CONSEQUENCES OF CEOS' DECISIONS TO HOLD THEIR OWN FIRM'S STOCK

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of the requirements for the degree of

Doctor of Philosophy in Business Administration

University of Pittsburgh

2017

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JOSEPH M. KATZ GRADUATE SCHOOL OF BUSINESS

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ABSTRACT

CEOs commonly hold large amounts of unconstrained stock in their own firm, i.e., vested shares in addition to any shares required by the firm's stock ownership requirements or regulatory rules. This dissertation examines the consequences of the CEO owning and holding these additional shares. I begin with a theoretical model of why CEOs hold additional shares in their own firm when doing so is riskier than holding a more diversified portfolio. I establish conditions under which only a mixed-strategy equilibrium is feasible in which the CEO randomizes between holding and selling his additional shares. My model predicts that CEOs who own more unconstrained stock will be more likely to hold their additional shares and that this larger stake in the firm will lead to better future performance by the firm.

These empirical predictions are supported by tests using data on CEO equity holdings in S&P 1500 firms between 1992 and 2014. Specifically, I find that the incentives provided by unconstrained stock are negatively associated with the CEO's stock selling activity and positively associated with firm performance in each of the subsequent three years. Additional results provide evidence consistent with the CEO's unconstrained stock influencing future firm performance through the CEO's choice of productive effort. My results concerning the positive association between unconstrained stock ownership and subsequent firm performance are also

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robust to the alternative explanation of the CEO's information advantage over investors and an alternative measure of unconstrained stock that incorporates the firm's ownership policies.

Overall, this dissertation highlights the importance of the CEO's unconstrained stock ownership and provides new insight concerning how CEOs' stock ownership influences their own firm's performance.

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PREFACE

I would like to thank my dissertation committee members Esther Gal-Or, Nandu Nagarajan and Dhinu Srinivasan for their comments and advice on each draft of this project. I especially thank my dissertation co-chairs Harry Evans and Mei Feng for generously sharing me their time, technical knowledge, and career advice. Harry oversees my dissertation and another project. He shared with me his knowledge about analytical modeling and showed me in great detail what good research should be and how to be a good writer. More importantly, his work ethic and values help shape me towards becoming a better researcher, a better teacher, and a better person in general. Mei gave me detailed guidance in each single step of this dissertation. She helped me solve numerous technical problems that I might otherwise not have been able to solve. She taught me how to manage my time better. Thank you for your continued encouragement. I would also like to especially thank Nandu Nagarajan for his patient guidance and great care in my first three years in the PhD program. Many of my research interests and research ideas were developed through working with Nandu.

My thanks also go to other professors at the University of Pittsburgh, especially Elise Boyas, Vicky Hoffman, Chan Li and Don Moser. Thank you for helping me build the technical foundation for my future career and providing comments and suggestions to my research projects. I thank my fellow PhD students, especially Jordan Bable, Eric Chan, Yangyang Fan, Michele Frank, and Jing Sun. Thanks you for going through this tough yet fruitful journey with me. I thank Carrie Woods, Chris Fedor, Natalia Fenton and Chris Gursky for providing excellent administrative support. I thank Katz Graduate School of Business, the Mervis Doctoral

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Fellowship, and the Doris & Douglas Bernstein Award for their financial support. Finally, I thank my wife Xihui, my daughter Claire, and my parents for supporting me in pursuing an academic career and motivating me to work hard. Thank you for being patient with my PhD study and forgiving me for not being able to spend enough family time with you.

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1.0 INTRODUCTION

CEOs commonly hold much more stock in their own firm than they are required to hold (Core and Guay, 2010; Armstrong et al., 2015). For example, my sample CEOs in S&P 1500 firms between 1992 and 2014 on average (at the median) hold stock they are free to sell with a value of $7.5 ($3.3) million. I distinguish between *constrained* stock that the CEO is required to hold due to regulatory restrictions, the firm's stock ownership requirements, and other firm-specific restrictions versus *unconstrained* stock that the CEO voluntarily chooses to hold. I then focus on the consequences of the CEO's *unconstrained* stock ownership.

Chapter 2 provides background information for my study and presents my research questions. Prior literature generally does not differentiate between constrained and unconstrained managerial ownership and reports mixed results on the relation between the extent of managers' ownership of the firm and the firm's subsequent performance. While some studies argue and find evidence that managerial ownership is positively associated with firm performance at least in certain ranges of ownership, others posit and find no cross-sectional association.

My dissertation takes a different approach and emphasizes the distinction between unconstrained stock and constrained stock. I argue that, because a CEO is free to sell his[1] unconstrained stock, owning such stock can potentially provide the CEO with very different

[1] For expositional simplicity, throughout this paper I assume the CEO/manager is male.

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incentives to exert effort than owning constrained stock. Further, because a significant portion of the CEO's total wealth is related to the ownership of the firm's stock,[2] I expect that CEOs who hold different amounts of unconstrained stock will behave differently with respect to whether to hold or sell their stock in the future and devote how much effort to maximize firm value. Finally, given that the CEO is the firm's most important decision maker, I expect the CEO's unconstrained stock ownership and the CEO's resulting effort choices and stock holding/selling decisions to have a significant impact on subsequent firm performance.

My investigation of the consequences of the CEO's unconstrained stock ownership is a two-step process. Holding large amounts of unconstrained stock in the CEO's own firm may appear to be suboptimal because of the associated risk of holding an undiversified portfolio. To address this issue, my first step is to analyze a theoretical model of conditions under which a CEO would voluntarily hold his own firm's stock even when the CEO faces no sale restrictions. Based on this model, I then generate predictions regarding the CEO's subsequent stock selling and the firm's subsequent performance. My second step is to conduct empirical tests of these predictions.

Chapter 3 presents my theoretical model and generates hypotheses from the model. My one-period model considers a manager endowed with a certain fraction of the firm's unconstrained stock that he is free to sell in a stock market. The firm offers the manager a contract comprised of salary and an additional fraction of the firm that he is constrained to hold until the end of the period. Once he accepts the contract, the manager simultaneously decides

[2] Although CEOs' personal wealth is typically undisclosed, the literature generally agrees that a large fraction of a CEO's wealth is invested in his own firm through holding stock and options. Becker (2006) provides some statistics for the composition of CEO wealth in Sweden, where the disclosure of personal wealth is mandatory. He shows that in 1999 Swedish CEOs' median firm (nonfirm) wealth is 5.4 (2.7) million SEK, suggesting that about 2/3 of these CEOs' wealth is related to their own firm.

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whether to hold or sell his unconstrained stock and how much productive effort to exert, where this effort positively affects expected firm value at the end of the period.

In this environment, I demonstrate that no pure-strategy equilibrium exists in which the manager holds his unconstrained stock with probability one, and I also establish conditions under which no pure-strategy equilibrium exists in which the manager sells his unconstrained stock with probability one. These results follow because if investors believe that the manager holding unconstrained stock is an equilibrium arrangement, the firm's equilibrium stock price will be higher based on the manager's anticipated greater effort level. However, when making decisions on how much effort to exert and whether to hold or sell his stock, a manager faced with such a higher stock price would have incentive to simultaneously reduce his effort and sell all of his unconstrained stock. This would reduce both the manager's cost of effort and his cost of risk aversion from holding the firm's stock. Conversely, if the manager is faced with a lower stock price that reflected investors' belief that the manager would sell his stock, he would have incentive to increase his effort and hold his unconstrained stock to enjoy the additional net payoff from effort, given that this additional payoff from effort exceeds the increase in the cost of risk aversion from holding more firm stock.

Similar to the one-period model of contract renegotiation under moral hazard analyzed by Fudenberg and Tirole (1990), I establish conditions under which a mixed strategy will exist in equilibrium. In this equilibrium the firm's stock price will be just sufficient to induce the manager to randomize between holding and selling his unconstrained stock. As a result, the manager will hold unconstrained stock and exert a corresponding high effort with a certain probability, and sell unconstrained stock and exert a corresponding low effort with the remaining

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probability. The firm's stock price will be consistent with the manager's chosen probabilities of following each strategy.[3]

The first prediction from my model is that the more unconstrained stock a manager initially holds, the lower will be the probability that he sells his stock. That is, relative to selling his unconstrained stock, the choice of holding the stock will be more attractive when the manager starts with a higher level of unconstrained stock ownership. This follows because the total return for holding unconstrained stock and hence the attractiveness of the holding strategy, which represent the tradeoff between the expected increase in the manager's share of the firm and the additional cost of effort as well as the additional cost of risk aversion associated with stock ownership, is an increasing function of the manager's initial unconstrained stock ownership. The second important prediction from my model is that greater initial ownership of unconstrained stock by the manager will be positively associated with better future firm performance. This association follows because a higher current unconstrained stock ownership is positively related to the manager's future effort, given the manager's choice of holding unconstrained stock. In addition, the probability of the manager continuing to hold, rather than sell, unconstrained stock will be greater when the manager initially holds more unconstrained stock.

The intuition of my model can be seen by comparing two otherwise identical managers who differ in their initial unconstrained stock ownership in their own firm. My model predicts that in equilibrium both managers will randomize between holding and selling their unconstrained stock. Further, compared to the manager who owns less unconstrained stock, the

[3] My model also endogenizes the firm's contracting decision. I show that in the mixed strategy equilibrium, the firm does not use the information about the manager's initial unconstrained stock ownership when contracting with the manager.

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manager who owns more initial unconstrained stock (1) will be less likely to sell his stock and (2) his firm will subsequently perform better.

Chapter 4 of this dissertation provides empirical evidence consistent with my predictions in Chapter 3. My empirical tests are based on a sample of CEOs from S&P 1500 firms between 1992 and 2014. I treat my sample CEOs' vested stock as unconstrained and control for their holdings of unvested stock, vested options, and unvested options. To make cross-sectional comparisons, I follow Edmans et al. (2009) and measure the CEO's equity incentives by the CEO's wealth-performance elasticity (WPE hereafter) rather than the CEO's fractional ownership in the firm.[4] Prior literature shows that fractional ownership decreases with firm size and might not capture the cross-sectional variation of the CEO's incentives (Hall and Liebman, 1998; Baker and Hall, 2004; Edmans et al., 2009). WPE measures the percentage change in the CEO's wealth in response to a percent change in firm value and is calculated as the dollar value of the CEO's equity ownership divided by his total annual pay.

CEOs in my sample hold vested stock with an average (median) dollar value of $7.5 ($3.3) million, which is equivalent to 2.38 (1.10) times the CEO's total annual pay. I examine the relation between a CEO's incentives from this current vested stock ownership and his subsequent stock selling activity. I find that CEOs with greater incentives from vested stock at the beginning of the year, measured as WPE, sell less of their own firm's stock during the year. The magnitude of this effect is economically significant. That is, relative to the average fraction of stock that a CEO sells during a given year, a one standard deviation increase in the CEO's initial vested stock

[4] In my formal model development, I also follow Edmans et al. (2009) and use wealth-performance elasticity to measure the strength of the manager's incentives from stock ownership.

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WPE is associated with a 13.8% decrease in fraction of beginning vested stock that the CEO sells.

Next, I follow Himmelberg et al. (1999) and use a firm fixed effect model to assess the relation between the CEO's equity incentives and subsequent firm performance. I find that the CEO's current vested stock WPE, which reflects the percentage change in the CEO's total wealth from holding vested stock in response to a one percent change in the firm's value, is positively associated with the firm's industry-adjusted operating ROA and Tobin's Q in each of the subsequent three years. This effect is also economically significant. A one standard deviation increase in the CEO's initial vested stock WPE is associated with an increase in the firm's year-three industry-adjusted operating ROA (Tobin's Q) that is equivalent to 3.6% (1.7%) of the firm's median operating ROA (Tobin's Q). Further, consistent with the view that equity incentives are endogenously determined by the contracting environment (Demsetz and Lehn, 1985) and should not have cross sectional association with firm performance, I find that the CEO's WPEs for other equity holdings are generally not significantly related to the firm's subsequent performance.

To corroborate my findings in Chapter 4 and to give additional support to my theoretical model, Chapter 5 presents six additional empirical tests. The first two tests are related to the mechanism in my model that the manager's current unconstrained stock ownership positively affects future firm performance through his productive effort. This mechanism works first through the manager's freedom to choose the level of productive effort. Better corporate governance reduces managerial shirking and limits the CEO's discretion in effort choice. Therefore I predict that the association between the CEO's incentives from vested stock and future firm performance will be weaker if the firm has better corporate governance. My

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predictions are supported by tests using institutional ownership to measure governance. However, results using board independence and CEO duality as the alternative measure of governance provide weaker results.

Second, the manager's productivity of effort serves as the second channel through which his effort mediates the positive relation between his unconstrained stock ownership and the firm's subsequent performance. My model in Chapter 3 predicts that the sensitivity of future firm performance on the CEO's current unconstrained stock ownership is a positive function of the CEO's productivity and hence his influence over the firm's operation. I use three measures of the CEO's influence on firm operations, the level of R&D spending, long-term asset intensity, and recent sales growth. My results provide mixed support for my prediction.

In my third additional test, I rule out the alternative explanation that the positive association between the CEO's unconstrained stock ownership and subsequent firm performance is driven by the CEO's information advantage regarding the firm's future performance. I divide my full sample into two subsamples according to the number of analysts following the firm, a proxy for the information asymmetry between the firm and investors. I find that future firm performance is positively associated with the CEO's vested stock ownership in both high and low analyst-following subsamples. Therefore, the CEO's information advantage alone cannot explain the results for the subsample with high analyst following, where the amount of information asymmetry is lower between the firm and investors.

Fourth, I consider the effect of a firm's stock ownership policies in limiting the CEO's ability to sell vested stock. I refine the measure of unconstrained stock by subtracting from the CEO's vested stock the portion that is constrained through the firm's ownership guidelines. My

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results concerning the association between vested stock incentives and subsequent firm performance are robust to using this refined measure.

Fifth, I repeat my main analysis concerning the association between the CEO's vested stock ownership and subsequent firm performance, but now using fractional ownership in the firm as the alternative measure of equity ownership. My results using this alternative measure are much weaker. As I explain in Chapter 2, these weak results are to be expected because a manager's fractional ownership has a limited ability to accurately capture the cross-sectional variation in the manager's incentive to exert effort. because firm size increases faster than the manager's compensation. I divide my full sample into three subsamples based on firm size and find some evidence consistent with this argument.

Finally, I empirically test the prediction in my proposition in Chapter 3 that the manager's pay is not a function of his current unconstrained stock ownership. Using CEO compensation data from ExecuComp, I find that neither equity-based compensation nor total compensation that the CEO receives from the firm is significantly associated with his existing ownership of vested stock. These results are consistent with a dynamic view of my model. Because in the mixed strategy equilibrium the manager randomizes between holding and selling unconstrained stock, the observed ex-post stock holding decision contains no information that the firm can use to set the manager's future pay level.

Chapter 6 concludes my dissertation. I discuss the contributions of my dissertation and potential future research. My study contributes first to the literature on the relation between managerial ownership and future firm performance by establishing why the distinction between constrained and unconstrained stock is important. Second, my study adds to the emerging literature that seeks to understand why managers voluntarily hold unconstrained equity. Unlike

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other studies in this literature, I argue that voluntary unconstrained stock holding are part of a mixed-strategy equilibrium in which the CEO holds his unconstrained stock with a certain probability and sells the stock with the remaining probability. Finally, my dissertation contributes to the literature on insider trading. I argue that the manager can impact the firm's fundamental value through holding unconstrained stock and show that an insider's stock ownership can be informative even if no trading takes place.

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2.0 BACKGROUND AND RESEARCH QUESTIONS

2.1 OVERVIEW OF CHAPTER

This chapter provides background information and develops the research questions examined in my dissertation. Section 2.2 discusses the literature related to the CEO's decision to hold/sell unconstrained firm stock. Section 2.3 describes the mixed empirical evidence provided by prior literature that links managerial ownership and subsequent firm performance. One potential reason for these mixed results is the empirical proxy for equity incentives. Therefore, Section 2.4 discusses three different proxies that prior studies use and their limitations. Section 2.5 provides the research questions of this dissertation and provides a summary of the approach I take to answer my research questions.

2.2 THE CEO'S DECISION TO HOLD/SELL UNCONSTRAINED STOCK

My dissertation is related first to literature that examines a CEO's sale of his own stock in the firm. Some early studies examine CEO stock selling behavior and the reasons for the observed variation in this behavior. Ofek and Yermack (2000) examine managers' sale of vested restricted stock and stock acquired in exercising vested options during years 1995 to 1997. They find that

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executives often immediately sell the shares they convert from stock options. Also, managers with high stock ownership are more likely to sell restricted stock immediately after the vesting period, while low-ownership managers generally hold restricted stock longer after vesting. Jin and Kothari (2008) analyze the determinants of managers' decisions to sell their stock. They find that the extent of the tax burden from selling stock adversely affects a manager's sale of the company's stock. Prior literature also finds that CEOs tend to sell more of their firm's stock when recent stock returns are higher (Jin and Kothari, 2008; Cheng and Warfield, 2005).

Another stream of literature examines the link between CEOs' stock selling and earnings management. Cheng and Warfield (2005) examine the effect of equity incentives on the likelihood of reporting earnings that meet or just beat analysts' forecasts. They find that managers with high equity incentives subsequently sell larger amounts of stock. They further find that managers' ownerships of stock and unexercisable stock option are positively related to meeting/beating analysts' forecasts and abnormal accrual. McVay et al. (2006) find that managers sell more shares subsequent to meeting and beating analysts' forecasts.

Another group of studies examine CEOs' stock selling from the perspective of insider trading. These studies assume that the stock market is inefficient and insiders have advantageous information about their firm's future performance. These studies consistently find that insider trades are more profitable than uninformed trading transactions (Seyhun 1988, Lakonishok and Lee, 2001). They also find that insider purchases are more informative about future stock movements than insider sales, possibly because insiders' sales are often driven by their need for liquidation instead of their knowledge about weak future firm performance (Lakonishok and Lee, 2001; Fidrmuc et al., 2006).

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Finally, an emerging literature attempts to explain why managers voluntarily hold unconstrained equity. Armstrong et al. (2015) find that on average more than half of a CEO's equity holdings are unconstrained. The decision to hold unconstrained equity is puzzling because the manager bears the largely undiversified risk related to these holdings. Thus, if the firm's stock price incorporates the expected level of the manager's future productive effort, the manager could opportunistically sell these holdings and exert minimum effort.

In this emerging literature, some studies solve this puzzle through asset pricing models and show that one mechanism to ensure that the manager holds the firm's unconstrained stock and exerts effort is a rational equilibrium where the firm's stock price does not fully reflect the manager's future effort until it has been exerted (Blonski and Von Lilienfeld-Toal, 2016; Gorton et al., 2014). Consistent with this theory, Von Lilienfeld-Toal and Ruenzi (2014) find that firms where the CEO has large ownership of vested stock earn positive future abnormal returns. Armstrong et al. (2015) empirically test various explanations for CEOs' holdings of large amounts of unconstrained equity and find evidence that some of the CEO's unconstrained equity holdings might actually be constrained, and that the CEO's risk aversion and tax burden provide a limited explanation for the amount of unconstrained equity holdings. Neither Von Lilienfeld-Toal and Ruenzi (2014) nor Armstrong et al. (2015) find evidence that CEOs hold unconstrained stock due to private information about the firm's future returns.

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2.3 MANGERIAL OWNERSHIP AND FIRM PERFORMANCE

My dissertation is also related to the literature that links managers' stock ownership with firm performance. On the one hand, some prior studies argue that managers' stock ownership might not be at the optimal level and therefore can lead to cross-sectional association with firm performance. For example, Morck et al. (1988), McConnell and Servaes (1990), and Hermalin and Weisbach (1991) find that insiders' stock ownership has an inverse-U shape relation with firm performance, measured as Tobin's Q and ROA. Aggarwal and Samwick (2006) and Kale et al. (2009) examine the incentives provided by the manager's entire equity portfolio, including stock and options, and find a positive relationship between firm performance and managerial equity incentives.

On the other hand, other researchers argue that in equilibrium there should be no causal relationship between managerial ownership and firm performance because both are determined by the firm's contracting environment (Demsetz, 1983; Demsetz and Lehn, 1985). Empirical support for this view includes Himmelberg et al. (1999) and Coles et al. (2012), who find no evidence of an association between managerial ownership and firm performance after using econometric techniques to control for endogeneity.[5]

[5] Zhou (2001) argues that the firm fixed effect model used by Himmelberg et al. (1999) is unlikely to capture the effect of ownership on performance because managerial ownership changes slowly from year to year within a firm.

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2.4 EMPIRICAL PROXIES FOR EQUITY INCENTIVES

Other than the underlying mechanism that links managerial ownership and firm performance, an additional potential reason for prior literature's disagreement on the empirical relationship between managers' equity incentives and firm performance is the variation in empirical proxies used to measure the strength of equity incentives. Most prior studies have measured the strength of equity incentives as fractional ownership in the firm (for example, Morck et al., 1988; McConnell and Servaes, 1990; Aggarwal and Samwick, 2006).[6] Fractional ownership captures the value change in the manager's equity holdings in response to a dollar change in the firm's total market value. However, fractional ownership has a limited ability to capture the cross-sectional variation in managerial incentives across firms that vary in size. Hall and Liebman (1998) and Baker and Hall (2004) find that incentives measured as percentage ownership decline strongly with firm size. In fact, in very large firms a small fraction of the firm's stock may be sufficient to incentivize the CEO to work hard. In other words, fractional ownership will unduly underestimate (overestimate) the strength of equity incentives for CEOs in larger (smaller) firms.

A second measure of equity incentives that prior literature uses is the dollar value of equity ownership (for example, Core and Guay, 2002). Baker and Hall (2004) show that fractional ownership is an appropriate measure for incentives only when the manager's productivity affects the *dollar returns* of the firm regardless of firm size.[7] They argue that the

[6] For a manager's stock holdings, fractional ownership is simply the percentage of the firm's stock that the manager owns. For option holdings, fractional ownership is measured as the sensitivity of their options' Black and Scholes (1973) value to stock price, i.e., option delta, converted to a fraction of the firm (Murphy, 1999).

[7] Consider two firms that differ in size. Firm A has a market cap of $1,000 while firm B has a $10,000 market cap. Suppose further that the CEO owns stock of the firm worth $200 in both cases. That is, CEO stock ownership is 20% in firm A and 2% in firm B. Further suppose the CEO's productive effort will increase firm value by $100 regardless of firm size. That is, the value of firm A (B) will increase by 10% (1%) when the CEO works hard. In this

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manager's productivity is more likely to affect the *percentage returns* of the firm than the dollar returns of the firm. To the extent that this reasoning is plausible for the majority of actions taken by managers, especially by the firm's CEO, the dollar value of equity holdings is a more appropriate measure for incentives.[8] At the cross section, dollar value of equity ownership still has limited ability to capture the variation in equity incentives. This is because it does not consider the manager's outside wealth. Since an individual's utility function is more likely to follow constant *relative* risk aversion than constant *absolute* risk aversion, an equity ownership of a given dollar value typically provides greater incentives to a manager who has lower total wealth (Core and Guay, 2010).[9] Therefore, dollar value of equity ownership will unduly overestimate (underestimate) the strength of equity incentives for CEOs in larger (smaller) firms.

As an alternative approach to address these issues in measuring the strength of equity incentives, Edmans et al. (2009) introduce an incentive measure that scales the manager's dollar equity incentives by total pay and measures the wealth-performance elasticity (WPE) of the manager's equity holdings, i.e., the percentage change in the manager's wealth for a one percent change in firm value. They show that this measure is independent of firm size and advocate it as a cross-sectional empirical measure for equity incentives.

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environment, the CEO's fractional ownership (20% and 2%) is a better cross-sectional measure of the strength of the CEO's incentives because the effect of CEO stock incentives on firm performance, measured as percentage return, is a 1% firm return for every 2% CEO stock ownership.

[8] Using the same two firms in footnote 7, now suppose the CEO's productive effort will increase firm value by 1% ($10 and $100) regardless of firm size. Now the dollar value of equity ($200) is a more appropriate proxy for incentives because every $100 CEO stock ownership is associated with 0.5% firm return.

[9] Becker (2006) finds empirical evidence supporting an effect on incentives from the CEO's total wealth.

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2.5 RESEARCH QUESTIONS AND RESEARCH APPROACH

This dissertation distinguishes between constrained and unconstrained stock and examines the consequences of CEOs' ownership of unconstrained stock. My research questions are (1) *How is the CEO's unconstrained stock ownership associated with his subsequent decision to hold unconstrained stock?* and (2) *What is the association between the CEO's unconstrained stock ownership and the firm's subsequent performance?*

To answer my research questions, in Chapter 3 I first develop and analyze a theoretical model of conditions under which the CEO would voluntarily hold his unconstrained stock ownership. I use this model to generate empirical predictions about the CEO's subsequent sale of unconstrained stock and the firm's subsequent performance. I then provide empirical evidence in Chapters 4 and 5 to test these predictions.

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3.0 THEORETICAL MODEL AND HYPOTHESES

3.1 OVERVIEW OF CHAPTER

This chapter provides a one-period theoretical model to analyze the manager's decision to hold his unconstrained stock ownership of the firm. Section 3.1 sets up the model, Section 3.2 characterizes the equilibrium for the model, and Section 3.3 generates empirical hypotheses from the model.

3.2 MODEL SETUP

My one-period model is consistent with Edmans et al. (2009) in that I treat effort as having multiplicative effects on production and the manager's leisure/effort preferences. I use the LEN (Linear compensation, negative Exponential utility, and Normally distributed performance measures) framework in modeling the effect of the manager's effort choice on firm outcome and contract design, but depart slightly in defining the manager's utility function to incorporate the multiplicative effects of managerial effort and the manager's relative risk aversion. I also incorporate a stock market in which the manager can sell his stock.

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An owner-manager with outside wealth of w_0 manages a firm with assets of m. The manager owns a fraction $\alpha>0$ of the firm's stock that is vested and unconstrained from any sale restriction.[10] In other words, the manager is free to sell his α ownership. The manager's compensation consists of a fixed salary $s\geq 0$ plus an additional fraction β of the firm's stock at the beginning of the period, where β vests and becomes unconstrained (vested) at the end of the period. This means the manager must hold the fraction β of firm stock during the period. Throughout the model I use terms "vested" and "unconstrained" interchangeably when referring to the manager's fractional ownership α, and "unvested" and "constrained" interchangeably for his fractional ownership β.

The manager chooses a productive effort, e, at the beginning of the period that increases the value of the firm's assets. The manager's effort has a multiplicative effect on firm value such that the firm's value at the end of the period becomes $m(1 + Le + \delta)$, where m is the firm's initial asset value, e is the manager's effort exerted at beginning of the period, L is the productivity of effort, and δ is a random noise, $\delta \sim N(0,\sigma^2)$. Denote $y = Le + \delta$ as the outcome of the manager's effort so that firm value at the end of the period equals $m(1 + y)$.

At the same time as choosing his effort, the manager chooses whether to hold or sell his fraction α of vested stock. Denote the choice of this action as V, where $V=H$ if the manager holds the vested stock, and $V=S$ if he sells the vested stock.[11] At the end of the period, the firm liquidates and the manager receives his share of the firm's assets in cash. Further, if the manager

[10] Throughout the model, I treat the firm as having one share and each shareholder owns a fraction of this share. As a result, the firm's stock price is the same as its total market value.

[11] An alternative approach would allow the manager to choose any fraction of vested stock to hold. In other words, the manager chooses a certain fraction of his vested stock to continue to hold. Denote the fraction of the α portion of vested stock that he continues to hold as θ, $\theta \in [0,1]$. I show in Appendix A that, for this alternative set-up, there exists no pure strategy equilibrium in which the manager chooses a combination of a certain θ and a certain e.

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sells his portion α of vested stock, he keeps the proceeds as cash through the end of the period. In other words, outside investment opportunities provide a zero rate of return.

The manager's utility is $U(w)$, where w is the manager's wealth at the end of the period net of the cost of his productive effort $c(e)$. I assume the cost of effort has a quadratic functional form and follow Edmans et al. (2009) to model the manager's cost of effort as multiplicative in his wealth, $c(e)= w_0 e^2/2$.[12] Therefore, $w = w_0 + w_f - w_0 e^2/2$, where w_f is the manager's wealth related to the firm. The manager's utility is given by $U(w) = -exp(-\tau w)$, where τ is the factor of constant absolute risk aversion. I follow Baker and Hall (2004) and assume that the manager's absolute risk aversion is a function of his outside wealth, $\tau=\rho/w_0$, where ρ is the factor of relative risk aversion.[13] Thus $U(w) = -exp(-\rho w/w_0)$. Denote $f = w/w_0 =1+ w_f /w_0 - e^2/2$ as the manager's wealth factor and rewrite the manager's utility as $U(w)=G(f) = -exp(-\rho f)$.

The manager's reservation utility is $U(\overline{w})$, which can be interpreted as his utility when he sells his share of the firm at the beginning of the period and finds an outside job that pays him a fixed salary w_a and requires no effort. In other words, $U(\overline{w}) = G(\overline{f})$, where $\overline{f}$ is the manager's wealth factor corresponding to this alternative job opportunity. Further assume that other shareholders of the firm are risk-neutral. Table 1 provides all notation used in my model and Figure 1 provides a timeline of the model.

[Insert Table 1 Here]

[Insert Figure 1 Here]

[12] Similar to Edmans et al. (2009), I treat the private benefit of shirking as a normal good. Edmans et al. (2009) argue that while leisure time remains constant, the value of leisure increases with the manager's wealth.

[13] This assumes that all managers have the same relative risk aversion, but may differ in their absolute risk aversion due to the difference in their outside wealth. The manager makes decisions to maximize the utility from the *percentage* change in his total wealth relative to his initial outside wealth, net of the cost of effort.

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3.3 THE EQUILIBRIUM

The equilibrium of the model is solved based on a framework of rational expectation. It jointly considers the manager's decisions on the amount of stock to hold and the level of effort to exert, shareholders' pricing of the firm's stock, and the contract that the manager receives from the firm. I discuss this framework in more detail in Section 3.3.1. Next, I prove in Sections 3.3.2 and 3.3.3 propositions that there exists no pure strategy equilibrium that the manager holds (Proposition 3.1) or sells (Proposition 3.2) his unconstrained stock. I then show in Section 3.3.4 that under certain conditions there exists a mixed strategy equilibrium in which the manager is indifferent between holding and selling unconstrained stock. Finally, Section 3.3.5 solves the firm's contracting decision.

3.3.1 A Framework of Rational Expectation

I solve the model by backward induction. Taking the firm's contract (s, β) as given, the firm's stock price P at the beginning of the period reflects shareholders' expectations of the manager's vested stock ownership decision, V, and his choice of effort level, e. In response to the firm's beginning stock price P, the manager chooses an effort level, e, and whether to hold or sell his α vested stock to maximize his expected utility. Finally, shareholders' selections of contract parameters s and β reflect their equilibrium expectations of e, V, and P.

In this rational expectations framework, the manager's total stock ownership after making the stock sale decision takes one of three values: (1) β unvested stock and α vested stock, i.e., $V=H$ with probability one, (2) β unvested stock and no vested stock, i.e., $V=S$ with probability

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one, and (3) a mixed-strategy scenario in which the manager holds β plus α with probability q and only β with probability $1–q$, ie., $V=H$ with probability q and $V=S$ with probability $1–q$.

If the manager chooses to hold his α vested stock at the beginning of the period, i.e., $V=H$, his firm wealth w_f and wealth factor f at the end of the period given effort e will be

$$w_f(e|H) = s + (\alpha+\beta)[m(1+y) - s] = s + (\alpha+\beta)(m-s) + (\alpha+\beta)my, \text{ and}$$

$$f(e|H) = 1 + \frac{w_f(e|H)}{w_0} - \frac{e^2}{2} = 1 + \frac{s}{w_0} + \frac{(\alpha+\beta)(m-s)}{w_0} + \frac{(\alpha+\beta)my}{w_0} - \frac{e^2}{2}$$

The manager's objective is to maximize his utility, $G(f)$. Becasue $G(f) = -exp(-\rho f)$ and $y \sim N(Le, \sigma^2)$, the manager maximizes his certainty equivalent for $f(e|H)$, given by

$$CE(e|H,P,s,\beta) = 1 + \frac{s}{w_0} + \frac{(\alpha+\beta)(m-s)}{w_0} + \frac{(\alpha+\beta)mLe}{w_0} - \frac{e^2}{2} - \frac{(\alpha+\beta)^2 m^2 \sigma^2 \rho}{2{w_0}^2}$$

Definition 3.1 *The manager's wealth-performance elasticities (WPEs) related to vested stock α and unvested stock β are defined as:*

(1) WPE for vested stock, $A = \alpha m/w_0$,

(2) WPE for unvested stock, $B = \beta m/w_0$.

With these WPE definitions, $CE(e|H, P, s, \beta)$ can be rewritten as

$$CE(e|H,P,s,\beta) = 1 + \frac{s(1-\alpha-\beta)}{w_0} + A + B + (A+B)Le - \frac{e^2}{2} - \frac{(A+B)^2\sigma^2\rho}{2} \quad (3.1)$$

If the manager chooses to sell his α vested stock, i.e., $V=S$, his firm wealth w_f, wealth factor f, and certainty equivalent at the end of the period given effort e and stock price P will be

$$w_f(e|P,S) = s + \alpha P + \beta[m(1+y) - s] = s + \alpha P + \beta(m-s) + \beta my,$$

$$f(e|S) = 1 + \frac{w_f(e|S)}{w_0} - \frac{e^2}{2} = 1 + \frac{s}{w_0} + \frac{\alpha P}{w_0} + \frac{\beta(m-s)}{w_0} + \frac{\beta my}{w_0} - \frac{e^2}{2}, \text{and}$$

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$$CE(e|S,P,s,\beta) = 1 + \frac{s}{w_0} + \frac{\alpha P}{w_0} + \frac{\beta(m-s)}{w_0} + \frac{\beta mLe}{w_0} - \frac{e^2}{2} - \frac{\beta^2 m^2 \sigma^2 \rho}{2{w_0}^2}$$

$$= 1 + \frac{s(1-\beta)}{w_0} + \frac{\alpha P}{w_0} + B + BLe - \frac{e^2}{2} - \frac{B^2\sigma^2\rho}{2} \quad (3.2)$$

Further, the firm's stock price at the beginning of the period, *P*, equals the firm's end-of-period expected value, given the manager's choices of *e* and *V*, i.e., $P = E($ m$(1 + y) - s \mid e, V)$. I will later analyze how the firm's stock price *P* varies with the manager's decision *V*.

3.3.2 Pure Strategy of Holding Vested Stock

Proposition 3.1 *There exists no pure strategy equilibrium in which the manager holds vested stock α with probability one.*

Proof: Suppose the manager holds *α* vested stock, i.e., *V=H*, with probability one. Denote the manager's effort level in this equilibrium as e_H and the firm's stock price at the beginning of the period as P_H. The existence of a pure strategy equilibrium in which *V=H* implies that

$$CE(e_H|H,P_H,s,\beta) \geq CE(e'|H,P_H,s,\beta), \forall e' \neq e_H \quad (3.3)$$

and

$$CE(e_H|H,P_H,s,\beta) \geq CE(e'|S,P_H,s,\beta), \forall e' \quad (3.4)$$

Inequality (3.3) must hold because otherwise the manager would not choose $e=e_H$, given *V=H*, $P=P_H$, and contract *(s, β)*. Further, inequality (3.4) ensures that the manager is always better off by choosing the equilibrium strategy of holding his *α* vested stock (*V=H)* and exerting e_H, as opposed to selling his *α* stock (*V=S)* and exerting any possible effort.

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From (3.3) and (3.1), $e_H = argmax_e CE(e|H, P_H, s, \beta)$

$$= argmax_e \left[1 + \frac{s(1-\alpha-\beta)}{w_0} + A + B + (A+B)Le - \frac{e^2}{2} - \frac{(A+B)^2\sigma^2\rho}{2}\right]$$

$$= L(A+B) \tag{3.5}$$

Next, substituting for *CE* (e_H | *H*, P_H, *s*, *β*) and *CE* (*e'* | *S*, P_H, *s*, *β*) from (3.1) and (3.2), constraint (3.4) becomes

$$1 + \frac{s(1-\alpha-\beta)}{w_0} + A + B + (A+B)Le_H - \frac{{e_H}^2}{2} - \frac{(A+B)^2\sigma^2\rho}{2} \geq$$

$$1 + \frac{s(1-\beta)}{w_0} + \frac{\alpha P_H}{w_0} + B + BLe' - \frac{e'^2}{2} - \frac{B^2\sigma^2\rho}{2}, \forall\, e' \tag{3.6}$$

Because *V=H* is the assumed equilibrium, the price of the firm at the beginning of the period will be

$$P_H = E(m(1+y) - s|e_H, H) = m(1+Le_H) - s = (m-s) + mL^2(A+B) \tag{3.7}$$

Also, at the right-hand-side of (3.6), the manager's optimal effort conditional on selling *α* vested stock is *e'= LB*. Substituting for e_H, P_H, and *e'*, (3.6) becomes

$$1 + \frac{s(1-\alpha-\beta)}{w_0} + A + B + \frac{L^2(A+B)^2}{2} - \frac{(A+B)^2\sigma^2\rho}{2} \geq$$

$$1 + \frac{s(1-\beta)}{w_0} + \frac{\alpha[(m-s) + mL^2(A+B)]}{w_0} + B + \frac{L^2B^2}{2} - \frac{B^2\sigma^2\rho}{2}.$$

This reduces to

$$\frac{L^2(A^2+2AB+B^2)}{2} - \frac{(A+B)^2\sigma^2\rho}{2} \geq \frac{L^2(2A^2+2AB+B^2)}{2} - \frac{B^2\sigma^2\rho}{2}.$$

Given that *A >0*, this yields a contradiction and hence a pure strategy of holding α vested stock cannot be an equilibrium.

Q.E.D.

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Proposition 3.1 suggests that if the manager is faced by a stock price that reflects his higher effort e_H corresponding to the decision of holding unconstrained stock, he would prefer to sell his unconstrained stock and shirk by providing the lower effort e_S. This preference arises from both the manager's risk aversion and net return of effort, i.e., the manager's expected cash received from effort less the cost of effort. First, the manager benefits from selling unconstrained stock because it reduces the cost of having his wealth tied to the firm's risky assets.

Second, deviating and selling unconstrained stock allows the manager to gain in the net return of effort through shirking. Given the manager's ownership of the firm, the cost of shirking is the reduction in expected cash corresponding to his ownership, while its benefit is the smaller cost of effort. In the assumed equilibrium where the manager holds both α and β and exerts $e_H = L(A+B)$, the marginal cost and benefit of shirking are the same, both being $L(A+B)$. Now suppose the manager deviates by selling his unconstrained stock. Because the stock market offers a *fixed* price P_H, the manager will not be penalized on the ownership α that he sells even if selling ownership α results in the manager choosing an effort lower than e_H and the firm's expected value falling below P_H. That is, when the manager sells ownership α and shirks, he is only penalized on his ownership β of the firm. Thus by deviating from the assumed equilibrium, the manager's marginal cost of shirking will be LB rather than $L(A + B)$. In contrast, the manager receives the same marginal benefit of shirking, $L(A + B)$, regardless of whether he deviates. Therefore, the alternative strategy of selling ownership α and shirking dominates the assumed equilibrium.

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3.3.3 Pure Strategy of Selling Vested Stock

Proposition 3.2 *There exists no pure strategy equilibrium in which the manager sells vested stock α with probability one when* $\beta/\alpha < (L^2 - \sigma^2\rho)/2\sigma^2\rho$.

The proof is very similar to the proof for Proposition 3.1, thus I only discuss the intuition. Again, the manager's risk aversion and his net return from effort affect his decision regarding whether to stay or deviate from the assumed equilibrium of selling α unconstrained stock. First, by deviating and holding α, the manager will incur additional cost of risk aversion, which works in favor of the manager *staying* in the assumed equilibrium.

Second, deviating from the assumed strategy of selling vested stock while exerting the lower effort $e_S=LB$, the strategy of holding vested stock and working hard at the higher effort $e_H=L(A+B)$ allows the manager to receive a higher net return of effort. This difference in net return of effort is again caused by the manager's inability to commit to a stock ownership level. In the assumed equilibrium, the manager's marginal cost and benefit of effort are the same, both being LB. In this assumed equilibrium the manager sells his ownership α at a *fixed* and low stock price and he will not be rewarded on this ownership for providing additional effort. However, by deviating and not selling any of his α unconstrained stock, the manager's marginal benefit of effort increases from LB to $L(A + B)$. In contrast, his marginal cost of effort stays at $e_S=LB$ regardless of whether he deviates. This difference in the manager's marginal benefit and marginal cost of effort gives rise to his preference of holding α and providing higher effort.

Recall that the manager's risk aversion prevents him from deviating and holding α. When $\beta/\alpha < (L^2 - \sigma^2\rho)/2\sigma^2\rho$, the manager's benefit of deviation with respect to the net return of effort will exceed his additional cost of risk aversion related to holding unconstrained stock, resulting

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in a preference for deviating from the assumed equilibrium of selling unconstrained stock.[14] This condition reflects the manager's tradeoff between receiving a greater payoff from effort and bearing more cost related to the firm's performance volatility when deciding whether to deviate. It can be attained more easily when the cost of risk aversion is smaller, i.e., σ^2 or ρ is smaller, or when the manager's gain in return of effort from deviating is greater, i.e., α is greater.

3.3.4 Mixed Strategy

Proposition 3.3 *For a manager with $\beta/\alpha < (L^2 - \sigma^2\rho)/2\sigma^2\rho$, there exists an equilibrium in which the manager is indifferent between holding and selling vested stock.*

Proof: Suppose such a mixed strategy equilibrium exists and the manager holds his share α *(V=H)* with probability q and sells his share α *(V=S)* with probability *1-q*. Let P_M be the stock price at the beginning of the period. As shown in Propositions 3.1 and 3.2, the manager's effort level when he chooses to hold his vested stock is $e_H = L(A + B)$ and his effort when he chooses to sell his vested stock is $e_S = LB$. For the manager to play a mixed strategy, his utility when he holds vested stock (*V=H*) and exerts effort e_H must be the same as his utility when he sells vested stock (*V=S*) and exerts effort e_S. This requires that:

$$CE(e_H|H, P_M, s, \beta) = CE(e_S|S, P_M, s, \beta), \text{ or}$$

$$1 + \frac{s(1-\alpha-\beta)}{w_0} + A + B + (A+B)Le_H - \frac{{e_H}^2}{2} - \frac{(A+B)^2\sigma^2\rho}{2} =$$

$$1 + \frac{s(1-\beta)}{w_0} + \frac{\alpha P_M}{w_0} + B + BLe_S - \frac{{e_S}^2}{2} - \frac{B^2\sigma^2\rho}{2} \qquad (3.8)$$

[14] When $\beta/\alpha > (L^2 - \sigma^2\rho)/2\sigma^2\rho$, the manager's benefit of deviation with respect to net return of effort will be smaller than his additional cost of risk aversion related to holding the vested stock. As a result, there will be a pure strategy equilibrium in which the manager sells unconstrained stock with probability one. In this case, the manager's initial ownership of unconstrained stock will be unrelated to firm outcome and the firm's design of contract.

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Substituting for $e_H = L(A + B)$ and $e_S = LB$, the solution for P_M in (3.8) is

$$P_M = m - s + m\left(B + \frac{A}{2}\right)(L^2 - \sigma^2\rho) \tag{3.9}$$

P_M also equals the firm's expected asset value at the end of the period:

$$\begin{aligned} P_M &= E[m(1+y) - s|e, V] \\ &= qE[m(1+y) - s|e_H, H] + (1-q)E[m(1+y) - s|e_S, S] \\ &= q(m - s + mLe_H) + (1-q)(m - s + mLe_S) = m - s + mL^2B + qmL^2A \end{aligned} \tag{3.10}$$

In (3.10), P_M has three components: (1) $m - s$, the firm's initial asset value less salary paid to the manager, (2) $m\ L^2B$, firm output induced by granting the manager fraction β of constrained firm stock, and (3) qmL^2A, the expected production output related to the manager's decision to hold his unconstrained stock and exert a higher level of effort.

Combining (3.9) and (3.10) gives

$$q = \frac{1}{2} - \frac{\sigma^2\rho}{L^2}\left(\frac{1}{2} + \frac{B}{A}\right) \tag{3.11}$$

The probability that the manager holds unconstrained stock, q, has two components. First, 1/2 represents the fact that the manager's effort–aversion prevents him from holding or selling unconstrained stock with probability one. The stock price that gives a risk-neutral manager the same net payoff of effort from holding versus selling unconstrained stock is consistent with $q=1/2$.[15]

The second term of (3.11), $-\sigma^2\rho(1/2 + B/A)/L^2$, is related to the manager's risk-aversion. It has a negative sign because holding unconstrained stock is more costly to the risk-averse manager and the manager would prefer to sell unconstrained stock if he were faced by a stock

[15] The reason why the value 1/2 is not related to α and β is because the manager's cost of effort has a quadratic functional form. If the manager's cost of effort is more (less) convex than the quadratic function, then the value of q that makes the manager indifferent between holding and selling stock will move towards 0 (1) and will be a function of α and β.

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price that is consistent with $q=1/2$. Thus an equilibrium stock price must reflect a value of q lower than 1/2 to lower the manager's utility for the strategy of selling unconstrained stock such that the manager is indifferent between selling and holding unconstrained stock.

Suppose this downward adjustment of q from the value of 1/2 *is* Δq, *i.e.,* $q = 1/2 - \Delta q$. This adjustment will result in a downward change in stock price $\Delta P=m(\Delta q L^2 A)$, because the manager's probability of holding vested stock and providing the higher effort is now Δq lower. Faced by this lower stock price, the manager's selling-strategy certainty equivalent will decrease by $\alpha\Delta P/w_0= \Delta q\ L^2A^2$. Further, recall that the downward adjustment of q by Δq from the value of 1/2 serves the purpose of eliminating the manager's preference for the selling strategy due to the manager's risk aversion. Therefore the decrease in the manager's selling strategy certainty equivalent related to Δq must equal the difference in the cost of risk aversion between the holding and selling strategies, i.e., $\Delta q\ L^2A^2 = (A+B)^2\sigma^2\rho/2 - B^2\sigma^2\rho/2$, which gives $\Delta q = \sigma^2\rho(1/2+ B/A)/L^2$.

3.3.5 The Firm's Contracting Decision

The final step of the equilibrium problem is the firm's selection of s and β, taking q as given. The firm's objective is to choose s and β to maximize the expected value of existing shareholders' share of the firm at the end of the period:

$$\begin{aligned} &\mathrm{Max}_{s,\beta}(1-\beta)E[m(1+y)-s|q] = \mathrm{Max}_{s,\beta}(1-\beta)P_M \\ &= Max_{s,\beta}(1-\beta)\left[m - s + m\left(B+\frac{A}{2}\right)(L^2-\sigma^2\rho)\right] \end{aligned} \tag{3.12}$$

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Proposition 3.4 *In the optimal contract β is independent of α.*

Proof: The contract *(s, β)* gives the manager an expected utility equal to his reservation utility. Since in equilibrium the manager is indifferent between holding stock and selling stock, the following equation holds:

$$G[f(e|H, P_M, s, \beta)] = G[f(e|S, P_M, s, \beta)] = G(\overline{f}), \text{ or}$$

$$G\left[1 + \frac{s(1-\beta)}{w_0} + \frac{\alpha P_M}{w_0} + B + BLe_S - \frac{{e_S}^2}{2} - \frac{B^2\sigma^2\rho}{2}\right] = G(\overline{f}) \tag{3.13}$$

The manager's reservation utility $G(\overline{f})$ is his utility when he does not contract with the firm, sells his share of the firm, and takes an outside job that pays him a fixed salary w_a while requiring no effort, thus $\overline{f}$ can be rewritten as

$$\overline{f} = 1 + \frac{\alpha P_M}{w_0} + \frac{w_a}{w_0}$$

Thus equation (3.13) becomes

$$\frac{s(1-\beta)}{w_0} + B + Be_S - \frac{{e_S}^2}{2} - \frac{B^2\sigma^2\rho}{2} = \frac{w_a}{w_0} \tag{3.14}$$

Solve for *s* in (3.14) and substitute into (3.12), the firm's objective function becomes

$$Max_{s,\beta}(1-\beta)m\left[1 + \left(B + \frac{A}{2}\right)(L^2 - \sigma^2\rho)\right] - w_a + w_0\left[B + \frac{B^2}{2}(L^2 - \sigma^2\rho)\right] \tag{3.15}$$

The FOC of (3.15) with respect to β is

$$(L^2 - \sigma^2\rho)\frac{m^2}{w_0}\left(1 - \beta - \frac{\alpha}{2}\right) = 0 \tag{3.16}$$

The LHS of (3.16) is always positive because $L^2 - \sigma^2\rho > 0$ is a necessary condition for the mixed strategy to exist and $1 - \beta - \alpha/2 = (1 - \beta - \alpha) + \alpha/2 > 0$. Thus β should take its maximal

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value given (3.14) and $s \geqslant 0$. Because none of the parameters in (3.14) is a function of α, β is unrelated to α.

Q.E.D.

Two forces generate the result in Proposition 3.4. First, the firm offers a contract that makes the manager indifferent among three options: (a) selling unconstrained stock and exiting the firm to receive the reservation wage, (b) selling unconstrained stock and working for the firm with lower effort, and (c) holding unconstrained stock and working for the firm with higher effort. The manager's indifference between options (a) and (b) implies that the manager's expected payoff from the contract alone, given the choice of selling constrained stock, is equal to his reservation wage and this equation does not involve the manager's initial unconstrained stock ownership α. Second, as a necessary condition for the mixed strategy to exist, $L^2-\sigma^2\rho>0$ implies that the manager's payoff of effort net of the cost of effort and the cost related to holding stock is positive. Thus, the firm saves salary by increasing β, the constrained stock granted to the manager. This saving in salary exceeds the firm's cost of giving the manager more ownership of the firm, resulting in the firm's preference to "sell" the entire firm to the manager. In other words, there is no binding relation between β and α from the firm's objective in maximizing shareholder value.

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3.4 COMPARATIVE STATICS AND EMPIRICAL HYPOTHESES

3.4.1 The CEO's Subsequent Stock Selling

My first hypothesis is related to the CEO's tendency to sell unconstrained stock. From (3.11), the probability that the CEO sells unconstrained stock is $1 - q = \frac{1}{2} + \frac{\sigma^2 \rho}{L^2}\left(\frac{1}{2} + \frac{B}{A}\right)$. Because B does not vary with A, $1 - q$ is decreasing in A.

The negative association between the CEO's probability of selling stock and the CEO's unconstrained stock ownership can be explained using the following example. Two otherwise identical CEOs in two identical firms own different levels of their own firm's unconstrained stock, with CEO A owning more unconstrained stock than CEO B. Recall that in deciding whether to hold unconstrained stock and exert the corresponding high effort, both CEOs are faced by the tradeoff between the increase in their share of the firm related to higher effort and the increases in the cost of effort and the cost of risk aversion due to higher effort and higher stock ownership.

In the mixed strategy equilibrium the CEO's net increase in the return of effort from holding more unconstrained stock, calculated as the expected increase in the CEO's share of the firm net of the increase in cost of effort, exceeds his additional cost of risk aversion associated with greater stock ownership. This has to hold because otherwise the equilibrium would be a pure strategy equilibrium in which the CEO always sells his unconstrained stock and exerts low effort. In other words, the net return for holding the firm's stock is positive and increases with the CEO's unconstrained stock ownership. Therefore, the choice of holding the stock will be more attractive for CEO A who has a higher level of unconstrained stock ownership, and CEO A will

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be likely to sell his stock. Because in my model wealth-performance elasticity (WPE) measures the incentives provided by a CEO's stock ownership, my first hypothesis is:

H1. *The CEO is less likely to sell stock as his unconstrained stock WPE increases.*

Note that an increase in the CEO's unconstrained stock ownership will move the CEO away from the holding strategy because his cost of risk aversion increases with unconstrained stock ownership. However, this increase in the CEO's unconstrained stock ownership also moves the CEO from the selling strategy to the holding strategy for the following reason. Recall that the equilibrium stock price is a weighted average of firm outcomes under the CEO's holding and selling strategies. Thus, if the CEO chooses the selling strategy, the price at which he sells his unconstrained stock will be greater than the expected firm outcome corresponding to his effort. That is, the CEO receives some 'free cash' for his unconstrained stock ownership without having to exert effort.

As I discuss in Section 3.3.4 regarding the composition of q, the market first offers a certain amount of 'free cash' to account for the CEO's indifference between selling and holding unconstrained stock related to his effort aversion.[16] However, due to the CEO's risk aversion and the resulting preference for selling stock, the 'free cash' is then discounted to ensure that the CEO is still indifferent between holding and selling unconstrained stock.[17] The total discount in this 'free cash', a cost to the CEO, will be greater when the CEO's unconstrained stock ownership increases and therefore will drive the CEO to move away from the selling strategy towards the holding strategy. Under my model's specification, the increase in the discount of selling strategy 'free cash' when the CEO's unconstrained stock increases will be faster than the

[16] As I discuss in Section 3.3.4, this initial 'free cash' that the market offers is consistent with a value of q=1/2.
[17] This discount or negative adjustment of price is consistent with the downward adjustment of q discussed in more details in section 3.3.4,

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increase in his cost of risk aversion should he choose the holding strategy, resulting in the CEO's preference for the holding strategy.

3.4.2 The Firm's Subsequent Performance

My second hypothesis is related to the association between the CEO's ownership of unconstrained stock and future firm performance. From (3.9), the firm's percentage return is $r=(B + A/2)(L^2 - \sigma^2\rho)$. The first-order derivative with respect to A is $\partial r/\partial A=(L^2 - \sigma^2\rho)/2$. Again, because the CEO's net increase in the return of effort from holding more unconstrained stock exceed his additional cost of risk aversion from greater stock ownership, implying that $L^2-\sigma^2\rho>0$, $\partial r/\partial A$ will be positive.

This positive relation arises because firm performance is positively associated with the CEO's expected effort, which increases with the CEO's initial unconstrained stock ownership through two channels. First, a higher current unconstrained stock ownership is positively related to the CEO's future effort, given his choice of holding unconstrained stock. Second, as I demonstrate in H1, the probability of the CEO continuing to hold, rather than sell, unconstrained stock will be greater if he initially holds more unconstrained stock. Using WPE as the empirical measure of the CEO's incentives from unconstrained stock, my second hypothesis is:

H2. *The firm's future performance increases with the WPE of the CEO's unconstrained stock ownership.*

Note that the variation in *WPE* could come from the CEO's fractional ownership of unconstrained stock or the firm's value. Thus, the positive relationship between the firm's future performance and the CEO's unconstrained stock WPE is expected to exist not only cross-

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sectionally between different firms but also within a firm as the firm's stock price changes year by year.

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4.0 EMPIRICAL EVIDENCE

4.1 OVERVIEW OF CHAPTER

This chapter provides initial empirical evidence for my two hypotheses. Section 4.2 presents sample selection, variables used in this dissertation, and summary statistics. Section 4.3 provides empirical results for testing my first hypothesis. Finally, Section 4.4 provides empirical results for testing my second hypothesis.

4.2 SAMPLE AND VARIABLES

The sample selection process is provided in Table 2. I start from 32,104 firm-year observations covered by *ExecuComp*, *CompuStat*, and *CRSP* between 1992 and 2014 that involve 5,909 CEOs whose stock trading data is also available in *Thomson Reuters Insider Filing* data. From *ExecuComp* I collect information about the CEO's stock and option holdings. I exclude 2,015 observations with a negative number of shares for vested stock, calculated by subtracting the number of unvested shares (*STOCK_UNVEST_NUM* in *ExecuComp*) from total number of

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shares the CEO owns (*SHROWN_EXCL_OPTS* in *ExecuComp*).[18] To ensure that the observed pattern in firm performance is due to managerial incentives from compensation, as opposed to control considerations or founder effect (Anderson and Reeb, 2003), I delete 7,014 observations that involve 994 CEOs who own more than 5% of their firm at any year during their tenure as CEO. I also delete 1,051 observations where one or more of the CEO's equity holding incentives measured by WPE, explained further next, are not computable. Finally, I delete 738 observations with missing control variables in my regression models. The final sample I use to test my hypotheses includes 21,286 observations that involve 4,474 CEOs in 2,540 firms in the period between 1992 and 2014.[19]

[Insert Table 2 Here]

I focus on the CEO's ownership of vested and unconstrained stock that is free from any firm or regulatory restrictions and hence the CEO is free to sell. My empirical tests treat a CEO's entire vested stock ownership as unconstrained. I make this choice for two reasons despite the recent trend in compensation practice involving companies adopting stock ownership policies to limit their executives' ability to cash out vested stock (Core and Larcker, 2002; Armstrong et al., 2015; Shilon, 2015). First, companies that have a specified ownership policy often allow their executives to count time-vesting restricted stock toward the ownership requirement, which enables executives to unload virtually all vested shares given that they already hold large amounts of restricted stock (Equila Inc., 2013; Shilon, 2015). Second, there is large variation in specific details of these ownership policies and other firm-specific trade restrictions, which

[18] These negative numbers might be due to the firm reporting vested stock ownership incorrectly as total ownership, the firm reporting the CEO's total ownership as of proxy statement date instead of year-end date, or data input error.
[19] In testing each of my hypotheses, my sample size is further reduced due to missing dependent variables or each regression's unique independent variables, which will be discussed in more details in each individual section of hypothesis testing.

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companies do not always fully disclose (Shilon, 2015).[20] Including ownership requirement information is likely to introduce measurement errors that will add noise to my equity incentive variables. Section 4.2 analyzes the reduction in unconstrained stock by ownership policies using a subsample with relevant data and report results that are similar to my main findings.

According to my model, the CEO's vested stock incentives are measured as wealth performance elasticity (WPE) to capture the percentage change in the CEO's wealth in response to a percent change in the firm's value. WPE for the CEO's vested stock is defined as the dollar value of vested stock divided by his outside wealth. Because the CEO's outside wealth is unobservable, I use current year total compensation as an alternative to outside wealth.[21] Therefore, the CEO's vested stock WPE in year *t* is calculated as:

$$WPE\_VestedStock_t = \frac{\#Shares\ in\ Vested\ Stock_{\ t} \times Stock\ Price_t}{Total\ Compensation_t}$$

Besides vested stock, three additional components of a CEO's entire equity portfolio are unvested stock, vested options, and unvested options. I calculate the WPE for each of these three equity holdings by dividing each of their dollar values by the CEO's total annual compensation.[22]

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[20] For example, while most companies do not allow their executives to count options toward the ownership requirement, some companies allow them to include a certain percentage of vested options. As another example, companies do not have the same policy for executives who have not met the ownership requirement. Some require that the executive withhold all or a portion of newly vested stock or stock obtained in the exercise of stock options, while others only specify a 'deadline' for compliance, without specifying actions needed before compliance. Currently there is no regulatory guideline with respect to companies' practice of executive ownership policies.

[21] This assumes that the CEO's outside wealth is proportional to his current total compensation. The empirical evidence in Edman et al. (2009) provides further support for making this assumption. Their WPE measure is the same as the measure I use in this paper and is shown to have no cross-sectional relation with firm size, which would not hold if the elasticity of CEO's outside wealth over annual compensation is systematically different from one.

[22] In calculating the WPE for stock options, the dollar value of options is calculated as the change in the options' Black-Scholes value (Black and Scholes, 1973) in response to 1% change in stock price, multiplied by 100. Note that prior to 2006 companies were not required to disclose details of their executives' outstanding options. Thus for observations prior to 2006 I follow the procedure in Core and Guay (2002) and treat all vested options as one grant and unvested options as another grant.

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Descriptive statistics on the CEO's equity holdings, measured as dollar values and WPEs, are provided in Table 3, Panel A. The mean (median) dollar value of the CEO's total equity holdings is $27,136 (15,078) thousand. These holdings, when measured as WPE, translate to 7.09 (5.45) times the CEO's total annual compensation. Now turn to each component of equity holdings. The mean (median) dollar values of the CEO's vested stock and unvested stock are $7,525 (3,269) thousand and $1,444 (28) thousand. These numbers translate to 2.38 (1.10) and 0.32 (0.02) times the CEO's annual compensation. On average, the CEO's ownership of vested stock is 31.4% (81.2%) of his total equity (stock) ownership. In contrast, the CEO's unvested stock on average accounts for 8.0% (18.8%) of his total equity (stock) ownership. Thus over my sample period the CEOs commonly hold larger amounts of vested firm stock than unvested firm stock.

[Insert Table 3 Here]

The correlations among the four components of equity incentives and total equity incentives, measured as WPEs, are provided in Table 4. The WPE for vested stock is positively correlated with the WPEs for unvested stock, vested options, and unvested options, which is consistent with the implicit contracting explanation in Armstrong, et al. (2015) that a part of the CEO's unconstrained stock is in fact constrained, possibly through implicit agreements between the firm and the CEO. Further, the WPE for unvested stock is negatively correlated with the WPEs for vested options and unvested options, consistent with firms using restricted stock and stock options as substitutes in CEO compensation.

[Insert Table 4 Here]

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4.3 TEST OF H1: THE CEO'S SUBSEQUENT STOCK SELLING

H1 predicts that the CEO is less likely to sell stock if his vested stock ownership provides him with more incentives. I test this prediction using the regression model in equation (4.1).

$$StockSold_t = Beg.VestedStock_t (\lambda_1 + \gamma_1 WPE\_VestedStock_{t-1} + \Theta_1 Z_t) + NewVestedStock_t (\lambda_2 + \gamma_2 WPE\_VestedStock_{t-1} + \Theta_2 Z_t) \quad (4.1)$$

This model treats the CEO's stock sale in a year as decisions on the fractions to sell among two sources of stock that the CEO can potentially sell, which are vested stock at the beginning of the year and stock newly vested during the year. I allow the selling fractions for these two sources to differ for two reasons. First, tax consideration has differential effect on the CEO's decision regarding which stock to sell. Because newly vested stock is taxed as ordinary income, the CEO will be more likely to sell stock to receive cash in reservation for this tax liability in years when more restricted stock becomes vested. Thus, tax considerations could result in a difference in the *level* of selling fraction between beginning vested stock and newly vested stock. Second, unobservable firm policies may differentially restrict the CEO's ability to sell beginning vested stock and newly vested stock. For example, some firms require their CEOs to retain a certain percentage of newly vested stock while others require the CEO to own vested stock exceeding a certain amount (Equilar Inc., 2013). In the first case, the CEO's ability to sell newly vested stock is restricted. In the second case, the CEO's ability to sell beginning vested stock is restricted if in the current year there is no newly vested stock. Under the influence of unobservable firm policies, both the *level* of selling fraction and the *sensitivity* of selling fraction to unconstrained stock incentives might differ between the two stock sources.

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In (4.1), the fraction of beginning vested stock that the CEO sells is $\lambda_1 + \gamma_1 WPE\_VestedStock_{t-1} + \Theta_1 Z_t$, which is a linear combination of an intercept, the CEO's incentives from vested stock measured as WPE, and Z_t, a vector of control variables that I will discuss next. Because H1 predicts that the CEO is less likely to sell stock when he has greater incentives from unconstrained stock, in model (4.1) I expect γ_1 and γ_2 both to be negative.

The linear combination of control variables, ΘZ_t, is illustrated in equation (4.2).

$$\Theta_i Z_t = \theta_{i,1} WPE\_Unvest.Stk_{t-1} + \theta_{i,2} WPE\_VestedOptions_{t-1} + \theta_{i,3} WPE\_Unvest.Options_{t-1} + \theta_{i,4} Stock\ Return + \theta_{i,5} Firm\ Size + \theta_{i,6} Stock\ Volatility + \theta_{i,7} Market\ to\ Book + \theta_{i,8} Leverage + \theta_{i,9} CEO\ Overconfidence + \theta_{i,10} CEO\ tenure + \sum \eta_{i,j} Year_j ,$$
$$i=1\ for\ Beg.VestedStock;\ i=2\ for\ NewVestedStock \quad (4.2)$$

I control for the incentives from the CEO's other equity holdings. I also control for firm and manager characteristics and year fixed effect. I expect the coefficient for Stock Return to have a positive sign because prior literature shows that managers sell more stock in years when stock returns are higher (Cheng and Warfield, 2005; Jin and Kothari, 2008). Firm size, stock volatility, market to book, and leverage are included to control for the firm's contracting environment. CEO overconfidence and tenure are included to account for the impact on stock selling from the CEO's specific characteristics. Definitions for all variables are provided in Appendix B.

To estimate model (4.1), I obtain the CEO's stock selling transactions from *Thomson Reuters Insider Filing* data. I exclude stock sales that occur within the (-1 day, +1 day) window of stock option exercises because the involved shares are newly obtained in option exercises while my study concerns the CEO's selling decisions on *existing* stock and *newly vested* stock.

Following prior literature (Cheng and Warfield, 2005; Jin and Kothari, 2008), I measure $StockSold_t$, $Beg.VestedStock_t$, and $NewVestedStock_t$ as percentages of the firm's total outstanding

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shares. For example, $StockSold_t = 100 \times$ *Number of shares the CEO sells in year t / Total firm outstanding shares at the end of year t.* Prior to 2006 companies do not disclose the number of newly vested shares. Thus, in these years I infer newly vested shares using the following equation: *Beginning restricted shares + Newly granted restricted shares – Newly vested shares = Ending restricted shares*.

Because the estimation of model (4.1) requires data on the CEO's lag WPEs, my sample size reduces to 17,099 observations. Descriptive statistics for this sample on variables related to the CEO's sale of stock are provided in Table 3, Panel C. On average, CEOs sell stock infrequently. In fact, stock selling transactions only occur in 17% firm-years in my sample. The CEO's mean (median) ownership of vested stock at the beginning of the year is 0.432% (0.177%) of the firm's total outstanding stock. Also, during the year, the CEO's mean (median) newly vested stock is 0.034% (0.0004%) of the firm's total outstanding stock.

The results of regressions using model (4.1) are provided in Table 5. In Column 1 I only include *Beg.VestedStock* and *NewVestedStock*, the two stock sources, as independent variables to estimate the CEO's average baseline selling fractions, which I later use to interpret the economic magnitude of the association between the CEO's incentives from vested stock and his stock selling activity. As expected, the coefficients for *Beg.VestedStock* and *NewVestedStock* are both positive and significant. On average, CEOs sell 2.75% (12.3%) beginning vested stock (newly vested stock) during a year.

[Insert Table 5 Here]

In Columns 2 and 3 I add the interactions between the two stock sources and the CEO's four equity holding incentives, measure as WPEs. In Column 3 I further include the interactions with firm characteristics, CEO characteristics, and year dummies. My main tests are on the

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coefficients of *Beg.VestedStock* × *WPE_VestedStock* (γ_1) and *NewVestedStock* × *WPE_VestedStock* (γ_2), which H1 predicts to be negative. Consistent with H1 prediction, γ_1 is negative and significant in both Columns 2 and 3 (γ_1= -0.0015 and -0.0012, p's<0.001), suggesting that the CEO sells a smaller fraction of beginning vested stock as his vested stock provides greater incentives. To put this effect in perspective using Column 3 estimation, a one standard deviation increase in *WPE_VestedStock* (an increase of 3.17) is associated with a 0.38% (0.0012×3.17) decrease in the fraction of beginning vested stock that the CEO sells, which is equivalent to 13.8% of the CEO's baseline selling fraction for beginning vested stock (0.38%/2.75%=13.8%).

Also consistent with my expectation, in both Columns 2 and 3 the coefficient for *NewVestedStock* ×*WPE_VestedStock* (γ_2) is negative. However, γ_2 is not significantly different from zero at conventional levels in Column 2 and is marginally significant at p=0.091 (one-sided) in Column 3. These weaker results could be due to the measurement error in estimating newly vested stock for data prior to 2006.[23] As a robustness test, I rerun the regressions in Table 5 for a subsample of firm-years since 2006. The coefficients for γ_2 in both new regressions of Columns 2 and 3 (untabulated) are negative and significant at p<0.05, with an economic magnitude comparable to that of γ_1. Overall, these results are consistent with H1 that the CEO is less likely to subsequently sell stock when he has greater initial incentives from unconstrained stock.

[23] Prior to 2006 companies only disclose the dollar values of restricted stock grants but not the numbers of shares involved or the dates of these grants. I use the year-end stock price to estimate the number of new restricted stock granted for these years. The CEO's newly vested stock, which is calculated based on the estimate of new restricted stock granted, is therefore more subject to measurement error.

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4.4 TEST OF H2: FUTURE FIRM PERFORMANCE

H2 predicts that the firm's future performance is positively associated with the incentives related to the CEO's vested stock ownership, measured as WPE. The regression model I use to test H2 is equation (4.3).

$$Performance_{t+i} = \lambda_0 + \lambda_1 WPE\_VestedStock_t + \lambda_2 WPE\_Unvest.Stock_t + \lambda_3 WPE\_VestedOptions_t + \lambda_4 WPE\_Unvest.Options_t + \lambda_5 Performance_t + \lambda_6 Stock\ Return_t + \lambda_7 Size_t + \lambda_8 Market\text{-}to\text{-}book_t + \lambda_9 Leverage + \lambda_{10} Stock\ volatility_t + \lambda_{11} Overconfidence_t + \lambda_{12} LogTenure_t + Year\ fixed\ effect + Firm\ fixed\ effect + e \quad (4.3)$$

In this model, I regress future firm performance at year $t+i$ (i=1, 2, 3) on the CEO's vested stock incentives at the end of year t while controlling for the CEO's other equity incentives. I use two measures of firm performance. The first measure is industry-adjusted operating ROA (AOROA), calculated as income after depreciation divided by average assets, adjusted by the Fama-French 48 industry median in the same year. The second measure is Tobin's Q, calculated as the firm's market value of assets divided by book value of assets.

As explained before, I measure the four components of equity incentives as WPEs, which increase with the firm's stock price. However, the change in stock price also includes information about the market's expectations on future accounting returns, which works in favor of finding a positive association between future AOROA and current equity incentives. On the other hand, the current change in stock price is negatively associated with future stock movement due to mean reversion, which works against finding a positive association between future Q and current WPEs. To mitigate these potential biases, I include current stock return as a control variable. I further control for firm and CEO characteristics and year effects. Finally, following Himmelberg et al. (1999), I use firm fixed effect to control for unobservable firm characteristics

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that could simultaneously affect the CEO's equity incentives and future firm performance.

The results of regressions using model (4.3) are provided in Table 6. The sample includes 19,311 firm-years that have non-missing performance variables in both the current year and the next year. To test my H2 prediction about the positive relation between the CEO's current vested stock incentives and the firm's future performance, I use *AOROA* as the dependent variable in Columns 1 to 3 of Table 6, and use *Tobin's Q* as the dependent variable in Columns 4 to 6. Within each set of performance regressions, I examine the association between vested stock WPE and firm performance for each of the three years following current year.

[Insert Table 6 Here]

The results in Table 6 are consistent with H2. Specifically, the coefficients of *WPE_VestedStock* are positive and significant across the first three columns (λ_1=0.0003, 0.0006, and 0.0009, p=0.072, 0.041, and 0.006 respectively), where *AOROA* is used as the dependent variable. When *Tobin's Q* is used as the dependent variable (Columns 4 to 6), the coefficients for *WPE_VestedStock* are also positive and significant in all three specifications (λ_1=0.0059, 0.0061, and 0.0074, p=0.011, 0.031, and 0.026 respectively). These effects are also economically meaningful. For example, a one standard-deviation increase in *WPE_VestedStock* (an increase of 3.17) in year *t* is associated with a 0.003 (0.023) increase in the firm's *AOROA (Tobin's Q)* in year *t+3*, which translates to 3.6% (1.7%) of the firm's median *Operating ROA (Tobin's Q)* in year *t*.

Consistent with the view that equity incentives are endogenously determined by contracting environment and adjusted by the firm through compensation when they are not at optimal levels (Demsetz and Lehn, 1985; Core and Guay, 1999), the coefficients for the other three equity incentives are generally insignificantly different from zero at conventional levels,

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except that *WPE_Unvest.Stock* and *WPE_Unvest.Options* are both positive and significant when *AOROA* in year *t+1* is the dependent variable. Thus, it appears that it takes the firm some time to fully adjust for the change in the CEO's incentives related to unvested equity.

Overall, my results in Table 6 support my H2 prediction that the CEO's current incentives from holding unconstrained stock are positively associated with the firm's subsequent performance.

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5.0 ADDITIONAL EMPIRICAL TESTS

5.1 OVERVIEW OF CHAPTER

In this chapter, I conduct six additional tests to corroborate my findings in Chapter 4 and give additional support to my theoretical model in Chapter 3. Section 5.2 provides additional results for the association between future firm performance and the CEO's vested stock ownership based on the prediction that the association will be stronger if corporate governance is weaker. Section 5.3 provides the results for the association between future firm performance and the CEO's vested stock ownership based on the prediction that the association will be stronger if the CEO has greater influence on the firm's operations. Section 5.4 rules out the alternative explanation for my Table 6 results that information asymmetry drives the relation between future firm performance and the CEO's vested stock ownership. Section 5.5 replicates my results in Table 6 using an alternative measure of the CEO's unconstrained stock ownership that considers the firm's ownership policies. Section 5.6 replicates my results in Table 6 using fractional ownership as the alternative measure for equity incentives. Finally, Section 5.7 tests the prediction in Proposition 3.4 that CEO compensation is not related to the CEO's current unconstrained stock ownership.

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5.2 CORPORATE GOVERNANCE

In my model, one reason the manager's current unconstrained stock ownership positively affects future firm performance is the manager's freedom to choose effort. That is, the more unconstrained stock ownership the manager has, the higher effort he will exert and the better his firm will perform. Better corporate governance and closer monitoring by the board and large blockholders will reduce managerial shirking and limit the manager's discretion over effort choice. Thus, I predict that the link between the CEO's incentives from vested stock and future firm performance will be weaker (stronger) if the firm has stronger (weaker) corporate governance.[24]

To test this prediction, I first measure the firm's corporate governance by institutional ownership. Institutional ownership has been shown by the prior literature as a monitoring mechanism that mitigates the CEO's myopic behavior (Bushee, 1998) and thus is related to better governance of the firm. I divide my full sample into two subsamples according to whether or not the firm's institutional ownership is above the median institutional ownership of all firms in the same year. I then separately estimate my main regression model in equation (4.3) for each subsample. The CEO will have greater freedom in choosing his effort when the firm is less controlled by institutions. Thus I expect a stronger association between future firm performance and the CEO's unconstrained stock ownership for the subsample with lower institutional ownership.

[24] My prediction is consistent with the argument by Von Lilienfeld-Toal and Ruenzi (2014) that stock ownership and corporate governance are substitutes in improving firm performance.

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Descriptive statistics for variables in each subsample are shown in Table 7, Panel A. Mean institutional ownership for the high (low) institutional ownership subsample is 84% (54%) and the difference is significant at $p<0.001$. Mean vested stock WPE for CEOs in high institutional ownership subsample is 2.23, which is significantly lower at $p<0.001$ than the corresponding 2.43 mean value for CEOs in low institutional ownership subsample. Further, firms in the high institutional ownership subsample are larger in size, have greater market-to-book ratio and leverage, and their stock is more volatile. The effects of these differences in firm characteristics on the firm's subsequent performance are controlled in the regression model.

Regression results using equation (4.3) for the two subsamples are provided in Table 7, Panels B and C. Consistent with my expectation, the coefficient for *WPE_VestedStock* is not significant in any column in Panel B of Table 7, where observations in the sample have higher institutional ownership. In contrast, in Panel C, where the sample includes firms with lower institutional ownership, the coefficient for *WPE_VestedStock* is positive and significant in all columns. Chow tests that compare the coefficients for WPE_VestedStock across Panel B and Panel C suggest that the coefficient is greater in Panel C for all columns and significant in Columns 2, 4, 5 and 6.[25] Overall, the results in Table 7 provide strong support to my argument that the association between future firm performance and current CEO unconstrained stock ownership is stronger when corporate governance is weaker.

[Insert Table 7 Here]

[25] An alternative way to test my prediction is to run firm fixed effect regressions for my full sample and include dummy variables for high institutional ownership and its interactions with equity incentives. However, institutional ownership might not have much variation within a firm across years. Zhou (2001) demonstrates that firm fixed effect models do not work well when the variable of interest has larger cross-sectional variation across firms but is relatively sticky within a firm. As another alternative, I create the permanent classification of high/low institutional ownership by comparing the numbers of years a firm falls into the high and low institutional ownership subsamples. The results are similar to those in Table 7.

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In addition to institutional ownership, I also measure corporate governance by (1) board independence, i.e., the percentage of independent directors on the firm's board, and (2) CEO duality, i.e., whether or not the CEO is also the chairman of the board. Lower board independence and CEO serving as the chairman of the board are both related to weak monitoring of the CEO by the board and greater freedom for the CEO to choose his effort. Thus, I expect the relation between future firm performance and the CEO vested stock WPE to be stronger when the board is less independent and when the CEO is also the chairman of the board.

Similar to my tests in Table 7, I divide my full sample into two groups of subsamples according to (1) whether the firm's percentage of independent directors is above or below median board independence among all firms in the same year, and (2) whether the CEO also has "Chairman" in his title in ExecuComp. I then separately estimate equation (4.3) for each subsample. The results are provided in Table 8. These results are weaker than results in Table 7 that use institutional ownership as the proxy for corporate governance. For example, the coefficient for *WPE_VestedStock* is significantly positive in only one out of six specifications for the low board independence subsample (Panel B) and the Chairman subsample (Panel C). Further, Chow-tests that compare the coefficients for *WPE_VestedStock* between Panel A and Panel B, and between Panel C and Panel D for regressions using the same model but different subsample suggest that none of the coefficients is different across subsamples with different level of board independence or across subsamples with versus without CEO duality.

The weak results in Table 8 could be due to the negative link between CEO vested stock ownership and performance in firms with lower board independence or a Chairman CEO that arises through CEO entrenchment. CEO entrenchment is shown to be related to lower firm performance (Bebchuk et al., 2011; Morck et al., 1988) and higher CEO compensation (Bebchuk

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et al., 2009; Bebchuk et al., 2011), which is also positively related to the CEO's stock ownership [26] This negative association between CEO vested stock ownership and firm performance through entrenchment could offset the incentive effect of vested stock ownership on firm performance.

5.3 NATURE OF BUSINESS

In Chapter 3, one reason for the positive association between unconstrained stock ownership and future firm performance is the positive effect of the manager's productive effort on expected firm value. Recall that in Section 3.4.2, the firm's percentage return is $r=(B + A/2) (L^2 - \sigma^2\rho)$. The first-order derivative of the firm's percentage return with respect to A is $\partial r/\partial A=(L^2 - \sigma^2\rho)/2$. Here L denotes the productivity of the manager's effort such that L and the manager's effort jointly influence the firm's expected future value.[27] It is thus straightforward to make the prediction that the association between future firm performance and current CEO unconstrained stock ownership will be stronger if the CEO's effort is more productive, i.e., the nature of the firm business is one where the CEO is more influential with respect to operational decisions.

To test this prediction, I first measure the CEO's influence over firm operations by the firm's R&D activity. I divide my full sample into two subsamples according to whether or not the firm has a positive R&D expense. I then separately estimate my main regression model in equation (4.3) for each subsample. R&D activities require the CEO to make decisions with

[26] Indeed, my sample observations' mean CEO vested stock WPE is greater when the firm's board independence is lower and when the CEO is also chairman.
[27] More specifically, in Chapter 3 the firm's value at the end of the period is expressed as $m(1 + Le + \delta)$ where m is the firm's value at the beginning of the period, e is the manager's effort, and δ is a random noise.

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respect to project selection and resource allocation. Further, R&D activities have an impact on the firm's long-term performance. Thus, I expect a stronger association between future firm performance and the CEO's unconstrained stock ownership for the subsample with positive R&D expense.

Table 9, Panel A provides descriptive statistics for variables in the positive R&D subsample and the zero R&D subsample. CEOs in the positive R&D subsample holds smaller amounts of vested firm stock (mean WPE_VestedStock=2.08) than CEOs in zero R&D subsample (mean WPE_VestedStock=2.54). Further, as compared to firms with no R&D expense, firms that have R&D activities are smaller in size, have greater market-to-book ratio and lower leverage, and their stock is more volatile. Again, my regression model controls for these firm characteristics.

Regression results using equation (4.3) for the two subsamples are provided in Table 9, Panels B and C. Consistent with my expectation, the coefficient for *WPE_VestedStock* is significantly positive in all columns in Panel B of Table 9, where observations in the sample have a positive R&D expense. In contrast, in Panel C, where the sample includes firms with no R&D expense, the coefficient for *WPE_VestedStock* is positive and significant only in Columns 3 and 6, where firm performance in three years in the future is the regressor. Chow tests that compare the coefficients for WPE_VestedStock across Panel B and Panel C suggest that the coefficient is greater in Panel B across all columns. However, the difference is significant only in Column 4. Overall, the results in Table 9 provide partial support for my argument that the association between future firm performance and current CEO unconstrained stock ownership is stronger when the nature of the firm's business suggests that the CEO's decisions are more influential.

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I also measure the CEO's influence on firm operations using two alternative proxies: long-term asset intensity and sales growth. Similar to R&D, firms with more long-term assets or faster sales growth require the CEO to make more decisions. Thus, I expect a stronger link between future firm performance and the CEO's unconstrained stock ownership for these firms as compared to firms with lower long-term asset intensity or slower sales growth. To test these predictions, I again generate subsamples of firms with high versus low long-term asset intensity and subsamples of firms with high versus low recent sales growth. I then separately estimate model (4.3) for each subsample.

The results, shown in Table 10, are mixed. Similar to results in Table 9, the coefficient for *WPE_VestedStock* is positive in all regressions that involve firms with higher long-term asset intensity, and significant in four out of six specifications (Panel A). In contrast, the coefficient is positive and significant in only two columns in Panel B, where the sample firms have lower long-term asset intensity. However, the results are weaker in Panels C and D, where sales growth is used to divide the sample. Specifically, the coefficient for *WPE_VestedStock* is significantly positive in one (three) specifications for the subsample with higher (lower) sales growth. Also, none of Chow tests that compare the coefficients of *WPE_VestedStock* between Panel A and Panel B and between Panel C and Panel D suggests a significant difference in the coefficient.

The limited support from my results in Tables 9 and 10 to the argument about the role of the CEO's influence on firm operations could be due to the importance of the CEO to the firm in general. That is, if the CEO is already responsible for making virtually all of the important decisions of the firm's operations, then the difference in the amount of discretion that the CEO has on operations in firms with more R&D/long-term assets or faster growth versus firms with

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less R&D/long-term assets or slower growth might not be large enough to generate statistical significance using my model.

5.4 INFORMATION ASYMMETRY

One alternative explanation for my results in Table 6 is the private information explanation: the CEO, who has favorable private information about the firm's future performance, holds stock to benefit from future stock returns when such favorable information becomes public. To rule out the private information explanation, I divide my sample firm-years into two subsamples using analyst following to proxy information asymmetry. I first collect information from IBES on analyst following at eight months prior to the year end. I then divide all firms in my sample into a subsample with higher analyst following and another subsample with lower analyst following according to whether the number of analysts following the firm is above or below the median analyst following among all sample firms in the same year. As shown in Panel A of Table 11, firms with higher analyst following are on average larger in size, have higher market-to-book ratio and higher leverage. Their stock is also less volatile.

I then separately estimate my main regression model in equation (4.3) for each subsample. Similar to my analysis in Tables 7 to 10, the model controls for the differences in firm characteristics. The results are provided in Table 11, Panels B and C. Under the private information explanation, the coefficient for *WPE_VestedStock* (λ_1) is expected to be positive in Panel C, where analyst following is lower, but not Panel B, where analyst following is higher. My results in Table 11, Panel B show that, for the sample of firms with higher analyst following,

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λ_1 is positive in all columns and significant in Columns 2, 3, 5 and 6, suggesting that the positive association between current vested stock WPE and long-term future firm performance exists even if there is relatively low information asymmetry between the firm and the stock market. λ_1 is also generally positive and significant in Panel C, where fewer analysts follow the firm. Further, Chow tests suggest that the coefficient for WPE_VestedStock is not significantly different between Panel B and Panel C in any of the six columns. In summary, the results in Table 11 provide little support for the claim that the CEO's information advantage drives the association between future firm performance and vested stock ownership.

[Insert Table 11 Here]

5.5 OWNERSHIP POLICIES

Chapter 4 treats the CEO's entire vested stock ownership as unconstrained. In recent years, many firms start to implement stock ownership policies that limit the amount of stock their executives can sell (Equilar Inc., 2013, Shilon, 2015).[28] Here I consider the effect of these policies in reducing the CEO's ability to sell vested stock and reexamine the association between future firm performance and the CEO's incentives from unconstrained stock.

My available data allows me to calculate the number of vested shares the CEO holds that become constrained and unsellable due to the firm's ownership policy for 7,305 observations among the sample of 19,311 firm-years in Section 4.4. The data on ownership policies and the

[28] For example, 89.4% of Fortune 100 companies in 2012 have publicly disclosed executive stock ownership policies (Equilar Inc., 2013).

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computations of the CEO's required stock ownership and vested stock constrained by the firm's ownership policy are discussed in more detail in Appendix C. For these observations, I divide the CEO's stock ownership into unconstrained stock and constrained stock using the following equations: *Unconstrained Stock = Vested Stock – Vested Stock Constrained by Ownership Policy*, and *Constrained Stock = Unvested Stock + Vested Stock Constrained by Ownership Policy*. Note that vested stock constrained by ownership policy is sometimes smaller than the policy's specified ownership target because some firms allow the CEO to count restricted stock towards the ownership requirement.[29] I then calculate the WPEs for the CEO's unconstrained stock ownership and constrained stock ownership, use them to replace *WPE_VestedStock* and *WPE_Unvest.Stock,* and re-estimate model (4.3).

The results, provided in Table 12, are very similar to those in Table 6. Specifically, the coefficient for *WPE_Uncons.Stock* (λ_1), the refined measure of the CEO's incentives from unconstrained stock, is positive and significant in all columns, while the coefficients for all other equity WPEs (λ_2 through λ_4) are generally indistinguishable from zero. These results provide additional support that the incentives provided by stock ownership that the CEO has freedom to sell are positively associated with the firm's subsequent performance.

[Insert Table 12 Here]

[29] Refer to Appendix C for more detailed discussion. Among the 2,862 firm-years where an ownership policy exists, the mean (median) dollar value of total vested stock is $10,214 ($3,948) thousand, and the mean (median) dollar value of stock holdings the firm specifies in the ownership guideline is $4,243 (3,811) thousand. The mean (median) dollar value of vested stock that is constrained by the firm's ownership policy among the same firm-year observations is $1,933 ($1,297) thousand.

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5.6 ALTERNATIVE MEASURE OF EQUITY INCENTIVES

A measure of equity incentives that prior studies use in examining the relation between firm performance and equity incentives is fractional ownership (Morck et al., 1988; McConnell and Servaes, 1990; Aggarwal and Samwick, 2006; and Kale et al, 2009). As a robustness test, I repeat my main analysis in Table 6 using fractional ownership to measure equity incentives. The results are shown in Table 13, Panel A.

[Insert Table 13 Here]

Although the coefficient for *VestedStock_p*, the CEO's fractional ownership of vested stock, is positive in every column of Table 13, Panel A, it is significant only in Column 4. As I argue earlier in Chapter 2, these weak results could be due to the effect from firm size (Hall and Liebman, 1998; Baker and Hall, 2004; Edmans et al., 2009). That is, a small fractional stock ownership in a large firm will likely provide the same level of incentives to the CEO as a large fractional stock ownership can do in a smaller firm. To test this explanation, I divide my full sample into three subsamples of firms that have small, medium, and large firm size according to the firm's tercile rank in total assets among all sample firms in the same year. I then repeat the analysis in Panel A for each of these three subsamples. I expect that the association between future performance and the CEO's fractional ownership of vested stock will be stronger within each subsample than in Panel A's pooled regressions.

My results in Panels B-D partially support my expectation. Specifically, in Panel B (D) where the sample includes small (large) firms, λ_1 is positive and significant in two (three) out of three regressions using Tobin's Q as the dependent variable. λ_1 is also positive in all columns of regressions using AOROA as the dependent variable in these two subsamples. However, it is

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significant only in Column 3 of Panel B. The results are weak in Panel C for firms of medium size. It is unclear why a positive link between the CEO's fractional ownership of vested stock and the firm's subsequent performance cannot be found in this subsample.

5.7 DO FIRMS CONSIDER THE CEO'S UNCONSTRAINED STOCK OWNERSHIP IN COMPENSATION CONTRACTS?

Proposition 3.4 states that new stock ownership that the firm grants the manager as compensation is independent of the manager's unconstrained stock ownership. Because in the real world, firms grant both stock ownership and options to the CEO as long-term incentives, I test Proposition 3.4 by examining the relation between long-term compensation and the CEO's existing ownership of vested stock. I obtain compensation data from ExecuComp. Long-term compensation is defined as the total value of stock and option grants. I regress the logarithm of (1 + long-term CEO compensation) on the CEO's current equity incentives measured as WPE and control variables. I also use total compensation in place of long-term compensation as an alternative test. The results, as provided in Table 14, are consistent with Proposition 3.4. Specifically, I find that the coefficient for $WPE\_VestedStock_{t}$ (λ_1) is not distinguishable from zero at conventional statistical levels in either column of Table 14.

[Insert Table 14 Here]

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6.0 CONCLUSION AND DISCUSSION

6.1 OVERVIEW OF CHAPTER

This chapter concludes my dissertation by discussing its findings, contributions and potential future research. Section 6.2 describes the main findings of this dissertation. Section 6.3 discusses the contributions of this dissertation to the literature. Section 6.4 concludes by discussing potential future research.

6.2 DISCUSSION OF FINDINGS

This dissertation examines how the CEO's ownership of unconstrained stock affects his effort choice and subsequent stock selling activity, and the firm's future performance. I first develop a theoretical model to characterize conditions under which the CEO will voluntarily hold additional shares of their firm. The equilibrium is one in which the firm's stock price is just sufficient to induce the CEO to play a mixed strategy in which he randomizes between (1) holding unconstrained stock and exerting high effort and (2) selling unconstrained stock and exerting low effort. My model predicts that if a CEO holds more unconstrained stock, then he will be less likely to sell stock and the firm will subsequently perform better.

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My empirical tests provide results consistent with these predictions. Specially, I find that CEOs with greater incentives from vested stock at the beginning of the year sell less of their own firm's stock during the year. Further, the CEO's current vested stock ownership is positively associated with the firm's industry-adjusted operating ROA and Tobin's Q in each of the subsequent three years. Additional tests suggest that the positive relation between the CEO's vested stock ownership and the firm's subsequent performance exists only when corporate governance is weaker, which is consistent with managerial ownership influencing firm performance through the CEO's productive effort. My results about the positive relation between the CEO's ownership of vested stock and future firm performance are also robust to the alternative explanation of the CEO's information advantage and a more accurate measure of unconstrained stock ownership that considers the firm's ownership policies.

In contrast to unconstrained stock ownership, the CEO's holdings of unvested stock and unvested options are generally not associated with the firm's future performance. These results are consistent with the view that no causal relation exists between equity ownership and subsequent firm performance because both are results of the firm's contracting environment (Demsetz, 1983; Demsetz and Lehn, 1985; Himmelberg et al., 1999). They are also consistent with the dynamic view that managerial incentives may become suboptimal as the contracting environment changes, but will be subsequently adjusted by the firm to revert to their optimal levels (Core and Guay, 1999; Core and Larcker, 2002; Core et al., 2003).

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6.3 CONTRIBUTIONS

My dissertation contributes to the literature in three ways, starting with the literature on the effect of managerial ownership on firm performance. Prior studies on this topic implicitly assume that the manager's entire stock ownership is constrained and argue that in equilibrium no causal relation should exist between the manager's stock ownership and firm performance because both are determined by the firm's contracting environment (Demsetz, 1983; Demsetz and Lehn, 1985; Himmelberg et al., 1999). I make the distinction between constrained and unconstrained stock and show that in equilibrium there exists a positive relation between unconstrained stock ownership and future firm performance. This relation arises because the more unconstrained stock the manager initially owns, the more likely he will continue to hold this stock and the higher the effort he will exert.[30]

Second, my dissertation adds to the literature on the determinants of managers' decisions to hold unconstrained equity. Prior literature is relatively silent about why CEOs voluntarily hold large amounts of unconstrained equity that is clearly riskier than a well-diversified portfolio. One notable attempt to address this issue is Armstrong et al. (2015). They argue that implicit agreements between the board and the CEO could be an additional reason for CEOs' unconstrained equity holdings.[31] As an alternative explanation, I interpret the CEO's voluntary holding of unconstrained stock as part of a mixed-strategy equilibrium in which the CEO holds his unconstrained stock with a certain probability and sells the stock with the remaining

[30] My theoretical model also suggests that the firm gives the CEO the same contract regardless of his initial unconstrained stock ownership. In other words, constrained stock ownership that the firm grants as a part of the CEO's contract does not offset the positive performance effect of the CEO's unconstrained stock ownership.

[31] Although they do not provide explicit empirical evidence, Armstrong et al. (2015) argue that such implicit contracts might be reached through informal agreements between the board and the CEO.

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probability. My explanation also differs from that in Blonski and Von Lilienfeld-Toal (2016), who derive an equilibrium in which the stock price is set below a certain level to induce the manager to always hold unconstrained stock and to exert high effort. Their explanation relies on the existence of a large blockholder or coordination among investors. My explanation does not have these limitations and can be applied to a larger group of companies.

Finally, my dissertation is related to the literature on insider trading. Prior studies on insider trading examine the information content of insiders' purchases and sales but do not address their decisions to hold stock. These studies commonly take the firm's fundamental value as exogenous and assume that insiders' trading reveals information about this fundamental value (for example, Lakonishok and Lee, 2001; Fidrmuc et al., 2006). In contrast, my analysis shows that an insider's unconstrained stock ownership will be informative even if no trading takes place. My study provides an alternative perspective in which the CEO, as an insider, can affect the firm's fundamental value in the long run through productive effort choices associated with the level of his unconstrained stock ownership.

6.4 FUTURE RESEARCH

The reason why the CEO's current unconstrained stock ownership matters is because he is unable to commit to a stock holding level and the firm is uncertain about how much effort the CEO will exert. Thus, a natural question is whether firms should more fully constrain the CEO's ability to sell stock. For example, contracts could be written such that none of the stock that the firm grants vests until the CEO retires. On the one hand, doing so will ensure that the CEO exerts

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maximal effort with probability one, resulting in higher productive outcome for the firm. On the other hand, more extensive constraints on stock selling will increase the risk imposed on the CEO and require the firm to pay the CEO more. My model suggests that the stock market already influences the CEO's stock selling through asset pricing. Therefore, the additional premium the firm would need to pay the CEO to hold additional stock, i.e., to convert unconstrained stock to constrained stock, might not be as high as one would expect. Thus, the net effect of constraining the CEO's ability to sell stock is an interesting empirical question.

An interesting setting that future research can use is the recent trend in compensation practice that involves companies adopting ownership policies to limit executives' ability to sell their own firm's stock. First, new ownership policies, especially those adopted after 2000, are more likely to be companies' window dressing of their policies than driven by the intention to improve firm performance (Shilon, 2014).[32] Therefore, the adoption of these newer policies can offer a relatively clean setting for examining the changes in the cost of contracting with the CEO and subsequent firm performance, which I discussed previously. Second, it is unclear why ownership policies differ across firms. Future research can examine the determinants of companies' choice of specific ownership policies. Finally, because many new ownership policies are structured in such ways that managers can still sell all of their vested stock (Shilon, 2014),[33] these policies could provide an off-equilibrium setting to test my model about the CEO's mixed strategy. According to my model, the CEO will sell his stock if stock price is "too high" due to

[32] Core and Larcker (2002) find that firm performance increases following target ownership plans that were implemented between 1991 and 1995. However, they also find that the implementation of these plans is associated with poor prior firm performance. Further, they do not examine the change in CEO compensation.

[33] As discussed earlier, many ownership guidelines allow the CEO to count restricted stock toward the firm's specified ownership target. If the CEO already owns a large amount of restricted stock, then such guidelines have limited ability to limit the CEO's sale of vested stock.

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the market not being fully informed about new ownership policies, which would run counter to the firm's intention of constraining CEO stock selling.

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APPENDIX A

A Modified Model in Which the Manager Can Sell a Fraction of Vested Stock

Instead of choosing whether to hold or sell his entire α vested stock, assume that the manager chooses a fraction $\theta \in [0,1]$ of his α vested stock to continue to hold until the end of the period. In this setting, the manager's firm wealth at the end of the period, w_f, will have the following four components: (1) salary, s, (2) cash proceeds from selling stock, $(1-\theta)\,\alpha\,P$, (3) his share of the firm's net assets when the firm liquidates, $(\theta\alpha+\beta)\,[m(1+y)-s]$. Thus, the manager's wealth factor f as a function of effort e and stock holding decision θ, while taking stock price P and contract (s, β) as given, is

$$f(e,\theta|P,s,\beta) = 1 + \frac{s}{w_0} + \frac{(1-\theta)\alpha P}{w_0} + \frac{(\theta\alpha+\beta)(m-s)}{w_0} + \frac{(\theta\alpha+\beta)my}{w_0} - \frac{e^2}{2}$$

The manager's problem is choosing e and θ to maximize the expected value of $G(f(e, \theta \mid P, s, \beta))$. With $G(f) = -\exp(-\rho f)$ and $y \sim N(Le, \sigma^2)$, the manager's certainty equivalent for $f(e, \theta \mid P, s, \beta)$ is

$$CE(e,\theta|P,s,\beta) = 1 + \frac{s}{w_0} + \frac{(1-\theta)\alpha P}{w_0} + \frac{(\theta\alpha+\beta)(m-s)}{w_0} + \frac{(\theta\alpha+\beta)mLe}{w_0} - \frac{e^2}{2} - \frac{(\theta\alpha+\beta)^2 m^2 \sigma^2 \rho}{2{w_0}^2} \quad \text{(A1)}$$

Proposition A. *Given any stock price P and contract (s, β), there is no θ ∈ (0,1) that maximizes the manager's expected utility. In other words, in equilibrium θ can only take the value of 0 or 1.*

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Proof: Suppose a pure strategy equilibrium exists in which the manager chooses a combination of stock holding fraction θ^* and effort level e^*, given stock price P and contract (s, β). From the manager's perspective, in equilibrium the following two inequalities must hold:

$$CE\ (e^*, \theta^* \mid P, s, \beta) \geq CE\ (e', \theta^* \mid P, s, \beta),\ \forall\ e' \neq e^* \tag{A2}$$

$$CE\ (e^*, \theta^* \mid P, s, \beta) \geq CE\ (e', \theta' \mid P, s, \beta),\ \forall\ e', \theta' \tag{A3}$$

Inequality (A2) must hold because otherwise the manager would not choose $e=e^*$, given P, s, β and θ^*. Inequality (A3) ensures that the manager is always better off by choosing the equilibrium holding strategy of θ^* and exerting e^*, as opposed to choosing any other combination of θ and e.

From (A1) and (A2),

$$e^* = argmax_e\ CE(e \mid P, \theta^*, s, \beta) = (\theta^*\alpha + \beta)mL/w_0 = (\theta^*A + B)L \tag{A4}$$

Now turn to (A3), which states that given P and (s, β), the manager's choice of combination (e^*, θ^*) is the combination among all possible combinations of (e, θ) that gives him maximal expected utility. Following the same logic as (A2) and (A4), for any $\tilde{\theta} \in [0,1]$, the effort that maximizes the manager's expected utility is $\tilde{e} = (\tilde{\theta}A + B)L$. Thus (A3) is equivalent to

$$CE\ (\theta^* \mid P, e^*, s, \beta) \geq CE\ (\tilde{\theta} \mid P, \tilde{e}, s, \beta),\ \forall\ \tilde{\theta} \tag{A5}$$

Substituting for $\tilde{e} = (\tilde{\theta}A + B)\,L$ and after some algebra,

$$CE\ (\tilde{\theta}|P, \tilde{e}, s, \beta) = 1 + \frac{s}{w_0} + \frac{(1-\tilde{\theta})\alpha P}{w_0} + \frac{(\tilde{\theta}\alpha + \beta)(m-s)}{w_0}$$

$$+ \frac{(\tilde{\theta}A + B)^2(L^2 - \sigma^2\rho)}{2} \tag{A6}$$

In order for a solution $\theta^* \in (0,1)$ to exist for (A5), the first order derivative of $CE\ (\tilde{\theta} \mid P, \tilde{e}, s, \beta)$ with respect to $\tilde{\theta}$ must equal zero when valued at θ^*:

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$$\frac{\partial CE\ (\tilde{\theta}|P,\tilde{e},s,\beta)}{\partial\tilde{\theta}}|_{\tilde{\theta}=\theta^*}=0$$

This suggests that

$$\frac{-\alpha P}{w_0}+\frac{\alpha(m-s)}{w_0}+A(\theta^*A+B)(L^2-\sigma^2\rho)=0 \qquad \text{(A7)}$$

With $\theta=\theta^*$ and $e=(\theta^*A+B)L$ being the equilibrium, the firm's stock price will be $P=m(1+Ey)-s=m-s+m(\theta^*A+B)L^2$. Substituting for this stock price, the LHS of (A7) becomes $-A(\theta^*A+B)\sigma^2\rho$, which will always be negative. This suggests that the manager will prefer to hold less stock given any assumed equilibrium value of $\theta\in(0,1)$.

Q.E.D.

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APPENDIX B

Definitions for Variables Used in Empirical Tests

Dependent Variables	
SharesSold	100 times the number of shares the CEO sells in a year, divided by the firm's total number of outstanding shares at the end of the year.
AOROA	Industry-adjusted operating ROA. Calculated as income after depreciation divided by average assets, adjusted by the Fama-French 48 industry median in the same year.
Tobin's Q	Market value of assets divided by book value of assets, where market value of assets is equal to market value of the firm plus total debt.
Independent Variables	
WPE_VestedStock	Incentives provided by vested stock, measured as *(# Vested Shares * Stock Price)/Total Compensation,* where *# Vested Shares = Total # Shares the CEO Owns – # Shares in Restricted Stock.*
WPE_UnvestedStock	Incentives provided by unvested stock, measured as *(# Shares in Restricted Stock * Stock Price)/Total Compensation.*
WPE_VestedOptions	Incentives provided by vested stock options, measured as *(∑ # Vested Options in an Outstanding Award * Option Delta) * Stock Price /Total Compensation,* where *Option Delta* is calculated using the Black-Scholes model (1973). Vested Options held prior to 2006 are treated as one grant and valued following Core and Guay (2002).
WPE_UnestedOptions	Incentives provided by unvested stock options, measured as *(∑ # Unvested Options in an Outstanding Award * Option Delta) * Stock Price /Total Compensation,* where *Option Delta* is calculated using the Black-Scholes model (1973). Unvested Options held prior to 2006 are treated as one grant and valued following Core and Guay (2002).
Control Variables	
Return	Stock return of the firm's stock, measured as cumulative return for the firm's stock over the twelve months in a given year.
Size	Firm size, measured as the natural log of the firm's total assets.
Volatility	Stock volatility, measured as the standard deviation of the firm's monthly stock returns over the past 60 months, then converted to annual volatility.
Mtb	Market value of equity divided by book value of equity.
Leverage	Leverage of the firm, calculated as long-term debt divided by total assets.
Overconfidence	=1 if the CEO has had at least two years over his CEO tenure in which average moneyness of his vested stock options is at least 67%, =0 otherwise.
Tenure	The CEO's tenure, which equals 1 for the CEO's first year in office and increases by 1for each additional year in office.

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APPENDIX C

Ownership Policies Data and the Calculation of Vested Stock Constrained by Ownership Target

I have data on 797 firms' ownership policies in 12,911 firm-years. The data provides information about whether a firm discloses an ownership policy in the proxy statement in a given year and details of the policy if one is disclosed. I exclude 578 firm-years that have general stock retention policies, i.e., policies that require the CEO to retain for a certain period of time all or part of the after-tax shares he receives in the exercise of options or through vesting of restricted stock. Calculating the number of shares the CEO needs to hold under general retention policies will require data on his personal tax rate and full information on previous years' stock vesting, option exercise, and the number of shares sold following these transactions, which companies do not typically disclose. I also exclude 1,466 observations due to insufficient information for calculating the CEO's required stock holdings.

The remaining 10,867 observations either have no disclosed ownership policy (7,011 observations) or have an ownership policy in the form of ownership guidelines (3,856 observations), which typically specify the number of shares or dollar value of stock the CEO needs to hold. Most frequently ownership guidelines require the CEO to hold stock with a dollar value equal to a certain multiple of his base salary. For the 3,856 observations that have ownership guidelines for the CEO, I calculate the number of vested shares that are constrained by the firm's ownership requirement in three steps: (1) calculating the number of shares the firm

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requires the CEO to hold, (2) calculating the number of shares the firm allows the CEO to count toward the ownership requirement, (3) comparing the numbers calculated in steps (1) and (2) and calculating the number of vested shared constrained by the firm's ownership requirement.

Step (1) is straightforward, because ownership guidelines specify either the number of shares or the dollar value of shares the CEO needs to hold, which can be readily converted to the number of shares. In step (2) I require detailed information about which stock and options, if any, count toward the ownership target. Among the 2,157 (56%) observations that disclose whether the CEO can count *restricted stock*, 339 (16%) do not allow the CEO to include any, 42 (2%) allow the CEO to include a certain percentage between 0% and 100%, and 1,776 (82%) allow the CEO to include 100%. Among the 2,182 (57%) observations that disclose whether the CEO can count *in-the-money portion of vested stock options*, 1,699 (78%) do not allow the CEO to include any, 113 (5%) allow the CEO to include a certain percentage between 0% and 100%, and 370 (17%) allow the CEO to include 100%. Based on these statistics, if a firm does not provide full disclosure about which equity holdings can be included toward the firm's ownership requirement, then I assume the CEO can count his entire restricted stock but none of his stock options. Finally, in step (3) I compare the numbers I calculate in steps (1) and (2). I assume that the CEO first uses restricted stock and in-the-money portion of vested options, if the firm allows, to meet the firm's ownership requirement. If these holdings are not enough to meet the ownership target, then the CEO's vested stock starts to get constrained.

Here is an example of how to calculate the number of vested shares that are constrained by the firm's ownership policy. Suppose a CEO has 1,000 shares of vested stock and 500 shares of restricted stock. The firm requires that the CEO holds at least 700 shares and allows him to count restricted stock toward this requirement. In this case, the CEO first uses the 500 shares of

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restricted stock to meet the ownership target (700 shares). However, because the CEO's restricted stock is not enough to meet the target, he needs to put 200 shares of vested stock aside to ensure that he meets the firm's requirement (500 shares of unvested stock + 200 shares of vested stock = 700 shares to meet the requirement). Thus, these 200 shares are vested but become constrained and unsellable. The maximum amount of vested shares the CEO can sell, i.e., unconstrained and sellable shares, is 800 shares.

Note that when ownership guidelines are first implemented, executives are often given a certain period of time, typically three to five years, to achieve the ownership targets. Further, some firms require the CEO to retain a fraction of newly vested stock and stock obtained in option exercise before the CEO meets the ownership requirement. For simplicity, I assume that the ownership requirement takes effect immediately and the CEO must meet the firm's ownership requirement before selling any stock.

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Figure 1. Timeline of the Model

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Table 1. Notation Used in the Model

α	The manager's unconstrained ownership of the firm at the beginning of the period.
β	Constrained ownership that the firm grants to the manager at the beginning of the period, which vests at the end of the period.
δ	Random noise of the manager's production outcome, $\delta \sim N(0,\sigma^2)$.
ρ	The manager's constant relative risk aversion.
τ	The manager's constant absolute risk aversion, $\tau = \rho / w_0$.
A	Wealth-performance elasticity (WPE) of the manager's α unconstrained stock, $A = m\alpha / w_0$.
B	Wealth-performance elasticity (WPE) of the manager's β unconstrained stock, $B = m\beta / w_0$.
$c(e)$	Cost of effort, $c(e) = w_0 e^2/2$.
e	The manager's effort, exerted at the beginning of the period.
f	Wealth factor, $f = 1 + w_f / w_0 - e^2/2$.
$G(f)$	The manager's utility, $G(f) = -exp(-\rho f)$.
L	Productivity of the manager's effort.
m	The initial value of the firm.
P	The firm's stock price at the beginning of the period.
q	The probability that the manager holds the α unconstrained stock.
s	The manager's salary, paid at the beginning of the period.
$U(w)$	The manager's utility, $U(w) = -exp(-\tau w)$.
$U(\overline{w})$	The manager's reservation utility.
V	The manager's stock holding decision. $V=H$ if the manager holds vested stock, $V=S$ if the manager sells vested stock.
w	The manager's wealth, $w = w_0 + w_f - c(e)$.
w_0	The manager's outside wealth.
w_a	The pay of the manager's outside alternative job that requires no effort.
w_f	The manager's firm-related wealth.
y	The manager's production outcome, $y = Le + \delta$.

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Table 2. Sample Selection Process

This table reports my sample selection process. Starting from 32,104 firm-years among S&P 1500 firms over the period between 1992 and 2014 that involve 5,909 CEOs, I screen and identify 21,286 observations as the main sample for testing my hypotheses, which involve 4,474 CEOs in 2,540 firms over the period from 1992 to 2014.

Firm-years covered by ExecuComp, CompuStat, and CRSP with a CEO whose trading data is also available in Thomson Reuters Insider Filing data	32,104
Less: firm-years where the CEO's calculated number of vested shares is negative	(2,015)
Less: firm-years that involve a CEO who owns more than 5% of the firms at any year during his tenure as CEO	(7,014)
Less: firm-years where one or more of the CEO's equity holding incentives, measured by WPE, is not computable	(1,051)
Less: firm-years with missing control variables	(738)
Main sample for testing hypotheses	21,286

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Table 3. Summary Statistics

This table reports summary statistics for variables used in this study. Panel A reports summary statistics for the CEO's annual compensation and equity incentives, and control variables for the main sample that consists of 21,286 observations of firm-years, described in more detail in Section 4.1 and Table 2. The CEO's equity incentives are measured first in dollar values and then in wealth-performance elasticities (*WPE*s). Dollar values for stock options are calculated as 100 times the change in the options' Black-Scholes value in response to 1% change in stock price. WPE for a specific equity component is calculated as the dollar value of the equity divided by the CEO's current year total compensation. Panel B reports summary statistics for dependent variables and unique independent variables used in testing H1 and H2. The sample for testing H1 consists of 17,099 observations within the main sample of 21,286 firm-years that have non-missing *Beg.VestedStock, NewVestedStock,* and *StockSold*. *Dummy(StockSold>0)* takes value one if *StockSold*>0, and zero otherwise. *Beg.VestedStock* is 100 times the CEO's percentage stock ownership of the firm at the beginning of the year. *NewVestedStock* is 100 times the number of newly vested shares in the year divided by the firm's total outstanding shares. The number of newly vested shares in the pre-2006 period is calculated as *# Beginning restricted shares + Value of restricted stock grant / Year-end stock price – # Ending restricted shares.* The sample for testing H2 consists of 19,311 observations within the main sample of 21,286 firm-years that have non-missing $AOROA_{t}$, $AOROA_{t+1}$, $Tobin's\ _{t}$, and $Tobin's\ _{t+1}$. Definitions for variables not specifically discussed here are in Appendix B

Panel A. Equity Incentives

Variable	Mean	Median	Q1	Q3	P5	P95	Std. Dev.
CEO Incentives and Compensation ($000s)							
Total compensation	4,657	2,691	1,323	5,586	542	14,968	6,524
Total equity held	27,136	15,078	6,096	37,027	1,296	97,340	30,072
Vested stock	7,525	3,269	939	9,164	61	38,797	10,237
Unvested stock	1,444	28	0	1,726	0	8,943	2,487
Vested options	10,806	3,882	570	13,647	0	56,070	15,531
Unvested options	7,361	3,254	804	9,621	0	35,219	9,683
CEO Incentives (WPEs)							
Total equity held	7.09	5.45	2.88	9.73	0.97	18.59	5.71
Vested stock	2.38	1.10	0.40	2.81	0.03	12.26	3.17
Unvested stock	0.32	0.02	0.00	0.51	0.00	1.55	0.46
Vested options	2.70	1.58	0.31	3.86	0.00	11.10	3.10
Unvested options	1.69	1.27	0.50	2.39	0.00	5.85	1.59
Relative Importance of Vested/Unvested Stock							
Vested stock/Total equity	31.4%	24.7%	10.5%	46.3%	1.0%	87.1%	26.2%
Unvested stock/Total equity	8.0%	0.7%	0.0%	10.9%	0.0%	35.9%	13.7%
Vested stock/Total stock	81.2%	97.2%	67.5%	100.0%	23.9%	100.0%	25.8%
Unvested stock/Total stock	18.8%	2.8%	0.0%	32.5%	0.0%	76.1%	25.8%

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Table 3. Summary Statistics (Continued)

Panel B. Control Variables

Variable	Mean	Median	Q1	Q3	P5	P95	Std. Dev.
Return	0.151	0.099	-0.121	0.331	-0.499	0.961	0.473
Size	14.599	14.490	13.345	15.740	11.931	17.623	1.728
Volatility	0.406	0.358	0.261	0.497	0.174	0.824	0.204
Mtb	2.853	2.089	1.404	3.316	0.701	7.748	2.948
Leverage	0.380	0.347	0.168	0.540	0.016	0.911	0.266
Overconfidence	0.392	0.000	0.000	1.000	0.000	1.000	0.488
Tenure	6.372	5.000	3.000	8.000	1.000	17.000	5.272

Panel C. Dependent Variables and Unique Independent Variables Used in Hypothesis Testing

Variable	Mean	Median	Q1	Q3	P5	P95	Std. Dev.
Variables Used in Testing CEO Stock Selling Activity (H1)							
StockSold	0.02	0.00	0.00	0.00	0.00	0.12	0.07
Dummy (Stock sold>0)	0.17	0.00	0.00	0.00	0.00	1.00	0.38
Beg.VestedStock	0.432	0.177	0.056	0.502	0.006	1.872	0.652
NewVestedStock	0.034	0.0004	0.000	0.037	-0.002	0.182	0.076
Variables Used in Testing Firm Performance (H2)							
$AOROA_{t}$	0.053	0.026	-0.005	0.088	-0.076	0.276	0.115
$AOROA_{t+1}$	0.051	0.024	-0.006	0.085	-0.081	0.273	0.116
$Tobin's_{t}$	1.802	1.414	1.112	2.029	0.923	4.013	1.160
$Tobin's_{t+1}$	1.770	1.409	1.108	2.001	0.919	3.840	1.095

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Table 4. Correlations Among Incentive Provided by Different Equity Holdings

This table reports the correlations between different components of the CEO's equity incentives, measured as wealth-performance elasticities (*WPE*s). P-values are reported under correlations. Panel A reports Pearson correlations while Panel B reports Spearman correlations.

Panel A. Pearson Correlations

	Vested Stock	Unvested Stock	Vested Options	Unvested Options	Total Equity
Vested Stock	1.000	0.043	0.255	0.114	0.730
	-	(<.0001)	(<.0001)	(<.0001)	(<.0001)
Unvested Stock	0.043	1.000	-0.044	-0.101	0.052
	(<.0001)	-	(<.0001)	(<.0001)	(<.0001)
Vested Options	0.255	-0.044	1.000	0.420	0.798
	(<.0001)	(<.0001)	-	(<.0001)	(<.0001)
Unvested Options	0.114	-0.101	0.420	1.000	0.562
	(<.0001)	(<.0001)	(<.0001)	-	(<.0001)
Total Equity	0.730	0.052	0.798	0.562	1.000
	(<.0001)	(<.0001)	(<.0001)	(<.0001)	-

Panel B. Spearman Correlations

	Vested Stock	Unvested Stock	Vested Options	Unvested Options	Total Equity
Vested Stock	1.000	0.039	0.246	0.043	0.639
	-	(<.0001)	(<.0001)	(<.0001)	(<.0001)
Unvested Stock	0.039	1.000	-0.124	-0.148	-0.020
	(<.0001)	-	(<.0001)	(<.0001)	(0.006)
Vested Options	0.246	-0.124	1.000	0.439	0.762
	(<.0001)	(<.0001)	-	(<.0001)	(<.0001)
Unvested Options	0.043	-0.148	0.439	1.000	0.534
	(<.0001)	(<.0001)	(<.0001)	-	(<.0001)
Total Equity	0.639	-0.020	0.762	0.534	1.000
	(<.0001)	(0.006)	(<.0001)	(<.0001)	-

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Table 5. The CEO's Stock Selling Activity

This table reports the results of regressions using three specifications of the model in equation (4.1), where ΘZ_t is a linear combination of control variables illustrated in equation (4.2). The dependent variable is *StockSold*, calculated as 100 times the number of shares the CEO sells in a year, divided by the firm's total number of outstanding shares at the end of the year. *Beg.VestedStock* is calculated as 100 times the CEO's percentage stock ownership of the firm at the beginning of the year. *NewVestedStock* is calculated as 100 times the number of newly vested shares in the year divided by the firm's total outstanding shares. The number of newly vested shares in the pre-2006 period is calculated as *# Beginning restricted shares + Value of restricted stock grant / Year-end stock price – # Ending restricted shares.* Definitions for all other variables are in Appendix B. The sample consists of 17,099 observations within the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have non-missing dependent variable and independent variables. Standard errors are clustered at the firm level. Panel A reports the coefficients for *Beg.VestedStock , NewVestedStock ,* and their interactions with equity incentive WPEs. Panel B reports the coefficients for the interactions between *Beg.VestedStock* or *NewVestedStock* and control variables for the regression in Panel A, Column 3, where the full model of equation (4.1) is used. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

	Predicted Sign	StockSold $_t$		
		(1)	(2)	(3)
Beg.VestedStock $_t$ (λ_1)	+	0.0275***	0.0291***	0.0404*
		(<0.001)	(<0.001)	(0.086)
NewVestedStock $_t$ (λ_2)	+	0.123***	0.103***	-0.254
		(<0.001)	(<0.001)	(0.117)
Interaction between Beg.VestedStock $_t$ and				
WPE_VestedStock $_{t-1}$ (γ_1)	-		-0.0015***	-0.0012***
			(<0.001)	(0.001)
WPE_Unvest.Stock $_{t-1}$ ($\theta_{1,1}$)	?		-0.0021	-0.0054
			(0.607)	(0.185)
WPE_VestedOptions $_{t-1}$ ($\theta_{1,2}$)	?		0.0010*	0.0006
			(0.080)	(0.354)
WPE_Unvest.Options $_{t-1}$ ($\theta_{1,3}$)	?		0.0045***	0.0029**
			(0.003)	(0.041)
Interaction between NewVestedStock $_t$ and				
WPE_VestedStock $_{t-1}$ (γ_2)	-		-0.0019	-0.0071*
			(0.355)	(0.091)
WPE_Unvest.Stock $_{t-1}$ ($\theta_{2,1}$)	?		0.0506**	0.0480**
			(0.020)	(0.030)
WPE_VestedOptions $_{t-1}$ ($\theta_{2,2}$)	?		0.0044	0.0001
			(0.476)	(0.987)
WPE_Unvest.Options $_{t-1}$ ($\theta_{2,3}$)	?		-0.0222*	-0.0153
			(0.053)	(0.164)
Interactions with firm/CEO characteristics included		N	N	Y
Interactions with year dummies included		N	N	Y
Standard errors clustered by		Firm	Firm	Firm
Observations		17,099	17,099	17,099
R-squared		0.128	0.139	0.171

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Table 5. The CEO's Stock Selling Activity (Continued)

Panel B. Coefficients for Control Variables in the Regression in Panel A, Column (3)

Control variable	Predicted sign	Interaction between control variable and	
		Beg.VestedStock $_t$	NewVestedStock $_t$
Return $_t$	+	0.0138***	0.0766***
		(<0.001)	(0.003)
Size $_t$	?	-0.0021	0.0089
		(0.227)	(0.377)
Volatility $_t$	+	-0.0189**	0.0429
		(0.042)	(0.481)
Mtb $_t$	?	0.0016**	-0.0000
		(0.014)	(0.997)
Leverage $_t$	?	-0.0209***	-0.1026*
		(0.002)	(0.055)
Overconfidence $_t$	-	0.0008	0.0060
		(0.829)	(0.830)
LogTenure $_t$	+	0.0019	0.0355**
		(0.170)	(0.023)

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Table 6. Future Firm Performance

This table reports the results of regressions using the model in equation (4.3). Definitions for all variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. The sample for each column consists of all observations among the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have non-missing dependent variable, $AOROA_t$, and $Tobin's\ Q_t$. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

	Predicted Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
$WPE\_VestedStock_t$ (λ_1)	+	0.0003*	0.0006**	0.0009***	0.0059**	0.0061**	0.0074**
		(0.072)	(0.041)	(0.006)	(0.011)	(0.031)	(0.024)
$WPE\_Unvest.Stock_t$ (λ_2)	?	0.0027**	0.0027	0.0006	-0.0012	-0.0057	-0.005
		(0.026)	(0.146)	(0.777)	(0.927)	(0.740)	(0.787)
$WPE\_VestedOptions_t$ (λ_3)	?	0.0002	0.0002	0.0001	-0.0033	0.0023	0.0011
		(0.411)	(0.453)	(0.712)	(0.266)	(0.537)	(0.770)
$WPE\_Unvest.Options_t$ (λ_4)	?	0.0009**	0.0003	0.0004	-0.0021	-0.0074	-0.0063
		(0.0367)	(0.630)	(0.470)	(0.683)	(0.217)	(0.291)
$AOROA_t$	+	0.539***	0.251***	0.120***			
		(<0.001)	(<0.001)	(<0.001)			
Tobin's Q_t	+				0.441***	0.205***	0.0863***
					(<0.001)	(<0.001)	(0.002)
$Return_t$	+/-	0.0175***	0.0077***	0.0027*	-0.0116	-0.0303**	-0.0260*
		(<0.001)	(<0.001)	(0.056)	(0.254)	(0.045)	(0.072)
$Size_t$	?	-0.0137***	-0.0178***	-0.0167***	-0.277***	-0.342***	-0.280***
		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Mtb_t	?	0.001***	0.0002	-0.0004	-0.0008	-0.0014	0.0007
		(0.004)	(0.698)	(0.466)	(0.865)	(0.805)	(0.926)
$Leverage_t$	?	0.0174**	0.0254**	0.0359***	-0.0091	0.0747	0.0520
		(0.012)	(0.015)	(0.003)	(0.914)	(0.487)	(0.682)

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Table 6. Future Firm Performance (Continued)

	Predicted Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
Overconfidence	?	0.0017	0.0020	0.0010	0.0499***	0.0498**	-0.0052
		(0.246)	(0.345)	(0.681)	(0.008)	(0.030)	(0.822)
Volatility $_t$	?	-0.0110**	-0.0074	0.0001	-0.0042	0.0741	0.149
		(0.045)	(0.390)	(0.990)	(0.949)	(0.406)	(0.109)
LogTenure $_t$	-	-0.0017**	-0.0018	-0.0021*	-0.0253***	-0.0287***	-0.0131
		(0.030)	(0.113)	(0.099)	(0.001)	(0.004)	(0.208)
Constant	?	0.198***	0.267***	0.252***	4.793***	5.945***	5.381***
		(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Year fixed effect		Y	Y	Y	Y	Y	Y
Firm fixed effect		Y	Y	Y	Y	Y	Y
# Firms		2,420	2,266	2,107	2,420	2,265	2,105
# Observations		19,311	17,335	15,454	19,311	17,316	15,432
R-squared		0.377	0.109	0.048	0.334	0.172	0.117

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Table 7. Corporate Governance: Institutional Ownership

This table reports the results of regressions using the model in equation (4.3). Definitions for all variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. Each subsample is a portion of the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have available institutional ownership data from Thomson Reuters Institutional (13f) Holdings file and have non-missing dependent variable, $AOROA_t$, and $Tobin's\ Q_t$. The High (low) institutional ownership subsample includes observations with institutional ownership equal to/above (below) yearly median institutional ownership. Panel A provides descriptive statistics for each subsample. Panels B and C provide regression results for each subsample. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

Panel A. Descriptive statistics for each subsample

	High inst. ownership subsample		Low inst. ownership subsample	
	Mean	Median	Mean	Median
Inst. ownership	0.84	0.84	0.54***	0.56
WPE_VestedStock	2.23	1.09	2.43***	1.10
Size	14.45	14.37	14.74***	14.76
Mtb	3.04	2.27	2.80***	1.97
Leverage	0.34	0.32	0.41***	0.39
Volatility	0.42	0.38	0.40***	0.33

Panel B. High institutional ownership subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
$WPE\_VestedStock_t$	?	0.0002	-0.0000	0.0006	0.0035	-0.0047	-0.0004
		(0.469)	(0.993)	(0.316)	(0.446)	(0.390)	(0.948)
$WPE\_Unvest.Stock_t$	?	0.0039**	0.0057**	0.0021	0.0043	0.0002	0.0200
		(0.047)	(0.048)	(0.532)	(0.825)	(0.996)	(0.498)
$WPE\_Vest.Options_t$	?	0.0005*	0.0006	0.0005	-0.0042	0.0011	-0.0011
		(0.068)	(0.219)	(0.349)	(0.320)	(0.828)	(0.831)
$WPE\_Unvest.Options_t$	?	0.0006	0.0001	-0.0004	0.0075	-0.0051	-0.0061
		(0.405)	(0.925)	(0.721)	(0.415)	(0.614)	(0.574)
$AOROA_t$	+	0.5479***	0.2374***	0.1313***			
		(0.000)	(0.000)	(0.001)			
$Tobin's\ Q_t$	+				0.4532***	0.2090***	0.0861**
					(0.000)	(0.000)	(0.028)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,475	1,342	1,248	1,475	1,341	1,244
# Observations		8,280	7,374	6,597	8,280	7,361	6,580
R-squared		0.350	0.098	0.048	0.351	0.169	0.119

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Table 7. Corporate Governance: Institutional Ownership (Continued)

Panel C. Low institutional ownership subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	+	0.0006**	0.0011**	0.0014**	0.0120***	0.0139***	0.0170***
		(0.049)	(0.023)	(0.010)	(0.002)	(0.002)	(0.003)
WPE_Unvest.Stock $_t$	?	0.0004	-0.0005	-0.0019	0.0021	0.0034	-0.0003
		(0.809)	(0.841)	(0.475)	(0.927)	(0.896)	(0.991)
WPE_Vest.Options $_t$	?	-0.0000	-0.0007	-0.0010*	-0.0077	-0.0064	-0.0081
		(0.964)	(0.207)	(0.059)	(0.144)	(0.298)	(0.208)
WPE_Unvest.Options $_t$	?	0.0016**	0.0015	0.0020*	0.0026	0.0094	0.0135
		(0.046)	(0.143)	(0.062)	(0.812)	(0.423)	(0.224)
AOROA $_t$	+	0.4429***	0.2008***	0.0771*			
		(0.000)	(0.000)	(0.078)			
Tobin's Q $_t$	+				0.4165***	0.2108***	0.0580
					(0.000)	(0.000)	(0.167)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,500	1,379	1,285	1,500	1,377	1,284
# Observations		8,269	7,357	6,620	8,269	7,345	6,608
R-squared		0.263	0.074	0.036	0.303	0.170	0.106

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Table 8. Corporate Governance: Board Independence and CEO Duality

This table reports the results of regressions using the model in equation (4.3). Definitions for all variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. Each subsample is a portion of the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have non-missing dependent variable, $AOROA_t$, and $Tobin's\ Q_t$. The subsamples in Panels A and B further require available board independence from ISS, which is calculated as the number of independent directors divided by the total number of directors on the firm's board. The High (Low) board independence subsample in Panel A (B) includes observations with board independence equal to/above (below) yearly median board independence. The Chairman (Non-chairman) subsample in Panel C (D) includes observations with a CEO whose title in ExecuComp includes (does not include) "Chairman". Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

Panel A. High board independence subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	?	-0.0001	0.0005	0.0013**	0.0030	0.0027	0.0086
		(0.792)	(0.376)	(0.019)	(0.481)	(0.614)	(0.187)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,374	1,235	1,145	1,374	1,231	1,141
# Observations		7,009	6,229	5,555	7,009	6,216	5,543
R-squared		0.324	0.074	0.032	0.335	0.196	0.145

Panel B. Low board independence subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	+	-0.0002	-0.0001	0.0001	0.0059*	0.0033	0.0057
		(0.333)	(0.476)	(0.414)	(0.098)	(0.283)	(0.192)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,607	1,458	1,329	1,607	1,455	1,329
# Observations		7,035	6,219	5,553	7,035	6,210	5,543
R-squared		0.308	0.084	0.071	0.281	0.168	0.145

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Table 8. Corporate Governance: Board Independence and CEO Duality (Continued)

Panel C. Chairman subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	+	0.0002	0.0004	0.0011**	0.0007	0.0040	0.0046
		(0.239)	(0.199)	(0.015)	(0.413)	(0.146)	(0.154)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,607	1,489	1,384	1,607	1,487	1,382
# Observations		10,386	9,401	8,589	10,386	9,389	8,573
R-squared		0.280	0.082	0.038	0.340	0.184	0.132

Panel D. Non-chairman subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	?	0.0005	0.0011*	0.0008	0.0111**	0.0070	0.0117
		(0.239)	(0.080)	(0.253)	(0.034)	(0.299)	(0.145)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,840	1,707	1,550	1,840	1,702	1,547
# Observations		8,931	7,839	6,894	8,931	7,821	6,878
R-squared		0.323	0.085	0.045	0.297	0.154	0.112

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Table 9. Nature of Business: R & D

This table reports the results of regressions using the model in equation (4.3). Definitions for all variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. Each subsample is a portion of the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have non-missing dependent variable, $AOROA_t$, and $Tobin's\ Q_t$. The Positive (Zero) R&D subsample includes observations with positive (zero) R&D in CompuStat. Panel A provides descriptive statistics for each subsample. Panels B and C provide regression results for each subsample. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

Panel A. Descriptive statistics for each subsample

	Positive R&D subsample		Zero R&D subsample	
	Mean	Median	Mean	Median
R&D	0.07	0.04	0.00***	0.00
WPE_VestedStock	2.08	0.93	2.54***	1.20
Size	14.18	14.04	14.81***	14.71
Mtb	3.47	2.56	2.42***	1.82
Leverage	0.27	0.26	0.44***	0.43
Volatility	0.46	0.40	0.38***	0.34

Panel B. Positive R&D subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
$WPE\_VestedStock_t$	?	0.0008**	0.0011**	0.0015**	0.0133***	0.0103*	0.0103*
		(0.047)	(0.035)	(0.027)	(0.008)	(0.065)	(0.100)
$WPE\_Unvest.Stock_t$	?	0.0043**	0.0061*	0.0074**	0.0207	0.0233	0.0064
		(0.046)	(0.059)	(0.038)	(0.382)	(0.462)	(0.854)
$WPE\_Vest.Options_t$	?	0.0001	-0.0002	0.0002	-0.0088*	-0.0019	0.0005
		(0.867)	(0.700)	(0.743)	(0.076)	(0.748)	(0.939)
$WPE\_Unvest.Options_t$	?	0.0007	-0.0011	-0.0012	0.0174*	0.0156	0.0079
		(0.395)	(0.278)	(0.265)	(0.100)	(0.186)	(0.514)
$AOROA_t$	+	0.5119***	0.2685***	0.1470***			
		(0.000)	(0.000)	(0.001)			
$Tobin's\ Q_t$	+				0.3938***	0.1636***	0.0427
					(0.000)	(0.000)	(0.110)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,090	1,027	953	1,090	1,025	950
# Observations		8,882	8,051	7,235	8,882	8,027	7,211
R-squared		0.324	0.104	0.051	0.330	0.190	0.137

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Table 9. Nature of Business: R & D (Continued)

Panel C. Zero R&D subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	?	0.0001	0.0004	0.0007*	0.0013	0.0046	0.0064*
		(0.588)	(0.293)	(0.088)	(0.550)	(0.138)	(0.076)
WPE_Unvest.Stock $_t$	?	0.0025*	0.0018	-0.0025	-0.0220	-0.0342*	-0.0279
		(0.086)	(0.415)	(0.309)	(0.150)	(0.088)	(0.225)
WPE_Vest.Options $_t$	?	0.0003	0.0002	-0.0002	-0.0034	-0.0010	-0.0018
		(0.280)	(0.599)	(0.692)	(0.211)	(0.789)	(0.655)
WPE_Unvest.Options $_t$	?	0.0011**	0.0018**	0.0018**	-0.0013	-0.0085	-0.0029
		(0.031)	(0.018)	(0.023)	(0.814)	(0.287)	(0.704)
AOROA $_t$	+	0.5484***	0.2264***	0.0824***			
		(0.000)	(0.000)	(0.003)			
Tobin's Q $_t$	+				0.5696***	0.3428***	0.1962***
					(0.000)	(0.000)	(0.001)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,435	1,317	1,225	1,435	1,316	1,223
# Observations		10,435	9,189	8,248	10,435	9,183	8,240
R-squared		0.373	0.112	0.051	0.440	0.234	0.152

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Table 10. Nature of Business: Long-term Asset Intensity and Sales Growth

This table reports the results of regressions using the model in equation (4.3). Definitions for all variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. Each subsample is a portion of the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have non-missing dependent variable, $AOROA_t$, and $Tobin's\ Q_t$. Long-term asset intensity is defined as the ratio of long-term assets to total assets. The High (Low) long-term asset intensity subsample in Panel A (B) includes observations with long-term asset intensity equal to/above (below) yearly median long-term asset intensity. Sales growth is defined as the firm's average rate of sales growth for the past three years that end at the current year. The High (Low) sales growth subsample in Panel C (D) includes observations with sales growth equal to/above (below) yearly median sales growth. Standard errors are clustered at the firm level. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

Panel A. High long-term asset intensity subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
$WPE\_VestedStock_t$	+	0.0003	0.0006*	0.0013***	0.0014	0.0077**	0.0085**
		(0.173)	(0.059)	(0.003)	(0.303)	(0.017)	(0.017)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,267	1,174	1,096	1,267	1,173	1,094
# Observations		8,525	7,735	6,995	8,525	7,729	6,987
R-squared		0.300	0.071	0.036	0.393	0.192	0.128

Panel B. Low long-term asset intensity subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
$WPE\_VestedStock_t$	?	0.0007	0.0012*	0.0012	0.0128**	0.0083	0.0064
		(0.165)	(0.089)	(0.125)	(0.032)	(0.226)	(0.441)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,394	1,310	1,204	1,394	1,307	1,200
# Observations		8,515	7,678	6,856	8,515	7,654	6,833
R-squared		0.339	0.114	0.061	0.314	0.173	0.130

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Table 10. Nature of Business: Long-term Asset Intensity and Sales Growth (Continued)

Panel C. High sales growth subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	+	0.0002	0.0002	0.0010**	0.0050	0.0043	0.0083
		(0.261)	(0.321)	(0.047)	(0.121)	(0.209)	(0.102)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		2,132	1,967	1,847	2,132	1,963	1,841
# Observations		9,655	8,644	7,795	9,655	8,625	7,776
R-squared		0.310	0.100	0.041	0.315	0.177	0.115

Panel D. Low sales growth subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	?	0.0004	0.0007*	0.0007*	0.0046	0.0068*	0.0058
		(0.180)	(0.085)	(0.084)	(0.125)	(0.072)	(0.175)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,940	1,799	1,657	1,940	1,795	1,655
# Observations		9,648	8,585	7,678	9,648	8,574	7,665
R-squared		0.306	0.092	0.044	0.347	0.185	0.124

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Table 11. Information asymmetry

This table reports the results of regressions using the model in equation (4.3). Definitions for all variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. Each subsample is a portion of the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have available analyst following data from IBES and have non-missing dependent variable, $AOROA_t$, and $Tobin's\ Q_t$. Analyst following is measured as the number of analysts providing annual EPS forecast at eight months prior to year-end. High (low) analyst following subsample includes observations with analyst following equal to/above (below) yearly median analyst following. Panel A provides descriptive statistics for each subsample. Panels B and C provide regression results for each subsample. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

Panel A. Descriptive statistics for each subsample

	High analyst following subsample		Low analyst following subsample	
	Mean	Median	Mean	Median
# Analysts	16.99	15.00	4.91***	5.00
WPE_VestedStock	2.37	1.11	2.31	1.07
Size	15.43	15.38	13.66***	13.59
Mtb	3.25	2.39	2.58***	1.89
Leverage	0.38	0.35	0.34***	0.31
Volatility	0.38	0.33	0.45***	0.40

Panel B. High analyst following subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
$WPE\_VestedStock_t$	?	0.0002	0.0006*	0.0013***	0.0033	0.0093**	0.0135***
		(0.271)	(0.081)	(0.003)	(0.150)	(0.013)	(0.004)
$WPE\_Unvest.Stock_t$	?	0.0022	0.0023	-0.0005	-0.0225	-0.0280	-0.0185
		(0.158)	(0.336)	(0.852)	(0.222)	(0.280)	(0.504)
$WPE\_Vest.Options_t$	?	-0.0002	-0.0001	-0.0004	-0.0034	-0.0034	-0.0041
		(0.483)	(0.886)	(0.349)	(0.388)	(0.523)	(0.461)
$WPE\_Unvest.Options_t$	?	0.0013**	0.0004	-0.0002	0.0202***	0.0164*	0.0084
		(0.035)	(0.684)	(0.865)	(0.007)	(0.097)	(0.394)
$AOROA_t$	+	0.5144***	0.2008***	0.1017***			
		(0.000)	(0.000)	(0.003)			
$Tobin's\ Q_t$	+				0.4653***	0.2171***	0.0941***
					(0.000)	(0.000)	(0.001)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,534	1,416	1,319	1,534	1,414	1,316
# Observations		9,610	8,612	7,793	9,610	8,595	7,779
R-squared		0.329	0.082	0.045	0.387	0.214	0.150

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Table 11. Information asymmetry (Continued)

Panel C. Low analyst following subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
WPE_VestedStock $_t$	+	0.0005*	0.0009**	0.0009*	0.0076**	0.0022	0.0019
		(0.094)	(0.040)	(0.061)	(0.048)	(0.336)	(0.376)
WPE_Unvest.Stock $_t$	?	0.0038*	0.0032	0.0011	0.0283	0.0199	-0.0088
		(0.078)	(0.310)	(0.706)	(0.169)	(0.403)	(0.722)
WPE_Vest.Options $_t$	?	0.0006	0.0005	0.0004	-0.0087*	-0.0001	0.0012
		(0.125)	(0.372)	(0.462)	(0.065)	(0.979)	(0.845)
WPE_Unvest.Options $_t$	?	0.0001	0.0002	0.0010	-0.0064	-0.0129	-0.0106
		(0.875)	(0.880)	(0.356)	(0.555)	(0.258)	(0.337)
AOROA $_t$	+	0.4823***	0.2421***	0.1047**			
		(0.000)	(0.000)	(0.011)			
Tobin's Q $_t$	+				0.3712***	0.1846***	0.0759**
					(0.000)	(0.000)	(0.042)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,799	1,678	1,554	1,799	1,675	1,553
# Observations		9,421	8,371	7,461	9,421	8,358	7,443
R-squared		0.311	0.100	0.045	0.271	0.153	0.107

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Table 12. Effect of Ownership Policies

This table reports the results of regressions using the model in equation (4.3), with *WPE_VestedStock* and *WPE_Unvest.Stock* replaced by *WPE_Uncons.Stock* and *WPE_Cons.Stock*, where *Unconstrained Stock = Vested Stock – Vested Stock Constrained by Ownership Policy*, and *Constrained Stock = Unvested Stock + Vested Stock Constrained by Ownership Policy*. Appendix C provides a detailed discussion about how to calculate vested stock constrained by ownership policy. Definitions for all other variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. The sample for each column consists of all observations among the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have non-missing dependent variable, $WPE\_Uncons.Stock_t$, $AOROA_t$, and $Tobin's\ Q_t$. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
$WPE\_Uncons.Stock_t$ (λ_1)	+	0.0006**	0.0012**	0.0013**	0.0099**	0.0130**	0.0136**
		(0.049)	(0.016)	(0.021)	(0.013)	(0.013)	(0.016)
$WPE\_Cons.Stock_t$ (λ_2)	?	0.0013	0.0006	-0.0003	0.0226	0.0237	0.0160
		(0.389)	(0.802)	(0.910)	(0.166)	(0.299)	(0.495)
$WPE\_VestedOptions_t$ (λ_3)	?	0.0004	0.0004	0.0003	-0.0043	0.0022	0.0037
		(0.323)	(0.455)	(0.632)	(0.424)	(0.759)	(0.609)
$WPE\_Unvest.Options_t$ (λ_4)	?	0.0011*	0.0003	0.0006	0.0001	-0.0056	-0.0122
		(0.097)	(0.745)	(0.555)	(0.989)	(0.591)	(0.207)
$AOROA_t$	+	0.590***	0.289***	0.114***			
		(<0.001)	(<0.001)	(0.009)			
Tobin's Q_t	+				0.507***	0.258***	0.149***
					(<0.001)	(<0.001)	(<0.001)
Control variables		Y	Y	Y	Y	Y	Y
Year fixed effect		Y	Y	Y	Y	Y	Y
Firm fixed effect		Y	Y	Y	Y	Y	Y
# Firms		732	725	708	732	725	708
# Observations		7,311	6,857	6,409	7,311	6,851	6,403
R-squared		0.445	0.147	0.062	0.392	0.208	0.150

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Table 13. Future firm performance with incentives measured as % ownership

This table reports the results of regressions using the model in equation (4.3), with the four equity incentives measured as percentage ownership of the firm instead of WPE. For vested stock and unvested stock, percentage ownership is calculated as *# Shares / Total outstanding shares of the firm*. For vested options and unvested options, percentage ownership is calculated as (∑ *# Options * Option Delta) / Total outstanding shares of the firm*, where *Option Delta* is calculated using the Black-Scholes model (1973). Options held prior to 2006 are valued following Core and Guay (2002). Definitions for all other variables are in Appendix B. The dependent variable is the firm's industry-adjusted operating ROA (*AOROA*) or *Tobin's Q* for each of the subsequent one, two, and three years. In Panel A, the sample for each column consists of all observations among the main sample of 21,286 firm-years, described in more detail in Section 4.1 and Table 2, that have non-missing dependent variable, $AOROA_t$, and $Tobin's\ Q_t$. Samples in Panels B, C, and D include observations with total assets ranked at the bottom, middle, and top terciles, respectively, among all observations in the same year. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for one-tailed tests when there is a signed prediction for the independent variable and two-tailed tests when no signed prediction is given for the independent variable.

Panel A. Full sample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
VestedStock_p $_t$	?	0.0006	0.0007	0.0027	0.0400**	0.0264	0.0258
(λ_1)		(0.606)	(0.759)	(0.251)	(0.016)	(0.249)	(0.333)
Unvest.Stock_p $_t$	?	-0.0026	-0.0001	-0.0071	-0.0212	0.0122	-0.0084
(λ_2)		(0.595)	(0.989)	(0.357)	(0.596)	(0.826)	(0.896)
VestedOptions_p $_t$	?	-0.0017	-0.0031*	-0.0029	-0.0114	0.0067	0.0129
(λ_3)		(0.194)	(0.098)	(0.179)	(0.482)	(0.738)	(0.515)
Unvest.Options_p $_t$	?	-0.0009	-0.0016	-0.0021	0.0327	0.0192	0.0423*
(λ_4)		(0.648)	(0.560)	(0.445)	(0.142)	(0.478)	(0.079)
AOROA $_t$	+	0.5342***	0.2628***	0.1296***			
		(0.000)	(0.000)	(0.000)			
Tobin's Q $_t$	+				0.4490***	0.2187***	0.0935***
					(0.000)	(0.000)	(0.001)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		2,423	2,254	2,099	2,423	2,251	2,095
# Observations		19,318	17,241	15,483	19,318	17,211	15,451
R-squared		0.344	0.101	0.043	0.346	0.180	0.120

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Table 13. Future firm performance with incentives measured as % ownership (Continued)

Panel B. Small firms subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
VestedStock_p $_t$	+	0.0010	0.0013	0.0074**	0.0674**	0.0651**	0.0582
(λ_1)		(0.282)	(0.346)	(0.010)	(0.012)	(0.048)	(0.108)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,213	1,132	1,046	1,213	1,129	1,043
# Observations		6,433	5,714	5,038	6,433	5,694	5,023
R-squared		0.329	0.115	0.065	0.268	0.145	0.110

Panel C. Medium firms subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
VestedStock_p $_t$	+	0.0005	-0.0013	-0.0042*	0.0163	-0.0188	0.0002
(λ_1)		(0.382)	(0.556)	(0.082)	(0.161)	(0.261)	(0.496)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		1,214	1,109	1,024	1,214	1,109	1,021
# Observations		6,448	5,765	5,180	6,448	5,757	5,168
R-squared		0.325	0.073	0.040	0.310	0.138	0.096

Panel D. Large firms subsample

	Pred. Sign	AOROA			Tobin's Q		
		(1) t+1	(2) t+2	(3) t+3	(4) t+1	(5) t+2	(6) t+3
VestedStock_p $_t$	+	0.0009	0.0029	0.0024	0.0158*	0.0351**	0.0513***
(λ_1)		(0.265)	(0.156)	(0.245)	(0.053)	(0.027)	(0.006)
Control variables		Y	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y	Y	Y
Firm FE		Y	Y	Y	Y	Y	Y
# Firms		826	773	734	826	773	734
# Observations		6,437	5,762	5,265	6,437	5,760	5,260
R-squared		0.344	0.105	0.046	0.521	0.307	0.200

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Table 14. CEO compensation

This table reports the results of linear regressions of CEO compensation. The dependent variable is the logarithm of (1 + the CEO's equity based pay) in Column 1 and the logarithm of (1 + the CEO's total pay) in Column 2. Data of CEO pay is from ExecuComp. Equity based pay is defined as the total value of restricted stock grants and option grants. Total pay is *tdc1* in ExecuComp. *Boardsize* is the count of directors on the firm's board. *Independence* is the percentage of independent directors on the firm's board. *Chairman* is a dummy variable that takes the value of one if the CEO is the chairman of the board, and zero otherwise. Definitions for all other variables are in Appendix B. Standard errors are clustered at the firm level. P-values are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for two-tailed tests.

	(1) Log (1 + Equity Pay) $_{t+1}$	(2) Log (1 + Total Pay) $_{t+1}$
WPE_VestedStock $_t$	0.0046	-0.0005
(λ_1)	(0.730)	(0.903)
WPE_Unvest.Stock $_t$	0.0860	0.0367*
(λ_2)	(0.112)	(0.068)
WPE_Vest.Options $_t$	-0.0053	-0.0103***
(λ_3)	(0.641)	(0.004)
WPE_Unvest.Options $_t$	0.0223	0.0166**
(λ_4)	(0.306)	(0.026)
Return	0.1801***	0.1021***
	(0.000)	(0.000)
AOROA	0.8270*	0.4116***
	(0.059)	(0.008)
Tobin's Q	0.1508***	0.1160***
	(0.000)	(0.000)
Size	0.3588***	0.2554***
	(0.000)	(0.000)
MTB	0.0046	0.0066**
	(0.600)	(0.042)
Leverage	-0.8195***	-0.3399***
	(0.000)	(0.000)
Volatility	-0.3699	-0.0194
	(0.132)	(0.824)
LogTenure	0.0170	0.0529***
	(0.646)	(0.000)
Boardsize	0.0069	-0.0026
	(0.642)	(0.633)
Independence	0.7630**	0.1243
	(0.018)	(0.103)
Chairman	0.0189	0.0405*
	(0.775)	(0.087)
Constant	7.4660***	10.5619***
	(0.000)	(0.000)
Year/Firm FE	Y/Y	Y/Y
Observations	9,323	9,323
R-squared	0.056	0.144
Number of firms	1,726	1,726

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