependent Variable =	CEO $Delta_t$			
	OLS		GMM	
	(1)		(2)	
	estimate	t-value	estimate	t-value
CEO $Delta_{t-1}$	0.547	28.76	0.510	18.53
Firm Size	0.065	3.16	-0.448	-12.45
BM_{t-1}	0.057	2.20	-0.027	-0.79
Log(idiosyncratic risk) $_{t-1}$	0.094	3.27	0.041	1.07
Log (CEO Tenure) $_{t-1}$	0.255	10.77	0.205	5.17
Log (CEO Cash Compensation +1) $_{t-1}$	0.044	2.11	0.013	0.64
$Cash_{t-1}$	0.263	2.66	0.430	3.17
$Return_{t-1}$	0.020	1.89	0.007	0.51
ROA_{t-1}	-0.077	-0.96	-0.140	-1.27
$Leverage_{t-1}$	-0.067	-0.71	-0.320	-2.40
$Capital_{t-1}$	-0.049	-0.37	-0.115	-0.52
Free Cash Flow $Problem_{t-1}$	0.890	7.59	0.424	3.16
$Cumulative\_return_{t-1}$	-0.162	-1.99	-0.038	-0.22
CEO $Diversification_{t-1}$	0.579	27.42	0.807	42.19
Firm fixed effects	Yes		Yes	
Year fixed effects	Yes		Yes	
R^2	0.7923			
N	17,859		17,859	

Panel B: Speed of Adjustment using the Faulkender et al. (2012) OLS specification: $Delta_t - Delta_{t-1} = \alpha + \lambda * (Target\ Delta_{t-1} - Actual\ Delta_{t-1})$ *where* λ *= Speed of Adjustment.*

Dependent Variable =	Change of Delta	
	estimate	t-value
Intercept	-0.042	-8.11
Delta Gap	0.453	21.72
R^2	0.0788	
N	17,859	

Panel C: Speed of Adjustment using Faulkender et al. (2012) specification $Delta_t - Delta_{t-1} = \alpha + \lambda_1 Deficient\ Delta\ Gap_{t-1} + \lambda_2 Excess\ Delta\ Gap_{t-1}$ *where* λ_1 (λ_2) *= Speed of Adjustment for Deficient (Excess) Delta Gap.*

Dependent Variable =	Change of Delta	
	estimate	t-value
Intercept	-0.068	-6.29
Deficient Delta (λ_1)	0.505	18.04
Excess Delta (λ_2)	0.389	11.14
p-value for testing $\lambda_1 = \lambda_2$	0.0002	
R^2	0.0795	
N	17,859	

Table 6 Speed of Adjustment and Cross Sectional Variation in Monitoring Intensity, CEO Tenure, and Product Market Competition

In this table, we examine how cross sectional variations in monitoring intensity, CEO tenure, and product market competition affects the dynamic adjustment of CEO incentives as captured by the partial speed of adjustment (SOA). Specifically, we perform an interaction analysis in which Delta Gap is interacted with five cross sectional variables: analyst following, institutional ownership, CEO tenure and product market competition. In panel A, we interact Delta Gap with four cross sectional variables: analyst following, institutional ownership, CEO tenure and product market competition. Delta Gap = predicted delta using information available at t-1 based on column (3) of Table 2 minus actual delta at t-1. In panel B we separately examine cross-sectional effects separately for deficient incentives and excess incentives. Deficient Delta = Delta Gap when Delta Gap > 0 (i.e., $Target_{t-1}$ > Actual $Delta_{t-1}$), and equals zero otherwise. Excess Delta equals Delta Gap when Delta Gap < 0 (i.e., $Target_{t-1}$ < Actual $Delta_{t-1}$), and zero otherwise. The sample period covers 1992-2015. See appendix for variable definition and measurement. The OLS regressions are estimated clustered by firm. Standard errors are bootstrapped to account for generated regressors.

Panel A: Speed of Adjustment and Cross Sectional Variation in Monitoring Intensity, CEO Tenure, and Product Market Competition

Dependent Variable =	Change of Delta							
	(1)		(2)		(3)		(4)	
	estimate	t-value	estimate	t-value	estimate	t-value	estimate	t-value
Intercept	0.043	5.70	-0.011	-1.20	0.008	1.40	0.066	8.67
Delta Gap	0.366	16.20	0.383	14.17	0.340	17.81	0.273	10.37
Delta Gap * CV	0.157	4.75	0.111	3.27	0.128	2.44	0.232	5.98
CV	0.006	0.53	-0.005	-0.41	0.017	0.54	-0.043	-3.83
Cross sectional variable (CV)	High Analyst Following		High Institution Ownership		Early CEO Tenure		Product Market Competition	
R^2	0.1034		0.0793		0.0632		0.0923	
N	17,859		17,859		17,859		16,286	

Panel B: Speed of Adjustment and Cross Sectional Variation in Monitoring Intensity, Monitoring Intensity, CEO Tenure, and Product Market Competition: Deficient vs. Excess incentives

Dependent Variable =	Change of Delta							
	(1)		(2)		(3)		(4)	
	estimate	t-value	estimate	t-value	estimate	t-value	estimate	t-value
Intercept	-0.067	-5.72	-0.102	-7.03	-0.094	-10.03	-0.046	-3.53
Deficient Delta	0.575	16.45	0.551	14.74	0.553	18.54	0.484	11.67
Excess Delta	0.075	3.39	0.170	5.26	0.069	3.79	-0.04	-1.98
Deficient Delta * CV	-0.046	-0.95	-0.094	-1.52	-0.108	-1.45	0.05	0.93
Excess Delta * CV	0.443	8.66	0.370	6.48	0.431	3.5	0.513	9.04
CV	0.113	6.68	0.103	5.06	0.136	2.89	0.055	2.84
Cross sectional variable (CV)	High Analyst Following		High Institution Ownership		Early CEO Tenure		Product Market Competition	
R^2	0.1132		0.0848		0.0777		0.1027	
N	17,859		17,859		17,859		16,286	

Table 7 Excess versus Deficient Delta and Firm Performance: Cross Sectional Variation in Monitoring Incentives, CEO Tenure, and Product Market Competition

In this table we further examine how cross sectional variations in monitoring intensity affect the relation between Delta Gap and Tobin's Q/ROA. Delta Gap = predicted delta using information available at t-1 based on column (4) of Table 2 minus actual delta at t-1. Deficient Delta = Delta Gap when Delta Gap > 0 (i.e., $Target_{t-1}$ > Actual $Delta_{t-1}$), and equals zero otherwise. Excess Delta equals Delta Gap when Delta Gap < 0 (i.e., $Target_{t-1}$ < Actual $Delta_{t-1}$), and zero otherwise. The four cross sectional variables are analyst following, institutional ownership, CEO tenure and product market competition. In panel A, we consider Tobin's Q as performance measure and in Panel B, we consider ROA as performance measure. Controls are omitted for brevity and they are the same as those included in Table 3. The sample period covers 1992-2015. See the appendix for variable definition and measurement. The OLS regressions are estimated clustered by firm. Standard errors are bootstrapped to account for generated regressors.

Panel A: Tobin's Q: Cross Sectional Variation in Monitoring Intensity

Dependent Variable =	Tobin's Q							
	(1)		(2)		(3)		(4)	
	estimate	t-value	estimate	t-value	estimate	t-value	estimate	t-value
Intercept	1.613	3.15	1.334	2.92	1.340	3.03	1.321	3.07
Deficient Delta (β_1)	-0.036	-2.11	-0.044	-2.31	-0.042	-2.33	-0.041	-2.20
Excess Delta (β_2)	0.142	2.75	0.141	3.97	0.135	3.76	0.099	2.24
Deficient Delta * CV (β_3)	0.057	2.18	0.062	2.50	0.059	2.10	0.055	2.24
Excess Delta * CV (β_4)	-0.165	-2.51	-0.203	-3.21	-0.120	-2.92	-0.161	-2.38
Controls & CV	Yes		Yes		Yes		Yes	
Cross sectional variable (CV)	High Analyst Following		High Institution Ownership		Early CEO Tenure		Product Market Competition	
p-value for testing $\beta_1 = -\beta_3$	0.284		0.333		0.480		0.431	
p-value for testing $\beta_2 = -\beta_4$	0.341		0.104		0.629		0.057	
R^2	0.5841		0.5714		0.5678		0.5704	
N	19,182		19,182		19,182		16,018	

Panel B: ROA: Cross Sectional Variation in Monitoring Intensity

Dependent Variable =	ROA							
	(1)		(2)		(3)		(4)	
	estimate	t-value	estimate	t-value	estimate	t-value	estimate	t-value
Intercept	-0.127	-4.88	-0.150	-5.63	-0.135	-5.47	-0.122	-5.69
Deficient Delta (β_1)	-0.007	-3.33	-0.006	-2.80	-0.006	-3.63	-0.005	-2.64
Excess Delta (β_2)	0.007	2.86	0.008	3.73	0.005	2.42	0.010	3.62
Deficient Delta * CV (β_3)	0.007	2.67	0.006	2.17	0.011	3.82	0.008	2.84
Excess Delta * CV (β_4)	-0.007	-2.21	-0.009	-2.83	-0.010	-3.05	-0.008	-2.23
Controls	Yes		Yes		Yes		Yes	
Cross sectional variable (CV)	High Analyst Following		High Institution Ownership		Early CEO Tenure		Product Market Competition	
p-value for testing $\beta_1 = -\beta_3$	0.845		0.958		0.106		0.151	
p-value for testing $\beta_2 = -\beta_4$	0.716		0.651		0.109		0.370	
R^2	0.3735		0.3631		0.3639		0.3436	
N	19,182		19,182		19,182		16,018	

Table 8 Excess/Deficient Delta, SOA and Firm Performance: Cross Sectional Variation in CEOs' Incentives to Hold Unconstrained Equity

In this table we further examine how the relations between Deficient/Excess Delta and both SOA and firm performance (Q/ROA) is influenced by cross sectional variation in the incentives of CEOs to voluntarily hold unconstrained equity. Deficient Delta = Delta Gap when Delta Gap > 0 (i.e., $Target_{t-1}$ > Actual $Delta_{t-1}$), and equals zero otherwise. Excess Delta equals Delta Gap when Delta Gap < 0 (i.e., $Target_{t-1}$ < Actual $Delta_{t-1}$), and zero otherwise. Delta Gap = Target $Delta_{t-1}$ minus actual $Delta_{t-1}$, where Target $Delta_{t-1}$ is estimated in column (3) of Table 2 using information available at t-1. In panel A, we consider how cross sectional variation in the incentives of CEOs to voluntarily hold unconstrained equity affects the SOA; in Panel B (C) we consider how these incentives influence the relation between Deficient/Excess Delta Gap Tobin's Q (ROA). Controls are omitted for brevity and they are the same as those included in Table 3. The sample period covers 1992-2015. See the appendix for variable definition and measurement. The OLS regressions are estimated clustered by firm. Standard errors are bootstrapped to account for generated regressors.

Panel A: Speed of Adjustment Cross Sectional Variation in Voluntary Equity Holdings

Dependent Variable =	Change of Delta					
	(1)		(2)		(3)	
	estimate	t-value	estimate	t-value	estimate	t-value
Intercept	-0.085	-6.61	-0.034	-2.14	0.007	0.46
Deficient Delta (β_1)	0.529	14.80	0.493	12.52	0.611	12.76
Excess Delta (β_2)	0.558	13.36	0.497	9.55	0.260	6.51
Deficient Delta * DV	0.148	2.48	0.149	2.72	-0.080	-1.00
Excess Delta * DV	-0.195	-2.26	-0.195	-2.95	0.058	0.97
DV	-0.008	-0.32	-0.045	-2.16	0.058	2.62
	Signaling		Overconfidence		Informed Trade	
Voluntary holding determinant variable (DV)	Positive Stock Repurchase		High Investment-to-Cash-Flow Sensitivity		High Excess Return	
p-value for testing $\beta_1 = \beta_2$	0.4748		0.9414		0.0001	
R^2	0.1127		0.0973		0.1564	
N	16,346		16,950		13,623	

Panel B: Tobin's Q: Cross Sectional Variation in Voluntary Equity Holdings

Dependent Variable =	Tobin's Q					
	(1)		(2)		(3)	
	estimate	t-value	estimate	t-value	estimate	t-value
Intercept	0.976	3.57	0.847	3.61	1.175	3.90
Deficient Delta (β_1)	-0.033	-2.16	-0.045	-2.38	-0.045	-2.06
Excess Delta (β_2)	0.107	2.46	0.085	2.32	0.199	4.83
Deficient Delta * DV (β_3)	0.049	2.52	0.053	2.36	-0.020	-0.79
Excess Delta * DV (β_4)	0.121	2.39	0.103	2.07	-0.063	-1.50
Controls	Yes		Yes		Yes	
Voluntary holding determinant variable (DV)	Signaling: Positive Stock Repurchase		Overconfidence: High Investment-to-Cash-Flow Sensitivity		Informed Trade: High Excess Return	
p-value for testing $\beta_1 = -\beta_3$	0.102		0.606		0.002	
R^2	0.6100		0.6226		0.6022	
N	15,736		18,122		12,131	

Panel C: ROA: Cross Sectional Variation in Voluntary Equity Holdings

Dependent Variable =	ROA					
	(1)		(2)		(3)	
	estimate	t-value	estimate	t-value	estimate	t-value
Intercept	-0.127	-4.89	-0.129	-5.57	-0.161	-6.05
Deficient Delta (β_1)	-0.016	-6.75	-0.009	-3.91	-0.006	-2.64
Excess Delta (β_2)	0.005	1.97	0.006	2.22	0.007	2.72
Deficient Delta * DV (β_3)	0.019	6.42	0.012	4.61	0.003	1.00
Excess Delta * DV (β_4)	0.008	1.98	0.008	2.17	-0.003	-1.01
Controls	Yes		Yes		Yes	
Voluntary holding determinant variable (DV)	Signaling: Positive Stock Repurchase		Overconfidence: High Investment-to-Cash-Flow Sensitivity		Informed Trade: High Excess Return	
p-value for testing $\beta_1 = -\beta_3$	0.110		0.105		0.048	
R^2	0.3700		0.3533		0.3727	
N	15,736		18,122		12,131	