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THREE ESSAYS ON CORPORATE FINANCE

NANYANG TECHNOLOGICAL UNIVERSITY

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Table of Contents

Chapter I 1
I. Introduction 2
II. Institutional Background of Corporate Pension Plans and Main Hypotheses 9
A. Types of Pension Plans and Laws Related to DB Pension Plans 9
B. Main Hypotheses 12
III. Data 16
A. Compustat Sample 16
B. M&A Sample 18
IV. Empirical Methodology and Results 22
A. Methodology 22
B. Determinants of Pension Plan Choice and Size of Pension Deficit 23
C. Effects of Pension Deficits on M&A Activities 24
C.1. Pension Deficits and the Decision to Acquire Other Firms 24
C.2. Pension Deficits and M&A Announcement Effects 28
C.3. Pension Deficits and Payment Methods 31
V. Additional Tests 32
A. Alternative Measures of Pension Deficits 33
B. Self-Selection Bias 34
C. Financial Constraints as an Alternative Explanation 35
D. Importance of Pension Plan Characteristics 38
E. Target Firms' Pension Deficits and Takeover Gains 41
VI. Summary and Conclusion 43
Appendix A 45
Appendix B 46
Appendix C 48
References 50
Chapter II 69
I. Introduction 70
II. Institutional Background and Hypotheses Development 76
A. Employee Ownership in Defined Contribution Pension Plan 76
B. Employee Ownership and the CEO Compensation Contract 79
B.1. Employee Incentive Enhancement as a Substitute for CEO High-powered Compensation 80
B.2. Employee Risk Aversion towards CEO Risk-taking Incentives 81
B.3. Effects of Firm and Industry Characteristics on the Substitution Relation 82
III. Data, Sample, and Variable Construction 85
A. Data and Sample 85
B. Variables and Descriptive Statistics 86
IV. Empirical Design and Major Findings 89
A. Research Methodology 89
B. Determinants of the Level of Employee Ownership in the DC Plan 91
C. Effects of Employee Ownership on CEO Compensation and Incentives 93
C.1. Level of CEO Compensation 94

C.2. Structure of CEO Compensation 95
C.3. CEO Incentives 96
D. Labor Strength, Firm-specific Human Capital, Free-riding, Mutual Monitoring, and Capital Intensity 97
D.1. Labor Strength and Importance of Employee Retention 98
D.2. Free-riding Problem and Mutual Monitoring 99
D.3. Capital Intensity 100
V. Robustness Tests 101
A. Alternative Explanations 101
B. Additional Sensitivity Tests 103
VI. Conclusion 104
Appendix A 106
Appendix B 107
References 109
Chapter III 129
I. Introduction 130
II. Related Literature 136
A. Risk-taking Incentives and Employee Failure-Bearing in Corporate Innovation 136
B. Economic Functions of Non-executive Stock Option 138
III. Data, Sample, and Empirical Design 140
A. Data and Sample 140
B. Variables 141
B.1. Measuring Innovation 141
B.2. Measuring Non-executive Employee Stock Options 142
B.3. Other Explanatory Variables 143
C. Descriptive Statistics 144
D. Empirical Methodology 146
IV. Empirical Findings 148
A. Main results 148
B. Alternative Explanations 149
C. Additional Sensitivity Tests 152
V. Further Analysis 154
A. Effects of Firm and Industry Characteristics and the Stock Option Terms 154
A.1. Importance of Employee Retention and Labor Strength 154
A.2. Free-riding among Employees 155
A.3. Average Stock Option Expiration Period 156
A.4. Targeted vs. Broad-based Non-executive Stock Option Plan 157
B. R&D Activities 158
C. Employee Interest Alignment and Risk-taking Incentives and Innovation Productivity 159
VI. Summary and Conclusion 161
Appendix A 163
Appendix B 164
Reference 166

List of Tables

Table I.I: Sample distribution and mean and median values of pension variables by year 58
Table I.II: Summary statistics for Compustat firms, acquiring firms, and M&A characteristics 59
Table I.III: Determinants of the choice of pension plans and the size of pension deficits..... 60
Table I.IV: The effect of pension deficits on the likelihood of acquiring other firms 61
Table I.V: Regression of cumulative abnormal returns (-1, 1) for bidders on explanatory variables..... 62
Table I.VI: Regressions of value-weighted portfolio returns of the acquirer and the target and takeover premium on explanatory variables 63
Table I.VII: Regression of the fraction of cash payment on explanatory variables 64
Table I.VIII: Robustness checks 65
Table I.IX: Reestimation of regressions in Tables IV through VII for subsamples of firms classified according to firms' financial constraints and annual GDP growth rates and by including mandatory pension contribution as an additional control for financial constraints 66
Table I.X: Reestimation of regressions in Tables IV through VII for subsamples of defined benefit (DB) plan firms classified according to their pension demographic characteristics, collective bargaining status, and industry unionization rate 68
Table II.I: Sample distribution and mean and median values of employee ownership by year..... 116
Table II.II: Summary statistics for CEO compensation contracts, and firm and CEO characteristics..... 117
Table II.III: Determinants of employee ownership in DC plan 118
Table II.IV: Regressions of the level of CEO compensation on employee ownership 119
Table II.V: Regressions of the structure of CEO compensation on employee ownership 121
Table II.VI: Effects of employee ownership on CEO incentives..... 123
Table II.VII: Effects of labor strength and importance of employee retention, free-riding problem, mutual monitoring, and capital intensity 125
Table II.VIII: Reestimation of regressions by controlling for additional variables 127
Table II.IX: Robustness checks 128
Table III.I: Sample distribution and median and mean counts of patents and citations and values of the non-executive stock options per employee 172
Table III.II: Summary statistics 173
Table III.III: Effect of non-executive stock options per employee on corporate innovation productivity 174
Table III.IV: Reestimation of regressions in Table III using the instrumental variable approach 175
Table III.V: Reestimation of regressions by controlling for potential omitted variables..... 176
Table III.VI: Additional sensitivity tests..... 177
Table III.VII: Effects of firm and industry characteristics and expiration period of stock options 178
Table III.VIII: Effect of non-executive stock options per employee on R&D activities 180
Table III.IX: Effect of employee incentives on innovation productivity 181

List of Figures

Figure I.1: Aggregate funding status of defined benefit (DB) pension plans 56
Figure I.2: Pension deficits and acquisition outcomes over time..... 57
Figure II.1: Aggregate employer stocks in define contribution (DC) pension plans and the share of employer stocks in total DC pension assets 114
Figure II.2: CEO compensation incentives and employee ownership in ESOP firms over time..... 115
Figure III.1: The aggregate value of non-executive stock options and mean and median values of non-executive stock options per employee over time 171

Summary

Essay one examines the disciplinary role of corporate pension deficits (the difference in value between pension liabilities and pension assets) in the market for corporate control. We find that during the 1981 to 2008 period, firms with larger pension deficits are less likely to engage in mergers and acquisitions (M&As), particularly diversifying M&As, than those with smaller or no pension deficits. We also find that the announcement returns of both the acquirer and the value-weighted portfolio of the acquirer and the target increase with acquirers' pension deficits. Further, acquirers' pension deficits are negatively related to the premiums paid to targets, but positively related to the percentage of cash used in payment to targets. These results are evident only for a subsample of financially unconstrained acquirers, suggesting that they are not driven by lack of acquirers' internal funds. The results are also more pronounced for subsamples of acquirers whose pension plans are dominated by actively working employees (i.e., fewer retirees), those whose pension plans are collectively bargained, and those in more unionized industries. These findings indicate that corporate pension deficits provide employees with strong incentives to monitor managerial performance and influence managers to make value-enhancing investment decisions.

Essays two examines the executive compensation schemes of firms whose employees invest in company stocks in the defined contribution (DC) pension plan. I find that during the period 1992 to 2007, firms with higher employee ownership are more likely to reduce the level and fraction of CEO pay in the form of stock options. CEO interest alignment (Delta) and risk-taking incentives (Vega) are significantly suppressed in these firms. These results are more evident for subsamples of firms in more unionized industries, firms whose employees are more difficult to retain, firms with weaker free-riding problems among employees, firms that adopt broad-based employee stock ownership plans, and firms with higher capital intensity. These findings suggest that employee ownership enhances the mutual monitoring of and coordination among rank-and-file employees, thereby reducing the need for high-powered CEO stock option. They also indicate that when employees bear large amounts of undiversified risk by holding

employer stocks in the DC plan, firms tend to lower managerial risk-taking incentives so as to avoid costly labor costs and litigations.

In essay three, we examine whether employee stock options motivate employees to contribute to corporate innovation. Our analysis shows that the innovation output in a firm measured by the numbers of total patents applied, total citations of the patents, and citations per patent significantly increases with the non-executive stock options per employee after controlling for the research and development (R&D) expenditures and executive stock options. The positive effects of employee stock options on corporate innovation are more evident in subsamples of firms in more unionized industries, firms where employees are more difficult to retain, firms with a weaker free-riding problem among employees, firms whose stock options have a longer expiration period, and firms organize a broad-based employee stock option plan. Finally, we show that the enhancement of corporate innovation productivity is mainly from an increase in employees' risk-taking incentives (vega) rather than employees' interest-alignment incentives (delta). Taken together, these findings suggest that employee stock options enhance employees' risk-taking incentives and failure-bearing capacities in a firm's high risk-profile innovative activities, leading to a significant improvement in the productivity of corporate innovation.

Chapter I

Corporate Pension Funding Status and the Market for Corporate Control: The Disciplinary Role of Pension Deficits in Mergers and Acquisitions

with Xin Chang and Jun-koo Kang

"Employee engagement levels are linked to perceptions of a company's leadership and, more specifically, the extent to which members of the workforce believe senior management is committed to their well-being. Leading organizations understand that retirement programs and, more specifically, benefit security, can play a role in favorably influencing employee perceptions of senior management and the overall organization."

Towers Perrin (*2009*) *"CFO guidebook: pensions and corporate financial performance - intricately linked"*

I. Introduction

The extent of debt in a firm's capital structure can influence managerial decisions. For example, Jensen (1986) argues that while managers with large free cash flow have incentives to over-invest beyond the optimal level, high debt serves as a controlling mechanism that prevents managers from wasting free cash. Consistent with this argument, Maloney, McCormick, and Mitchell (1993) and Kang (1993) show that a bidder's announcement returns are positively related to the bidder's leverage, and Ofek (1993) documents that high leverage increases the likelihood of asset restructuring and employee layoffs for firms experiencing a performance decline. In addition, Berger, Ofek, and Yermack (1997) show that firms with entrenched managers tend to maintain lower leverage and Hanka (1998) finds that higher debt is associated with more frequent employment reductions and lower wages. The banking literature further shows that the disciplinary role of debt is more evident for bank loans than for public debt (Campbell and Kracaw (1980), Diamond (1984), Fama (1985)).[1]

Although the studies above enhance our understanding of the disciplinary role of conventional debt, and of bank debt in particular, in corporate decisions, little is known about the disciplinary role of a firm's debt to its employees through its defined benefit (DB hereafter) pension plan.[2] This lack of evidence is surprising, given that the combined pension deficits (difference in the value of the projected pension benefit obligation and the fair value of plan assets) of all U.S. publicly listed companies reached an

[1] The banking literature suggests that as inside debtholders, banks have a competitive advantage over other capital market participants in collecting information about the borrowing firms (Fama (1985), Rajan (1992)) and thus can intervene quickly and informally.

[2] A DB pension plan commits the sponsoring firm to pay a pre-specified benefit to its employees at a given future date. Under such a plan, if the value of pension assets is insufficient to pay the promised benefits, the sponsoring firm is responsible for the shortfall (pension deficit). This commitment is financially equivalent to a firm's legal promise to pay off conventional debt on its balance sheet.

astonishing $707 billion at the end of 2008.[3] To the extent that pension deficits create long-term unsecured debtors out of employees (Ippolito (1985a, 1985b)), employees thus can be considered as one of the most important debtholders when DB sponsoring firms have large pension deficits.[4]

In this paper we focus on the role of employees as informed large unsecured debtholders and examine how corporate pension deficits, a type of "inside" debt, influence managerial incentives to make value-enhancing investment decisions. Specifically, using all firms covered in Compustat over the 1981 to 2008 period, we examine whether pension deficits affect a firm's decision to undertake mergers and acquisitions (M&As). Further, for a large sample of M&As, we examine how pension deficits affect acquirer announcement returns, value-weighted portfolio returns of the acquirer and the target, premiums paid to targets, and the choice of payment methods.

We argue that pension deficits are likely to serve as an important control mechanism that limits managers' discretionary power, for several reasons. First, underfunded pension plans have an adverse effect on welfare and job security of employees. Munnell, Aubry, and Muldoon (2008) argue that large pension deficits force sponsoring firms to go bankrupt, lay off their employees, or freeze/terminate their DB pension plans, which would result in fewer retirement benefits for their employees than those anticipated. Thus, to minimize the adverse effects of pension deficits on their welfare, employees are expected to have strong incentives to monitor sponsoring firms' investment decisions. Second, pension deficits account for a significant portion of total debt. Moreover, firms with large pension deficits are required by law to make periodic mandatory contributions and pay a high insurance premium to the Pension Benefit Guaranty Corporation (hereafter, PBGC). These characteristics of pension deficits help

[3] The aggregate pension deficits are computed based on all U.S. firms with a DB pension plan covered in Compustat between 1981 and 2008. Figure 1 shows the time trend of the aggregate funding status of DB pension plans.

[4] Francis and Reiter (1987) also maintain that underfunded DB pension plans make employees as sponsoring firms' debtholders. Similarly, Edward Burrows, the former president of the American Society of Pension Professionals & Actuaries, argues that unpaid accrued pension benefit obligations in DB plans are loans from plan participants to sponsors. He suggests that "…These loans (pension deficits) differ from most commercial loans in an important respect: the lenders (the employees) are not establishing diversified loan portfolios. They must deal with just one borrower: the plan sponsor…"

reduce the free cash flow available to managers.[5] Third, as insiders, employees are expected to possess material private information about their employers, which gives them a competitive advantage in collecting information and thus enhanced capabilities to monitor managers. Finally, previous studies show that pension deficits increase employees' perceived risk of sponsoring firms (Ippolito (1997)), reduce employee incentives to work hard (Hanka (1998)), increase the cost of capital (Cardinale (2007), Campbell, Dhaliwal, and Schwartz (2011)), and lower the credit rating of sponsoring firms (Rauh (2007)). As a result, pension deficits can incentivize managers to make value-enhancing investment decisions because value-destroying investments will only further exacerbate the negative effect of pension deficits on employee behavior and firm value (Logue (1979), Ippolito (1997)). Taken together, these arguments suggest that pension deficits can serve as an effective control mechanism that mitigates managerial incentive problems.[6]

Controlling for conventional leverage ratio (total debt/total assets) and correcting for the nonrandom choice of whether to sponsor a DB plan and the endogeneity of the size of pension deficits, we find results that are largely consistent with the view that pension deficits serve as an important disciplinary mechanism. Specifically, we find that firms with larger pension deficits are significantly less likely to engage in M&As than those with smaller or no pension deficits. We also find that conditional on engaging in acquisitions, firms with larger pension deficits are less likely to make diversifying acquisitions: a one-standard deviation increase in the ratio of pension deficits to total assets is associated with a 3.4% decrease in the likelihood of making diversifying acquisitions. Moreover, bidder

[5] Generally, for firms with pension deficits, mandatory contributions are set equal to the sum of new pension benefits accrued during the previous year and a fraction of pension deficits (Rauh 2006a). The actual total pension contributions in a given year can exceed mandatory contributions if the sponsor makes voluntary contributions in addition to mandatory contributions. The control function of pension deficits is expected to be more disciplinary and effective for mandatory contributions than for voluntary contributions due to nondiscretionary and predictable natures of mandatory contributions, similar to interest payments on conventional debt.

[6] The following anecdotal evidence in Franzoni (2009) is consistent with the idea that an underfunded pension plan helps reduce a firm's potentially unproductive expenses: "For example, due to the need to save cash for the $4.8 billion pension contributions that it owed to the pension plan, in March 2002 General Motors revised a bonus plan for 3,500 of its top executives. Similarly, in July 2003, Twin Disc Corp., whose 65% funded pension plans had triggered statutory contributions, announced across-the-board wage reductions for corporate officers. While these examples do not prove …, they show the channels through which the firm can disengage from potentially wasteful commitments thanks to pension contributions (pp. 501)."

announcement returns and announcement returns of the value-weighted portfolio of the bidder and the target increase significantly (at the 1% level) with a bidder's pension deficits. Economically, a one-standard deviation increase in a bidder's pension deficits over total assets translates into a 0.34% increase in the bidder's announcement returns over the three-day event window around the announcement date and a 0.91% increase in the combined portfolio's announcement returns over the same event window. Thus, the disciplinary effect of pension deficits appears to be both statistically and economically significant. Finally, we find that acquirers' pension deficits are negatively associated with the premiums paid to targets but positively related to the percentage of cash used in payment to the targets: a one-standard deviation increase in an acquirer's pension deficits over total assets results in a 2.9% decrease in takeover premium and a 16.3% increase in the fraction of cash payment. These results suggest that pension deficits not only limit managerial hubris in overpaying for targets (Roll (1986)) but also influence managers to choose undervalued targets, thereby creating higher value gains in M&As (Shleifer and Vishny (2003), Dong et al. (2006)).

Although we find that the estimated coefficients on conventional leverage are also significant and have the same signs as those on pension deficits in most regressions, the magnitudes of the coefficients on pension deficits are much larger than those of the coefficients on conventional debt, suggesting that pension deficits impose more binding constraints than conventional debt in disciplining managers.

We conduct a battery of additional tests to ensure that our results are robust to alternative empirical specifications and variable definitions. In addition, we examine several alternative arguments that might explain our results. For example, under a financial constraint argument, financially constrained firms (e.g., firms with pension deficits) undertake only profitable investments due to lack of their internal funds. It is also possible that the cash drain caused by mandatory pension contributions influences managers of firms with pension deficits to engage in more profitable mergers. We test these alternative explanations in the robustness section and find little evidence to support them. We also examine whether our main results are driven by post-acquisition pension fund revisions or synergistic gains created by merging the

acquirers with an underfunded plan with the targets with an overfunded plan and find little support for these alternative explanations.

Finally, to further provide evidence on the disciplinary role of pension deficits, we conduct several subsample analyses. In particular, we investigate how demographic characteristics of a pension plan influence the control function of pension deficits. We find that our results are mainly driven by subsamples of firms with a shorter plan age and those with a higher fraction of actively working employees (i.e., fewer retired employees). To the extent that young or current employees have stronger monitoring incentives than old or retired employees, these results provide further evidence in support of the control function of pension deficits. We also examine how employees' collective efforts to monitor managers affect our main results by partitioning our sample firms according to the collective bargaining status of a pension plan and the sample median of the industry unionization rate, respectively. We find that the impact of pension deficits on several aspects of takeover decisions is more pronounced for firms having pension plans that are collectively bargained and for those in more unionized industries. To the extent that collective bargaining and unionization strengthen labor's bargaining power and enhance its collective actions, these results suggest that cooperation and mutual monitoring among employees enhance employees' incentives to exert efforts (Chen, Kacperczyk, and Ortiz-Molina (2010), Hochberg and Lindsey (2010), Comprix and Muller (2011).

Our work is related to several recent studies that examine the impact of pension funding on corporate investments. For example, Rauh (2006a) examines the effects of mandatory pension contributions on corporate investments and finds a significantly negative relation, which suggests that firms underinvest as a result of pension contribution obligations. In a more recent paper, Rauh (2007) investigates the effects of changes in a firm's financial condition on capital expenditures and shows that an increase in a firm's leverage ratio has a strong negative impact on the firm's capital investment even when the increase in leverage is strictly due to pension fund asset performance that is uncorrelated with the sponsor's investment opportunities. Bergstresser, Desai, and Rauh (2006) argue that managers adjust assumed rates of return on pension assets in managing earnings and show that managers adjust these rates of return more

aggressively prior to acquiring other firms. Finally, Franzoni (2009) investigates stock price reactions to the payment of mandatory pension contributions to a firm's DB pension plan. He finds that the price decline is more severe for financially constrained firms and interprets this result as evidence of a negative effect of financing frictions on investment.

Although our paper also examines the effect of pension funding status on corporate investments, it is distinct from prior studies in at least two important ways. First, while previous papers explore a firm's underinvestment in capital expenditures in the presence of financial constraints, highlighting the costs of raising external fund, our paper focuses on the disciplinary role of pension deficits by investigating how pension deficits serve as a control mechanism that limits managers' ability to engage in overinvestment and incentivizes managers to improve investment quality. We examine this issue by using an integrated approach that jointly examines several outcomes of takeover decisions, such as the frequency of M&As, their quality (i.e., valuation effects of M&As), and the choice of payment methods (i.e., cash versus stock payments). Second, whereas prior papers focus on capital expenditure decisions, we use takeover bids as our experimental setting. Unlike other routine capital expenditure decisions, takeover bids provide a natural experiment for providing evidence on the disciplinary role of pension deficits because takeover decisions typically represent large and discrete investment choices. Furthermore, because managers can pursue private objectives at the expense of shareholder wealth during acquisitions (Jensen and Ruback (1983), Jarrell, Brickley, and Netter (1988)), informed stakeholders such as large shareholders, creditors, and workers can each have an important impact on managerial decisions with respect to takeover bids.

Our paper is also related to several recent papers that examine the role of the workforce in corporate decisions. Pagano and Volpin (2005) argue that managers who want to enjoy higher private benefits are more likely to guard against takeover threats by offering long-term contracts to workers who, to keep such contracts, are likely to resist hostile takeovers. Supporting this argument, Rauh (2006b) shows that large employee stock holdings in their own companies form a takeover defense that entrenched managers can use to insulate themselves from market discipline. Similarly, Faleye, Mehrotra, and Morck (2006) investigate the role of labor in corporate governance and find that labor's voice in corporate governance is

associated with lower equity value, sales growth, and job creation. Unlike these papers that focus on employees' negative role in influencing corporate decisions, our paper emphasizes their positive role in monitoring managerial behavior and shows that pension deficits influence managers to make value-enhancing investment decisions.

By examining the effect of pension deficits on takeover decisions, we extend the existing literature in two important ways. First, our paper sheds light on the governance role of pension deficits. Previous studies show that debt serves as an important mechanism to control managerial discretion, but no study investigates how pension deficits as inside debt affect managerial behavior and firm value. We show that pension deficits play an important disciplinary role in a firm's M&A decisions, influencing managers to make value-enhancing decisions. Second, our study extends the literature on the stakeholder theory of the firm by showing that employees have strong incentives to exert pressure on managerial behavior when their claims on firm value are at stake. Further, we show that the interests of employees and shareholders are more closely aligned when a large portion of workers' retirement claims is tied to managers' investment quality, thereby identifying an important channel through which pension plan funding status is linked to shareholder wealth. Our results therefore complement the findings of Faleye and Trahan (2007), who show that firms offering higher employee welfare outperform those offering lower employee welfare on productivity, profitability, and value creation, and those of Cronqvist et al. (2009), who show that entrenched CEOs are willing to pay employees more to enjoy private benefits.

The rest of the paper is organized as follows. Section II briefly reviews the institutional background of U.S. pension plans and develops the paper's main hypotheses. In Section III, we describe the data and report summary statistics. Section IV outlines our empirical methodology and presents the empirical results. Section V discusses robustness tests. Finally, we present summary and concluding remarks in Section VI.

II. Institutional Background of Corporate Pension Plans and Main Hypotheses

A. Types of Pension Plans and Laws Related to DB Pension Plans

There are two basic types of retirement plans in the U.S., namely, defined contribution (DC hereafter) and DB pension plans. A DC plan is similar to a savings account. It requires that employers, and possibly employees, make regular contributions each year to employees' pension accounts. The employees' final retirement benefits hinge upon the total contributions and the investment performance of pension assets. Employees have discretion over the assets into which they invest and bear all of the shortfall risk upon retirement.

A firm sponsoring a DB plan, on the other hand, has an obligation to retirees and current employees that amounts to the present value of the future payments estimated based on various actuarial assumptions concerning mortality rates, discount rates, etc. To meet a stream of future committed payments, the firm makes periodic tax-deductible contributions to a pension fund. From a legal point of view, the firm's contributions, along with the investment returns from these contributions, should be adequate to meet its future obligations. If, however, the value of pension assets is insufficient to pay the promised benefits, the firm is responsible for the shortfall (i.e., pension deficit). The pension funding status of a DB plan is considered underfunded (fully funded or overfunded) if the present value of the pension liabilities is more than (equal to or less than) the fair value of the pension assets.

Figure 1 presents the aggregate amounts of pension assets and pension liabilities for all publicly listed DB plan sponsors covered in Compustat during the 1981 to 2008 period. While aggregate pension assets and pension liabilities have both increased over time, pension liabilities have grown at a faster pace than pension assets, especially in recent years. Figure 1 also plots the time trend of aggregate pension deficits, which are defined as the difference between the aggregate value of pension liabilities and the aggregate value of pension assets. Negative aggregate pension deficits prior to 2001 suggest that DB pension plans were generally overfunded over the first two decades of our sample period. For example, in 1999 Compustat DB plan sponsors collectively show a surplus of around $349 billion. However, due to a stock market downturn and a reduction in interest rates in 2002, DB pension plans became significantly

underfunded by almost $621 billion in 2002. Although pension funding status displayed a slight rebound in 2006 and 2007, the 2008 sub-prime crisis worsened the situation. By the end of 2008, the aggregate pension deficits reached an astonishing level of $707 billion.[7]

Pension plan sponsors are required by law to make mandatory contributions to their underfunded pension plans. These mandatory pension contributions are mainly determined by the extent of pension deficits and funding rules established by the Internal Revenue Code and several pension protection acts that went through the changes over time, such as the Employment Retirement Income Security Act (ERISA) of 1974, the Pension Protection Act of 1987, the Retirement Protection Act of 1994, and the Pension Protection Act of 2006.[8] These laws regulating firms' contributions to pension deficits are binding constraints on managers and hence are expected to effectively reduce the agency problems associated with a firm's free cash flow.

The PBGC, created by the ERISA of 1974, insures the benefits of DB plan participants and serves as a statutory trustee of terminated pension plans when a sponsoring firm has insufficient assets to pay the benefits that participants are owed. If the sponsoring firm of underfunded plans is in severe financial distress or bankruptcy, the PBGC will terminate the plans, pay participants benefits up to a statutory maximum amount, and hold the sponsoring firm liable for pension deficits up to 30 percent of the fair

[7] Shivdasani and Stefanescu (2010) point out that in recent years some firms have frozen or terminated their DB plans and switched to DC plans. Nevertheless, the use of DB pension plans remains pervasive among U.S. companies in spite of these freezes and terminations. For example, according to the PBGC, mainly small DB plans were frozen during 2003 and only about 2.5% of participants in DB plans were affected by freezes. An employer freezes a DB plan to limit the ability of employees to earn benefits in the plan. An employer may choose to "hard freeze" its pension plan by ending benefit accruals for all employees, or it may "soft freeze" its pension plan by ending benefit accruals only to newly hired employees. The driving forces behind such freezes or termination include deteriorating market conditions that lead to severe underfunding and increasing pension contributions caused by the decline in mortality rates and increase in life expectancy.

[8] For example, in 1987, the Pension Protection Act amended the ERISA, which requires that a deficit reduction contribution of between 13.75% and 30% of any underfunding should be deposited into the plan. The Retirement Protection Act of 1994 further increased the level of deficit reduction contributions of severely underfunded pension plans. To further improve the funding status of DB plans and the financial condition of the PBGC, the Pension Protection Act of 2006 has shortened the period over which a firm must fully fund its pension plans to seven years; firms were previously required to fund 90% of their pension liabilities over thirty years. For details on these changes in pension protection rules, see Moody's special comment, "Pension Reform Will Increase Funding Requirements for Underfunded U.S. Pension Plans," August 2006.

market value of the firm's net worth.[9] After the PBGC pays guaranteed benefits to participants, it makes every effort to recover funds from sponsoring firms. However, according to the ERISA of 1974, the claims held by the PBGC on sponsoring firms have the same priority as federal tax liens, which are usually junior to senior secured bondholders but senior to other bondholders. In particular, the PBGC with a lien that has not yet been perfected at the time of the commencement of the bankruptcy proceeding may find itself in the same position as the general unsecured creditors (Chen, Yu, and Zhang (2008), Shivdasani and Stefanescu (2010)).

PBGC insurance coverage of benefits under the DB plan is limited to a certain extent and far from comprehensive from the standpoint of employees. For example, the PBGC does not guarantee benefits for which employees do not have a vested right or have not met all age, service, or other requirements at the time the plan terminates. Benefit increases and new benefits that have been in place for less than five years are also only partly guaranteed. In addition, because of limitation provisions set by the ERISA, large pension plans and participants with benefits exceeding the maximum limit are not fully protected by the PBGC.[10] Thus, in general, pension deficits are considered to be sponsoring firms' unsecured senior inside debt owed to employees, which are partly insured by the PBGC.

It is important to note that while the extent of pension deficits is significantly affected by exogenous factors (e.g., financial market conditions), it is also subject to considerable managerial discretion. For example, managers can increase voluntary contributions or manipulate pension actuarial assumptions to reduce pension deficits (Bergstresser, Desai, and Rauh (2006)). It is also possible that managers deliberately underfund their pension plans in order to facilitate long-term contracts between unions and

[9] The maximum pension benefit guaranteed by the PBGC is adjusted annually. For single-employer plans that end in 2011, workers who retire at age 65, 60, and 50 can receive up to $4,500, $2,925, and $1,575 per month, respectively.
[10] Anecdotal evidence also indicates that pension deficits are far from fully guaranteed by the PBGC. For example, *Reuters* reports that "…the underfunded liability was estimated at $41 billion for GM, Chrysler and Ford Motor Co. at the end of 2008, the latest PBGC figures show. GM accounted for half the shortfall and only $4 billion of that gap would be insured if plans were terminated now, according to the PBGC. Chrysler had a $9 billion shortfall of which $2 billion would be covered." (*Reuters*, April 23, 2009). *USA Today* also reports that many underfunded DB plans that are terminated in bankruptcy or taken over by the PBGC reduce the retirement income for the retirees to some extent. For instance, the termination of United Airlines' plans in 2005, which were underfunded by approximately $9.8 billion, leads to a loss of almost 50% of benefits, since the PBGC only guaranteed another half of that amount (*USA Today*, May 15, 2005).

shareholders (Ippolito (1985a)), avoid costly pension asset reversions in the future (Ippolito (2001)), or deter potential takeover threats (Cocco and Volpin (2010)). For example, Ippolito (1985a) argues that by maintaining underfunded pension plans, firms essentially make unionized workers long-term unsecured bondholders and thus prevent unions from raising wages or reducing productivity to the point of threatening the long-term viability of the firm. Benmelech, Bergman, and Enriquez (2010) further argue that financially distressed airline companies strategically use pension deficits to obtain wage concession from their employees. Ippolito (2001) shows that firms choose to reduce pension contributions following a sequence of increasing reversion tax rates on the amount of pension assets in excess of pension obligations reverted to plan sponsors upon pension plan termination. Cocco and Volpin (2010) further show that large pension deficits effectively serve as poison pills that increase the uncertainty with respect to the equity value of the sponsoring firm, thereby making the firm less attractive to potential buyers. Overall, these studies suggest that pension funding status is determined by various internal and external factors and the disciplinary function of pension deficits proposed in this paper can be one of the benefits that pension deficits bring to the firm.

B. Main Hypotheses

We hypothesize that pension deficits serve as an important control mechanism that limits managers' discretionary power. In this subsection we discuss several rationales for the disciplinary role of pension deficits to provide strong theoretical guidance to our empirical tests.

First, underfunded plans can have a significant bearing on welfare and job security of employees. For example, Bulow (1982) argues that employees of DB plan sponsoring firms sacrifice high wages for the stable pension income and that large pension deficits impose tremendous pressure on sponsors and expose employees to considerable risk of losing their jobs. Similarly, Munnell, Aubry, and Muldoon (2008) suggest that large pension deficits may force stressed firms to lay off workers, financially unhealthy firms to go bankrupt, or compel healthy firms to freeze their DB plans. They also show that in these events, employees would end up with significantly lower retirement incomes than those they had anticipated,

despite the protection provided by the PBGC, because retirement benefits are usually computed based on wages at the time of the layoff, bankruptcy, or freeze, instead of at retirement. Moreover, their analysis suggests that compared to retirees and employees who are about to reach full retirement age, active and young employees are more adversely affected by the risk caused by pension deficits. Thus, to the extent that employees, especially active and young ones, have strong incentives to minimize these potential costs imposed by pension deficits and care about the long-term viability of the firm, they are expected to play an important role in monitoring firms' investment decisions when their pension plans are significantly underfunded.

Second, Jensen (1986) argues that managers with large free cash flow have incentives to overinvest beyond the optimal level, but large debt obligations allow managers to effectively bond their promise to pay out future cash flows, thus reducing the agency costs of free cash flow. Paying a stream of committed pension obligations to retirees and making mandatory periodic contributions to meet future retirement payments for current employees can significantly reduce the free cash flow available to managers. Furthermore, the PBGC charges high insurance premiums to firms whose pension plans are severely underfunded. For example, in 2003, the annual insurance premium was $19 per employee, plus $9 per $1,000 of shortfall. In 2009, it was increased to $34 per employee. To avoid these high insurance premiums, firms with underfunded pension plans usually use their internal cash flow to accelerate their contributions, which further reduces the cash flow available for managers to spend at their discretion. Unlike conventional debt whose periodic interest payments are regular and predictable, the pension contributions made by sponsoring firms are unstable and difficult to predict since they are influenced by various factors such as pension funding status, the availability of firms' cash flows, and managerial discretion. However, a significant part of pension contributions such as mandatory pension contributions

and insurance premiums paid to the PBGC are regular and nondiscretionary and thus can serve as an important control mechanism in limiting managers' discretionary behavior.[11]

Third, as Fama (1985) argues, inside debtholders have access to private information about borrowers that is not easily available to other debtholders, which provides them a significant advantage in monitoring their borrowers. Since employees participate in a firm's daily operations and are able to directly observe daily management decisions, they can be considered as important inside debtholders. Moreover, compared to public debtholders, employees are likely to spend less time and effort collecting information about their employer since they are on-the-spot. These information advantages are therefore expected to provide employees with enhanced monitoring capabilities and in turn stronger incentives to monitor their employer.

Finally, Hanka (1998) shows that higher debt is associated with more layoffs, greater reliance on part-time and seasonal employees, and lower wages. To the extent that these adverse effects of high debt on employees weaken the incentives of employees to work hard and lead to higher employee turnover, pension deficits, which account for a significant portion of a firm's debt, can have similarly negative effects on employee behavior. In addition, previous studies show that debt rating agencies take pension deficits into account when evaluating a firm's credit rating, with large pension deficits leading to a high cost of debt. For instance, Cardinale (2007) finds that credit spreads incorporate the extent of unfunded pension liabilities, and that their sensitivity to pension deficits is larger than their sensitivity to ordinary long-term debt. Rauh (2007) also shows that credit rating agencies are more likely to upgrade (downgrade) a firm's credit rating when its pension assets perform well (poorly). Thus, managers of firms with large pension deficits are expected to make value-enhancing investment decisions to mitigate the adverse effects of pension deficits on employee behavior and the cost of capital.

We empirically evaluate the above arguments for the disciplinary role of pension deficits as follows. First, we investigate whether the likelihood of engaging in acquisitions is lower for DB firms with a

[11] Rauh (2006a) shows that the impact of mandatory contributions on capital expenditures is economically significant, especially for financially constrained firms – a $1 mandatory pension contribution reduces capital expenditures by more than $0.60.

larger pension deficit than for other firms. According to the above arguments, pension deficits reduce a firm's free cash flow and thus provide managers with few incentives to engage in empire building. We therefore expect that all else being equal, DB firms with a larger pension deficit are less likely to engage in M&As than other firms. Further, as shown in Lang and Stulz (1994), Berger and Ofek (1995), Lins and Servaes (1999), and Lamont and Polk (2002), if the value-reducing consequences of investments are larger for diversified acquisitions than for non-diversified acquisitions, we expect this effect to be more pronounced for diversified acquisitions.

Second, we examine the relation between the extent of an acquirer's pension deficits and the announcement returns for both the acquirer and the value-weighted portfolio of the acquirer and the target. If large pension deficits allow the acquirer to overcome free cash flow problems and the reduction in agency problems translates into better acquirer performance, we expect the abnormal returns for both the acquirer and the value-weighted portfolio of the acquirer and the target to be higher when the acquirer has larger pension deficits.

Third, we examine whether the takeover premiums paid by DB acquirers with a larger pension deficit are different from those paid by other acquirers. Our arguments above suggest that offer prices are affected by the disciplinary role of pension deficits, as pension deficits help reduce the extent of managerial overconfidence (Roll (1986)). Since the interests of bidding firms' employees and shareholders are likely to be more closely aligned when bidding firms have larger pension deficits, we expect DB acquirers with a large pension deficit to pay smaller takeover premiums to their targets than other acquirers.

Finally, we examine whether the extent of an acquirer's pension deficits affects its methods of payment in acquisitions. Harford, Klasa, and Walcott (2009) find that acquirers use a smaller fraction of cash in paying for acquisitions when they are highly leveraged, while Shleifer and Vishny (2003) and Dong et al. (2006) show that acquirers are more likely to use cash as a method of payment when they acquire undervalued targets. Thus, if a firm's pension deficit is simply a part of its debt, then an acquirer's pension deficit is expected to be negatively related to the fraction of cash used in the payment

for a target. However, if pension deficits serve as an effective controlling mechanism and thus influence managers to make better acquisition decisions (i.e., to choose undervalued targets), then an acquirer's pension deficit is expected to be positively related to the fraction of cash used in acquisitions.

III. Data

A. Compustat Sample

We begin our analysis with the universe of all U.S. firms (including both DB and non-DB firms) listed in the Compustat North America database at any point between 1981 and 2008.[12] We exclude firm-years that have missing data on the book value of assets, stock returns, and the control variables used in the regression analysis. These sample criteria yield an unbalanced panel consisting of 13,569 unique firms and 115,960 firm-year observations. To mitigate the impact of outliers or misrecorded data on the results, all firm characteristics, including the market-to-book ratio (*M/B*) and return on assets (*ROA*), are winsorized at the 0.5% level at both tails of the distribution. All dollar values are converted into 2000 constant dollars using the GDP deflator. The accounting items related to DB pension plans and financial statement data are drawn from Compustat.[13] Stock price data come from the Center for Research in Security Prices (CRSP) files.

Firms are defined to have DB plans if both the fair value of pension plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The key variable of our interest, the pension deficit (*DEF*), is defined as the difference between *PBO* and *PPA*. Thus, a positive (negative) *DEF* indicates that the firm's DB pension plan is underfunded (overfunded). A positive pension deficit represents a true liability for the sponsoring company even if it does not appear on the balance sheet.

[12] The sample period is constrained by the availability of the Compustat data items related to DB pension plans, which are available starting from 1980. Since our empirical analysis uses one-year lagged pension variables in regressions, our sample period starts from 1981.

[13] U.S. Department **of** Labor Form 5500 is an alternative data source for a firm's pension-related variables, as it offers detailed information concerning plans' finances, participants, and administrators. However, using Form 5500 would significantly reduce our sample size, since complete filings are available only for fiscal years 1990 through 1998.

Appendix A briefly reviews the history of pension accounting in the U.S. and describes how *PPA* and *PBO* are calculated using Compustat data.

Following Jin, Merton, and Bodie (2006) and Shivdasani and Stefanescu (2010), we normalize each of the pension variables (*PBO*, *PPA*, and *DEF*) and control variables used in subsequent regressions using the end-of-period adjusted book value of assets (*Assets*). *Assets* is measured by adjusting the reported book value of assets for pension-related items, such as prepaid pension cost, accrued pension liabilities, and additional minimum liability.[14]

Table I reports summary statistics for our Compustat sample firms by year. Column (3) shows that during our sample period, 34.1% of Compustat firms sponsor DB pension plans. Untabulated results show that DB plan sponsors account for 75% of Compustat firms' total book value of assets, and they operate primarily in construction, chemicals, and automotive industries; the use of DB plans is less pervasive in high-tech industries such as software and telecom services. Column (3) also indicates that more than 50% of Compustat firms have DB plans in the early 1980s, reflecting the historical importance of DB plans in helping many U.S. workers attain an economically secure retirement. However, the percentage of DB firms decreases thereafter, hitting the lowest level around the 2001 recession, although it rebounds slightly afterwards until the end of the sample period.[15]

Columns (4)-(9) of Table I report the time series of annual mean and median values of *PBO/Assets*, *PPA/Assets*, and *DEF/Assets*, respectively. Consistent with the time trend of aggregate levels of pension funding deficits shown in Figure 1, the average funding status of DB pension plans has deteriorated over time. On average, DB pension plans had been sufficiently funded until the 1990s, during which time the

[14] For a detailed description about measuring *Assets*, see the netting approach described in Table 1 of Shivdasani and Stefanescu (2010). Our results remain qualitatively the same if we use the unadjusted book value of assets as in Rauh (2006a, 2007).

[15] The declining trend in the fraction of DB firms in our sample can be due to the change in numerator (the number of DB plan sponsors), the change in denominator (the number of total sample firms), or both in estimating the fraction. Fama and French (2001) document that in the **last** third of the twentieth century, **s**welling numbers of new listings tilt the population of Compustat firms increasingly toward small and young firms with low profitability and strong growth opportunities – characteristics typical of non-DB firms. The diminishing advantages and increasing costs associated with DB pension plans in recent years have also led to many cases of DB plan terminations, which might also contribute to the reduction in the percentage of DB sponsors over time in our sample. Thus, the declining trend in the percentage of DB firms is likely to be driven by both the increase in listed firms and the decrease in DB plan sponsors over time.

booming stock markets increased the value of pension assets. However, owing to both low interest rates and weak stock markets, the value of pension assets dropped significantly in the 2000s, leading to positive mean and median values of *DEF* between 2001 and 2008.

Panel A of Table II reports the mean firm characteristics for the full Compustat sample as well as those for the DB and non-DB plan sponsor subsamples. The DB plan sponsor subsample is further divided into DB plan sponsors with a pension deficit ($DEF > 0$) and those with a pension surplus ($DEF \leq 0$). Appendix B provides a detailed description of the construction of the variables reported in Table II and other tables.

Comparing firms sponsoring DB pension plans with those sponsoring non-DB pension plans, we find that DB plan sponsors are larger (*Ln*(*Asset*)), older (*Age*), and more leveraged. They also have more employees, more tangible assets (*PPE/Assets*), lower growth opportunities (*M/B* and *Sales Growth*), higher profitability and cash flows (*ROA* and *Cash Flows*/*Assets*)), less volatile earnings (*Earnings Volatility*), higher marginal tax rates (*Tax Rate*), and a lower likelihood of financial distress (*Z-score*).

Comparing firms with a pension surplus with those with a pension deficit (columns (5) and (6)), we find that the latter firms are on average younger and more leveraged, and they have fewer tangible assets than the former firms. In addition, underfunded firms exhibit higher growth opportunities, lower profitability, and a higher likelihood of financial distress than overfunded firms.

B. M&A Sample

To examine the disciplinary role of pension deficits, we then limit our attention to firms that engage in M&As. The initial sample of M&A firms comes from Thomson Financial's Security Data Corporation (SDC) M&As database. Our final sample of M&As includes all M&As completed between 1981 and 2008 subject to the following selection criteria:

(1) The acquiring firm owns less than 50% of the target's shares before the announcement date and controls 100% of the target's shares after acquisition.

(2) The acquiring firm is publicly traded and has accounting data available from Compustat.

(3) The deal value disclosed in SDC exceeds 1% of the acquiring firm's market value of equity at the end of the fiscal year prior to the acquisition announcement.

These sample criteria yield a final sample of 26,329 M&As, among which 8,386 (32%) are made by DB firms and 17,943 (68%) by non-DB firms. Untabulated tests show that the number of M&As increases until the late 1990s, peaking in 1998 and then dropping off significantly through the end of the sample period. Throughout our regression analysis, we use year dummies to control for variation in M&A activity over time.

Panel B of Table II reports the mean firm and deal characteristics for our M&A sample. Comparing firm characteristics between DB firms and non-DB firms, and those between DB firms with a pension deficit and DB firms with a pension surplus, we find that the results mirror those for our full Compustat sample.

For deal-specific characteristics, we document that the offer price (*Deal Value*) and *Deal Value* divided by the acquirer's market value of equity at the end of the fiscal year prior to the acquisition announcement (*Relative Size*) are significantly larger and smaller, respectively, for acquisitions by DB plan sponsors compared to acquisitions by non-DB plan sponsors. These results suggest that despite DB acquirers' larger size, DB acquirers purchase relatively smaller targets than non-DB acquirers. We also find that compared to non-DB plan firms, DB plan firms are more likely to acquire publicly held targets (*Public Target*), make hostile acquisitions (*Hostility*), participate in multiple bids (*Multiple Bids*), acquire targets whose three-digit SIC codes are different from theirs (*Diversify*), and pay for acquisitions using cash only (*PureCash*). The percentage of the total transaction value paid in cash (*Pct_Cash*) is also higher for acquisitions by DB plan sponsors than for acquisitions by non-DB plan sponsors. When comparing acquirers with underfunded DB plans ($DEF > 0$) to those with overfunded DB plans ($DEF \leq 0$), we find that the former make fewer diversifying M&As than the latter. Acquirers with underfunded DB plans are also less likely to acquire publicly held firms, make hostile acquisitions, and participate in multiple bids.

Panel B of Table II also reports the cumulative abnormal return (*CAR*) for the acquirer from one day before to one day after the announcement date of the M&A (*CAR*(-1,1)), the market-capitalization weighted *CAR* of the acquirer and the target during the same event window (*WCAR*(-1,1)), and the premium paid to the target by the acquirer (*Premium*). We employ a standard event study methodology to measure abnormal announcement day returns. To obtain our estimates of the market model we use 200 trading days of return data, beginning 205 days before and ending 6 days before the M&A announcement date. We use as the market return the CRSP value-weighted return. Using the CRSP equally-weighted returns yields qualitatively similar results. Following Bradley, Desai, and Kim (1988), we use the market capitalizations of the bidder and the target two days prior to the announcement date as the weights in calculating *WCAR*(-1,1). Following Moeller, Schlingemann, and Stulz (2004), we calculate *Premium* as the difference between the acquirer's offer price (total value of cash, stock, and other securities offered by the acquirer to the target) and the target's market value of equity 50 days prior to the M&A announcement date, scaled by the target's market value of equity on the same day.[16] To minimize the impact of extreme values and misrecorded data, we follow Dong et al. (2006) and truncate *Premium* at -50% and 150%.

We find that the average *CAR*(-1,1) for non-DB plan acquirers is a significant 1.54%. The corresponding *CAR* for DB plan acquirers is a significant 0.56%. The difference in mean *CAR*(-1,1) between the two groups is statistically significant, suggesting that the market views M&As made by firms with DB pension plans as less value-increasing investments. The mean *WCAR*(-1,1) and *Premium* do not display statistically significant differences between DB and non-DB firms.

When comparing acquirers with underfunded DB plans to those with overfunded DB plans, we find that the former acquirers realize higher *CAR*(-1,1) and higher *WCAR*(-1,1) and use more cash as the method of payment. These results, together with those for the deal characteristics discussed above,

[16] Because many targets are privately held and their stock prices are not available, the sample sizes in calculating *WCAR* and *Premium* are reduced to 3,515 and 3,301, respectively.

suggest that acquirers with underfunded DB plans are more likely to undertake value-enhancing M&As than acquirers with overfunded DB plans.[17]

Finally, Panel B of Table II shows the differences in financial constraints among acquiring firms in our sample. We use three different measures of financial constraints, namely, Whited and Wu's (2006) financial constraint index (*WW* index), Hadlock and Pierce's (2010) financial constraint index (*HP* index), and the dividend-payer indicator.[18] By construction, higher scores of *WW* or *HP* indices indicate that firms are more financially constrained. Dividend paying firms are considered to be less financially constrained than those paying no dividends (Fazzari, Hubbard, and Petersen (1988)). We find that acquirers with pension deficits are more financially constrained than those with pension surplus. In Section V.C., we examine how these differences in financial constraints affect our main results for the disciplinary role of pension deficits.

Figure 2 presents the time-series profile of the relation between the median *DEF/Assets* and various acquisition outcome variables during our sample period, including the percentage of diversifying acquisitions, the median *CAR*(-1,1), the median *Premium*, and the median *Pct_Cash*. Since *DEF/Assets* can be computed only for DB firms, we exclude acquiring firms that do not sponsor DB plan in the analysis. The results show that as the median *DEF/Assets* increases, the percentage of diversifying acquisitions and the premiums paid to targets tend to decrease while acquirers' abnormal merger announcement returns and their propensity to use cash increase. The results are similar if we use mean values of *DEF/Assets* and acquisition outcome variables to plot the charts.

[17] Previous studies show that stock-financed M&As, diversifying M&As, hostile M&As, and acquisitions of publicly listed firms generally result in lower bidder returns. For example, Travlos (1987) finds that the announcements of stock- (cash-)financed acquisitions are associated with lower (higher) acquirer abnormal returns; Morck, Shleifer, and Vishny (1990) find that diversifying acquisitions tend to destroy shareholder value; Schwert (2000) reports that acquirers making hostile offers experience lower abnormal returns, and Fuller, Netter, and Stegemoller (2002) show that acquiring firms experience significantly negative (positive) abnormal returns when buying publicly held firms (privately held firms or subsidiaries).

[18] The *WW* index is constructed based on a structural model that avoids the measurement errors associated with Tobin's *Q* in traditional tests. The *HP* index measures a firm's financial constraints as a function of its age and size. Hadlock and Pierce (2010) argue that in many contexts their index is a more reasonable measure of a firm's financial constraints than other types of constraint measures, such as the Kaplan and Zingales' (1997) index of constraints. Appendix B provides a detailed description of the construction of *WW* and *HP* indices.

IV. Empirical Methodology and Results

A. Methodology

To examine the impact of *DEF/Assets* on various aspects of acquisition activities, our empirical specification needs to address two types of endogeneity. The first type concerns the nonrandom choice of whether or not to be a DB plan sponsor. The pension deficit is only observable for DB plan sponsors. However, sponsors' choice between DB and non-DB pension plans is likely to be endogenous and some firms may self-select into becoming DB plan sponsors based on their firm characteristics. A failure to control for such self-selection may result in biased estimates. Second, conditional on a firm being a DB plan sponsor, the firm's pension funding status, i.e., the size of its pension deficit, may also be endogenously determined.

To address these two types of endogeneity concerns, we employ a three-step bootstrapping procedure that is similar to the approach proposed by Shivdasani and Stefanescu (2010). Specifically, in the first step we model the likelihood of a firm being a DB plan sponsor (pension selection equation). In the second step, conditional on a firm being a DB sponsor, we predict the size of its pension deficit (*DEF/Assets*). To obtain consistent and asymptotically efficient coefficient estimates, we jointly estimate the regressions in the first and second steps using Heckman's (1979) maximum likelihood estimator. This procedure yields the predicted pension deficit, $\overline{DEF / Asset}$. In the final step we use $\overline{DEF / Asset}$ and its interaction with *DB* (a dummy variable that equals one if the firm chooses a DB pension plan and zero otherwise) as the key independent variables in regressions to investigate the impact of pension deficits on various aspects of acquisition activities. Although the last step is the focus of our empirical analysis, the first and second steps are included to control for self-selection bias and the endogeneity of the size of pension deficits, respectively. To further mitigate the latter effect, we estimate the size of pension deficits lagged one period based on firm-specific variables lagged two periods. We bootstrap the three-step system 500 times to obtain consistent standard errors and report the coefficients' 95% confidence interval estimates in the tables. Appendix C provides a detailed description of this three-step procedure.

B. Determinants of Pension Plan Choice and Size of Pension Deficit

Table III reports the results obtained by jointly estimating the first and second steps using Heckman's (1979) maximum likelihood estimator. We use the full sample of Compustat firms to estimate the regressions. Column (1) presents the first-step estimates of the pension selection equation, which concerns the decision of whether to sponsor a DB pension plan (i.e., choice of pension plan). The second-step estimates, in which *DEF/Assets* is the dependent variable, are reported in column (2).

Consistent with the univariate results in Table II, column (1) of Table III shows that larger firms (*Ln*(*Asset*)), older firms (*Ln*(*Age*)), and firms with more employees (*Ln*(*Employees*)), lower growth (*M/B*), higher *ROA*, lower earnings volatility (*Earnings Volatility*), higher asset tangibility (*PPE/Assets*), and higher marginal tax rates (*MTR*) are more likely to sponsor DB pension plans. We also find that employee tenure (*Tenure*), which is defined as the median employee tenure for two-digit SIC industry firms obtained from the Employee Benefits Survey provided by the Bureau of Labor Statistics, is negatively associated with the decision to adopt DB pension plans (z-statistic = -4.6). More importantly, from an identification perspective, we find that the impact of the unionization rate (*Union*) on the incidence of DB pension plans is positive and highly significant (z-statistic = 23.2), suggesting that firms are more likely to adopt DB pension plans when the labor force is organized by unions.

Column (2) indicates that the size of a firm's pension deficit is large for small DB plan sponsors, young DB plan sponsors, and DB plan sponsors with a large number of employees, high growth potential, a high likelihood of financial distress as measured by *Z-score*, low *ROA*, high earnings volatility, low asset tangibility, low marginal tax rate, and low employee tenure. In addition, we find that firms with negative book value of equity (*Negative Equity*) and high leverage are more underfunded. In contrast, firms with rated debt (*Debt Rating*) have better pension funding status, possibly due to easier access to the corporate bond market. The size of a firm's pension deficit is found to decrease with the level of interest rates (*Interest Rate*) and stock market returns (*Stock Market Return*). We also find that the age of a firm's

pension plan (*Plan Age*) has a negative effect on the size of its pension deficit (*z*-statistic = -2.5), suggesting that a firm's funding status generally improves as the plan ages.

The λ coefficient, a statistic for the selectivity effect, in our Heckman estimation is -0.004 and is significant at the 5% level, indicating that self-selection is indeed a concern. The estimated correlation between the error terms in the equations in the first and second steps is -0.10, significant at the 5% level. Note, however, that our main objective here is not to identify a complete list of determinants that affect the pension plan choice and the size of a firm's pension deficit, but rather to identify variables that are correlated with the pension plan choice and the size of a firm's pension deficit in order to address the endogeneity issues discussed in Section IV.A.

C. Effects of Pension Deficits on M&A Activities

In this subsection, using multivariate regression models, we examine how pension deficits affect various aspects of M&A activities, such as the decision to engage in M&As, acquirer returns and portfolio returns of the acquirer and the target around the M&A announcement dates, takeover premiums paid by acquirers, and the choice of payment methods in acquisitions. Our tests include both DB and non-DB plan sponsors and compare the marginal effects that pension plan type has on various aspects of M&A activities. The key variable of interest is the interaction between *DB* and *DEF/Assets*, which captures the impact of DB sponsors' pension deficits.

C.1. Pension Deficits and the Decision to Acquire Other Firms

To examine the effect of a firm's DB pension deficits on its decision to acquire other firms, we use a probit regression. Specifically, using *all* firms in our Compustat sample, which includes 23,072 acquirers and 92,888 non-acquirers, we estimate the following probit model to predict which firms become acquirers:[19]

[19] Since a firm may make more than one acquisition in a given year, the number of acquirers (23,072) is smaller than the number of acquisitions (26,329) in our sample.

$$P[Acquirer = 1] \; = \; F(d_1 + d_2 DB + d_3 DB \times DEF / Assets + d_4 C + \varepsilon), \qquad (1)$$

where *P* stands for the probability of being an acquirer, *Acquirer* is a dummy variable that takes a value of one if a firm acquires at least one firm in a fiscal year and zero otherwise, *F* denotes the normal cumulative distribution function, *DB* is a dummy variable that takes a value of one if a firm chooses to sponsor the DB plan and zero otherwise, and *DEF/Assets* is the size of pension deficits. The coefficient on *DB*, d_2, reflects the difference in the likelihood of being an acquirer between DB plan sponsors and non-DB firms. To the extent that pension deficits reduce the incentives of DB plan sponsors to engage in acquisitions, the coefficient on the interaction term between *DB* and *DEF/Assets*, d_3, is expected to be negative.

In equation (1), *C* denotes a set of control variables shown by prior literature to influence a firm's decision to acquire. Following Comment and Schwert (1995) and Harford (1999), we include as control variables *Leverage*, *Ln*(*Assets*), *Ln*(*Age*), *PPE*/*Assets*, *ROA*, *Earnings Volatility*, *M/B*, *Sales Growth*, and *Stock Return* (the compounded monthly stock returns over the fiscal year prior to the acquisition). As a key control variable in regressions, *Leverage* is measured as the ratio of the sum of short-term and long-term debt to *Assets*. Several studies show that the availability of internal funds is an important determinant of a firm's investment decisions. For example, Harford (1999) documents that cash-rich firms are more likely to become bidders, and Fazzari, Hubbard, and Petersen (1988) find that corporate investment is sensitive to internal cash flows. Therefore, we include as additional control variables *Cash/Assets* and *Cash Flows*/*Assets*. Since dividend payments can reduce the cash available to managers for new acquisitions, we also add *Dividend*/*Assets* as a control variable. Consistent with Jensen's (1986) free cash flow hypothesis, Lang, Stulz, and Walkling (1991) find that firms with low Tobin's *Q* and high cash flows are more likely to undertake value-decreasing acquisitions. We thus add the indicator variable, *Agency*, which equals one if a firm's *M/B* is below the industry median (based on the firm's three-digit SIC code) and its *Cash Flows*/*Assets* exceeds the industry median in a given year, and zero otherwise. To mitigate endogeneity concerns, all independent variables in equation (1) are pre-determined (one-period

lagged) except *Cash Flows*/*Assets*, which is calculated using contemporaneous cash flows.[20] Two-digit SIC industry dummies are included to control for industry-specific merger waves as documented by Mitchell and Mulherin (1996) and Harford (2005). Also included are year dummies to account for merger waves over time.

Columns (1) and (2) of Table IV report the estimates from the probit regressions. We report the marginal effects that measure the effect of a one unit change in the continuous explanatory variables (moving from zero to one for dummy variables) on the dependent variable. Column (1) presents estimates obtained by using a simple maximum likelihood approach and the actual value of *DEF/Assets* in the probit regression. For non-DB firms, we set their *DEF* equal to zero. We allow for clustering of firm observations to adjust the standard errors for serial correlation and also correct standard errors for heteroskedasticity. In column (2), we report the results obtained using the three-step bootstrapping procedure outlined in Appendix C. In particular, we predict the value of *DEF/Assets* by jointly estimating the equations for the first and second steps using the specification in Table III, and use the predicted value of *DEF/Assets* in equation (1).

We find that the results using these two different estimation procedures are qualitatively similar. Both columns indicate that the pension plan choice (*DB*) is not significantly associated with the likelihood of being an acquiring firm. In column (1) the *z*-statistic of the coefficient estimate on *DB* is an insignificant 0.4. Similarly, in column (2) the bootstrapped 95% confidence interval for *DB* spans zero, indicating that the coefficient estimate on *DB* is insignificantly different from zero. The coefficient estimate on *DB*×*DEF/Assets* in column (1) is negative and significant at the 1% level (*z*-statistic = -3.7), suggesting that pension deficits reduce DB sponsors' incentives to engage in M&As. The estimated coefficient (-0.256) suggests that a one-standard deviation increase in *DEF/Assets* (0.041) decreases the likelihood of being an acquirer by 1.05 (= -0.256 × 0.041) percentage points, which implies a reduction in the probability of being an acquirer by more than 5.3% given the unconditional likelihood of 19.9% (=

[20] The use of contemporaneous cash flows is consistent with the literature on investment-cash flow sensitivities (e.g., Fazzari, Hubbard, and Petersen (1988), Kaplan and Zingales (1997), Rauh (2006a)).

number of acquirers / total number of firm-years = 23,072/115,960 = 19.9%) for all firms in our Compustat sample. To put it in perspective, increasing a firm's *Leverage* by a one standard deviation (0.20) decreases the probability of being an acquirer by a similar magnitude (-0.063 × 0.20 = 1.26%). The bootstrapped results in column (2) also indicate that the negative effect of *DB*×*DEF/Assets* is significant at less than the 5% level.

The coefficient estimates on the control variables generally have consistent signs with prior literature. For example, firms that are larger, less risky, more subject to agency problems, or that have a higher past stock return are more likely to acquire other firms. Unreported results show that industry and year dummies are jointly significant, implying the importance of merger waves across industries and over time in affecting the decision to acquire.

In columns (3) and (4) of Table IV, we replace the dependent variable in columns (1) and (2), *Acquirer*, with *Diversify*. We use a sample of 26,329 acquisitions in estimating columns (3) and (4), of which 13,764 (52%) are diversifying acquisitions.

In column (3), *DB* is positively related to the likelihood of making diversifying acquisitions. The marginal effect of changing from a non-DB firm to a DB plan sponsor increases the likelihood of making diversifying acquisitions by 7%. Column (4), which is estimated using the bootstrapped approach, also shows that this effect is significant at less than the 5% level. The coefficient estimate on *DB*×*DEF/Assets* is negative and significant at the 1% level in column (3). The estimated coefficient (-0.835) suggests that increasing *DEF/Assets* by a one standard deviation lowers the probability of making diversifying acquisitions by 3.4% (= -0.835 × 0.041) for DB plan sponsors. In contrast, conventional debt ratio, *Leverage*, has a statistically insignificant coefficient of 0.035 (*z*-statistic = 1.3). The result using the bootstrapped approach in column (4) shows that the estimated coefficient on *DB*×*DEF/Assets* is also negative and significant at the 5% level. In untabulated tests, using negative Poisson regressions, we examine the impact of pension deficits on the number of acquisitions and the number of diversifying acquisitions and find similar results.

Taken together, our findings in Table IV suggest that firms with underfunded DB pension plans engage in fewer acquisitions and are less likely to make diversifying acquisitions if they do decide to enter the market for corporate control. These results are consistent with our hypothesis that pension deficits limit managerial incentives to spend resources on empire building. The results also indicate that when employees' retirement benefits are tied to the firm's performance, employees discipline managerial empire building behaviors, supporting the view of Blair (1999) that, as important stakeholders, employees can curb managerial power and participate in corporate governance.

C.2. Pension Deficits and M&A Announcement Effects

To examine the impact of pension deficits on the quality of investment, we regress acquirers' *CAR*(-1,1) on *DB*, *DB*×*DEF/Assets*, and acquirer and deal characteristics.[21] As acquirer characteristics, we include *Leverage*, *Ln*(*Assets*), *M/B*, and *Cash Flows/Assets*. To control for deal characteristics, we include *Relative Size*, *Multiple Bids*, *Diversify*, *High Tech* (a dummy variable equal to one if a deal is made between two high tech firms as defined by Loughran and Ritter (2004) and zero otherwise), *Hostility*, *Public Target*, and *Industry M&A* (for each year and each of the three-digit SIC industries, the value of all SDC acquisition deals in the industry divided by total book value of assets of Compustat firms in the same industry). We include *Relative Size* and *Multiple Bids* because Moeller, Schlingemann, and Stulz (2004) show that bidder announcement returns increase with relative deal size and decrease when there are multiple bidders. We include *Diversify* since Morck, Shleifer, and Vishny (1990) show that bidders earn negative returns when making unrelated acquisitions. *High Tech* is included as Loughran and Ritter (2004) document that when both the acquirer and the target are in high-tech industries, the acquirer is more likely to underestimate the costs and overestimate the synergies of the combination. Schwert (2000) finds that acquirers realize lower abnormal returns in hostile takeovers, so we include *Hostility*, which equals one if the SDC classifies the acquisition as a hostile takeover and zero

[21] Using either the abnormal return on the announcement day (*CAR*(0)) or the cumulative abnormal return from two days before to two days after the announcement date (*CAR*(-2,2)) as the dependent variable does not change our main results.

if the SDC classifies the acquisition as a friendly takeover. In addition, Fuller, Netter, and Stegemoller (2002) document that acquirers experience significantly negative abnormal returns when they buy publicly held targets and significantly positive abnormal returns when they buy privately held targets or subsidiaries, and thus we include *Public Target* as a control variable. Since cash (stock) is more likely to be used as a method of payment when there is low (high) valuation uncertainty in the acquisition (Travlos (1987), Loughran and Vijh (1997)), we also control for *PureCash* in the regression.[22] Finally, we include Moeller, Schlingemann, and Stulz's (2004) industry M&A activity measure (i.e., *Industry M&A*) to control for the intensity of acquisition activity in the target industry. The regression also controls for the industry and year fixed effects.

Columns (1) and (2) of Table V present the regression results. Column (1) presents the estimates from ordinary least squares (OLS) regressions. The *t*-statistics are calculated using Huber/White/ Sandwich heteroskedasticity-consistent errors, which are corrected for serial correlation across observations for a given firm. We find that the coefficient estimate on *DB*×*DEF/Assets* is positive and significant at the 1% level (*t*-statistic = 4.2). Furthermore, the effect of pension deficits on bidder returns is economically large and significant: a one-standard deviation increase in *DEF/Assets* results in an approximately 0.34% (= 0.083 × 0.041) increase in bidder returns. In comparison, we find that a one-standard deviation increase in leverage (0.20) is associated with an increase in bidder returns of only 0.16% (= 0.008 × 0.2).[23] Thus, pension deficits are more than twice as likely to have a positive effect on bidder returns as is conventional debt. In column (2), we report the results obtained using the three-step bootstrapping procedure. We find that the effect of *DEF/Assets* on bidder returns is positive and significant at less than the 5% level. Taken as a whole, these results support the disciplinary role of

[22] Chang (1998) and Fuller, Netter, and Stegemoller (2002) find that bidder returns are significantly positive when bidders use stock financing to acquire a privately held target, attributing the result to "efficient monitoring" by a new blockholder. Thus, as a robustness check, we replace *Public Target* and *PureCash* with six interaction terms used in Masulis, Wang, and Xie (2007), namely, public all-dash deal, public stock deal, private all-cash deal, private stock deal, subsidiary all-cash deal, and subsidiary stock deal. We find that our main results do not change using this alternative specification.

[23] Masulis, Wang, and Xie (2007) find that for their sample of acquiring firms during the 1990 to 2003 period, a one-standard deviation increase in leverage is associated with an approximately 0.09% increase in acquirer *CAR*(-2, 2).

corporate pension deficits. We also find that the signs of the coefficients on control variables in both regressions are generally consistent with prior studies: bidder announcement returns are positively associated with *Relative Size* and *PureCash*, but are negatively related to *Ln*(*Assets*), *M/B* , and *Public Target*.

Masulis, Wang, and Xie (2007) show that the quality of corporate governance has a significant effect on acquirer returns. Specifically, using the governance index (G-index) constructed by Gompers, Ishii, and Metrick (2003), they find that entrenched managers protected by more anti-takeover provisions face weaker discipline from the market for corporate control, and hence are more likely to destroy shareholder value by making unprofitable acquisitions. To check whether our results are robust to the inclusion of the governance index, we reestimate the regressions in Table V by adding G-index as an additional control variable. Although we lose about 75% of the sample observations because of unavailability of their G-index, untabulated results show that the coefficient estimate on *DB*×*DEF/Assets* remains positive and significant in both OLS regressions and regressions using the bootstrapping procedure.

To further explore whether acquirers with a pension deficit make better acquisition decisions than those with a pension surplus, we examine whether larger pension deficits are associated with higher portfolio synergistic gains between the acquirer and the target (*WCAR*(-1,1)) and lower premiums paid to targets (*Premium*). The regression results are reported in Table VI.

In columns (1) and (2) of Table VI, we use *WCAR*(-1,1) as the dependent variable. In addition to including the independent variables used in Table V, to be consistent with Moeller, Schlingemann, and Stulz (2004), Dong et al. (2006), and Wang and Xie (2009), we include target firm characteristics ($Leverage^{Target}$, $Ln(Assets)^{Target}$, and M/B^{Target}) as additional control variables.[24] We find that in column (1), which presents the estimates from the OLS regression, the coefficient estimate on *DB*×*DEF/Assets* is positive and significant at the 1% level (*t*-statistic = 3.3). Thus, the value-weighted announcement returns

[24] Because we include target characteristics in regressions reported in Tables VI and VII, our tests in these tables are conducted over a smaller sample for which target characteristics are available in Compustat. In untabulated tests, we also estimate the regressions in Tables VI and VII using the full sample of acquisitions and not including target characteristics, and find that the coefficient estimates on *DB*×*DEF/Assets* are positive and significant at the 1% level in all regressions.

of the bidder-target portfolio are higher when DB acquirers have larger pension deficits, further supporting the disciplinary role of pension deficits. The coefficient of 0.221 suggests that a one-standard deviation increase in *DEF/Assets* is associated with a 0.91% (= 0.221 × 0.041) increase in *WCAR*(1,1). In comparison, the corresponding effect of *Leverage* on *WCAR*(1,1) is only 0.36% (= 0.018 × 0.2). Thus, the economic significance of pension deficits on portfolio returns is more than twice as large as that of conventional debt. The results using the three-step bootstrapping procedure in column (2) confirm those in column (1): the bootstrapped 95% confidence interval of the coefficient estimate on *DB*×*DEF/Assets* is positive and does not span zero.

In columns (3) and (4) of Table VI, we use *Premium* as the dependent variable. Since we hypothesize that larger pension deficits limit managerial hubris to overpay, we expect the coefficient estimate on *DB*×*DEF/Assets* to be negative. Consistent with this prediction, we find that the coefficient on *DB*×*DEF/Assets* in column (3) is negative and significant at the 5% level. The coefficient of -0.705 indicates that a one-standard deviation increase in *DEF/Assets* lowers the premiums paid to targets by 2.9% (= -0.705 × 0.041). The coefficient on *Leverage*, however, is not significant. The analysis using the three-step bootstrapping procedure in column (4) suggests that the bootstrapped coefficient of *DEF/Assets* is negative (-1.03), but not significant at the 5% level.

Overall, the results in Tables V and VI suggest that market participants value the governance role of pension deficits in disciplining managers, and hence the stock prices of acquiring firms react more favorably to acquisitions by DB sponsors with larger pension deficits. Moreover, DB sponsors with larger pension deficits pay smaller premiums to their targets than other acquirers, further supporting the disciplinary role of pension deficits.

C.3. Pension Deficits and Payment Methods

In this subsection we examine the disciplinary role of pension deficits by investigating whether the level of an acquirer's pension deficits affects its choice of payment methods in M&As. To the extent that acquirers are more likely to use cash as a method of payment when they acquire undervalued targets

(Shleifer and Vishny (2003), Dong et al. (2006)), we expect the level of an acquirer's pension deficits to be positively related to the use of cash as the method of payment in acquisitions.

In columns (1) and (2) of Table VII, we report the estimates from tobit regressions in which the dependent variable is the cash payment as a fraction of the acquisition's transaction value (*Pct_Cash*). We use as explanatory variables those used in Dong et al. (2006). Consistent with our prediction, we find that the coefficient estimate on *DB×DEF/Assets* in column (1) is positive and significant at the 1% level. The coefficient of 3.965 suggests that a one-standard deviation increase in *DEF/Assets* leads to a 16.3% increase in the fraction of cash payment. The bootstrapped results in column (2) also indicate that this effect is significant at less than the 5% level.[25] These results suggest that larger pension deficits influence managers to make better acquisition decisions by choosing undervalued targets.[26]

V. Additional Tests

To check the robustness of our main results, we conduct a battery of additional tests and report the results in Tables VIII through X. Although the dependent and control variables used in Tables VIII through X are the same as those used in Tables IV through VII, to save space, we only report the coefficient estimates on pension-related variables. Also, for the sake of brevity, we only report results obtained using the plain-vanilla pooled OLS, probit, and tobit models. In untabulated tests, we find that our results using the three-step bootstrapping procedure are qualitatively similar to those reported in Tables VIII through X.

[25] In untabulated tests, we estimate probit regressions in which the dependent variable (*PureCash*) is a dummy variable that takes a value of one if the acquirer pays for acquisitions using cash only and zero otherwise. The results are similar to those reported in Table VII.

[26] It is possible that acquirers with larger pension deficits are more likely to use cash rather than stocks in acquisitions because they are undervalued in the market (Shleifer and Vishny (2003)). However, Franzoni and Marin (2006) and Franzoni (2009) document that firms with underfunded pension plans tend to be overvalued and experience lower stock returns than those with overfunded pension plans. Although we control for *M/B* in the regressions reported in Table VII, to further ensure that our findings are not driven by the undervaluation of acquiring firms, we include the past one-year stock return as an additional control variable. Untabulated results show that the significance of the coefficient estimates on *DB×DEF/Assets* reported in Table VII does not change.

A. Alternative Measures of Pension Deficits

Thus far, we have measured pension deficits as the ratio of the difference between *PBO* and *PPA* to adjusted total assets. To check whether our results are sensitive to the use of a different deflator in measuring pension deficits, first, we scale a firm's pension deficits by its market capitalization (*MVE*) (Franzoni and Marin (2006)). We then reestimate the regressions in Tables IV through VII using this new definition of pension deficits. The results are reported in Panel A of Table VIII. We find that the coefficient estimates on the interaction term between *DB* and this variable remain statistically significant in all regressions with the expected signs, suggesting that our key finding that pension deficits play an important disciplinary role is robust to the alternative deflator used in scaling pension deficits.

Second, to examine the relative importance of pension assets and pension liabilities in driving the disciplinary role of pension deficits, we reestimate the regressions in Tables IV through VII by replacing *DEF* with its two components, *PPA* and *PBO*, both of which are scaled by adjusted total assets. The results reported in Panel B of Table VIII show that each component contributes almost equally to the disciplinary effect of pension deficits. The only exception is the result for the likelihood of making diversifying acquisitions reported in column (2), in which the coefficient estimate on $DB \times PPA/Assets$ is significant at the 1% level while that on $DB \times PBO/Assets$ is not significant.

Third, to examine whether the change in pension deficits has an effect on merger outcome variables, we decompose our measure of pension deficits ($DEF_{t-1}/Assets_{t-1}$) into the change in pension deficits from t-2 to t-1 ($(DEF_{t-1}-DEF_{t-2})/Assets_{t-1}$) and the level of pension deficits at t-2 ($DEF_{t-2}/Assets_{t-1}$) and then reestimate the regressions in Tables IV through VII by including these two variables. The results reported in Panel C of Table VIII show that the coefficient estimate on $DB \times DEF_{t-2}/Assets_{t-1}$ is significant in all regressions. We also find that $DB \times (DEF_{t-1}-DEF_{t-2})/Assets_{t-1}$ has the significant coefficients in all regressions except for *WCAR*(-1,1) and *Pct_Cash* regressions, implying that the control function of pension deficits strengthens as pension funding status deteriorates.[27]

[27] The change in pension deficits can be due to a multitude of factors, such as the choice and performance of pension assets, changes in discount factors, voluntary contribution decisions, and the change in structure of pension benefits.

Fourth, while a significant portion of pension deficits is exogenously determined by capital market conditions that are beyond managers' control, the reported pension deficits are also subject to considerable managerial discretion. For example, Bergstresser, Desai, and Rauh (2006) show that managers manipulate pension actuarial assumptions to artificially improve funding status before acquiring other firms. If managers understand that pension deficits incentivize employees to monitor them more closely and deter them from undertaking acquisitions with high private benefits, they might have an incentive to engage in "window dressing" and change the pension plan assumptions (e.g., discount rates used to calculate pension liabilities) prior to acquisitions. Although firms are required to use the 30-year Treasury bond yield as the discount rate in estimating their pension liabilities during the period 1987-2003, they are allowed to choose a discount rate from a blend of long term corporate bond yields since April 2004 onwards. To ensure that our results are not driven by managerial discretion to choose a different discount rate prior to acquisitions, following Bulow (1979) and Feldstein and Morck (1985), we use the 30-year Treasury bond yield across all sample years in estimating pension liabilities and recalculate pension deficits (*DEF_adj/Assets*). We then reestimate the regressions in Tables IV through VII by replacing *DEF/Assets* with *DEF_adj/Assets*. The results are reported in Panel D of Table VIII. Our main results remain qualitatively the same except that the coefficient on *DEF_adj/Assets* is statistically insignificant (*t*-statistics = -1.6) in column (5). Thus, our findings are not likely to be driven by the fact that managers manipulate discount rates before acquisitions.

B. Self-Selection Bias

So far, to mitigate concerns of self-selection bias, our tests in Tables IV through VII have included both DB and non-DB firms and used the interaction term, *DB×DEF/Assets*, to capture the impact of pension deficits on several aspects of takeover decisions. To ensure that our results are not simply driven by the inclusion of non-DB firms in our analysis, we reestimate the regressions in Tables IV through VII

Although it would be interesting to examine which of these factors drives the link between the change in pension deficit and merger outcome variables, their detailed information is difficult to obtain due to data availability.

using DB firms only and report the results in Panel E of Table VIII. By limiting the attention to DB firms in the regression analyses, we essentially treat the pension plan choice as a pre-determined variable. Consistent with the results in Tables IV through VII, we find that the coefficient estimates on *DEF/Assets* are significant in all regressions with the expected signs, suggesting that our key results are not driven by including non-DB firms in the analyses.

To further address the self-selection bias, we utilize the fact that the pension-plan choice is sticky. Specifically, we reestimate the regressions in Tables IV through VII using only firms that have sponsored DB plans for longer than three years. If a DB plan has been in place for several years, then it is unlikely that the choice of a DB plan is a byproduct of the firm's *current* financial characteristics and investment decisions.[28] Thus, the degree of self-selection bias is likely to be smaller in this subsample. The results are reported in Panel F of Table VIII. We find that all of the estimated coefficients on *DEF* remain statistically significant with expected signs.

C. Financial Constraints as an Alternative Explanation

Although our results above support the view that pension deficits play an important role in reducing inefficient investment, some of them are also consistent with the alternative explanation that firms with larger pension deficits are those with higher financial constraints. For example, Rauh (2006a) shows that firms that make mandatory pension contributions, especially those that are financially constrained, reduce capital expenditures (including acquisitions) because they experience a lack of internal funds. This result suggests that financial constraints, but not necessarily the control function of pension deficits, influence DB firms with large pension deficits to make fewer investments.[29] To see if the financial constraint explanation may be behind our results, we divide our sample acquirers into two subsamples according to the extent of their financial constraints and reestimate the regressions in Tables IV through VII separately

[28] The concern with this approach, however, is that it cannot mitigate self-selection bias driven by time-invariant characteristics.

[29] However, some of our findings, for example, the findings that acquiring firms with larger pension deficits realize higher announcement returns and are more likely to use cash to purchase targets, are consistent with the disciplinary effects of pension deficits rather than financial constraint effects.

for these two subsamples. The financial constraint explanation would suggest that the impact of *DEF/Assets* on several aspects of takeover decisions is more pronounced for financially constrained (*FC*) firms than for financially unconstrained (*FUC*) firms. In contrast, our hypothesis predicts that the effect of *DEF/Assets* on these aspects is more evident for *FUC* firms than for *FC* firms.

We use three measures of financial constraints to examine this issue: *WW* index, *HP* index, and the dividend-payer indicator. Since the *WW* (*HP*) index is higher for firms facing more financial constraints, we classify a firm as *FC* if its *WW* (*HP*) index is above the sample median and as *FUC* if its *WW* (*HP*) index is below the sample median. For the dividend-payer indicator, we classify firms that do not pay dividends as *FC* and firms that do pay dividends as *FUC*. The regression results for these subsamples are reported in Panel A of Table IX. We find that our key results from the previous tables (i.e., the significance of the coefficient estimates on *DB*×*DEF/Assets*) are mainly driven by *FUC* firms, suggesting that the disciplinary effect of pension deficits we have identified is not merely a reflection of a firm's financial constraints.[30] The differences in coefficient estimates on *DB*×*DEF/Assets* between *FUC* and *FC* firms, however, are not statistically significant in most regressions (not reported).

As another test of financial constraint argument, we examine whether our results are affected by the general condition of economy. The overinvestment problem is likely to be more severe in good economic times during which firms have easier access to large free cash flows. However, Figure 1 shows that pension funding status improves in good economic times, suggesting that the control function of pension deficits may be weak when it should matter the most. To address this concern, we divide our sample period into high and low GDP growth periods according to the sample median of annual GDP growth rates compiled by the *Bureau of Economic Analysis* and then reestimate the regressions in Tables IV through VII separately for these two subperiods. The results are presented in Panel B of Table IX. We find that our main results largely hold in both high and low growth periods except for model (1), suggesting that the disciplinary mechanism of pension deficits works irrespective of the general condition

[30] As robustness checks, in unreported tests we also experiment with other alternative measures of financial constraints, such as firm size (*Ln*(*Assets*)), Altman's *Z* score, and bond ratings, and find that the results are similar to those reported in Panel A of Table IX.

of economy. The results are similar when we use other alternative measures of macroeconomic variables, such as the *NBER* recession dummy, stock market returns, and the aggregate corporate profit growth rate, to partition the sample period (not reported).

To further ensure that the channels through which pension deficits affect investment decisions are not merely through the cash drain caused by financial constraints, we augment the regressions in Tables IV through VII by including a proxy for mandatory pension contribution (*MC*), which is usually triggered by large pension deficits. Following Campbell, Dhaliwal, and Schwartz (2011), we measure *MC* as the ratio of pension expenses, as recorded in Compustat, to total assets if a firm's pension plan is underfunded, and zero if a firm's pension plan is fully funded or overfunded. Campbell, Dhaliwal, and Schwartz (2011) show that their measure of *MC* has a similar economic impact on investment compared to Rauh's (2006a) measure estimated using the IRS Form 5500 data. Since *MC* can be measured only for DB firms, we use only these firms in the analysis.

The results are reported in Panel C of Table IX. We find that the estimated coefficients on *DEF/Assets* remain economically and statistically significant even after controlling for mandatory pension contributions. The only regression in which the coefficient on *DEF/Assets* is not significant is model (1) which examines the impact of a firm's *DEF/Assets* on the likelihood of acquiring other firms. In that regression, the coefficient on *DEF/Assets* is positive and insignificant, but the coefficient on *MC* is negative and significant. These findings are consistent with Rauh (2006a), who shows that pension deficits affect capital expenditures through the cash drain caused by mandatory pension contributions. Our results in model (1), however, do not necessarily contradict the control function of pension deficits in a sense that mandatory pension contributions reduce the free cash flow available to managers. In untabulated tests, we find that using all firms including non-DB firms and including interaction terms (*DB*×*MC* and *DB*×*DEF/Assets*) in the regressions lead to similar inferences.[31]

[31] However, controlling for *MC* may not completely address the concern that pension deficits are correlated with unobserved investment opportunities and potential financial constraints. Although our three-step bootstrapping procedure may not completely account for this endogeneity bias, we expect it to mitigate the concern to some extent.

The results in Table IX, together with those of Rauh (2006a) and Franzoni and Marin (2006), suggest that the impact of pension deficits on investment decisions is twofold. On the one hand, using a measure for cash flow shocks that is exogenous to investment opportunities, Rauh (2006a) shows that pension deficits exacerbate a firm's financial constraints and hence lead to underinvestment, and using an asset pricing approach Franzoni and Marin (2006) reach a similar conclusion. On the other hand, we find that as inside debt, pension deficits can serve as an effective disciplinary mechanism when the firms make risky and discretionary investments, and thus reduce overinvestment problems and improve investment efficiencies. These two different sets of findings are consistent with Franzoni (2009), who argues that the incentives for underinvestment and overinvestment may coexist even within the same firm.

D. Importance of Pension Plan Characteristics

In this subsection, using a sample of acquiring firms sponsoring a DB plan, we examine how pension plan characteristics affect the disciplinary role of pension deficits in M&As. The first characteristic we consider is the fraction of actively working employees who are covered by DB pension plans. While DB plans cover both active and retired employees, active employees are the ones who participate in firms' daily operations and directly observe daily management decisions since they are on-the-spot. Moreover, according to PBGC's Guarantee Limits – an Update (2008), the average loss in benefits computed based on the PBGC maximum insurance limitation is twice as large for active participants as for retired participants.[32] Thus, active employees of firms with underfunded pension plans should have stronger capabilities and incentives to monitor managers than retirees, suggesting that the control function of pension deficits is more effective when the plans cover a larger faction of active employees.

We use two pension demographic characteristics to address this issue. The first variable is the age of a pension plan (*Plan Age*), which is measured as the number of years since a firm reported pension data in Compustat. Atanasova and Gatev (2010) use this variable as a measure of pension plan maturity under the assumption that older pension plans cover relatively older workforce. The second variable we use is

[32] http://www.pbgc.gov/Documents/guaranteelimits.pdf.

the faction of active employees, which is computed as the ratio of the number of active employees to the sum of the numbers of active and retired employees in the DB plan. Since the faction of active employees is highly correlated with firm size, firm age, and the size of pension plan, to purge out these size and age effects, we first regress the fraction of active employees on firm size, firm age, and *PBO/Assets*. We then use the residual from this regression as a measure for the fraction of active employees. We obtain information on the numbers of active and retired employees from the IRS Form 5500 data provided by the Centre for Retirement Research at the Boston College.[33]

The regression results are reported in Table X. In Panels A1 and A2, we divide firms into active-employee dominated (*Active*) and retiree dominated (*Retired*) firms according to the sample medians of *Plan Age* and the fraction of active employees in the pension plan, respectively, and reestimate the regressions in Tables IV through VII separately for these two subsamples.[34] We find that the coefficient estimate on *DEF/Assets* is more significant in regressions using an *Active* subsample than using a *Retired* subsample, suggesting that the disciplinary role of pension deficits is indeed more salient for plans with greater shares of active employees.

The second characteristic we consider is whether the pension plans are collectively bargained or whether firms are in more unionized industries. A typical DB pension plan covers many employees, each of whom is likely to have a trivial influence on managerial decisions. Employees' incentives and abilities to exert influence over managers, however, become stronger if they are able to coordinate their actions and organize their bargaining power in a more systematic way. Supporting this view, Comprix and Muller (2011) argue that collective bargaining agreement and union give employees a collective voice through which they can represent their preference and dissatisfaction and thus enhance employees' incentives to exert efforts. Thus, we expect that the control function of pension deficits, if it exists,

[33] Rauh (2009) uses the same measure to capture the demographic structure of a DB plan and finds a positive relation between risk taking in pension assets investment and the share of active employees in the pension plan.
[34] In Panel A1 of Table X, the sample size for *Active* is larger than that for *Retired* because we include firms whose plan age is equal to the sample median in the *Active* subsample. Including these firms in the *Retired* subsample does not change our results.

should be more effective for firms whose pension plans are collectively bargained or those that operate in industries where labor force is well organized.[35]

To examine this conjecture, we partition our sample acquiring firms according to whether their pension plans are collectively bargained and then reestimate the regressions in Tables IV through VII separately for these two subsamples. The information on whether the pension plans are collectively bargained is obtained from Form 5500. The results are reported in Panel B of Table X. We find that the significant relation between pension deficits and various acquisition outcomes is evident only for firms whose pension plans are collectively bargained, supporting the view that collective bargaining provides employees with stronger incentives to monitor.

To future explore the impact of bargaining power on employee monitoring, we bifurcate our sample according to the sample median industry unionization rate (*Union*) and repeat our analysis in Tables IV through VII separately for firms with high and low unionization rates. Chen, Kacperczyk, and Ortiz-Molina (2010) argue that labor unions can coordinate employees' actions and allow unionized workers to use their power to influence management.[36] Furthermore, unionized workers tend to be locked into the firm with their firm-specific human capital investments. Thus, to prevent their firms from becoming financially unhealthy, unionized workers might have strong incentives to monitor management. This argument suggests that the disciplinary effects of pension deficits, if they exist, are expected to be stronger for firms with more organized labor. The results reported in Panel C of Table X show that the impact of pension deficits on several aspects of takeover decisions is indeed more pronounced for firms in more unionized industries than for firms in less unionized industries, confirming the argument of Chen, Kacperczyk, and Ortiz-Molina (2010).

[35] Collective bargaining can also mitigate the free-rider problem since in individual bargaining, employees have incentives to let others negotiate improvements and enjoy the benefits at no cost (Dau-Schmidt (1992)).

[36] Chen, Kacperczyk, and Ortiz-Molina (2010) suggest several mechanisms through which employees organized by unions can affect corporate affairs. They argue that by threatening to withdraw the contributions to the firm, employees can play an important role in firms' internal governance. For instance, unions can use collective bargaining agreements to raise a voice in firms' important decisions. Unions can also engage in boycotts, strikes, and public denouncements when firms' decisions are not aligned with their interests. Moreover, unions sometimes have their representatives on large U.S. firms' boards, thus directly involving in firms' decision process.

E. Target Firms' Pension Deficits and Takeover Gains

Thus far, we have focused on the impact of acquiring firms' pension deficit on takeover gains. In this subsection we examine the role of target firms' pension deficit in explaining these gains. Pontiff, Shleifer, and Weisbach (1990) argue that firms have incentives to acquire targets with overfunded pension plans to engage in potential post-acquisition pension fund reversions (i.e., an acquiring firm's act to redistribute wealth from target employees to its shareholders by terminating the target's overfunded pension plan or replacing the overfunded plan with a plan that offers lower payments to target employees). They show that a significant part of takeover premiums paid to target shareholders during the 1981-1988 period can be explained by post-acquisition pension fund reversions. To the extent that target shareholders require higher takeover premiums for mergers motivated by pension fund reversions and acquirers' incentives for pension fund reversions are greater when they have larger pension deficits, the reversion explanation predicts that targets' pension deficits are *negatively* related to takeover premiums.

To test this prediction regarding the effect of target firms' pension deficits on takeover premiums, in untabulated tests, we augment our takeover premium model in column (3) of Table VI by including pension deficit measures for both acquirers and targets ($DEF^{Acquirer}/Assets^{Acquirer}$ and $DEF^{Target}/Assets^{Target}$). We find that the coefficient estimate on our main variable of interest, $DEF^{Acquirer}/Assets^{Acquirer}$, remains negative and significant at the 1% level (coefficient = -0.763). However, the coefficient estimate on $DEF^{Target}/Assets^{Target}$ is *positive* and significant at the 1% level (coefficient = 0.758), which does not support the pension assets reversion explanation of takeover premiums. This result is somewhat different from the evidence documented by Pontiff, Shleifer, and Weisbach (1990), who show that although the reversions are too small to be the sole, or even dominant, source of takeover gains, they can still explain approximately 11% of the takeover premium in cases where they actually occur. Although our result is not directly comparable to theirs since our result is based on the multivariate regression analysis while their analysis is derived from the univariate analysis, we propose two possible explanations for this difference in results. First, while their sample period covers only from 1981 to 1988, the most of our

sample period covers the period after 1986. After the passage of the Tax Reform Act of 1986, there was a sequence of escalating reversion tax rates from 10% in 1986 to 50% in 1990 on reversion amounts, significantly weakening the importance of pension asset reversions as a source of takeover gains. Indeed, Petersen (1992) finds that the 1986 excise tax on asset reversions reduces plan termination for reversions by 36% in 1986.[37] Second, Pontiff, Shleifer, and Weisbach (1990) only look at tender offers that are reported in the *Wall Street Journal*, while we include all M&As in which acquiring firm owns less than 50% of the target's shares before the announcement date and controls 100% of the target's shares after acquisition.

Our result that there is a positive relation between targets' pension deficits and takeover premiums, however, is consistent with the view that pension deficits are an important control mechanism for the targets as well. The result also supports the view that targets' pension deficits are an important anti-takeover device that deters potential buyers from purchasing target shares. Using UK data, Cocco and Volpin (2010) document that firms sponsoring DB pension plans, especially those having large pension deficits, are less likely to be targeted and acquired. Since employees in targets with underfunded pension plans are concerned about their post-acquisition retirement benefits, to reduce employee resistance in target firms, acquirers may have to pay higher acquisition premiums, which can be used to compensate target employees for their underfunded pension plans. Consistent with the view that anti-takeover devices increase acquisition premiums, Comment and Schwert (1995) and Heron and Lie (2006) show that conditional on attempted takeovers, anti-takeover devices such as poison pill enable target management to negotiate for a higher takeover premium.

Finally, we examine whether high announcement returns for the acquirer and the value-weighted portfolio of the acquirer and the target are due to synergistic gains created by merging the acquirers with an underfunded plan with the targets with an overfunded plan. Mergers between these types of acquirers and targets may benefit both parties because otherwise excess assets in the overfunded pension plan

[37] In an untabulated test, we reestimate our takeover premium model in column (3) of Table VI using all hostile takeovers during the 1981-1986 period in which the reversion explanation predicts a negative coefficient on $DEF^{Target}/Assets^{Target}$. However, we find the coefficient on $DEF^{Target}/Assets^{Target}$ remains positive but insignificant.

cannot be fully and directly reverted to sponsors through standard terminations or reversions given high excise tax rates on asset reversions. For example, in 1984, Gulf Oil agreed to a friendly merger with Chevron Oil Corp in an attempt to recover its excess pension assets. As a result, approximately $550 million excess pension assets accumulated in the Gulf Oil pension plan were merged into the Chevron pension plan, creating a single overfunded pension plan after the merger. To examine this synergy argument as a potential explanation for acquirer returns and value-weighted portfolio returns of the acquirer and the target, we add $DEF^{Target}/Assets^{Target}$ and its interaction with $DEF^{Acquirer}/Assets^{Acquirer}$ in regression models reported in Tables V and VI and reestimate these regressions. Untabulated results show that in all regressions, while the coefficient estimates on $DEF^{Acquirer}/Assets^{Acquirer}$ remain statistically significant, the coefficient estimates on $DEF^{Acquirer}/Assets^{Acquirer} \times DEF^{Target}/Assets^{Target}$ are not significant, suggesting that synergistic gains created by combining two firms with different pension funding status, if they exist, are dominated by the control function of pension deficits in acquiring firms. As an alternative test, we include a dummy variable for acquirers with an underfunded pension plan, and a dummy variable for targets with an overfunded pension plan, an interaction term between these two dummy variables in the regressions and find that the coefficients on the interaction term are not significant except for the regression using acquirer $CAR(-1,1)$ as the dependent variable. In this regression, we find that the coefficient estimate on the interaction term is negative and significant while the coefficient estimate on the dummy variable for acquirers with an underfunded pension plan is positive and significant.

VI. Summary and Conclusion

Previous studies suggest that DB pension plans are an integral part of a firm's financing decisions. However, despite the fact that pension deficits have increased significantly during the past two decades, few empirical studies examine how these claims owed to employees affect firms' investment decisions and performance. In this paper, we investigate this little-explored issue using a large sample of M&As during the 1981 to 2008 period and show that pension deficits play an important role in disciplining managerial discretion in M&A decisions. Specifically, after controlling for endogeneity in both sponsors'

choice between DB and non-DB pension plans and the size of firms' pension deficit, we find that firms with larger pension deficits are less likely to engage in M&As, particularly diversifying M&As. We also find that acquirers' pension deficits have a significant positive effect on their announcement returns as well as the announcement returns of value-weighted portfolio of the acquirer and the target. Further, compared to acquirers with smaller pension deficits, those with larger pension deficits pay lower takeover premiums to their targets and use more cash in payment to their targets. These results are robust to several model specification tests and more pronounced for subsamples of acquirers whose pension plans are dominated by actively working employees, acquirers whose pension plans are collectively bargained, and acquirers in more unionized industries. Finally, we examine several alternative hypotheses that might explain our results, such as financial constraints, cash drains caused by mandatory contributions, post-acquisition pension fund revisions, and synergistic gains created by merging the acquirers with an underfunded plan with the targets with an overfunded plan, and find little support for these alternative explanations. Overall, our results suggest that corporate pension deficits serve as an effective monitoring mechanism that influences managers to make value-enhancing investment decisions.

Although our tests identify M&As decisions as the set of decisions over which employees have strong incentives to monitor managerial behavior when their claims on the firm's value are at stake, these incentives could also exist in other instances. For firms with large pension deficits, the questions of when the interests of employees are more likely to be closely aligned with those of shareholders and when employees exert a strong influence on management decisions represent useful areas for additional work.

Appendix A
History of pension accounting in the U.S. and calculation of pension items using Compustat

This appendix briefly reviews the history of pension accounting in the U.S. and describes how the fair value of pension plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are calculated in this paper.

According to Statement of Financial Accounting Standards (SFAS) No. 87, the fair value of pension assets represents the value of a DB plan's assets (as of the benefit information date) that have been set aside and restricted to pay benefits when due. Plan assets include amounts contributed by the employer and amounts earned from investing the contributions, less benefits paid. The projected pension benefit obligation represents the actuarial present value of all benefits earned by an employee as of the benefit information date for service rendered prior to that date plus projected benefits attributable to future salary increases. The obligation should increase with service cost (i.e., actuarial present value of pension benefits that employees earned during the year) and decrease with the interest rates used to discount future pension obligations.

Pension accounting in the U.S. has changed substantially over time. Prior to 1985, firms mainly adopted a non-capitalization based practice to account for pension costs. Under such a practice, many firms chose not to report pension liability or disclose information regarding the amounts of pension asset and liability on the balance sheet. The SFAS No. 87 issued in December 1985, however, mandates that pension assets and liabilities should be recorded as off-balance sheet items and allows firms to smooth fluctuations in pension cost from year to year by delaying and spreading the recognition of actuarial gains and losses. Later, the SFAS No. 158 issued in December 2006 requires firms to adopt a netting approach and recognize the overfunded or underfunded status of a defined benefit pension plan as an asset or a liability on the balance sheet. For detailed discussions on the evolution of pension accounting in the U.S., see Rauh (2006a) and Shivdasani and Stefanescu (2010).

To incorporate these changes in accounting rules over time, we calculate *PPA* and *PBO* using different Compustat data items across our sample period (Compustat Xpressfeed variable names are given in italics). Following Franzoni and Marin (2006), for fiscal years prior to 1987 we set *PPA* equal to the net asset value of pension benefits (*pbnaa*) and *PBO* equal to the present value of vested benefits (*pbnvv*). SFAS 87 requires that firms report items for overfunded and underfunded pension plans separately. Thus for fiscal years between 1987 and 1997, *PPA* is measured as the sum of overfunded and underfunded pension assets (*pplao* + *pplau*) and *PBO* is measured as the sum of overfunded and underfunded pension benefit obligations (*pbpro* + *pbpru*). Due to the introduction of SFAS 132, which is effective for fiscal years beginning after December 15, 1997, Compustat consolidates overfunded and underfunded pension items into one item that was previously reserved for overfunded plans. Therefore, for fiscal years starting after December 1997, we set *PPA* and *PBO* equal to their corresponding Compustat items, *pplao* and *pbpro*, respectively. Our definition of *PBO* is not consistent over time because *pbnvv* is based on current and past compensation levels only, while *pbpro* and *pbpru* incorporate pension obligations attributable to future salary increases. To ensure that our results are unaffected by this discrepancy, in untabulated tests we reestimate all the regressions reported in tables after excluding firms with fiscal years before 1987 and find that that our main results still hold.

Appendix B
Variable definitions

Variables	Definitions
Acquirer	Dummy variable that equals one if the firm acquires the majority of other firms, and zero otherwise.
Active (*Retired*)	Dummy variable that equals to one if the *Plan Age* or *Active Emplyees* is above the sample median, and zero otherwise.
Active Employees	The residual obtained from the regression of the fraction of active employees on firm size (*Ln*(*Assets*)), firm age (*Age*), and the size of the pension plan (*PBO/Assets*). The fraction of active employees is defined as the number of active employees over the sum of the numbers of active and retired employees in the pension plan from IRS Form 5500.
Age	Number of years since the firm entered CRSP.
Agency	Dummy variable that equals one if *M/B* is lower than 3-digit SIC industry median and *Cash Flow/Assets* exceeds industry median, and zero otherwise.
Assets	Book value of assets adjusted for prepaid cost/accrued cost, intangible assets, and pension funding status using the netting approach of Shivdasani and Stefanescu (2010) for DB firms. For non-DB firms, it is equal to book value of assets.
CAR(-1, 1)	Three-day cumulative abnormal return for acquirers calculated using the market model.
Cash Flows/Assets	(Income before extraordinary items + depreciation and amortization) / beginning-of-period assets.
Collective Bargaining	Dummy variable that equals one if the IRS Form 5500 reports that a firm's pension plan is collectively bargained, and zero otherwise.
DB	Dummy variable that equals one if a firm chooses to sponsor DB plans, and zero otherwise.
Deal Value	Offer price paid by the acquirer, excluding fees and expenses.
Debt Rating	Dummy variable that equals one if a company has a debt rating assigned by Standard & Poor's, and zero otherwise.
DEF	(Projected benefit obligation (*PBO*) - pension plan assets (*PPA*)) / beginning-of-period total assets.
Discount Factor of Pension Liability	An estimated rate used to determine the present value at which the *PBO* could be effectively settled.
Diversify	Dummy variable that equals one if the target and acquirer have different 3-digit SIC codes reported by SDC, and zero otherwise.
Dividends/Assets	Cash dividends / beginning-of-period assets.
Dividend Payer	Dummy variable that equals one if a firm pays cash dividend in a given year, and zero otherwise.
Earnings Volatility	Standard deviation of the change in EBITDA / average book value of assets over a firm's entire life in Compustat.
GDP Growth	Real GDP growth rate from the National Economic Accounts complied by the Bureau of Economic Analysis.
Hadlock and Pierce (*HP*) *Index*	$-0.737\times Ln(Assets) + 0.043\times(Ln(Assets))^2 - 0.040\times Age$
High Tech	Dummy variable that equals one if a deal is made between two firms in high tech industries as defined by Loughran and Ritter (2004), and zero otherwise.
Hostility	Dummy variable that equals one if the SDC classifies the acquisition as a hostile takeover, and zero if the SDC classifies the acquisition as a friendly takeover.
Industry Median DEF	3-digit SIC industry median *DEF*.
Industry M&A	Value of all SDC acquisition deals each year in each of the 3-digit SIC industry divided by total book value of assets of Compustat firms each year in the same 3-digit SIC industry.
Interest Rate	Annualized average rate on thirty-year Treasury bonds over the last four years.
Leverage	(Short-term debt + long-term debt) / total assets.

Ln (*Assets*)	Natural log of book value of total assets.
Ln (*Employees*)	Natural log of the number of employees.
Multiple Bids	Dummy variable that equals one if multiple firms make public bids for the same target, and zero otherwise.
M/B	Market-to-book ratio = (total assets + market value of equity - book value of equity) / total assets.
MVE	Market value of equity = fiscal year-end share price × the number of shares outstanding.
Negative Equity	Dummy variable that equals one (zero) if the book value of equity is negative (positive).
PBO	Actuarial present value of all benefits earned by employee as of the benefit information date for service rendered prior to that date plus projected benefits attributable to future salary increases.
Pct_Cash	Percentage of cash payment in the transaction value.
Pension Service Cost	Value of expected future pension payments attributed to active employees' services performed during the current year.
Plan Age	Number of years since a firm reported pension data in Compustat
PPA	Fair value of a DB plan's assets that have been set aside and restricted to pay benefits when due.
PPE/Assets	Net PPE scaled by total assets
Premium	Deal value minus target market capitalization 50 days prior to the announcement date scaled by the target market capitalization on the same day.
Public Target	Dummy variable that equals one if the target is a public firm, and zero otherwise.
PureCash	Dummy variable that equals one if the acquisition is financed by all cash, and zero otherwise.
Relative Size	*Deal Value* divided by the acquirer's market value of equity at the end of the fiscal year prior to the acquisition announcement.
ROA	Operating income before depreciation and amortization (EBITDA) / total assets.
Sale Growth	Change in net sales scaled by the lagged net sales.
Stock Market Return	Compounded annual returns on the CRSP value-weighted index of stocks traded on NYSE, NASDAQ, and AMEX computed using monthly return data.
Stock Return	Compounded monthly stock returns over the fiscal year prior to the acquisition.
Tax Rate	Book simulated marginal tax rates defined using coefficients reported in Table IV (Panel B and Model C) of Graham and Mills (2008).
Tender Offers	Dummy variable that equals one if the acquirer makes a tender offer, and zero otherwise.
Tenure	Median years of tenure with current employer for workers at the 2-digit SIC industry level.
Union	Percentage of workforce in an industry covered by unions. The data is downloaded from the website maintained by Barry Hirsch and David Macpherson (www.unionstats.com).
WCAR (-1, 1)	Value-weighted portfolio *CAR* (-1, 1) of the target and the bidder based on their market capitalization two days prior to the announcement date.
Whited and Wu (*WW*) *Index*	-0.091×*Cash Flows/Assets* - 0.062×*Dividend Payer* + 0.021×long-term debt/*Assets* - 0.044×*Ln*(*Assets*) + 0.102×industry median *Sale Growth* - 0.035×*Sale Growth*
Z-Score	(3.3×pretax income + sales + 1.4×retained earnings + 1.2×(current assets - current liabilities))/*Assets*.

Appendix C
Three-step Bootstrapping Procedure

To address endogeneity concerns associated with estimating the effect of *DEF/Assets* on various aspects of acquisition activities, we employ a three-step bootstrapping procedure. In the first step we model the likelihood of a firm being a DB plan sponsor; in the second step we estimate the size of a firm's pension deficit (conditional on the firm being a DB sponsor); and in the third step we investigate the impact of a firm's pension deficit on various aspects of acquisition activity. We discuss each of these steps in turn below.

In the first step, we assume that firms choose to sponsor DB (non-DB) plans if the net benefit from doing so is positive (non-positive). Let Π denote a latent variable that captures the net benefit from sponsoring a DB pension plan. Π is unobservable, but it can be approximated by a linear function of firm-specific characteristics Z and K (to be defined below); firms' actual choice of pension plan, however, is observable. The pension selection equation can thus be specified as

$$\begin{cases} \Pi = a_1 + a_2 Z + a_3 K + \mu \\ DB = 1 \text{ if } \Pi > 0 \text{ and } DB = 0 \text{ if } \Pi \le 0, \end{cases} \tag{A1}$$

where Z is a vector of control variables that influence both the likelihood of sponsoring a DB plan and the size of the firm's pension deficit, K is a vector of indentifying variables that affect the choice of pension plan but not the size of the pension deficit, μ is a standard normally distributed error term, and *DB* is a dummy variable that represents the choice of pension plan.

In the second step, conditional on a firm being a DB sponsor, we estimate the size of the firm's pension deficit, *DEF/Assets*, using the equation

$$DEF / Assets = b_1 + b_2 Z + b_3 L + b_4 M + \nu, \tag{A2}$$

where Z is as defined in equation (A1), L represents other determinants of a firm's pension deficit that are not included in Z, M denotes instrumental variables that affect the pension deficit but not the dependent variables in the third step, and v is an error term. The correlation coefficient between the error terms u and v is ρ. When $\rho \neq 0$, standard regression techniques applied to equation (A2) yield biased results. To obtain consistent and asymptotically efficient coefficient estimates, we jointly estimate the regressions in the first and second steps using Heckman's (1979) maximum likelihood estimator. This procedure yields the predicted pension deficit, $\overline{DEF / Assets}$.

In the final step, we investigate the impact of a firm's pension deficit on various aspects of acquisition activity using the specification

$$Y = c_1 + c_2 DB + c_3 DB \times \overline{DEF / Assets} + c_4 X + \varepsilon, \tag{A3}$$

where Y denotes variables that capture various aspects of acquisition activity, such as acquisition intensity and acquisition announcement returns, *DB* is as defined in equation (A1), $\overline{DEF / Assets}$ is the predicted pension deficit from equation (A2), X is a vector of pre-determined control variables affecting Y, and ε is an error term. The coefficient c_2 captures the impact of the choice of pension plan on acquisition activity. The coefficient c_3 reflects the impact of a pension deficit on DB plan sponsors.

We employ a number of firm-, industry-, and market-specific characteristics as explanatory variables in equations (A1) and (A2). Among the control variables, Z, that affect both the pension selection decision and the size of a firm's pension deficit, we first include the log of the book value of assets (*Ln*(*Assets*)) as a proxy for firm size. In addition, we include the log of the number of employees (*Ln*(*Employees*)) and the log of the firm's age (*Ln*(*Age*)), where *Age* is defined as the number of years since the firm entered CRSP. Petersen (1994) suggests that growth firms may avoid sponsoring DB plans because of the high potential costs of financial distress, which can be triggered by the minimum pension contribution requirements. However, growth firms that are DB sponsors are more likely to have a pension deficit if they cut pension contributions in order to fund new investments. We thus use *M/B* to control for a firm's growth potential and Altman's (1968) *Z-score* to capture the likelihood of financial distress. Next, since Petersen (1994) and Shivdasani and Stefanescu (2010) show that the level and volatility of profitability affect firms' choice of pension plan and pension funding status, we employ *ROA* and *Earnings Volatility* in the regressions. We further add *PPE*/*Assets* to measure asset tangibility. Tax considerations also play an important role in corporate pension

policy as pension contributions are tax deductible and employee taxes are deferred. Thomas (1988) documents that corporate tax status is positively related to the likelihood of sponsoring DB plans as well as pension contributions, and Petersen (1992) finds that DB plan sponsors are more likely to terminate pension plans in low tax years. Accordingly, we include in equations (A1) and (A2) the book-simulated marginal tax rate (*Tax Rate*) proposed by Graham and Mills (2008). Finally, Mitchell (1982) and Ippolito (1985a) find that DB pension plans and higher pension surplus are associated with lower employee turnover, and thus we add the industry median employee tenure (*Tenure*) in the regressions; we expect *Tenure* to be negatively correlated with a firm's employee turnover.

Following Shivdasani and Stefanescu (2010), we use the unionization rate (*Union*) as an instrument (*K*) in equation (A1).[38] Data on the unionization rate, which is the percentage of unionized workers in an industry, come from the Union Membership and Coverage Database compiled by Hirsch and Macpherson (2003).[39] Shivdasani and Stefanescu (2010) argue that the degree of unionization should be positively related to the labor force's negotiation power with respect to the adoption of DB pension plans, but orthogonal to the size of pension benefits. We find that the correlation between the unionization rate and pension deficits is low (correlation coefficient of - 0.03), albeit statistically significant at the 5% level, in our sample. To control for industry and year fixed effects, we also include two-digit SIC industry dummies and year dummies in equation (A1).

A firm's pension deficit, the difference between the discounted value of all future pension obligations and the market value of pension contributions invested in traded assets, should be negatively related to the market value of pension assets, the value of new contributions, and the rate at which pension obligations are discounted. We therefore employ several variables as additional determinants of pension deficits (*L*) in equation (A2). In particular, we add *Negative Equity*, a dummy variable that equals one if the book value of equity is negative and zero otherwise, to capture a firm's inability to make new pension contributions. We also include *Cash Flows*/*Assets* to control for a sponsor's ability to meet pension contribution requirements using internal funds. A firm's pension deficit can be a consequence of an inability to borrow. Franzoni and Marin (2006), for instance, document that highly leveraged firms are more likely to have underfunded pension plans. We therefore introduce the leverage ratio (*Leverage*), defined as total debt (the sum of short-term and long-term debt) divided by total assets, and *debt rating*, an indicator variable that equals one if a company has a debt rating assigned by Standard & Poor's and zero otherwise, to capture sponsors' debt capacity and access to bond markets, respectively. In addition, the funding status of DB plan sponsors is sensitive to the stock market performance since on average approximately 60% of pension assets are invested in stocks (Franzoni (2009)). We therefore include *Stock Market Return* as a proxy for equity market conditions that drive the market value of pension assets. Next, while the rate at which pension obligations are discounted is chosen by plan sponsors, it is associated with the level of interest rates. We thus add the average interest rate on thirty-year Treasury bonds over the last four years (*Interest Rate*) to capture the discount rate effect.[40] Year dummies are also included in equation (A2) to control for the variation in pension deficits over time reported in Table I.

We use *Plan Age*, the number of years since a firm reported pension data in Compustat, as an instrument (*M*) to identify equation (A2). Petersen (1996) shows that pension fund managers become more sophisticated in managing their pension plan as the plan ages. Guercio and Tkac (2002) and Atanasova and Gatev (2010) document that plan age is positively associated with the return on pension assets. We therefore expect the age of a pension plan to have a negative impact on pension deficits. However, we have no *a priori* reason to expect plan age to be related to M&A decisions. Finally, we add the two-digit SIC industry median pension deficit to control for industry-level pension funding status.

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[38] As indicated by Shivdasani and Stefanescu (2010), the nonlinearity introduced by maximum likelihood estimation of equation (1) offers an additional source of identification (Heckman and Navarro-Lozano (2004)).

[39] This database reports unionization rates for industries classified using three-digit Census Industry Classification (CIC) codes. We match CIC codes with the four- or three-digit SIC codes and manually assign unionization rates to firms in our sample.

[40] According to the Omnibus Budget Reconciliation Act of 1987, the interest rate used to discount future liabilities must range between 90% and 110% of the average rate on thirty-year Treasury bonds over the last four years (Petersen (1994)). Interest rates are retrieved from the Federal Reserve files at www.federalreserve.gov.

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Figure I.1: Aggregate funding status of defined benefit (DB) pension plans

The sample consists of all U.S. firms with a defined benefit (DB) pension plan covered in the Compustat database between 1981 and 2008. The left Y axis corresponds to the aggregate pension assets (*PPA*) and the aggregate projected pension benefit obligation (*PBO*) over time. The right Y axis corresponds to the aggregate amount of pension deficit (*DEF*), which is defined as the difference between *PBO* and *PPA*. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The aggregate amounts of pension items are in billions of dollars.

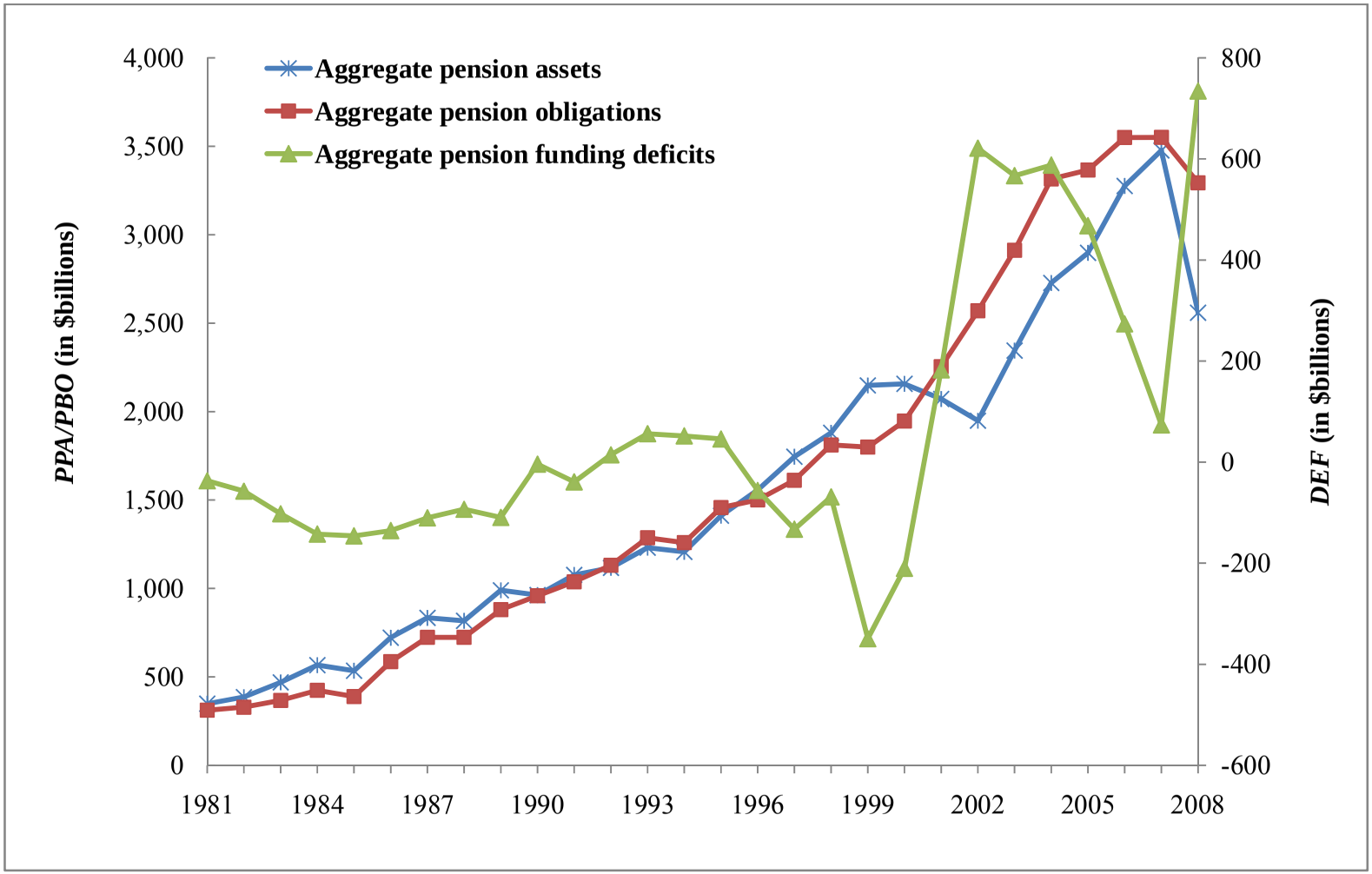

Figure I.2: Pension deficits and acquisition outcomes over time

The sample consists of defined benefit (DB) firms acquiring the majority shares of target firms in the U.S. between 1981 and 2008, reported in the Securities Data Corporation's Mergers and Acquisitions database. The left Y axes correspond to the median values of pension deficits (*DEF/Assets*) over time, which are estimated as the difference between pension benefit obligation (*PBO*) and pension assets (*PPA*), deflated by the end-of-period book value of assets adjusted for pension items on the balance sheet. The right Y axes correspond to acquisition outcomes over time (percentage of diversifying acquisitions, median acquirer *CAR*(-1,1), median takeover premium (*Premium*), and median percentage of cash payment in the transaction value (*Pct_Cash*)). The detailed definitions of variables are described in Appendices A and B.

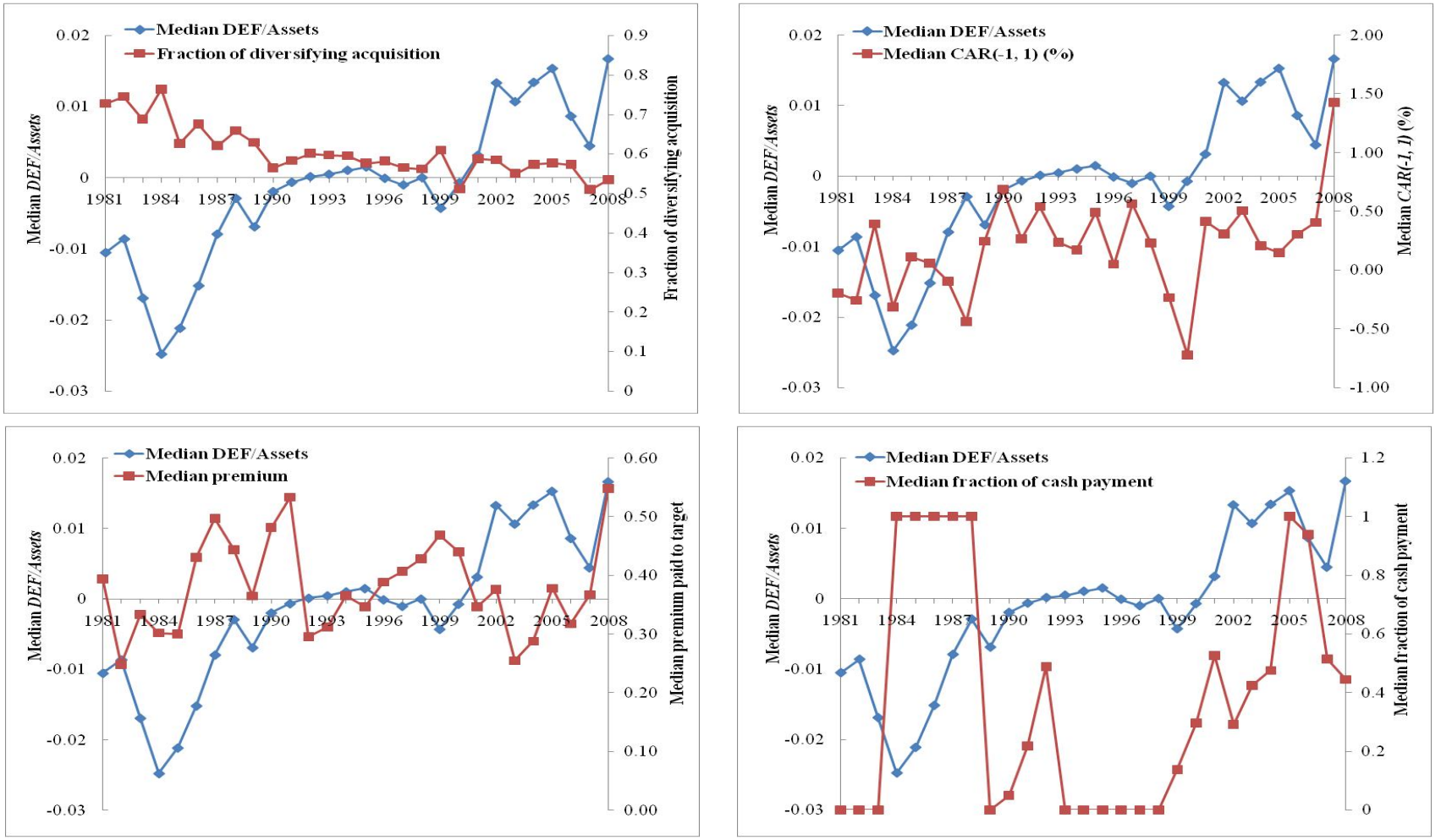

Table I.I: Sample distribution and mean and median values of pension variables by year

The sample consists of all U.S. firms with either a defined benefit (DB) or a non-DB pension plan covered in the Compustat database between 1981 and 2008. Excluded are firms that have missing data on the book value of assets, stock returns, and variables used in the regression analysis. Firms are defined to have DB plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The pension funding deficit (*DEF*) is defined as the difference between *PBO* and *PPA*. All pension items are deflated by the end-of-period book value of assets adjusted for pension items on the balance sheet (*Assets*) and are winsorized at the 0.5% level at both tails of the distribution.

Year	Number of total firms	% of DB plan firms	*PBO/Assets* (%)		*PPA/Assets* (%)		*DEF/Assets* (%)	
			Mean	Median	Mean	Median	Mean	Median
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1981	3,225	57.5	9.8	7.1	8.8	5.5	-1.0	-0.9
1982	3,406	53.6	10.5	7.5	9.2	5.7	-1.4	-1.1
1983	3,488	50.4	11.7	8.4	9.3	5.7	-2.3	-1.8
1984	3,682	45.5	11.9	8.3	9.1	5.7	-2.7	-2.0
1985	3,788	42.0	12.1	8.6	9.3	5.8	-2.7	-2.0
1986	3,791	39.9	13.4	9.6	11.1	7.0	-2.2	-1.6
1987	3,947	38.2	13.0	9.3	11.8	8.0	-1.2	-0.7
1988	4,040	35.9	12.7	9.0	11.8	8.2	-0.9	-0.5
1989	3,941	34.9	13.7	9.6	12.6	8.6	-1.1	-0.6
1990	3,888	34.1	13.4	9.0	13.2	9.2	-0.2	0.0
1991	3,898	34.0	15.3	10.2	14.6	10.1	-0.7	-0.1
1992	4,062	33.2	15.4	10.3	15.1	10.2	-0.3	0.1
1993	4,316	32.0	15.8	10.3	16.2	10.9	0.4	0.5
1994	4,545	30.9	14.3	9.3	14.6	9.7	0.3	0.4
1995	4,727	29.9	15.1	9.9	15.4	10.7	0.3	0.4
1996	4,868	29.4	15.6	10.4	15.1	10.5	-0.4	0.0
1997	5,201	27.7	16.4	10.9	15.3	10.5	-0.8	-0.2
1998	5,229	26.5	16.4	10.9	15.9	10.9	-0.3	0.1
1999	4,983	26.4	16.6	10.9	14.6	9.8	-1.7	-0.6
2000	4,766	26.1	15.8	9.9	14.7	9.5	-0.9	-0.1
2001	4,696	26.2	14.7	9.1	16.1	10.5	1.4	1.0
2002	4,445	28.4	13.2	7.8	17.6	11.4	3.8	2.7
2003	4,186	30.2	14.0	8.3	17.8	11.2	3.4	2.2
2004	3,976	31.5	14.2	8.4	17.7	11.4	3.3	2.2
2005	3,861	32.7	14.3	8.2	17.7	10.9	3.1	2.2
2006	3,812	33.6	14.2	8.3	16.4	10.1	2.1	1.4
2007	3,682	34.2	13.3	7.3	14.5	8.5	1.1	0.7
2008	3,511	34.2	10.4	5.3	14.2	8.0	3.4	2.2
Mean	-	34.1	13.7	8.9	13.6	8.6	-0.1	0.0
Total	115,960	-	-	-	-	-	-	-

Table I.II: Summary statistics for Compustat firms, acquiring firms, and M&A characteristics

The sample in Panel A consists of all U.S. firms with either a defined benefit (DB) or a non-DB pension plan covered in the Compustat database between 1981 and 2008. Excluded are firms that have missing data on the book value of assets, stock returns, and variables used in the regression analysis. Firms are defined to have DB plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The pension funding deficit (*DEF*) is defined as the difference between *PBO* and *PPA*. All pension items are deflated by the end-of-period book value of assets adjusted for pension funding status. $DEF > 0$ means that DB firms have pension deficits and $DEF \leq 0$ means that DB firms have pension surpluses. The sample in Panel B consists of firms acquiring the majority shares of target firms in the U.S. between 1981 and 2008, reported in the Securities Data Corporation's Mergers and Acquisitions database. Dollar values (in millions) are converted into 2000 constant dollars using the GDP deflator. All variable are winsorized at the 0.5% level at both tails of the distribution and are defined in Appendix B. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Total firms		Non-DB firms	DB firms				
				All	$DEF > 0$	$DEF \leq 0$		
	Mean (1)	Standard deviation (2)	Mean (3)	Mean (4)	Mean (5)	Mean (6)	Test of differences (4) – (3)	(5) – (6)
Panel A: Compustat firm characteristics (sample size = 115,960 firm-years)								
Assets: millions of dollar	1942.4	8646.2	729.0	4285.1	4859.7	3701.4	3556.1***	1158.3***
Ln(Assets)	5.08	2.25	4.26	6.65	6.74	6.55	2.48***	0.19***
Age: year	17.00	12.57	10.50	24.58	23.62	25.55	14.08***	-1.94***
# of employees: thousands	7.31	20.38	3.54	14.53	15.07	13.99	10.99***	1.08***
Market-to-Book (M/B)	1.97	2.19	2.23	1.48	1.55	1.42	-0.74***	0.13***
Sales Growth	0.21	0.93	0.27	0.10	0.11	0.09	-0.17***	0.01***
ROA	-0.01	0.33	-0.06	0.08	0.08	0.09	0.14***	-0.01***
Earnings Volatility	0.11	0.12	0.13	0.06	0.06	0.06	-0.08***	0.00***
PPE/Assets	0.31	0.24	0.28	0.38	0.36	0.41	0.11***	-0.05***
Leverage	0.24	0.20	0.22	0.27	0.28	0.26	0.06***	0.02***
Z-Score	0.68	6.63	0.03	1.93	1.81	2.06	1.90***	-0.25***
Tax Rate	0.31	0.07	0.29	0.33	0.32	0.34	0.04***	-0.02***
Cash Flows/Assets	0.02	0.30	-0.01	0.09	0.08	0.09	0.10***	-0.01***
DEF/Assets	0.00	0.04	-	0.00	0.03	-0.03	-	0.06***
Panel B: Acquiring firm and M&A characteristics (sample size = 26,329 M&As)								
Leverage^{Acquirer}	0.22	0.20	0.21	0.25	0.26	0.25	0.04***	0.01***
Ln(Assets)^{Acquirer}	5.95	2.13	5.23	7.50	7.36	7.66	2.27***	-0.30***
Market-to-Book (M/B)^{Acquirer}	2.22	2.47	2.52	1.58	1.64	1.52	-0.94***	0.11***
Cash Flows/Assets^{Acquirer}	0.04	0.42	0.02	0.10	0.10	0.10	0.08***	0.00**
Deal Value: millions of dollar	376.3	2780.6	204.6	743.7	693.8	800.3	539.1***	-106.4
Relative Size	0.32	0.75	0.34	0.26	0.27	0.26	-0.08***	0.01
Public Target: indicator	0.19	0.39	0.15	0.28	0.25	0.31	0.12***	-0.06***
Hostility: indicator	0.05	0.21	0.03	0.08	0.06	0.10	0.05***	-0.04***
Multiple Bids: indicator	0.01	0.11	0.01	0.02	0.02	0.03	0.01***	-0.01
CAR(-1,1): %	1.23	8.07	1.54	0.56	0.91	0.17	-0.98***	0.74***
WCAR(-1,1): %	1.84	7.64	1.65	2.03	2.45	1.69	0.38	0.75**
Diversify: indicator	0.52	0.50	0.49	0.60	0.57	0.63	0.11***	-0.06***
Pct_Cash: %	60.62	44.10	58.06	66.10	71.99	59.41	8.04***	12.58***
PureCash: indicator	0.47	0.50	0.44	0.55	0.58	0.50	0.11***	0.08***
Premium: %	43.85	35.48	44.29	43.41	42.75	43.93	-0.88	-1.18
Whited and Wu (WW) index	-0.29	0.12	-0.25	-0.38	-0.36	-0.39	-0.13***	0.03***
Hadlock and Pierce (HP) index	-3.26	0.85	-2.94	-3.96	-3.90	-4.04	-1.03***	0.14***
Dividend Payer indicator	0.03	0.08	0.03	0.04	0.03	0.04	0.00**	-0.01***

Table I.III: Determinants of the choice of pension plans and the size of pension deficits

The sample consists of all U.S. firms with either a defined benefit (DB) or a non-DB pension plan covered in the Compustat database between 1981 and 2008. The regression model with selection is fitted using Heckman's maximum likelihood estimator. Column (1) reports the first-step probit estimates of the selection equation, which investigates the determinants of the choice of pension plans. Firms are defined to have DB plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. Column (2) reports the second-step estimates of the regression in which the dependent variable is the pension funding deficit (*DEF/Assets*). *DEF/Assets* is estimated as the difference between *PBO* and *PPA,* deflated by the end-of-period book value of assets adjusted for pension items on the balance sheet. The *z*-statistics and *t*-statistics are reported in parentheses. All explanatory variables are defined in Appendix B. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: Choice of pension plans (= 1 if a firm chooses a *DB* pension plan)		Dependent variable: Size of pension deficits *(DEF/Assets*)
	(1)		(2)
Ln(*Assets*)	0.242***		-0.003***
	(45.0)		(-10.3)
Ln(*Employees*)	0.051***		0.003***
	(5.9)		(8.5)
Ln(*Age*)	0.610***		-0.004***
	(74.3)		(-6.3)
M/B	-0.087***		0.001***
	(-18.3)		(3.0)
Z-Score	-0.009**		0.000
	(-2.0)		(1.2)
ROA	0.569***		-0.000
	(8.8)		(-0.0)
Earnings Volatility	-2.703***		0.036***
	(-29.1)		(6.8)
PPE/*Assets*	0.298***		0.004***
	(10.1)		(4.1)
MTR	0.464***		-0.055***
	(4.5)		(-12.5)
Tenure	-0.024***		0.000
	(-4.6)		(1.0)
Union	0.017***		
	(23.2)		
Negative Equity			0.008***
			(6.5)
Cash Flows/*Assets*			-0.002
			(-1.0)
Leverage			0.017***
			(13.6)
Debt Rating			-0.000
			(-0.7)
Stock Market Return			-0.012***
			(-6.1)
Interest Rate			-0.007***
			(-31.6)
Plan Age			-0.001**
			(-2.5)
Industry Median DEF/Assets			0.669***
			(31.9)
Industry (2-digit SIC) dummies	YES		NO
Year dummies	YES		YES
Intercepts	YES		YES
Estimated Correlation Coefficient (ρ)		-0.10	
$\chi 2$ of the Likelihood Ratio Test for $\rho = 0$		5.74**	
Heckman's λ		-0.004**	
Sample Size / Pseudo R^2 (Probit)	115,960 / 0.41		115,960

Table I.IV: The effect of pension deficits on the likelihood of acquiring other firms

In columns (1) and (2), the sample consists of all U.S. firms covered in the Compustat database between 1981 and 2008. The dependent variable is a dummy variable that equals one if the firm acquires the majority of a target's shares in a year and zero if it does not engage in the majority acquisition (*Acquirer*). The sample of acquisitions is obtained from Thomson Financial's Securities Data Corporation Mergers and Acquisitions database. In columns (3) and (4), the sample consists of firms that complete majority acquisitions between 1981 and 2008. The dependent variable is a dummy variable that equals one if the acquirer and the target are in the same 3-digit SIC industry and zero otherwise (*Diversify*). Coefficient estimates reported are the marginal effects that measure the effect of a one unit change in continuous explanatory variables (moving from 0 to 1 for dummy variables) on the dependent variable. Firms are defined to have defined benefit (DB) plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. *Cash Flow*/*Assets* is measured over the fiscal year in which the acquisition is announced. All other explanatory variables are measured at the fiscal year-end that immediately precedes the announcement date of share acquisitions. The detailed definitions of explanatory variables are described in Appendix B. Columns (1) and (3) report results from probit regressions that are estimated using the actual value of pension funding deficits (*DEF/Assets*), which is calculated as the difference between *PBO* and *PPA*, deflated by the end-of-period book value of assets adjusted for pension items. Columns (2) and (4) report results from the three-step bootstrapping procedure outlined in Appendix C and use the predicted value of *DEF/Assets* obtained using Heckman's (1979) maximum likelihood estimator. The 95% confidence intervals in square brackets are calculated from 500 bootstrap replications of the three-step estimation based on resampling from the data set with replacement of clusters. The *z*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: Acquirer (=1 if the firm acquires the majority of a target's shares)		Dependent variable: *Diversify* (= 1 if the acquirer and the target are in the same 3-digit SIC industry)	
	Probit	Three-step bootstrap	Probit	Three-step bootstrap
	(1)	(2)	(3)	(4)
DB	0.002	0.013	0.070***	0.091
	(0.4)	[-0.002, 0.028]	(5.5)	[0.060, 0.119]
DB×*DEF/Assets*	-0.256***	-0.940	-0.835***	-1.360
	(-3.7)	[-1.280, -0.667]	(-3.7)	[-2.180, -0.611]
Leverage	-0.063***	-0.056	0.035	-0.038
	(-7.0)	[-0.074, -0.037]	(1.3)	[-0.084, 0.010]
Ln(*Assets*)	0.039***	0.039	-0.016***	-0.012
	(33.8)	[0.036, 0.041]	(-5.1)	[-0.017, -0.006]
Ln(*Age*)	-0.016***	-0.024	0.024***	0.012
	(-7.5)	[-0.030, -0.018]	(3.1)	[-0.004, 0.028]
PPE/Assets	-0.165***	-0.166	-0.212***	-0.263
	(-15.8)	[-0.188, -0.147]	(-6.7)	[-0.320, -0.205]
ROA	-0.020**	-0.017	-0.027	-0.080
	(-2.3)	[-0.036, 0.000]	(-1.1)	[-0.129, -0.032]
Sales Growth	0.008***	0.008	0.005	0.007
	(8.1)	[0.006, 0.010]	(1.6)	[0.000, 0.014]
M/B	0.009***	0.009	-0.007***	-0.009
	(8.5)	[0.007, 0.011]	(-3.5)	[-0.014, -0.005]
Cash Flows/Assets	0.081***	0.082	-0.023*	0.017
	(7.0)	[0.058, 0.105]	(-1.9)	[-0.024, 0.058]
Agency	0.021***	0.021	-0.023**	-0.041
	(5.9)	[0.014, 0.027]	(-2.2)	[-0.059, -0.021]
Cash/Assets	-0.095***	-0.094	-0.138***	-0.214
	(-9.9)	[-0.114, -0.077]	(-5.1)	[-0.263, -0.162]
Stock Return	0.022***	0.021	0.004	0.006
	(12.7)	[0.018, 0.025]	(0.7)	[-0.004, 0.016]
Earnings Volatility	-0.150***	-0.146	-0.048	-0.085
	(-7.2)	[-0.185, -0.108]	(-0.9)	[-0.196, 0.025]
Dividend/Assets	0.009	0.008	0.365***	0.288
	(0.2)	[-0.064, 0.076]	(4.2)	[0.015, 0.549]
Industry dummies	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES
Constant	YES	YES	YES	YES
Sample size / Pseudo R^2	115,960 / 0.10	500 replications	26,329 / 0.06	500 replications

Table I.V: Regression of cumulative abnormal returns (-1, 1) for bidders on explanatory variables

The sample consists of firms acquiring the majority shares of target firms in the U.S. between 1981 and 2008, reported in the Securities Data Corporation's Mergers and Acquisitions database. The abnormal returns are calculated using the market model. The market model is estimated by using 200 trading days of return data ending 6 days before the acquisition announcement. The CRSP equally weighted return is used as a proxy for the market return. The dependent variable is cumulative abnormal returns from one day before to one day after the announcement date of the M&A for acquirers (*CAR*(-1,1)). Firms are defined to have defined benefit (DB) plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The pension funding deficit (*DEF/Assets*) is defined as the difference between *PBO* and *PPA*, deflated by the end-of-period book value of assets adjusted for pension items. All explanatory variables are measured at the fiscal year-end that immediately precedes the announcement date of share acquisitions. All variables are winsorized at the 0.5% level at both tails of the distribution and are defined in Appendix B. Column (1) uses the actual value of *DEF/Assets* in OLS regression. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Column (2) reports results from the three-step bootstrapping procedure outlined in Appendix C and uses the predicted value of *DEF/Assets* obtained using Heckman's (1979) maximum likelihood estimator. The 95% confidence intervals in square brackets are calculated from 500 bootstrap replications of the three-step estimation based on resampling from the data set with replacement of clusters.

	Dependent variable: *CAR*(-1,1)	
	OLS	Three-step bootstrap
	(1)	(2)
DB	0.001	-0.001
	(0.5)	[-0.004, 0.002]
DB×*DEF/Assets*	0.083***	0.180
	(4.2)	[0.096, 0.271]
$Leverage^{Acquirer}$	0.008**	0.004
	(2.3)	[-0.002, 0.011]
$Ln(Assets)^{Acquirer}$	-0.004***	-0.004
	(-10.0)	[-0.004, -0.003]
Relative Size	0.013***	0.011
	(9.0)	[0.008, 0.014]
$(M/B)^{Acquirer}$	-0.001	-0.001
	(-1.3)	[-0.002, 0.000]
$(Cash\ Flows/Assets)^{Acquirer}$	-0.000	-0.006
	(-0.1)	[-0.012, 0.000]
Diversify	-0.000	-0.001
	(-0.1)	[-0.003, 0.002]
High Tech	-0.003*	-0.004
	(-1.7)	[-0.007, -0.001]
Public Target	-0.027***	-0.033
	(-13.5)	[-0.037, -0.029]
Hostility	0.018***	0.023
	(4.3)	[0.015, 0.030]
Multiple Bids	0.001	0.003
	(0.1)	[-0.014, 0.022]
PureCash	0.001	0.001
	(1.3)	[0.000, 0.003]
Industry M&A	0.000	0.000
	(0.2)	[0.000, 0.001]
Industry dummies	Yes	Yes
Year dummies	Yes	Yes
Constant	Yes	Yes
Sample size / Adjusted R^2	25,645 / 0.05	500 replications

Table I.VI: Regressions of value-weighted portfolio returns of the acquirer and the target and takeover premium on explanatory variables

The sample consists of firms acquiring the majority shares of publicly listed targets in the U.S. between 1981 and 2008, reported in the Securities Data Corporation's Mergers and Acquisitions database. The abnormal returns are calculated using the market model. The market model is estimated by using 200 trading days of return data ending 6 days before the acquisition announcement. The CRSP equally weighted return is used as a proxy for the market return. In columns (1) and (2), the dependent variable is market-capitalization weighted portfolio cumulative abnormal returns of the acquirer and the target from one day before to one day after the announcement date of the M&A (*WCAR(-1,1)*). In columns (3) and (4), the dependent variable is the premium paid to the target by the acquirer (*Premium*). *Premium* is measured by the difference between the acquirer's offer price (total value of cash, stock, and other securities offered by the acquirer to the target) and the target's market value of equity 50 days prior to the M&A announcement date, scaled by the target's market value of equity on the same day. Firms are defined to have defined benefit (DB) plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The pension funding deficit (*DEF/Assets*) is defined as the difference between *PBO* and *PPA*, deflated by the end-of-period book value of assets adjusted for pension items. All explanatory variables are measured at the fiscal year-end that immediately precedes the announcement date of share acquisitions. All variables are winsorized at the 0.5% level at both tails of the distribution and are defined in Appendix B. Columns (1) and (3) use the actual value of *DEF/Assets* in OLS regressions. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Columns (2) and (4) report results from the three-step bootstrapping procedure outlined in Appendix C and use the predicted value of *DEF/Assets* obtained using Heckman's (1979) maximum likelihood estimator. The 95% confidence intervals in square brackets are calculated from 500 bootstrap replications of the three-step estimation based on resampling from the data set with replacement of clusters.

	Dependent variable: *WCAR*(-1,1)		Dependent variable: *Premium*	
	OLS (1)	Three-step bootstrap (2)	OLS (3)	Three-step bootstrap (4)
DB	-0.002	0.002	-0.010	-0.010
	(-0.5)	[-0.007, 0.010]	(-0.6)	[-0.044, 0.026]
DB×DEF/Assets	0.221***	0.535	-0.705**	-1.030
	(3.3)	[0.299, 0.827]	(-2.5)	[-2.301, 0.266]
$Leverage^{Acquirer}$	0.018*	0.015	-0.073	-0.042
	(1.9)	[-0.005, 0.034]	(-1.6)	[-0.132, 0.046]
$Ln(Assets)^{Acquirer}$	-0.005***	-0.004	0.033***	0.035
	(-3.5)	[-0.007, -0.001]	(5.0)	[0.022, 0.049]
Relative Size	0.010***	0.009	0.040***	0.035
	(4.4)	[0.004, 0.014]	(3.6)	[0.015, 0.057]
$M/B^{Acquirer}$	-0.001	-0.001	0.011***	0.015
	(-1.2)	[-0.004, 0.002]	(3.2)	[0.007, 0.021]
$Cash\ Flows/Assets^{Acquirer}$	-0.000	0.007	0.020	0.048
	(-0.0)	[-0.008, 0.023]	(0.8)	[-0.045, 0.163]
Diversify	-0.007**	-0.005	-0.012	-0.001
	(-2.5)	[-0.011, 0.001]	(-0.9)	[-0.029, 0.027]
High Tech	-0.012**	-0.014	0.027	0.017
	(-2.4)	[-0.022, -0.006]	(1.1)	[-0.025, 0.059]
Public Target	0.010	0.008	0.066	0.073
	(1.3)	[-0.005, 0.021]	(1.5)	[-0.004, 0.148]
Hostility	0.028***	0.031	0.099***	0.093
	(7.2)	[0.025, 0.038]	(5.3)	[0.060, 0.127]
Multiple Bids	-0.012**	-0.015	0.006	-0.002
	(-2.1)	[-0.025, -0.005]	(0.2)	[-0.053, 0.042]
PureCash	0.022***	0.017	-0.078***	-0.093
	(7.2)	[0.011, 0.023]	(-5.0)	[-0.124, -0.060]
Industry M&A	0.001	0.001	0.006	0.008
	(0.9)	[-0.001, 0.004]	(1.2)	[-0.001, 0.017]
$Ln(Assets)^{Target}$	0.004***	0.003	-0.036***	-0.033
	(3.3)	[0.000, 0.005]	(-5.6)	[-0.047, -0.020]
M/B^{Target}	-0.001	-0.002	-0.018***	-0.023
	(-0.7)	[-0.004, -0.001]	(-4.5)	[-0.031, -0.015]
$Leverage^{Target}$	-0.008	-0.006	0.314***	0.351
	(-1.1)	[-0.019, 0.008]	(7.0)	[0.268, 0.435]
Industry dummies	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES
Constant	YES	YES	YES	YES
Sample size / Adjusted R^2	3,515 / 0.13	500 replications	3,301 / 0.12	500 replications

Table I.VII: Regression of the fraction of cash payment on explanatory variables

The sample consists of firms acquiring the majority shares of publicly listed targets in the U.S. between 1981 and 2008, reported in the Securities Data Corporation's Mergers and Acquisitions database. In columns (1) and (2), the dependent variable is the fraction of cash payment in the transaction value (*Pct_Cash*). Firms are defined to have defined benefit (DB) plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The pension funding deficit (*DEF/Assets*) is defined as the difference between *PBO* and *PPA*, deflated by the end-of-period book value of assets adjusted for pension items on the balance sheet. All explanatory variables are measured at the fiscal year-end that immediately precedes the announcement date of share acquisitions. All variables are winsorized at the 0.5% level at both tails of the distribution and are defined in Appendix B. Column (1) uses the actual value of *DEF/Assets* in the tobit regression. The *z*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Column (2) reports results from the three-step bootstrapping procedure outlined in Appendix C and uses the predicted value of *DEF/Assets* obtained using Heckman's (1979) maximum likelihood estimator. The 95% confidence intervals in square brackets are calculated from 500 bootstrap replications of the three-step estimation based on resampling from the data set with replacement of clusters.

	Dependent variable: *Pct_Cash*	
	Tobit	Three-step bootstrap
	(1)	(2)
DB	-0.023	0.018
	(-0.3)	[-0.176, 0.202]
DB×*DEF/Assets*	3.965***	16.386
	(3.0)	[12.004, 21.640]
$Leverage^{Acquirer}$	-0.218	-0.488
	(-1.2)	[-0.838, -0.143]
$Ln(Assets)^{Acquirer}$	0.167***	0.205
	(5.3)	[0.146, 0.265]
Relative Size	-0.016	-0.019
	(-0.4)	[-0.095, 0.062]
$M/B^{Acquirer}$	-0.124***	-0.115
	(-5.0)	[-0.158, -0.070]
$Cash\ Flows/Assets^{Acquirer}$	0.853***	0.549
	(5.1)	[0.182, 0.875]
Diversify	-0.012	-0.053
	(-0.2)	[-0.165, 0.066]
High Tech	0.014	0.032
	(0.1)	[-0.135, 0.192]
Public Target	1.125***	1.056
	(4.3)	[0.578, 1.524]
Hostility	1.668***	1.646
	(19.4)	[1.496, 1.798]
Multiple Bids	0.470***	0.343
	(4.3)	[0.168, 0.523]
Industry M&A	0.016	0.033
	(0.7)	[-0.004, 0.076]
$Ln(Assets)^{Target}$	-0.202***	-0.195
	(-6.4)	[-0.251, -0.140]
M/B^{Target}	-0.103***	-0.101
	(-4.1)	[-0.147, -0.056]
$Leverage^{Target}$	-0.396**	-0.486
	(-2.5)	[-0.784, -0.180]
Industry dummies	YES	YES
Year dummies	YES	YES
Constant	YES	YES
Sample size / Pseudo R^2	3,815 / 0.20	500 replications

Table I.VIII: Robustness checks

In columns (1) and (2), the sample consists of all U.S. firms covered in the Compustat database between 1981 and 2008. In other columns, the sample consists of firms acquiring the majority shares of publicly listed targets in the U.S. between 1981 and 2008, reported in the Securities Data Corporation's Mergers and Acquisitions database. The table reports results from the robustness tests that reestimate the regressions in Tables IV through VII using different measures of pension items. Firms are defined to have DB plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. *DEF* is the difference between *PBO* and *PPA*. In Panel A, a DB firm's market capitalization is used to deflate *DEF*. In Panel B, *DEF* is replaced by *PBO* and *PPA*, both of which are deflated by the end-of-period book value of assets adjusted for pension items. In Panel C, pension deficits are decomposed into the change in pension deficits from *t*-2 to *t*-1 and the level of pension deficits at *t*-2. In Panel D, *DEF* is adjusted based on the *PBO* computed using the 30-year Treasury rate. In Panel E, only *DB* firms are included in the regressions. In Panel F, only *DB* firms with plan age longer than three years are included in the regressions. Intercept and control variables are included in the estimation of regressions, but not reported in the table. All variables are winsorized at the 0.5% level at both tails of the distribution and defined in Appendix B. The *t*- and *z*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Acquirer	*Diversify*	*CAR*(-1,1)	*WCAR*(-1,1)	*Premium*	*Pct_Cash*
	Probit	Probit	OLS	OLS	OLS	Tobit
Dependent variables	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Using market capitalization (MVE) to deflate DEF						
DB	0.002	0.069***	0.001	-0.002	-0.009	-0.023
	(0.5)	(5.5)	(0.5)	(-0.5)	(-0.6)	(-0.3)
DB×(*PBO-PPA*)/*MVE*	-0.158***	-0.589***	0.050***	0.145***	-0.345*	2.152**
	(-5.5)	(-4.2)	(3.6)	(3.1)	(-1.9)	(2.4)
N	115,960	26,329	25,645	3,515	3,301	3,815
Panel B: Separating DEF into pension obligation (PBO) and pension assets (PPA) components						
DB	0.002	0.037***	0.001	-0.003	-0.007	-0.104
	(0.4)	(2.6)	(0.9)	(-0.9)	(-0.4)	(-1.3)
DB×*PBO/Assets*	-0.258***	-0.278	0.065***	0.275***	-0.593**	3.181**
	(-3.9)	(-1.4)	(3.3)	(3.1)	(-2.2)	(2.5)
DB×*PPA/Assets*	0.256***	0.656***	-0.071***	-0.252***	0.558**	-2.256*
	(4.0)	(3.3)	(-3.8)	(-3.0)	(2.1)	(-1.9)
N	115,960	26,329	25,645	3,515	3,301	3,815
Panel C: Decomposing pension deficits into the change in pension deficits and the level of lagged pension deficits						
DB	0.003	0.069***	0.001	-0.002	-0.008	-0.001
	(0.7)	(5.4)	(0.5)	(-0.5)	(-0.5)	(-0.0)
$DB \times (DEF_{t-1}-DEF_{t-2})/Assets_{t-1}$	-0.166*	-0.594*	0.071*	0.063	-0.902*	-0.654
	(-1.7)	(-1.7)	(1.8)	(0.6)	(-1.8)	(-0.3)
$DB \times DEF_{t-2}/Assets_{t-1}$	-0.312***	-0.590***	0.074***	0.254***	-0.533*	3.367***
	(-4.1)	(-2.8)	(3.7)	(3.5)	(-1.9)	(2.8)
N	109,290	26,077	25,403	3,471	3,246	3,751
Panel D: Adjusting DEF based on the pension obligation (PBO) computed using the 30-year Treasury rate						
DB	0.002	0.072***	0.000	-0.003	-0.007	-0.046
	(0.5)	(5.6)	(0.3)	(-0.8)	(-0.4)	(-0.7)
DB×*DEF_adj/Assets*	-0.071*	-0.338***	0.038***	0.132***	-0.231	3.953***
	(-1.7)	(-3.0)	(3.3)	(3.4)	(-1.6)	(5.0)
N	115,958	26,329	25,645	3,515	3,301	3,815
Panel E: Using only DB firms						
DEF/Assets	-0.141*	-0.906***	0.065***	0.183***	-0.713**	2.905**
	(-1.8)	(-4.0)	(3.2)	(2.6)	(-2.4)	(2.2)
N	50,212	8,363	8,210	1,719	1,634	1,852
Panel F: Using only DB firms with a plan age older than three years						
DEF/Assets	-0.149*	-0.890***	0.066***	0.177**	-0.735**	2.696**
	(-1.9)	(-3.9)	(3.2)	(2.6)	(-2.5)	(2.0)
N	48,829	7,768	7,615	1,619	1,540	1,748

Table I.IX: Reestimation of regressions in Tables IV through VII for subsamples of firms classified according to firms' financial constraints and annual GDP growth rates and by including mandatory pension contribution as an additional control for financial constraints

In columns (1) and (2), the sample consists of all U.S. firms covered in the Compustat database between 1981 and 2008. In other columns, the sample consists of firms acquiring the majority shares of publicly listed targets in the U.S. between 1981 and 2008, reported in the Securities Data Corporation's Mergers and Acquisitions database. Firms are defined to have defined benefit (DB) plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The pension funding deficit (*DEF*) is defined as the difference between *PBO* and *PPA*, deflated by the end-of-period book value of assets adjusted for pension funding status. All explanatory variables are measured at the fiscal year-end that immediately precedes the announcement date of share acquisitions. All variables are winsorized at the 0.5% level at both tails of the distribution and are defined in Appendix B. In Panels A1 and A2, firms are divided into financially constrained (*FU*) and unconstrained *(FUC*) firms according to the median values of the Whited and Wu (2006) index and the Hadlock and Pierce (2010) index, respectively. In Panel A3, firms that do not pay any dividends are classified as *FC* and firms that pay dividends are classified as *FUC*. In Panel B, the sample period is divided into high and low growth periods according to the sample median of annual GDP growth rates compiled by the *Bureau of Economic Analysis*. In Panel C, mandatory pension contribution (*MC*) is included in the regression to control for financial constraints. *MC* is measured as the ratio of pension expenses, as recorded in Compustat, to total assets if a firm's pension plan is underfunded, and zero if a firm's pension plan is fully funded or overfunded. Only *DB* firms are used in estimating the regressions in Panel C. Intercept and control variables are included in the estimation of regressions, but not reported in the table. The *t*- and *z*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Acquirer		*Diversify*		*CAR(-1,1)*		*WCAR(-1,1)*		*Premium*		*Pct_Cash*	
Dependent variables	Probit (1)		Probit (2)		OLS (3)		OLS (4)		OLS (5)		Tobit (6)	
	Panel A: Partitioning the sample according to various measures of a firms' financial constraints											
	FUC	*FC*	*FUC*	*FC*	*FUC*	*FC*	*FUC*	*FC*	*FUC*	*FC*	*FUC*	*FC*
	Panel A1: White and Wu (WW) index											
DB	-0.002	-0.012**	0.039**	0.083***	0.000	0.001	-0.002	0.006	-0.009	-0.026	-0.100	0.161
	(-0.4)	(-2.1)	(2.3)	(4.8)	(0.1)	(0.6)	(-0.6)	(0.7)	(-0.5)	(-0.8)	(-1.2)	(1.3)
DB×DEF/Assets	-0.220**	-0.023	-1.115***	0.038	0.054***	0.173***	0.205***	0.067	-0.846***	1.018	2.917**	3.156
	(-2.4)	(-0.2)	(-4.2)	(0.1)	(2.6)	(3.3)	(2.8)	(0.3)	(-2.9)	(1.4)	(2.1)	(0.8)
N	57,972	57,954	11,690	14,639	11,457	14,188	2,438	1,050	2,290	985	2,603	1,179
	Panel A2: Hadlock and Pierce (HP) index											
DB	-0.002	-0.006	0.050***	0.078***	0.001	0.001	-0.003	0.004	-0.005	-0.044	-0.059	0.241*
	(-0.4)	(-1.0)	(3.0)	(4.3)	(0.5)	(0.6)	(-0.6)	(0.4)	(-0.3)	(-1.2)	(-0.7)	(2.0)
DB×DEF/Assets	-0.177**	-0.225	-0.833***	-0.559	0.064***	0.173***	0.169***	0.662	-0.865***	1.045	2.574*	11.363**
	(-2.0)	(-1.5)	(-3.5)	(-0.9)	(3.1)	(3.1)	(2.7)	(1.6)	(-3.0)	(1.0)	(1.9)	(2.4)
N	57,971	57,975	12,117	14,212	11,900	13,745	2,484	1,031	2,329	972	2,653	1,162
	Panel A3: Dividend-payout indicator											
DB	0.002	-0.007	0.054***	0.107***	-0.000	0.000	-0.000	-0.008	-0.015	0.009	-0.057	0.280*
	(0.4)	(-1.0)	(3.5)	(4.6)	(-0.2)	(0.0)	(-0.1)	(-0.8)	(-0.6)	(0.2)	(-0.7)	(1.9)
DB×DEF/Assets	-0.210**	-0.183	-0.701***	-0.934	0.079***	0.022	0.200***	0.547	-0.821***	-0.483	3.035**	-0.322
	(-2.5)	(-1.4)	(-2.9)	(-1.3)	(3.7)	(0.3)	(2.8)	(1.3)	(-2.7)	(-0.4)	(2.3)	(-0.1)
N	64,338	44,108	13,965	8,430	13,536	8,219	1,950	730	1,806	677	2,135	807
	Panel B: Partitioning the sample period according to annual GDP growth rate											
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
DB	-0.017***	-0.007	0.060***	0.073***	0.000	0.001	-0.003	0.002	-0.042**	-0.002	0.034	-0.140
	(-3.3)	(-1.3)	(3.8)	(4.5)	(0.3)	(0.3)	(-0.8)	(0.3)	(-2.0)	(-0.1)	(0.3)	(-1.5)
DB×DEF/Assets	0.085	0.097	-1.272***	-0.364	0.109***	0.062**	0.203**	0.219*	-0.696**	-0.796	3.505*	6.643***

	(1.0)	(1.1)	(-4.4)	(-1.2)	(3.9)	(2.3)	(2.6)	(1.7)	(-2.0)	(-1.4)	(1.9)	(3.5)
N	60,245	55,698	14,577	11,343	14,427	11,218	2,194	1,321	2,066	1,235	2,337	1,430
Panel C: Controlling for mandatory pension contributions (MC)												
MC/Assets	-2.317***		4.705***		-0.151		0.113		0.402		-25.287**	
	(-3.7)		(2.8)		(-0.9)		(0.2)		(0.2)		(-2.4)	
DEF/Assets	0.084		-1.290***		0.070***		0.175**		-0.793**		4.595***	
	(0.9)		(-4.7)		(2.8)		(2.3)		(-2.4)		(2.7)	
N	49,749		8,257		8,103		1,695		1,613		1,824	

Table I.X: Reestimation of regressions in Tables IV through VII for subsamples of defined benefit (DB) plan firms classified according to their pension demographic characteristics, collective bargaining status, and industry unionization rate

In columns (1) and (2), the sample consists of U.S. defined benefit (DB) plan firms covered in the Compustat and IRS Form 5500 databases between 1981 and 2008. In other columns, the sample consists of DB plan firms acquiring the majority shares of publicly listed targets in the U.S. between 1981 and 2008, covered in the Securities Data Corporation's Mergers and Acquisitions and IRS Form 5500 databases. Firms are defined to have DB plans if both the fair value of plan assets (*PPA*) and the projected pension benefit obligation (*PBO*) are available in Compustat. The detailed definitions of *PPA* and *PBO* are described in Appendix A. The pension funding deficit (*DEF*) is defined as the difference between *PBO* and *PPA*, deflated by the end-of-period book value of assets adjusted for pension funding status. All explanatory variables are measured at the fiscal year-end that immediately precedes the announcement date of share acquisitions. All variables are winsorized at the 0.5% level at both tails of the distribution and are defined in Appendix B. In Panels A1 and A2, firms are divided into active-employee dominated (*Active*) and retiree dominated (*Retired*) firms according to a firm's pension plan age and the faction of actively working employees in the pension plan, respectively. In Panel A1, a firm is classified as *Active* if its plan age is below the sample median, and *Retired* otherwise. In Panel A2, a firm is classified as *Active* if the fraction of actively working employees is above the sample median, and *Retired* otherwise. In Panel B, firms are divided into two subsamples according to whether their pension plans are collectively bargained as reported in the IRS Form 5500. In Panel C, firms are divided into two subsamples according to the sample median of industry unionization rate (*Union*). Intercept and control variables are included in the estimation of regressions, but not reported in the table. The *t*- and *z*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Acquirer		*Diversify*		*CAR*(-1,1)		*WCAR*(-1,1)		*Premium*		*Pct_Cash*	
Dependent variables	Probit (1)		Probit (2)		OLS (3)		OLS (4)		OLS (5)		Tobit (6)	
	Panel A: Partitioning the sample according to pension demographic characteristics											
	Active	Retired	Active	Retired	Active	Retired	Active	Retired	Active	Retired	Active	Retired
	Panel A1: Partitioning the sample according to the age of pension plans											
DEF/Assets	-0.243**	-0.052	-1.305***	-0.432	0.082**	0.045*	0.384**	0.008	-0.712	-0.700	6.456**	-0.615
	(-2.5)	(-0.4)	(-3.7)	(-1.4)	(2.4)	(1.7)	(2.6)	(0.1)	(-1.5)	(-1.6)	(2.3)	(-0.5)
N	30,982	19,208	5,068	3,277	4,992	3,218	1,076	643	1,055	579	1,168	684
	Panel A2: Partitioning the sample according to the percentage of actively working employees in the pension plan											
DEF/Assets	0.231	-0.036	-0.830*	-0.262	0.095**	0.040	0.190*	0.076	-1.727**	-0.974	3.564*	1.379
	(1.1)	(-0.2)	(-1.7)	(-0.6)	(2.4)	(0.9)	(1.8)	(0.6)	(-2.4)	(-1.3)	(1.7)	(0.6)
N	6,400	6,427	1,690	1,815	1,714	1,838	414	363	392	335	428	381
	Panel B: Partitioning the sample according to whether the pension plan is collectively bargained											
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
DEF/Assets	0.060	0.197	-0.878*	0.179	0.068*	0.017	0.121	0.009	-1.750**	-0.918	3.321**	2.132
	(0.3)	(1.0)	(-1.8)	(0.4)	(1.7)	(0.4)	(1.0)	(0.1)	(-2.3)	(-1.0)	(2.3)	(0.7)
N	5,792	7,229	1,385	2,121	1,413	2,140	267	511	239	488	276	534
	Panel C: Partitioning the sample according to the median industry unionization rate (*Union*)											
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
DEF/Assets	-0.169*	-0.074	-0.929***	-0.404	0.075***	0.085	0.176**	0.330	-1.056***	0.339	2.631**	5.030
	(-1.7)	(-0.6)	(-3.7)	(-0.8)	(3.3)	(1.5)	(2.2)	(1.6)	(-3.1)	(0.6)	(2.1)	(1.3)
N	24,572	25,593	5,381	2,901	5,303	2,844	931	782	878	750	1,016	830

Chapter II

The Tradeoff between Employee Ownership and CEO Compensation: Evidence from Defined Contribution Pension Plans

I. Introduction

The holding of employer stocks by rank-and-file employees in defined contribution (DC hereafter) pension plans is a unique arrangement in the U.S. retirement system.[41] Since the 1990s, the majority of employee stock ownership plan (ESOP hereafter) has occurred through the DC plan. According to the Internal Revenue Service (IRS) Form 5500, the aggregate value of employer stocks in DC plans of S&P 1500 firms in manufacturing industries reached approximately $82.3 billion by the end of 2007 and these employer stocks on average accounted for more than 26 percent of total pension assets in the DC plan during the period 1992 to 2007. As such, employee ownership of company stocks constitutes a significant proportion of employees' retirement income.

Prior literature suggests a variety of motives behind sponsoring employee ownership in the DC plan. For example, Beatty (1995) finds that favorable tax concessions provided by the government strongly motivate firms to invest in employer stocks via their employees' DC accounts. Moreover, employee stock ownership in the DC plan promotes labor productivity, improves firm performance (Beatty (1995), Park and Song (1995)), and undermines labor union hostility by reducing labor disputes (Cramton, Mehran, and Tracy (2008)). Employee ownership in the DC plan can also be used as an effective takeover defense strategy, which enables managers and workers to form an alliance to deter the discipline executed by the corporate control market (Gordon and Pound (1990), Chaplinsky and Niehaus (1994), Rauh (2006)).

However, despite the above-mentioned findings, few studies investigate how employee ownership in the DC plan affects firms' executive compensation schemes. This issue is important since the planning of compensation for executives is particularly important for firms that offer employees a stake of the

[41] In general, there are two types of pension plans in the U.S., namely, defined benefit (DB) and DC pension plans. A firm organizing a DB plan has a specified financial obligation to its retired employees, the present value of which is computed based on an array of actuarial assumptions. Since the employees' future benefits are explicitly defined, the employer assumes the risk of any shortfall between its investment return on pension assets and the committed pension liabilities. However, a DC plan makes employees bear the investment risk of its pension assets; a DC plan operates like a savings account in which the employer is only obligated to make periodic contributions to it. The ultimate pension benefits that employees will receive depend on the return generated by investments of these contributions.

company as an incentive for their work. For example, while firms' boards of directors have to ensure that management compensation schemes are adequate so as to attract and retain qualified managers, they are also required to consider and manage managerial incentive problems and legal risk associated with employee ownership, thereby preventing corporate assets from being wasted on excessive executive compensation and avoiding the potential violation of ESOP fiduciary duty that these excessive incentives may bring about.[42]

In this paper I focus on the role employee ownership in DC plan in incentivizing employees to work harder and its effect on CEO compensation, CEO interest alignment, and risk-taking incentives. I also examine how firms' boards of directors strike a balance between the alignment of employees' interests and the adequacy of CEO compensation. I argue that employee ownership in the DC plan serves as a substitute for high-powered CEO stock option because of several reasons. First, to manage labor, firms can choose between behavior control, i.e., monitoring by the management and output control, i.e., granting incentive compensation to rank-and-file employees (Jensen and Meckling (1976), Bloom and Milkovich (1998)). To induce intensive managerial monitoring, shareholders have to pay managers high-powered equity-based compensation (Wilson (2011)), which introduces additional volatility to the managers' wealth. Consequently, undiversified managers require premiums in their compensation when they are compensated with equity-based pay (Holmstrom and Milgrom (1987)), incurring a high cost for the shareholders. In the meantime, employee ownership, as a group-based incentive mechanism, encourages mutual monitoring and cooperation among employees (FitzRoy and Kraft (1987), Jones and Kato (1995)) by exposing co-workers under peer pressure (Jones (1984), Kandel and Lazear (1992)). Moreover, in contrast to cash salary, employee ownership can better motivate employees since stock price

[42] The degree of employee ownership in a firm's DC plan is at the discretion of its board of directors given that employees' retirement decisions are dictated by the firm's policy (Anthony Mathews, the *National Center for Employee Ownership* (NCEO) report, March 2000). For instance, Mantech International Corporation, in its charter of the retirement plan committee of the board of directors, claims that "The members of the Retirement Plan Committee shall be appointed annually by, and serve at the pleasure and discretion of, the Board". U.S. court also supports such an arrangement. After the Department of Labor (DOL)'s lawsuit against Enron in August 2003, courts consistently take a more narrow view on the board's duty to monitor the fiduciary so as to make sure that the fiduciary is qualified to do the job and is complying with the ERISA and the plan amendments.

corresponds more closely to factors under their control (Rajan and Zingales (2000)). These arguments suggest that when group incentive is efficient, it is economically rational for shareholders to substitute employee ownership for the costly CEO stock option, the largest component of discretionary equity-based compensation.

Second, employees bear substantial amounts of undiversified risk by holding employer stocks in their DC accounts given that they already invest large amounts of human-capital into the firm (Poterba (2003), Berk, Stanton, and Zechner (2008), Bae, Kang, and Wang (2011)). Within the principal-agent framework, employees may demand more shares to offset the risk of holding employer stocks in their retirement accounts if managers seek risky investments for their firms (Mitchell and Utkus (2002)), thereby leading to a rising labor cost. A high-risk profile of company stocks also puts ESOP trustee, in most cases plan sponsors, at risk of litigations (Chen, Lai, and Wu (2010)); by virtue of the Employee Retirement Income Security Act of 1974 (ERISA), the ESOP trustee is to act solely in the interest of plan participants and an undiversified portfolio of pension assets is considered suboptimal. Since the convexity of managers' wealth-performance relation created by stock options encourages managers' risk-taking behaviors (Guay (1999), Coles, Daniel, and Naveen (2006), Low (2009)), for the sake of lawsuit avoidance, firms with higher employee ownership in the DC plan are more likely to reduce stock options in the CEO compensation package.

Using a sample of 1,328 firms (6,226 firm-years) sponsoring DC pension plans during 1992 to 2007 and controlling for the endogeneity of employee ownership, time invariant firm characteristics, and the reverse causality concerns, I find results that are largely consistent with the view that employee ownership serves as an effective group incentive mechanism and as a motive for shareholders to reduce managers' risk-taking behaviors. Specifically, I find that employee ownership is negatively related to the level of CEO stock option after controlling for the factors that determine CEO compensation documented in previous literature. Economically, a one standard deviation increase in employee ownership (0.0315) translates into a reduction of $0.46 million in option value, holding all variables at the mean level. Examining the pay structure, I find that the stock option component of CEO pay decreases as employee

ownership increases: a one standard deviation increase in employee ownership is associated with a 2.23 percent decrease in the stock option component of CEO pay.[43] Finally, I directly test the effects of employee ownership on CEO incentives using Delta and Vega developed by Core and Guay (2002) as proxies for CEO interest alignment and the risk-taking incentives respectively.[44] The results indicate that employee ownership has a significant negative impact on CEO Delta and Vega at less than the 1% level: a one standard deviation increase in employee ownership leads to a $60,325 reduction in Delta and a $6,598 reduction in Vega, holding all variables at the mean level.[45]

The substitution of employee ownership for CEO stock option is far from perfect; it is influenced by a number of firm and industry characteristics. Eisenhardt (1989) maintains that if behavioral control of employees by managerial monitoring is difficult, firms tend to adopt a compensation system that aligns the interests of shareholders with those of employees. In the same vein, I argue that the substitution of employee ownership for CEO stock option is more likely to occur if output control by providing incentive pay to employees is more efficient, e.g., when management-labor relationship is more critical to the production, when employees are more valuable to the firm, when the free-riding problem is weaker, when employees' co-monitoring motivation is stronger, and when firms' business risk is higher.

To test these hypotheses, I partition the sample according to the sample medians of the industry unionization rate, the industry employee voluntary turnover rate, and the Herfindahl index. The sample is also divided according to the number of employees, the growth option per employee as defined in Core and Guay (2001), the employee coverage of ESOP, and the capital intensity measures based on Bae, Kang, and Wang (2011). I then re-estimate regressions for these subsamples. Consistent with my hypotheses, I find that substitution is more evident in subsamples of firms in more unionized industries, firms in industries whose employee voluntary turnover rate is lower, and firms in more competitive industries.

[43] This is calculated based on the marginal effect for the unconditional expected value of the dependent variable in the Tobit regression. In an untabulated test, I also investigate the effect of an increase in employee ownership on the number of stock option grants and also find a significant negative relation with a *t*-statistic of -1.7.
[44] Delta and Vega measure CEOs' wealth change compared to one percent change in shareholder wealth, and the dollar change in CEO option holdings for one percent change in stock return volatility, respectively.
[45] The current Delta and Vega, which measure the CEO pecuniary incentives in the current period, are reduced by $3,106 and $2,279, respectively.

The substation effect is also more pronounced in subsamples of firms with smaller number of employees and greater growth options per employee, firms adopting broad-based ESOPs, and firms with higher capital intensity.

I conduct various robustness checks to verify the validity of the results. First, I test the alternative explanations to the results: (1) corporate governance – Rauh (2006) finds that employee ownership and managerial equity holdings are both dependent on a firm's governance structure; (2) management quality – Milbourn (2003) argues that low-quality managers have lower ownership because they are more likely to be replaced. Meanwhile, these low-quality managers, who rely on the bid premium to enhance firm value, also encourage employee ownership as a takeover defense maneuver; (3) employees as a blockholder – an exceptionally large ownership of company stocks gives employees a voice in corporate governance and enables them to exert predominant influence on corporate policies (Kim and Ouimet (2011), Faleye, Mehrotra, and Morck (2006)); (4) reallocation of compensation among top executives – the fraction of the aggregate compensation of the top-five executive team captured by the CEO decreases as a reflection of declining CEO power due to an increase in employee holdings (Bebchuk, Cremers, and Peyer (2011)); (5) employee ownership as a means of management entrenchment – Chang and Mayers (1992) argue that shareholders are more likely to reduce managerial ownership in firms with larger employee holdings under managers' control so as to overcome the agency problem. I find little support to these alternative explanations. I also examine the effect of employee ownership on the compensation package and incentives of the top five executives. The results indicate that the effects of employee ownership on top five executives are similar to those on CEOs. Further, if employee ownership in the DC plan serves as a management entrenchment device, I expect the effect to be stronger in a hot mergers and acquisitions (M&A) market, where entrenched managers can obtain greater private benefits and extract more rents by deterring potential bidders.[46] Thus, I partition the sample period based on the sample median of industry M&A intensity as defined in Moeller, Schlingemann, and Stulz (2004). The findings

[46] The hot M&A market is defined as the industries in which the value of all SDC acquisition deals in the industry divided by the total book value of assets of Compustat firms for each of the two-digit SIC industries in each year is above the sample median.

indicate that the substitution effect is significant in both active and inactive M&A markets in a particular industry, suggesting that the management entrenchment argument does not explain the findings.

Finally, to eliminate the possibility that my results only capture the effect of certain corporate events or the regulation change, I exclude from my sample firms with CEO turnover and firms with a sample period after 2006, the year in which the SFAS 123R was implemented; under the SFAS 123R, firms are no longer allowed to recognize the expenses associated with stock options at the intrinsic values. To rule out the effect of missing data, I also exclude the incomplete IRS Form 5500 data series in 1999, 2000, and 2003. In addition, to rule out the possibility that the results are driven by a large number of sample firms with zero employee ownership in the DC plan and to address the concern of sample selection bias, I re-estimate the regressions, removing firms with zero employee ownership, including an indicator to denote zero employee ownership, and using firms with investments in employer securities for at least three years. The results remain unaffected by these parsimonious tests.

My study contributes to the recent debate over the governance role of employee ownership. On one hand, Gordon and Pound (1990) provide evidence that the use of ESOPs decreases shareholder value in 1980s by deterring the disciplinary role of the corporate control market. Rauh (2006) finds that employee ownership held in the DC pension plan in Delaware firms is reduced in response to the change in the Delaware takeover environment in the mid-1990s and concludes that the DC investments in employer securities serve as a mechanism to deter takeover in the corporate control market. On the other hand, Jiraporn (2007) presents evidence that firms with higher employee ownership are less likely to engage in earnings management. Cramton, Mehran, and Tracy (2008) find that employee ownership in unionized firms alleviates the management-labor conflict by facilitating negotiations between managers and the labor union and reducing costly strikes. Bova, Dou, and Hope (2011) find that firms sponsoring ESOPs disclose greater information on a voluntary basis. Although my work also examines the governance role of employee ownership, it is distinct from prior studies in two important ways. First, to my best knowledge, it is the first paper that examines the executive compensation issues in firms that invest in company stocks via employees' DC accounts. I investigate this issue on a comprehensive scale by

simultaneously examining the level and structure of the CEO compensation, and the CEO interest alignment and risk-taking incentives. Second, I identify a channel through which employee ownership affects CEO compensation scheme. Previous papers studying the governance role of employee ownership overlook shareholders' choice between behavior control and output control over employees as well as the effect of high-powered equity-based compensation on the degree of managerial intensive monitoring. The findings in this paper shed some light on the bright side of employee ownership by highlighting the positive role of employee ownership in aligning the interest of employees with that of shareholders and reinforcing the mutual monitoring of and coordination among employees.

The rest of the paper is organized as follows. Section II discusses the institutional background of employee ownership in the DC pension plan and presents the hypotheses. Section III describes the data sources, sample selection criteria, and detailed variable constructions. Section IV presents my empirical design and major findings. Section V provides the results of various robustness tests. Section VI concludes.

II. Institutional Background and Hypotheses Development

A. Employee Ownership in Defined Contribution Pension Plan

Employee ownership can be attained in a number of ways. Employees can purchase stock directly, receive stock options from the company, obtain stock through a profit sharing plan, or be granted the company stocks as a bonus. However, thus far the most common form of employee ownership in the U.S. is the ESOP. In an ESOP, a company sets up a trust fund and contributes new shares of its own stock or cash to buy existing shares for the trust fund. Alternatively, an ESOP can borrow money to buy new or existing shares while the company makes cash contributions to the plan to pay off the loan. Regardless of how the plan acquires stocks, company contributions to the trust are tax-deductible within certain limits. Since the late 1980s, many firms have viewed the DC plan as a vehicle to promote employee ownership because the government provides favorable tax incentives for the investment of company stocks in retirement plans. Furthermore, the diversification requirement by the ERISA does not apply to the

holdings of employer stocks in DC plans in the U.S.[47] Starting in the 1990s, the majority of new ESOPs are organized through DC plans such as 401(k) plans (Mitchell and Utkus (2002), Rauh (2006)). Unlike the employee stock purchase plan (ESPP), the employees' DC account does not entitle its plan participants the discretion to buy or not to buy company stocks. Rather, employers simply direct or match company stocks to the DC account on behalf of their employees.[48] According to the current law, DC plan participants are generally not free to sell their holdings in the plan while they are employed, except after reaching the age of 55 or after providing 10 years of service to their firms (Mitchell and Utkus (2002)).[49] However, these participants generally have the rights to receive dividend and vote.

Figure 1 presents the aggregate amounts of employer stocks for S&P 1500 DC plan sponsors in manufacturing industries covered in both the IRS Form 5500 and the ExecuComp during the period 1992 to 2007. The aggregate value of employer stocks increased over the period 1992 to 1998. There was a sharp fall in the value of employer stocks in the DC plan during the technology bubble period in 1999 and 2000, but a rebound in 2001. Such a trend may indicate that firms, to lower the legal risk, avoid contributing overvalued stocks to the DC plan. This is consistent with the 'lawsuit avoidance' argument of Chen, Lai, and Wu (2010). The amounts stayed relatively stable from 2001 onwards and by the end of 2007, the aggregate value of employer stocks for the sample firms was maintained at a level of $82.3 billion. Figure 1 also plots, for firms with nonzero employee ownership in their DC plans, the time trend of the annual mean percentage of the firms' equity that is held by employees. While the share of the firm's equity that employees hold declined steadily over time, the market value of these employer stocks still consists of more than 15 percent of the total pension assets. Note that there is a downward bias in

[47] For defined benefit (DB) pension plans, the ERISA prohibits investment of more than ten percent of DB plan pension assets in the sponsor's stocks. However, for DC plans, there is no such restriction on the holdings of sponsor's stocks.

[48] Babenko and Sen (2011) document that firms outperform when lower-level employees voluntarily hold more stocks in employee stock purchase plan, implying that employees possess inside information.

[49] However, upon termination of the employment, participants are free to receive the vested portion of their accounts in stock or cash.

estimating the holdings of employer stocks in DC plans due to the lack of information about the shares held by common/collective or master trusts.[50]

Abundant literature discusses the motivations of employee ownership. First of all, compared with other types of DC plan, a DC plan with concentrated holdings of employer stocks provides plan sponsors unique preferential tax treatments.[51] Even and Macpherson (2006), Rauh (2006), and Bova, Dou, and Hope (2011) find that tax incentive is an important motive for the management to encourage employee ownership. Moreover, financially constrained firms encourage employee ownership in the DC plan so as to save cash contributions, especially when employees value the shares more than the market does (Rauh (2006)). In relation to corporate governance, employee ownership in the DC plan can be employed by managers as an effective takeover defense strategy to deter the discipline by the corporate control market (Gordon and Pound (1990), Chaplinsky and Niehaus (1994), Rauh (2006)).

More importantly, many studies document that ESOP can be used to promote labor productivity and improve firm performance from the perspectives of employment stability, organizational commitment, and employee effort. For instance, Chang and Mayers (1992) claim that as the vesting of shares increases with employees' length of service in ESOP firms, employee turnover rate declines and labor productivity is enhanced with better trained employees. Rajan and Zingales (2000) and Core and Guay (2001) also argue that as deferred compensation, employee ownership in the DC plan encourages long employee tenure and employees' firm-specific human capital investment. Using Japanese data, Jones and Kato (1995) find that ESOP increases employees' loyalty to the company and encourages their participation in productivity-enhancing activities. Beatty (1995) documents an increase in labor quality in the two years after the adoption of the ESOP. Park and Song (1995) find a significant improvement in firms' long-term performance after establishing or expanding ESOPs.

[50] Based on the calculation by the Employee Benefit Security Administration of the Department of Labor, these trusts also hold sponsors' stocks.

[51] According to the Internal Revenue Code, contributions to the principal repayment of an ESOP loan are tax deductible up to 25% of covered compensation and contributions to the repayment of interest on the loan are deductible with no limits. Employers can also deduct dividends paid directly to participants or through the ESOP within a certain period provided that the amount of dividend payment is reasonable. Dividends are also deductible with no limits if they are used to repay the ESOP loan.

Besides, ESOP also undermines the hostility between labor union and the management. Cramton, Mehran, and Tracy (2008) find that employee ownership in unionized firms lessens labor disputes and facilitates negotiations between the management and the labor union by reducing costly strikes. Bova (2008) documents that employee ownership substantially alleviates managers' incentives to signal declining profitability by missing analysts' earnings forecast in unionized firms. Bova, Dou, and Hope (2011) find that employee ownership mitigates managers' incentives to keep information opaque in their negotiation with labor union by reducing the above-market rent extracting incentives of rank-and-file employees.

Overall, these studies suggest that employee ownership in the DC plan is determined by various internal and external factors. This paper considers the motivations that can explain why shareholders substitute employee stock holdings for the high-powered stock options they grant to the senior management. I focus on the setting of executive compensation because the planning of compensation for executives is an important issue in ESOP firms. Boards of directors have to strike a balance between the amount of compensation they pay to lower level employees and the senior level management. In particular, they have to not only ensure that an adequate executive compensation package is in place to attract and retain qualified managers but also consider and manage the adverse consequences that excessive executive compensation may bring about, namely, the incentive effect and legal risk associated with employee ownership.

B. Employee Ownership and the CEO Compensation Contract

In this paper, I treat the employee ownership in the DC plan as a tool to incentivize employees to work harder and as a motive for shareholders to reduce managerial risk-taking incentives. I test for a decline in the portion of high-powered stock option in the CEO compensation package in response to an increase in the degree of employee ownership. I discuss several rationales for the substitution effect to provide strong theoretical guidance for my empirical tests.

B.1. Employee Incentive Enhancement as a Substitute for CEO High-powered Compensation

First, employee behaviors often deviate from those dictated by organizational goals since employees may choose to shirk, steal, or mispresent their abilities so as to maximize their personal utilities. To solve these 'moral hazard' and 'adverse selection' problems, shareholders seeking to ameliorate the agency costs that arise from the divergence of interest between firm owners and their employees, design a system for behavior control (conventional monitoring by managers) and output control (incentive compensation) over employees (Jensen and Meckling (1976), Bloom and Milkovich (1998)). Specifically, shareholders typically do not monitor rank-and-file employees but delegate the task to the management. However, to induce intensive monitoring of employees on the part of the management, shareholders have to provide the latter with equity-based compensation to better align managers' interests to those of shareholders (Wilson (2011)). If monitoring by the management is difficult, shareholders can offer incentive-based remuneration to employees directly (Eisenhardt (1989)).

Second, although some studies cast doubt that employee ownership provides little incentives due to employees' potential free-riding behaviors, collectively, important benefits arise when employee ownership serves as a group-based incentive mechanism, which induces the co-monitoring of and cooperation among rank-and-file employees (FitzRoy and Kraft (1987), Blasi, Conte, and Kruse (1996)). In fact, Baker, Jensen, and Murphy (1988) argue that employees' collusive agreement to exert efforts and punish colleagues who do not do so may increase the coordination among them. Studies have found that employee ownership, as a group-based incentive scheme, motivates employees to actively report any slack effort of co-workers to managers and enforces the group's attitudes towards shirking by exposing individual employees to peer pressure (Jones (1984), Kandel and Lazear (1992)). Therefore, in the framework of mutual monitoring, employee ownership has a positive incentive effect on firm productivity.

Third, managers' equity-based compensation represents an expensive cost to the shareholders. Although classical agency theory suggests that equity-based compensation aligns the interests of firm owners and managers (e.g. Jensen and Meckling (1976), Holmstrom and Milgrom (1987)), company stock ownership entails different risk implications for the two stakeholders. Unlike external shareholders,

managers are less diversified because the latter also invest significant amounts of firm-specific human capital into their firms (Amihud and Lev (1981), Smith and Stulz (1985)). According to the principal-agent framework, risk-averse managers require a premium to compensate for the pay-performance sensitivity that equity-based compensation creates as increased firm risk increases the volatility of managers' wealth.

Taken together, the arguments suggest that employee ownership provides greater incentives for firms to monitor from below and hence reduces the demand for costly equity-based compensation, which induces intensive managerial monitoring. Given that stock option constitutes the largest portion of discretionary CEO equity-based compensation, I hypothesize that:

H1: Employee ownership serves as a substitute for the excessive high-powered CEO stock option and the resulting costly pay-performance sensitivity, as measured by Delta.

B.2. Employee Risk Aversion towards CEO Risk-taking Incentives

First, theoretical and empirical works have shown that employees are undiversified when they invest firm-specific human capital into the firm (Poterba (2003), Berk, Stanton, and Zechner (2008), Bae, Kang, and Wang (2011)). Since the holdings of employer stocks in the DC pension plan cannot be sold for cash unless employees leave the company, fulfill a long service period, or reach the age of 55, employees bear the extra risk of insufficient diversification by holding their employer's stocks (Meulbroek (2005), Even and Macpherson (2006)). Consequently, employees, as shareholders, express low tolerance to firm risk.[52] Mitchell and Utkus (2002) maintain that if managers seek risky investments, employees would demand a premium in their compensation, e.g. more stocks, to offset the increased risk of under-diversification as

[52] Gao (2010) observes a positive correlation between the ability of CEOs to hedge their incentive pay and their risk tolerance. Unlike senior management, rank-and-file employees are quite naïve. The study of Benartzi (2001) reveals that employees have a strong tendency to invest their contributions into employer stocks when their employer's contributions are automatically directed to a 401(k) plan, consistent with the endorsement effect.

well as to compensate for the financial immobility induced by the stock sale restrictions imposed by their DC plans.[53]

Second, although investment in employer stocks is statutorily exempted from the ERISA's diversification requirement in DC plans, the law still mandates that ESOP trustee should manage the retirement plan in the best interest of its participants. If the fiduciaries do not act with the necessary "care, skill, prudence and diligence", litigations involving sponsors' failure to comply with ERISA's prudence standard may follow lawsuit.[54] Hence, a high-risk profile of company stocks not only entails undesirable risk of under-diversification for plan participants but also puts ESOP trustee, in most cases plan sponsors, at risk of litigations. Consistent with this view, Chen, Lai, and Wu (2010) find that, as a means of lawsuit avoidance, firms with poor fundamentals and volatile stock price tend to favor matching cash over company stocks when making pension contributions to employees' 401(k) plans.

Overall, I expect that to avoid the increasing labor costs and costly litigations, firms with higher employee ownership in the DC plan are more willing to restrain managers' risk-taking incentives in order to cater for the employees, who now obtain the rights to vote and select representatives on the board. Stock options lower managerial risk aversion and encourage risk-taking behavior since the value of options increases as the stock return volatility increases (Smith and Stulz (1985)). Thus the second hypothesis is that:

H2: Firms with high employee ownership reduce CEO stock option and risk-taking incentives, as measured by Vega.

B.3. Effects of Firm and Industry Characteristics on the Substitution Relation

The proposed substitution of employee ownership for CEO stock option is based on the assumption that behavioral control by managerial monitoring and output control by adopting incentive compensation

[53] Kim and Ouimet (2011) show that wage increase only happens when employee ownership is small, implying a sharing of productivity gains. However, their measure does not include the portion of company stocks in employees' compensation package.

[54] Anecdotal evidence shows that the falling of stock price or collapse of firm triggers lawsuits from employees, who suffer from holding employer stocks in the DC plans of prominent firms including Lucent, Enron, and WorldCom.

are substitutable. However, the substitution of these two control mechanisms is far from perfect due to the difference in job nature of senior management and rank-and-file employees and subject to the effect of several firm and industry characteristics discussed below.

First, by providing managers with equity-based compensation to induce intensive managerial monitoring, the management-labor conflict could be exacerbated, particularly in unionized industries.[55] For instance, CEOs who are closely aligned with shareholders are more likely to prevent employees from extracting rents from the firm. As a response, a strong labor union may choose to make the detection of slack effort costly (Wilson (2011)).[56] To the extent that employee ownership makes the costly equity-based compensation redundant by breaking down the 'them' and 'us' doctrine and ensuring employees a share of the otherwise extracted rents, the substitution effect should be stronger in firms in more unionized industries. Additionally, since employees have direct control over their performance outcomes (Rajan and Zingales (2000)), employee ownership in firms where employee human capital is a more important input to the production process, creates higher net marginal benefits than CEO incentive pay does. Hence when retaining key employees and attracting talented potential employees are important to a firm, it is efficient to transfer firm risk to employees through incentive compensation. This yields my third hypothesis:

H3: The substitutions of employee ownership for CEO stock option and CEO Delta and Vega are more pronounced in firms that operate in more unionized industries and in industries where employees are more difficult to retain.

Second, employee ownership functions as a strong group-based incentive device to enhance the morale of employees and encourage them to work harder. However, these incentives are diluted if the firm has a serious employee free-riding problem. Hochberg and Lindsey (2010) document that the

[55] Another type of management-labor conflict is employees' 'holdup' problem. The findings of Burkart, Gromb, and Panunzi (1997) suggest that employees (agents) are less inclined to show initiatives when the management (principals) is likely to interfere.

[56] Several studies document that CEOs, on behalf of shareholders, use capital structure, cash holdings, and pension funding status to limit labor union's payoff (e.g., Perotti and Spier (1993), Klasa, Maxwell, and Ortiz-Molina (2009), Benmelech, Bergman, and Enriquez (2010)).

positive impact of employees' incentive compensation on firm performance appears only in firms with a weaker free-riding problem such as firms with fewer employees and more individual growth options. In the same vein, the replacement of managerial monitoring with employee incentive pay is more likely to happen if the joint efforts from employees are not easily shared by the free riders. Therefore I hypothesize that:

H4: The substitutions of employee ownership for CEO option and CEO Delta and Vega are more likely to appear in firms with a weaker free-riding problem.

Third, employee ownership fosters mutual monitoring among employees given that the lower efforts of one worker may lead to a lower chance of wealth enhancement for their co-workers. However, mutual monitoring, a sanctioning mechanism that exposes employees to peer pressure and encourages their co-workers to report slack effort to the management, is more likely to occur in firms whose workers are well aware that all employees have similar wealth maximizing incentives so that they can jointly decide the optimal level of efforts to exert and punish those who shirk. Hochberg and Lindsey (2010) provide evidence that compared with firms that merely grant stocks to certain key employees, firms that grant non-executive equity-based compensation on a broad-based basis experience a greater improvement in firm operating performance. In a similar fashion, my fifth hypothesis is that:

H5: The substitutions of employee ownership for CEO stock option and CEO Delta and Vega are stronger if employee ownership covers more employees in the firm.

Finally, team-based work practices in capital-intensive firms are more important than individual-based ones since the production process emphasizes cooperation not only between employees and management but also among employees (Milgrom and Roberts (1992)). In the meantime, managerial monitoring costs are high when a firm's operations involve the heavy use of sophisticated and expensive machineries (Bell and Kruse (1995)). Furthermore, capital-intensive firms have high business risk due to their high operating leverage (Mandelker and Rhee (1984)). Consequently, the reduction of CEO risk-taking incentives plays an important role in encouraging cautious employees to make firm specific human-capital investment. These arguments lead to the last hypothesis:

H6: The substitutions of employee ownership for CEO stock option and CEO Delta and Vega are more evident in firms that have higher capital intensity.

III. Data, Sample, and Variable Construction

A. Data and Sample

The sample covers an unbalanced panel of S&P 1500 firms in the ExecuComp database, which also reports DC pension assets in the IRS Form 5500 between 1992 and 2007.[57] I further identify 6,226 firm-year observations (1,328 firms) in the sample, among which 2,696 observations (643 firms) have non-zero employee ownership in DC plans.

Firms with DC plans that cover more than 100 participants in the U.S. are required to file Form 5500 to the Department of Labor (DOL), the IRS, and the Pension Benefit Guarantee Corporation (PBGC). A number of forms filed by private firms are not used in the analysis. I focus on single-employer DC pension plans, which comprise the majority of the DC pension plans, since I cannot assign to a specific firm, the assets in a multiple-employer pension plan. Following Rauh (2006), I exclude firm-year observations that have investments in common/collective or master trusts since these trusts also hold sponsors' stocks according to the Employee Benefit Security Administration, an agency of the DOL.[58] Plan level data are aggregated at the firm level and matched to Compustat by the identifier, *Employer Identification Number* (EIN). Gron and Madrian (2004) prove that the EIN reliably links Compustat and Form 5500 data together.[59]

Since SFAS 123R dictated a change in the disclosure requirement for executive compensation from 2006 onwards, I follow Hayes, Lemmon, and Qiu (2010) to generate consistent executive compensation measures during the entire sample period, i.e., from 1992 to 2007. The total compensation for each CEO

[57] I am grateful to the Center for Retirement Research (CRR) at the Boston College for providing the IRS Form 5500 data and the detailed instructions, in the technical appendix, on the procedures to clean the data. The reporting of standardized IRS Form 5500 by firms started in 1990 and ceased in 2007. The ExecuComp data are available from 1992 onwards. As such, the sample period is from 1992 to 2007.
[58] Adding back these observations do not affect the results.
[59] Jin, Merton, and Bodie (2006), Even and Macpherson (2006) and Yu and Zhang (2010) use the same matching method.

in the sample consists of five components, namely, salary, bonus, stock option, restricted stock (RS) and long-term incentive award (LTIA). Due to the similar incentive features of RS and LTIA, I combine both components and treat them as equity compensation in the empirical analysis. The detailed calculation method of each compensation variable during the pre- and post-SFAS 123R periods is provided in the appendix of Hayes, Lemmon, and Qiu (2010).

Furthermore, I exclude financial and utility companies (SIC code: 6000-6999 and 4900-4999) because these firms are highly regulated and have a distinct pay structure. I also remove firms, from which I am not able to identify their CEOs and firms with negative CEO tenure, missing total compensation (*tdc1*) from the ExecuComp, and zero total compensation from my calculation. Finally, if there is more than one CEO for a firm in a year (e.g., when there is a CEO turnover), the average across CEOs is reported. Appendix A illustrates the construction of the sample.

Other data sources utilized in the paper include Compustat and CRSP from which I obtain accounting information and stock prices, *Unionstats* from which I obtain the industry unionization rate at the four-digit SIC level; *Unionstats* is complied by Hirsch and Macpherson (2003).[60] The IRRC database is tapped on for the corporate governance index and board characteristics, CDA/Spectrum for institutional holdings, the Bureau of Labor Statistics for the industry employee voluntary turnover rates, and the SDC database for the M&A data.

B. Variables and Descriptive Statistics

For the period 1992 to 1998, complete pension asset valuations are available in the main IRS Form 5500. However, from 1999 onwards, such information is recorded in the Schedule H attached to the main form. I extract from the IRS Form 5500, on a plan level basis, the value of pension investments in

[60] This database reports unionization rates for industries classified using three-digit Census Industry Classification (CIC) codes. I match CIC codes with the three- or four-digit SIC codes and manually assign unionization rates to firms in my sample.

employer stocks at the end of each fiscal year.[61] Similar to Rauh (2006), employee ownership is defined as the market value of employer securities, scaled by the market capitalization of the firm at the fiscal year end.

Table I reports the sample distribution and annual breakdown of employee ownership in the DC plan. Column (2) shows that 14,633 firm-years have DC pension plans during the sample period. The number of such firms has been increasing steadily since 1992, stabilizing gradually only from 2000 onwards. By the end of 2007, more than 60 percent of the S&P 1500 firms in manufacturing industries sponsor DC pension plans, reflecting the increasing popularity of the DC plan in the U.S. After the removal of firms with investments in master and common/collective trusts, my initial sample includes 6,226 firm-year observations. As more firms choose to invest in such trusts, the number of observations in each year decreases slightly during the late 2000s.

Columns (4) and (5) list the number of DC firms that choose to invest in employer stocks and the percentage of DC firms with non-zero employee ownership in the initial sample, respectively. On average, 43.3% of DC firms hold employer stocks and the percentage of ESOP sponsors is relatively steady throughout the sample period. Columns (6) and (7) show respectively, the annual median and mean values of employee ownership in DC accounts after zero values in the initial sample are removed. On average, 2.8% of total number of company shares is held by employees in firms that invest in employer stocks. The median value of 1.3% implies that a few firms invest heavily in company stocks in their DC plans. In terms of magnitude, these numbers are comparable to those of Rauh (2006).

Table II presents the summary statistics for the sample. All variables are winsorized at 0.5 percentile at both tails of the sample distribution to avoid the effects of observations with extreme values and all dollar values are converted to 2000 constant dollars. Detailed variable definitions are provided in Appendix B. Panel A summarizes the terms of CEO compensation contract; all variables are valued at the fiscal year end. I first present the levels of all annual compensation variables. The average total

[61] Based on the technical appendix of IRS Form 5500 data manual, I exclude plans with zero pension assets at the fiscal year end.

compensation is $3.66 million, which is lower than the mean value of the ExecuComp universe. In terms of dollar value, stock option and salary are the largest and second largest components of CEO compensation, respectively. While high-value CEO stock options cluster in certain firms, a large percentage of firms do not grant stock option to the CEOs at all. In terms of the pay structure, salary and stock option constitute, on average, 37.57% and 36.15% of CEO total compensation, respectively.

Panel A also provides summary statistics for the CEO incentive measures, i.e., Delta and Vega, which are calculated based on the methodology outlined in Core and Guay (2002). Specifically, Delta captures the CEOs' wealth change for a one percent change in stock price. Vega, on the other hand, captures CEOs' risk taking incentives and is defined as the dollar change in CEO stock option holdings for a one percent change in annualized volatility of the past 3 years' monthly stock returns. The mean values of total Delta and total Vega are $693,193 and $57,817 respectively and the mean values of current Delta (*c_Delta*) and current Vega (*c_Vega*), calculated based on the annual stock and stock option grant, are $36,775 and $20,923 respectively.

Panel B presents the characteristics of the sample firms. Untabulated statistics show that, on the basis of the total sales (*Sales*) and the time since the firms first entered the CRSP (*Firm age*), the DC firms in my sample are smaller and younger than the ExecuComp universe. These firms also have a lower leverage ratio (*Leverage*), which is defined as the sum of short-term and long-term debt over total assets, and lower profitability (*ROA*). Growth opportunities (*Sales growth* and *Tobin's q*) are, however, higher than the DB firms covered by the ExecuComp. In addition, stocks of these firms experience higher returns and volatility. The ratios of capital expenditures over assets (*Capex/Assets*) and R&D expenses over total sales (*R&D/Sales*) are also higher for the DC firms in my sample. The difference in firm characteristics between the DC firms in my sample and the DB firms covered by the ExecuComp universe is consistent with the findings in Chang, Kang, and Zhang (2011).

In Panel C, CEO characteristics of the sample firms are reported. In particular, I focus on CEO age, CEO tenure, and whether a CEO serves as the chairman of the board, a dummy variable that takes the value of one if the CEO and the board chairman are the same person in a firm, and zero otherwise.

Untabulated results indicate that CEOs in my sample, compared with CEOs in DB firms covered by the ExecuComp, are younger with an average age of 54, have a longer tenure of 7.92 years, and are less likely to be assigned as the chairman of the board with an average probability of 0.54.

Figure 2 presents the time-series profile of the relation between employee ownership and CEO incentives, for which only firms that have non-zero employee ownership in the initial sample are kept. I plot the median values of CEO Delta and Vega against the median value of employee ownership in the DC plan during the sample period over 1992 to 2007. The trends in the figure indicate an inverse relationship between employee ownership and CEO Delta and Vega. Specifically, as the employee ownership decreases, CEO Delta and Vega increase.

IV. Empirical Design and Major Findings

A. Research Methodology

To examine the relation between employee ownership and CEO compensation, the empirical model needs to solve two concerns: (1) the endogenous determination of employee ownership and (2) the joint determination of employee ownership and CEO compensation. I employ several econometric techniques to deal with the endogeneity and reverse causality issues.

First, I conduct a two-step bootstrapping procedure to control for the endogeneity of employee ownership similar to Chang, Dasgupta, and Hilary (2006). In the first step, I estimate the determinants of employee ownership. To the extent that the investing of employer stocks in the DC plan has minimal benefits or employees are extremely risk averse, the unobserved *desired* level of employee ownership is negative.[62] Hence I follow Rauh (2006) and estimate employee ownership using a Tobit model of firm-specific characteristics *Z and L* (to be defined below) in the first stage as the level of employee ownership is strictly between zero and one. To further mitigate the endogeneity concern, all firm-specific variables are lagged one period. The Tobit model is specified as:

[62] According to a report by the Urban Institute in 2000, the cost of maintaining an ESOP can be substantial due to "the complex nondiscrimination rules, coverage standards and contribution limits applied to qualified plans as well as reporting and disclosure requirements".

$$Tobit[Employee\ ownership] = F(b_1 + b_2 Z + b_3 L + v), \quad (1)$$

where Z is a vector of control variables that influence the determinants of employee ownership in firms' DC plan, and L denotes instrumental variables that affect the employee ownership but not the dependent variables in the second step, and v is an error term. This procedure yields the predicted employee ownership. In the second step, I use the predicted employee ownership ($\overline{Employee\ ownership}$) in the first step as the key independent variable in the regressions and examine the effects of employee ownership on CEO compensation and CEO incentives using the specification:

$$Y = c_1 + c_2 \overline{Employee\ ownership} + c_3 X + \varepsilon, \quad (2)$$

where Y denotes variables that capture CEO compensation components, i.e., the level and the structure of CEO compensation and CEO Delta and Vega, $\overline{Employee\ ownership}$ is the predicted employee ownership from equation (1), X is a vector of pre-determined control variables affecting Y, and ε is an error term. The coefficient c_2 reflects the impact of employee ownership on CEO compensation and CEO incentives. To obtain consistent and asymptotically efficient coefficient estimates, I bootstrap the two-step system 100 times to obtain consistent standard errors and report the coefficients' 95% confidence interval estimates in the tables.

Second, to control for the firm characteristics that do not change over time, I conduct firm fixed effect regressions. Finally, to the extent that the decisions on the compensation for both rank-and-file employees and managers can be jointly made, I estimate the simultaneous equations using Zellner's (1962) seemingly unrelated regressions (SUR) to address the reverse causality concern. The SUR framework using the generalized least squares (GLS) technique takes into account the correlation between the error terms across the equations, thus a superior method to the three-stage least squares framework.

B. Determinants of the Level of Employee Ownership in the DC Plan

In modeling the determinants of employee ownership in the DC plan using the two-step bootstrapping procedure, I employ a number of firm- and industry-specific characteristics as explanatory variables in equation (1) in Section A. Among the control variables, *Z*, that affect employee ownership, I follow Rauh (2006) and include the leverage ratio (*Leverage*), the log of the total sales (*Ln*(*Sales*)), the growth opportunities (*Sales growth* and *Tobin's q*), and the stock performance (*Stock return*). *Liquidity*, defined as the current assets minus current liabilities as a share of total assets, is included in the regression since prior literature documents that employee ownership in the DC plan, compared with cash contributions, has cost advantage especially for financially constrained firms. Cramton, Mehran, and Tracy (2008) document that industry unionization rate is positively related to the size of employee ownership since employee ownership is a tool to undermine labor union's hostility and mitigate employee dissent when labor is strong. Accordingly, I include the industry unionization rate (*Union*). Prior literature also argues that firms increase employee ownership in the DC plan as a takeover defense strategy. I thus include *Industry M&A intensity* as an additional control, which is defined according to Moeller, Schlingemann, and Stulz (2004) as the value of all SDC acquisition deals in the industry divided by the total book value of assets of Compustat firms for each of the two-digit SIC industries in each year.

To control for the endogeneity of employee ownership, I use two instrumental variables, *L*, in equation (1). The first instrumental variable is related to the tax incentives on investing in company stocks in the DC plan, i.e. *Marginal tax rate* proposed by Graham and Mills (2008). Firms invest in company stocks in the DC plan can enjoy unique and privileged tax treatments according to the tax code (Beatty (1995), Core and Guay (2001), Rauh (2006)). However, tax is not a major reason for the dramatic increase in executive stock options since 1980. Hall and Liebman (2000) find that stock options only have a slight tax advantage relative to cash (approximately $4 per $100 of pretax compensation to the executive). Thus I expect the tax incentives to affect executive compensation only through employee ownership.

Hochberg and Lindsey (2010) document that the granting of non-executive employee stock options in the local geographic region affects an individual firm's option usage through local labor market competition and fixed-agent peers. Similarly, I expect that the granting of stocks to rank-and-file employees in DC plans also has this geographic feature. Consequently, I construct my second instrumental variable, *Employee ownership in near firms in other industry*, as the average employee ownership for firms in the company's geographic region (two-digit zip code) that are not in the firm's industry (two-digit SIC code) and I expect this geography-based measure to affect CEO compensation only through employee ownership.[63] Finally, to capture the year- and industry- specific effects, I include year dummies and the mean employee ownership at the two-digit SIC industry level.

I use all DC firms without any investments in common/collective or master trusts to estimate the regression. Table III reports the regression result obtained using the Tobit regression in equation (1). Consistent with Rauh (2006), the result in Table III shows that larger firms and firms with lower growth and higher leverage ratio are more likely to maintain a higher level of employee ownership. However, I do not find a significant impact of stock performance on the level of employee ownership. Liquidity is negatively associated with the level of employee ownership (*t*-statistic = -7.6), consistent with Core and Guay (2001) who argue that equity-based compensation for rank-and-file employees serves as a substitute to the costly cash contributions. In addition, *Industry M&A intensity* has a significant positive impact on the level of firms' DC investment in employer stocks, supporting prior literature that highlights the role of employee ownership as an anti-takeover device.[64] The industry unionization rate (*Union*) on the level of employee ownership is positive but not significant.

More importantly, from an identification perspective, the impact of the marginal tax rate and the employee ownership in near firms in other industries on the level of employee ownership is positive and highly significant (*t*-statistics = 4.0 and 3.4), suggesting that to lower the marginal tax rate constitutes an

[63] I obtain the zip codes from the Compact Disclosure Database complemented by the data from Compustat.
[64] Moller, Schlingemann, and Stulz (2004) and Masulis, Wang, and Xie (2007) use industry M&A intensity as a proxy for the competitiveness of the M&A market in an industry.

important motive for firms to contribute stocks to employees in their DC account and firms tend to follow other firms in their geographic proximity to adopt the similar employee retention policy.

C. Effects of Employee Ownership on CEO Compensation and Incentives

I examine the effects of employee ownership on CEO compensation terms and the pecuniary incentives in this section. All regressions control for industry (two-digit SIC) and year dummies. Standard errors are corrected for heteroskedasticity and serial correlation across observations. I report the major findings in Panel A of the tables and selective key findings using the two-step bootstrapping procedure (the 95% confidence interval), the firm fixed effect regressions and the SUR in Panel B.

I carefully choose control variables to be consistent with existing literature. To further mitigate the endogeneity concern, all control variables are lagged one period with additional controls for firms' concurrent operating and stock performance following prior literature. Specifically, according to John and John's (1993) theoretical work, managers tend to transfer wealth from debtholders to shareholders by pursuing risky investment projects when they are vested with more stock options. I hence control for a firm's book ratio of leverage in the empirical model. Jin (2002) and Baker and Hall (2004) find that firm size is an important predictor for a CEO's incentives at the cross-sectional level. To control for the size effect, I include the natural logarithm of sales (*Ln*(*Sales*)). Yermack (1995) suggests that shareholders in firms with more growth opportunities provide managers with more equity-based compensation due to the difficulty in evaluating managers' decisions. I add two measures, *Tobin's q* and *Sales growth*, in the regressions to control for the potential effect of growth opportunities on CEO pay.

Since Murphy (2000) points out that a majority of firms use accounting earnings as a performance measure in the CEO compensation contracts, I include return on assets (*ROA*) as a proxy for a firm's accounting performance. In addition, I include stock returns as a measure of stock performance based on the findings of Murphy (1985) that equity-based executive compensation and total compensation are positively associated with the stock performance in a firm. To be consistent with Core, Guay, and Larcker (1999), I control for firm risk, which is measured as the annualized volatility of monthly stock

returns during the past fiscal year. Furthermore, I follow Low (2009) to control for corporate investments such as capital expenditures over assets (*Capex/Assets*) and R&D expenses over sales (*R&D/Sales*). An indicator to denote the missing R&D expenses is also included in the analysis. Natural logarithm of firm age (*Ln*(*age*)) is controlled for similar to Cadman, Klasa, and Matsunaga (2009). Finally, since Fernandes, Ferreira, Matos, and Murphy (2009) document that CEO characteristics are also important determinants of CEO pay, I include in the empirical model the log of CEO tenure (*Ln*(*CEO tenure*)), the log of CEO age (*Ln*(*CEO age*)), and a dummy variable to indicate whether CEO simultaneously serve as the board chairman (*Chairman dummy*).

C.1. Level of CEO Compensation

Panel A in Table IV summarizes the estimates of the effects of employee ownership on the level of CEO compensation by OLS regressions. Employee ownership has a significant negative impact on the levels of CEO stock option and the total compensation respectively (*t*-statistics = -3.1 and -3.9) in columns (4) and (5) but has a marginal positive effect on the level of CEO equity pay (*t*-statistic = 1.9) in column (3). Columns (1) and (2) demonstrate that there is no significant impact of employee ownership on the level of CEO salary or bonus, however. The marginal effect of the estimated coefficients suggests that a one standard deviation increase in employee ownership (0.0315) is associated with a $0.46 million decrease in the value of CEO stock option but only a $0.25 million decrease in the value of total compensation due to a slight increase in the equity pay, holding all variables at the mean level.[65]

The coefficients of control variables are generally consistent with previous literature. For instance, similar to Bryan, Hwang, and Lilien (2000), I find a negative impact of leverage on CEO stock option. The negative effect of CEO age on CEO stock option value is consistent with Gibbons and Murphy

[65] For instance, to calculate the marginal effect of employee ownership on the value of CEO stock option at the mean level, I multiply a one standard deviation of employee ownership (0.0315) by the coefficients on employee ownership (-6.95) and also by the mean value of options plus one (2096.59+1). (Note: since $dLn(1+y)/dx = 1/(1+y)\ dy/dx$, $dy/dx = (1+y)\ dLn(1+y)/dx$)

(1992), who argue that older CEOs could prefer cash-based compensation to equity-based compensation because of their shorter employment horizon.

In Panel B of Table IV, I report selective results on CEO equity pay, stock option, and total pay obtained by using the two-step bootstrapping procedure, the firm fixed effect regression and the SUR. I find that the results using these alternative estimation procedures are qualitatively similar for CEO stock option and total pay to the results in Panel A. However, in the regression concerning CEO equity pay in column (1), the bootstrapped 95% confidence interval for the coefficient on employee ownership spans zero, indicating that the coefficient estimate on employee ownership is insignificantly different from zero. The estimated coefficient is also insignificant in the firm fixed regression in column (2) concerning CEO equity pay. The results in columns (1) and (2) raise doubt that the association between employee ownership and CEO equity compensation could be spurious due to potential omitted variables or time-invariant firm characteristics.

Taken together, the findings suggest that CEOs in firms with higher employee ownership are more likely to have a lower level of stock option and total pay. These results are consistent with my hypothesis that employee ownership serves as a substitute for CEO stock option that encourages intensive CEO monitoring on employees and risk-taking behaviors.

C.2. Structure of CEO Compensation

The change in the level of compensation does not necessarily cause a change in the structure of compensation. In Panel A of Table V, I use Tobit regressions to examine the effects of employee ownership on the structure of CEO compensation that is more related to CEO incentives.[66] The result in column (4) indicates that employee ownership has a significant negative effect on the fraction of CEO pay comprised of stock option (*t*-statistic = -3.5). Furthermore, the fractions of both salary and equity pay significantly increase in response to an increase in employee ownership with the same *t*-statistics equal to 2.1 in both columns (1) and (3). In an unreported table, I combine equity and stock option together as the

[66] I repeat the analysis using OLS regression and the results are qualitatively similar to Table V.

equity-based pay and find that employee ownership still has a significant negative impact on the share of equity-based pay in the CEO total pay with a *t*-statistic of -2.2. However, I observe an insignificant effect of employee ownership on the fraction of bonus in the CEO compensation package in column (2). Economically, a one standard deviation increase in the employee ownership leads to a 2.23 percent drop in the fraction of pay comprised of stock option based on the marginal effect for unconditional expected value of the dependent variable in the Tobit regression.

Panel B of Table V presents the results on fractions of CEO pay comprised of equity and stock option using the two-step bootstrapping procedure, the firm fixed effect regressions, and the SUR. These results are consistent with the findings in Panel A except for an insignificant coefficients on employee ownership in the regressions for the fraction of equity pay in columns (1) and (2), suggesting that the increase in CEO equity pay in response to an increase in employee ownership is sensitive to the correction for the endogeneity and the time-invariant firm characteristics.

Overall, the results in Table V together with the findings in Table IV suggest that firms with higher employee ownership are more inclined to maintain a lower level of CEO stock option and a smaller fraction of CEO stock option in the total compensation, which are in support of my conjecture that the employee ownership in the DC plan serves as an interest alignment and risk sharing mechanism, which makes the excessive monitoring- and risk-inducing CEO stock option unnecessary.

C.3. CEO Incentives

Delta and Vega, the sensitivity of CEO wealth to the stock price and the sensitivity of CEO wealth to the stock return volatility respectively, are more direct measures of management interest alignment with shareholders and risk-taking incentives. Panel A in Table VI presents the estimates from the OLS regressions using these two measures. In columns (1) and (3), the main dependent variables are log of current measures of CEO Delta (*c_Delta*) and Vega (*c_Vega*) calculated using the current equity-based compensation, while in columns (2) and (4) the dependent variables are log of total CEO Delta and Vega, the accumulative measures of CEO incentives calculated based on the method in Core and Guay (2002).

The results in columns (2) and (4) in Panel A indicate that employee ownership has strong negative effects on both CEO Delta and Vega at less than the 1% level (*t*-statistics = -3.5 and -2.8). The results using current CEO Delta and Vega as dependent variables in columns (1) and (3) have the same implications. In terms of economic significance, a one standard deviation increase in employee ownership translates into a decrease in *c_Delta* by $3,104 and Delta by $60,325 per 1 percent change in shareholder wealth and a decrease of *c_Vega* by $2,279 and Vega by $6,598 per 1 percent change in stock return volatility, holding all variables at the mean level.

The results reported in Panel B of Table VI reveal that the negative effects of employee ownership on CEO incentives are not driven by the potential omitted variables, time invariant firm characteristics, and reverse causality. Collectively, the findings in Table VI provide strong supportive evidence to my hypothesis. Specifically, the substitution effect of employee ownership on CEO Delta and Vega suggests that if a firm decides to increase the investments of employer stocks in the DC plans to incentivize employees to work harder, it is more prone to loosen its CEO's interest alignment with shareholders to alleviate the adverse effect of excessive managerial monitoring on employees. In the meantime, this firm is also motivated to reduce CEO risk-taking incentives to take care of the needs of the undiversified employees and to avoid the costly litigations with employees who are particularly protective under the current labor law.

D. Labor Strength, Firm-specific Human Capital, Free-riding, Mutual Monitoring, and Capital Intensity

In this section, I examine the effects of firm and industry characteristics on the substitution relations between employee ownership and CEO stock option and CEO Delta and Vega.[67] The control variables are the same as those in Tables IV to VI. To save space, only coefficients estimated on key variables of interest are reported.

[67] I focus on CEO stock option not only because stock option is the largest discretionary component in the equity-based compensation but also because the convexity nature of option is most closely related to CEOs' risk-taking incentives. In addition, Hall and Liebman (1998) find that the rise of pay-performance sensitivity in executive compensation is also mainly driven by the increase of stock options.

D.1. Labor Strength and Importance of Employee Retention

The management-labor relationship is more critical to the production in more unionized firms (Wilson (2011)). Bae, Kang, and Wang (2011) argue that employees who work in lower turnover industries are better educated and are more difficult to be retained. In addition, firms operating in more competitive industries are more difficult to retain employees since these employees have more opportunities to switch to another company in the same industry. Consequently, firms in industries with lower employee voluntary turnover and more competitive industries are more likely to adopt labor-friendly policies.

To examine these effects, I partition the sample into high labor strength/importance (*High*) and low labor strength/importance (*Low*) subsamples according to three measures: (1) industry unionization rate; I classify firms with higher than the sample median industry union coverage as *High* and firms with lower than the sample median industry union coverage as *Low*; (2) industry employee voluntary turnover rate at the three-digit SIC; I classify firms with lower than the sample median industry employee voluntary turnover rate as *High* and firms with higher than the sample median industry employee voluntary turnover rate as *Low*; (3) Herfindahl index at the three-digit SIC; I classify firms in industries with Herfindahl indices below the sample median (lower industry concentration) as *High* and firms in industries with Herfindahl indices above the sample median (higher industry concentration) as *Low*.

I re-estimate the regressions in Tables IV to VI for a subsample analysis and the results are reported in Panel A of Table VII. The evidence demonstrates that the substitution effect is mainly from firms operating in high unionized industries, lower turnover rate, and lower product market concentration. These findings further confirm my prediction that firms are more inclined to adjust CEO compensation according to employee holdings in DC account if the management-labor relationship is more critical to a firm's production and employees in a firm are more difficult to be retained.

D.2. Free-riding Problem and Mutual Monitoring

Hochberg and Lindsey (2010) argue that mutual monitoring among rank-and-file employees is more likely to occur in firms with a weaker free-riding problem. Specifically, they argue that free-riding is weaker in smaller firms where the overall performance of the firm is more sensitive to the actions of individual workers. In the similar fashion, free-riding is also weaker in firms with substantial individual growth opportunities where the ability of individual employees is more likely to influence the firm valuation (Core and Guay (2001)).

Similar to Hochberg and Lindsey (2010) and Core and Guay (2001), I partition the sample into subsamples with high tendency of a free-riding problem (*High*) and lower tendency of a free-riding problem (*Low*) according to two measures: 1) the number of employees; I classify firms with higher than the sample median of the number of employees as *High* and firms with lower than the sample median of the number of employees as *Low*; 2) growth options per employee, defined as the market value of equity minus the book value of equity divided by the number of employees; I classify firms with lower than the sample median values of growth option per employee as *High* and firms with higher than the sample median values of option per worker as *Low*.

Furthermore, mutual monitoring among co-workers is more likely to occur in firms that adopt broad-based ESOPs since workers having similar incentives are more likely to make a joint decision on exerting efforts and sanctioning those who deviate from the organization goals (Hochberg and Lindsey (2010)). Hence I divide the sample into subsamples with broad-based ESOP and targeted ESOP. To avoid the double counting of the same participants covered by multiple DC plans in a firm, I, in the analysis, only keep ESOP firms that sponsor single DC plan. I classify an ESOP as a broad-based ESOP (*Broad*) if the number of active employees covered by the ESOPs over total number of employees in a firm is above the sample median and as a targeted ESOP (*Targeted*) if the ratio is below the sample median.

I repeat the regressions in Tables IV to VI for the subsamples and present the results in Panels B and C in Table VII. I find that the effects of employee ownership primarily come from the subsamples with the smaller number of employees, higher growth options per employee, and higher employee coverage by

ESOPs.[68] To sum up, these findings support my prediction that weaker free-riding and group-based incentives encourage mutual monitoring among employees, creating a strong incentive for the firms to replace costly CEO stock option that induces intensive monitoring with employee incentive pay.

D.3. Capital Intensity

Capital-intensive firms, compared with labor-intensive firms, have higher operating leverage and higher business risk. Meanwhile, capital-intensive firms also require more team-based work practices to operate the sophisticated and expensive machinery. As a consequence, to reduce CEO's risk-taking incentives and to promote cooperative management-labor relation in firms with high employee ownership is critical in capital-intensive firms. Following Bae, Kang, and Wang (2011), I employ two proxies for capital intensity, i.e., a three-year average of depreciations over labor expenses and a three-year average of capital expenditures over labor expenses. To estimate the firm-level labor expenses, I use the industry-level wage rate multiplied by firm-level total number of employees.

I then split the sample based on the sample median values of capital intensity measures and re-estimate the regressions in Tables IV to VI for the subsamples separately. In particular, I classify firms as capital-intensive (*Intensive*) firms if the value of a three-year average of depreciations or capital expenditures over labor expenses is above the sample median and labor-intensive (*Non-intensive*) firms if it is below the sample median.

The results of the subsample analysis are presented in Panel D of Table VII. Consistent with my hypothesis, I find that the replacements of CEO stock option and CEO Delta and Vega with employee ownership are more likely to appear in the firms with higher capital intensity, reflecting the importance of strengthening management-labor cooperation and lowering risk in firms having more physical assets in place when employees hold a large stake.

[68] There are two exceptions: (1) result for Delta is significant in the subsample of firms with low growth options per employee possibly due to a high correlation between Delta and growth options per employee (17%); (2) result for Vega is insignificant in subsamples of firms with both broad-based and targeted ESOPs due to a smaller sample size by eliminating firms sponsor multiple pension plans.

V. Robustness Tests

I conduct a series of robustness tests in this section to verify the validity of the results. For brevity, I only report the coefficients estimated on key variables of interest.

A. Alternative Explanations

First, Rauh (2006) finds that the passage of anti-takeover law in Delaware in mid-1990s leads to a significant decline in employee holdings in the DC plan. In addition, Bebchuk and Fried (2003) argue that strong corporate governance reduces a rampant executive rent seeking. These results suggest that both employee ownership and CEO compensation can be dependent on a firm's corporate governance structure *per se*. To ensure that the results are not driven by the omitted corporate governance status, I re-estimate the regressions from Tables IV to VI by including additional corporate governance variables such as *G-index* compiled by Gompers, Ishii and Metrick (2003), the board size and board independence, CEO ownership, and institutional holdings in Panels A to D in Table VIII.

I find that the substitution effect between employee ownership and CEO stock option cannot be explained by the governance environment in a firm. The coefficients of the additional governance variables are generally consistent with previous literature. For instance, the positive effect of *G-index* on CEO Vega is consistent with Low (2009), who argues that the reduction of firm risk in the presence of effective protection from takeovers has a negative impact on shareholder wealth and shareholders hence grant more options to induce managers' moderate risk taking. The results also show that CEOs in firms with higher board independence have a higher level of stock option, consistent with Ryan and Wiggins (2004). In addition, firms with high institutional holdings and lower CEO ownership are more inclined to raise CEO Vega. This is consistent with Adams, Almeida, and Ferreira (2005) who find that firms with less powerful CEOs experience lower variability in performance and thus more stock options are granted by shareholders to overcome CEOs' risk aversion.

Second, management quality can be an alternative explanation to the findings since low-quality managers have low ownership as they are more likely to be replaced (Milbourn (2003)). Meanwhile, low-quality managers rely on the bid premium to enhance firm value and hence are associated with higher employee ownership as a stronger anti-takeover device. I include in the regressions a proxy for management quality, *CAR*(*-3 year, -1 year*), defined as the cumulative abnormal returns (CAPM adjusted) during the past three years. The results reported in Panel E of Table VIII indicate that the substitution effect is not due to the management quality. *CAR*(*-3 year, -1 year*) has a positive impact on the CEO stock option and Delta, consistent with Milbourn (2003). I do not observe a significant impact of *CAR*(*-3 year, -1 year*) on CEO Vega though.

Third, Kim and Ouimet (2011) argue that employee ownership large than five percent forms a blockholding, which increases the voice of employees in the corporate governance in a firm. It is possible that employees, who own a large holding, directly affect the design of executive compensation via voting or selecting representatives sitting on the board. Therefore I include a dummy variable to denote a larger than the five percent employee ownership in the regressions. The empirical evidence reported in Panel F of VIII shows that the results are not affected qualitatively after the indicator of employee blockholding is included. I also find that the large employee holding indicator is insignificant in most regressions.

Fourth, although an increase in employee ownership leads to a reduction in CEO stock options, it is possible that more stock options are granted to other top four executives simply as a reflection of a declining CEO power in the senior management, thus no change in incentives of the senior management as a team. To explore the possibility, I estimate the compensation package and calculate the Delta and Vega for the top five executives for the sample firms. Subsequently, I re-estimate the regressions in Tables IV to VI using these new measures as dependent variables. The results (unreported) indicate that the substitution effect in Tables IV to VI is also valid for the top five executives, suggesting that the substitution of employee ownership for stock options, and Delta and Vega occurs between the lower and upper level of employees as a whole.

Finally, I investigate the possibility of employee ownership as a management entrenchment mechanism in the substitution relation I observe in the study. Chang and Mayers (1992) argue that shareholders are more likely to reduce managerial ownership in firms with larger employee holdings under managers' control to overcome the agency problem. If employee ownership in the DC plan serves as a management entrenchment device, I expect that the substitution effect is stronger in a hot M&A market, where entrenched managers can obtain greater private benefits and extract more rents by deter the potential bidders.[69] To explore the possibility, I partition the sample period based on the measure of *Industry M&A intensity*.[70] Specifically, I split the sample within industries and classify industries in years with lower than the median value of M&A intensity as *Inactive* and industries in years with higher than the median value of M&A intensity as *Active*.[71] I then re-estimate the regressions in Tables IV to VI for both subsamples. The results (unreported) indicate that the substitution effect is significant in both active and inactive M&A markets in a particular industry. In a word, the evidence suggests that the management entrenchment argument cannot fully explain my findings.

B. Additional Sensitivity Tests

To eliminate the possibility that the results only capture the effect of certain corporate events, the regulation change or missing data, I conduct additional sensitivity tests in this section. First, I exclude firm-year observations with CEO turnovers since Kang and Mitnik (2008) document that firm experiencing CEO turnovers tend to largely reduce the option value in the total compensation to the successors, which may cause the change of CEO incentives. Second, Hayes, Lemmon, and Qiu (2010) find that after the implementation of SFAS 123R in 2006 that requires the expensing of options by the market value, firms are more likely to grant restricted stocks and reduce stock options. Thus I limit the sample period from 1992 to 2005. Third, due to the change of the service provider to process the IRS

[69] The untabulated results show that employee ownership in my sample does have a statistical influence on managerial ownership.
[70] Using three-digit SIC code to redefine *Industry M&A intensity* does not affect the results.
[71] Classifying the industry M&A market into active and inactive markets by pooling the industries together does not affect my results.

Form 5500, the data series are incomplete in years of 1999, 2000 and 2003.[72] I hence exclude the data in the three years and re-estimate the regressions to avoid any potential bias. I re-estimate the regressions in Tables IV-VI according to these new sample selection criteria and report the results in Panels A to C in Table IX.

Finally, to rule out the possibility that the results are driven by a large number of sample firms with zero employee ownership in the DC plan, I remove zero employee ownership and re-estimate the regressions. Furthermore, to further mitigate the impact of potential sample selection bias, I adopt two methods to address this issue: (1) I include an indicator to denote zero employee ownership in all regressions; (2) I use a long tenure approach by only keeping firms with investments in employer securities for at least three years. I re-estimate the regressions using these alternative model specifications and the results are reported in Panels D to F in Table IX. The findings are not affected by these parsimonious tests.

VI. Conclusion

Despite abundant evidence documented on the motivations to sponsor employee ownership, few empirical studies examine the executive compensation scheme in firms that invest in their own stocks for employees in the DC account. Using a large sample covered by both the ExecuComp and the IRS Form 5500 during the 1992 to 2007 period, I empirically examine the effects of employee ownership on CEO compensation as well as the CEO pay-performance sensitivity and risk-taking incentives.

I find that employees' holding of company stocks in the DC plan significantly reduces the value of stock options to CEOs and the fraction of CEO pay comprised of stock option. I also find that the sensitivity of CEO wealth to the firm's stock price and the sensitivity of CEO wealth to the volatility of the stock returns decrease in response to an increase in employee ownership. Examining the effects of firm and industry characteristics on the substitution relation between employee ownership and CEO

[72] Based on Cheng and Michalski (2010), the firms, where missing filings exist, were random and therefore, the reduction in the firm-year observations has minimal effects on biasing the sample.

compensation, I find that my results are primarily driven by subsamples of firms that operate in industries with stronger unions, firms that attach higher importance to employee retention, firms where the free-riding problem of employees is less severe, firms offering a broad based ESOP, and firms having high capital intensity.

Overall, these results suggest that employee ownership facilitates the cooperative behaviors between employees and the management and encourages the mutual monitoring among rank-and-file employees. Consequently, it is optimal for firms to reduce the grants of high-powered stock option to CEOs to avoid intensive managerial monitoring on employees and excessive risk-taking behaviors of the managers. My findings are consistent with FitzRoy and Kraft (1987) and Blasi, Conte, and Kruse (1996) who argue that group-based incentive schemes such as ESOP induce co-monitoring, reducing costly monitoring by managers. The findings complement the literature that highlights the bright side of employee ownership.

Appendix A
Sample construction

This table contains the observation counts by fiscal year for the sample at different stages of construction. I start from all Compustat firms reported during 1990 to 2007 and merge IRS Form 5500 data with Compustat by the *Employment Identification Number* (EIN) as in Madrian and Gron (2004) and Jin, Merton, and Bodie (2006). The combined IRS Form 5500-Compustat data are then merged with the ExecuComp data. For Compustat data, I require that the firms have non-missing EINs. For IRS Form 5500 data, the sample selection criteria are to (1) exclude multiple-employer and multiemployer DC plans and defined benefit (DB) pension plans; (2) drop pension plans if pension assets at the end of fiscal year are zero and (3) drop pension plans without the plan number assigned by the DOL. For the ExecuComp data, I remove firms, from which I am not able to identify CEOs and firms with negative CEO tenure, missing total compensation (*tdc1*) in ExecuComp and zero total compensation. In addition, if there is more than one CEO for a firm in a year (e.g., when there is a CEO turnover), the averages across CEOs are reported.

Order	Key variables	Data source	Period	Number of observations
(1)	Accounting measures and stock performance	Compustat and CRSP merged database	1990 - 2007	180,364 firm-years
(2)	Pension assets and employer securities	IRS Form 5500	1990 - 2007	808,927 plan-years
(3)	Merger (1) with (2) and exclude firms with pension investments in master and common/collective trusts and unreasonable employee ownership	-	1990 - 2007	46,639 firm-years
(4)	CEO compensation terms	ExecuComp	1992 - 2007	20,337 firm-years
(5)	Merge (3) with (4), exclude financial and utility firms and drop observations with missing control variables	-	1992 - 2007	6,226 firm-years

Appendix B
Variable definitions

Variables	Definitions
5% Ownership Indicator	Dummy variable that equals one if employee ownership is larger than 5%, and zero otherwise.
Board Size	Number of board members from Risk Metrics.
Bonus	BONUS before the SFAS 123R and BONUS + NON_EQ_TARG after the SFAS 123R from ExecuComp following Hayes, Lemmon, and Qiu (2010).
Broad-based Plan	Dummy variable that equals one if the number of active participants covered by the ESOP over the number of total employees is above the sample median, and zero otherwise.
Capex/Assets	Capital expenditure/total assets.
CAR (-3 year, -1 year)	Cumulative abnormal returns (CAPM adjusted) during the past three years as a measure of management quality following Milbourn (2003).
CEO Age	Current calendar year - CEO birth year.
CEO Ownership	Shares owned by CEO/total shares outstanding from ExecuComp.
CEO Tenure	Number of years since he/she became CEO of a firm from ExecuComp.
Chairman Dummy	Dummy variable that equals one if a CEO also serves as the board chairman in a firm, and zero otherwise from ExecuComp.
Delta	Dollar change in CEO stock and option portfolio for 1% change in stock price, in thousands following Core and Guay (2002).
Employee Ownership	Value of employer securities scaled by market capitalization at the fiscal year end.
Employee Ownership in Near Firms in Other Industry	The mean employee ownership for firms in the company's geographic region (2digit zip code) that are not in the firm's industry (2-digit SIC code).
ESOP Indicator	Dummy variable that equals one if a DC firm invests in employer stocks, and zero otherwise.
Firm Age	Number of years since the firm entered CRSP.
Growth Option per Employee	Market value of equity minus book value of equity divided by the number of employees following Core and Guay (2001).
G-index	Gompers, Ishii and Metrick (2003) from Risk Metrics.
Herfindahl Index	Industry Herfindahl index based on all Compustat firms, where industries are defined by 3-digit SIC.
Independent Directors (%)	Number of independent directors / board size from Risk Metrics.
Industry Employee Voluntary Turnover Rate	Industry-level employee voluntary turnover rate during 2001 - 2006 from the U.S. Department of Labor.
Industry Mean Employee Ownership	The mean employee ownership in the firm's industry (2-digit SIC code).
Industry M&A Intensity	The value of all corporate control deals in a particular year and two-digit SIC code divided by the book value of all assets in the corresponding year and two-digit SIC code.
Institutional Ownership	Shares owned by institutional investors/total shares outstanding from CDA/Spectrum Institutional (13f) Holdings.
Leverage	(Short-term debt + long-term debt) / total assets.
Liquidity	Current assets minus current liabilities, as a share of total assets following Rauh (2006).
Long-term Incentive Awards (LTIAs) - current grant	SHRTARG*the stock price at the fiscal year end or VALTARG before the SFAS 123R and EQ_TARG after the SFAS 123R from ExecuComp following Hayes, Lemmon and Qiu (2010).
Long-term Incentive Awards (LTIAs) - prior grant	I assume that the CEO holds each year's new grant for the time period of LT_PERIOD before the SFAS 123R and EIP_UNEARN_VAL after the SFAS 123R from ExecuComp following Hayes, Lemmon and Qiu (2010).
Marginal Tax Rate	Book simulated marginal tax rates defined using coefficients reported in Table 4 (Panel B and Model C) of Graham and Mills (2008).
Options - current grant	Calculated using the Black-Scholes formula by assuming that the grant date is July 1st of that year and the valuation date is at the fiscal year end. Inputs include NUMSECUR before the SFAS 123R and OPTS_GRT after the SFAS 123R from ExecuComp. Option term is 0.7*(EXDATE - Grant Date) and stock volatility is the standard deviation of past 36 months' monthly stock return*square root of 12 following Hayes, Lemmon and Qiu (2010).
Options - prior grant	Calculated using the Black-Scholes formula by assuming that the grant date is July 1st of that year and the valuation date is at the fiscal year end. Inputs include OPT_UNEX_UNEXER_NUM, OPT_UNEX_EXER_NUM, OPT_UNEX_UNEXER_EST_VAL and OPT_UNEX_EXER_EST_VAL. Option term is 0.7*(EXDATE - Grant Date) and stock volatility is the standard deviation of past 36 months' monthly stock return*square root of 12 following Hayes, Lemmon and Qiu (2010).
Restricted Stock (RS) - current grant	RSTKGRNT before the SFAS 123R and SHARES_GRT*the stock price at the fiscal year end after the SFAS 123R from ExecuComp following Hayes, Lemmon and Qiu (2010).

Restricted Stock (RS) - prior grant	SHROWN_EXCL_OPTS from ExecuComp.
ROA	Operating income before depreciation and amortization (EBITDA)/total assets.
R&D/Sales	R&D expenses/total sales.
R&D Dummy	Dummy variable that equals one if the R&D expenses are missing, and zero otherwise.
Salary	SALARY from ExecuComp.
Sales	Value of total sales.
Sales Growth	Ln(1+change in net sales scaled by the lagged net sales).
Stock Return	Compounded monthly stock returns over the fiscal year.
Stock Volatility	Standard deviation of monthly stock return over the past fiscal year.
Tobin's q	(Total assets + market value of equity - book value of equity) / total assets.
Total pay	Salary + Bonus + RS + Options + LTIAs.
Union	Percentage of workforce in an industry employed by unions. The data is downloaded from the website maintained by Barry Hirsch and David Macpherson (www.unionstats.com).
Vega	Dollar change in CEO option holdings for a 1% change in stock return volatility, in thousands following Core and Guay (2002).

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Figure II.1: Aggregate employer stocks in define contribution (DC) pension plans and the share of employer stocks in total DC pension assets

The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. The left Y-axis corresponds to the aggregate value of employer stocks in firms that sponsor DC plans. The right Y-axis corresponds to the average share of employee DC holdings invested in employer stocks in firms that chose to invest in employer stocks.

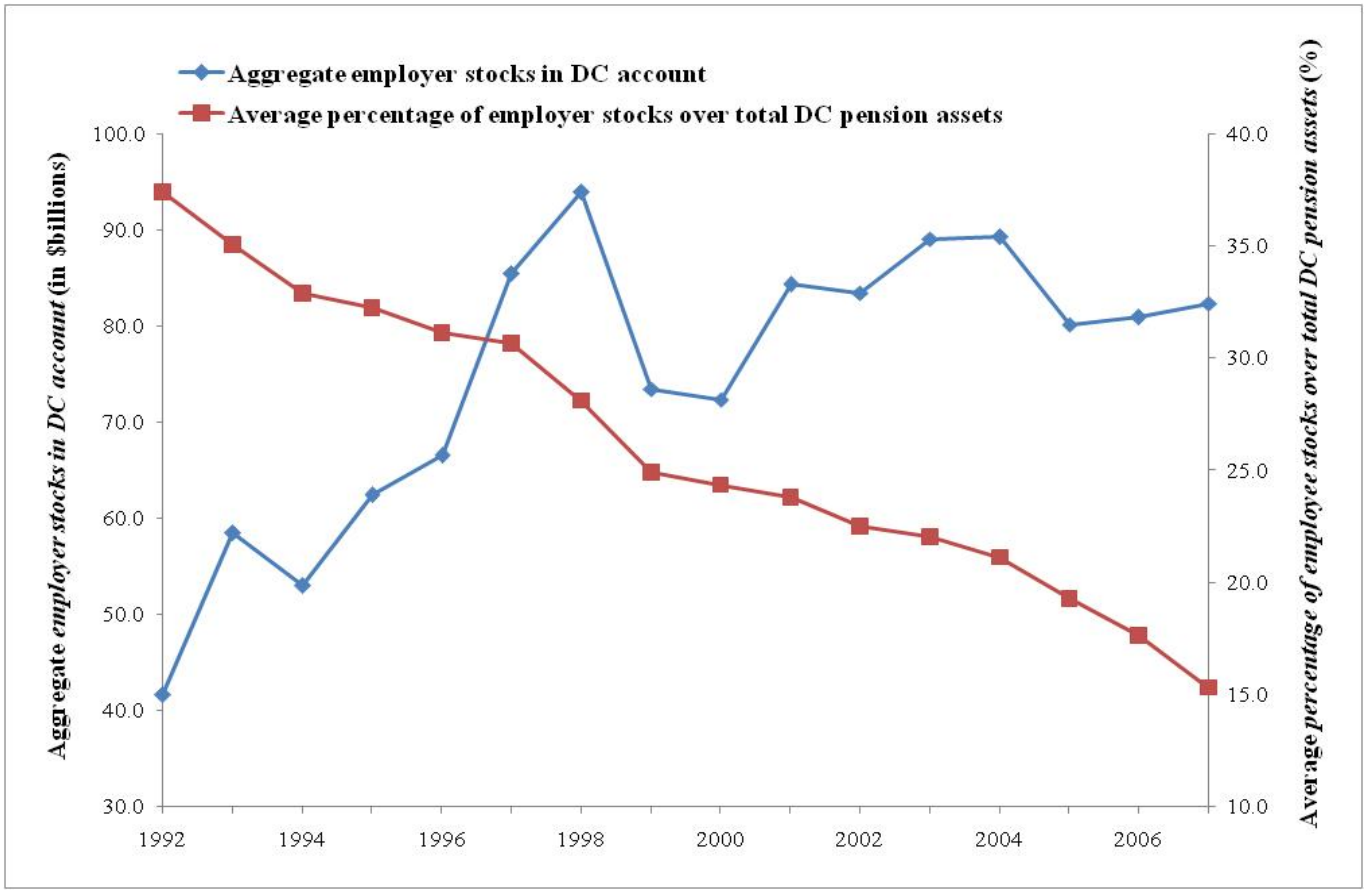
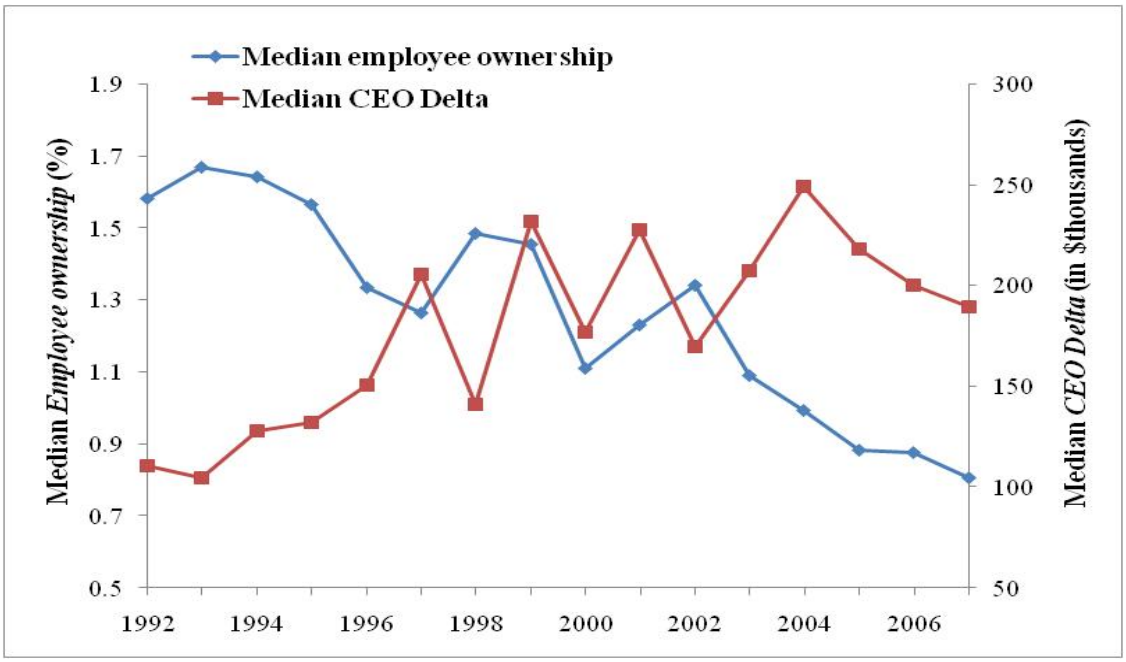


Figure II.2: CEO compensation incentives and employee ownership in ESOP firms over time
The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. Firms with pension investments in common/collective or master trusts are removed. The left Y-axis corresponds to the median value of employee ownership in firms that choose to invest in employer stocks in DC plans. The right Y-axis corresponds to the median value of CEO Delta and Vega, which are defined as the CEO pay-performance sensitivity and risk-taking incentives.



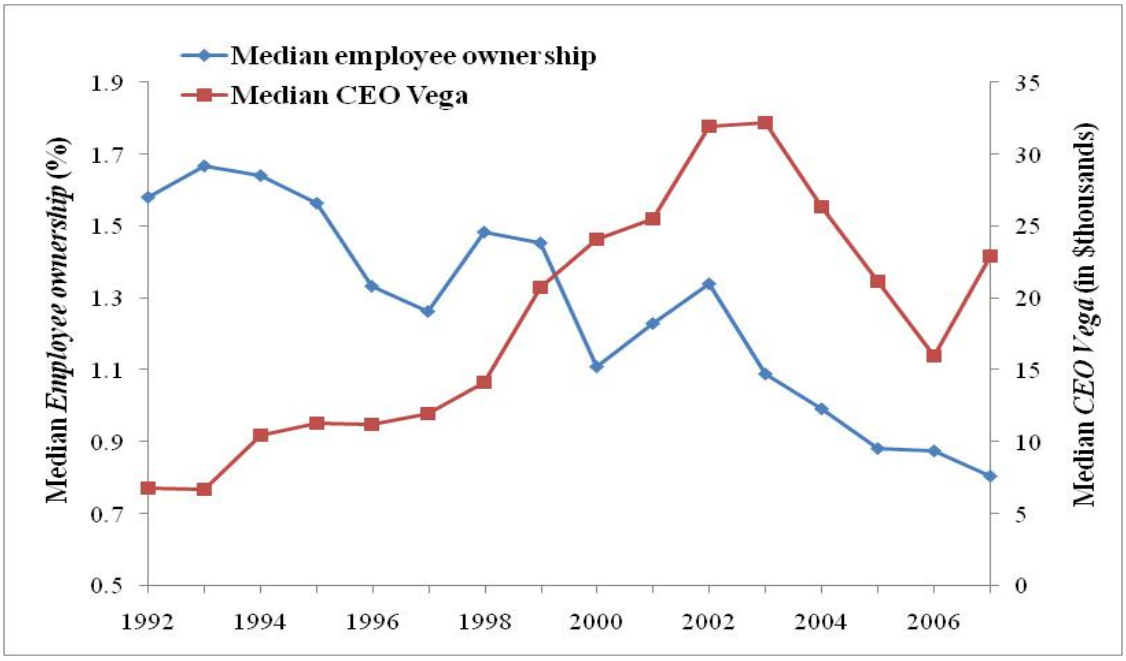


Table II.I: Sample distribution and mean and median values of employee ownership by year

The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. Plan level data are aggregated to the firm level. The sample construction is listed in Appendix A and detailed definitions of variables are described in Appendix B. All pension items are winsorized at the 0.5% level at both tails of the distribution.

Year	Number of DC firms	Number of DC firms with no investments in master or common/collective trusts (initial sample)	Number of DC firms with ownership in the initial sample	% of DC firms with ownership in the initial sample	% of firm's equity market value held by employees in DC accounts in the initial sample (non-zero observation)	
					Median	Mean
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1992	436	217	101	46.5	1.6	4.6
1993	704	351	162	46.2	1.7	3.7
1994	771	401	175	43.6	1.6	3.7
1995	825	428	192	44.9	1.6	3.5
1996	891	451	194	43.0	1.3	2.9
1997	952	478	202	42.3	1.3	2.6
1998	1009	507	201	39.6	1.5	3.1
1999	798	382	170	44.5	1.6	3.2
2000	822	369	149	40.4	1.2	2.7
2001	974	410	183	44.6	1.3	2.6
2002	1027	401	177	44.1	1.4	2.7
2003	1118	428	191	44.6	1.1	2.3
2004	1087	389	172	44.2	1.0	2.0
2005	1050	354	153	43.2	0.9	1.9
2006	1095	339	142	41.9	1.0	1.7
2007	1074	321	132	41.1	0.9	1.6
Mean	-	-	-	43.3	1.3	2.8
Total	14633	6226	2696	-	-	-

Table II.II: Summary statistics for CEO compensation contracts, and firm and CEO characteristics

The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. The detailed definitions of variables are described in Appendix B. Dollar values (in millions) are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution.

	Mean	SD	Min	P25	P50	P75	Max
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Terms of CEO compensation contracts (N = 6226)							
Level of CEO compensation (in $thousands)							
Total compensation	3655.35	6892.52	99.01	752.06	1579.64	3524.32	62161.03
Salary	508.03	273.70	0.00	319.67	449.56	637.19	2043.52
Bonus	478.39	822.93	0.00	43.01	243.09	561.97	8845.57
RS	266.81	1070.13	0.00	0.00	0.00	0.00	11494.66
LTIA	127.53	800.71	0.00	0.00	0.00	0.00	11887.21
Options	2096.59	5132.59	0.00	0.00	462.17	1846.01	42052.59
Percentage of CEO compensation over total compensation (%)							
Salary	37.57	28.60	0.00	14.44	29.53	54.88	100.00
Bonus	18.26	18.01	0.00	2.18	14.17	28.41	84.54
RS	5.45	13.84	0.00	0.00	0.00	0.00	79.47
LTIA	2.28	9.20	0.00	0.00	0.00	0.00	81.04
Options	36.15	32.58	0.00	0.00	32.78	64.61	99.46
CEO incentives (in $thousands)							
c_Delta	36.77	86.88	0.00	0.27	10.16	33.60	876.44
Delta	693.19	2124.90	0.00	52.73	155.58	475.12	24331.57
c_Vega	20.92	47.25	0.00	0.00	5.60	19.44	495.43
Vega	57.82	123.70	0.00	0.00	16.87	54.39	1351.83
Panel B: Firm characteristics (N = 6226)							
Sales (in $millions)	1886.21	4727.31	0.04	198.56	532.09	1452.13	45971.98
Leverage	0.18	0.18	0.00	0.01	0.14	0.30	0.93
Sales growth	0.14	0.30	-2.21	0.02	0.11	0.23	2.61
Tobin's q	2.56	2.55	0.44	1.36	1.86	2.87	45.21
ROA	0.09	0.15	-2.40	0.05	0.10	0.15	0.50
Stock return	0.28	0.75	-0.92	-0.14	0.13	0.49	4.37
Stock volatility	0.03	0.02	0.01	0.02	0.03	0.04	0.19
R&D dummy	0.33	0.47	0.00	0.00	0.00	1.00	1.00
R&D/Sales	0.28	5.61	0.00	0.00	0.01	0.10	299.30
Capex/Assets	0.07	0.06	0.00	0.03	0.05	0.09	0.51
Firm age (years)	18.20	15.51	2.00	8.00	13.00	25.00	83.00
Employee ownership	0.01	0.03	0.00	0.00	0.00	0.01	0.31
Panel C: CEO characteristics (N = 6226)							
CEO tenure	7.92	7.81	0.00	2.00	5.00	11.00	53.00
CEO age (years)	54.47	7.88	30.00	49.00	54.50	60.00	85.00
Chairman dummy	0.54	0.50	0.00	0.00	1.00	1.00	1.00

Table II.III: Determinants of employee ownership in DC plan

The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. The table reports the estimates of *Tobit* model, where the dependent variable is the employee ownership in the DC plan. The detailed definitions of variables are described in Appendix B. Dollar values are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: employee ownership in DC plan
Leverage	0.02***
	(3.0)
Ln(Sales)	0.01***
	(14.8)
Sales growth	-0.00
	(-1.0)
Tobin's q	-0.00***
	(-4.4)
Liquidity	-0.03***
	(-7.6)
Stock return	0.00
	(0.5)
Union	0.00
	(1.5)
Industry M&A intensity	0.02*
	(1.8)
Marginal tax rate	0.06***
	(4.0)
Employee ownership in near firms in other industry	0.08***
	(3.4)
Industry mean employee ownership	1.10***
	(16.3)
Constant	-0.10***
	(-14.2)
Industry dummies	N
Year dummies	Y
N	5919

Table II.IV: Regressions of the level of CEO compensation on employee ownership

The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. Equity compensation includes annual grant of both restricted stocks and long-term incentive awards. Total pay includes salary, bonus, equity pay and stock option. In Panel A the estimates of OLS regressions are reported and Panel B reports the results of two-step bootstrapping procedure, firm fixed effect regressions and simultaneous equations. The detailed definitions of variables are described in Appendix B. Dollar values are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: OLS regression

	Ln(1+Salary)	*Ln(1+Bonus)*	*Ln(1+Equity)*	*Ln(1+Option)*	*Ln(1+Total pay)*
	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
Employee ownership	-0.49	-0.68	4.03*	-6.95***	-2.19***
	(-1.1)	(-0.5)	(1.9)	(-3.1)	(-3.9)
Leverage	0.09	-0.34	0.64**	-0.77*	-0.20
	(1.1)	(-1.1)	(2.0)	(-1.9)	(-1.5)
Ln(Sales)	0.20***	0.48***	0.44***	0.47***	0.42***
	(14.1)	(10.8)	(8.7)	(7.6)	(19.9)
Sales growth	0.11***	0.84***	0.30**	0.37**	0.32***
	(3.1)	(5.1)	(2.6)	(2.0)	(5.0)
Tobin's q	-0.01*	-0.03	0.01	0.00	0.02*
	(-1.9)	(-1.2)	(0.5)	(0.1)	(1.8)
Concurrent ROA	-0.16	2.16***	-0.29	-1.43***	-0.19
	(-1.4)	(3.3)	(-0.7)	(-2.6)	(-0.9)
ROA	-0.03	-1.19**	-0.06	0.74	-0.04
	(-0.2)	(-2.3)	(-0.1)	(1.4)	(-0.2)
Concurrent stock return	0.01	0.54***	0.16***	0.39***	0.32***
	(1.4)	(9.9)	(3.5)	(5.2)	(11.5)
Stock return	0.03**	0.30***	0.07	0.15**	0.13***
	(2.2)	(6.1)	(1.5)	(2.1)	(5.4)
Stock volatility	-3.57***	-21.43***	-9.40**	0.46	0.01
	(-3.1)	(-5.1)	(-2.4)	(0.1)	(0.0)
R&D dummy	0.01	0.04	0.21	-0.62***	-0.10
	(0.2)	(0.3)	(1.2)	(-3.4)	(-1.5)
R&D/Sales	-0.00	0.02***	0.01**	0.02***	0.01***
	(-0.2)	(3.2)	(2.1)	(4.2)	(4.7)
Capex/Assets	-0.34	-2.28***	-1.46**	1.31	-0.47
	(-1.6)	(-3.2)	(-2.1)	(1.1)	(-1.4)
Ln(Firm age)	0.05***	0.04	0.28***	0.47***	0.05*
	(2.9)	(0.5)	(3.0)	(5.2)	(1.8)
Ln(CEO tenure)	0.04**	-0.18***	-0.40***	-0.24***	-0.05*
	(2.4)	(-3.0)	(-6.2)	(-3.1)	(-1.7)
Ln(CEO age)	0.23*	-0.47	-0.09	-2.34***	-0.44**
	(1.9)	(-1.2)	(-0.2)	(-4.5)	(-2.2)
Chairman dummy	0.05*	0.22**	0.43***	0.02	0.12***
	(1.8)	(2.3)	(4.1)	(0.2)	(2.7)
Constant	3.64***	3.92**	-2.51*	9.91***	5.90***
	(8.0)	(2.5)	(-1.7)	(4.9)	(7.9)
Industry FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
N	6226	6226	6226	6226	6226
R-squared	0.31	0.21	0.27	0.15	0.35

Table II.IV (cont'd)
Regressions of the level of CEO compensation on employee ownership

Panel B: Two-step bootstrapping procedure, firm fixed effect, and simultaneous equation

	Ln(1+Equity)			*Ln(1+Option)*			*Ln(1+Total pay)*		
	Two-step bootstrap	FE	SUR	Two-step bootstrap	FE	SUR	Two-step bootstrap	FE	SUR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Employee ownership	6.83	-0.08	10.81***	-15.46	-9.39***	-10.68***	-6.59	-2.54***	-3.03***
	[15.71, -4.49]	(-0.0)	(9.7)	[-26.46, -3.08]	(-2.6)	(-7.5)	[-11.04, -2.19]	(-2.7)	(-7.3)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	N	Y	Y	N	Y	Y	N	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	Y	N	N	Y	N	N	Y	N
N	100 replications	6226	6047	100 replications	6226	6047	100 replications	6226	6047
R-squared	-	0.17	0.26	-	0.09	0.15	-	0.21	0.35

Table II.V: Regressions of the structure of CEO compensation on employee ownership

The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. Equity compensation includes annual grant of both restricted stocks and long-term incentive awards. Total pay includes salary, bonus, equity pay and stock option. In Panel A the estimates of Tobit regressions are reported and Panel B reports the results of two-step bootstrapping procedure, firm fixed effect regressions and simultaneous equations. The detailed definitions of variables are described in Appendix B. Dollar values are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Tobit regression

	Salary %	*Bonus %*	*Equity %*	*Option %*
	Tobit	Tobit	Tobit	Tobit
	(1)	(2)	(3)	(4)
Employee ownership	0.35**	0.13	0.73**	-1.02***
	(2.1)	(1.0)	(2.1)	(-3.5)
Leverage	0.07*	0.01	0.14**	-0.12**
	(1.8)	(0.4)	(2.4)	(-2.2)
Ln(Sales)	-0.05***	0.01***	0.05***	0.03***
	(-10.0)	(3.8)	(6.7)	(4.0)
Sales growth	-0.06***	0.04***	0.03	0.02
	(-3.0)	(2.6)	(0.8)	(0.8)
Tobin's q	-0.00	-0.00**	-0.00	0.00
	(-0.3)	(-2.0)	(-0.4)	(0.4)
Concurrent ROA	-0.10	0.27***	0.04	-0.15**
	(-1.5)	(4.1)	(0.3)	(-2.0)
ROA	0.08	-0.15***	-0.07	0.08
	(1.4)	(-3.3)	(-0.5)	(1.1)
Concurrent stock return	-0.07***	0.03***	0.02*	0.05***
	(-11.4)	(5.8)	(1.9)	(5.4)
Stock return	-0.03***	0.02***	0.02	0.01
	(-4.5)	(4.2)	(1.5)	(1.5)
Stock volatility	0.44	-1.84***	-3.27***	0.91
	(0.9)	(-4.4)	(-3.3)	(1.3)
R&D dummy	0.03*	0.02	0.06**	-0.09***
	(1.9)	(1.6)	(2.0)	(-3.8)
R&D/Sales	-0.00***	0.00**	0.00	0.00***
	(-4.7)	(2.2)	(1.1)	(3.0)
Capex/Assets	-0.03	-0.11*	-0.37**	0.28*
	(-0.3)	(-1.7)	(-2.2)	(1.8)
Ln(Firm age)	-0.01	-0.01	0.06***	0.04***
	(-1.6)	(-1.6)	(3.5)	(3.4)
Ln(CEO tenure)	0.04***	-0.00	-0.08***	-0.03***
	(4.9)	(-1.0)	(-6.4)	(-2.8)
Ln(CEO age)	0.23***	0.02	0.03	-0.33***
	(4.9)	(0.7)	(0.4)	(-5.0)
Chairman dummy	-0.02*	0.01	0.08***	-0.01
	(-1.7)	(1.1)	(3.8)	(-0.9)
Constant	-0.27	0.05	-0.33	1.22***
	(-1.5)	(0.4)	(-1.1)	(4.8)
Industry FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	6226	6226	6226	6226

Table II.V (cont'd)
Regressions of the structure of CEO compensation on employee ownership

Panel B: Two-step bootstrapping procedure, firm fixed effect, and simultaneous equation

	Equity %			*Option %*		
	Two-step bootstrap	FE	SUR	Two-step bootstrap	FE	SUR
	(1)	(2)	(3)	(4)	(5)	(6)
Employee ownership	1.24	0.03	0.63***	-2.95	-0.67**	-1.29***
	[-0.45, 3.15]	(0.1)	(9.7)	[-4.70, -1.16]	(-2.4)	(-9.8)
Controls	Y	Y	Y	Y	Y	Y
Industry FE	Y	N	Y	Y	N	Y
Year FE	Y	Y	Y	Y	Y	Y
Firm FE	N	Y	N	N	Y	N
N	100 replications	6226	6047	100 replications	6226	6047
(Pseudo) R-squared	-	0.16	0.23	-	0.10	0.18

Table II.VI: Effects of employee ownership on CEO incentives

The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. Delta and Vega are CEO pay-performance sensitivity and risk-taking incentives. The detailed definitions of variables are described in Appendix B. In Panel A the estimates of OLS regressions are reported and Panel B reports the results of two-step bootstrapping procedure, firm fixed effect regressions and simultaneous equations. The detailed definitions of variables are described in Appendix B. Dollar values are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: OLS regression

	Ln(1+c_Delta)	*Ln(1+Delta)*	*Ln(1+c_Vega)*	*Ln(1+Vega)*
	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)
Employee ownership	-2.60***	-2.75***	-3.29***	-3.55***
	(-3.2)	(-3.5)	(-3.4)	(-2.8)
Leverage	-0.45**	-0.51***	-0.48**	-0.36
	(-2.3)	(-2.7)	(-2.5)	(-1.5)
Ln(Sales)	0.43***	0.47***	0.38***	0.40***
	(13.4)	(15.5)	(12.6)	(10.4)
Sales growth	0.38***	0.69***	0.40***	0.35***
	(4.2)	(7.6)	(5.2)	(3.6)
Tobin's q	0.04**	0.15***	0.04**	0.03*
	(2.1)	(8.5)	(2.5)	(1.8)
Concurrent ROA	-0.57**	-0.62**	-0.78***	-0.88***
	(-2.1)	(-2.4)	(-3.7)	(-3.1)
ROA	0.30	0.79***	0.50**	0.29
	(1.3)	(3.6)	(2.5)	(1.1)
Concurrent stock return	0.35***	0.49***	0.10***	0.05
	(9.0)	(17.6)	(3.3)	(1.3)
Stock return	0.11***	0.12***	0.06**	0.03
	(3.2)	(3.9)	(2.0)	(0.8)
Stock volatility	-1.36	-13.96***	-8.43***	-11.31***
	(-0.6)	(-5.7)	(-3.9)	(-3.8)
R&D dummy	-0.21**	-0.12	-0.27***	-0.39***
	(-2.3)	(-1.3)	(-3.2)	(-3.6)
R&D/Sales	0.01***	0.01***	0.01***	0.01***
	(4.3)	(8.6)	(4.9)	(2.9)
Capex/Assets	0.02	1.46***	0.41	0.29
	(0.0)	(2.7)	(0.8)	(0.5)
Ln(Firm age)	0.18***	-0.13***	0.18***	0.27***
	(4.0)	(-2.7)	(4.4)	(5.1)
Ln(CEO tenure)	-0.13***	0.67***	-0.10***	-0.04
	(-3.5)	(16.1)	(-3.0)	(-1.0)
Ln(CEO age)	-1.13***	-0.83***	-1.09***	-1.46***
	(-4.3)	(-3.2)	(-4.8)	(-4.8)
Chairman dummy	0.14**	0.24***	0.07	0.10
	(2.2)	(3.9)	(1.3)	(1.4)
Constant	3.20***	4.12***	3.22***	4.62***
	(3.2)	(4.1)	(3.6)	(3.9)
Industry FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
N	6226	6226	6226	6226
R-squared	0.24	0.42	0.22	0.22

Table II.VI (cont'd)
Effects of employee ownership on CEO incentives

Panel B: Two-step bootstrapping procedure, firm fixed effect, and simultaneous equation

	Ln(1+c_Delta)			*Ln(1+Delta)*			*Ln(1+c_Vega)*			*Ln(1+Vega)*		
	Two-step bootstrap	FE	SUR	Two-step bootstrap	FE	SUR	Two-step bootstrap	FE	SUR	Two-step bootstrap	FE	SUR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Employee ownership	-8.04	-4.22**	-3.22***	-8.39	-2.56*	-5.12***	-7.02	-4.31**	-4.69***	-8.84	-5.22**	-4.96***
	[-13.98, -1.70]	(-2.5)	(-4.8)	[-15.08, -3.08]	(-1.9)	(-8.4)	[-12.30, -1.37]	(-2.4)	(-7.5)	[-15.58, -1.42]	(-2.1)	(-6.5)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	N	Y	Y	N	Y	Y	N	Y	Y	N	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	Y	N	N	Y	N	N	Y	N	N	Y	N
N	100 replications	6226	6047	100 replications	6226	6047	100 replications	6226	6047	100 replications	6226	6047
R-squared	-	0.12	0.24	-	0.25	0.42	-	0.10	0.22	-	0.12	0.22

Table II.VII: Effects of labor strength and importance of employee retention, free-riding problem, mutual monitoring, and capital intensity

This table re-estimates the regressions related to CEO stock option and CEO Delta and Vega for subsamples of firms classified according to industry unionization and importance of employee retention, tendency of free-riding problems, broad versus targeted plans, and capital intensity. All partition variables are measured a priori. All regressions include the same control variables as those used in Tables IV-VI, but the coefficients on these variables are not tabulated. The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. Delta and Vega are CEO pay-performance sensitivity and risk-taking incentives. The detailed definitions of variables are described in Appendix B. Dollar values are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution. In Panel A, the firm facing high unionization rate or high importance of employee retention is classified as *High* and low unionization rate or low importance of employee retention is classified as *Low* if variables measuring the unionization rate or the importance of employee retention are above or below the sample median respectively. In Panel B, the firm is classified as high tendency of free-riding problems (*High*) if the number of employees is below the sample median or the growth options per employee are above the medians, and low tendency firms (*Low*) otherwise. In Panel C, ESOP firms that sponsor only single DC plan are kept. The firm is classified as targeted plan (*Targeted*) if the number of active employees covered by the DC plan over the total number of employees is above the sample median and as broad plan (*Broad*) if the number of active employees covered by the DC plan over the total number of employees is below the sample median. In Panel D, the firm is classified as a capital-intensive firm (*Intensive*) if a three-year average of depreciations or capital expenditure over the labor expenses are above the sample median, or as a labor intensive firm (*Non-intensive*) if a three-year average of depreciations or capital expenditure over the labor expenses are below the medians.

Dependent variables	*Ln(1+Option)*		*Option%*		*Ln(1+c_Delta)*		*Ln(1+Delta)*		*Ln(1+c_Vega)*		*Ln(1+Vega)*	
	OLS		Tobit		OLS		OLS		OLS		OLS	
	(1)		(2)		(3)		(4)		(5)		(6)	
Panel A: Partitioning sample according to labor strength and the importance of employee retention												
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Panel A1: Partitioning sample according to industry unionization rate												
Employee ownership	-3.53	-6.67**	-0.68	-0.92**	-2.72	-1.60*	-2.48	-2.82**	-2.30	-2.98**	-1.98	-3.26**
	(-0.9)	(-2.5)	(-1.4)	(-2.5)	(-1.3)	(-1.8)	(-1.6)	(-2.5)	(-1.3)	(-2.6)	(-0.8)	(-2.0)
N	3098	3159	3098	3159	3098	3159	3098	3159	3098	3159	3098	3159
Panel A2: Partitioning industry employee voluntary turnover rate (2-digit SIC)												
Employee ownership	-9.74	-19.52***	-1.11	-2.48***	-6.71	-5.22**	-5.35	-4.00*	-4.89	-8.88***	-3.55	-12.33***
	(-1.1)	(-3.3)	(-0.9)	(-3.4)	(-1.4)	(-2.1)	(-1.4)	(-1.9)	(-1.2)	(-3.3)	(-0.6)	(-3.7)
N	1047	1177	1047	1177	1047	1177	1047	1177	1047	1177	1047	1177
Panel A3: Partitioning sample according to Herfindahl index (3-digit SIC)												
Employee ownership	-4.54	-7.58**	-0.65	-1.07***	-0.41	-4.20***	-2.13*	-2.80**	-2.22*	-3.36**	-2.38	-3.29*
	(-1.4)	(-2.4)	(-1.6)	(-2.8)	(-0.4)	(-3.1)	(-1.7)	(-2.4)	(-1.7)	(-2.4)	(-1.3)	(-1.7)
N	3063	3163	3063	3163	3063	3163	3063	3163	3063	3163	3063	3163
Panel B: Partitioning sample according to the tendency of free-rider problem												
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Panel B1: Partitioning sample according to the number of employees												
Employee ownership	-3.33	-17.72***	-0.39	-3.30***	-0.82	-7.81***	-1.88**	-3.74**	-1.55	-7.81***	-1.32	-9.49***
	(-1.5)	(-4.3)	(-1.5)	(-4.3)	(-1.0)	(-3.4)	(-2.0)	(-2.3)	(-1.5)	(-4.9)	(-0.9)	(-4.5)
N	3092	3093	3092	3093	3092	3093	3092	3093	3092	3093	3092	3093
Panel B2: Partitioning sample according to growth options per employee												
Employee ownership	-3.43	-15.12***	-0.51*	-1.98***	-0.97	-5.74***	-2.43***	-1.29	-1.56	-7.19***	-1.67	-7.95***
	(-1.5)	(-3.5)	(-1.7)	(-3.9)	(-1.2)	(-3.9)	(-2.8)	(-0.9)	(-1.6)	(-3.5)	(-1.3)	(-3.2)
N	3092	3092	3092	3092	3092	3092	3092	3092	3092	3092	3092	3092
Panel C: Partitioning sample according to the targeted and broad plans (single ESOP plan only)												
	Targeted	Broad	Targeted	Broad	Targeted	Broad	Targeted	Broad	Targeted	Broad	Targeted	Broad
Employee ownership	0.11	-8.24*	-0.27	-1.17**	2.27*	-5.20***	2.22	-3.15*	0.30	-4.29**	0.85	-3.57
	(0.0)	(-1.9)	(-0.4)	(-2.3)	(1.7)	(-2.9)	(1.3)	(-1.9)	(0.1)	(-2.4)	(0.3)	(-1.4)
N	938	938	938	938	938	938	938	938	938	938	938	938
Panel D: Partitioning sample according to the capital intensity												
	Non-intensive	Intensive	Non-intensive	Intensive	Non-intensive	Intensive	Non-intensive	Intensive	Non-intensive	Intensive	Non-intensive	Intensive
Panel D1: Partitioning sample according to labor expenses over a three-year average of depreciations												
Employee ownership	-4.23	-9.75***	-0.70*	-1.34***	-1.73	-3.33***	-0.93	-3.69***	-1.71	-5.01***	-1.32	-5.95***
	(-1.5)	(-3.4)	(-1.9)	(-3.4)	(-1.5)	(-3.8)	(-0.9)	(-4.3)	(-1.4)	(-4.2)	(-0.8)	(-3.7)
N	3043	3043	3043	3043	3043	3043	3043	3043	3043	3043	3043	3043
Panel D2: Partitioning sample according to labor expenses over a three-year average of capital expenditures												
Employee ownership	-2.93	-10.97***	-0.55	-1.45***	-1.16	-3.88***	-1.12	-3.64***	-1.15	-5.61***	-0.80	-6.41***
	(-1.1)	(-3.6)	(-1.6)	(-3.5)	(-1.1)	(-4.1)	(-1.1)	(-4.0)	(-1.0)	(-4.5)	(-0.5)	(-3.8)
N	2971	2971	2971	2971	2971	2971	2971	2971	2971	2971	2971	2971

Table II.VIII: Reestimation of regressions by controlling for additional variables

This table re-estimates the regressions related to CEO stock option and CEO Delta and Vega by including additional control variables. All regressions include the same control variables as those used in Tables IV-VI except for Panel E, where the lagged stock return is excluded, but the coefficients on these variables are not tabulated. The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. Delta and Vega are CEO pay-performance sensitivity and risk-taking incentives. The detailed definitions of variables are described in Appendix B. Dollar values are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	*Ln(1+Option)*	*Option%*	*Ln(1+c_Delta)*	*Ln(1+Delta)*	*Ln(1+c_Vega)*	*Ln(1+Vega)*
	OLS	Tobit	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Controlling for G-index						
Employee ownership	-5.35**	-0.71**	-2.02**	-2.49***	-2.72**	-2.58*
	(-2.1)	(-2.4)	(-2.4)	(-3.0)	(-2.4)	(-1.7)
G-index	0.06**	0.01**	0.03**	-0.02	0.03*	0.04**
	(2.2)	(2.3)	(2.3)	(-1.4)	(2.0)	(2.0)
N	3978	3978	3978	3978	3978	3978
Panel B: Controlling for board characteristics						
Employee ownership	-10.32**	-1.28***	-3.76***	-2.12*	-4.94***	-5.46**
	(-2.5)	(-2.7)	(-2.8)	(-1.7)	(-2.7)	(-2.3)
Board size	0.06	0.00	0.00	-0.04*	0.02	0.03
	(1.3)	(0.1)	(0.1)	(-1.9)	(1.1)	(0.9)
Independent directors (%)	1.93***	0.22***	1.30***	-0.50**	0.99***	1.58***
	(3.9)	(3.7)	(5.4)	(-2.2)	(4.4)	(5.3)
N	3067	3067	3067	3067	3067	3067
Panel C: Controlling for CEO ownership						
Employee ownership	-6.69***	-0.95***	-2.39***	-2.04***	-3.35***	-3.47**
	(-2.8)	(-3.1)	(-2.9)	(-3.0)	(-3.2)	(-2.5)
CEO ownership	-10.57***	-1.49***	-4.89***	9.33***	-4.22***	-6.11***
	(-10.8)	(-9.0)	(-10.1)	(18.1)	(-9.9)	(-11.1)
N	5463	5463	5463	5463	5463	5463
Panel D: Controlling for institutional ownership						
Employee ownership	-5.94***	-0.87***	-2.08***	-2.85***	-2.85***	-2.99**
	(-2.8)	(-3.1)	(-2.8)	(-3.7)	(-3.1)	(-2.4)
Institutional ownership	3.15***	0.43***	1.62***	-0.32**	1.38***	1.77***
	(10.8)	(11.2)	(11.1)	(-2.1)	(10.4)	(10.5)
N	6221	6221	6221	6221	6221	6221
Panel E: Controlling for management quality						
Employee ownership	-5.66**	-0.80***	-2.02**	-2.93***	-2.81***	-2.87**
	(-2.4)	(-2.7)	(-2.5)	(-3.7)	(-2.8)	(-2.1)
CAR (-3 year,-1 year)	0.09*	0.01**	0.05**	0.11***	0.02	-0.03
	(1.8)	(2.1)	(2.0)	(4.7)	(0.9)	(-1.0)
N	5829	5829	5829	5829	5829	5829
Panel F: Controlling for large employee ownership (>5%)						
Employee ownership	-9.27***	-1.40***	-3.42***	-4.39***	-4.20***	-4.57**
	(-2.8)	(-3.0)	(-2.7)	(-3.8)	(-3.0)	(-2.5)
5% ownership indicator	0.36	0.06	0.13	0.26*	0.14	0.16
	(0.9)	(1.1)	(0.8)	(1.9)	(0.7)	(0.7)
N	6226	6226	6226	6226	6226	6226

Table II.IX: Robustness checks

This table reestimates the regressions by using different sample selection criteria and model specifications. All regressions include the same control variables as those used in Tables IV-VI, but the coefficients on these variables are not tabulated. The sample consists of firms with a defined contribution (DC) pension plan covered in both the ExecuComp and the IRS Form 5500 between 1992 and 2007. The detailed variables are described in Appendix B. Dollar values are converted into 2000 constant dollars using the GDP deflator. All variables are winsorized at the 0.5% level at both tails of the distribution. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	*Ln(1+Option)*	*Option%*	*Ln(1+c_Delta)*	*Ln(1+Delta)*	*Ln(1+c_Vega)*	*Ln(1+Vega)*
	OLS	Tobit	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Excluding firm-year with CEO turnover						
Employee ownership	-7.12***	-1.07***	-2.78***	-2.85***	-3.46***	-3.79***
	(-3.2)	(-3.6)	(-3.4)	(-3.6)	(-3.7)	(-2.9)
N	5907	5907	5907	5907	5907	5907
Panel B: Removing the effect of SFAS 123R by limiting the sample period to 1992-2005						
Employee ownership	-6.45***	-0.98***	-2.38***	-2.54***	-3.07***	-3.12**
	(-3.0)	(-3.3)	(-3.0)	(-3.2)	(-3.3)	(-2.5)
N	5566	5566	5566	5566	5566	5566
Panel C: Excluding incomplete IRS Form 5500 data in years of 1999, 2001 and 2003						
Employee ownership	-6.42***	-0.93***	-2.39***	-2.63***	-3.01***	-3.33**
	(-2.8)	(-3.1)	(-2.8)	(-3.2)	(-3.1)	(-2.5)
N	5047	5047	5047	5047	5047	5047
Panel D: Excluding zero ESOP						
Employee ownership	-4.44**	-0.74***	-1.60*	-1.53*	-2.57***	-2.57*
	(-2.1)	(-2.7)	(-1.9)	(-1.8)	(-2.6)	(-2.0)
N	2696	2696	2696	2696	2696	2696
Panel E: Including an indicator to denote an ESOP sponsor						
ESOP indicator	-0.51***	-0.06***	-0.26***	-0.05	-0.21***	-0.24***
	(-3.4)	(-3.3)	(-3.6)	(-0.6)	(-3.0)	(-2.7)
Employee ownership	-4.21*	-0.67**	-1.19	-2.50***	-2.18**	-2.27*
	(-1.8)	(-2.2)	(-1.5)	(-3.0)	(-2.2)	(-1.7)
N	6226	6226	6226	6226	6226	6226
Panel F: Using only ESOP firms with an ESOP age older than three years						
Employee ownership	-5.11**	-0.74**	-1.78*	-1.10	-3.08***	-3.07**
	(-2.2)	(-2.4)	(-1.9)	(-1.1)	(-2.9)	(-2.1)
N	2130	2130	2130	2130	2130	2130

Chapter III

Employee Stock Options and Corporate Innovation

with Xin Chang, Kangkang Fu, and Angie Low

Most great ideas for enhancing corporate growth and profits aren't discovered in the lab late at night, or in the isolation of the executive suite. They come from the people who daily fight the company's battles, who serve the customers, explore new markets and fend off the competition. In other words, the employees.

The Wall Street Journal (*August 23, 2010*) – *"Who Has Innovative Ideas? Employees."*

I. Introduction

Innovation has become an increasingly important corporate strategy that boosts the long-term growth and enhances the competitiveness of a firm. On the one hand, by fostering the innovative streak, *Google*, one of the top two most innovative companies according to *Business Week*'s annual survey in 2010, has achieved phenomenal success in the last thirteen years, growing from a small firm to a company with approximately $200 billion market cap today. One of the most important factors behind *Google*'s success is that it aptly understands and adopts the credo that creativity is nurtured from individual employees. *Google* describes its innovation policy as "*Our commitment to innovation depends on everyone being comfortable sharing ideas and opinions. Every employee is a hands-on contributor, and everyone wears several hats. Because we believe that each Googler is an equally important part of our success…*"

On the other hand, according to the *New York Times*, *Google* employees and former employees are holding exercisable (vested) options that are worth roughly $2.1 billion by the end of November, 2007. In addition, unvested options and the stock that employees hold amount to $4.1 billion (The *New York Times*, November 12, 2007). Is this intensive use of employee stock options simply a generous means, on part of the employer, of sharing profits with employees or a key driving force behind *Google*'s business success? In this paper, we examine this issue from the perspective of the incentive effect created by stock options on employees' innovativeness.[73]

[73] Politicians and corporate executives generally support the positive effect of employee stock options on corporate innovations. For instance, in a news release, *Dreier and Eshoo Reintroduce Stock Options Legislation* (February 17, 2005), the Congressman David Dreier, also the Chairman of the U.S. House Rules Committee stated that "The U.S. House of Representatives overwhelmingly voted for legislation that would have ensured the continued ability of innovative companies to offer stock options to rank-and-file employees…Giving investors the ability to understand how stock options impact the value of their shares is critical. And equally important is preserving the ability of companies to use this innovative tool to attract talented employees." In addition, Cisco Systems, Inc., the world leader in the communications and information technology, stated in its high tech policy guide that "Employee stock options fuel innovation and the entrepreneurial spirit."

Innovation is about people. Innovation arises when active, motivated and engaged people generate ideas, consider and evaluate ideas, make prioritization decisions, prototype or pilot, and convert ideas into new products, services or business models. Recent literature in corporate finance examines the mechanism that motivates people to be more innovative in the corporate innovative activities. The theoretical work of Manso (2010) and the experimental study of Ederer and Manso (2011) show that incentives that do not penalize failure and promote long-term success lead to more innovative business strategies. Empirical studies discussing the mechanisms that foster innovations are generally consistent with these arguments. For instance, Chemmanur and Tian (2011) find that anti-takeover provisions increase a firm's innovation productivity by insulating managers from short-term pressures from the corporate control market, thus allowing managers to focus on long-term firm value creations. Aghion, Van Reenen, and Zingales (2009) argue that higher institutional ownership lowers the likelihood of CEOs being fired and that the alleviation of CEOs' career concern is associated with higher innovation efficiency. Tian and Wang (2011) document that IPO firms backed by more failure-tolerant venture capital investors are associated with better innovative outcomes. Francis, Hasen, and Sharma (2011) investigate the role of executives' incentive pay in fostering innovation and find that the convexity of pay-offs created by stock options incentivizes managers to assume more risk, resulting in a positive impact on the innovation productivity.

Although these studies enhance our understandings of the mechanisms that motivate managers to be more innovative, the role of non-executive employees and their compensation schemes in affecting corporate innovations receives little attention. This lack of evidence is surprising since the companies, beginning in the late 1980s, have changed the innovation process by replacing the centralized corporate research and development (R&D) laboratories with divisional laboratories, where employees emerge as the most important innovators in a firm (Lerner and Wulf (2007)).[74]

In this paper, we focus on the role of employees as the key generator of innovative ideas and examine how employee stock options influence the innovation efficiency in a firm. We hypothesize

[74] Anecdotal evidence in Harden, Kruse, and Blasi (2008) is consistent with this view that employees are the most important innovation generators in a firm: "Whirlpool credits their successful product innovations not to a couple of departments, such as engineering or marketing. Instead, they contribute their success to the 61,000 employees who have the ability to contribute and develop product, service, or processes innovations (pp. 4)."

that employee stock options, as an important group incentive scheme, improve employees' failure-bearing ability and encourage their risk-taking behaviors, and thus enhance the efficiency of corporate innovation.

Holmstrom (1989) points out that corporate innovation, unlike conventional corporate investments, involves a high probability of failure due to its dependence on various unpredictable contingent conditions. A standard pay-for-performance system created by the incentive compensation is not able to provide sufficient failure tolerance for the risk associated with the innovative activities. The award of stock options with a long vesting schedule and expiration period to employees solves this problem for three reasons. First, employee stock options encourage employees' risk-taking behaviors. Abundant literature in relation to the executive compensation documents that executive stock options encourage managers to assume more risk as managers' wealth is positively related to the stock return volatility (Smith and Stulz (1985), Guay (1999)). In the same vein, we expect that the convexity of wealth-performance relation created by employee stock options incentivizes employees to take more risk, and thus has a beneficial influence on the innovation productivity. Second, employee stock options create an effective failure-bearing mechanism. Oyer (2004) argues that the asymmetric payoff structure of the stock option rewards employees when the firm's stock performance is favorable but protects them in the event of adverse stock prices. Stock options therefore create a strong employee retention mechanism especially when the correlation between employees' outside opportunities and their firms' performance is high. Consequently, employee stock options improve employees' willingness and ability to tolerate failures in risky innovative activities. Finally, employee stock options usually have a long vesting period of more than three years and a long average time to expire (e.g., Core and Guay (2001), Murphy (2003), Graham, Lang, and Shackelford (2004)). The deferral feature of employee stock options helps overcome the problem of employee myopia and ensures a long-term commitment, diffusing the threat of departure of key employees and encouraging employees' firm-specific human capital investment (Rajan and Zingales (2000)).[75] Taken together, these arguments and empirical evidence suggest that employee stock

[75] Lerner and Wulf (2007) and Francis, Hasen, and Sharma (2011) examine the relationship between executive incentive contracts and innovation and find that only compensation components tied to long-term incentives

options can serve as an effective tool encouraging employees to participate in risky innovative activities, which yield high innovation productivity.

Using 1,672 firms (7,866 firm-years) in industries that must have at least one patent in any year from the National Bureau of Economic Research (NBER) Patent and Citation Database between 1993 and 2003, we examine whether employee stock options affect the number of patents and citations of patents, both of which, according to Griliches (1990) and Aghion, Van Reenen, and Zingales (2009), reflect the most important measure of innovative output and the productivity of R&D.[76] We rely on the ExecuComp to estimate the Black-Scholes value of non-executive stock options. Following Core and Guay (2001) and Bergman and Jenter (2007), we define non-executive employees as all employees except the top five executives in a firm. Further, we examine how employee interest alignment incentive (delta) and risk-taking incentive (vega) created by non-executive stock options affect the innovative outcomes. To this end, we use the IRRC Dilution Database to define individual employee's delta and vega for a subsample of 1,147 firms (3,614 firm-years) between 1998 and 2003.[77]

We find the results to be consistent with our hypothesis that non-executive stock options have a positive effect on the productivity of a firm's innovative activities. Specifically, the evidence indicates that the value of non-executive stock options per employee is positively related to the number of patents, the total number of citations of patents and the average number of citations per patent after we control for the R&D expenditures, CEO compensation incentives, and other determinants of innovation output documented in previous literature. Economically, holding other explanatory variables at their mean levels, a one standard deviation increase in the value of non-

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have a positive impact on corporate innovations. Moreover, in addition to the employee retention and encouragement of human capital investment, Rajan and Zingales (2000) point out that employee stock options are also an important profit-sharing mechanism which prevents the agency conflict by granting employees voting power until the options are exercised.

[76] The sample period of the NBER Patent and Citation Database is from 1976 to 2006. Since we date patent according to the application year, we take a 3-year "safety lag" to address the truncation concern following Hall, Jaffe, and Trajtenberg (2001). Hence we stop the sample in 2003. See Section III for details.

[77] The IRRC collects information on year-end outstanding grants, weighted average exercise price of options outstanding, and weighted average contractual life of outstanding options, allowing us to track the characteristics of a firm's entire option portfolio. We calculate individual employees' interest alignment incentive and risk-taking incentive as the sensitivity of employee wealth to an increase in the stock price in a firm (i.e., per employee delta of the firm's outstanding non-executive option portfolio) and the sensitivity of employee wealth to an increase in the stock return volatility in a firm (i.e., per employee vega of the firm's outstanding non-executive option portfolio), respectively.

executive stock options per employee ($21,469.42) translates into a 14.8% increase in the average number of raw patents, a 23.7% and 18.1% increase in the counts of total citations adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time and technology class fixed effect, respectively and a 10.3% and 10.2% increase in the counts of average citation per patent calculated using the above-mentioned two methods, respectively.[78] These results suggest that as a risk-taking incentive and failure-bearing mechanism, non-executive stock options play a crucial role in fostering innovation output.

One concern with regard to our findings is that employee stock options may be endogenously determined. Omitted variables that are also correlated with innovation productivity may drive the observed effect of employee stock options. To address this concern, we perform two-stage least squares (2SLS) regressions by using two instrument variables, namely employee stock options in firms of other industries but in geographic proximity and the marginal tax rate of a firm. We find little evidence that the positive relation between non-executive stock options and innovation output measures is due to the endogeneity of non-executive stock options.

We perform a number of empirical tests to rule out alternative arguments that possibly explain our findings. For instance, a firm's governance environment and ownership structure are related to its employee stock option policy and are also associated with the innovative outcomes. Hence we control for multiple internal and external governance measures in the regressions. We also consider a variable, the cumulative abnormal return during the past three years of a firm's stock, as a proxy for management quality. Previous studies document that high quality managers, in an effort to retain employees, are more likely to grant stock options to the latter. In the meantime, these managers are also associated with more patents and citations. Finally, we include a financial constraint measure in the regressions to ensure that our findings are not driven by the possibility that financially constrained firms with increasing large expenditures on innovative activities are more likely to grant stock options to employees so as to save cash. We test these alternative explanations by including additional controls and find little support for them.

[78] Due to the finite length of the sample, the citations suffer from a truncation bias. Hence our citation counts are adjusted based on the quasi-structural approach and the fixed effect approach outlined in Hall, Jaffe, and Trajtenberg (2001).

We also investigate the effects on the positive relation between non-executive stock options and the innovation productivity of different firm and industry characteristics, terms of these stock options, and employee stock option plan feature. Specifically, we partition the sample according to the importance of labor retention and labor strength, the tendency of free-riding among employees, the average expiration period of stock options in a firm, and the target of the employee stock options. We find that our results are more pronounced in subsamples of firms in industries with lower employee voluntary turnover, firms with better employee treatment, and firms in more unionized industries. Moreover, our results are also more evident in subsamples of firms with a smaller number of employees and higher growth options for each employee. Finally, we observe that our results are mainly from firms whose stock options have a longer average expiration period and firms that grant options to employees on a broad-based basis rather than to selective employees.

Employee stock options increase the sensitivity of employees' wealth to both the stock price and the stock return volatility of their employers. To identify the channel through which employee stock options affect innovation productivity, we directly test the effects of delta and vega, induced by non-executive stock options, on the output of innovative activities. We include both the per employee delta and vega and the CEO delta and vega in the regressions. We find that non-executive vega per employee has a significant positive impact on innovative outcomes at less than the 1% level, while per employee delta has no significant effect. These results are consistent with Manso (2010) and support our hypothesis that non-executive stock options encourage employees' innovative activities by altering employees' risk aversion.

Our work is related to several recent studies that examine the role of senior management in promoting corporate innovation. For example, Francis, Hasan, and Sharma (2011) investigate the effect of CEO compensation incentives on innovation and find that long-term incentives, in the form of options and golden parachute that entitles CEOs to certain benefits in the event of employment termination, are positively related to patents and citations of the patents. Hirshleifer, Low, and Teoh (2011) examine the role of CEO psychological traits in corporate innovation and show that firms with overconfident CEOs obtain greater innovation success such as more patents and patent citations for given R&D expenditure. Aghion, Van Reenen, and Zingales (2009) present evidence that

institutional ownership mitigates CEOs' career concern of being fired in the face of profit downturns, thereby spurring innovation output.

Our paper is different from the above-mentioned papers for an important reason. While previous studies emphasize the role of executives in the innovation process, our work focuses on non-executive employees who are the most important innovators since 1980s. To our best knowledge, this is the first paper that investigates the role of non-executive stock options as a group incentive scheme in the setting of corporate innovation by a large scale analysis. In addition, unlike prior papers that focus on executive incentives, our paper compares the effects of pay-performance sensitivity and risk-taking incentives created by employee stock options on innovation efficiency and identifies a channel through which employee stock options affect innovation productivity.

Furthermore, our paper complements previous studies that examine the motives for firms to grant stock options to non-executive employees and emphasizes how granting non-executive stock options induces employees to be more innovative, hence shedding light on the positive role of employees, as an important stakeholder, in affecting firm value via corporate innovation.[79] Last but not least, our analysis also suggests a channel through which non-executive stock options affects the firm performance and hence complements the findings of Hochberg and Lindsey (2010), who show a positive relation between non-executive stock option and firm performance.

II. Related Literature

A. Risk-taking Incentives and Employee Failure-Bearing in Corporate Innovation

The theoretical work of Manso (2010) suggests that incentives that promote long-term success but do not penalize failure lead to more innovative business strategies. The experimental findings of Ederer and Manso (2011) also support this idea. Empirical research discussing the mechanisms to spur innovations is basically along this theme.

[79] Hall (1998) surveys the papers on how the financial markets value the knowledge assets of publicly traded firms and finds strong link between patents and the firm value. He also claims that the information on firm value, as conveyed by patents is beyond that conveyed by the R&D measure. Hirshleifer, Hsu, and Li (2011) also maintain that firms with higher innovative efficiency tend to be more profitable and have better operating performance.

For instance, Chemmanur and Tian (2011) find a positive association between anti-takeover provisions and a firm's innovation productivity and argue that the protection of managers against short-term pressures from the corporate control market encourages them to focus on long-term value-enhancing innovative activities. Francis, Hasan, and Sharma (2011) show that golden parachute that ensures managers certain benefits in the event of employment termination is positively related to a firm's patents and citations. Aghion, Van Reenen, and Zingales (2009) argue that higher institutional ownership ensures CEOs a secure job and hence helps overcome CEOs' myopia and promotes innovation productivity. Tian and Wang (2011) find that venture capital-financed IPO firms with a longer average investment duration in the past failed projects exhibit higher innovation productivity. In addition, several recent papers show that legal systems that are lenient to managerial or employee failures encourage innovation productivity. For instance, Fan and White (2003) and Armour and Cumming (2008) show that 'forgiving' personal bankruptcy laws encourage entrepreneurship and innovation. Acharya, Baghai, and Subramanian (2009, 2010) find that stringent labor laws and wrongful discharge laws that do not punish employees for short-run failures foster innovations. Furthermore, Francis, Hasen, and Sharma (2011) investigate the role of incentive pay in fostering innovation and find that CEOs' new options grants and previously granted unvested and vested options have a positive relation with innovation outputs. Moreover, they also find that a higher sensitivity of CEO wealth to the stock price volatility results in better innovative outcomes.

Finally, He and Wang (2009) suggest that innovative knowledge assets lead to greater information asymmetry among managers and firm owners. Consequently, unlike conventional shareholder monitoring that limits managerial discretion in making resource deployment decisions, incentive compensation is more innovative efficient. In a similar fashion, Lerner and Wulf (2007) suggest that the incentive pay as a risk-sharing mechanism is efficient in firms that rely heavily on inputs from intellectual capital since stock prices of these firms correspond more closely to factors within managers' control. Moreover, the pay linked to firm performance mitigates managers' incentives to fund their 'pet projects'. On the contrary, Holmstrom (1989) maintains that since innovation is risky, unpredictable, long-term and labor-intensive, the conventional incentive pay does not provide sufficient failure tolerance for the innovative activities and makes the risk-averse agents pass up risky

projects. Hirshleifer and Suh (1992) argue that risk-averse managers, who already have a large amount of firm-specific human capital tied to the firm, prefer less risky projects when they receive extensive equity-based compensation.

B. Economic Functions of Non-executive Stock Option

Stock options, as an incentive-based compensation, are extended to non-executive employees on a large scale basis. The value of stocks issued to employees through compensation plans exceeds the total amount raised through seasoned equity offerings (SEOs) between 1985 and 2009 (McKeon (2011)). Figure 1 presents the aggregate Black-Scholes value of stock options granted to non-executive employees each year by S&P 1500 companies in industries that have at least one patent in any year from the NBER Patent and Citation Database between 1993 and 2003. The aggregate value of non-executive stock options increased over the period 1993 to 2003 and amounted to approximately $77 billion by the end of 2003. Figure 1 also plots the time trend of the annual mean and median values of non-executive stock options per employee. The mean and median values of non-executive stock options per employee also increased over the period. However, the bigger difference in the mean and median values implies a large variation in the stock option grant policies across firms.

Abundant literature documents the motives for firms to grant stock options to non-executive employees. For instance, employee stock options can be used by cash-constrained firms as a substitute for cash wages (Core and Guay (2001), Yermack (1995)).[80] Employee stock options are tax deductible and hence are able to generate substantial non-debt tax shields (Graham, Lang, and Shackelford (2004)).[81] The theoretical work of Inderst and Muller (2004) shows that, in bad state, non-executive stock options minimize firms' expected future wage payments, thereby reducing the adverse impact of employees' rent extraction by requiring high fixed wage on firm owners' inefficient

[80] Babenko, Lemmon, and Tserlukevich (2011) suggest that cash flows generated by the exercise of employee stock options alleviate firms' financing constraints and increase investment precisely when the demand for capital is high.

[81] Babenko and Tserlukevich (2009) find that the exercise of employee stock option creates direct tax benefits because employees are more inclined to exercise stock options when corporate taxable income is high, shifting corporate tax deductions to years of high tax rates.

exit. Firms also use non-executive options to sort certain types of employees. By assuming that employees have heterogeneous beliefs, Oyer and Schaefer (2005) posit that employee stock options attract optimistic and productive employee who value firm's stock options at more than their market price. Bergman and Jenter (2007) further take into account employees' ability to purchase stocks in the financial market and show that employee sentiment drives the granting of stock options by firms, to non-executive employees.

Furthermore, although some studies argue that equity-based compensation provides little incentives to employees due to the potential free-riding behaviors among employees, several papers present evidence that substantial benefits arise if employee equity-based compensation serves as a group-based incentive mechanism (e.g., FitzRoy and Kraft (1987), Blasi, Conte, and Kruse (1996)). For instance, Hochberg and Lindsey (2010) find that the pay-for-performance system created by employee stock options reinforces the mutual monitoring and cooperation among rank-and-file employees, resulting in better firm operating performance.

More importantly, the convexity of wealth-performance relation created by stock options promotes employees' risk-taking incentives (Murphy (2003)). This feature receives extensive attention in the studies of executive compensation (e.g., Smith and Stulz (1985), Guay (1999), Coles, Daniel, and Naveen (2006)), Low (2009)). However, few studies examine this feature in the framework of non-executive employee compensation. Besides, the payoff of stock options is structured to rewards employees for 'good luck' but shields employees from 'bad luck'. Such an asymmetric payoff structure effectively enhances employees' failure tolerance especially when opportunities in the outside labor market are correlated with firm performance (Oyer (2004)). In addition, the long-term nature of employee stock options' vesting and expiration periods (Core and Guay (2001), Murphy (2003), Graham, Lang, and Shackelford (2004)) encourages employee long-term commitment and helps overcome employee myopia, benefiting employees in accumulating firm-specific human capital (Rajan and Zingales (2000)).

In this paper, we treat stock options granted to non-executive employees as a tool to enhance employees' failure-bearing ability and risk-taking incentives in firms' risky innovative activities, and test for an increase in the innovation productivity, i.e., patents and citations of patents, in response to

an increase in the value of non-executive stock options per employee. Furthermore, we also evaluate the role of individual employee's interest alignment and risk-taking incentives created by non-executive stock options in encouraging innovation productivity.

III. Data, Sample, and Empirical Design

A. Data and Sample

Our main sample consists of companies included in both the NBER Patent and Citation Database and the ExecuComp Database at any point between 1993 and 2003. The NBER Patent and Citation Database provides detailed information on all U.S. patents granted by the U.S. Patent and Trademark Office (USPTO) between 1976 and 2006. According to Hall, Jaffe, and Trajtenberg (2001), the average time lag between patent application date and grant date is two years. Patents applied in 2004 and 2005 may not be completely covered by the database as it only includes patents that are eventually granted. We hence follow Hall, Jaffe, and Trajtenberg (2001) and stop our sample period in 2003.[82]

Standard and Poor's ExecuComp is used to compute the value of non-executive stock options as well as CEO pay-performance sensitivity and risk-taking incentives. Financial data are from the Compustat Industrial Annual files and the data on stock prices and returns are retrieved from the Center for Research in Security Prices (CRSP) files. Furthermore, we follow Hirshleifer, Low, and Teoh (2011) and exclude firms in industries with no patents in any year and firms in financial and utility industries (SIC code: 6000-6999 and 4900-4999). Also excluded are firms with unidentified CEOs, negative CEO tenure, missing total compensation (ExecuComp data item *tdc1*), zero total compensation, and less than two top executives in a given year.[83] Finally, our sample consists of 1,672 firms (7,866 firm-years) between 1993 and 2003. Appendix A illustrates the construction of the sample. For a subsample of firms in our main sample, for which we can compute individual

[82] We use the patent application year rather than the grant year to merge the NBER Patent and Citation Database and the ExecuComp Database since Hall, Jaffe, and Trajtenberg (2001) suggest that the application date, compared to the grant date, is closer to the actual time of inventions.

[83] If there is more than one CEO for a firm in a year, we use the average across CEOs. We exclude firms with less than two top executives because Spalt (2011) argues that the adjustment for the grants of employee stock options in these firms demonstrated in Section III.B.1 is not sufficient to rule out incentive motives for executive option grants.

employees' delta and vega using the data from the IRRC Dilution Database, we identify 1,147 firms (3,614 firm-years) between 1998 and 2003.

Other data sources utilized in the paper include the IRRC Governance and Director Databases from which we obtain the corporate governance index and board characteristics respectively and CDA/Spectrum from which we obtain institutional holding data. We also extract industry employee voluntary turnover rates from the Bureau of Labor Statistics, employee treatment ratings from the KLD Research & Analytics, Inc.'s SOCRATES Database, and the industry unionization rate at the four-digit SIC level from the *Unionstats*.[84]

B. Variables

B.1. Measuring Innovation

Our first measure of innovation is the number of patents applied by a firm in a given year (*#patent*). The patent count, however, is not able to fully capture the underlying technological and economic heterogeneity of innovation. We therefore use citations of patents to measure the quality of innovation, following Hall, Jaffe, and Trajtenberg (2001, 2005).[85] The raw citation count suffers from the truncation bias due to its lifetime-dependency. For example, a patent's post-2006 citations are not counted if 2006 is not the end of its lifetime. This truncation bias is more severe for more recent patents since they have less time to accumulate citations than patents created in earlier years. We use two methods to deal with the truncation bias. First, we adjust each patent's raw citation count by multiplying the weighting index from Hall, Jaffe, and Trajtenberg (2001, 2005), also provided in the NBER Patent and Citation Database. The weighting index is derived from a quasi-structural model, where the shape of the citation-lag distribution is econometrically estimated. *Qcitations_t* and *Qcitations* are the sum and average of the adjusted citations across all patents applied during each firm-year using this weighting scheme. Second, we adjust the raw citation counts using the fixed-

[84] *Unionstats* is complied by Hirsch and Macpherson (2003). This database reports unionization rates for industries classified using three-digit Census Industry Classification (CIC) codes. We match CIC codes with the three- or four-digit SIC codes and manually assign unionization rates to firms in our sample.

[85] We do not exclude self-citations since Hall, Jaffe, and Trajtenberg (2005) find that self-citations are more valuable than external citations. They argue that self-citations, which come from subsequent patents, represent strong competitive advantage, less need of technology acquisition, and lower risk of rapid entry.

effect approach. Specifically, we scale the raw citation counts by the average citation counts of all patents applied in the same year and technology class. The fixed-effect approach purges the data from any effect due to truncation and the different propensity of different year and technology class to cite without making any additional assumptions. However, this approach cannot identify the real part of the propensity, which is related to true knowledge and value generation, and remove it as well.[86] *TTcitations_t* and *TTcitations* are the sum and average of the adjusted citations during each firm-year for the time and technology class fixed effects.

B.2. Measuring Non-executive Employee Stock Options

We follow Bergman and Jenter (2007) and Kumar, Page, and Spalt (2011) to calculate the value of non-executive stock options (*E-option*). Firms are not required to disclose the number of option grants to non-executive employees. However, this number can be extrapolated by using the "*pcttotop*" from the ExecuComp, which indicates the percentage of each grant to top five executives in all option grants by a firm (Desai (2003), Bergman and Jenter (2007), Kumar, Page, and Spalt (2011)). Specifically, we estimate the total number of option grants in a given firm-year for each option grant to executives. Following Bergman and Jenter (2007), we use the mean of these estimates as the total number of option grants and exclude observations in which the sample standard deviation of these estimates is greater than 10% of the mean. Subsequently, we calculate the option grants to non-executive employees by subtracting the option grants to top five executives from the total options granted by a firm (Core and Guay (2001), Bergman and Jenter (2007)). Finally, we compute the Black-Scholes value of non-executive stock options and scale it by the number of employees. As the exercise price and time to maturity of non-executive options are not reported in the ExecuComp, we set the exercise price as the midpoint of the year-high and year-low stock prices from the Compustat and assume that the maturity is 7.5 years, consistent with prior literature. Other Black-Scholes inputs such as annualized volatility of the past 36 months' monthly stock returns and dividend yield are calculated from the Compustat and CRSP Merged Database. Risk-free rates are retrieved from the Federal Reserve files. All option values are measured at the fiscal year end each year.

[86] See Hirshleifer, Low, and Teoh (2011) for a detailed discussion for the drawback of this approach.

To estimate employees' pay-performance sensitivity (delta) and risk-taking incentives (vega), we rely on the IRRC Dilution Database since the ExecuComp does not provide any information on the characteristics of a firm's entire portfolio of outstanding option grants, while the IRRC Dilution Database provides information on year-end outstanding grants, weighted average exercise price of options outstanding, weighted average life of outstanding options and other details of the S&P 1500 firms. Thus we are able to calculate the delta and vega for the entire option holdings in a firm.[87] By subtracting the delta and vega of the top five executives' option holdings from the delta and vega for all options outstanding, we estimate per employee delta (*E-delta*) and vega (*E-vega*) as the sensitivity of employee option value to a 1% increase in stock price divided by the number of employee and the sensitivity of employee option value to a 1% increase in the stock return volatility divided by the number of employees, respectively.

B.3. Other Explanatory Variables

To identify the effects of non-executive stock options on the innovation productivity, we control for an array of firm characteristics that have been documented as important determinants of innovation. Our first control variable is the input of innovation, R&D expenses scaled by assets (*R&D/Assets*). Furthermore, we control for firm size (*Ln*(*Assets*)), defined as the log of total assets and capital intensity (*Ln*(*PPE/#employees*)), define as the log of the net Property, Plant, and Equipment (PPE) scaled by the number of employees since Hall and Ziedonis (2001) argue that large firms and capital-intensive firms are associated with more patents and citations. Since financially constrained firms, investing heavily in innovative activities, are associated with a greater use of stock option to save cash (Core and Guay (2001)), we control for the cash holdings (*Cash/Assets*) of a firm.[88]

[87] For the purpose of consistency, we do not use the Black-Sholes inputs such as stock price, stock return volatility, dividend yield, and risk-free rates provided by the IRRC Dilution Database when calculating the incentive measures. Instead, we use the same Black-Sholes inputs as those used to calculate the value of non-executive stock options and executive incentive measures in the ExecuComp sample.

[88] Ittner, Lambert, and Larcker (2003), however, document that new economy companies with greater cash flows use employee options more extensively.

We also control for profitability (*ROA*), growth opportunities (*Sales growth* and *Tobin's q*) and leverage ratio (*Leverage*) to be consistent with prior literature on innovation. Additionally, Hirshleifer, Low, and Teoh (2011) find that high innovation productivity is associated with better stock performance. Hence, we include the compounded monthly stock returns over the fiscal year (*Stock return*). Since stock return volatility is positively related to innovation (Campbell et al. (2001)), we include the standard deviation of monthly stock return over the past fiscal year (*Stock volatility*) as an additional control. Core and Guay (2001) argue that non-executive stock options attract and retain high quality employees. As a consequence, it is possible that higher labor productivity leads to higher innovation productivity. We hence control for the labor quality (*Ln*(*Sales/#employees*)), which is defined as the log of sales per employee similar to Faleye, Mehrotra, and Morck (2006). Aghion et al. (2005) document an inverted-U relationship between product market competition and innovation. Accordingly, we include Herfindahl index at the three-digit SIC and its squared item as controls similar to Atanassov (2008) and Chemmanur and Tian (2011).

Francis, Hasan, and Sharma (2011) find that CEO pay-performance sensitivity (*CEO delta*) harms their innovative incentives, while CEO risk-taking incentive (*CEO vega*) encourages the innovation efficiency. We therefore control for the log of one plus CEO delta (*Ln*(*1+CEO delta*)) and the log of one plus CEO vega (*Ln*(*1+CEO vega*)) in the regressions.[89] Finally, we include the log of one plus CEO tenure (*Ln*(*1+CEO tenure*)) following Hirshleifer, Low, and Teoh (2011). All our control variables, except for stock return and stock volatility, are lagged by one period and all variables are winsorized at 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator.

C. Descriptive Statistics

Table I presents the sample distribution and the annual breakdown of median and mean patent and citation counts as well as the value of non-executive stock options per employee. As shown in column (2), the number of firms gradually increases over the sample period. Columns (3) and (4) report the number of firms with non-zero patents and with non-zero citations, respectively. Each year,

[89] These CEO incentive measures are constructed based on the method outlined in Core and Guay (2002).

approximately 50% of firms apply for patents and receive citations from their patents applied. This ratio is stable over the entire sample period.

Columns (5) and (6), and (7) and (8) show the annual median and mean raw patent and raw citation counts after the removal of firms with zero patents and citations, respectively, and columns (9) and (10) show the annual median and mean raw citations per patent for firms with non-zero citations. We observe that the counts of patents and citations are higher in early periods than that in recent years. The large difference between their median and mean values indicates that these measures are highly skewed. Hence we use the log form of these measures in the regression analysis. Columns (11) and (12) report the annual median and mean values of non-executive options per employee. There is an upward trend in the dollar value of non-executive options per employee from 1993 to 2000, followed by a slight fall in 2003, possibly due to the burst of the dotcom bubbles.

Columns (1) to (3) of Table II report the summary statistics for the whole sample. In columns (4) to (7) we bifurcate firms into two groups according to the median value of *E-option* each year. Panel A summarizes firm characteristics. We find that firms with higher values of *E-option*, compared with those with lower values, are smaller and more profitable, and have a smaller number of employees, greater growth opportunities measured by *Tobin's q* and *Sales* growth, higher capital intensity and leverage, and larger cash holdings. These firms also have higher labor productivity and stock volatility, and are more likely to invest in R&D activities.

Panel B reports statistics for non-executive employee *versus* CEO compensation terms of our sample. The mean and median values of *E-option* are $8,880 and $1,192, respectively. The number of option grants to non-executive employees is on average 5.43 times as large as the number of options granted to top five executives, suggesting that the incentive pays of non-executive employees as a whole are larger than those of executives. *E-delta* and *E-vega* for our subsample from the IRRC Dilution Database are on average $490.81 and $233.58, respectively. In contrast, the mean values of *CEO delta* and *CEO vega* are much larger and equal to $618,041 and $75,813, respectively. We also observe that firms in the high *E-option* subsample have higher *CEO delta* and *CEO vega* than firms in the low *E-option* subsample. A comparison of medians in both subsamples yields similar implications.

Panel C reports the summary statistics for our corporate innovation measures. On average, a firm applies for 13.87 patents each year and receives 2.70 citations for each of its patent. The total citations of patents adjusted based on the weighting scheme of Hall, Jaffe, and Trajtenberg (2001, 2005) (*Qcitations_t*) and on the year and technology class fixed effect method (*TTcitations_t*) are 515.56 and 40.14, respectively, and the corresponding mean values of average citations per patent (*Qcitations*) and (*TTcitations*) are 6.46 and 0.55 counts, respectively. Consistent with our hypothesis, firms in the high *E-option* subsample, compared with firms in low *E-option* subsample, are more innovative as measured by both patent and citation counts. Apple Computer, which has 2,159 (24.44) *Qcitations_t* (*Qcitations*) and 122.85 (1.10) *TTctiations_t* (*TTcitations*), is identified as one of the most innovative firms based on all our measures of innovations.

D. Empirical Methodology

We test the effects of non-executive stock options per employee on a firm's patenting activities and patent citations by using the following baseline model:

$$Ln(1 + Innovation) = c_1 + c_2 Ln(1 + E - option) + \boldsymbol{c_3 X} + \varepsilon \quad (1)$$

where *Innovation* refers to the number of patents, total citations of patents, and average citations per patent. The key explanatory variable is the log of one plus *E-option* (*Ln*(*1*+*E-option*)). *X* is a vector of firm characteristics, which has been described in detail in Section III.B.3. We also include industry and year dummies in the regressions to control for the industry and time fixed effect. We allow for clustering of firm observations to adjust the standard errors for serial correlation and also correct standard errors for heteroskedasticity.

The above empirical model is subject to two types of endogeneity biases. The first type is regarding the omitted variable. In particular, if one omitted variable affects both a firm's innovation productivity and its value of non-executive stock options per employee, the relation we observe is spurious. The other possible endogeneity issue is the reverse causality. For instance, it is possible that innovative firms are more likely to grant stock options to their employees rather than the other

way around. In this case, the coefficient estimates from the ordinary least squares (OLS) regressions are biased and inconsistent.

To address this issue, we use the instrument variable approach in the framework of a two-stage least squares (2SLS) regression. Our first instrument variable is *E-options in near firms in other industry*, which is constructed in the spirit of Hochberg and Lindsey (2010). Hochberg and Lindsey (2010) argue that local peers' option granting behavior affects an individual firm's option granting practices through local market competition or fixed-agent peers. The local same-industry firms should be excluded since the fundamentals of local firms within same industry correlate with each other. Hence we expect that such employee compensation practices of firms in geographic proximity but in other industries only affect a firm's innovation output through the employee stock options of the firm. We define *E-options in near firms in other industry* as the average value of *Ln*(*1+E-option*) for all companies in a firm's geographic region (defined by the two-digit ZIP code) but not in the firm's industry (defined by the three-digit SIC code). We expect this instrumental variable to be positively related to *Ln*(*1+E-option*). Our second instrument variable is the marginal tax rate of a firm. In contrast to the immediate tax deduction for cash compensation, stock options result in a future tax deduction from deferred compensation. Consequently, option compensation is more costly for firms with higher marginal tax rates (Core and Guay (2001), Hochberg and Lindsey (2010)). Therefore, we expect that the marginal tax rate affects innovative outcomes only through employee stock options of a firm and predict a negative relationship between marginal tax rate and option granting.[90] Our first stage model in the 2SLS regression is specified as:

$$Ln(1+E-option) = c_1 + \boldsymbol{c_2 L} + \boldsymbol{c_3 X} + \varepsilon \tag{2}$$

where L denotes instrumental variables and X is a vector of control from the innovation equation. In the second stage, we use the predicted value of non-executive stock options per employee ($\overline{Ln(1+E-option)}$) from equation (2) as the key explanatory variable in equation (3) and examine the effect of $\overline{Ln(1+E-option)}$ on the innovation productivity using the specification:

[90] Even if the marginal tax rate can affect the R&D expenditures since these expenses are tax deductible, we do not expect marginal tax rate to directly affect the innovation quality after R&D expenditures are included in the regressions.

$$Ln(1+Innovation) = c_1 + c_2\,\overline{Ln(1+E-option)} + \mathbf{c_3 X} + \varepsilon \quad (3)$$

IV. Empirical Findings

A. Main results

Table III reports the results of our baseline regressions in equation (1). In column (1), the dependent variable is the total number of patents. The coefficient of *Ln*(*1+E-option*) is positive and significant (*t*-statistic = 2.7). Economically, the coefficient of 0.057 suggests that a one standard deviation increase in *E-option* ($21469.42) represents an increase in the average number of patents by almost 14.8%, holding other variables at the mean level.[91]

In columns (2) and (3), the dependent variables are the total number citation counts, i.e., the log of one plus *Qcitations_t* and *TTcitations_t*, respectively. In columns (4) and (5), the dependent variables are the average number of citation counts per patent, i.e., the log of one plus *Qcitations* and *TTcitations*, respectively. We find that the coefficients of *Ln*(*1+E-option*) are positive and significant in all of these regressions at less than the 5% level. In terms of economic significance, a one standard deviation increase in *E-option* increases the average number of *Qcitations_t* by 23.7%, *TTcitations_t* by 18.1%, *Qcitations* by 10.3% *and TTcitations* by 10.2%.

The coefficients of other control variables are generally consistent with prior literature. We find that firms with larger R&D expenditures are associated with higher innovation productivity. Furthermore, *CEO delta* has a negative but *CEO vega* has a positive relation with the innovative outcomes. The coefficient of *Ln*(*1+CEO tenure*) is negative but insignificant. These findings are consistent with Francis, Hasan, and Sharma (2011). Similar to Hirshleifer, Low, and Teoh (2011), we also find that larger firms, more profitable firms, and firms with more growth opportunities and better stock performance have more patents and citations. However, we find an insignificant impact of cash

[91] For instance, to calculate the effects of non-executive stock options per employee on the number of patent counts at the mean level, we first multiply a one standard deviation of *E-option* ($21469.42) by the coefficients on *Ln*(*1+E-option*) (0.057), and by the mean number of patents plus one (13.87+1), and then divide by the mean value of *E-option* plus one (8880.01+1). (Note: $\frac{dLn(1+y)}{dln(1+x)} = \frac{(1+x)}{(1+y)}\frac{dy}{dx}$, $\frac{dy}{dx} = \frac{(1+y)}{(1+x)}\frac{dLn(1+y)}{dln(1+x)}$). A one standard deviation increase of E-option translates into a 2.05 increase in the number of patents. Given that the average number of patents that a firm applies for in a given year is 13.87, an increase of 2.05 patents represents an increase in the average number of patents by almost 14.7% ($\frac{2.05}{13.87}$).

holdings and capital intensity on innovative outcomes. The coefficients on labor productivity are negatively related to innovative outcomes since Hochberg and Lindsey (2010) argue that firms with higher labor productivity are often more physical-capital-intensive than human-capital-intensive.

Table IV reports the results from the 2SLS regressions using the instrumental approach. Column (1) presents the results from equation (2). We find that the coefficient on the first instrumental variable, *E-options in near firms in other industry*, is significantly and positively related to *Ln*(*1+E-option*) (*t*-statistic = 5.2), and the coefficient on the second instrumental variable, the marginal tax rate, is negative and significant (*t*-statistic = -2.2). In the second stage, the coefficient of $\overline{Ln(1+E-option)}$ is positive and significant at less than the 5% level for all measures of innovation productivity. The over-identification tests also support the validity of these instrumental variables. In untabulated tests, we estimate 2SLS models using the methods of limited information maximum likelihood (LIML) and generalized method of moments (GMM) and find that our results are not affected by these alternative model specifications.

Taken together, the results suggest that non-executive stock options not only tolerate employees' failures in the short-run but also reward employees' success in the long run, thereby forming an effective group incentive to induce employees to be innovative and strongly enhancing the innovation productivity in a firm.

B. Alternative Explanations

To the extent that our measure of per employee stock options is associated with alternative interpretations, we perform several additional tests to eliminate the alternative explanations for our findings. First, Landsman, Lang, and Yeh (2006) find that firms with better governance are more likely to grant stock options to lower level employees than to CEOs. In the meantime, Chemmanur and Tian (2011) find that firms shielded with a larger number of anti-takeover provisions are associated with better innovative outcomes by alleviating the short-term pressure on managers from the corporate control market. Moreover, Atanassov (2008) points out that an effective board structure may mitigate the negative impact of anti-takeover legislation on innovation efficiency. These results

suggest that non-executive stock options may capture the effect of the governance status such as the anti-takeover defense and the board monitoring in a firm. To investigate this possibility, we add a governance index (*G-index*) compiled by Gompers, Ishii, and Metrick (2003) and two additional controls of board size and board independence (percentage of independent directors) to regressions in Table III respectively and reestimate the regressions. The results reported in Panels A and B of Table V indicate that the coefficient of *Ln*(*1+E-option*) is still positive and significant.[92]

Second, although we control for CEO delta and vega in the regressions in Table III, non-executive stock options per employee may still be correlated with the incentives of other top executives. We hence calculate the delta and vega for the top five executives from the ExecuComp and include them in the regressions in Table III.[93] The results are presented in Panel C of Table V. We find that the coefficient of *Ln*(*1+E-option*) is still positive and significant. Furthermore, the delta of the top five executives has a negative relation and the vega of the top five executives has a positive relation with the innovation efficiency, in support of Manso (2010).

Third, prior literature documents that effective monitoring and incentive pay are substitutes (Eisenhardt (1988), Zhang (2011)). Consequently, a high institutional holding reduces the demand for the employee stock options as a tool to overcome the agency problem. Additionally, Graves (1988) finds that institutional investors negatively affect innovation in computer industry due to a short-term interest.[94] It is possible that firms with larger institutional holdings are less likely to grant options to employees and meanwhile are less interested in the long-term value enhancing innovative activities. To address this issue, we include institutional ownership as an additional control variable in the regressions and report the results in Panel D of Table V. We find that our results are not affected by

[92] The coefficient of *G-index* is positive but insignificant. This may reflect a mixed effect of *G-index* on innovation productivity since Atanassov (2008) finds that the firms create fewer patents and fewer citations of patents after the enactment of anti-takeover laws in certain states, highlighting the agency issue in the corporate innovative activities. The board size has a negative but insignificant coefficient, while board independence has a significant positive effect on the innovation productivity, which provides supportive evidence to Atanassov (2008), who highlights the agency issue in the corporate innovative activities.

[93] We drop CEO tenure in the regressions in Panel C but adding it back does not change our results.

[94] Sherman, Beldona, and Joshi (1998) further examine the roles of different institutional investors and show that pension funds with long-term investment horizon have positive effects on innovation, while mutual funds with short-term investment horizon have negative effects innovation.

the inclusion of institutional holdings.[95] Furthermore, Cai et al. (2010) find that undiversified managers owning a large stake in the firm tend to transfer the risk to employees by granting them more stock options. Francis and Smith (1995) argue that a concentrated ownership positively affects R&D expenditure since it reduces agency costs. To rule out this explanation, we include the ownership of the top five executives in the regressions in Table III and report the estimates from the regressions in Panel E of Table V. We find that controlling for the managerial ownership does not affect the significance of the coefficient of *Ln*(*1+E-option*).[96]

Fourth, Core and Guay (2001) argue that the importance of retaining employees is greatest in firms requiring higher-quality managers, thus resulting in a broad-based employee stock option plan. Meanwhile, Dey and Liu (2011) find that successful managers are associated with more patents and citations of patents. To see whether it is the management quality that drives our results, we follow Milbourn (2003) by including a proxy for management quality, *CAR*(*-3 year, -1 year*), defined as the cumulative abnormal returns (CAPM adjusted) during the past three years, in the regressions in Table III.[97] The results in Panel F of Table V suggest that the significance of the coefficient on *Ln*(*1+E-option*) is not affected by including the management quality measure.[98]

Finally, it is possible that innovative firms, which spend large expenditures on innovative activities, grant options to employees to save cash due to the financial constraint (Core and Guay (2001), Yermack (1995)). Although we include cash holdings in all of our regressions, to mitigate the

[95] However, the coefficient of institutional ownership is insignificant in most regressions. This may be due to the mixed effect of institutional ownership on innovative outcomes since in addition to the negative effect of institutional investor short-termism on innovations, Aghion, Van Reenen, and Zingales (2009) also find that institutional owners can encourage innovation efficiency by reducing managers' career concern on the risky projects.

[96] We find that the ownership of the top five executives has a negative effect on patents and citations of patents but not all are significant, which is not in support of Francis and Smith (1995) but is consistent with Ederer and Manso (2011) and Francis, Hasan, and Sharma (2011) who argue that the pay-for-performance created by the equity-based compensation harms managers' innovative incentives by increasing the volatility of their wealth.

[97] We exclude the past year stock return in the regressions since our management quality measure has already absorbed its effect.

[98] Alternatively, the measure of *CAR*(*-3 year, -1 year*) can also be used as a proxy for employee sentiment. Oyer and Schaefer (2005) and Bergman and Jenter (2007) argue that one of the major functions of non-executive stock options is to sort optimistic employees, who demand to be paid by options. To the extent that non-executive stock options help sort the most optimistic employees, who are the essential inputs to the innovation process, we also observe a positive effect of employee stock options on innovative outcomes. Similar to Bergman and Jenter (2007) who use the prior two-year stock return as a proxy for employee sentiment, our measure of *CAR*(*-3 year, -1 year*) also well captures the effect of employee sentiment as Benartzi (2001) suggests that employee sentiment improves with prior stock price performance.

concern on the financial constraint to drive our findings, we include Hadlock and Pierce's (2010) constraint index as an additional control in the regressions in Table III.[99] The results reported in Panel G of Table V suggest that the financial constraint arguments cannot explain our findings.[100]

C. Additional Sensitivity Tests

First, we consider a Negative Binomial model specification to estimate the regressions given the discrete nature of patent count and citation count. A Negative Binomial model is preferable to a Poisson model because the likelihood ratio test of no over-dispersion is rejected for all the models. Panel A of Table VI show that the results are robust to this alternative estimation method. In addition, to control for the time-invariant firm characteristics that are related to the innovation productivity, we introduce a mean scaling approach similar to Blundell, Grinffith, and Van Reenen (1999) and Aghion, Van Reene, and Zingales (2011).[101] Specifically, we calculate the pre-sample average of patents and citations given that we have a long pre-sample history on patenting behavior from 1976 to 1992. We then include these mean scaling factors in the Negative Binomial models in Panel A. The results are presented in Panel B of Table VI. We find that the coefficient of *Ln*(*1+E-option*) is positive and significant in all regressions except for the regression model with *TTcitations* as the dependent variable, in which the coefficients are positive but insignificant.

Second, we use an alternative measure for non-executive stock options per employee. Oyer and Schaefer (2005) argue that Core and Guay's (2001) measure of employees as all individual employees employed by the company except for the top executives reported in the ExecuComp is problematic since this definition wrongly includes a number of executives other than the top five executives. We use a calibration method similar to Oyer and Schaefer (2005) to construct a new measure of non-executive stock options. In particular, we assume that the high-level management other than the top

[99] We also include Kaplan and Zingales' (1997) constraint index and Whited and Wu's (2006) constraint index. The results are qualitatively the same.

[100] By construction, higher scores of Hadlock and Pierce's (2010) index indicate that firms are more financially constrained. We find that the Hadlock and Pierce's (2010) index has a negative effect on innovation output, suggesting that financially constrained firms have lower innovation efficiency, complementing the findings of Hirshleifer, Low, and Teoh (2011) that cash-constrained firms are less likely to expand the R&D expenditures.

[101] Aghion, Van Reene, and Zingales (2011) explain that the Monte Carlo evidence shows that the pre-sample mean scaling estimator performs well compared to alternative econometric estimators for dynamic panel data models with weakly endogenous variables.

five executives in a firm receives an average grant one-tenth as large as the average executive in the second through fifth compensation rank. But unlike Oyer and Schaefer (2005) who assume that the number of these high-level managers is ten percent of the total number of employees, we follow Kumar, Page and Spalt (2011) and assume that the number of high-level managers in a firm can be approximated by the square root of the total number of employees since they argue that a linear estimate is likely to overstate the number of executives in large firms. We include this new measure in the regressions in Table III and present the results in Panel C of Table VI. We find that our results do not change qualitatively by using this alternative measure of per employee stock options.

Third, our sample contains a large number of zero patent and citation counts. To examine whether our results are driven by a structure break stemming from zero patents (citations) to at least one patent (citation), we remove all firm-year observations with zero patents (citations) and reestimate the regressions. In addition, to mitigate the sample selection bias, we employ a long-tenure approach by keeping only firms that organize the non-executive stock option plan for more than five years. We present the results in Panels D and E of Table VI and find that our results remain similar.

Fourth, to the extent that diversified firms, compared with single-segment firms, can self-cite across the different lines of business, we exclude a firm's self-citations from the total citation counts and reestimate the regressions. Furthermore, non-executive stock options usually have a long vesting period and a long expiration period (Core and Guay (2001), Murphy (2003), Graham, Lang, and Shackelford (2004)). To the extent that there is a considerable lag before the incentive generated by employee stock options turn into innovative outcomes, we add a two-year lag on the measure of non-executive stock options per employee and controls in the regression models. We report the results in Panels F and G in Table VI and observe that the results are not affected by the alternative variables and model specifications.

Fifth, Hirshleifer, Low, and Teoh (2011) argue that the innovative outcomes are more important in industries in which good opportunities for innovation are available. We hence create a dummy to denote the difference in industry innovativeness following the method outlined in Hirshleifer, Low, and Teoh (2011). Specifically, the innovative industry indicator takes a value of one if the industry level (two-digit SIC) *Qcitations* are above the sample median each year, and zero otherwise.

Subsequently, we add an interaction term of *Ln*(*1+E-option*) and the innovative industry dummy together with *Ln*(*1+E-option*) in the regressions.[102] The results presented in Panel H of Table VI indicate that the coefficient on the interaction term is highly significant, which suggests that the effects of non-executive stock options on innovation efficiency are much stronger in innovative industries than in non-innovative industries.

Finally, in untabulated results, we also use total sales or the number of employees as alternative proxies of firm size; limit our sample period by removing the 98-00 due to tech bubbles; and control for the number of segments. Our results are insensitive to these parsimonious tests.

V. Further Analysis

A. Effects of Firm and Industry Characteristics and the Stock Option Terms

In this section, we examine the effects of firm and industry characteristics and the stock option terms on the cross-sectional relation between non-executive stock options and innovative outcomes. The control variables are the same as those in Table III. To save space, only coefficients estimated on key variables of interest are reported.

A.1. Importance of Employee Retention and Labor Strength

Bae, Kang, and Wang (2011) argue that employees who work in lower employee turnover industries are better educated and are more difficult to be retained and meanwhile firms are more likely to adopt employee friendly policy if they value employees' firm-specific human capital. In addition, extant literature documents that organized labor is easier to be coordinated as the union acts on behalf of individual employees as a group and a strong union also ensures that employees benefit from human capital investments by increasing employees' bargaining power (Klasa, Maxwell, and Ortiz-Molina (2009), Chen, Kacperczyk, and Ortiz-Molina (2011)). Given that employees' firm-specific skills are the fundamental input to innovation production, we expect that employee incentives

[102] Since we already control industry dummies in the regressions, we do not include the innovative industry dummy separately in the regressions.

provided by stock options have a stronger impact on the innovation productivity in firms where employees are more difficult to be retained and firms where labor strength is stronger.

To examine these effects, we partition the sample into high labor importance/strength (*High*) and low labor importance/strength (*Low*) subsamples according to three measures: (1) industry level employee voluntary turnover rate at the three-digit SIC from the Bureau of Labor Statistics; we classify firms with lower than the sample median of industry level employee voluntary turnover rate as *High* and firms with higher than the sample median of industry level employee voluntary turnover rate as *Low*;[103] (2) employee treatment index from the KLD Database;[104] we classify firms with larger than zero employee treatment index as *High* and firms with zero employee treatment index as *Low*; (3) industry unionization rate at the four-digit SIC level from the *Unionstats*; we classify firms with higher than the sample median of industry union coverage as *High* and firms with lower than the sample median of industry union coverage as *Low*. We reestimate the regressions in Table III for the two subsamples separately and report the results in Panel A of Table VIII. The results show that our findings are more pronounced in subsamples of firms in industries with lower employee voluntary turnover rate, firms with higher employee treatment index, and firms in more unionized industries. These results further confirm our conjecture that employee stock options can better improve the innovation productivity if employees are more difficult to be retained and the labor force is more organized.

A.2. Free-riding among Employees

Employee stock options form a strong group-based incentive device to promote the innovative outcomes. However, these incentives are diluted if free-riding problems are serious. Hochberg and Lindsey (2010) argue that the positive impact of non-executive stock options on firms' operating

[103] In Panels A1 and A3 of Table VII, the sample size for *High* is larger than that for *Low* because we include firms whose industry level turnover rate or unionization rate is equal to the sample median in *High* subsample. Including these firms in *Low* subsample does not change our results.

[104] We follow Bae, Kang, and Wang (2011) to construct the employee treatment index that ranges from zero and five. The employee treatment index covers the strength in five categories of employee relations including union relations, cash profit-sharing, employee involvement, retirement benefits strength, and health and safety strength. A higher value of employee treatment index indicates better employee treatment. See Bae, Kang, and Wang (2011) for a detailed description of these strengths.

performance is more likely to occur in firms with a weaker free-riding problem. Specifically, they argue that free-riding is weaker in smaller firms where the overall performance of the firm is more sensitive to the actions of individual workers and in firms with substantial individual growth opportunities where the ability of individual employees is more likely to influence the firm valuation. In the same vein, we expect that employee stock options in firms with a weaker free-riding problem have stronger effect on the innovation productivity.

Similar to Hochberg and Lindsey (2010), we divide our sample into two subsamples with high tendency of free-riding problem (*High*) and lower tendency of free-riding problem (*Low*) according to two measures: 1) the number of employees; we classify firms with higher than the sample median of the number of employees as *High* and firms with lower than the sample median of the number of employees as *Low*; 2) growth options per employee, which is defined as the market value of equity minus the book value of equity divided by the number of employees according to Core and Guay (2001); we classify firms with lower than the sample median value of growth option per employee as *High* and firms with higher than the sample median value of option per worker as *Low*. We repeat the regressions in Table III for both subsamples and present the results in Panel B of Table VII. The results indicate that our results are more evident in subsamples of firms with a smaller number of employees and higher growth options per employee. Collectively, these results provide supportive evidence for our prediction that non-executive stock options in firms with a weaker free-riding problem more effectively encourage risk-taking behaviors among employees, resulting in higher innovation efficiency.

A.3. Average Stock Option Expiration Period

Manso (2010) maintains that in the innovation process, the agents have superior information about the success rate of the projects. As a consequence, the optimal incentive contract for innovations must provide the agent with a long-term commitment. Francis, Hasan, and Sharma (2011) argue that stock options ensure a long-term commitment since they have a lengthy expiration period. Noting these arguments, we expect that the positive relation between employee stock options and innovative outcomes is stronger if a firm's options have a longer expiration period.

To explore this possibility, we split our sample into two subsamples with a long expiration period (*Long*) and a short expiration period (*Short*) according to the average expiration period for all stock options in a firm. Specifically, we classify firms whose stock options have a longer than the sample median of expiration period as *Long* and firms whose stock options have a shorter than the sample median of expiration period as *Short*. We reestimate the regressions in Table III for both subsamples. The results presented in Panel C of Table VII show that our results are more pronounced in subsamples of firms whose stock options have a longer expiration period. These results suggest that employee stock options with a longer expiration period create a long-term commitment for employees and prevent employees' myopic behaviors, thus enhancing innovation efficiency.

A.4. Targeted vs. Broad-based Non-executive Stock Option Plan

There is a large literature debating on the targeting of the non-executive stock option plan. On the one hand, Oyer and Shaefer (2005) and Bergman and Jenter (2007) document that attraction and retention of certain key employees are the major purpose of the non-executive stock option plan. On the other hand, Hochberg and Lindsey (2010) provide evidence that firms adopting a broad-based non-executive stock option plan, compared with firms merely granting stocks to certain key employees, experience a greater improvement in firm operating performance since broad-based plan creates an environment for mutual monitoring among employees where workers know all their co-workers have similar incentives.

To distinguish these two arguments, we construct a broad-based stock option plan dummy, which takes a value of one if the number of non-executive stock options over shares outstanding is greater than the sample median each year, and zero otherwise. We then use this variable to partition our sample into *Targeted* and *Broad-based* employee stock option plans. Since in Section V.A.2 we show that our results are mainly driven by firms with a smaller number of employees, we reestimate the regressions in Table III for the *Targeted* and *Broad-based* subsamples respectively in these firms.. We report the results in Panel D of Table VI. We find that our findings are more evident for subsamples of firms with *Broad-based* rather than *Targeted* plans. These results suggest that to attract and retain certain employees is not the major motive for firms to grant non-executive stock

options. In contrast, mutual monitoring among rank-and-file employees induced by non-executive stock options is the major source of the effect of employee stock options on innovation productivity.

B. R&D Activities

Although we have examined the effects of non-executive stock options on innovation outputs such as patents and citations of patents, how non-executive stock options affect R&D activities, the inputs of innovations, is still unclear. In this section, we use R&D scaled by assets and R&D intensity measured as the log of one plus the R&D expenditure per employee as dependent variables to test the relation between non-executive stock options and R&D activities in a firm.

The results in Table VIII present the estimates from the OLS regressions. The models in columns (1) and (2) show a significant positive effect of non-executive stock options on both R&D expenditures and R&D intensity as the coefficients on *Ln*(*1+E-option*) are significant at less than the 1% level.[105] The results also suggest that firms with more investment opportunities measured by *Tobin's q*, poorer operating performance, and lower leverage are associated with higher R&D expenditures and R&D intensity. Consistent with Coles, Daniel, and Naveen (2006), we also find that lower CEO delta and higher CEO vega are associated with higher R&D activities. Similar to Hirshleifer, Low, and Teoh (2011), we find that firm with larger cash holdings spend more on R&D activities.

A caveat to the analysis is that we do not intend to establish a causal link between non-executive stock options and R&D activities in a firm. On the one hand, the management and the board of directors usually have significant discretions on the resources allocated to R&D activities (Francis, Hasan, and Sharma (2011)). The grant of non-executive stock options and the expansion of R&D expenditures can be an integrated strategy in a firm's innovation practice. On the other hand, it is also possible that non-executive stock options attract more innovative employees to engage in R&D activities.

[105] In untabulated tests, we reestimate the regressions in Table VIII by deleting firms with missing R&D expenditure and find similar results.

C. Employee Interest Alignment and Risk-taking Incentives and Innovation Productivity

Classical agency theory has argued that equity-based compensation aligns the interest between firm owners and managers, hence improving firm performance (Jensen and Meckling (1976), Holmstrom and Milgrom (1987)). One of the most motives for firms to adopt incentive-based forms of remunerations to employees is that conventional managerial monitoring is difficult in firms with high levels of intellectual capital. Furthermore, in these firms employees have better control over performance outcomes, consequently it is efficient to transfer risk to employees via incentive pay (Rajan and Zingales (2000)). Ample empirical evidence shows that employee equity-based pay can form an efficient risk-sharing channel. FitzRoy and Kraft (1987) and Blasi, Conte, and Kruse (1996) maintain that employee equity-based compensation induces co-monitoring and encourages cooperation among rank-and-file employees. Jones (1984) and Kandel and Lazear (1992) argue that employee incentive pay motivates employees to actively report the slack efforts of co-worker to managers and enforces group's attitudes towards shirking by exposing individual employees to peer pressure. He and Wang (2009) and Lerner and Wulf (2007) claim that the pay-for-performance system created by stock options can alleviate the managerial incentive to obtain private benefits at the expense of shareholders, e.g., funding 'pet projects' or selecting their own favorable labs. In a similar fashion, non-executive stock options, by aligning the interest of employees with that of shareholders, could reduce inefficient R&D investments and enhance the innovation productivity.

Notwithstanding, Holmstrom (1989) points out that the conventional pay-for-performance system that intends to solve the agency problem is inefficient in the high-risk innovative activities since the increased firm risk increases the volatility of manager's total firm-specific wealth. Thus, risk-averse managers may switch to less risky projects and pass up the value-enhancing innovative projects. The findings of Smith and Stulz (1985) and Hirshleifer and Suh (1992) provide supportive evidence for this argument. In addition, Ederer and Manso's (2011) experimental study also finds that a standard pay-for-performance incentive scheme does not encourage the discovery of a novel business strategy by the lab subjects. Taken together, whether the delta from non-executive stock options promotes or discourages innovation outputs is inconclusive.

Vega created by non-executive stock options is calculated as employees' wealth dollar change in their stock option holdings for one percent change in the volatility of the stock returns. Hence vega compared with delta is a more straightforward measure of employees' risk-taking incentives. Murphy (2003) maintains that the convex payoffs from options can induce otherwise risk-averse agents to take riskier projects. Guay (1999) also finds an increase in firms' stock return volatility in response to an increase of the CEO vega. Low (2009) shows that Delaware firms raise CEO vega after the passage of the anti-takeover law in mid-1990s to overcome the adverse effect of increasing protections on managers' risk-taking incentives. Moreover, Francis, Hasan, and Sharma (2011) present evidence that CEO vega has a positive relation with the number of patents and citations. Overall, these findings predict that vega from non-executive stock options is positively associated with innovative outcomes.

To comprehensively evaluate these arguments, we examine the per employee delta and vega from non-executive stock options simultaneously in the regressions analysis. The choice of control variables is similar to that in Section IV.[106] Table IX presents the estimates from the regressions. In Panels A and B, we control for CEO delta and vega, and the delta and vega of the top five executives in a firm, respectively. The results in Panels A and B indicate that non-executive delta per employee has an insignificant effect on the patens and citations in a firm, while non-executive vega per employee is significantly and positively associated with the innovation output measures at less than the 5% level.[107] Additionally, we also observe a positive sign on the coefficient of executive vega on the innovation productivity but a negative sign on the coefficient of executive delta on the innovation productivity of a firm, which are consistent with Francis, Hasan, and Sharma (2011) and Ederer and Manso (2011). However, none of the effects of executive incentive measures dominate the strong effect of vega from non-executive stock options on the innovative outcomes. Taken together, these results suggest that risk-taking incentive rather than the interest-alignment incentive created by non-executive stock options plays a crucial role in fostering innovation output.

[106] We drop CEO tenure in the regression where we include delta and vega of the top five executives. However, adding it back does not affect our results.

[107] In terms of economic significance, for Panel A, a one standard deviation increase in non-executive vega per employee increases the average number of patents by 23.5%, *Qcitations_t* by 35.2%, *TTcitations_t* by 22.8%, *Qcitations* by 14.4% and *TTcitations* by 13.0%. For panel B, these values are 19.5% for the number of patents, 29.8% for *Qcitations_t*, 19.3% for *TTcitations_t*, 11.7% for *Qcitations* and 11.6% for *TTcitations.*

VI. Summary and Conclusion

Innovation has become a core strategy to enhance a firm's competitiveness in the new millennium. How to design an appropriate incentive mechanism to foster innovation productivity constitutes a challenge to a firm's innovation practice. Despite abundant literature discusses various mechanisms to spur innovations, few studies examine the role of employees and employees' incentive scheme in the innovation production. Our paper fills this gap. Using a large sample of firms covered by both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003, we empirically examine the effects of non-executive employee stock options on the innovative outcomes.

We find that the value of non-executive stock options per employee has a significant positive relation with the number of patents, the total number of citations of the patents, and the average number of citations per patent even after we control for the R&D expenditure in a firm. These results are robust to several model specification tests and are more pronounced in subsamples of firms in industries with higher employee voluntary turnover rates, firms with better employment treatment, and firms in more unionized industries. We also find that the results are more evident in subsamples of firms with weaker free-riding problems and firms whose options have a longer expiration period. Finally, our results suggest that promoting mutual monitoring among employees rather than targeting certain key employees is the major purpose for firms to grant employee stock options to induce employees to be more innovative.

More importantly, for a subsample of firms for which we can calculate the pay-performance sensitivity (delta) and the risk-taking taking incentive (vega) created by non-executive options from the IRRC Dilution Database, we evaluate the effects of these incentive measures together with the executive incentives and find that only vega per employee is positively associated with the innovative outcomes, while delta per employee has no significant impact.

Overall, these results suggest that non-executive stock options as a group incentive scheme enhance employees' risk-taking incentives, improving the innovation efficiency. Meanwhile, the asymmetric payoff structure of stock option that protects employees from the adverse stock performance and rewards employees for favorable stock performance and the long-term vesting and

expiration period of stock options create an effective failure-bearing mechanism, form a strong employee retention incentive, and encourage employees' firm-specific human capital investment, a fundamental input to the innovation production.

Our findings highlight the positive role of employee stock options as an effective tool to promote employees' innovation productivity and shed some light on the bright side of employees as an important innovation generator, hence enriching the stakeholder theory. Furthermore, our findings complement Hochberg and Lindsey (2010) by identifying a channel through which employee stock options exert a beneficial influence on firm performance.

Appendix A
Sample construction

This table contains the observation counts by fiscal year for the sample at different stages of construction. We start from all ExecuComp firms reported during 1992 to 2006 and merge the ExecuComp with Compustat and CRSP. The combined dataset is then merged with the NBER Patent and Citation Database. For the ExecuComp data, we remove firms, from which we are not able to identify CEOs and firms with negative CEO tenure, missing total compensation (*tdc1*) in ExecuComp and zero total compensation. In addition, if there is more than one CEO for a firm in a year (e.g., when there is a CEO turnover), the averages across CEOs are reported. For the NBER Patent and Citation data, the sample selection criterion is to exclude firms in industries that have no patent in any year.

Order	Key variables/selection criteria	Data source	Period	Number of observations
(1)	*numsecur* and *pcttotopt*: remove error observations and missing variables	ExecuComp - Stock Option Grants	1992 - 2006	129,062 executive-firm-years
(2)	Remove firm-years with standard deviation of the total number of option grants estimated from each executive option grant greater than 10% of the mean	ExecuComp - Stock Option Grants	1992 - 2006	113,106 executive-firm-years and 18,574 firm-years
(3)	Remove firm-years with less than two executives	ExecuComp - Stock Option Grants	1992 - 2006	17,344 firm-years
(4)	Remove firms without year-high and year-low prices from Compustat, 36 months of stock return data from CRSP to calculate stock return volatility, or other Black-Scholes (BS) formula inputs (the same as CEO options' BS inputs)	ExecuComp - Stock Option Grants, Compustat, and CRSP	1992 - 2006	16,682 firm-years
(5)	Remove missing lagged non-executive options and merge with Compustat, CRSP, and NBER Patent and Citation Database	ExecuComp - Stock Option Grants, Compustat, CRSP, and NBER Patent and Citation Database	1993 - 2003	11,991 firm-years
(6)	Merge with CEO delta and vega. Remove firms with no CEO, cannot identify CEO age, tenure, *tdc1* etc.	ExecuComp, Compustat, CRSP, and NBER Patent and Citation Database	1993 - 2003	11,446 firm-years
(7)	Drop financial and utilities and firm-years with missing dependent variables	ExecuComp, Compustat, CRSP, and NBER Patent and Citation Database	1993 - 2003	8,336 firm-years
(8)	Require non-missing control variables	ExecuComp, Compustat, CRSP, and NBER Patent and Citation Database	1993 - 2003	7,866 firm-years

Appendix B
Variable definitions

Variables	Definitions
#employees	Number of employees in thousands.
Assets	Total assets in millions.
Average Stock Option Expiration Period	Average expiration period for all stock options in a firm from IRRC Dilution Database.
Board Size	Number of board members from IRRC Director Database.
Broad-based Stock Option Plan Dummy	A dummy variable takes a value of one if the number of non-executive stock options over the total shares outstanding is above the sample median each year, and zero otherwise.
CAR(*-3 year, -1 year*)	Cumulative abnormal returns (CAPM adjusted) during the past three years.
Cash/Assets	Cash/total assets.
CEO Delta	Dollar change in CEO stock and option portfolio for 1% change in stock price, following Core and Guay (2002).
CEO Tenure	Number of years since he/she became the CEO of a firm from ExecuComp.
CEO Vega	Dollar change in CEO option holdings for a 1% change in stock return volatility, following Core and Guay (2002).
Citations (*raw*)	Total number of citations summed across all patents applied by the firm during the year.
E-delta	Dollar change in non-executive (other than top five executives) option portfolio for 1% change in stock price divided by the number of employees from IRRC Dilution Database, following Hochberg and Lindsey (2010).
E-option	Black-Scholes value of non-executive stock options per employee.
E-option in Near Firms in Other Industry	The log of one plus non-executive stock options per employee averaged across firms in the same two-digit ZIP code excluding the firm itself and others in its industry
E-vega	Dollar change in non-executive option holdings for a 1% change in stock return volatility divided by the number of employees from IRRC Dilution Database, following Hochberg and Lindsey (2010).
G-index	Gompers, Ishii and Metrick (2003) from IRRC Governance Database.
Growth Option per Employee	Market value of equity minus the book value of equity divided by the number of employees, following Core and Guay (2001).
Hadlock and Pierce's (*2010*) *Index*	-0.737 * Ln(Assets) + 0.043* Ln(Assets)]2 + 0.04*Age, from Hadlock and Pierce (2010).
Herfindahl Index	Industry Herfindahl index based on all Compustat firms, where industries are defined by 3-digit SIC.
Independent Directors (*%*)	Number of independent directors / board size from IRRC Director Database.
Industry Employee Voluntary Turnover Rate	Industry-level voluntary employee turnover rate during 2001 - 2006 from the U.S. Department of Labor.
Innovative Industry	An industry is innovative if the industry level (2-digit SIC) Qcitation is above the sample median each year.
Institutional Ownership	Shares owned by institutional investors/total shares outstanding from CDA/Spectrum Institutional (13f) Holdings.
KLD Employee Treatment Index	Summation of KLD ratings on firms' employee relations, including union relations, cash profit-sharing, employee involvement, retirement benefits strength, and health and safety strength, following Bae, Kang, and Wang (2011).
Leverage	(Short-term debt + long-term debt) / total assets.
Managerial Ownership	Shares owned by top five executives/total shares outstanding from ExecuComp.
Marginal Tax Rate	Simulated marginal tax rates obtained from John Graham. If missing, fill with marginal tax rates computed using coefficients reported in Table 4 (Panel B and Model C) of Graham and Mills (2008).
Non-executive Employees vs. Top Five Executive Option Grant Ratio	Number of options granted to non-executives employees/number of options granted to top five executives.
Patents (*raw*)	Number of patents applied for during the year.
PPE/#employees	Net property, plant, and equipment per employee in thousands.
Qcitations	Average number of citations of all patents applied by the firm during the year. Each patent's number of citations is multiplied by the weighting index from Hall, Jaffe and Trajtenberg (2001, 2005).
Qcitations_t	Total number of citations summed across all patents applied by the firm during the year. Each patent's number of citations is multiplied by the weighting index from Hall, Jaffe and Trajtenberg (2001, 2005).
R&D/Assets	R&D expenses/the total assets.
R&D Intensity	The log of one plus R&D expenses per employee.
ROA	Operating income before depreciation and amortization (EBITDA)/total assets.
Sales Growth	Ln(1+change in net sales scaled by the lagged net sales).
Sales/#employees	Sales per employee in thousands.
Stock Return	Compounded monthly stock returns over the fiscal year.
Stock Volatility	Annualized standard deviation of monthly stock return over the fiscal year.
Tobin's q	(Total assets + market value of equity - book value of equity) / total assets.
Top Five Executive Delta	Dollar change in top five executives' stock and option portfolio for 1% change in stock price,

	following Core and Guay (2002).
Top Five Executive Vega	Dollar change in top five executives' option holdings for a 1% change in stock return volatility, following Core and Guay (2002).
TTcitations	Average number of citations of all patents applied by the firm during the year. Each patent's number of citations is divided by the average citation count of all patents in the same technology class and applied in the same year.
TTcitations_t	Total number of citations summed across all patents applied by the firm during the year. Each patent's number of citations is divided by the average citation count of all patents in the same technology class and applied in the same year.
Union	Percentage of workforce in an industry employed by unions. The data is downloaded from the website maintained by Barry Hirsch and David Macpherson (www.unionstats.com).

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Figure III.1: The aggregate value of non-executive stock options and mean and median values of non-executive stock options per employee over time

The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. The left Y-axis corresponds to the aggregate value of non-executive stock options in billions of dollars. The right Y-axis corresponds to the mean and median values of non-executive stock options per employee in thousands of dollars. The detailed definitions of variables are described in Appendix B.

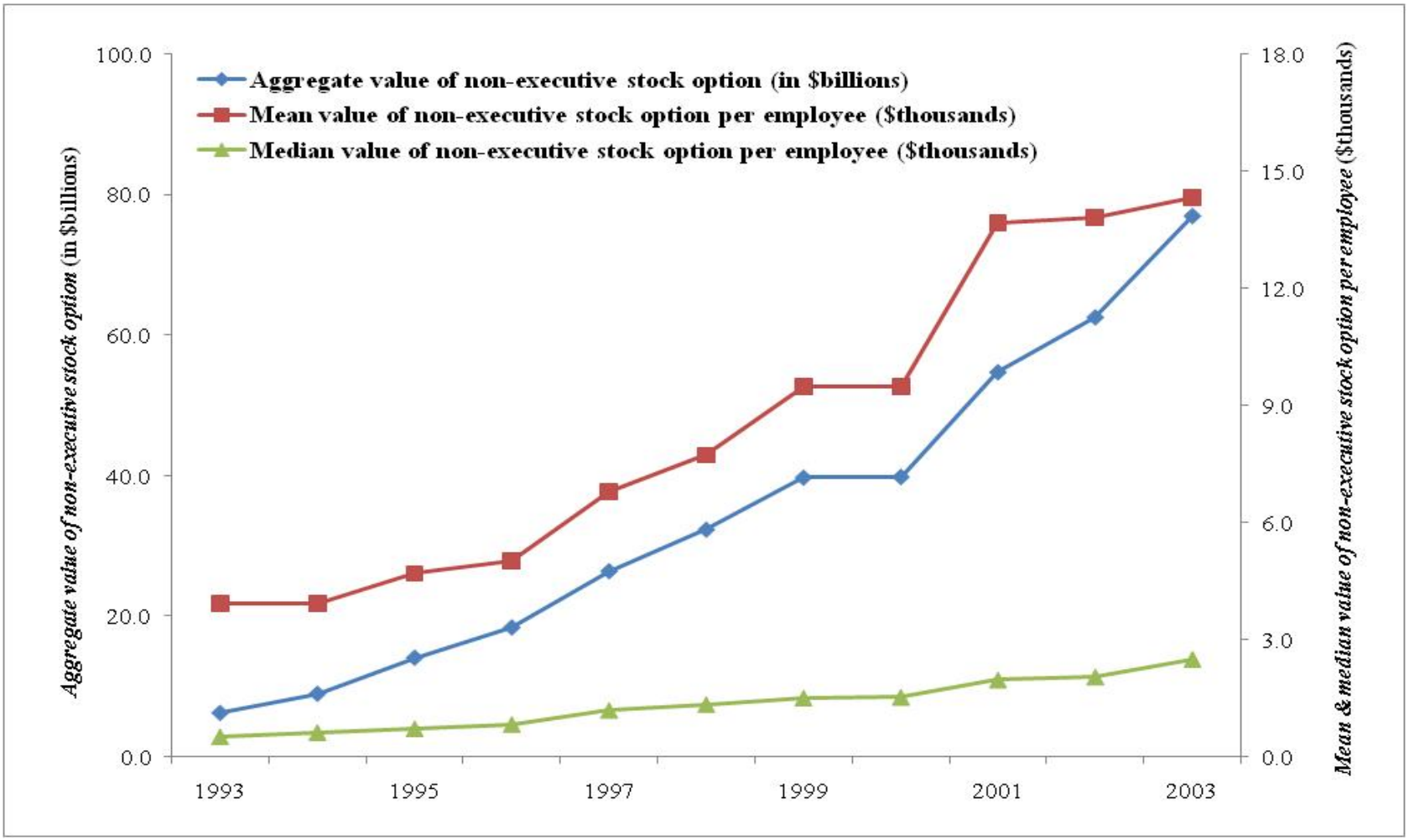

Table III.I: Sample distribution and median and mean counts of patents and citations and values of the non-executive stock options per employee

The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. The sample construction is listed in Appendix A and detailed definitions of variables are described in Appendix B.

Year	No. of total firms	No. of firms with non-zero patents	No. of firms with non-zero citations	Patent count (raw) (non-zero patents)		Total counts of patent citation (raw) (non-zero citations)		Average citation per patent count (raw) (non-zero citations)		Non-executive stock option per employee ($dollars)	
				Median	Mean	Median	Mean	Median	Mean	Median	Mean
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1993	324	160	159	14.00	31.84	158.00	781.92	8.86	10.91	495.17	3082.62
1994	555	281	278	10.00	29.79	126.50	857.98	9.69	12.29	572.36	4044.70
1995	636	330	328	12.00	31.25	117.00	851.60	8.27	10.50	631.31	3873.49
1996	676	338	333	10.00	29.53	77.00	797.90	7.20	9.44	735.88	4664.54
1997	721	380	373	9.00	29.86	71.00	757.91	6.40	8.05	902.06	5788.44
1998	740	376	364	9.00	27.19	49.00	539.25	5.00	6.49	1225.80	7914.25
1999	820	421	405	9.00	25.93	38.00	301.23	3.75	4.81	1377.98	9590.35
2000	823	419	388	10.00	25.78	29.00	224.90	2.33	3.07	1673.63	15513.24
2001	798	389	334	10.00	27.16	17.00	142.50	1.31	1.78	2078.25	13880.49
2002	864	423	337	9.00	27.11	10.00	72.48	0.67	0.90	2386.80	13825.00
2003	909	412	274	8.00	24.34	6.00	27.76	0.33	0.47	1528.45	8038.39
Mean	-	-	-	9.00	27.77	39.00	469.00	4.00	5.95	1192.30	8880.01
Total	7866	3929	3573	-	-	-	-	-	-	-	-

Table III.II: Summary statistics

The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. High (low) *E-option* subsample is the sample of firms with higher (lower) than the sample median of non-executive stock options per employee each year. *E-delta* and *E-vega* are the sensitivity of non-executive stock option to 1% change in stock price divided by the number of employees and the sensitivity of non-executive stock option to 1% change in stock return volatility divided by the number of employees, calculated from the IRRC Dilution Database from 1998 to 2003. The sample size for *E-delta*/*E-vega* in the high and low *E-option* subsamples is 1,745 and 1,869 firm-years, respectively. To be included in the sample, firms in the same industry must have at least one patent in any year. *Qcitations* and *TTcitations* are adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time-technology class fixed effect, respectively. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. *T*-tests (Wilcoxon-Mann-Whitney tests) are conducted to test for differences between the means (medians) for the high *E-option* subsample and low *E-option* subsample. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	The whole sample			High *E-option* subsample		Low *E-option* subsample	
	N = 7866			*N =3931*		*N = 3935*	
	Mean	Median	SD	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Panel A: Firm characteristics				
Assets ($millions)	3929.77	993.46	8770.73	3419.48***	742.57***	4439.55	1348.76
Employees (thousands)	16.51	5.70	26.23	9.64***	2.50***	23.37	10.75
Tobin's q	2.22	1.65	1.81	2.87***	2.15***	1.56	1.38
Sales growth	0.11	0.08	0.27	0.15***	0.13***	0.06	0.06
PPE/#employees ($thousands)	135.70	41.30	373.38	192.60***	49.12***	78.85	36.98
Leverage	0.22	0.22	0.17	0.18***	0.15***	0.26	0.26
Cash/Assets	0.14	0.06	0.18	0.21***	0.14***	0.06	0.03
Sales/#employees ($thousands)	275.10	192.17	314.47	348.64***	229.00***	201.64	160.42
Stock volatility	0.03	0.03	0.02	0.03***	0.03***	0.03	0.02
Stock return	0.18	0.10	0.59	0.20***	0.09	0.16	0.10
ROA	0.09	0.10	0.13	0.09***	0.11***	0.10	0.10
R&D/Assets	0.04	0.01	0.08	0.07***	0.04***	0.01	0.00
Herfindahl index	0.19	0.13	0.17	0.15***	0.10***	0.22	0.17
			Panel B: Employee vs. CEO compensation terms				
E-option ($dollars)	8880.01	1192.30	21469.42	17257.07***	5489.43***	511.47	378.68
E-delta ($dollars)	490.81	111.25	1052.31	947.92***	394.37***	64.03	42.39
E-vega ($dollars)	233.58	78.48	423.44	426.55***	216.25***	53.42	36.58
Non-executive employee over top five executive option grant ratio	5.43	3.06	10.63	6.94***	3.73***	3.92	2.52
CEO delta ($dollars)	618041.30	174847.40	1614981.00	827958.60***	234524.60***	408337.40	133250.40
CEO vega ($dollars)	75813.57	30265.58	129747.70	86648.87***	33326.27***	64989.29	27433.71
CEO tenure (Years)	7.17	5.00	7.13	7.26	5.00***	7.08	5.00
			Panel C: Corporate innovation measures				
#patents (raw)	13.87	0.00	28.55	15.81***	1.00***	11.94	0.00
#citations (raw)	2.70	0.00	5.24	3.37***	0.00***	2.04	0.00
#Qcitations_t	515.56	0.00	3208.09	735.32***	0.00***	296.03	0.00
#TTcitations_t	40.14	0.00	203.42	55.13***	0.00***	25.17	0.00
#Qcitations	6.46	0.00	10.68	8.22***	0.00***	4.71	0.00
#TTcitations	0.55	0.00	0.81	0.65***	0.00***	0.45	0.00

Table III.III: Effect of non-executive stock options per employee on corporate innovation productivity

The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. *Qcitations* and *TTcitations* are adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time-technology class fixed effect, respectively. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Ln(1+#patent)	*Ln(1+Qcitations_t)*	*Ln(1+TTcitations_t)*	*Ln(1+Qcitations)*	*Ln(1+TTcitations)*
	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
Ln(1+E-option)	0.057***	0.098***	0.073***	0.037**	0.015**
	(2.7)	(2.8)	(3.2)	(2.1)	(2.4)
R&D/Assets	4.006***	7.187***	4.151***	3.416***	0.934***
	(7.3)	(7.4)	(7.3)	(6.9)	(5.9)
Ln(1+CEO delta)	-0.038**	-0.060**	-0.033*	-0.022	-0.004
	(-2.2)	(-2.0)	(-1.8)	(-1.4)	(-0.7)
Ln(1+CEO vega)	0.011*	0.020*	0.008	0.010*	0.002
	(1.9)	(1.9)	(1.3)	(1.9)	(1.0)
Ln(1+CEO tenure)	-0.012	-0.024	-0.024	-0.012	-0.007
	(-0.5)	(-0.6)	(-0.9)	(-0.5)	(-0.9)
Ln(PPE/#employees)	-0.001	0.015	-0.006	0.019	0.002
	(-0.0)	(0.2)	(-0.1)	(0.5)	(0.2)
Leverage	-0.808***	-1.438***	-0.858***	-0.616***	-0.160***
	(-4.9)	(-5.3)	(-4.9)	(-4.6)	(-3.4)
Cash/Assets	0.086	0.194	0.028	0.167	0.045
	(0.5)	(0.6)	(0.1)	(1.1)	(0.8)
Ln(Sales/#employees)	-0.114**	-0.150*	-0.110**	-0.037	-0.012
	(-2.5)	(-1.9)	(-2.3)	(-0.9)	(-0.9)
Ln(Assets)	0.562***	0.809***	0.567***	0.244***	0.073***
	(20.5)	(19.1)	(19.6)	(13.1)	(11.1)
Sales growth	-0.240***	-0.395***	-0.255***	-0.122**	-0.035*
	(-4.4)	(-4.0)	(-4.2)	(-2.3)	(-1.8)
Tobin's q	0.051***	0.080***	0.051***	0.029**	0.011**
	(3.9)	(3.4)	(3.4)	(2.2)	(2.5)
Stock volatility	3.613**	6.927**	4.925**	3.180**	0.876*
	(2.0)	(2.3)	(2.6)	(2.2)	(1.7)
Stock return	0.064***	0.109***	0.080***	0.044*	0.011
	(3.0)	(2.8)	(3.4)	(1.9)	(1.4)
ROA	1.053***	1.988***	1.217***	0.957***	0.263***
	(4.8)	(5.4)	(5.2)	(5.0)	(3.9)
Herfindahl index	-0.060	0.712	0.063	0.732*	0.190
	(-0.1)	(0.9)	(0.1)	(1.9)	(1.4)
Herfindahl index^2	0.199	-0.594	0.032	-0.745	-0.192
	(0.4)	(-0.6)	(0.1)	(-1.6)	(-1.2)
Constant	-3.652***	-5.534***	-3.872***	-1.879***	-0.607***
	(-11.3)	(-10.5)	(-11.1)	(-7.3)	(-6.7)
Industry FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
N	7866	7866	7866	7866	7866
R-squared	0.53	0.50	0.49	0.40	0.30

Table III.IV: Reestimation of regressions in Table III using the instrumental variable approach

The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. Column (1) reports the estimate of the first-stage regression using the two-stage least squares (2SLS) model and columns (2) to (6) report the estimates of the second-stage regressions using the 2SLS model. *Qcitations* and *TTcitations* are adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time-technology class fixed effect, respectively. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Ln(1+E-option)	*Ln(1+#patent)*	*Ln(1+Qcitations_t)*	*Ln(1+TTcitations_t)*	*Ln(1+Qcitations)*	*Ln(1+TTcitations)*
	1st stage	2nd stage	2nd stage	2nd stage	2nd stage	2nd stage
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(1+E-option)	N/A	0.527**	1.054***	0.566**	0.539***	0.145**
		(2.3)	(2.7)	(2.3)	(2.8)	(2.3)
E-options in near firms in other industry	0.069***	N/A	N/A	N/A	N/A	N/A
	(5.2)					
Marginal tax rate	-0.437**	N/A	N/A	N/A	N/A	N/A
	(-2.2)					
R&D/Assets	2.804***	2.624***	4.375***	2.697***	1.938***	0.552**
	(5.0)	(3.1)	(3.0)	(3.1)	(2.7)	(2.4)
Ln(1+CEO delta)	0.236***	-0.151***	-0.288***	-0.151**	-0.142***	-0.035**
	(12.4)	(-2.6)	(-2.9)	(-2.5)	(-2.9)	(-2.2)
Ln(1+CEO vega)	0.006	0.008	0.014	0.005	0.007	0.001
	(1.1)	(1.3)	(1.3)	(0.8)	(1.2)	(0.6)
Ln(1+CEO tenure)	-0.138***	0.052	0.106	0.043	0.057	0.011
	(-6.1)	(1.3)	(1.5)	(1.0)	(1.6)	(1.0)
Ln(PPE/#employees)	0.349***	-0.162*	-0.314**	-0.176*	-0.153**	-0.043*
	(12.7)	(-1.7)	(-2.0)	(-1.8)	(-2.0)	(-1.7)
Leverage	-0.501***	-0.584***	-0.982***	-0.623***	-0.377**	-0.098*
	(-3.3)	(-2.8)	(-2.8)	(-2.8)	(-2.2)	(-1.7)
Cash/Assets	2.570***	-1.185*	-2.393**	-1.309*	-1.192**	-0.307*
	(17.2)	(-1.8)	(-2.1)	(-1.9)	(-2.2)	(-1.8)
Ln(Sales/#employees)	0.597***	-0.401***	-0.736***	-0.413***	-0.345***	-0.092**
	(15.1)	(-2.7)	(-2.9)	(-2.7)	(-2.7)	(-2.3)
Ln(Assets)	-0.198***	0.656***	1.000***	0.665***	0.344***	0.098***
	(-10.3)	(12.4)	(11.1)	(11.9)	(7.9)	(6.9)
Sales growth	0.430***	-0.449***	-0.820***	-0.474***	-0.344***	-0.092***
	(5.6)	(-3.7)	(-3.9)	(-3.7)	(-3.2)	(-2.7)
Tobin's q	0.157***	-0.024	-0.071	-0.027	-0.050	-0.009
	(9.0)	(-0.6)	(-1.0)	(-0.6)	(-1.5)	(-0.8)
Stock volatility	9.067***	-1.121	-2.707	-0.053	-1.880	-0.435
	(4.9)	(-0.4)	(-0.5)	(-0.0)	(-0.7)	(-0.5)
Stock return	-0.060***	0.089***	0.159***	0.106***	0.070***	0.018**
	(-2.7)	(3.4)	(3.3)	(3.7)	(2.7)	(2.0)
ROA	0.293	0.962***	1.804***	1.121***	0.860***	0.238***
	(1.2)	(4.1)	(4.3)	(4.5)	(3.8)	(3.2)
Herfindahl index	-1.612***	0.661	2.179**	0.821	1.502***	0.389**
	(-4.5)	(1.1)	(2.0)	(1.2)	(2.8)	(2.2)
Herfindahl index^2	1.545***	-0.465	-1.946	-0.666	-1.455**	-0.376*
	(3.6)	(-0.7)	(-1.6)	(-0.9)	(-2.4)	(-1.8)
Constant	1.355***	-3.566***	-5.154***	-3.656***	-1.622***	-0.569***
	(4.9)	(-9.0)	(-7.7)	(-8.7)	(-5.0)	(-5.3)
Industry FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
J-Statistics (p-value)	N/A	0.66	0.42	0.14	0.40	0.15
N	7866	7866	7866	7866	7866	7866
R-squared	0.73	0.45	0.37	0.41	0.26	0.21

Table III.V: Reestimation of regressions by controlling for potential omitted variables

This table reestimates the regressions related to non-executive stock options per employee and the corporate innovation productivity by including additional control variables. All regressions include the same control variables as those used in Table III except for Panel C where CEO incentive measures and CEO tenure are excluded, Panel E where CEO incentive measures are replaced with incentive measures of top five executives and CEO tenure is excluded, and Panel F where stock return are excluded, but the coefficients on these variables are not tabulated. The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. *Qcitations* and *TTcitations* are adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time-technology class fixed effect, respectively. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	*Ln(1+#patent)*	*Ln(1+Qcitations_t)*	*Ln(1+TTcitations_t)*	*Ln(1+Qcitations)*	*Ln(1+TTcitations)*
	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
Panel A: Controlling for G-index					
Ln(1+E-option)	0.066**	0.117***	0.084***	0.053**	0.019***
	(2.5)	(2.7)	(2.9)	(2.6)	(2.7)
G-index	0.011	0.014	0.004	0.006	0.001
	(0.9)	(0.7)	(0.3)	(0.7)	(0.3)
N	6040	6040	6040	6040	6040
Panel B: Controlling for board characteristics					
Ln(1+E-option)	0.068**	0.111**	0.082***	0.046**	0.018**
	(2.5)	(2.6)	(2.8)	(2.4)	(2.5)
Board size	-0.008	-0.014	-0.012	-0.005	-0.002
	(-0.6)	(-0.6)	(-0.8)	(-0.5)	(-0.6)
Independent directors (%)	0.484***	0.704**	0.437**	0.318**	0.107**
	(2.7)	(2.5)	(2.3)	(2.5)	(2.3)
N	4688	4688	4688	4688	4688
Panel C: Controlling for top five executive incentives					
Ln(1+E-option)	0.058***	0.098***	0.072***	0.038**	0.014**
	(2.6)	(2.7)	(3.1)	(2.1)	(2.2)
Ln(1+top five executive delta)	-0.101***	-0.165***	-0.092***	-0.069***	-0.015**
	(-4.2)	(-4.0)	(-3.6)	(-3.2)	(-2.1)
Ln(1+top five executive vega)	0.080***	0.143***	0.077***	0.061***	0.019***
	(3.2)	(3.3)	(2.9)	(2.8)	(2.6)
N	7866	7866	7866	7866	7866
Panel D: Controlling for institutional ownership					
Ln(1+E-option)	0.064***	0.105***	0.078***	0.038**	0.015**
	(3.0)	(2.9)	(3.4)	(2.1)	(2.4)
Institutional ownership	-0.287**	-0.279	-0.253**	0.008	0.001
	(-2.4)	(-1.4)	(-2.0)	(0.1)	(0.0)
N	7862	7862	7862	7862	7862
Panel E: Controlling for top five executive ownership					
Ln(1+E-option)	0.056***	0.094***	0.071***	0.033*	0.013**
	(2.6)	(2.7)	(3.2)	(1.9)	(2.2)
Managerial ownership	-0.002	-0.006	-0.002	-0.007***	-0.002**
	(-0.6)	(-1.2)	(-0.5)	(-2.6)	(-2.5)
N	7866	7866	7866	7866	7866
Panel F: Controlling for management quality					
Ln(1+E-option)	0.065***	0.115***	0.080***	0.047***	0.017***
	(2.9)	(3.1)	(3.4)	(2.6)	(2.7)
CAR (-1 year,-3 year)	-0.025	-0.061**	-0.029	-0.039***	-0.009*
	(-1.5)	(-2.2)	(-1.6)	(-2.7)	(-1.7)
N	7546	7546	7546	7546	7546
Panel G: Controlling for financial constraint					
Ln(1+E-option)	0.081***	0.134***	0.092***	0.050***	0.017***
	(3.7)	(3.6)	(3.9)	(2.8)	(2.8)
Hadlock and Pierce's (2010) index	-0.244***	-0.356***	-0.192***	-0.129***	-0.025
	(-3.8)	(-3.5)	(-2.9)	(-2.7)	(-1.6)
N	7866	7866	7866	7866	7866

Table III.VI: Additional sensitivity tests

This table reports the regression results of various robustness tests. All regressions include the same control variables as those used in Table III, but the coefficients on these variables are not tabulated. The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. *Qcitations* and *TTcitations* are adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time-technology class fixed effect, respectively. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Ln(1+#patent)	*Ln(1+Qcitations_t)*	*Ln(1+TTcitations_t)*	*Ln(1+Qcitations)*	*Ln(1+TTcitations)*
Dependent variables	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)
Panel A: Negative binomial estimation (Dependent variables are not in log form)					
Ln(1+E-option)	0.094***	0.250***	0.196***	0.106***	0.071***
	(2.7)	(5.0)	(3.9)	(3.5)	(3.4)
N	7866	7866	7866	7866	7866
Panel B: Negative binomial estimation using mean scaling approach (Dependent variables are not in log form)					
Ln(1+E-option)	0.152***	0.259***	0.218***	0.072**	0.009
	(4.3)	(4.9)	(4.3)	(2.2)	(0.4)
N	6995	6995	6995	6995	6995
Panel C: Using an alternative measure of non-executive stock option per employee					
Ln(1+E-option)	0.032***	0.055***	0.037***	0.022***	0.007***
	(3.5)	(3.6)	(3.8)	(3.0)	(2.7)
N	7103	7103	7103	7103	7103
Panel D: Excluding zero patents or citations					
Ln(1+E-option)	0.106***	0.193***	0.147***	0.075***	0.028***
	(4.6)	(5.9)	(5.3)	(5.4)	(3.8)
N	3929	3573	3573	3573	3573
Panel E: Using only firms granting non-executive options for more than five years					
Ln(1+E-option)	0.052**	0.089**	0.067**	0.035*	0.015**
	(2.0)	(2.1)	(2.4)	(1.8)	(2.0)
N	4998	4998	4998	4998	4998
Panel F: Excluding self-citations					
Ln(1+E-option)	-	0.098***	0.071***	0.036**	0.014**
	-	(2.9)	(3.3)	(2.2)	(2.5)
N	-	7866	7866	7866	7866
Panel G: Lagged independent variables for two periods					
Ln(1+E-option)	0.090***	0.159***	0.107***	0.064***	0.023***
	(3.4)	(3.6)	(3.8)	(2.9)	(3.0)
N	5312	5312	5312	5312	5312
Panel H: Innovative and non-innovative industries					
Ln(1+E-option)	0.044**	0.072**	0.052**	0.020	0.006
	(2.0)	(2.0)	(2.3)	(1.1)	(1.0)
Ln(1+E-option) × Innovative industry indicator	0.018***	0.035***	0.027***	0.023***	0.011***
	(2.8)	(3.0)	(3.8)	(3.7)	(4.9)
N	7866	7866	7866	7866	7866

Table III.VII: Effects of firm and industry characteristics and expiration period of stock options

This table reestimates the regressions related to non-executive stock options per employee and the corporate innovation quality for subsamples of firms classified in each year according to the importance of employee retention and industry level unionization, tendency of free-riding problem, stock option expiration period, and broad versus targeted plans. All partition variables are measured a priori. All regressions include the same control variables as those used in Table III, but the coefficients on these variables are not tabulated. The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. *Qcitations* and *TTcitations* are adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time-technology class fixed effect, respectively. In Panel A, a firm facing high importance of employee retention or high unionization rate is classified as *High* and low importance of employee retention or low unionization rate is classified as *Low* if variables measuring the importance of employee retention or the unionization rate are above or below the sample median respectively. In Panel B, a firm is classified as high tendency of free-riding problem (*High*) if the number of employees is above the sample median or the growth options per employee are below the medians, and low tendency firms (*Low*) otherwise. In Panel C, a firm having a longer than the sample median of weighted average stock option expiration period is classified as (*Long*) and a firm having a shorter than the sample median of weighted average stock option expiration period is classified as (*Short*). In Panel D, a firm is classified as a targeted plan (*Target*) if the number of option grants to non-executives over the total shares outstanding is below the sample median each year and a broad plan (*Broad*) if the number of option grants to non-executives over the total shares outstanding is above the sample median each year. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table III.VII (cont'd)
Effects of firm and industry characteristics and expiration period of stock options

Dependent variables	*Ln(1+#patent)*		*Ln(1+Qcitations_t)*		*Ln(1+Ttcitations_t)*		*Ln(1+Qcitations)*		*Ln(1+TTcitations)*	
	OLS		OLS		OLS		OLS		OLS	
	(1)		(2)		(3)		(4)		(5)	
Panel A: Partitioning sample according to the importance of employee retention and labor strength										
	Low	High	Low	High	Low	High	Low	High	Low	High
Panel A1: Partitioning sample according to industry employee voluntary turnover rate (2-digit SIC)										
Ln(1+E-option)	-0.065*	0.183***	-0.077	0.241***	-0.057	0.184***	-0.000	0.076**	0.004	0.039***
	(-1.8)	(4.0)	(-1.3)	(3.3)	(-1.4)	(3.5)	(-0.0)	(2.6)	(0.3)	(2.6)
N	750	1013	750	1013	750	1013	750	1013	750	1013
Panel A2: Partitioning sample according to KLD employee treatment index										
Ln(1+E-option)	0.017	0.158***	0.031	0.265***	0.046	0.186***	0.003	0.117***	0.006	0.045***
	(0.3)	(2.8)	(0.4)	(3.0)	(0.9)	(3.1)	(0.1)	(3.0)	(0.5)	(3.1)
N	2260	1233	2260	1233	2260	1233	2260	1233	2260	1233
Panel A3: Partitioning sample according to the industry unionization rate										
Ln(1+E-option)	0.023	0.078**	0.028	0.151***	0.022	0.109***	0.005	0.067***	0.003	0.030***
	(0.8)	(2.6)	(0.6)	(3.1)	(0.8)	(3.4)	(0.2)	(2.8)	(0.3)	(3.5)
N	3719	3997	3719	3997	3719	3997	3719	3997	3719	3997
Panel B: Partitioning sample according to the tendency of free-riding problem										
	High	Low	High	Low	High	Low	High	Low	High	Low
Panel B1: Partitioning sample according to the number of employees										
Ln(1+E-option)	0.039	0.076***	0.062	0.131***	0.064*	0.086***	0.015	0.053**	0.008	0.019**
	(1.1)	(3.3)	(1.1)	(3.1)	(1.8)	(3.3)	(0.6)	(2.3)	(1.0)	(2.3)
N	3923	3943	3923	3943	3923	3943	3923	3943	3923	3943
Panel B2: Partitioning sample according to growth options per employee										
Ln(1+E-option)	0.007	0.088***	0.016	0.171***	0.013	0.112***	0.007	0.078***	0.002	0.027***
	(0.3)	(2.8)	(0.4)	(3.3)	(0.5)	(3.4)	(0.3)	(3.1)	(0.3)	(3.1)
N	3931	3935	3931	3935	3931	3935	3931	3935	3931	3935
Panel C: Partitioning sample according to average stock option expiration period										
	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long
Ln(1+E-option)	0.046	0.086**	0.080	0.151**	0.063	0.116***	0.042	0.045*	0.020*	0.021**
	(1.1)	(2.3)	(1.2)	(2.6)	(1.4)	(2.9)	(1.5)	(1.7)	(1.8)	(2.0)
N	1776	1859	1776	1859	1776	1859	1776	1859	1776	1859
Panel D: Targeted vs. broad plans (Subsamples of firms with a smaller number of employees only)										
	Targeted	Broad	Targeted	Broad	Targeted	Broad	Targeted	Broad	Targeted	Broad
Ln(1+E-option)	0.033	0.098***	0.083	0.169***	0.046	0.114***	0.055	0.071**	0.021	0.029**
	(1.0)	(2.8)	(1.3)	(2.7)	(1.4)	(3.0)	(1.4)	(2.0)	(1.6)	(2.3)
N	1624	2319	1624	2319	1624	2319	1624	2319	1624	2319

Table III.VIII: Effect of non-executive stock options per employee on R&D activities

The sample consists of firms covered in both the ExecuComp and the NBER Patent and Citation Database between 1993 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. Column (1) reports the estimates of OLS regression with *Ln*(*R&D/#employees*) as the dependent variable. In column (2), the dependent variable is *R&D/Assets*. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	R&D intensity	*R&D/Assets*
	OLS	OLS
	(1)	(2)
Ln(1+E-option)	0.228***	0.009***
	(12.9)	(8.1)
Ln(1+CEO delta)	-0.071***	-0.004***
	(-4.9)	(-4.8)
Ln(1+CEO vega)	0.021***	0.001***
	(4.8)	(5.0)
Ln(1+CEO tenure)	-0.003	0.001
	(-0.2)	(0.8)
Ln(PPE/#employees)	0.057	-0.001
	(1.5)	(-0.3)
Leverage	-0.817***	-0.025**
	(-6.7)	(-2.4)
Cash/Assets	2.000***	0.095***
	(13.1)	(6.1)
Ln(Sales/#employees)	-0.025	-0.009***
	(-0.6)	(-3.0)
Ln(Assets)	0.158***	0.001
	(8.5)	(0.6)
Sales growth	-0.206***	-0.004
	(-3.9)	(-0.6)
Tobin's q	0.052***	0.005***
	(4.2)	(2.6)
Stock volatility	8.186***	0.144
	(5.1)	(0.9)
Stock return	0.077***	-0.001
	(4.0)	(-0.4)
ROA	-1.161***	-0.194***
	(-6.2)	(-5.1)
Herfindahl index	-1.654***	-0.088***
	(-4.3)	(-5.6)
Herfindahl index^2	1.802***	0.088***
	(4.1)	(5.3)
Constant	-1.651***	0.041**
	(-6.3)	(2.2)
Industry FE	Y	Y
Year FE	Y	Y
N	7866	7866
R-squared	0.72	0.53

Table III.IX: Effect of employee incentives on innovation productivity

This table estimates the regressions related to non-executive delta per employee (*E-delta*) and non-executive vega per employee (*E-vega*) and the corporate innovations. Panel A reports the estimates of regressions after controlling for CEO incentives. Panel B reports the estimates of regressions after controlling for top five executive incentives. The sample consists of firms jointly covered in the ExecuComp, the NBER Patent and Citation Database, and the IRRC Dilution Database between 1998 and 2003. To be included in the sample, firms in the same industry must have at least one patent in any year. *E-delta* and *E-vega* are the sensitivity of non-executive stock option to 1% change in stock price divided by the number of employees and the sensitivity of non-executive stock option to 1% change in stock return volatility divided by the number of employees calculated from the IRRC Dilution Database during 1998 to 2003. *Qcitations* and *TTcitations* are adjusted using the weighting index of Hall, Jaffe, and Trajtenberg (2001) and the method of time-technology class fixed effect, respectively. The detailed definitions of variables are described in Appendix B. All variables are winsorized at the 1% level at both tails of the distribution. Dollar values are converted into 2000 constant dollars using the GDP deflator. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are also corrected for correlation across observations for a given firm. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table III.IX (cont'd)
Effect of employee incentives on innovation productivity

Panel A: Employee incentives and corporate innovation productivity by controlling for CEO incentives

	Ln(1+#patent)	*Ln(1+Qcitations_t)*	*Ln(1+TTcitations_t)*	*Ln(1+Qcitations)*	*Ln(1+TTcitations)*
	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
Ln(1+E-delta)	0.004	0.011	0.019	0.005	0.002
	(0.1)	(0.2)	(0.5)	(0.2)	(0.2)
Ln(1+E-vega)	0.128***	0.205***	0.126***	0.073***	0.027***
	(4.6)	(4.4)	(4.1)	(3.2)	(3.3)
R&D/Assets	4.525***	7.181***	4.403***	2.797***	0.854***
	(4.8)	(4.5)	(4.5)	(3.7)	(3.2)
Ln(1+CEO delta)	-0.016	-0.028	-0.015	-0.008	-0.002
	(-0.6)	(-0.7)	(-0.6)	(-0.4)	(-0.3)
Ln(1+CEO vega)	0.008	0.013	0.002	0.008	0.001
	(1.1)	(1.0)	(0.2)	(1.3)	(0.4)
Ln(1+CEO tenure)	-0.002	-0.020	-0.022	-0.018	-0.012
	(-0.1)	(-0.3)	(-0.6)	(-0.7)	(-1.1)
Ln(PPE/#employees)	-0.012	-0.011	-0.016	0.009	-0.001
	(-0.2)	(-0.1)	(-0.3)	(0.3)	(-0.0)
Leverage	-0.741***	-1.244***	-0.803***	-0.350**	-0.091
	(-3.2)	(-3.4)	(-3.2)	(-2.0)	(-1.3)
Cash/Assets	-0.012	-0.129	-0.069	-0.018	0.018
	(-0.0)	(-0.3)	(-0.3)	(-0.1)	(0.2)
Ln(Sales/#employees)	-0.134**	-0.146	-0.125*	-0.024	-0.017
	(-2.2)	(-1.5)	(-1.9)	(-0.5)	(-0.9)
Ln(Assets)	0.568***	0.821***	0.585***	0.219***	0.079***
	(16.9)	(16.3)	(16.5)	(11.0)	(10.0)
Sales growth	-0.321***	-0.536***	-0.347***	-0.187**	-0.058*
	(-3.7)	(-3.6)	(-3.5)	(-2.5)	(-1.9)
Tobin's q	0.042**	0.095***	0.062***	0.047***	0.019***
	(2.3)	(3.0)	(3.0)	(2.7)	(2.9)
Stock volatility	2.463	7.965*	4.727	4.832**	1.607**
	(0.9)	(1.8)	(1.6)	(2.4)	(2.0)
Stock return	0.086**	0.171***	0.107***	0.084***	0.021*
	(2.6)	(3.0)	(2.9)	(2.7)	(1.7)
ROA	1.260***	1.964***	1.193***	0.793***	0.230**
	(4.2)	(3.8)	(3.6)	(3.1)	(2.3)
Herfindahl index	-0.091	0.374	0.068	0.313	0.068
	(-0.2)	(0.4)	(0.1)	(0.8)	(0.4)
Herfindahl index^2	0.453	0.232	0.269	-0.010	0.033
	(0.7)	(0.2)	(0.4)	(-0.0)	(0.2)
Constant	-4.404***	-7.371***	-4.788***	-2.784***	-0.879***
	(-7.5)	(-7.8)	(-7.6)	(-6.5)	(-5.2)
Industry FE	Y	Y	N	Y	Y
Year FE	Y	Y	Y	Y	Y
N	3614	3614	3614	3614	3614
R-squared	0.56	0.53	0.51	0.41	0.30

Table III.IX (cont'd)
Effect of employee incentives on innovation productivity

Panel B: Employee incentives and corporate innovation productivity by controlling for top five executive incentives

	Ln(1+#patent)	*Ln(1+Qcitations_t)*	*Ln(1+TTcitations_t)*	*Ln(1+Qcitations)*	*Ln(1+TTcitations)*
	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)
Ln(1+E-delta)	0.021	0.041	0.035	0.020	0.006
	(0.5)	(0.7)	(0.9)	(0.7)	(0.6)
Ln(1+E-vega)	0.106***	0.174***	0.110***	0.059**	0.024***
	(3.7)	(3.6)	(3.6)	(2.5)	(2.8)
R&D/Assets	4.376***	6.973***	4.297***	2.710***	0.833***
	(4.7)	(4.4)	(4.5)	(3.6)	(3.1)
Ln(1+top five executive delta)	-0.076**	-0.129**	-0.068*	-0.059**	-0.018*
	(-2.2)	(-2.4)	(-1.9)	(-2.3)	(-1.8)
Ln(1+top five executive vega)	0.071*	0.095	0.042	0.041	0.008
	(1.9)	(1.6)	(1.1)	(1.4)	(0.8)
Ln(PPE/#employees)	-0.008	-0.007	-0.016	0.010	-0.001
	(-0.1)	(-0.1)	(-0.3)	(0.3)	(-0.1)
Leverage	-0.779***	-1.306***	-0.834***	-0.383**	-0.100
	(-3.4)	(-3.5)	(-3.3)	(-2.2)	(-1.4)
Cash/Assets	-0.002	-0.121	-0.069	-0.016	0.016
	(-0.0)	(-0.3)	(-0.3)	(-0.1)	(0.2)
Ln(Sales/#employees)	-0.134**	-0.148	-0.125*	-0.026	-0.017
	(-2.1)	(-1.5)	(-1.8)	(-0.6)	(-0.9)
Ln(Assets)	0.563***	0.826***	0.590***	0.227***	0.083***
	(13.6)	(13.0)	(13.5)	(8.5)	(8.2)
Sales growth	-0.305***	-0.513***	-0.337***	-0.179**	-0.057*
	(-3.5)	(-3.5)	(-3.4)	(-2.4)	(-1.9)
Tobin's q	0.050***	0.108***	0.069***	0.054***	0.021***
	(2.7)	(3.4)	(3.2)	(3.1)	(3.1)
Stock volatility	2.366	7.676*	4.511	4.657**	1.525*
	(0.9)	(1.8)	(1.5)	(2.3)	(1.9)
Stock return	0.086**	0.171***	0.106***	0.083***	0.020*
	(2.6)	(2.9)	(2.9)	(2.6)	(1.7)
ROA	1.237***	1.940***	1.176***	0.792***	0.230**
	(4.2)	(3.8)	(3.5)	(3.1)	(2.3)
Herfindahl index	-0.086	0.388	0.078	0.325	0.074
	(-0.1)	(0.4)	(0.1)	(0.8)	(0.5)
Herfindahl index^2	0.419	0.172	0.232	-0.042	0.020
	(0.6)	(0.2)	(0.3)	(-0.1)	(0.1)
Constant	-4.382***	-7.214***	-4.672***	-2.692***	-0.841***
	(-7.4)	(-7.4)	(-7.1)	(-6.0)	(-4.7)
Industry FE	Y	Y	N	Y	Y
Year FE	Y	Y	Y	Y	Y
N	3614	3614	3614	3614	3614
R-squared	0.56	0.53	0.51	0.41	0.30