Three Essays in Finance

by

Feng Zhang

B.A., Xi'an Jiaotong University, 1999

M.A., Xi'an Jiaotong University, 2002

M.Sc., National University of Singapore, 2004

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Abstract

This dissertation contains three studies.

Chapter 2 investigates interactions between antitakeover provisions and managerial ownership, two corporate governance mechanisms. Antitakeover provisions weaken the incentive effect of managerial ownership and magnify its entrenchment effect, and thus will decrease the effect of managerial ownership on firm value. I show that the value effect of managerial ownership crucially depends on the strength of antitakeover provisions. For firms with weak antitakeover provisions, managerial ownership enhances firm value, unless managers have very high ownership. For firms with strong antitakeover provisions, however, increasing managerial ownership always destroys firm value. Also, managerial ownership significantly decreases with the strength of antitakeover provisions. These findings support the hypotheses that antitakeover provisions decrease the value effect of managerial ownership and affect managers' compensation contract.

Chapter 3 proposes a model to investigate the role of information precision in IPO pricing. The model shows that more precise information will exert more influence on the offer price. In strong support of the model, I find that the proportion of the industry return during the waiting period that is incorporated into the offer price increases with a proxy for precision of the industry return as a measure of the change in the IPO firm's value during the waiting period. This study enhances our understanding of the partial adjustment phenomenon: noisy information will be partially incorporated into the offer price.

Chapter 4 shows that young male CEOs appear to be combative: they are four percent more likely to be acquisitive and, having initiated an acquisition, they are over 20 percent more likely to withdraw an offer. Furthermore, a young target male CEO is two percent more likely to force a bidder to resort to a tender offer. We argue that this combative nature is a result of testosterone levels that are higher in

young males. Testosterone is a hormone associated with male dominance seeking. The acts of attempting or resisting an acquisition can be viewed as striving to achieve dominance. We argue that the evidence reported in this paper is consistent with the presence of a significant hormone effect in M&As.

Preface

This preface provides a statement of co-authorship for the work contained in this thesis.

The studies in Chapters 2 and 3 were carried out on my own. I have benefited from discussions with many people (see footnotes in these two chapters for names of the people), including my advisors: Profs. Rob Heinkel, Thomas Hellmann, Mo Levi, Kai Li, and Hernan Ortiz-Molina.

The work in Chapter 4 was undertaken collaboratively with Profs. Mo Levi and Kai Li. A version of this chapter has been published in the September 2010 issue (Volume 56, Number 9) of *Management Science* on pages 1462-1483. I actively participated in all aspects of the development of this paper, including idea development, data analysis, and writing.

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I also want to thank the professors and peer PhD students at the finance division of the Sauder School of Business who have participated in my presentations at UBC and given me valuable suggestions on my research.

My special and sincere thanks go to my loving family. I would like to thank my parents for their belief in me and their love in my whole life. To my wife, Toyo, I want to thank her for her love and support. Life is so colorful with her and my lovely daughter, Sayuri.

Dedication

To my wife, Toyo, and my daughter, Sayuri.

Chapter 1

Introduction

Managerial ownership and antitakeover provisions are two important mechanisms of an effective corporate governance system. The separation of ownership from control results in an agency problem: the interest of managers is not necessarily aligned with that of shareholders. Received wisdom has it that shareholdings of managers alleviate, if not eliminate, the shareholder-manager interest conflict (Jensen and Meckling, 1976). However, too much ownership helps entrench the managers with the associated voting power (Stulz, 1988). Antitakeover provisions enhance the bargaining position of the target firm against the bidder, and therefore will raise the bid premium. The strengthened bargaining position may be utilized by the managers of the target firm to entrench themselves (DeAngelo and Rice, 1983; Comment and Schwert, 1995).

The previous literature separately studies the firm value effects of managerial ownership and antitakeover provisions.[1] These studies, however, did not consider possible interactions between managerial ownership and antitakeover provisions.

In Chapter 2 of this dissertation, I show that antitakeover provisions and managerial ownership interact with each other through two channels. First, antitakeover provisions and managerial ownership magnify each other's entrenchment effect. For example, a supermajority requirement to approve an acquisition makes the target managers' voting power more pivotal, and thus makes it easier for the managers to block the acquisition. Second, antitakeover provisions weaken the incentive effect of

[1] See, among others, Morck et al. (1988), Stulz (1988), McConnell and Servaes (1990), Hermalin and Weisbach (1991), Kole (1995), Holderness et al. (1999), McConnell et al. (2008), Fahlenbrach and Stulz (2009), Gompers et al. (2003), and Bebchuk et al. (2009).

managerial ownership. Both channels of interaction predict that antitakeover provisions will decrease the effect of managerial ownership on firm value. I find strong empirical evidence consistent with this prediction.

Chapter 3 investigates the role of information precision in IPO pricing. After filing an IPO, the issuing firm learns about firm value from investors and the market. There have been studies on how this information affects the offer price.[2] However, the role of precision of this information in IPO pricing remains underexplored.

In a rational expectations equilibrium model, I show that more precise information will exert more influence on the offer price. The empirical results strongly support the prediction of the model: I find that the proportion of the industry return during the waiting period that is incorporated into the offer price increases with precision of the industry return as a measure of the change in the IPO firm's value during the waiting period.

Chapter 4 investigates the role of hormones in mergers and acquisitions. Previous studies find a significant positive relation between dominant/aggressive behavior and testosterone, suggesting that high-testosterone males are more willing to be dominance seeking.[3] Winning an acquisition "contest" enhances the CEO's dominance. Therefore, we expect that testosterone will affect outcomes of M&As.

Using age as a proxy for the level of testosterone, we show that young male CEOs, who are supposed to have high levels of testosterone, are more likely to be acquisitive and, having initiated an acquisition, they are more likely to withdraw an offer. Furthermore, a young target male CEO is more likely to force a bidder to resort to a tender offer. Initiating or resisting an acquisition can be interpreted as dominance seeking. The evidence reported in this chapter is consistent with the presence of a significant hormone effect in M&As.

[2]See Benveniste and Spindt (1989), Hanley (1993), Loughran and Ritter (2002), Bradley and Jordan (2002), Lowry and Schwert (2004), and Edelen and Kadlec (2005).

[3]See Book et al. (2001), Olweus et al. (1980), Harris et al. (1996), and Mazur and Booth (1998).

Chapter 2

Antitakeover Provisions, Managerial Incentives, and Firm Value [1]

2.1 Introduction

As essential parts of a corporate governance system, antitakeover provisions and managerial ownership work together to affect governance in a firm. This study investigates their interactions in affecting corporate governance and firm value. The specific questions of interest are as follows. Do antitakeover provisions affect the incentives generated by manager shareholdings? If so, how should shareholders adjust the manager's compensation contract accordingly? How do antitakeover provisions and managerial ownership interact in affecting firm value? No paper to my knowledge has examined the combined effect that managerial ownership and antitakeover provisions have on corporate governance and firm value.[2] This study attempts to fill the void.

[1]I thank Rob Heinkel, Thomas Hellmann, and Kai Li for many insightful comments and guidance. In addition, I am grateful to Jan Bena, Jason Chen, Glen Donaldson, Ron Giammarino, Alan Kraus, Ali Lazrak, Mike Lemmon, Mo Levi, Hernan Ortiz-Molina, Ning Tang, seminar participants at UBC, University of Utah, University of Toronto, and conference participants at the 2010 Northern Finance Association meetings for their comments and suggestions. Financial support from the Canadian Foundation for Governance Research's Robert Bertram Doctoral Research Awards is gratefully acknowledged. All remaining errors are mine.

[2]The literature has examined related but different questions. Stein (1988) shows that antitakeover provisions encourage managers to commit to long-term investments. Bertrand and Mullainathan (1999, 2000) and Cheng and Indjejikian (2009) study how the second-generation state takeover laws affect the level and structure of executive compensation.

There are two channels of interaction between antitakeover provisions and managerial ownership. First, antitakeover provisions and managerial ownership magnify each other's entrenchment effect. The voting power of managers' shareholdings helps entrench the managers (Stulz, 1988). Anittakeover provisions may also entrench the managers by protecting them from takeovers. These two entrenchment mechanisms could complement each other. For instance, before the passage of the second-generation antitakeover laws in the 1980s, an acquirer can purchase a significant proportion of a firm's shares and then dismiss the firm's managers with the voting power of the acquired shares, even if the managers also hold non-trivial ownership. The antitakeover laws usually require that the acquirer must receive the approval of a supermajority (usually 75% or 80%) of the target firm's shareholders before the acquirer purchases significant amount of the target's shares. The supermajority requirement makes the target managers' voting power pivotal, and thus makes it easier for the target managers to block the acquisition with their voting power.

The second channel of interaction is that antitakeover provisions weaken the incentive effect of managerial ownership. The intuition is as follows. When the target manager exerts less effort, the stand-alone value of the target firm is lower and so acquiring this firm will generate a greater potential synergy gain. That is, less managerial effort leads to greater synergies. Antitakeover provisions enhance the bargaining position of the target firm against the bidder, and therefore will raise the bid premium. When the target firm is able to seize more of the synergy with the help of antitakeover provisions, its manager has incentives to increase the size of the synergy by reducing effort, *ceteris paribus*. This implies that antitakeover provisions reduce managerial effort; or put another way, since managerial ownership leads to increased manager effort, antitakeover provisions weaken the incentive effect of managerial ownership.

Taken together, antitakeover provisions magnify the entrenchment effect of managerial ownership and weaken its incentive effect. These two channels of interaction predict that antitakeover provisions will decrease the effect of managerial ownership on firm value.

Employing a sample of almost 15,000 firm-year observations over the period 1992-2007, I show that antitakeover provisions significantly, both economically and statistically, reduce the effect of managerial ownership on firm value. The strength of antitakeover provisions is proxied by the entrenchment index (E index hereafter) constructed by Bebchuk et al. (2009) using six antitakeover provisions. A greater E

index indicates stronger antitakeover provisions. Each additional antitakeover provision in the E index reduces the marginal effect of managerial ownership on firm value by approximately a third. The impact of antitakeover provisions is so large that the effect of managerial ownership on firm value becomes negative when the E index is above the median. On the other hand, managerial ownership enhances firm value when the E index is below the median, unless the managers have very high levels of ownership. These results are robust to a battery of robustness checks, including alternative measures of managerial ownership and different econometric specifications. In addition, the antitakeover provisions in the E index decrease the value effect of managerial ownership not only in aggregate but also individually.

Aware of the negative impact of antitakeover provisions on the incentive effect of managerial ownership, shareholders should grant fewer shares to the manager when there are stronger antitakeover provisions. I show that managerial ownership decreases significantly with the strength of antitakeover provisions. On average, the combined ownership of the top five executives is 7.6% in the firms with the weakest antitakeover provisions, and 2.1% in the firms with the strongest antitakeover provisions.

The empirical results are prone to endogeneity concerns because, arguably, both the level of managerial ownership and the strength of antitakeover provisions are endogenously determined. The last part of the paper deals with potential endogeneity issues by controlling for firm fixed effects, conducting an event study, running instrumental variable regressions, and excluding alternative explanations. The results of these analyses uniformly support that antitakeover provisions weaken the value effect of managerial ownership. For example, the event study shows that antitakeover provisions reduce the announcement returns of manager share purchases in the open market.

This paper relates to the literature on managerial ownership, which documents an inverse U-shaped relation between managerial ownership and firm value.[3] I show that the inverse U-shaped relation holds only when antitakeover provisions are weak. With strong antitakeover provisions, increasing managerial ownership always destroys firm value.

[3]See, among others, Morck et al. (1988), McConnell and Servaes (1990), Hermalin and Weisbach (1991), Kole (1995), Holderness et al. (1999), McConnell et al. (2008), and Fahlenbrach and Stulz (2009).

This paper also contributes to a growing literature on the interactions between different corporate governance mechanisms. Cremers and Nair (2005), Cremers et al. (2007), Huson et al. (2001), and Kini et al. (2004) study how the market for corporate control interacts with the board of directors and/or institutional investor monitoring. Cohn and Rajan (2010) model the interaction between the board and activist investors. Giroud and Mueller (2010a,b) study the interaction between antitakeover provisions and product market competition. Kim and Lu (2010) study whether and how CEO ownership interacts with product market competition and institutional investor monitoring. Bertrand and Mullainathan (1999, 2000); and Cheng and Indjejikian (2009) study how the second-generation state takeover laws affect the level and structure of executive compensation. This paper adds to the existing literature by studying the interactions antitakeover provisions and managerial incentives on firm value.

The rest of the paper is organized as follows. Section 2.2 presents a simple model to analyze the impacts of antitakeover provisions on managerial incentives and compensation contract. Section 2.3 describes the data and econometric methodology. Section 2.4 presents the empirical results and implements various robustness checks. Section 2.5 addresses potential endogeneity issues.

2.2 Antitakeover Provisions and Managerial Incentives

2.2.1 Antitakeover Provisions and the Compensation Contract

The shareholders hire a professional manager to run their firm. They compensate the manager with a salary, s, and a certain amount of ownership, $\alpha \in [0,1]$.[4] The shareholders are assumed to be risk neutral.

The manager decides how much effort to exert given the compensation contract. The effort exerted by the manager is neither observed by the shareholders, nor is it contractible. The manager's effort is denoted as e, and is costly to the manager. For simplicity, the cost-of-effort function is assumed to be quadratic: $C(e) = \frac{1}{2k}e^2$, where $k > 0$. A greater k indicates a lower cost of effort. The firm's stand-alone value is

[4]This compensation contract may not be the optimal one. A linear contract is the second-best solution under certain conditions, as shown by Holmström and Milgrom (1987). This linear contract is used for its simplicity. A complex compensation contract would make it difficult to highlight the economic intuition.

equal to the manager's effort plus a noise: $\phi = e + \varepsilon$, where ε is normally distributed with zero mean and variance σ^2. The manager has a mean-variance risk preference represented by the following utility function:

$$u(w,e) = E\left[w - C(e)\right] - \frac{\eta}{2} var(w), \tag{2.1}$$

where w is the amount of compensation the manager receives, $E(.)$ and $var(.)$ are the mean and variance operators, respectively, and $\eta > 0$ is the coefficient of risk aversion.[5] The manager's reservation utility is $\bar{u}$, which is known to the shareholders.

The above model setup is standard in the literature on linear compensation contracts (Bolton and Dewatripont, 2005). New to the literature, this paper introduces antitakeover provisions to the model and explores how they affect the contract and managerial incentives. Antitakeover provisions are assumed to be exogenously given. This simplifies the algebra and thereby allows me to clearly demonstrate the impact of antitakeover provisions on managerial incentives. Antitakeover provisions are endogenized in Appendix A.

A raider tries to acquire the above-mentioned target firm at the end of the model. The value of the target firm to the raider is: $\tau = \bar{v} + \varepsilon$, where ε is the same noise that affects the stand-alone value of the target firm, and $\bar{v}$ is the intrinsic value of the target firm to the raider.[6] Thus, the synergy gain associated with the takeover is: $\tau - \phi = \bar{v} - e$.

How the synergy is divided between the raider and the target depends on the target's bargaining position, which in turn is determined by the strength of the target firm's antitakeover provisions. Stronger antitakeover provisions enable the target shareholders to form a cartelized response to the takeover bid and therefore enhance the target's bargaining position. That is, stronger antitakeover provisions enable the target to seize a larger share of the synergy. Section 2.2.2 discusses how antitakeover provisions enhance the target's bargaining position in more detail. Suppose the target's antitakeover provisions allow it to seize p of the synergy. In other words, the raider will pay a bid premium $p(\bar{v} - e)$ to the target's shareholders.

[5] When the amount of compensation follows a normal distribution, this mean-variance utility function is equivalent to the constant absolute risk-averse (CARA) utility function with coefficient of absolute risk aversion η: $u(w,e) = -\exp\{-\eta\left[w - C(e)\right]\}$.

[6] The results are not affected if $\bar{v}$ is assumed to depend on e as long as the synergy decreases with e. The results are also not affected if τ does not depend on ε.

The shareholders choose a compensation contract (s and α) to maximize their expected wealth, subject to the manager's optimal choice of effort and the manager's participation constraint:

$$\max_{s,\alpha} \quad \psi = (1-\alpha)[e + p(\bar{v} - e)] - s \tag{2.2}$$

$$s.t. \quad e \in \arg\max \left\{ s + \alpha\,[e + p(\bar{v} - e)] - \frac{1}{2k}e^2 - \frac{\eta}{2}\alpha^2\sigma^2 \right\} \tag{2.3}$$

$$s + \alpha\,[e + p(\bar{v} - e)] - \frac{1}{2k}e^2 - \frac{\eta}{2}\alpha^2\sigma^2 \geq \bar{u}. \tag{2.4}$$

The optimal managerial ownership and the optimal managerial effort are:

$$\alpha^* = \frac{k(1-p)^2}{k(1-p)^2 + \eta\sigma^2}, \tag{2.5}$$

$$e^* = k\alpha(1-p) = \frac{k^2(1-p)^4}{k(1-p)^2 + \eta\sigma^2}. \tag{2.6}$$

Proposition 2.1 *Antitakeover provisions have the following impacts on managerial incentives:*

1. *Antitakeover provisions reduce managerial effort ($\frac{de^*}{dp} \leq 0$).*
2. *Antitakeover provisions decrease the marginal effect of managerial ownership on firm value ($\frac{\partial^2 \pi}{\partial \alpha \partial p} \leq 0$, where π denotes firm value).*
3. *Managerial ownership decreases with the strength of antitakeover provisions ($\frac{d\alpha^*}{dp} \leq 0$).*

Proof: See Appendix B. ■

The intuition behind Proposition 2.1 can be explained as follows. Less managerial effort leads to a greater synergy gain, which is divided between the target and the raider. Stronger antitakeover provisions raise the target's share of the synergy, and thus encourage the manager to exert less effort because more of the synergy accrues to the target with stronger antitakeover provisions. That is, antitakeover provisions reduce managerial effort, *ceteris paribus*. A high managerial ownership incentivizes the manager to exert more effort. Antitakeover provisions weaken this incentive effect by reducing managerial effort. Consequently, the marginal effect of managerial ownership on firm value decreases with the strength of antitakeover provisions.

Aware of this negative impact of antitakeover provisions on the incentive effect of managerial ownership, shareholders grant fewer shares to the manager when there are stronger antitakeover provisions.

2.2.2 Antitakeover Provisions and Target Firms' Bargaining Position

This section discusses how antitakeover provisions enhance a target firm's bargaining position against an acquirer, which is a key assumption in the model.

Suppose a raider launches a takeover bid to acquire up to 100% of the target firm's shares. The bid succeeds if more than 50% of shares are tendered. Grossman and Hart (1980) suggest that a necessary condition for the bid to succeed is that the offer price must be greater than the stock price of the target after the bid succeeds. Otherwise, the free rider problem arises and no shareholder will tender.

The target's shareholders as a group have an incentive to not tender their shares (hold up) in order to push up the bid price. If the shareholders are able to form a cartel then no shareholder will tender at a low price, and consequently they will be able to bargain for a higher offer. However at an individual level, each shareholder has an incentive to tender at a low price because the bid premium will be lost if he or she holds up while other shareholders tender more than 50% of the total shares of the firm. In other words, individual shareholders have an incentive to tender, while as a group they have an incentive to hold up.

DeAngelo and Rice (1983) suggest that antitakeover provisions help the target's shareholders form a cartelized response to a tender offer and thus enhance their bargaining position. For example, supermajority provisions raise the level of ownership that must be purchased in order to ensure subsequent shareholder approval of a merger, and therefore encourage shareholders to hold out for a higher price.

Another example of antitakeover provisions is poison pills, which make it almost impossible for a bid to succeed without the approval of the target's board. Poison pills can be removed by the board without the approval of shareholders. Therefore, one way to circumvent poison pills is to initiate a proxy fight in the hope of replacing the directors who resist the acquisition. The proxy fight may not succeed given that many firms have staggered boards, which would prevent the raider from replacing the directors all at once and would thus increase the cost of the proxy fight. Hence,

poison pills and staggered boards force the raider to negotiate directly with the target's directors on the bid premium. Since there are fewer directors than shareholders, and since the directors meet more frequently, they can collude at a lower cost and therefore bargain for better acquisition terms. This enhanced bargaining position will increase the proportion of the synergy that accrues to the target's shareholders, provided that the board is acting in the shareholders' interest.

The above discussions suggest that antitakeover provisions enhance the bargaining position of the target firm, and therefore enable the target to seize a larger share of the synergy. Consistent with these discussions, Comment and Schwert (1995) and Heron and Lie (2006) find that antitakeover provisions significantly increase the bid premiums in large samples of takeovers.

2.2.3 Testable Implications

In summary, the implications of antitakeover provisions for managerial incentives and firm value are:

1. Antitakeover provisions decrease the incentive effect of managerial ownership on firm value.

2. Managerial ownership decreases with the strength of antitakeover provisions.

In the sections that follow, I first empirically evaluate the above predictions in a multivariate context; I then account for potential endogeneity concerns about managerial ownership and antitakeover provisions.

2.3 Methodology and Data

2.3.1 Methodology

Following the literature (e.g., Morck et al. (1988)), firm value is proxied by Tobin's Q. Managerial ownership is calculated as the percentage ownership of the top five executives covered in the Standard and Poor's ExecuComp database.[7] Restricted

[7]The literature uses various measures of managerial ownership. For example, Morck et al. (1988) and Hermalin and Weisbach (1991) use the ownership of the board of directors; McConnell and Servaes (1990) and Fahlenbrach and Stulz (2009) use the ownership of insiders (both

stocks are included in the calculation, while stock options are excluded. Including stock options does not qualitatively affect the results, as will be shown in section 2.4.

The strength of a firm's antitakeover provisions is proxied by the E index constructed by Bebchuk et al. (2009) using six antitakeover provisions: staggered boards, poison pills, supermajority requirement for mergers, limits to amend bylaws, limits to amend charter, and golden parachutes. The value of the E index increases by one for each antitakeover provision in place. Therefore, it takes a value from zero (for the weakest antitakeover provisions) to six (for the strongest antitakeover provisions).

The following econometric model is employed to test the implication of antitakeover provisions for vale effect of managerial ownership:

$$\begin{aligned} Q_{it} = \; & \beta_0 + \beta_1 \times \text{Managerial ownership}_{it} + \beta_2 \times \text{Managerial ownership}_{it}^2 \\ & + \beta_3 \times \text{E index}_{it} + \beta_4 \times \text{Managerial ownership}_{it} \times \text{E index}_{it} \\ & + \beta_5 \times X_{it} + u_{it}. \end{aligned} \tag{2.7}$$

where Q_{it} is the Tobin's Q of stock i in year t; X_{it} is a vector of control variables; and u_{it} is the residual. The interaction variable of managerial ownership and the E index captures the impact of antitakeover provisions on the effect of managerial ownership on firm value. Following Morck et al. (1988) and others, the square of managerial ownership is also added as an explanatory variable.[8]

Following Himmelberg et al. (1999), I control for possible determinants of managerial ownership in the regression. Firms whose assets are difficult to monitor should provide greater incentives to their managers in order to mitigate the moral hazard problem. Therefore, the following variables are included as proxies for the scope of managerial discretionary spending: capital-to-sales ratio, research and development (R&D) spending, advertisement spending, investment, and profit margin. The first three variables are related to asset tangibility; profit margin measures the profit available for operation; and capital expenditure measures the scope for discretionary

top managers and directors). Directors do not necessarily share the same interest as professional managers. This paper explores how antitakeover provisions affect the incentives of professional managers. Therefore, managerial ownership is measured with the ownership of the top five executives.

[8]See Footnote 3 for the literature on the inverse U-shaped relation between managerial ownership and firm value. In unreported results, an interaction variable of the E index and the square of managerial ownership is also added on the right hand side of the regression. The coefficient on this interaction variable is statistically indifferent from zero. Also, adding this interaction variable does not qualitatively change the results of this paper.

investments. All else being equal, managers in firms with greater idiosyncratic risks prefer lower ownership for the reason of diversification. Therefore, idiosyncratic risk is also included as a control variable. In addition, I control for firm size as measured by sales. Descriptions of these variables can be found in Appendix C.

2.3.2 Data

The data on managerial ownership are retrieved from Standard and Poor's ExecuComp database, which provides compensation data for the top five executives of the S&P 1500 companies. The data are collected directly from each company's annual proxy statements since 1992. For each fiscal year from 1992-2007, managerial ownership of each firm is calculated as the total number of shares owned by the top five executives divided by the total number of shares outstanding. Stock return data are retrieved from the CRSP database, accounting numbers from the Compustat database, and corporate governance data from the RiskMetrics database. Utilities (SIC codes 4900-4949) and financial firms (SIC codes 6000-6999) are excluded from the sample. Including them in the sample yields similar results throughout. The final sample has 14,962 firm-year observations.

Table 2.1 presents the summary statistics of managerial ownership over the sample period. There are 524 firms in the sample in 1992. The number of firms increases to more than 700 during the period 1993-1997, and reaches 1,000 in 1998.[9] The number stays stable at around 1,000 firms during the period 1998-2001, and further increases to more than 1,100 firms after 2001. On average, the executives own 3.9 percent of their companies. The distribution of managerial ownership is positive-skewed with a median of 0.8 percent. The mean managerial ownership is more than 4 percent in the 1990s and gradually decreases to 2.7 percent in 2007, while the median managerial ownership has been relatively stable over the years.

RiskMetrics collects data on antitakeover provisions for the S&P 1500 firms in the years of 1990, 1993, 1995, 1998, 2000, 2002, 2004, and 2006. For the years when the antitakeover provision data are not updated, the most recent data are used following Bebchuk et al. (2009). Table 2.2 Panel A presents the summary statistics of the E index for the years when the antitakeover provision data are updated.[10] The

[9]The number of firms is less than 1,500 because data on accounting numbers, managerial ownership, and antitakeover provisions are missing.

[10]I also include the year of 1992, the first year of the sample period.

Table 2.1: Managerial Ownership, 1992-2007

This table presents the summary statistics of managerial ownership. The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables.

Year	N	mean	sd	p5	p50	p95
1992	524	4.17%	10.12%	0.03%	0.54%	22.72%
1993	714	4.44%	9.44%	0.05%	0.87%	23.96%
1994	711	4.38%	8.88%	0.05%	0.88%	24.47%
1995	775	4.40%	8.77%	0.04%	0.80%	25.01%
1996	772	4.08%	8.53%	0.05%	0.69%	23.68%
1997	783	3.91%	7.91%	0.05%	0.73%	21.85%
1998	1073	4.77%	9.03%	0.06%	0.93%	24.92%
1999	1004	4.52%	8.71%	0.06%	0.85%	23.70%
2000	972	4.60%	8.83%	0.06%	0.91%	23.68%
2001	946	4.13%	8.45%	0.05%	0.79%	21.96%
2002	1145	3.98%	8.21%	0.05%	0.80%	20.09%
2003	1136	3.50%	7.32%	0.04%	0.72%	18.55%
2004	1169	3.36%	7.26%	0.05%	0.76%	16.90%
2005	1095	3.04%	6.53%	0.06%	0.75%	15.52%
2006	1104	2.94%	6.26%	0.05%	0.73%	15.45%
2007	1039	2.69%	6.00%	0.06%	0.70%	13.36%
Total	14962	3.87%	8.08%	0.05%	0.77%	21.39%

mean E index is around 2.3 in the 1990s and increases slightly to around 2.5 in the 2000s. The median E index is 2 or 3 over the sample period. The summary statistics are similar to those in Bebchuk et al. (2009).

Table 2.2 Panel B presents the frequencies of the six antitakeover provisions in the E index. Golden parachutes, staggered boards, and poison pills are the most commonly adopted provisions. On average, 62 percent of firms use golden parachutes, 59 percent use staggered boards, and 59 percent use poison pills. A supermajority requirement to approve mergers and limits to amend bylaws are adopted by 18 percent of the firms. Limits to amend charter is the least commonly adopted antitakeover provision among the six: on average, only 2 percent of firms implement it. The frequencies of staggered boards, poison pills, and limits to amend charter were stable during the sample period with only small fluctuations over the years. The frequency of having a supermajority requirement to approve mergers steadily decreased from approximately 40 percent in 1992 to less than 33 percent in 2006. On the contrary, limits to amend bylaws gained popularity during this period—its frequency increased from 13 percent in 1992 to 19 percent in 2006. The most salient changes however

Table 2.2: The E Index, 1992-2006

This table presents the summary statistics of managerial ownership (Panel A) and the E index (Panel B). Panel C reports the frequencies of the six provisions in the E index. In Panels B and C, only the years when the E index is updated are included. The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables.

Panel A: E Index, 1992-2006

Year	N	mean	sd	p5	p50	p95
1992	524	2.27	1.42	0.00	2.00	5.00
1993	714	2.28	1.40	0.00	2.00	4.00
1995	775	2.27	1.36	0.00	2.00	4.00
1998	1073	2.17	1.31	0.00	2.00	4.00
2000	972	2.31	1.31	0.00	2.00	4.00
2002	1145	2.47	1.28	0.00	3.00	4.00
2004	1169	2.49	1.24	0.00	3.00	4.00
2006	1104	2.41	1.24	0.00	2.00	4.00
Total	7476	2.35	1.31	0.00	2.00	4.00

Panel B: Frequencies of Antitakeover Provisions

Year	Staggered board	Poison pill	Super-majority	Limits to amend bylaws	Limits to amend charter	Golden parachutes
1992	57.82%	62.40%	39.89%	12.98%	2.48%	51.72%
1993	59.38%	60.08%	38.94%	14.99%	2.66%	52.38%
1995	60.13%	57.94%	38.71%	14.58%	2.97%	52.52%
1998	57.04%	55.17%	34.30%	15.66%	2.33%	52.47%
2000	58.23%	58.85%	34.36%	17.28%	2.16%	60.08%
2002	60.52%	62.10%	33.80%	20.79%	1.40%	68.03%
2004	59.97%	61.68%	32.42%	20.87%	1.71%	72.11%
2006	55.53%	56.25%	32.52%	19.02%	1.81%	76.27%
Total	58.56%	59.15%	34.97%	17.60%	2.10%	62.37%

happened to golden parachutes: the proportion of firms that had golden parachutes increased from about 50 percent in 1992 to about 75 percent in 2006.

Table 2.3 presents the summary statistics of Tobin's Q, managerial ownership, the E index, and the control variables. The mean Tobin's Q and industry-adjusted Tobin's Q are 2.0 and 0.4, respectively. As shown in Table 1, the mean managerial ownership is 3.9 percent; the mean E index is 2.4. The average firm has annual sales of approximately $5 billion. On average, property, plant, and equipment (PPE) accounts for 38 percent of annual sales. The mean idiosyncratic risk is about 2.4 percent, while the mean profit margin is about 15 percent. On average, the sample firms spend 28 percent of PPE on R&D, 9.5 percent on advertisement, and 23 percent on investment. Lastly, the data on R&D spending and advertisement spending are

available for 64 percent and 36 percent of the firms, respectively.

Table 2.3: Summary Statistics

This table presents the summary statistics of the variables. The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables.

Variable	N	mean	sd	p5	p50	p95
Tobin's Q	14962	2.02	1.28	0.94	1.62	4.53
Industry-adjusted Q	14962	0.41	1.19	-0.73	0.08	2.72
Managerial ownership (%)	14962	3.87	8.08	0.05	0.77	21.39
E index	14962	2.35	1.31	0.00	2.00	4.00
Sales ($Bn)	14962	4.95	11.52	0.16	1.37	20.50
Tangibility	14962	0.38	0.53	0.04	0.22	1.37
Idiosyncratic risk (%)	14962	2.37	1.17	1.08	2.07	4.69
Profit margin	14962	0.15	0.15	0.01	0.13	0.39
R&D	14962	0.28	0.67	0.00	0.01	1.51
R&D dummy	14962	0.64	0.48	0.00	1.00	1.00
Advertising expense	14962	0.09	0.31	0.00	0.00	0.46
Advertising dummy	14962	0.36	0.48	0.00	0.00	1.00
Investment	14962	0.23	0.14	0.07	0.20	0.51

Before presenting the multivariate regression results, it is necessary to examine the correlations between the variables, which are presented in Table 2.4. Managerial ownership is positively and significantly correlated with both Tobin's Q and industry-adjusted Tobin's Q; while the E index is negatively and significantly correlated with Tobin's Q, industry-adjusted Tobin's Q, and managerial ownership. The extent of the correlation among most pairs of variables raises little concern for multicollinearity in the regression analyses.

Table 2.4: Correlation Matrix

This table presents the correlation matrix of the variables. The *p*-values for statistical significance of the correlations are presented in the brackets. The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Tobin's Q	1.00												
2	Industry-adjusted Q	0.94	1.00											
		[0.00]												
3	Managerial ownership	0.02	0.05	1.00										
		[0.00]	[0.00]											
4	E index	-0.13	-0.13	-0.19	1.00									
		[0.00]	[0.00]	[0.00]										
5	Sales	-0.04	0.00	-0.15	0.02	1.00								
		[0.00]	[0.80]	[0.00]	[0.07]									
6	Tangibility	-0.11	-0.10	-0.05	0.01	-0.08	1.00							
		[0.00]	[0.00]	[0.00]	[0.20]	[0.00]								
7	Idiosyncratic risk	0.01	0.01	0.05	-0.09	-0.41	0.01	1.00						
		[0.53]	[0.07]	[0.00]	[0.00]	[0.00]	[0.46]							
8	Profit margin	0.22	0.21	-0.03	-0.01	0.15	0.28	-0.30	1.00					
		[0.00]	[0.00]	[0.00]	[0.31]	[0.00]	[0.00]	[0.00]						
9	R&D	0.22	0.13	-0.06	-0.08	-0.29	-0.14	0.26	-0.21	1.00				
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]					
10	R&D dummy	0.12	0.08	-0.10	0.02	0.00	-0.23	0.07	-0.12	0.31	1.00			
		[0.00]	[0.00]	[0.00]	[0.04]	[0.59]	[0.00]	[0.00]	[0.00]	[0.00]				
11	Advertising expense	0.08	0.08	0.05	-0.07	-0.02	-0.15	0.01	-0.06	0.16	-0.03	1.00		
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.21]	[0.00]	[0.00]	[0.00]			
12	Advertising dummy	0.09	0.09	0.02	-0.05	0.12	-0.15	-0.02	-0.04	0.08	0.06	0.41	1.00	
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]		
13	Investment	0.30	0.25	0.03	-0.11	-0.15	-0.19	0.18	0.01	0.34	0.06	0.18	0.08	1.00
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.09]	[0.00]	[0.00]	[0.00]	[0.00]	

2.4 Empirical Results

2.4.1 Multivariate Regression Results

Table 2.5 presents the multivariate regression results of the model (2.7). Column (1) reports the pooled OLS regression results. Column (2) controls for both industry fixed effects and year fixed effects. The residuals in the regression may be correlated across firm or over time, leading to over- or under-stated standard errors in the pooled OLS regressions. Following the suggestions of Petersen (2009), I control for year fixed effects and cluster the residuals by firm in column (3) in order to have robust standard errors. As an alternative way to show the impact of antitakeover provisions on the effect of managerial ownership on firm value, the sample is divided into two sub-samples based on the E index: the firms in the first sub-sample have an E index between 0 and 2, while those in the second sub-sample have an E index between 3 and 6.[11] Columns (4) and (5) of Table 2.5 present the regression results for these two sub-samples, respectively. In column (6), the dependent variable is replaced with the industry-adjusted Tobin's Q as an alternative way to control for industry effects.

The results in column (1) indicate that managerial ownership is positively and significantly associated with Tobin's Q at the one percent level; the coefficient on managerial ownership squared is negative and statistically significant at the ten percent level; and the E index is negatively and significantly associated with Tobin's Q at the one percent level. These findings are consistent with the previous literature. More interestingly, the coefficient on the interaction variable of managerial ownership and the E index is negative and statistically significant at the one percent level, suggesting that the marginal effect of managerial ownership on firm value decreases with the E index. This interaction is also economically significant. When the E index increases by one, the marginal effect of managerial ownership on Tobin's Q decreases by 0.552, which is approximately one third of the coefficient on managerial ownership (1.635).

The results are robust when controlling for industry and year fixed effects and clustering standard errors by firm: the results in columns (2), (3), and (6) are qualitatively similar to those in column (1).

[11] Figure 2.1 suggests that the effect of managerial ownership on firm value becomes negative for firms with an E index above 2.

Table 2.5: Determinants of Tobin's Q

The dependent variable in the first five columns and the last column are Tobin's Q and the industry-adjusted Tobin's Q, respectively. The firms that are used in the regression in column (4) have an E index between 0 and 2; the firms in column (5) have an E index between 3 and 6. The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables. The *p*-values are reported in the brackets. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Dependent Variable	Tobin's Q					Industry-adjusted Tobin's Q
Sample	Whole sample			E index ≤ 2	E index ≥ 3	Whole sample
	(1)	(2)	(3)	(4)	(5)	(6)
Managerial ownership	1.635***	1.858***	1.858**	1.891**	-1.268*	2.218**
	[0.000]	[0.000]	[0.046]	[0.030]	[0.076]	[0.019]
Managerial ownership squared	-1.091*	-1.360**	-1.360	-2.455	2.819*	-2.159
	[0.089]	[0.028]	[0.299]	[0.130]	[0.057]	[0.102]
E index	-0.050***	-0.044***	-0.044***			-0.044***
	[0.000]	[0.000]	[0.007]			[0.008]
Managerial ownership $\times$ E index	-0.552***	-0.536***	-0.536**			-0.560**
	[0.000]	[0.000]	[0.016]			[0.013]
Sales	-0.729***	-0.576***	-0.576***	-0.670***	-0.464***	-0.476***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.006]	[0.000]
Sales squared	4.622***	3.711***	3.711***	4.344***	2.971***	3.071***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.006]	[0.000]
Tangibility	-0.578***	-0.727***	-0.727***	-0.781***	-0.672***	-0.598***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tangibility squared	0.089***	0.147***	0.147***	0.190***	0.088**	0.110***
	[0.000]	[0.000]	[0.000]	[0.001]	[0.013]	[0.001]
Idiosyncratic risk	-0.009	-0.050***	-0.050***	-0.048*	-0.057***	-0.066***
	[0.404]	[0.000]	[0.008]	[0.084]	[0.010]	[0.000]
Profit margin	2.810***	2.627***	2.627***	2.592***	2.764***	2.238***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
R&D	0.260***	0.192***	0.192***	0.190***	0.212**	0.138***
	[0.000]	[0.000]	[0.000]	[0.002]	[0.012]	[0.004]
R&D dummy	0.188***	0.159***	0.159***	0.235***	0.065	0.121**
	[0.000]	[0.000]	[0.001]	[0.001]	[0.216]	[0.011]
Advertising expense	-0.021	-0.036	-0.036	0.062	-0.177	-0.004
	[0.658]	[0.452]	[0.705]	[0.510]	[0.287]	[0.960]
Advertising dummy	0.116***	0.046**	0.046	0.027	0.079	0.156***
	[0.000]	[0.046]	[0.325]	[0.691]	[0.184]	[0.001]
Investment	1.742***	1.837***	1.837***	1.940***	1.644***	1.484***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Constant	4.035***	3.574***	3.574***	3.831***	3.057***	1.785***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
Industry fixed effects	No	Yes	Yes	Yes	Yes	No
Year fixed effects	No	Yes	Yes	Yes	Yes	Yes
Cluster by firm	No	No	Yes	Yes	Yes	Yes
Observations	14962	14962	14962	7916	7046	14962
R^2	0.209	0.299	0.299	0.305	0.315	0.176

The results in columns (4) and (5) confirm that the effect of managerial ownership on firm value depends significantly on the level of the E index. The coefficient on managerial ownership is positive and statistically significant at the five percent level in column (4), where the firms have an E index from 0 to 2. It becomes negative and statistically significant at the ten percent level in column (5), where the firms have an E index from 3 to 6.

Figure 2.1 plots the fitted value of Tobin's Q against managerial ownership at different levels of the E index. The fitted value of Tobin's Q is generated using the regression results in column (3) of Table 2.5: $Q = 3.574 + 1.858 \times \text{Managerial ownership} - 1.360 \times \text{Managerial ownership}^2 - 0.044 \times \text{E index} - 0.536 \times \text{Managerial ownership} \times \text{E index}$. Since the top five executives in almost all firms have ownership below 20 percent, the figure focuses on the relation between managerial ownership and Tobin's Q over this empirical range of managerial ownership.[12] It shows that for the firms with an E index below 3, firm value increases with managerial ownership over the empirical range of managerial ownership. The effect of managerial ownership on firm value is indistinguishable from zero for the firms with an E index of 3, and becomes negative when the E index is above 3.[13]

Table 2.5 also shows that firms with smaller sales, less intangible assets, lower idiosyncratic risks, greater profit margins, more R&D spending, and more investments are positively associated with Tobin's Q. Moreover, sales squared and tangibility squared are positively associated with Tobin's Q.

2.4.2 Different Measures of Managerial Ownership

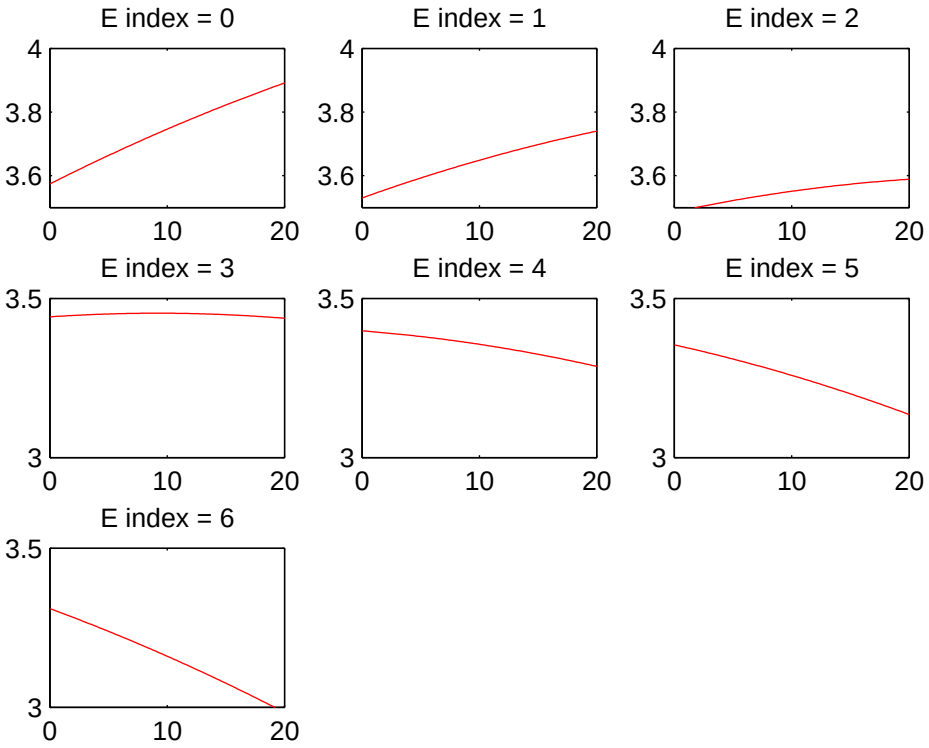
Stock options have been widely used to compensate executives since the early 1990s (Hall and Liebman (1998) and Aggarwal and Samwick (2003)). They are expected to provide similar incentives for executives as stock grants. As a robustness check, in this section I include stock options as part of managerial ownership. The CEO makes the most important corporate decisions and thus has the biggest impact on firm value. Therefore as another robustness check, this section also singles out the CEO's ownership and investigates its effect on firm value.

[12] The 95th percentile of managerial ownership is just above 20 percent in the sample.

[13] Over the full range of managerial ownership (from 0 to 100 percent) there is an inverse U-shaped relation between managerial ownership and Tobin's Q for the firms with an E index below 3. For the firms with an E index between 3 and 6, increasing managerial ownership always destroys firm value.

Figure 2.1: Relation between Managerial Ownership and Tobin's Q by E Index

This figure plots the fitted value of Tobin's Q against managerial ownership at different values of the E index. The X-axis is managerial ownership (in percentage). The Y-axis is Tobin's Q. The values of Tobin's Q are estimated from the regression results in column (3) of Table 2.5: $Q = 3.574 + 1.858 \times$ Managerial ownership $- 1.360 \times$ Managerial ownership$^2 - 0.044 \times$ E index $- 0.536 \times$ Managerial ownership $\times$ E index. Managerial ownership ranges from 0 to 20 percent in the figure since almost all firms in the sample have managerial ownership below 20 percent.



Pay-performance sensitivity (PPS) is commonly used to measure managers' incentives when both stocks and stock options are considered. For stocks, PPS is simply the percentage stock ownership; for stock options, PPS equals the number of shares underlying the options times the delta of each option divided by the total number of shares outstanding. The delta is defined as the partial derivative of the option value with respect to stock price. Managerial PPS is computed following Guay (1999) and Core and Guay (2002).

Table 2.6 Panel A reports the means of six different measures of managerial ownership for each year from 1992-2007. The six measures are managerial stock own-

Table 2.6: Different Measures of Managerial Ownership

The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables. The *p*-values are reported in the brackets. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Panel A: Mean Managerial Ownership

Year	Managerial ownership exc. options	Managerial PPS options only	Managerial PPS inc. options	CEO ownership exc. options	CEO PPS options only	CEO PPS inc. options
1992	4.17%	0.79%	4.96%	2.86%	0.23%	3.08%
1993	4.44%	1.13%	5.58%	2.76%	0.48%	3.19%
1994	4.38%	1.30%	5.68%	2.94%	0.57%	3.47%
1995	4.40%	1.45%	5.85%	2.91%	0.65%	3.51%
1996	4.08%	1.58%	5.66%	2.64%	0.73%	3.34%
1997	3.91%	1.77%	5.68%	2.62%	0.82%	3.42%
1998	4.77%	2.18%	6.95%	3.21%	0.97%	4.15%
1999	4.52%	2.29%	6.80%	3.09%	1.04%	4.10%
2000	4.60%	2.48%	7.08%	3.05%	1.13%	4.15%
2001	4.13%	2.49%	6.63%	2.83%	1.17%	3.95%
2002	3.98%	2.54%	6.52%	2.74%	1.21%	3.90%
2003	3.50%	2.45%	5.95%	2.44%	1.17%	3.59%
2004	3.36%	2.29%	5.65%	2.20%	1.10%	3.27%
2005	3.04%	2.04%	5.08%	1.93%	1.02%	2.93%
2006	2.94%	2.17%	5.08%	1.71%	1.10%	2.74%
2007	2.69%	2.06%	4.72%	1.72%	1.06%	2.69%
Total	3.87%	2.03%	5.90%	2.55%	0.97%	3.49%

Panel B: Median Managerial Ownership

Year	Managerial ownership exc. options	Managerial PPS options only	Managerial PPS inc. options	CEO ownership exc. options	CEO PPS options only	CEO PPS inc. options
1992	0.54%	0.45%	1.48%	0.16%	0.10%	0.38%
1993	0.87%	0.64%	2.12%	0.30%	0.20%	0.78%
1994	0.88%	0.78%	2.32%	0.33%	0.28%	0.94%
1995	0.80%	0.95%	2.42%	0.33%	0.35%	0.98%
1996	0.69%	1.02%	2.43%	0.28%	0.39%	1.00%
1997	0.73%	1.14%	2.56%	0.31%	0.47%	1.13%
1998	0.93%	1.57%	3.49%	0.38%	0.58%	1.45%
1999	0.85%	1.69%	3.35%	0.33%	0.67%	1.40%
2000	0.91%	1.87%	3.65%	0.34%	0.77%	1.55%
2001	0.79%	1.89%	3.58%	0.31%	0.81%	1.56%
2002	0.80%	1.99%	3.79%	0.33%	0.87%	1.67%
2003	0.72%	1.83%	3.50%	0.30%	0.81%	1.55%
2004	0.76%	1.77%	3.21%	0.31%	0.77%	1.44%
2005	0.75%	1.47%	2.84%	0.31%	0.63%	1.25%
2006	0.73%	1.66%	3.00%	0.29%	0.77%	1.29%
2007	0.70%	1.61%	2.75%	0.28%	0.73%	1.19%
Total	0.77%	1.43%	3.01%	0.31%	0.60%	1.30%

Table 2.6: Different Measures of Managerial Ownership (Continued)
Panel C: Regression Results with Different Measures of Managerial Ownership

Dependent Variable	Industry-adjusted Tobin's Q		
Measure of managerial ownership	Managerial PPS inc. options	CEO ownership exc. options	CEO PPS inc. options
	(1)	(2)	(3)
Managerial ownership	1.526*	2.793**	2.111*
	[0.093]	[0.022]	[0.074]
Managerial ownership squared	-0.656	-3.593*	-1.770
	[0.579]	[0.095]	[0.372]
E index	-0.034*	-0.053***	-0.048***
	[0.067]	[0.002]	[0.006]
Managerial ownership × E index	-0.625***	-0.632**	-0.687**
	[0.003]	[0.031]	[0.016]
Sales	-0.482***	-0.446***	-0.449***
	[0.000]	[0.001]	[0.001]
Sales squared	3.083***	2.871***	2.874***
	[0.000]	[0.001]	[0.001]
Tangibility	-0.607***	-0.588***	-0.595***
	[0.000]	[0.000]	[0.000]
Tangibility squared	0.111***	0.107***	0.108***
	[0.001]	[0.001]	[0.001]
Idiosyncratic risk	-0.066***	-0.067***	-0.069***
	[0.000]	[0.000]	[0.000]
Profit margin	2.237***	2.228***	2.227***
	[0.000]	[0.000]	[0.000]
R&D	0.131***	0.139***	0.132***
	[0.007]	[0.005]	[0.007]
R&D dummy	0.116**	0.124**	0.119**
	[0.015]	[0.012]	[0.015]
Advertising expense	-0.003	-0.005	-0.004
	[0.972]	[0.954]	[0.964]
Advertising dummy	0.157***	0.161***	0.163***
	[0.001]	[0.001]	[0.001]
Investment	1.491***	1.529***	1.525***
	[0.000]	[0.000]	[0.000]
Constant	1.821***	1.807***	1.830***
	[0.001]	[0.001]	[0.001]
Year fixed effects	Yes	Yes	Yes
Cluster by firm	Yes	Yes	Yes
Observations	14962	14196	14346
R^2	0.176	0.177	0.176

ership, managerial PPS of stock options, managerial PPS of both stocks and stock options, CEO stock ownership, CEO PPS of stock options, and CEO PPS of both stocks and stock options. The mean stock ownership of the top five executives was

more than 4 percent in the 1990s and gradually decreased to 2.7 percent in 2007. In contrast with the declining trend in managerial stock ownership, the mean managerial PPS of stock options gradually increased from 0.8 percent in 1992 to 2.5 percent in the new millennium, and then slightly decreased to 2.1 percent in 2007. The mean managerial PPS—calculated as the sum of managerial stock ownership and managerial PPS of stock options—was 5 percent in 1992, increased to 7 percent in the new millennium, and then decreased to 4.7 percent in 2007. The CEO stock ownership was on average 2.9 percent in 1992, slightly increased to its peak value of 3.2 percent in 1998, and then gradually decreased to 1.7 percent in 2007. On average, the CEO PPS of stock options was merely 0.2 percent in 1992, gradually increased to 1.2 percent in 2002, and then slightly decreased to 1.1 percent in 2007. Finally, the mean CEO PPS was 3.1 percent in 1992, increased to more than 4.1 percent during the "Internet Bubble" (1998-2000), and then decreased to 2.7 percent in 2007.

Table 2.6 Panel B reports the medians of the six measures of managerial ownership for each year from 1992-2007. The medians are much lower than their respective means in Panel A, but follow similar patterns as the means over the sample period. Taken together, the period 1992-2007 has exhibited diminishing managerial stock ownership and an increasing popularity in stock options as a component of executive compensation, while the total managerial PPS remained stable over the sample period. The temporal patterns observed in my sample are consistent with previous studies such as Hall and Liebman (1998) and Aggarwal and Samwick (2003).

To assess the robustness of the results in Table 2.5, I estimate model (2.7) using three alternative measures of managerial ownership: managerial PPS, CEO stock ownership, and CEO PPS. The results are reported in Table 2.6 Panel C. All these three measures of managerial ownership are positively associated with the industry-adjusted Tobin's Q, and all the associations are statistically significant. The coefficient on CEO stock ownership squared is negative and statistically significant at the ten percent level, whereas the coefficients on the squares of the other two measures are negative but statistically insignificant from zero. The E index is negatively and significantly associated with the industry-adjusted Tobin's Q in all three columns. In addition, the coefficients on the interaction variables between the E index and the three measures of managerial ownership are all negative and statistically significant at the one percent or five percent level. Finally, the coefficients on the control variables have similar economic and statistical significances across the three regressions.

Overall, the results are robust to different measures of managerial ownership.

2.4.3 Individual Antitakeover Provisions

The results in the last two sections suggest that the six antitakeover provisions in the E index as a whole decrease the marginal effect of managerial ownership on firm value. Does each individual antitakeover provision have the same effect? This section answers this question.

Poison pills and staggered boards make it almost impossible for a takeover to succeed without negotiating directly with the board of directors. The number of directors is much smaller than the number of shareholders and the directors meet more frequently than the shareholders. This makes it easier for the board to form a cartelized response to the acquirer and thereby enhances the target firm's bargaining position. This enhanced bargaining position will increase the proportion of the synergy that accrues to the target's shareholders, and consequently weakens the incentive effect of managerial ownership. Poison pills and staggered boards may also magnify the entrenchment effect of antitakeover provisions. For example, a staggered board allows the target firm's managers to use their voting power in more than one year to prevent the acquirer from replacing the target directors who oppose the acquisition. Hence, poison pills and staggered boards are expected to reduce the effect of managerial ownership on firm value.

Limits to amend bylaws and limits to amend charter usually require a supermajority vote in order to pass an amendment. Both these types of limits as well as a supermajority requirement to approve mergers increase the size of the ownership stake that must be purchased in order to ensure subsequent shareholder approval of the changes. From the perspective of each individual shareholder, these supermajority provisions encourage shareholders to hold out for a higher price. Therefore, these three supermajority provisions weaken the incentive effect of managerial ownership. These supermajority provisions also magnify the entrenchment effect of managerial ownership by making the managers' voting power more pivotal. Hence, these three supermajority provisions are expected to reduce the effect of managerial ownership on firm value.

Most managers lose their jobs after their firms are acquired, and fail to find a comparable job in other institutions (Hartzell et al., 2004). This is probably because

they have firm-specific skills which are not desirable for other firms. Such personal losses could lead the target's managers to resist profitable merger proposals. Golden parachutes, by reducing their personal losses, may persuade them to agree with the acquisition and thereby benefit the target's shareholders. Harris (1990) shows that golden parachutes increase the proportion of the synergy that accrues to the target firm using the Nash bargaining solution. Hence, golden parachutes are expected to weaken the incentive effect of managerial ownership.

To investigate the interactions between the six provisions and managerial ownership, the E index in model (2.7) is replaced with dummy variables of the presence of each antitakeover provision, one at a time:

$$\begin{aligned} Q_{it} = \; & \beta_0 + \beta_1 \times \text{Managerial ownership}_{it} + \beta_2 \times \text{Managerial ownership}_{it}^2 \\ & + \beta_3 \times \text{Individual provision}_{it} \\ & + \beta_4 \times \text{Managerial ownership}_{it} \times \text{Individual provision}_{it} \\ & + \beta_5 \times X_{it} + u_{it}, \end{aligned} \tag{2.8}$$

where Q_{it} is the industry-adjusted Tobin's Q of firm i in year t, and *Individual provision*$_{it}$ is a dummy variable that takes the value of one if firm i has the provision in place in year t, and zero otherwise.

Table 2.7 Panel A reports the regression results of model (2.8) for each of the six

Table 2.7: Individual Antitakeover Provisions and the G Index

For each of the six antitakeover provisions in the E index, panel A reports the regression results of model 2.8. To conserve space, only the coefficients and associated *p*-values of the provision and its interaction with managerial ownership are reported. Panel B reports the regression results for the G index. I control for year fixed effects and cluster the residuals by firm in all the regressions. The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Panel A: Individual Provisions in the E Index

	Provision		Ownership × Provision	
	Coefficient	p-value	Coefficient	p-value
Staggered board	-0.006	[0.896]	-1.220**	[0.034]
Poison pill	-0.094**	[0.040]	-0.238	[0.742]
Supermajority to approve merger	-0.031	[0.495]	-0.275	[0.633]
Limits to amend bylaws	-0.065	[0.202]	-1.150**	[0.029]
Limits to amend charter	-0.033	[0.723]	-2.999***	[0.000]
Golden parachutes	-0.137***	[0.003]	-1.314***	[0.006]

Table 2.7: Individual Antitakeover Provisions and the G Index (Continued)
Panel B: The G Index

Dependent Variable	Industry-adjusted Tobin's Q		
	(1)	(2)	(3)
Managerial ownership	2.218**	1.325	-0.329
	[0.019]	[0.244]	[0.789]
Managerial ownership squared	-2.159	-1.744	-1.610
	[0.102]	[0.185]	[0.214]
E index	-0.044***		
	[0.008]		
Managerial ownership × E index	-0.560**		
	[0.013]		
G index		-0.022***	
		[0.007]	
Managerial ownership × G index		-0.010	
		[0.921]	
G index - E index			-0.022*
			[0.065]
Managerial ownership × (G index - E index)			0.266
			[0.139]
Sales	-0.476***	-0.491***	-0.521***
	[0.000]	[0.000]	[0.000]
Sales squared	3.071***	3.223***	3.424***
	[0.000]	[0.000]	[0.000]
Tangibility	-0.598***	-0.608***	-0.610***
	[0.000]	[0.000]	[0.000]
Tangibility squared	0.110***	0.113***	0.113***
	[0.001]	[0.001]	[0.001]
Idiosyncratic risk	-0.066***	-0.067***	-0.063***
	[0.000]	[0.000]	[0.001]
Profit margin	2.238***	2.263***	2.282***
	[0.000]	[0.000]	[0.000]
R&D	0.138***	0.146***	0.148***
	[0.004]	[0.003]	[0.002]
R&D dummy	0.121**	0.117**	0.113**
	[0.011]	[0.014]	[0.018]
Advertising expense	-0.004	-0.004	0.001
	[0.960]	[0.964]	[0.991]
Advertising dummy	0.156***	0.158***	0.160***
	[0.001]	[0.001]	[0.001]
Investment	1.484***	1.466***	1.482***
	[0.000]	[0.000]	[0.000]
Constant	1.785***	1.925***	1.963***
	[0.001]	[0.000]	[0.000]
Year fixed effects	Yes	Yes	Yes
Cluster by firm	Yes	Yes	Yes
Observations	14962	14962	14962
R^2	0.176	0.171	0.171

provisions in the E index. To conserve space, only the coefficients and associated *p*-values of the provisions and their interactions with managerial ownership are reported. The coefficients on other variables are similar to those in Table 2.5. All six antitakeover provisions reduce the marginal effect of managerial ownership on firm value, but the impacts of poison pills and a supermajority requirement to approve mergers are statistically insignificant. The coefficients on all six provisions are negative, but only those on golden parachutes and poison pills are statistically significant. It is worth noting that staggered board, limits to amend bylaws, and limits to amend charter significantly affect firm value only through their interactions with managerial ownership.

The RiskMetrics database also collects information on eighteen other antitakeover provisions in addition to the six provisions included in the E index. The twenty four provisions constitute the G index developed by Gompers et al. (2003). Bebchuk et al. (2009) find that only the six provisions in the E index are significantly associated with firm value, while the other eighteen provisions are mainly "noises." Their findings imply that managerial ownership will not interact significantly with these eighteen provisions. To investigate this implication, I replace the E index in model (2.7) with the G index and the difference between the G index and the E index, respectively. The difference between the two indexes measures the strength of the eighteen provisions other than the six provisions in the E index.

Table 2.7 Panel B presents the regression results. The results indicate that both the G index and the difference between the G index and the E index are negatively associated with the industry-adjusted Tobin's Q, with the effects statistically significant at the one percent and ten percent level, respectively. However, neither the G index nor the difference between the G index and the E index significantly interacts with managerial ownership.

Taken as a whole, Table 2.7 suggests that the antitakeover provisions in the E index weaken the effect of managerial ownership on firm value not only in aggregate but also individually.

2.4.4 Does Managerial Ownership Decrease with the Strength of Antitakeover Provisions?

This section tests the second hypothesis, which states that managerial ownership decreases with the strength of antitakeover provisions.

Table 2.8 Panel A presents the summary statistics of managerial ownership for five groups of firms based on the E index. The first four groups of firms have an E index of 0, 1, 2, and 3, respectively. The last group of firms has an E index between 4 and 6. The firms with an E index of 5 and 6 account for only 2.5 percent of the sample, and thus are grouped together with the firms with an E index of 4. Managerial ownership decreases significantly as the E index increases. The mean (median) managerial ownership is 7.6 (1.3) percent for the firms with an E index of 0, and 2.1 (0.7) percent for the firms with an E index above 3.

Table 2.8 Panel B presents the regression results of the stock ownership and the PPS of the top five executives and the CEO on the E index and the control variables. The E index is negatively associated with all four measures of managerial ownership, and this effect is statistically significant at the one percent level. In terms of economic significance, each additional antitakeover provision in the E index decreases the ownership (options excluded) of the top five executives and the CEO by 1.1 percentage points and 0.8 percentage points, respectively. Recall that the mean managerial ownership of the top five executives is 3.9 percent, while mean ownership of the CEO is

Table 2.8: Relation between Managerial Ownership and the E Index

Panel A presents the summary statistics of managerial ownership for five subsamples based on the E index. Panel B presents the regression results of four measures of managerial ownership on the E index and other variables. Panel C presents the regression results of the four measures of managerial ownership on the E index and other variables with firm fixed effects controlled for. The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables. The *p*-values are reported in the brackets. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Panel A: Managerial Ownership by E Index

	N	mean	sd	p5	p50	p95
E index = 0	1412	7.55%	11.70%	0.04%	1.33%	32.56%
E index = 1	2679	5.40%	10.49%	0.04%	0.92%	27.73%
E index = 2	3825	3.88%	7.78%	0.04%	0.78%	21.67%
E index = 3	3987	2.88%	5.92%	0.05%	0.73%	14.12%
E index $\geq$ 4	3059	2.14%	5.11%	0.09%	0.66%	9.81%
Total	14962	3.87%	8.08%	0.05%	0.77%	21.39%

Table 2.8: Relation between Managerial Ownership and the E Index (Continued)
Panel B: Regression Results of Four Measures of Managerial Ownership

Dependent Variable	Managerial ownership exc. options	Managerial PPS inc. options	CEO ownership exc. options	CEO PPS inc. options
	(1)	(2)	(3)	(4)
E index	-0.011***	-0.010***	-0.008***	-0.008***
	[0.000]	[0.000]	[0.000]	[0.000]
Sales	-0.001	-0.012	-0.001	-0.007
	[0.873]	[0.156]	[0.832]	[0.330]
Sales squared	-0.069	-0.030	-0.040	-0.019
	[0.189]	[0.563]	[0.357]	[0.664]
Tangibility	-0.020**	-0.024***	-0.018**	-0.018***
	[0.025]	[0.009]	[0.012]	[0.010]
Tangibility squared	0.003	0.004*	0.003	0.003
	[0.165]	[0.088]	[0.138]	[0.118]
Idiosyncratic risk	-0.002	-0.001	-0.001	0.000
	[0.195]	[0.737]	[0.701]	[0.970]
Profit margin	-0.001	-0.007	0.005	0.003
	[0.909]	[0.540]	[0.521]	[0.737]
R&D	-0.011***	-0.010***	-0.007***	-0.007***
	[0.000]	[0.000]	[0.001]	[0.001]
R&D dummy	-0.008	-0.006	-0.007*	-0.006
	[0.101]	[0.194]	[0.069]	[0.129]
Advertising expense	0.007	0.008	0.005	0.005
	[0.333]	[0.294]	[0.353]	[0.309]
Advertising dummy	0.000	0.000	0.002	0.002
	[0.935]	[0.924]	[0.487]	[0.427]
Investment	-0.010	-0.005	-0.011	-0.009
	[0.336]	[0.610]	[0.202]	[0.338]
Constant	0.136***	0.194***	0.100***	0.128***
	[0.000]	[0.000]	[0.001]	[0.000]
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Cluster by firm	Yes	Yes	Yes	Yes
Observations	14962	14962	14196	14346
R^2	0.140	0.171	0.132	0.141

2.6 percent.

2.5 Dealing with Endogeneity

The findings reported so far have established that managerial ownership, the E index and their interaction are significantly associated with firm value. The statistical relations do not necessarily imply that managerial ownership or the E index causes variations in firm value. Neither does the statistical relation between managerial

Table 2.8: Relation between Managerial Ownership and the E Index (Continued)
Panel C: Regression Results of Four Measures of Managerial Ownership: Firm Fixed Effects

Dependent Variable	Managerial ownership exc. options	Managerial PPS inc. options	CEO ownership exc. options	CEO PPS inc. options
	(1)	(2)	(3)	(4)
E index	-0.001*	-0.001	-0.002***	-0.001*
	[0.065]	[0.471]	[0.002]	[0.098]
Sales	-0.008*	-0.014***	-0.003	-0.006
	[0.080]	[0.006]	[0.486]	[0.172]
Sales squared	-0.009	0.000	-0.032	-0.025
	[0.793]	[0.998]	[0.239]	[0.354]
Tangibility	-0.002	-0.002	0.002	0.002
	[0.731]	[0.762]	[0.614]	[0.579]
Tangibility squared	0.000	0.001	-0.001	-0.001
	[0.859]	[0.502]	[0.135]	[0.419]
Idiosyncratic risk	0.001	0.002**	0.001	0.001
	[0.237]	[0.024]	[0.319]	[0.300]
Profit margin	0.013**	0.013**	0.019***	0.020***
	[0.012]	[0.024]	[0.000]	[0.000]
R&D	-0.003***	-0.003*	-0.003**	-0.003**
	[0.008]	[0.056]	[0.014]	[0.026]
R&D dummy	0.004*	0.003	0.004*	0.003
	[0.053]	[0.200]	[0.079]	[0.239]
Advertising expense	0.001	0.001	-0.007**	-0.007**
	[0.731]	[0.741]	[0.029]	[0.026]
Advertising dummy	0.002	0.001	0.003*	0.002*
	[0.313]	[0.469]	[0.050]	[0.087]
Investment	0.006	0.005	0.006	0.005
	[0.168]	[0.319]	[0.108]	[0.193]
Constant	0.109***	0.153***	0.071***	0.091***
	[0.000]	[0.000]	[0.000]	[0.000]
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	14962	14962	14196	14346
R^2	0.785	0.779	0.770	0.759

ownership and the E index establish causality. Managerial ownership, antitakeover provisions, and firm value may be simultaneously determined by some fundamental firm characteristics, as shown in the model. These fundamental firm characteristics are usually unobserved by researchers and thus result in the unobserved heterogeneity problem. If this problem is indeed relevant, the statistical relations will disappear once *all* the relevant fundamental firm characteristics are *appropriately* controlled for.

This section addresses this unobserved heterogeneity concern in four ways. First,

I use firm fixed effects to control for time-invariant firm characteristics. Second, I investigate the impact of antitakeover provisions on the announcement returns of manager share purchases in the open market. Third, I construct instrumental variables for managerial ownership and the E index. Lastly, I propose and test an alternative explanation for the main findings of this paper.

2.5.1 Firm Fixed Effects

If the unobserved firm characteristics are constant over time, adding firm fixed effects in the regression can effectively resolve the unobserved heterogeneity problem. This observation motivates Himmelberg et al. (1999) to employ firm fixed effects to deal with the endogeneity issue concerning managerial ownership.

I run OLS regressions with firm fixed effects for Tobin's Q and the industry-adjusted Tobin's Q and present the results in the two columns of Table 2.9. Managerial ownership is positively associated with Tobin's Q and the industry-adjusted Tobin's Q, and both effects are significant at the one percent level. The coefficients on managerial ownership squared in the two columns are negative and statistically significant at the one percent level. The coefficients on the E index become statistically indifferent from zero. They are statistically significant at the one percent level in Table 2.5 where firm fixed effects are not controlled for. The coefficients on the interaction variable of managerial ownership and the E index are negative and statistically significant at the five percent and one percent level in columns (1) and (2), respectively. These results indicate that antitakeover provisions affect firm value only through their interactions with managerial ownership.

Firm fixed effects also influence the relation between managerial ownership and the E index. Table 2.8 Panel C shows that the E index is still negatively associated with managerial ownership after controlling for firm fixed effects. However, comparing Panels B and C of Table 2.8 reveals that the negative association between managerial ownership and the E index is significantly weakened after controlling for firm fixed effects. Without firm fixed effects, each additional antitakeover provision reduces managerial ownership by about 1 percentage point; after controlling for firm fixed effects each additional antitakeover provision reduces managerial ownership by about 0.1 percentage points. That is, approximately 90 percent of the effect of antitakeover provisions on managerial ownership is attributable to firm fixed effects.

Table 2.9: Determinants of Tobin's Q: Firm Fixed Effects

The sample consists of 14,962 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables. The *p*-values are reported in the brackets. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Dependent Variable	Tobin's Q	Industry-adjusted Tobin's Q
	(1)	(2)
Managerial ownership	1.965***	2.067***
	[0.000]	[0.000]
Managerial ownership squared	-2.367***	-2.125***
	[0.000]	[0.001]
E index	-0.019	-0.013
	[0.217]	[0.375]
Managerial ownership × E index	-0.281**	-0.379***
	[0.015]	[0.001]
Sales	-0.986***	-0.973***
	[0.000]	[0.000]
Sales squared	4.803***	4.619***
	[0.000]	[0.000]
Tangibility	-1.129***	-1.103***
	[0.000]	[0.000]
Tangibility squared	0.202***	0.198***
	[0.000]	[0.000]
Idiosyncratic risk	-0.056***	-0.060***
	[0.000]	[0.000]
Profit margin	2.438***	2.259***
	[0.000]	[0.000]
R&D	-0.074	-0.053
	[0.167]	[0.299]
R&D dummy	-0.025	-0.011
	[0.546]	[0.780]
Advertising expense	0.009	0.009
	[0.908]	[0.902]
Advertising dummy	-0.138***	-0.120***
	[0.000]	[0.000]
Investment	1.146***	1.044***
	[0.000]	[0.000]
Constant	6.429***	4.917***
	[0.000]	[0.000]
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	Yes
Observations	14962	14962
R^2	0.714	0.689

Zhou (2001) points out that managerial ownership changes slowly from year to year within a company, and argues that small, one-year changes in ownership are

unlikely to provide sufficient incentives that would lead to substantive within-year changes in firm value. By relying on within variations, regressions with firm fixed effects may not detect an effect of managerial ownership on firm value even if one exists. This argument also applies to the E index, which shows small variations over the sample period (Table 2.2).

Zhou's argument implies that firm fixed effects militate against finding significant effects of managerial ownership and the E index on firm value. Even so, I find that antitakeover provisions still significantly weaken the effect of managerial ownership on firm value after controlling for firm fixed effects. Meanwhile, the E index is no longer directly associated with firm value after controlling for firm fixed effects. These results indicate that antitakeover provisions affect firm value only through their interactions with managerial ownership.

2.5.2 An Event Study

Another way to resolve the unobserved heterogeneity problem is to investigate how changes in managerial ownership affect firm value. This method has two merits relative to the firm fixed effects approach. First, by relating changes in managerial ownership to changes in firm value, it controls for any unobserved firm-specific fixed effects. Second, changes in firm value within a short event window contain less "noise" than the annual changes in firm value using the firm fixed effects approach. Following McConnell et al. (2008), I study the market reactions to announcements of manager share purchases in the open market. Share sales are excluded because they usually occur after option exercises and thereby are anticipated by the market (Ofek and Yermack, 2000).

I merge the ExecuComp database with the Thomson Reuters insider trading database to retrieve open market stock purchases by the top executives whose shareholdings are reported in the ExecuComp database. Multiple manager share purchase announcements on the same day are combined into one. During the period 1993-2008, the top executives announced 4,162 stock purchases of the firms they manage. The mean (median) size of share purchases is 0.065 (0.008) percent of the total number of shares outstanding. Similar to McConnell et al. (2008), I compute the 7-day ([-1, +5]) cumulative abnormal returns (CARs) around the share purchase announcement. This 7-day window is chosen because the information usually does not enter the

public domain for several days after being filed with the SEC (Lakonishok and Lee, 2001). The announcements are greeted with a mean (median) 7-day CARs of 2.08 (0.86) percent. The 5-day ([-1, +3]) CARs are also computed as a robustness check.

The following model is employed to investigate how antitakeover provisions influence the effect of manager share purchases on firm value:

$$\begin{aligned} CARs = \; & \beta_0 + \beta_1 \times \text{Manager share purchases}_i \\ & + \beta_2 \times \text{Pre-purchase managerial ownership}_i + \beta_3 \times \text{E index}_i \\ & + \beta_4 \times \text{Manager share purchases}_i \times \text{Pre-purchase managerial ownership}_i \\ & + \beta_5 \times \text{Manager share purchases}_i \times \text{E index}_i + u_i. \end{aligned} \tag{2.9}$$

where *Manager share purchases* is the number of shares the manager purchases divided by the total number of shares outstanding, and *Pre-purchase managerial ownership* is the managerial ownership at the beginning of the fiscal year.[14] The model is similar to the one used by McConnell et al. (2008) except that I add the interaction variable of manager share purchases and the E index. The first interaction variable in the model captures the diminishing marginal effect of managerial ownership on firm value; the second interaction variable captures the impact of antitakeover provisions on the value effect of manager share purchases. If antitakeover provisions weaken the effect of managerial ownership on firm value, β_5 will be negative.

Table 2.10 presents the regression results of the model (2.9). The dependent variable is the 5-day CARs in the first column, and the 7-day CARs in the second column. The results indicate that the amount of manager share purchases is positively associated with the announcement returns. This effect is statistically significant at the five percent level for 5-day CARs and at the one percent level for 7-day CARs. In terms of economic significance, the purchase of one percent of a firm's shares by its managers increases the stock price by approximately 7 percent and 4 percent over the 7- and 5-day announcement period, respectively. The E index is negatively associated with

[14]The regression results are qualitatively unchanged if the managerial ownership right before the share purchase is used instead. This alternative measure requires tracking the changes in managerial ownership from the beginning of the fiscal year to the open market stock purchase, which are very small and thus do not change the results. The changes in managerial ownership during that period are hard to compute because the Thomson Reuters insider trading database only records open-market transactions and exercises of stock options, but does not include other changes in managerial ownership such as grants of restricted stocks. Therefore, the managerial ownership at the beginning of the fiscal year is preferable.

Table 2.10: An Event Study: Manager Share Purchases in the Open Market

This table presents the OLS regression results of the 5- and 7-day cumulative abnormal returns commencing from the day before the manager share purchase announcement. The sample consists of 4,128 stock purchases announced by the top five executives of the firms in the ExecuComp database over the period 1993-2008. See the Appendix for the descriptions of the variables. The *p*-values are reported in the brackets. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Dependent Variable	CAR5	CAR7
	(1)	(2)
Manager share purchases	4.007**	7.071***
	[0.020]	[0.009]
Pre-purchase managerial ownership	-0.014	-0.021
	[0.408]	[0.342]
E index	-0.001	-0.002
	[0.571]	[0.201]
Manager share purchases × Pre-purchase ownership	-4.493*	-8.634**
	[0.066]	[0.015]
Manager share purchases × E index	-0.584*	-0.959**
	[0.063]	[0.025]
Constant	0.003	0.009*
	[0.449]	[0.096]
Industry fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Cluster by firm	Yes	Yes
Observations	4128	4128
R^2	0.022	0.029

the announcement returns, but this effect is statistically insignificant. The coefficient on the interaction variable of manager share purchases and pre-purchase managerial ownership is negative and statistically significant, suggesting that the marginal effect of managerial ownership on firm value diminishes as managers hold more shares. Importantly, the coefficient on the interaction variable of manager share purchases and the E index is negative and statistically significant at the ten percent and five percent level, respectively; indicating that antitakeover provisions weaken the effect of managerial ownership on firm value.

2.5.3 Instrumental Variable Regressions

In this section I construct instrumental variables for managerial ownership and the E index to deal with the endogeneity issue. The first instrument for the E index is the firm's E index in 1990. Table 2.2 shows that the E index has small time-series

variations, indicating significant correlations between the E index in 1990 and the E indexes in later years. To be a valid instrument, the E index in 1990 should not be correlated with the error term in the model (2.7). I argue that the E index in 1990 is unlikely to be correlated with the error terms in the years far away from 1990. To make it a valid instrument, I also exclude the data before 1995 from the regressions to leave a longer gap between the instrument year and the data year.[15] Similarly, I use the managerial ownership in 1992 (the first year when the data on managerial ownership are available) as an instrument for managerial ownership.

The second instruments for the E index and managerial ownership are the average E index and the average managerial ownership of the firm's industry peers, respectively. Firms in the same industry may have a similar E index and managerial ownership level because of common industry characteristics. Meanwhile, the E index and managerial ownership of industry peers are unlikely to be correlated with the firm-specific error term in the model. This makes them valid instruments.

Since each state has different antitakeover laws, I also use the average E index of the firms incorporated in the same state as an instrument for the E index.

Columns (1) and (2) of Table 2.11 present the OLS regression results of managerial ownership and the E index, respectively, on the instruments and control variables. The results indicate that both managerial ownership and the E index are significantly and positively correlated with their respective instruments, suggesting that the proposed instrumental variables are strong ones.

Following Wooldridge (2001), I use the squared fitted managerial ownership from the regression in column (1) as an instrument for managerial ownership squared, and the product of the fitted managerial ownership times the fitted E index from the regression in column (2) as an instrument for the interaction variable of managerial ownership and the E index.

[15] Excluding the data before 1995 leaves at least a five year gap between the instrument year and the data year. On one hand, I want to make the gap as large as possible because the E index in 1990 is less likely to be correlated with the error term in the more remote future. On the other hand, I need to keep as many data points as possible for the results to be consistent. The empirical results are qualitatively similar if I use the cut-off year of 1993-1997.

Table 2.11: Instrumental Variable Regressions

Columns (1) and (2) report the OLS regression results where the dependent variables are managerial ownership and the E index, respectively. Column (3) presents the GMM regression results where the dependent variable is the industry-adjusted Tobin's Q. The instrumental variables for managerial ownership are the managerial ownership in 1992 and the average managerial ownership of industry peers; the instrumental variables for the E index are the E index in 1990, the average E index of industry peers, and the average E index of the firms incorporated in the same state; the instrumental variable for managerial ownership squared is the square of the fitted managerial ownership from the regression in column (1); the instrumental variable for the interaction variable of managerial ownership and the E index is the product of the fitted managerial ownership from the regression in column (1) times the fitted E index from the regression in column (2). See the Appendix for the descriptions of the variables. The *p*-values are reported in the brackets. Robust standard errors are used to compute the *p*-values. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Dependent Variable	Managerial ownership	E index	Industry-adjusted Tobin's Q
Stage of Estimation	First stage	First stage	Second stage
Estimation Method	OLS	OLS	GMM
	(1)	(2)	(3)
Managerial ownership in 1992	0.431***	-0.756***	
	[0.000]	[0.003]	
Average industry managerial ownership	0.105*	0.975	
	[0.089]	[0.328]	
E index in 1990	-0.006***	0.709***	
	[0.001]	[0.000]	
Average industry E index	0.002	0.192***	
	[0.515]	[0.004]	
Average state E index	0.007**	0.272***	
	[0.046]	[0.000]	
Managerial ownership			8.085***
			[0.008]
Managerial ownership squared			-11.860**
			[0.035]
E index			0.004
			[0.922]
Managerial ownership $\times$ E index			-1.587*
			[0.075]
Sales	0.006	0.792***	0.193
	[0.679]	[0.000]	[0.486]
Sales squared	-0.046	-5.421***	-0.810

Continued on next page

Table 2.11 – continued from previous page

Dependent Variable	Managerial ownership	E index	Industry-adjusted Tobin's Q
Stage of Estimation	First stage	First stage	Second stage
Estimation Method	OLS	OLS	GMM
	(1)	(2)	(3)
	[0.586]	[0.000]	[0.635]
Tangibility	-0.004	-0.176	-0.705***
	[0.662]	[0.265]	[0.000]
Tangibility squared	0.001	0.032	0.100
	[0.722]	[0.455]	[0.110]
Idiosyncratic risk	-0.001	0.053*	-0.019
	[0.819]	[0.096]	[0.546]
Profit margin	-0.017	0.237	3.794***
	[0.271]	[0.420]	[0.000]
R&D	-0.003	0.102	0.304**
	[0.393]	[0.218]	[0.044]
R&D dummy	-0.014***	-0.079	0.197***
	[0.008]	[0.253]	[0.005]
Advertising expense	0.025**	-0.050	0.182
	[0.047]	[0.762]	[0.400]
Advertising dummy	-0.002	0.000	0.226***
	[0.563]	[0.998]	[0.002]
Investment	0.001	0.102	0.798***
	[0.957]	[0.651]	[0.008]
Constant	-0.012	-3.047***	-1.610
	[0.872]	[0.000]	[0.151]
P-value of Sargen-Hansen *J*-test			0.421
Year fixed effects	Yes	Yes	Yes
Cluster by firm	Yes	Yes	Yes
Observations	4850	4850	4850
R^2	0.466	0.696	0.259

Column (3) of Table 2.11 presents the GMM regression results where the dependent variable is the industry-adjusted Tobin's Q. The results indicate that managerial ownership is positively associated with the industry-adjusted Tobin's Q and significant at the one percent level. The coefficient on managerial ownership squared is

negative and statistically significant at the five percent level. The coefficient on the E index is positive but statistically indifferent from zero. Finally, the coefficient on the interaction variable of managerial ownership and the E index is negative and statistically significant at the ten percent level. These findings again suggest that antitakeover provisions affect firm value only indirectly through their impacts on the value effect of managerial ownership.

It is necessary to check the validity of the proposed instruments. The *p*-value of the Sargen-Hansen *J*-test is 0.42, indicating that the instruments are not significantly correlated with the error term. The *p*-values associated with the *F*-tests of the strength of the instruments are all below the one percent level, indicating that they are strong instruments.

2.5.4 Accounting for Management Quality

Management quality may simultaneously determine managerial ownership, the E index, and firm value. High-quality managers should own more shares of their firms for two reasons. First, they may use high ownership to signal their quality (Leland and Pyle, 1977). Second, Milbourn (2003) shows that high-quality managers should have more ownership because they are less likely to be replaced. The lower probability of being replaced implies that more of their efforts—and less of the efforts of other managers who may replace them—are incorporated into stock prices. The more informative a manager's effort is, the more effective stock-based incentives are. Therefore, high-quality managers are granted with more ownership, and thus have incentives to exert more effort. Consequently, high-quality managers rely less on the bid premium to enhance firm value, and are associated with weaker antitakeover provisions. Firms with high-quality managers are more valuable because of high quality of management and high managerial ownership. Overall, high-quality managers are associated with more ownership, weaker antitakeover provisions, and greater firm value.

The management quality hypothesis can be empirically examined. Similar to Milbourn (2003), I use the cumulative abnormal returns (CARs) during the past three years as a proxy for management quality. The stock returns are adjusted with respect to the Fama-French three factors. The management quality hypothesis predicts that past stock returns, a measure of management quality, are negatively associated with

the E index, positively associated with managerial ownership, and positively associated with the firm value.

Table 2.12 presents the regression results. The CARs in the past three years are negatively, positively, and positively associated with the E index, managerial ownership, and the industry-adjusted Tobin's Q, respectively. These effects are all statistically significant at the one percent level, consistent with the management quality hypothesis. However, managerial ownership, the E index, and their interaction are still significantly associated with the industry-adjusted Tobin's Q after controlling for past stock returns. The results suggest that management quality is not the driving force behind the findings of this paper.

2.5.5 Reverse Causality?

The above empirical analysis focuses on the direction of causation from managerial ownership and antitakeover provisions to firm value. The direction of causation, however, may be the opposite way, i.e., from firm value to managerial ownership and antitakeover provisions. For instance, managers may adjust their shareholdings in anticipation of changes in firm value: they increase (decrease) their ownership if they expect high (low) firm performance. Since the amount of synergy gain decreases with firm performance, firms may adopt weaker (stronger) antitakeover provisions if they expect high (low) performance. This reverse causality hypothesis is able to explain the negative association between the E index and firm value, and the negative association between the E index and managerial ownership. In addition, it is consistent with the positive relation between managerial ownership and firm value for firms with low levels of the E index. However, this hypothesis predicts that the positive relation between managerial ownership and firm value does not depend on the strength of antitakeover provisions, and therefore fails to explain the negative association between managerial ownership and firm value for firms with high levels of the E index. Therefore, reverse causality cannot be the driving force behind the findings in this paper.

Table 2.12: Controlling for Management Quality

The cumulative abnormal return in the past three years is a proxy for management quality. The sample consists of 14,936 firm-year observations over the period 1992-2007. See the Appendix for the descriptions of the variables. The *p*-values are reported in the brackets. Significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Dependent Variable	E index	Managerial ownership	Industry-adjusted Tobin's Q
	(1)	(2)	(3)
CARs in past three years	-0.115***	0.005***	0.393***
	[0.000]	[0.000]	[0.000]
Managerial ownership			1.863**
			[0.038]
Managerial ownership squared			-1.663
			[0.184]
E index			-0.032**
			[0.043]
Managerial ownership × E index			-0.530**
			[0.013]
Sales	1.306***	-0.016*	-0.503***
	[0.000]	[0.050]	[0.000]
Sales squared	-8.663***	0.030	3.171***
	[0.000]	[0.564]	[0.000]
Tangibility	0.174	-0.022**	-0.581***
	[0.299]	[0.017]	[0.000]
Tangibility squared	-0.051	0.004	0.105***
	[0.292]	[0.115]	[0.001]
Idiosyncratic risk	-0.080***	-0.001	-0.017
	[0.001]	[0.579]	[0.343]
Profit margin	-0.736***	0.004	1.962***
	[0.000]	[0.707]	[0.000]
R&D	0.019	-0.011***	0.126***
	[0.652]	[0.000]	[0.006]
R&D dummy	0.063	-0.009*	0.085*
	[0.402]	[0.070]	[0.064]
Advertising expense	-0.229**	0.010	0.036
	[0.011]	[0.161]	[0.672]
Advertising dummy	-0.048	0.001	0.148***
	[0.429]	[0.825]	[0.001]
Investment	-0.191	-0.013	0.930***
	[0.261]	[0.233]	[0.000]
Constant	-2.257***	0.163***	1.925***
	[0.000]	[0.000]	[0.000]
Industry fixed effects	Yes	Yes	No
Year fixed effects	Yes	Yes	Yes
Cluster by firm	Yes	Yes	Yes
Observations	14936	14936	14936
R^2	0.132	0.112	0.228

Chapter 3

Information Precision and IPO Pricing [1]

3.1 Introduction

During the waiting period, which is from the initial public offering (IPO) filing to the offering, the issuer learns more information about the IPO firm's value. The information can be divided into two categories, private information and public information, depending on whether it is publicly observable. The private information is owned by investors and is subsequently revealed to the issuer in these investors' bids for IPO shares. The public information is observed by both the investors and the issuer. The most important public information during the waiting period is the market/industry return. The literature terms investor bids and the market/industry return during the waiting period as private information and public information, respectively.

There have been extensive studies on the effect of private and public information on the offer price.[2] Nevertheless, the role of the precision of the private and public information in IPO pricing remains underexplored: the study by Cornelli and Goldreich (2003) is the only examination of this issue that I am aware of. The authors analyze proprietary data of more than 60 international equity offerings by a European invest-

[1] I am grateful to Jason Chen, Rob Heinkel, Thomas Hellmann, Kai Li, and seminar participants at UBC for helpful comments and suggestions. All remaining errors are mine.

[2] See Benveniste and Spindt (1989), Hanley (1993), Loughran and Ritter (2002), Bradley and Jordan (2002), Lowry and Schwert (2004), and Edelen and Kadlec (2005). Section 3.2 briefly reviews this literature.

ment bank, and find that investor bids are more influential on the offer price when they show a consensus among investors. Their finding suggests that the precision of the private information is an important determinant of the offer price. Why is information precision important in IPO pricing? Does the precision of the public information also affect the offer price? This paper attempts to answer these questions, both theoretically and empirically.

One reason why the role of information precision in IPO pricing is underexplored lies in that the previous theories usually assume that either the issuer or investors know the true value of the IPO firm. Consequently, information precision is not considered in those models.[3] For example, Allen and Faulhaber (1989) and Grinblatt and Hwang (1989) assume that the issuer knows the true value. It is true that the issuer is involved with the IPO firm's daily operations and thus may know more about its future cash flows. The firm's value, however, also depends on information outside the firm, such as macroeconomic conditions, industry prospects, and financial market conditions. Sophisticated investors are arguably more knowledgeable about this information. This argument has led Rock (1986) to assume that investors know the true value, while the issuer does not. The reality may be somewhere between these two extreme cases: both the issuer and the investors have access to some information about the value of the offering firm, but neither knows the true value. I am not criticizing these theories, which shed bright light on our understanding of many aspects of equity offerings. Instead, my intention is to show that information precision also plays an important role in IPO pricing.

I first model the going-public process where both the issuer and a representative investor observe noisy signals about the firm value. This model allows me to investigate the role of information precision in IPO pricing. In the model a risk-averse issuer who owns the whole firm tries to sell some shares to a risk-averse investor. Before the IPO filing, each party observes a noisy private signal of the firm's value. Right before the offering, both parties observe a noisy public signal regarding the change in the IPO firm's value during the waiting period. The issuer determines the filing price, the number of shares filed, the offer price, and the number of shares offered.

[3]See, among others, Leland and Pyle (1977), Myers and Majluf (1984), Rock (1986), Allen and Faulhaber (1989), Benveniste and Spindt (1989), Grinblatt and Hwang (1989), Welch (1989), Welch (1992), Chemmanur (1993), Sherman (2000), and Sherman and Titman (2002). One exception is Yung (2005), who assumes that both underwriters and investors are able to acquire noisy information of the firm value.

The fully revealing equilibrium is characterized by partial adjustment of the offer price with respect to both the private and the public information. The information is fully incorporated into the offer price only when it contains no noise.

Another distinct feature of the model is that the number of shares offered is also endogenously determined. In equilibrium, the firm adjusts the number of shares offered with respect to both the private and the public information. Positive information, be it private or public, increases the expected firm value and thus the offer price. Consequently, the investor demands more shares, while the risk-averse issuer wants to invest less in the risky firm because positive information increases her expected wealth. As a result, positive (negative) information results in more (fewer) shares being sold to the investor.

The model produces several predictions that are distinct from the models in the prior literature. It predicts that the proportions of the private and public information that are incorporated into the offer price increase with their respective precision. It also predicts that the number of shares offered increases with the market/industry return during the waiting period.

The second part of the paper tests the model's predictions. Because the private information (investor bids) is unobserved, the tests focus on the predictions that are related to the public information. The public information is proxied with the industry return during the waiting period. Its precision, by definition, is the accuracy of the industry return as a measure of the change in the IPO firm's value during the waiting period. The change in the IPO firm's value may be caused by either industry-wide information or unobserved firm-specific information or by both. Therefore, the precision of the industry return is the fraction of the variance of the IPO stock return that is explained by the industry return, or the R^2 of the regression of the IPO stock return on a constant and the industry return.[4] Unable to observe the IPO's stock return before the offering, I proxy the precision with the average R^2 of the IPO firm's industry peers.

Employing a sample of 5,450 IPOs over the period 1985-2006, I find that the industry R^2, a proxy of the precision of the industry return, significantly affects the fraction of the industry return that is incorporated into the offer price. On average, 38% of the industry return is incorporated into the offer price. The fraction significantly increases by 39 percentage points for each 10% increase in the R^2. I also find

[4]See Morck et al. (2000).

that the number of shares offered is positively associated with the industry return during the waiting period. These findings are consistent with the predictions of the model.

The prior literature suggests that IPOs with a volatile firm value are associated with greater initial returns. For example, the winner's curse model of Rock (1986) predicts that IPOs that are more difficult to value will be underpriced by more. This prediction has received considerable empirical support (Tinic, 1988; Lowry et al., 2010). The current paper differs from this literature in at least two respects. First, this literature studies the relation between the uncertainty of the IPO firm's value and underpricing, while the current paper investigates how the precision of the information learned during the waiting period affects adjustments of the offer price and the number of shares offered. Second, Rock (1986) assumes that investors know the true value of the IPO firm while the issuer does not. This information asymmetry results in the underpricing of the IPO. In contrast, I assume that neither the issuer nor the investors know the true value.

This paper extends the literature in at least three respects. First, it complements Cornelli and Goldreich (2003) by extending their findings on the precision of the private information to the precision of the public information. Second, it builds a framework for investigating the role of information precision in IPO pricing. Third, it sheds light on the partial adjustment phenomenon, a phenomenon where only part of the information during the waiting period is incorporated into the offer price. The results of this paper suggest that noisy information will be partially incorporated into the offer price. Full adjustments occur only when the information reveals the true firm value or contains no noise. Given the difficulties in determining the true value of an IPO firm before the offering, it is not surprising to observe partial adjustments. Although information precision alone cannot fully explain the partial adjustment phenomenon, it complements the existing explanations such as those made by Benveniste and Spindt (1989), Loughran and Ritter (2002), and Edelen and Kadlec (2005).

The paper proceeds as follows. Section 3.2 briefly reviews the related literature. Section 3.3 discusses the model. Section 3.4 describes the data and econometric specifications. Section 3.5 presents the main empirical results.

3.2 Related Literature

This paper relates to the IPO pricing literature. The IPO bookbuilding theory shows that underwriters partially incorporate investors' information into the offer price in order to leave some money on the table as compensation for the revelation of information (Benveniste and Spindt, 1989; Benveniste and Wilhelm, 1990). It predicts a positive relation between the adjustment of the offer price and the IPO initial return. This is confirmed by Hanley (1993). Loughran and Ritter (2002) note that the bookbuilding theory does not apply to public information because it is observed by all agents without incurring any cost. In contrast with the bookbuilding theory, Loughran and Ritter (2002) and Lowry and Schwert (2004), among others, find that the IPO initial return is positively related to the market return during the waiting period. This so-called partial adjustment phenomenon is also demonstrated with a less than one coefficient on the waiting period market/industry return in the regression of the offer price adjustment (Lowry and Schwert, 2004; Edelen and Kadlec, 2005). Lowry and Schwert also document asymmetry in price adjustments: more negative public information is incorporated into the offer price than positive public information. Edelen and Kadlec, on the other hand, find that this asymmetry disappears after the sample selection problem is addressed (price adjustment is observed only for completed IPOs).

Loughran and Ritter (2002) provide an explanation for the partial adjustment phenomenon based on prospect theory. They argue that the issuer is content with positive price changes and thus does not bargain hard against the underwriter on offer price. The argument applies to both private and public information.

Other explanations for the partial adjustment phenomenon have been offered more recently. Edelen and Kadlec (2005) argue that firms partially adjust the offer price with respect to the public information in order to increase the probability of a successful IPO. In their model, the issuer's surplus from the IPO increases with the public information, while the probability of the IPO's success decreases with the offer price. To decrease the probability of failure, the issuer asks for a lower offer price if positive information is observed.

In Sherman (2005), IPOs are underpriced to compensate investors for the costs of information production. The offer price is partially adjusted with respect to the public information if it is more costly to evaluate IPOs in bull markets. For example,

investors' time value may be greater in a bull market than in a bear market.

Hoberg (2007) presents two underwriters, where one is informed of the true value of the IPO firm while the other is not. The two underwriters bid for the underwriting contract, with the higher bid being more likely to be accepted by the issuer. Both underwriters try to underprice the IPO as much as possible because, the author argues, investors return most of the money left on the table to the underwriter through commission fees or other methods.[5] This assumption implies that the offer price is partially adjusted because underwriters benefit from underpricing. In equilibrium, the uninformed underwriter bids the same price for both "good" IPOs and "bad" ones. The informed underwriter, on the other hand, bids a higher (lower) price for "good" ("bad") IPOs. Consequently, the informed underwriter is more likely to underwrite "good" IPOs, which are characterized by both greater price adjustment and greater underpricing. The model implies that the informed underwriter is responsible for the majority of the partial adjustment phenomenon.

3.3 The Model

Consider an entrepreneur who owns a firm. The total number of shares of the firm is normalized to 1. The entrepreneur (hereafter, I use the entrepreneur interchangeably with the issuer or the firm) plans to sell α shares of her stock. The underwriter's role is suppressed: the issuer sells the shares directly to a representative investor. That is, I assume homogeneous investors.

I propose three dates: 0, 1, and 2. The firm is liquidated at date 2 and pays dividend $\tilde{V}$. Neither the entrepreneur nor the investor knows the amount of the dividend. At time 0, the prior beliefs of the entrepreneur and the investor about the dividend follow a Gaussian distribution: $\tilde{V}_0 \sim N(\bar{V}, 1/\rho_V)$. In addition, each of them observes a private signal of the dividend

$$S_i = \tilde{V}_0 + \tilde{\varepsilon}_i \quad i = E, I \tag{3.1}$$

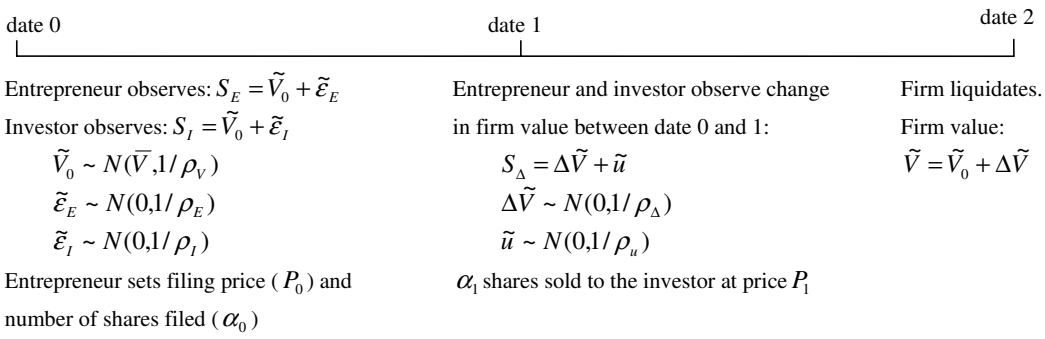
where $\tilde{\varepsilon}_i \sim N(0, 1/\rho_i)$; E and I refer to the entrepreneur and the issuer, respectively.

These assumptions deviate from the previous equity offering literature where either the entrepreneur or the investor is assumed to know the true value of the IPO firm,

[5] See also Loughran and Ritter (2002).

that is, $\rho_E = \infty$ or $\rho_I = \infty$. For instance, in classical corporate finance theories, the issuer is usually assumed to know the firm's value.[6] On the other hand, Rock (1986) assumes that investors know the firm's value but that the issuer does not. I argue that my assumptions are more realistic: although the issuer may have more information about the future cash flows of the IPO firm, sophisticated investors are arguably more knowledgeable about other crucial information such as macroeconomic conditions, financial market conditions, and industry prospects.

Figure 3.1: Information Environment of the Model



The going-public process begins at date 0 and ends at date 1. At date 0, the entrepreneur files a preliminary prospectus, which specifies the filing price (P_0) and the number of shares she plans to sell (α_0). At date 1, the entrepreneur and the investor observe a public signal about the change in the firm's fundamental value from date 0 to 1 (the waiting period), $\triangle\tilde{V}$:

$$S_\triangle = \triangle\tilde{V} + \tilde{u}, \tag{3.2}$$

where $\tilde{u} \sim N(0, 1/\rho_u)$. The prior belief of $\triangle\tilde{V}$ is

$$\triangle\tilde{V} \sim N(\triangle\overline{V}, 1/\rho_\triangle). \tag{3.3}$$

For simplicity, I assume $\triangle\overline{V} = 0$. The variables $\tilde{V}_0, \triangle\tilde{V}, \tilde{\varepsilon}_E, \tilde{\varepsilon}_I$ and $\tilde{u}$ are independent from each other. Hence the firm's liquidation value consists of two parts:

$$\tilde{V} = \tilde{V}_0 + \triangle\tilde{V}. \tag{3.4}$$

[6] See, for example, Leland and Pyle (1977) and Myers and Majluf (1984).

The information environment of the model is shown in Figure 3.1.

I also assume that there is a risk-free asset in the market aside from the firm's equity. The risk-free rate is assumed to be 0 for simplicity. The issuer is risk averse with a CARA utility function: $u(x) = -e^{-\gamma x}$. She sells α_1 shares at price P_1 to maximize her expected utility at time 2. The investor is endowed with wealth W, which is sufficient to buy the whole firm. He also has a CARA utility function $u(x) = -e^{-\beta x}$.

Usually, P_1 is different than P_0. I assume that the entrepreneur pays $C_P(P_1 - P_0)^2$ as an adjustment cost, where C_P is an exogenous constant. Similarly, I assume that there is a cost associated with adjusting the number of shares filed: $C_\alpha(\alpha_1 - \alpha_0)^2$.[7] Whenever the offer price and/or the number of shares is revised, the IPO firm has to re-file the prospectus with the Securities and Exchange Commission (SEC). The administrative expenses associated with re-filing might be negligible, but re-filing may result in a significant delay of the going-public process. Such a delay could be very costly, given the fast-changing market conditions. For example, if the offer price and/or the number of shares is adjusted so that the final filing amount is outside the 20% range of the prior estimated aggregate, the SEC needs to review the IPO filing again. On average, the review delays the offering by almost four weeks (Barcaskey, 2005). The offering may fail if the market conditions significantly deteriorate during these four weeks.

In the next two subsections, I derive the offer price, the number of shares offered, the filing price, and the number of shares filed. The equilibrium concept I employ is the rational expectations equilibrium. Due to the nature of the problem, I solve the model backward by first looking at date 1.

3.3.1 The Offer Price and the Number of Shares Offered

At date 1, the entrepreneur sells α_1 shares at price P_1 to maximize her expected utility at date 2:

$$max_{P_1} \quad E_1\left[-e^{-\gamma[P_1\alpha_1 - C_P(P_1-P_0)^2 - C_\alpha(\alpha_1-\alpha_0)^2 + (1-\alpha_1)\tilde{V}]}\right], \tag{3.5}$$

[7] As I shall show later, the main results of the model hold without the existence of these adjustment costs.

which is equivalent to

$$max_{P_1} \quad \gamma\alpha_1 P_1 - \gamma C_P (P_1 - P_0)^2 - \gamma C_\alpha (\alpha_1 - \alpha_0)^2 + \gamma(1-\alpha_1)E[\tilde{V}|I_1^E] - \frac{1}{2}\gamma^2(1-\alpha_1)^2 var[\tilde{V}|I_1^E], \tag{3.6}$$

where I_1^E is the entrepreneur's information set at date 1.

The model is solved within the framework of rational expectations equilibrium. I conjecture that the optimal offer price P_1^* has the following form:

$$P_1^* = k_0 + k_1\bar{V} + k_2 S_E + k_3 S_I + k_4 S_\triangle. \tag{3.7}$$

It shall be shown that this is indeed the solution. Note that the private signal of the entrepreneur, S_E, is revealed to the investor through the offer price. Consequently, the investor's information set at time 1 is $I_1^I = \{\bar{V}, S_E, S_I, \triangle\bar{V}, S_\triangle\}$.

Given the offer price, P_1, the investor's demand of the IPO shares is the solution of

$$max_{\alpha_1} \quad E_1\left[-e^{-\beta[W+\alpha_1(\tilde{V}-P_1)]}\right], \tag{3.8}$$

which is equivalent to

$$max_{\alpha_1} \quad \beta W + \beta\alpha_1(E[\tilde{V}|I_1^I] - P_1) - \frac{1}{2}\beta^2\alpha_1^2 var[\tilde{V}|I_1^I]. \tag{3.9}$$

The first-order condition yields the optimal number of shares that the investor demands:

$$\alpha_1^* = \frac{1}{\beta var[\tilde{V}|I_1^I]}(E[\tilde{V}|I_1^I] - P_1). \tag{3.10}$$

Note that the demand is positive only when the expected dividend is greater than the offer price. The equity offering fails if the demand is negative.

Given the assumption that the variables follow normal distributions, I can com-

pute the conditional mean and variance of $\tilde{V}$:

$$\begin{aligned} E[\tilde{V}|I_1^I] &= \left(\frac{\rho_V}{\rho_V+\rho_E+\rho_I}\right)\bar{V}+\left(\frac{\rho_E}{\rho_V+\rho_E+\rho_I}\right)S_E \\ &\quad +\left(\frac{\rho_I}{\rho_V+\rho_E+\rho_I}\right)S_I+\left(\frac{\rho_u}{\rho_u+\rho_\triangle}\right)S_\triangle \qquad (3.11) \\ \sigma^2 \equiv var[\tilde{V}|I_1^I] &= \frac{1}{\rho_V+\rho_E+\rho_I}+\frac{1}{\rho_u+\rho_\triangle}. \qquad (3.12) \end{aligned}$$

The conditional expectation of the firm value consists of two parts. The first part is a weighted average of the prior expectation of the firm value ($\bar{V}$), the entrepreneur's signal (S_E), and the investor's signal (S_I). The associated weights are the precisions of the three signals, respectively. The second part is a weighted average of the prior expectation of the change in the firm's value during the waiting period ($\triangle\bar{V}$) and the public signal ($S_\triangle$). The prior expectation of the change in the firm's value does not appear in the formula because of the assumption that $\triangle\bar{V}=0$. Also, note that the conditional variance of the firm value decreases with the precisions of both the entrepreneur's signal and the investor's signal.

Plugging equations (3.11) and (3.12) into (3.10) yields the investor's demand. Note that the demand reveals the investor's private signal S_I to the entrepreneur. Consequently, the model is fully revealing and the agents share the same information set at time 1. Put mathematically, $I_1^E = I_1^I = \{\bar{V}, S_E, S_I, \triangle\bar{V}, S_\triangle\}$.

In equilibrium, the demand of the IPO shares equals the supply. Plugging equation (3.10) into (3.6) yields:

$$\begin{aligned} max_{P_1} \quad & \frac{\gamma}{\beta\sigma^2}(E[\tilde{V}|I_1^I]-P_1)P_1-\gamma C_P(P_1-P_0)^2-\gamma C_\alpha\left[\frac{1}{\beta\sigma^2}(E[\tilde{V}|I_1^I]-P_1)-\alpha_0\right]^2 \\ + \quad & \gamma\left[1-\frac{1}{\beta\sigma^2}(E[\tilde{V}|I_1^I]-P_1)\right]E[\tilde{V}|I_1^E]-\frac{1}{2}\gamma^2\left[1-\frac{1}{\beta\sigma^2}(E[\tilde{V}|I_1^I]-P_1)\right]^2\sigma^2. \end{aligned} \qquad (3.13)$$

Taking the first-order derivative with respect to P_1 and rearranging yields the optimal offer price:

$$P_1^* = a_1E(\tilde{V}|I_1^E)+(1-a_1)P_0-a_2\alpha_0-a_3\sigma^2, \qquad (3.14)$$

where,

$$a_1 \equiv \frac{2\beta+\gamma+\frac{2C_\alpha}{\sigma^2}}{2\beta+\gamma+\frac{2C_\alpha}{\sigma^2}+2C_P\beta^2\sigma^2}, \tag{3.15}$$

$$a_2 \equiv \frac{2\beta C_\alpha}{2\beta+\gamma+\frac{2C_\alpha}{\sigma^2}+2C_P\beta^2\sigma^2}, \tag{3.16}$$

$$a_3 \equiv \frac{\beta\gamma}{2\beta+\gamma+\frac{2C_\alpha}{\sigma^2}+2C_P\beta^2\sigma^2}. \tag{3.17}$$

The following observations are noteworthy. First, the first two components of the offer price are a weighted average of the expected firm value and the filing price. The associated weights are a_1 and $1-a_1$, respectively. Note that $0<a_1<1$, $\frac{\partial a_1}{\partial C_p}<0$, and $\frac{\partial a_1}{\partial C_\alpha}>0$. An increase in the price adjustment cost (C_P) makes it more costly to deviate from the filing price. Consequently, the weight of the filing price ($1-a_1$) increases. On the other hand, an increase in the share adjustment cost (C_α) makes it relatively less costly to adjust the offer price than to adjust the number of shares offered, resulting in a lower weight of the filing price.

Second, the offer price is negatively related to the number of shares filed. When more shares are filed, more shares will be sold to the investor because of the share adjustment cost. To induce the investor to buy more shares, the offer price must be lower. This leads to the negative relation between the offer price and the number of shares filed. This relation becomes more negative when it is more costly to adjust the number of shares offered: $\frac{\partial a_2}{\partial C_\alpha}>0$.

Third, the offer price increases (decreases) with the conditional mean (variance) of the fundamental firm value, as the issuer and the investor have a CARA utility function.

3.3.2 The Filing Price and the Number of Shares Filed

At date 0, the entrepreneur sets the filing price (P_0) and the number of shares to be sold (α_0), and files the IPO. Her information set is $I_0^E=\{\bar{V},S_E,\triangle\bar{V}\}$. Clearly, $I_0^E\in I_1^E=\{\bar{V},S_E,S_I,\triangle\bar{V},S_\triangle\}$. She chooses the filing price and the number of shares

filed to maximize her expected utility at time 2; that is:

$$max_{P_0,\alpha_0} \quad E_0\Big\{\gamma\alpha_1 P_1 - \gamma C_P(P_1-P_0)^2 - \gamma C_\alpha(\alpha_1-\alpha_0)^2 + \gamma(1-\alpha_1)E[\tilde{V}|I_1^E] - \frac{1}{2}\gamma^2(1-\alpha_1)^2\sigma^2\Big\}. \tag{3.18}$$

Straightforward calculus yields the optimal filing price and the optimal number of shares filed:

$$P_0^* = E(P_1|I_0^E), \tag{3.19}$$

$$\alpha_0^* = E(\alpha_1|I_0^E). \tag{3.20}$$

The filing price and the number of shares filed are set to be the expected offer price and the expected number of shares offered, respectively, in order to reduce adjustment costs.

Plugging equation (3.14) into (3.19) yields

$$\begin{aligned} & P_0^* = a_1 E(\tilde{V}|I_0^E) + (1-a_1)P_0^* - a_2\alpha_0 - a_3\sigma^2 \\ \Rightarrow \quad & P_0^* = E(\tilde{V}|I_0^E) - \frac{a_2}{a_1}\alpha_0 - \frac{a_3}{a_1}\sigma^2, \end{aligned} \tag{3.21}$$

where $E(\tilde{V}|I_0^E) = \frac{\rho_V}{\rho_V+\rho_E}\bar{V} + \frac{\rho_E}{\rho_V+\rho_E}S_E$. The filing price consists of three parts. The first part is the conditional expectation of the firm value. The last part relates to the conditional variance of the firm value. These are intuitive because both agents have a CARA utility function. The second part is negatively related to the number of shares filed. The intuition is as follows. When more shares are filed, more shares will be sold because of the share adjustment cost. Similarly, the offer price increases with the filing price. As shown in equation (3.10), the number of shares offered is negatively related to the offer price. Consequently, the filing price decreases with the number of shares filed.

Equations (3.20), (3.10), (3.14), and (3.21) imply that

$$\begin{aligned} & \alpha_0^* = \frac{1}{\beta\sigma^2}\left[\frac{a_2}{a_1}\alpha_0^* + \frac{a_3}{a_1}\sigma^2\right] \\ \Rightarrow \quad & \alpha_0^* = \frac{\gamma}{\gamma+2\beta}. \end{aligned} \tag{3.22}$$

The number of shares filed only depends on the degrees of risk aversion of the entrepreneur and the investor. It increases (decreases) with the degree of risk aversion of the entrepreneur (the investor). When the entrepreneur is more risk averse, she will want to sell more shares. The number of shares filed does not depend on either the private information or the public information, as neither information is revealed to the entrepreneur at date 0.

3.3.3 The Equilibrium

Plugging equation (3.22) into (3.21), (3.14), and (3.10) yields the number of shares filed, the offer price, and the number of shares offered in equilibrium, which are summarized in the following proposition.

Proposition 3.1 (The Equilibrium) *At date 0, the entrepreneur files* $\alpha_0^* \left(= \frac{\gamma}{2\beta+\gamma}\right)$ *shares. The filing price is*

$$P_0^* = m_0 + m_1 \bar{V} + m_2 S_E. \tag{3.23}$$

At date 1, the number of shares sold to the investor and the offer price are given by:

$$\alpha_1^* = n_0 + n_1 \bar{V} + n_2 S_E + n_3 S_I + n_4 S_\triangle \tag{3.24}$$

$$P_1^* = k_0 + k_1 \bar{V} + k_2 S_E + k_3 S_I + k_4 S_\triangle. \tag{3.25}$$

The k's, m's and n's are constants and are given by

$$
\begin{aligned}
k_0 &= -\frac{a_2}{a_1}\alpha_0 - \frac{a_3}{a_1}\sigma^2, \\
k_1 &= a_1\frac{\rho_V}{\rho_V+\rho_E+\rho_I} + (1-a_1)\frac{\rho_V}{\rho_V+\rho_E}, \\
k_2 &= a_1\frac{\rho_E}{\rho_V+\rho_E+\rho_I} + (1-a_1)\frac{\rho_E}{\rho_V+\rho_E}, \\
k_3 &= a_1\frac{\rho_I}{\rho_V+\rho_E+\rho_I}, \\
k_4 &= a_1\frac{\rho_u}{\rho_u+\rho_\triangle}, \\
m_0 &= -\frac{a_2}{a_1}\alpha_0 - \frac{a_3}{a_1}\sigma^2, \\
m_1 &= \frac{\rho_V}{\rho_V+\rho_E}, \\
m_2 &= \frac{\rho_E}{\rho_V+\rho_E}, \\
n_0 &= \frac{1}{\beta\sigma^2}\left[\frac{a_2}{a_1}\alpha_0 + \frac{a_3}{a_1}\sigma^2\right], \\
n_1 &= \frac{1-a_1}{\beta\sigma^2}\left(\frac{\rho_V}{\rho_V+\rho_E+\rho_I} - \frac{\rho_V}{\rho_V+\rho_E}\right), \\
n_2 &= \frac{1-a_1}{\beta\sigma^2}\left(\frac{\rho_E}{\rho_V+\rho_E+\rho_I} - \frac{\rho_E}{\rho_V+\rho_E}\right), \\
n_3 &= \frac{1-a_1}{\beta\sigma^2}\left(\frac{\rho_I}{\rho_V+\rho_E+\rho_I}\right), \\
n_4 &= \frac{1-a_1}{\beta\sigma^2}\left(\frac{\rho_u}{\rho_u+\rho_\triangle}\right).
\end{aligned}
$$

The filing price is a weighted average of the unconditional expectation of the firm value and the entrepreneur's private signal. The weights, m_1 and m_2, increase in the precision of the prior belief (ρ_V) and the precision of the entrepreneur's signal (ρ_E), respectively. The offer price is a linear function of the signals, verifying the conjecture of the functional form of the offer price.

3.3.4 Price and Share Dynamics

The last subsection derives the equilibrium of the model. It is clear that both the offer price and the number of shares offered are adjusted from their filing counter-

parts with respect to the information learned during the waiting period. This section investigates how they are adjusted.

Adjustment of the Offer Price

The offer price depends on both the private signals observed at date 0 and the public signal observed at date 1. In the literature, S_I denotes private information, and $S_\triangle$ denotes public information. The filing price does not depend on either S_I or $S_\triangle$. Price adjustment ($\triangle P \equiv P_1^* - P_0^*$) can be derived from the proposition

$$\triangle P = (k_0 - m_0) + (k_1 - m_1)\bar{V} + (k_2 - m_2)S_E + k_3 S_I + k_4 S_\triangle. \tag{3.26}$$

Corollary 3.1 *The offer price is partially adjusted with respect to the private and public information:*

$$\frac{\partial(\triangle P)}{\partial S_I} = a_1 \frac{\rho_I}{\rho_V + \rho_E + \rho_I} \in (0,1), \tag{3.27}$$

$$\frac{\partial(\triangle P)}{\partial S_\triangle} = a_1 \frac{\rho_u}{\rho_u + \rho_\triangle} \in (0,1). \tag{3.28}$$

The partial adjustment of the offer price is driven by two forces: the noise in the information and the price adjustment cost. First, neither the private signals nor the public signal reveals the true firm value. Given that investors are risk averse, the noisy information will be partially incorporated into the offer price. Second, the firm is reluctant to fully adjust the offer price due to the cost of doing so. The price adjustment cost prevents the full adjustment of the offer price through a_1: $0 < a_1 < 1$ and $\lim_{C_p \to 0} a_1 = 1$. However, the price adjustment cost is not essential to the partial adjustment result. The results in *Corollary 1* still hold even if the price adjustment cost becomes zero:

$$\lim_{C_p \to 0} \frac{\partial(\triangle P)}{\partial S_I} = \lim_{C_p \to 0} a_1 \frac{\rho_I}{\rho_V + \rho_E + \rho_I} = \frac{\rho_I}{\rho_V + \rho_E + \rho_I} \in (0,1), \tag{3.29}$$

$$\lim_{C_p \to 0} \frac{\partial(\triangle P)}{\partial S_\triangle} = \lim_{C_p \to 0} a_1 \frac{\rho_u}{\rho_u + \rho_\triangle} = \frac{\rho_u}{\rho_u + \rho_\triangle} \in (0,1). \tag{3.30}$$

The following two corollaries summarize the role of information precision in IPO pricing.

Corollary 3.2 *The proportion of the private information that is incorporated into the offer price increases with the precision of the private information (ρ_I):*

$$\frac{\partial\left(\frac{\partial(\triangle P)}{\partial S_I}\right)}{\partial \rho_I} = \frac{\partial\left(a_1 \frac{\rho_I}{\rho_V+\rho_E+\rho_I}\right)}{\partial \rho_I} > 0. \tag{3.31}$$

Proof: It can be shown that $\frac{\partial a_1}{\partial \rho_I} > 0$ and $\frac{\partial\left(\frac{\rho_I}{\rho_V+\rho_E+\rho_I}\right)}{\partial \rho_I} > 0$. Also, $a_1 > 0$ and $\frac{\rho_I}{\rho_V+\rho_E+\rho_I} > 0$. ■

Corollary 3.3 *The proportion of the public information that is incorporated into the offer price increases with the precision of the public information (ρ_u):*

$$\frac{\partial\left(\frac{\partial(\triangle P)}{\partial S_\triangle}\right)}{\partial \rho_u} = \frac{\partial\left(a_1 \frac{\rho_u}{\rho_u+\rho_\triangle}\right)}{\partial \rho_u} > 0. \tag{3.32}$$

Proof: The same logic as the proof of *Corollary 2*. ■

Adjustment of the Number of Shares Offered

The issuer also adjusts the number of shares offered. More (fewer) shares are sold to the investor when the information is positive (negative). Positive information increases the firm's value, and thus increases the offer price and the issuer's expected wealth. As a result, the issuer lowers her demand for the shares of the risky IPO firm. The investor, on the other hand, demands more shares when the information is positive. Consequently, more shares are sold to the investor if the information is positive. This is summarized in the following corollary.

Corollary 3.4 *The adjustment of the number of shares offered is positively related to the private and public information:*

$$\frac{\partial(\triangle\alpha)}{\partial S_I} > 0, \tag{3.33}$$

$$\frac{\partial(\triangle\alpha)}{\partial S_\triangle} > 0. \tag{3.34}$$

Proof: From the proposition, it can be shown that

$$\begin{aligned} & \triangle\alpha = n0 - \frac{\gamma}{\gamma+2\beta} + n_1\bar{V} + n_2 S_E + n_3 S_I + n_4 S_{\triangle} \qquad (3.35) \\ \Rightarrow \quad & \frac{\partial(\triangle\alpha)}{\partial S_I} = n_3 > 0, \\ & \frac{\partial(\triangle\alpha)}{\partial S_{\triangle}} = n_4 > 0. \end{aligned}$$

■

The number of shares offered is not adjusted if both the price adjustment cost and the share adjustment cost are zero. In this case, the number of shares offered only depends on the risk aversion parameters and turns out to be the same as the number of shares filed. Put mathematically, it can be shown that $\lim_{C_P \to 0, C_\alpha \to 0} \alpha_1^* = \alpha_0^* = \frac{\gamma}{\gamma+2\beta}$.

3.3.5 Hypotheses

Corollaries 3.1, 3.2, 3.3, and 3.4 imply the following hypotheses:

Hypothesis 3.1 *The offer price is partially adjusted with respect to the private and public information. The proportions of the private information and the public information that are incorporated into the offer price increase with their respective precision.*

Hypothesis 3.2 *The adjustment of the number of shares offered is positively related to the private and public information.*

The hypotheses are unique to this model, which is the first to investigate the role of information precision in IPO pricing and endogenize the number of shares offered at the same time. Because the private information is not observed, I test the contents of the hypotheses that are related to the public information in the next two sections.

3.4 Data and Model Specification

3.4.1 Data

The sample starts with all firm-commitment IPOs in the Securities Data Company (SDC) database over the period 1985-2006. ADRs, REITs, closed-end funds, unit

offerings, and IPOs with the midpoint of the filing price range below $5 are excluded. Stock prices and returns are retrieved from the CRSP tapes. The Carter-Manaster underwriter reputation rankings are collected from Jay Ritter's IPO website[8] and extrapolated to 2006. Following Edelen and Kadlec (2005), the following filters and amendments are also applied to the data: (1) completed IPOs with a waiting period longer than one year are excluded; and (2) the withdrawal date is assumed to be 270 days after the amended filing date if it is missing or is the same as the filing date in SDC. In addition, I exclude one IPO whose offer price is adjusted upward by more than eight times the midpoint of the filing price range, and exclude seven IPOs for which the number of shares offered is more than six times the number of shares filed.[9] These IPOs either are outliers or represent errors in the SDC database. The final sample consists of 5,450 IPOs, 4,547 of which are completed and 903 of which are withdrawn.

3.4.2 Public Information and Its Precision

Following the literature, I proxy the public information with the cumulative equal-weighted Fama-French industry return during the waiting period. Equal weighting assigns more weight to small firms, which are more like IPOs than large firms. The results are qualitatively unchanged if value-weighted returns are used instead. Following Edelen and Kadlec (2005), for withdrawn IPOs with a waiting period longer than 270 days, the waiting period industry return is calculated over the 133 days after IPO filing, where 133 days is the median waiting period length of the IPOs that withdraw within 270 days.

How precise is the waiting period industry return as a measure of the change in the IPO firm's value during the waiting period? It is more precise if the IPO firm's stock return more closely follows the industry return. Changes in the IPO firm's value may be caused by either industry-wide information or firm-specific information or by both. Suppose that the IPO firm's stock return is generated by the following process:

$$r_{ot} = \alpha_o + \beta_o \times r_{it} + \varepsilon_{ot}, \tag{3.36}$$

where r_{ot} is the IPO firm's return on day t, α_o is a constant, r_{it} is the industry return

[8] http://bear.cba.ufl.edu/ritter/ipodata.htm.

[9] Including them in the sample does not qualitatively change the results.

on day t, and ε_{ot} is a random process that captures any information specific to the IPO firm. By definition, the precision of the industry return as a measure of the IPO firm's return is the fraction of the variance of r_{ot} explained by r_{it}, or the R^2 of the regression of r_{ot} on a constant and r_{it}.[10]

We cannot compute the R^2 of regression 3.36 for the IPO firm during the waiting period because stock returns of the IPO firm are observed only after the offering. Akin to Roll (1988) and Morck et al. (2000), I use the average R^2 of the IPO's industry peers during the waiting period as a proxy for the R^2 of the IPO.[11] Regression 3.36 is run for each industry peer of the IPO during the waiting period, and the associated R^2 is recorded. The average R^2 of the IPO's industry peers is then calculated and used as a proxy for the R^2 of the IPO firm. In consideration of reliability, industry peers that have fewer than 10 data points during the waiting period are excluded from the calculation of the industry R^2.

3.4.3 Control Variables

Following the previous literature, I control for other factors that may affect IPO decisions: the size of the IPO as proxied by the filing amount, the reputation of the underwriter, whether the IPO firm is backed by venture capitalists, and recent IPO market conditions. Carter and Manaster (1990) document that IPOs underwritten by prestigious banks have lower initial returns. Barry et al. (1990), Megginson and Weiss (1991), Gompers and Lerner (1997), Bradley and Jordan (2002), and Lee and Wahal (2004) find that the existence of venture capitalists affects IPO pricing.

Benveniste et al. (2002) and Benveniste et al. (2003) show that underwriters may bundle IPOs with a common value factor to efficiently extract information. Consequently, the performance of recent IPOs provides valuable information for the current IPO. I use two variables to capture the recent IPO market conditions: the recent IPO price adjustment—the average price adjustment of other IPOs completed 30 days prior to the IPO offering/withdrawal—and the relative withdrawal frequency, which is defined as the number of withdrawn IPOs divided by the number of IPO filings dur-

[10] $R^2 = 1 - \frac{\sum_t \varepsilon_{ot}^2}{\sum_t (r_{ot} - \bar{r}_o)^2}$.

[11] Morck et al. (2000) use the market R^2 to measure the synchronicity of stock prices. A high R^2 indicates a greater tendency for stock prices to move together. In other words, a high R^2 means that it is more precise to measure the return of one stock with the return of the market or with that of the industry or another stock. This supports using the industry R^2 to proxy for the precision of the industry return as a measure of the change in the IPO firm's value.

ing the 30 days prior to the IPO offering/withdrawal. Following Edelen and Kadlec (2005), these two variables are orthogonalized with respect to the industry return over the waiting period.

3.4.4 Data Overview

Panels A and B of Table 3.1 summarize characteristics of the completed and withdrawn IPOs, respectively. Take completed IPOs first. A typical completed IPO hires an investment bank with a Carter-Manaster underwriter rank of 8. The average completed IPO files 5.0 million shares with a filing price of $12.70 and plans to raise about $52 million (measured in 1985 dollars using CPI adjustment). The median filing amount is much lower at $25 million. The average completed IPO waits for 75 days from the filing to the offering, during which period the industry stock price increases by 7.5% on average. The average R^2 is 5.4%, implying that industry returns are able to explain about 5% of individual stock returns. During the 30 days prior to the offering, completed IPOs witness an average price adjustment of 1.6% by other IPOs, and an average relative withdrawal frequency—the number of withdrawn IPOs divided by the number of IPO filings—of 14.4%. On average, completed IPOs decrease the number of shares offered by -0.7% to 4.9 million shares, and increase the offer price by 0.4% to $12.75. Although the share and price adjustments are small on average, they vary tremendously across the IPOs: their standard deviations are 18.7% and 22.6%, respectively. Finally, 43.2% of the completed IPOs are backed by venture capitalists.

Panel B of Table 3.1 presents summary statistics for withdrawn IPOs. Withdrawn and completed IPOs hire investment banks with similar reputations: both the mean and median Carter-Manaster reputation rankings are similar for completed versus withdrawn IPOs. The average withdrawn IPO files 4.5 million shares at a filing price of $12.29 and plans to raise about $42 million, less than the average filing amount of $52 million for completed IPOs. The average withdrawn IPO has a waiting period of 295 days, much longer than the average waiting period of 75 days for completed IPOs. Although withdrawn IPOs have much longer waiting period, they experience lower industry returns during the waiting period: the average industry return is 2.0% for withdrawn IPOs versus 7.5% for completed IPOs. The average R^2 is 5.5%, very close to that found for completed IPOs (5.4%). During the 30 days

Table 3.1: Characteristics of Completed and Withdrawn IPOs, 1985-2006

The sample consists of 5,450 firm-commitment IPOs completed or withdrawn over the period 1985-2006. The data are retrieved from the SDC database excluding ADRs, REITs, closed-end funds, and unit offerings. Carter-Manaster underwriter rank is the 1-9 ranking of underwriter reputation collected from Jay Ritter's IPO website. Filing price is the midpoint of the filing price range. Filing amount is defined as the number of shares filed times the midpoint of the filing price range and is measured in 1985 dollars using CPI adjustment. Waiting period length is the number of days between IPO filing and offering/withdrawal. Waiting period industry return is the cumulative equal-weighted industry return over the period from the IPO filing to the offering/withdrawal. R^2 is the average industry R^2 of regression (3.36). Recent IPO price adjustment is the average price adjustment of other IPOs completed within 30 days prior to the IPO offering/withdrawal. Relative withdrawal frequency is defined as the number of withdrawn IPOs divided by the number of IPO filings within 30 days prior to the IPO offering/withdrawal. Proceeds equals the number of shares offered times the offer price and is measured in 1985 dollars using CPI adjustment. Price adjustment is defined as the ratio of the offer price to the midpoint of the filing price range, minus one. Share adjustment is defined as the ratio of the number of shares offered to the number of shares filed, minus one. Venture capital backing is a dummy variable taking the value of 1 if the firm is backed by venture capitalists and 0 otherwise.

Variables	N	mean	sd	5th percentile	median	95th percentile
			Panel A: Completed IPOs			
Carter-Manaster underwriter rank	4547	7.551	1.812	3.000	8.000	9.000
Number of shares filed (million)	4547	5.006	12.189	1.000	3.000	12.500
Filing price	4547	12.703	4.442	7.000	12.000	19.500
Filing amount ($m, 1985 dollars)	4547	51.647	158.568	5.981	25.188	138.841
Waiting period length (days)	4547	74.746	49.985	26.000	61.000	180.000
Waiting period industry return	4547	0.075	0.143	-0.088	0.052	0.296
R-squared	4547	0.054	0.039	0.019	0.043	0.129
Recent IPO price adjustment	4547	0.016	0.100	-0.126	0.005	0.184
Relative withdrawal frequency	4547	0.144	0.301	0.000	0.073	0.421
Number of shares offered (million)	4547	4.872	12.543	1.000	2.896	12.500
Offer price	4547	12.746	5.161	6.000	12.000	21.000
Proceeds ($m, 1985 dollars)	4547	50.279	147.026	5.430	24.573	135.092
Offer price adjustment	4547	0.004	0.226	-0.333	0.000	0.364
Share adjustment	4547	-0.007	0.187	-0.253	0.000	0.200
Venture capital backing	4547	0.432	0.495	0.000	0.000	1.000
			Panel B: Withdrawn IPOs			
Carter-Manaster underwriter rank	903	7.391	1.945	3.000	8.000	9.000
Number of shares filed (million)	903	4.540	6.281	1.000	3.100	11.900
Filing price	903	12.294	3.532	7.000	12.000	19.000
Filing amount ($m, 1985 dollars)	903	42.408	79.401	5.848	26.711	111.201
Waiting period length (days)	903	295.176	257.030	56.000	244.000	838.000
Waiting period industry return	903	0.020	0.196	-0.288	0.022	0.316
R-squared	903	0.055	0.048	0.013	0.035	0.165
Recent IPO price adjustment	903	-0.002	0.153	-0.169	-0.021	0.182
Relative withdrawal frequency	903	0.443	1.023	0.000	0.164	2.000

prior to withdrawal, withdrawn IPOs witness an average price adjustment of -0.2% by other IPOs and an average relative withdrawal frequency of 44.3%, implying that withdrawn IPOs face much worse IPO market conditions than completed IPOs.

The summary statistics in Table 3.1 are consistent with previous studies such as Edelen and Kadlec (2005).

3.4.5 Model Specification

The model predicts that the proportion of the industry return that is incorporated into the offer price increases with the R^2, a proxy for the precision of the industry return as a measure of the change in the IPO firm's value. To test this prediction, I include in the regression an interaction variable of the waiting period industry return and the R^2. Lowry and Schwert (2004) suggest that price adjustment is more sensitive to negative industry returns than positive industry returns. To explore this asymmetry, I add another interaction variable of the R^2 and the negative waiting period industry return, which equals to the waiting period industry return if it is negative and zero otherwise.

The offer price and the number of shares offered are not observed if an IPO is withdrawn, which creates a sample selection bias. To mitigate this bias, I employ the two-stage Heckman regressions as in Benveniste et al. (2003) and Edelen and Kadlec (2005). In the first stage, an IPO completion dummy—which takes the value of 1 if the IPO is completed and 0 otherwise—is regressed on the waiting period industry return, the negative waiting period industry return, the R^2, the two interaction variables, and the aforementioned control variables. The inverse Mills ratio is then computed and included in the second-stage regression. In summary, I employ the following

econometric model:

$$
\begin{aligned}
&\text{Price adjustment}_i/\text{Share adjustment}_i \\
= \;& \phi_0 + \phi_1 \times \text{Waiting period industry return}_i \\
&+ \phi_2 \times \text{Waiting period industry return}_i^- + \phi_3 \times R_i^2 \\
&+ \phi_4 \times \text{Waiting period industry return}_i \times R_i^2 \\
&+ \phi_5 \times \text{Waiting period industry return}_i^- \times R_i^2 \\
&+ \phi_6 \times \text{Inverse Mills ratio}_i + \phi_7 \times \text{Filing amount}_i \\
&+ \phi_8 \times \text{Venture capital backing}_i + \phi_9 \times \text{Carter-Manaster underwriter rank}_i \\
&+ \phi_{10} \times \text{Recent IPO price adjustment}_i + u_i, \qquad (3.37)
\end{aligned}
$$

where *Waiting period industry return*$^-$ equals the waiting period industry return if it is negative, and 0 otherwise; and R^2 is the average industry R^2 of the regression specified in equation (3.36).

Before proceeding to the empirical results, I examine the correlations between the variables. Panel A of Table 3.2 tabulates the pairwise correlations between the variables available for both completed and withdrawn IPOs. As expected, IPOs with a lower waiting period industry return and a higher relative withdrawal frequency are more likely to be withdrawn. Panel B of Table 3.2 tabulates the pairwise correlations for completed IPOs only. It is clear that the waiting period industry return is positively and significantly correlated with both the price adjustment and the share adjustment.

Table 3.2 raises some concern of multicollinearity. The correlation between the filing amount and the Carter-Manaster underwriter rank is 0.57 in both panels, implying that large IPOs are more likely to hire prestigious underwriters. To mitigate the potential multicollinearity problem, The Carter-Manaster underwriter rank is orthogonalized with respect to the filing amount.

Table 3.2: Correlation Matrix

Panel A: Correlation Matrix of the Variables Available for Both Completed and Withdrawn IPOs (Sample Size = 5,450)

		1	2	3	4	5	6	7
1	Withdrawal	1.000						
2	Waiting period industry return	-0.133	1.000					
		[0.000]						
3	R^2	0.002	-0.321	1.000				
		[0.899]	[0.000]					
4	Log filing amount ($m, 1985 dollars)	-0.013	-0.023	0.230	1.000			
		[0.351]	[0.097]	[0.000]				
5	Carter-Manaster underwriter rank	-0.033	-0.054	0.151	0.572	1.000		
		[0.016]	[0.000]	[0.000]	[0.000]			
6	Recent IPO price adjustment	-0.061	0.354	-0.058	0.067	0.039	1.000	
		[0.000]	[0.000]	[0.000]	[0.000]	[0.005]		
7	Relative withdrawal frequency	0.218	-0.132	0.208	0.123	0.044	-0.083	1.000
		[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	

Panel B: Correlation Matrix for Completed IPOs (Sample Size = 4,547)

		1	2	3	4	5	6	7	8	9
1	Offer price adjustment	1.000								
2	Share adjustment	0.079	1.000							
		[0.000]								
3	Waiting period industry return	0.289	0.054	1.000						
		[0.000]	[0.000]							
4	R^2	-0.001	-0.056	-0.255	1.000					
		[0.970]	[0.000]	[0.000]						
5	Log filing amount ($m, 1985 dollars)	0.049	-0.124	0.009	0.235	1.000				
		[0.001]	[0.000]	0.540	[0.000]					
6	Venture capital backing	0.121	-0.023	0.047	0.017	-0.033	1.000			
		[0.000]	[0.119]	[0.002]	[0.258]	[0.028]				
7	Carter-Manaster underwriter rank	0.153	-0.067	-0.017	0.140	0.566	0.175	1.000		
		[0.000]	[0.000]	[0.256]	[0.000]	[0.000]	[0.000]			
8	Recent IPO price adjustment	0.396	-0.019	0.446	-0.067	0.101	0.131	0.071	1.000	
		[0.000]	[0.210]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		
9	Relative withdrawal frequency	-0.001	-0.058	-0.013	0.210	0.168	0.026	0.029	-0.067	1.000
		[0.964]	[0.000]	[0.379]	[0.000]	[0.000]	[0.083]	[0.050]	[0.000]	

3.5 The Effect of Information Precision

3.5.1 Information Precision and Offer Price Adjustment

Table 3.3 presents the multivariate regression results where the dependent variable is IPO price adjustment. There are five model specifications. In column (1), the waiting period industry return, the control variables, and the inverse Mills ratio are included as explanatory variables. The interaction variable of the waiting period industry return and the R^2 is added in column (2). The negative waiting period industry return variable is added in column (3). Column (4) is the main model specification (equation (3.37)). As a robustness check, column (5) excludes the IPOs during the Internet bubble period (1998-2000) from the sample, as these IPOs experienced extraordinary initial returns. Across columns (1)-(5), I control for year and industry fixed effects and use robust standard errors.

On average, 38% of the waiting period industry return is incorporated into the offer price (column (1)). Consistent with Lowry and Schwert (2004), I find that IPO price adjustment shows an asymmetric response to positive versus negative industry returns: the coefficient on the negative waiting period industry return is positive and statistically significant at the 1% or 5% level in columns (3)-(5).

I also find that the R^2 is positively associated with IPO price adjustment. This effect is statistically significant at the 1% level. More interestingly, the interaction variable of the waiting period industry return and the R^2 is positively associated with IPO price adjustment, and the effect is statistically significant at the 1% level. This effect is symmetric for IPOs with negative versus positive waiting period industry returns: the interaction variable of the negative waiting period industry return and the R^2 is statistically insignificant in the last two columns. Further, column (5) shows that the empirical results are robust to excluding the IPOs during the Internet bubble period: the effects of the explanatory variables on IPO price adjustment in column (5) are qualitatively similar to those in column (4).

Across columns (1)-(5), among the control variables, I find that IPOs backed by venture capitalists, IPOs underwritten by prestigious investment banks, and IPOs that experience greater recent IPO price adjustments are associated with greater price adjustments. The coefficient on the inverse Mills ratio is negative and statistically significant in columns (1)-(3), positive and statistically significant in column (4), and

Table 3.3: Explaining Offer Price Adjustment

The sample consists of 4,547 firm-commitment IPOs completed over the period 1985-2006. The dependent variable is the offer price adjustment, which is defined as the ratio of the offer price to the midpoint of the filing price range, minus one. Waiting period industry return is the cumulative equal-weighted industry return over the period from the IPO filing to the offering. Waiting period industry return$^-$ is equal to the waiting period industry return if it is negative and 0 otherwise. R^2 is the average industry R^2 of regression (3.36). Filing amount is defined as the number of shares filed times the midpoint of the filing price range and is measured in 1985 dollars using CPI adjustment. Venture capital backing is a dummy variable taking the value of 1 if the firm is backed by venture capitalists and 0 otherwise. Carter-Manaster underwriter rank is the 1-9 ranking of underwriter reputation collected from Jay Ritter's IPO website. Recent IPO price adjustment is the average price adjustment of other IPOs completed within 30 days prior to the IPO offering. Inverse Mills ratio is computed from the probit regression of IPO completion. Robust standard errors are used in all model specifications. All 4,547 IPOs are included in the first four columns. Column (5) excludes the IPOs during the Internet bubble period (1998-2000). The corresponding p-value is reported in the brackets below each coefficient. Superscripts ***, **, and * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Dependent Variable	Adjustment of the offer price				
	(1)	(2)	(3)	(4)	(5)
Waiting period industry return	0.375***	0.240***	0.321***	0.211***	0.277***
	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]
Waiting period industry return$^-$			0.472***	0.844***	0.704**
			[0.001]	[0.000]	[0.016]
R^2		0.297***		0.626***	0.537***
		[0.005]		[0.000]	[0.001]
Waiting period industry return$\times R^2$		3.879***		3.280***	3.187***
		[0.000]		[0.010]	[0.004]
Waiting period industry return$^- \times R^2$				-0.793	-1.723
				[0.732]	[0.552]
Log(filing amount)	-0.001	0.002	0.001	0.005	0.004
	[0.740]	[0.641]	[0.788]	[0.167]	[0.309]
Venture capital backing	0.021***	0.022***	0.021***	0.022***	0.012*
	[0.003]	[0.002]	[0.002]	[0.001]	[0.066]
Carter-Manaster underwriter rank	0.021***	0.021***	0.021***	0.021***	0.016***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Recent IPO price adjustment	0.533***	0.559***	0.545***	0.599***	0.550***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Inverse Mills ratio	-0.143***	-0.056*	-0.081***	0.063*	-0.006
	[0.000]	[0.058]	[0.004]	[0.090]	[0.906]
Constant	-0.184***	-0.210***	-0.180***	-0.217***	-0.171***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	4547	4547	4547	4547	3676
Adjusted R-squared	0.248	0.253	0.250	0.256	0.208

statistically insignificant in column (5).

Taken together, the results in Table 3.3 suggest that more precise public information during the waiting period results in the incorporation of a greater proportion of the public information into the offer price. The results are consistent with the model's predictions.

3.5.2 Adjustment of the Number of Shares Offered

Table 3.4 presents the multivariate regression results where the dependent variable is the adjustment of the number of shares offered. Column (1) shows that the waiting period industry return is positively associated with IPO share adjustments, and that the effect is statistically significant at the 1% level. This effect becomes statistically significant at the 5% level in column (2). Column (2) also shows that neither the R^2 nor the interaction variable of the waiting period industry return and the R^2 is statistically significant.

The results in columns (3)-(5) indicate that the number of shares offered is asymmetrically adjusted with respect to positive versus negative waiting period industry returns: the coefficient on the negative waiting period industry return is positive and statistically significant at the 1% or 5% percent level.

The coefficient on the interaction variable of the negative waiting period industry return and the R^2 is negative and statistically significant at the 5% level in column (4). However, this coefficient becomes statistically insignificant in column (5), where the IPOs occurring during the Internet bubble period are excluded.

Across columns (1)-(5), among the control variables, I find that small IPOs and IPOs that experience greater recent IPO price adjustments are associated with greater share adjustments. The coefficient on the inverse Mills ratio is statistically insignificant in all five columns, suggesting that the sample selection bias is insignificant for share adjustment.

Table 3.4: Explaining Share Adjustment

The sample consists of 4,547 firm-commitment IPOs completed over the period 1985-2006. The dependent variable is the share adjustment, which is defined as the ratio of the number of shares offered to the number of shares filed, minus one. Waiting period industry return is the cumulative equal-weighted industry return over the period from the IPO filing to the offering. Waiting period industry return$^-$ is equal to the waiting period industry return if it is negative and 0 otherwise. R^2 is the average industry R^2 of regression (3.36). Filing amount is defined as the number of shares filed times the midpoint of the filing price range and is measured in 1985 dollars using CPI adjustment. Venture capital backing is a dummy variable taking the value of 1 if the firm is backed by venture capitalists and 0 otherwise. Carter-Manaster underwriter rank is the 1-9 ranking of underwriter reputation collected from Jay Ritter's IPO website. Recent IPO price adjustment is the average price adjustment of other IPOs completed within 30 days prior to the IPO offering. Inverse Mills ratio is computed from the probit regression of IPO completion. Robust standard errors are used in all model specifications. All 4,547 IPOs are included in the first four columns. Column (5) excludes the IPOs during the Internet bubble period (1998-2000). The corresponding p-value is reported in the brackets below each coefficient. Superscripts ***, **, and * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Dependent Variable	Adjustment of the number of shares offered				
	(1)	(2)	(3)	(4)	(5)
Waiting period industry return	0.100***	0.060**	0.053**	0.004	-0.022
	[0.000]	[0.049]	[0.020]	[0.919]	[0.616]
Waiting period industry return$^-$			0.412***	0.794***	0.776**
			[0.001]	[0.000]	[0.042]
R^2		-0.032		0.102	0.053
		[0.751]		[0.506]	[0.785]
Waiting period industry return$\times R^2$		0.864		1.319	2.809***
		[0.152]		[0.125]	[0.005]
Waiting period industry return$^- \times R^2$				-3.283*	-5.240
				[0.085]	[0.163]
Log(filing amount)	-0.030***	-0.030***	-0.029***	-0.028***	-0.030***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Venture capital backing	-0.003	-0.003	-0.002	-0.002	-0.004
	[0.652]	[0.671]	[0.679]	[0.704]	[0.480]
Carter-Manaster underwriter rank	0.003	0.003	0.003	0.003	0.008***
	[0.245]	[0.239]	[0.236]	[0.231]	[0.003]
Recent IPO price adjustment	0.098**	0.097**	0.107**	0.123***	0.054
	[0.024]	[0.030]	[0.013]	[0.008]	[0.400]
Inverse Mills ratio	-0.031	-0.020	0.023	0.063	0.012
	[0.164]	[0.475]	[0.382]	[0.118]	[0.853]
Constant	0.089*	0.089*	0.093**	0.088*	0.066
	[0.055]	[0.060]	[0.043]	[0.057]	[0.229]
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	4547	4547	4547	4547	3676
Adjusted R-squared	0.049	0.049	0.051	0.052	0.037

Chapter 4

Deal or No Deal: Hormones and the Mergers and Acquisitions Game [1]

4.1 Introduction

One important commonality shared between the mergers and acquisitions (M&As) process and the ultimatum game is that dominance is likely to play a critical role. The ultimatum game involves the division of a sum of money between two players, with one of the players, the "proposer," offering the other player, the "responder," part of an amount that is to be divided between them. The offer is final hence the term "ultimatum." If the proposer's offer is rejected, neither the proposer nor the responder receives anything. In the case of M&As, the bidder CEO can be viewed as the proposer and the target CEO as the responder: the very act of bidding can be viewed as dominance seeking. Further, the outcome of the M&A ultimately involves the division of the gain from the merger or acquisition involving the two companies: the more the bidding firm pays the greater is the target firm's share of the gain.

Economic rationality suggests that in the ultimatum game, the proposer will make a low offer, believing that since a low amount is better than nothing and that there

[1]A version of the chapter has been published in the September 2010 issue (Volume 56, Number 9) of *Management Science* on pages 1462-1483. We thank the Department Editor, the Associate Editor, three anonymous referees, Huasheng Gao, Michael Meloche, Xiaoyun Yu, and conference participants at the 2010 China International Conference in Finance (Guangzhou) for very helpful comments. We also thank Corrine Wu for excellent research assistance. We acknowledge the financial support from the Social Sciences and Humanities Research Council of Canada, and the Certified Management Accounting Society of British Columbia. All remaining errors are our own.

is no benefit from holding out for more in terms of future rounds of play this is a one-round game the low offer will nevertheless be accepted by the responder.[2] The surprising result is that while the proposer does generally make a low offer, the low offer is frequently rejected by the responder.[3] This has been attributed to a preference for distributional fairness, with players willing to sacrifice financially to achieve a fairer more equal division of the contested sum.[4] The outcome has also been attributed to players wishing to demonstrate to those administering the game that fairness matters to them, at least when contested sums are rather small.[5] However, perhaps even more intriguing than any of the possible explanations of the outcome is how the frequent failure to reach the rational equilibrium in the ultimatum game low offer proposed and low offer accepted depends on the hormone level of the responder who sees a low offer as a challenge to his dominance.

In a widely cited paper, Burnham (2007) describes how the outcome of the ultimatum game is related to levels of the steroidal hormone, testosterone, which in humans and other animals has been associated with male dominance seeking in a competitive situation. The challenge in the ultimatum game impedes cooperative behavior.[6]

Burnham's game is played by male students in a laboratory setting and involves the players dividing $40. The terms of the game are public knowledge to all players. To simplify the game the proposer is permitted to offer either $5 or $25 to the responder and keep the balance, with the ultimatum being a once-and-only offer and a once-and-only response. In order to evaluate the potential role played by testosterone, saliva is swabbed from the mouths of all players. This is done on several days before the experiment and again prior to the experiment.[7] It is observed that 45 percent of responders with above average testosterone who are offered $5 reject the offer. This compares to a 7 percent rejection rate among responders with below-average testosterone. Burnham argues that the outcome is consistent with high-testosterone

[2]For example, see Rubinstein (1982) and Stahl (1972) for the theoretical equilibrium.

[3]Numerous papers report this outcome, including Guth et al. (1982) and Roth (1995). This finding has been shown to occur even when the stakes are relatively large (Hoffman et al., 1996) and in different cultural environments (Roth et al., 1991; Henrich et al., 2001).

[4]See Bolton (1991), Fehr and Schmidt (1999), and Rabin (1993).

[5]See Alexander (1987) and Nowak et al. (2000).

[6]Zak et al. (2009) further show that exogenous administration of testosterone changes behavior in the same direction, specifically, elevated testosterone leads to lower offers in the ultimatum game.

[7]Experimental details can be found in Burnham (2007).

responders feeling more challenged by a low offer than are low-testosterone responders: low offers are seen as challenges to responders' dominance. Five of the seven responders with the highest testosterone levels reject the $5 offers versus just one of the 19 responders with the lowest levels. As for the proposers, there is a tendency for high-testosterone players to offer the higher sum, that is, $25, but this is not statistically significant.

While there are parallels between the nature of the ultimatum game and M&As, there are also some notable differences. Most importantly, unlike the situation in the ultimatum game, in the course of M&A negotiations there are opportunities to respond to offers and for offered amounts to be revised (Boone and Mulherin, 2007). As a result either the bidder CEO/proposer or the target CEO/responder may react negatively to challenges to their dominance. CEOs are clearly in dominant positions by virtue of their leading corporate roles: both the bidder and the target CEOs must have sought dominance to be at the pinnacle of their corporations. This makes them an interesting population to study hormones and dominance. In addition to the possibility of responses to and revisions of offers, bidders may opt for less amiable approaches, including going around the target board and making a tender offer directly to the target shareholders. Further, the very act of choosing to make an acquisition bid could well be associated with male dominance seeking. In light of these differences, it is possible that unlike in the ultimatum game where only the responder's testosterone matters, in M&A the testosterone of both parties could influence the course and outcome of negotiations.

Using data from over 350 acquisition bids for the period 1997-2007 and proxying testosterone by male CEO age, we find a strong and positive association between the bidder male CEO being young and the withdrawal rate of initiated M&As. In terms of the economic significance, the bidder male CEO being young increases the likelihood of bid withdrawal by over 20 percent, relative to the base case of the bidder male CEO being old. It appears that a young, high-testosterone bidder CEO may contribute to withdrawal by representing more of a dominance challenge to the counterpart CEO than an older CEO. This is different than in the ultimatum game where it is only the responder's testosterone that matters. We also find that the target male CEO being young is positively associated with the use of tender offers. In terms of the economic significance, the target male CEO being young increases the likelihood of a tender offer by about two percent, relative to the base case of the

target male CEO being old. We argue that this result is what we would expect if young CEOs are viewed as more challenging to the dominance of counterpart CEOs, and if the reaction of the target CEO is what leads to the bidder CEO resorting to tender offers. We also show that the bid premium is unaffected by the age of either the bidder or the target CEO. This suggests that it is not financial terms that are behind withdrawn offers. We further argue that other possible channels of influence of CEO age, channels which are alternatives to testosterone, work in the opposite direction to what we find, or that they are controlled for by other factors in our estimation. Finally, using data from over 12,000 firm-year observations for the period 1997-2007 and proxying testosterone by male CEO age, we find a positive and significant association between the male CEO being young and the likelihood of making an acquisition bid. In terms of the economic significance, the bidder male CEO being young increases the likelihood of a bid by four percentage points, relative to the base case of the bidder male CEO being old. As mentioned before, bidding to acquire another company might also be considered dominance seeking behavior.

The plan of the paper is as follows. The next section reviews the literature on the relations between age and testosterone and between testosterone and dominance behavior, and also develops our hypotheses. Despite an absence of prior work on the role and consequences of CEO hormones in M&As, studies of hormones in other contexts provide the basis for the suggested association we evaluate in this paper. Section 4.5 describes our M&A sample and the model specifications used to analyze the CEO age-M&A connection. Section 4.6 presents our main results on the incidences of bid withdrawal and tender offers. Section 4.7 considers whether age may be capturing effects other than those of hormones and investigates the role of testosterone in bid initiation.

4.2 Literature Review and Hypothesis Development

Ideally, an investigation of the effects of bidder and target male CEO testosterone levels on the nature of M&A negotiations would be based on observations of these levels along the lines of Burnham's laboratory investigation. However, given that we have to rely on historical M&A data on the characteristics of negotiations, this is not possible. Indeed, it would probably be difficult to observe CEO testosterone levels even if we were able to do an experiment in real time as not all CEOs would likely

consent to providing samples. Furthermore, it is not easy to identify when and at what stage(s) during negotiations the saliva samples should be taken. Finally, there are both circadian cycles (highest in the morning and lowest in the evening) and seasonal variations (lowest in the summer season and highest in the fall) in testosterone levels (Dabbs, 1990a,b), that might lead to poor reliability in testosterone measurement. In lieu of direct measurement, we base our study on male CEO age which, as we shall see, has been suggested to be associated with testosterone. Naturally, confidence in the findings of this paper depends on the closeness of this association, evidence for which is provided below.

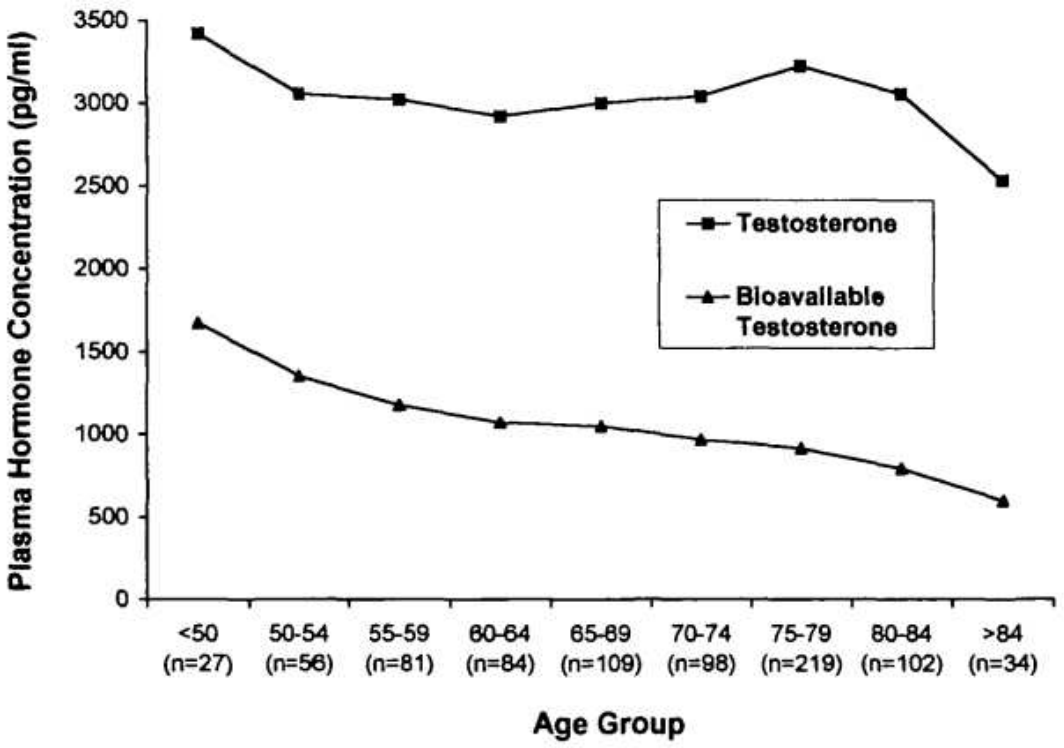
4.2.1 Testosterone versus Age

Studies of the age-testosterone association are divided into cross-sectional and longitudinal analyses. Typical of the cross-sectional research is Ferrini and Barrett-Connor (1998) who study age-associated variations in total as well as the more relevant bioavailable testosterone among 810 Caucasian men in Rancho Bernardo, California. Plasma samples from middle- and upper middle-class men aged 24-90 years were obtained in 1984-1987, frozen in polypropylene tubes at -70°C, and analyzed in 1993 using radioimmunoassay. The age-testosterone association is obtained after adjusting for subjects' weight, body-mass-index, alcohol consumption, smoking levels, exercise, caffeine intake, disease, and sample storage time. Diseases controlled for are diabetes and coronary heart problems, both of which are determined by subject questionnaire responses, reviews of medical records, as well as by physical examinations including plasma glucose measurement and electrocardiogram readings.

The results of the study are graphically illustrated in Figure 4.1, where we note that research subjects of less than 50 years of age have been lumped together. The graph shows that the bioavailable testosterone declines steadily with age: each point on the graph is the average for each of the five-year age groups except for the <50 years sample that contains subjects from 24-49 years. Ferrini and Barrett-Connor (*ibid.* p. 754) conclude their study by declaring: "bioavailable testosterone $\cdots$ decreased dramatically with age in these community-dwelling men, independently of body size, health behavior, and chronic disease."

Typical of the longitudinal studies of age and testosterone levels is that of Harman et al. (2001) who investigate stored samples taken from 890 men in the Baltimore Longi-

Figure 4.1: Age versus Total and Bioavailable Testosterone in Cross-Sectional Investigation of 810 Caucasian Men



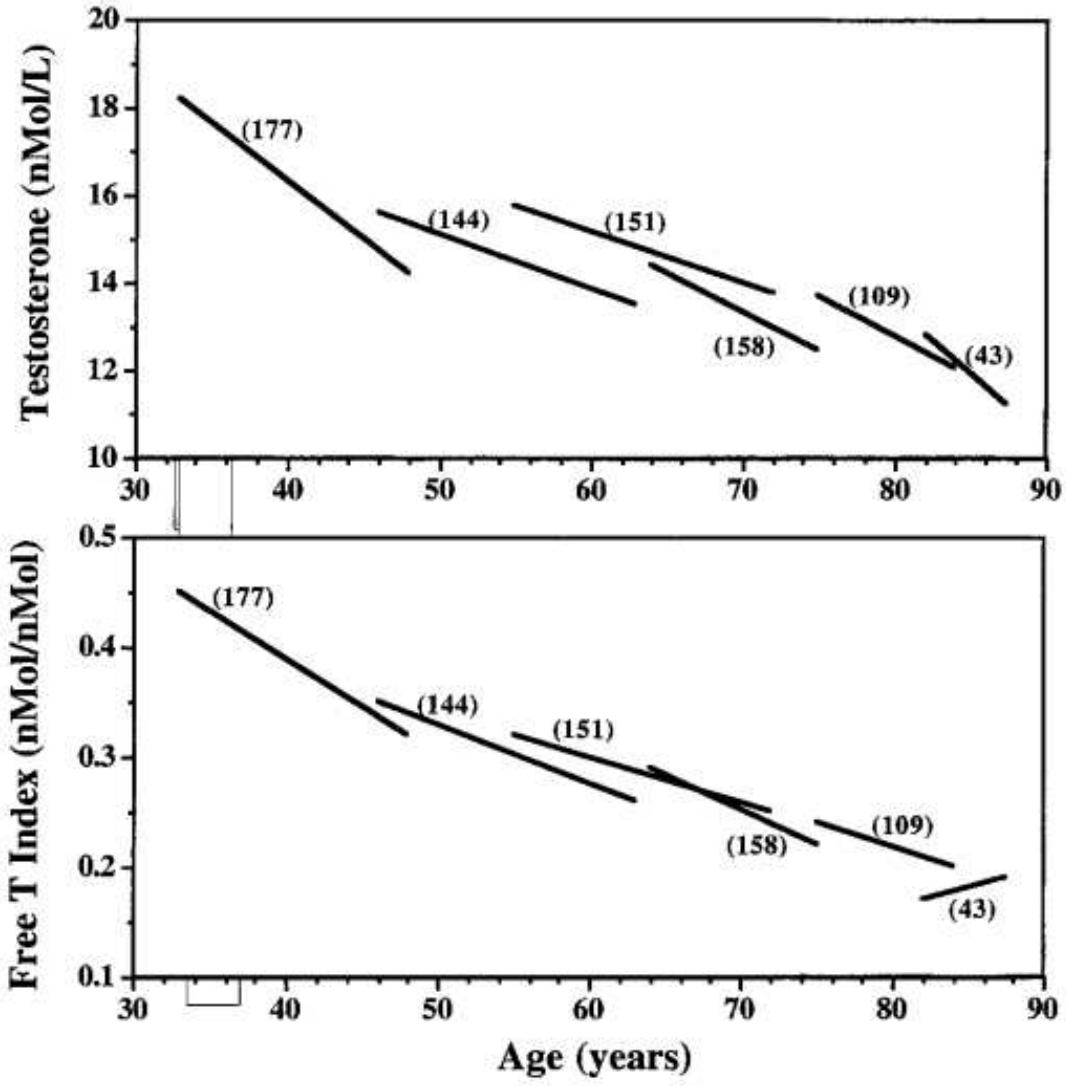
Source: Ferrini, R. L., E. B. Connor. 1998. Sex hormones and age: A cross-sectional study of testosterone and estradol and their bioavailable fractions in community-dwelling men. American Journal of Epidemiolology 147(8), pp. 750-754.

tudinal Study on Aging.[8] The researchers support the use of such a longitudinal evaluation on the grounds that cross-sectional investigations confound age and disease, obscuring the direct effects of age, although this does not apply to the Ferinni and Barrett-Connor research which goes to great lengths to control for disease as well as other factors. As in the aforementioned cross-sectional investigation, the sample used in the Harman et al. (2001) study consists largely of middle-class Caucasian men. These are examined at approximately two-year intervals.

The results for the effects of age on total testosterone and free testosterone (a calculated value related to bioavailable testosterone that is highly correlated with

[8]The large sample in the longitudinal study by Harman et al. (2001) follows two smaller studies by Zmuda et al. (1997) and Morley et al. (1997) that sample a population with a 13-year interval.

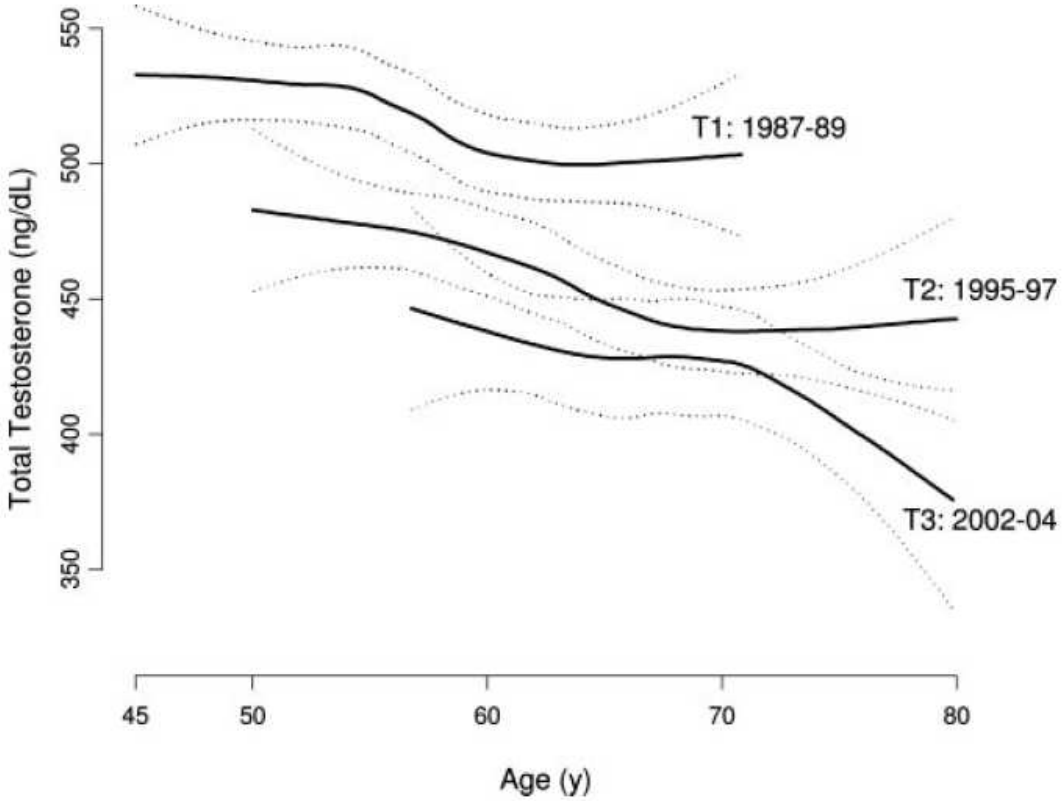
Figure 4.2: Age versus Total and Free Testosterone in Longitudinal Investigation of 890 Caucasian Men



Source: Harman, S. M., E. J. Metter, J. D. Tobin, J. Pearson, M. E. Blackman. 2001. Longitudinal effects of aging on serum total and free testosterone levels in healthy men. Journal of Clinical Endocrinology & Metabolism 86(2), pp. 724-731.

salivary testosterone examined by Burnham (2007)) are summarized in Figure 4.2. The graph shows essentially the same age-related decline in free testosterone as in the cross-sectional study of Ferrini and Barrett-Connor (1998) using bioavailable testos-

Figure 4.3: Secular Decline in Total Testosterone



Source: Travison, T. G., A. B. Araujo, A. B. O'Donnell, V. Kupelain, J. B. McKinlay. 2007. A population-level decline in serum testosterone levels in American men. Journal of Clinical Endocrinology & Metabolism 92(1), pp. 196-202.

terone.[9] Figure 4.3 from Travison et al. (2007) also illustrates that while total testosterone has declined in recent years, the distinct negative age-testosterone association has persisted.

4.3 Testosterone versus Male Dominance Seeking

A vast literature documents the association between testosterone and dominant behavior among men, where dominance can take various forms, from aggression

[9]The Harman et al. plot is over a slightly longer age range, but analysis of the detailed data shows a similar relative decline to that found in the cross-sectional research of Ferrini and Barrett-Connor (1998).

where the intent is to inflict harm on another person, to non-aggressive dominance involving enhancing one's status over another.[10] Indeed, testosterone not only affects behavior but also responds to it. Merely competing for social status can affect endogenous testosterone in two ways: first by causing it to increase in the face of a challenge as an anticipatory response to impending competition, and second from the sense of success after competition. These pathways have been documented in research such as that of Mazur and Booth (1998) who study Air Force veterans four times over the course of a decade. The human studies parallel those of an almost endless number of animals from mice to rhesus monkeys. While not every study of the effect of human testosterone on dominance behavior among men has identified a simple causal relationship comparable to what has been found in non-human animal research, the disparities have generally been linked to moderating variables such as metabolism, age, sex, circadian rhythm, stress, past experience, and social status.

In order to investigate the underlying systematic relation that might be obscured by these intervening factors, Book et al. (2001) perform a meta-analysis that begins with 106 articles on the human testosterone and behavior association. After carefully considering possible double-counting from including studies using the same or overlapping databases and preening out studies with information gaps, the study focuses on 45 research publications. When outcomes are weighed by the number of participants, a significant positive relation is revealed between dominant/aggressive behavior and testosterone, suggesting that high-testosterone males are more willing to be aggressive.[11] The conclusion is reinforced at numerous levels including studies of prison inmates, spousal violence, and adolescent males.[12]

4.4 Our Hypotheses

We empirically investigate the role of male CEO testosterone (proxied by age) in M&As to see whether it affects outcomes. In particular, we consider whether testosterone influences the likelihood that offers made are subsequently withdrawn, or whether negotiations where the bidder is unable to gain target board support result

[10]The various forms of dominance which include antisocial behavior, rebellion against authority and law breaking, as well as enhancing of social status, are described in Mazur and Booth (1998).

[11]In Burnham (2007), high-testosterone participants are shown to be quite generous in proposing a higher offer of $25, albeit not statistically significantly, suggesting that high-testosterone males can be quite generous if approached the right way. We thank an anonymous referee for this insight.

[12]See Olweus et al. (1980), Harris et al. (1996), and Mazur and Booth (1998).

in the bidder making a tender offer directly to the target shareholders (later in the paper we also consider bid initiation as a measure of dominance). The alternative hypotheses reflect the fact that threats to dominance in M&A discussions are not going to make agreement more likely. Either there is no effect, the null hypothesis, or there is an increased chance that an offer will be withdrawn or a tender offer will be made. This implies that the effects of male CEO age involve one-tailed tests. Also, the hypothesis should reflect the fact that adverse outcomes could be the result of the testosterone of either the target CEO, the bidder CEO, or both. With this in mind, our null and alternative hypotheses are the following:

With respect to the withdrawal likelihood:

H_0: The testosterone of the target (bidder) CEO, proxied by the target (bidder) CEO's age, is irrelevant to whether an offer is subsequently withdrawn.

H_1: The higher the target (bidder) CEO's testosterone, proxied by the target (bidder) CEO's age, the more likely an offer is to be withdrawn.

With respect to the tender offer likelihood:

H_0: The testosterone of the target (bidder) CEO, proxied by the target (bidder) CEO's age, is irrelevant to whether a tender offer is made.

H_1: The higher the target (bidder) CEO's testosterone, proxied by the target (bidder) CEO's age, the more likely a tender offer is to be made.

In the event that either of the foregoing null hypotheses is rejected in favor of the alternative hypotheses, we are interested in examining whether withdrawals or tender offers are the result of disagreement over the financial terms of the offer. The financial terms can be proxied by the bid premium: ceteris paribus, the higher the bid premium the more generous are the terms from the target's perspective, and the worse they are from the bidder's perspective. We consider two linked aspects of the bid premium. First, does the bid premium influence the likelihood of bid withdrawal or a tender offer? This involves including the bid premium as a control variable in the withdrawal and tender offer regressions. Second, does CEO age affect the bid premium? This requires regression of the bid premium on CEO age. Only if there are both an effect of age on the bid premium, and an effect of the bid premium on withdrawals/tender offers, is there an effect of financial terms. Finding that the bid premium is unrelated to CEO age is sufficient to support the view that age is not capturing the effect of financial terms. Given that we are agnostic as to how age

might affect financial terms, the alternative hypothesis in this case should be a two-tailed test:

With respect to the bid premium:

H_0: The testosterone of the target (bidder) CEO, proxied by the target (bidder) CEO's age, is irrelevant for the size of the bid premium.

H_1: The target (bidder) CEO's testosterone, proxied by the target (bidder) CEO's age, affects the size of the bid premium.

4.5 Our Research Framework and Data

In this section we present our empirical specifications to examine the role of bidder and target male CEO testosterone levels, proxied by age, in bid withdrawals and tender offers, and also describe how our M&A sample is formed.

4.5.1 Model Specifications

The aspect of M&As that perhaps most closely parallels the psychological experiment of Burnham (2007) is the probability of bid withdrawal; in such a case, both the bidder (proposer) and the target (responder) end up with none of the potential gain. To explore the role of CEO hormones in M&As, we run the following cross-sectional regression:

$$\begin{aligned}
&\text{Bid Outcome}_i \\
&= \alpha_0 + \beta_1 \text{Bidder Male CEO is Young}_i + \beta_2 \text{Target Male CEO is Young}_i \\
&+ \beta_3 \text{Target Board Size}_i + \beta_4 \text{Target Proportion of Independent Directors}_i \\
&+ \beta_5 \text{Target CEO is COB}_i + \beta_6 \text{Target Sales Growth}_i \\
&+ \beta_7 \text{Target Tobin's Q}_i + \beta_8 \text{Target ROA}_i + \beta_9 \text{Target Book Leverage}_i \\
&+ \beta_{10} \text{Target Runup}_i + \text{Other Controls} + e_i, \qquad (4.1)
\end{aligned}$$

where "Bid Outcome" could be bid withdrawal or the use of a tender offer. The variables of interest are the two indicator variables that the bidder male CEO is young, and that the target male CEO is young, with age proxying for hormone levels in both cases. We apply the one-tailed test criterion to these two variables of interest based on our null and alternative hypotheses. The target firm characteristics in Equation (1)

are motivated by Schwert (2000), Bange and Mazzeo (2004), and Chen et al. (2007). The other control variables (not shown in Equation (4.1)) are the bid characteristics and the bidder firm characteristics, with the former including indicator variables for competing bid, poison pill, all cash, all stock, and diversifying deal, and three continuous variables, toehold, relative size, and bid premium, and the latter being the same as those of target firm characteristics.

As a robustness check of our main model specification, we replace the single young CEO indicator variable with the multiple age indicator variables for older CEOs.[13] The alternative regression, where "Male CEO is Old" is measured by the multiple age indicator variables (to be defined later), is specified as follows:

$$\begin{aligned}
&\text{Bid Outcome}_i \\
&= \alpha_0 + \beta_1 \text{Bidder Male CEO is Old}_i + \beta_2 \text{Target Male CEO is Old}_i \\
&+ \beta_3 \text{Target Board Size}_i + \beta_4 \text{Target Proportion of Independent Directors}_i \\
&+ \beta_5 \text{Target CEO is COB}_i + \beta_6 \text{Target Sales Growth}_i \\
&+ \beta_7 \text{Target Tobin's Q}_i + \beta_8 \text{Target ROA}_i + \beta_9 \text{Target Book Leverage}_i \\
&+ \beta_{10} \text{Target Runup}_i + \text{Other Controls} + e_i, \qquad (4.2)
\end{aligned}$$

In all model specifications, we include year fixed effects and industry fixed effects (based on one-digit SIC codes),[14] and we employ robust standard errors. We apply the two-tailed test.

4.5.2 Our Sample

We start with acquisition bids made by US public companies for US public targets between January 1, 1997 and December 31, 2007 covered in the Thomson's SDC database. We retrieve all mergers (SDC deal form M), acquisition of majority interest (AM), and acquisition of assets (AA). There are a total of 4,959 such deals. We only include control bids where the bidder's toehold before the deal announcement is less than 50 percent, and the sum of the toehold and the percentage ownership sought in the deal is larger than 50 percent. This leaves us with 4,827 deals. Data

[13] We thank the Department Editor and the Associate Editor for making this suggestion.

[14] In unreported analysis, we have also used FF 48 industry fixed effects and found that there is still a significant testosterone effect, albeit its economic significance is reduced.

requirements on bid characteristics such as transaction value and bid premium further reduce the number of deals in our sample to 2,458. These bids are then merged with the RiskMetrics Group's corporate board and director data. The board variables are taken at the most recent annual meeting before the bid announcement. We include only deals in which both the bidder and target CEOs are male. These steps reduce our sample to 423 deals. We retrieve data on the target firm's adoption of poison pills from the RiskMetrics Group's corporate governance database. We are able to obtain the poison pills data for 393 deals. CEO tenure is retrieved from the Standard and Poor's ExecuComp database. Availability of data on bidder CEO tenure further reduces the sample to 367 deals. The stock returns and accounting variables are retrieved from the CRSP/Compustat merged database for the fiscal year end prior to the bid announcement. Our final sample consists of 357 acquisition bids.

4.5.3 Sample Overview

Table 4.1 shows that in our sample, about 13 percent of the acquisition bids are withdrawn. This is close to what is found using a much larger sample of 2,150 announced bids over the period 1984-2001 by Chen et al. (2007). In their sample the withdrawal frequency is 16 percent. About 13 percent of our M&A deals take the form of a tender offer, compared to results from Betton et al. (2008a), who show based on a sample of over 25,000 successful targets over the period 1980-2005 that the frequency of tender offers is 12 percent. Bid premium is defined as the ratio of the final offer price to the target stock price four weeks prior to the bid minus one. The sample average bid premium is 34 percent. Overall, our sample is not very different from these much larger samples covering earlier periods.

Across our sample, the average (median) age of bidding firm male CEOs is 56 (56) years old, and the average (median) age of target firm male CEOs is 55 (56) years old. Motivated by the studies of population testosterone levels reviewed earlier, we use the age of 45 years as the cut-off to separate young male CEOs from the rest. The data show that 5 percent of bidder male CEOs and 8 percent of target male CEOs are no older than 45 years.[15]

In terms of the target firm characteristics, we show that the average target board

[15]It is worth noting that our main conclusions remain the same if we use the cut-off age of 50 years (results available upon request). In this case, 21 percent of bidder male CEOs and 22 percent of target male CEOs are no older than 50 years.

Table 4.1: Sample Summary Statistics

Our sample consists of 357 merger and acquisition attempts announced during the period 1997-2007. The sample is retrieved from the SDC database and has available data from RiskMetrics/Execu-Comp/CRSP/Compustat. See the appendix for definition of the variables. All dollar amounts are in millions of 2007 dollars, and all percentages are in real numbers. All firm characteristics are measured at the fiscal year end prior to the bid announcement.

Variable	N	mean	sd	p5	p50	p95
Withdrawal	357	0.126	0.332	0.000	0.000	1.000
Tender Offer	357	0.135	0.342	0.000	0.000	1.000
Bid Premium	357	0.335	0.255	-0.012	0.302	0.786
Bidder CEO Age	357	55.734	6.223	46.000	56.000	64.000
Bidder Male CEO is Young	357	0.045	0.207	0.000	0.000	0.000
Target CEO Age	357	55.022	6.370	44.000	56.000	65.000
Target Male CEO is Young	357	0.078	0.269	0.000	0.000	1.000
Target Board Size	357	9.686	3.005	5.000	9.000	15.000
Target Proportion of Independent Directors	357	0.676	0.168	0.364	0.700	0.900
Target CEO is COB	357	0.684	0.466	0.000	1.000	1.000
Target Sales Growth	357	0.114	0.240	-0.212	0.092	0.550
Target Tobin's Q	357	1.808	1.054	1.000	1.446	3.791
Target ROA	357	0.046	0.095	-0.071	0.043	0.176
Target Book Leverage	357	0.240	0.179	0.000	0.243	0.502
Target Runup	357	0.072	0.228	-0.181	0.037	0.422
Competing Bid	357	0.132	0.339	0.000	0.000	1.000
Poison Pill	357	0.661	0.474	0.000	1.000	1.000
Toehold	357	0.004	0.029	0.000	0.000	0.000
All Cash	357	0.188	0.391	0.000	0.000	1.000
All Stock	357	0.345	0.476	0.000	0.000	1.000
Diversifying	357	0.331	0.471	0.000	0.000	1.000
Relative Size	357	0.320	0.359	0.009	0.178	1.095
Bidder CEO Tenure	357	7.734	6.890	1.000	6.000	23.000
Bidder Board Size	357	11.493	3.785	7.000	11.000	18.000
Bidder Proportion of Independent Directors	357	0.696	0.167	0.333	0.733	0.909
Bidder CEO is COB	357	0.790	0.408	0.000	1.000	1.000
Bidder Sales Growth	357	0.210	0.370	-0.144	0.121	0.835
Bidder Tobin's Q	357	2.210	1.896	1.068	1.621	5.333
Bidder ROA	357	0.062	0.113	-0.003	0.055	0.207
Bidder Book Leverage	357	0.251	0.157	0.004	0.237	0.528

size is 9.7. On average, about two thirds of the target board members are independent. In slightly over two thirds of the target companies the CEO is also the Chairman of the Board (COB). Compared to summary statistics reported in Bange and Mazzeo (2004) using 436 bids over the period 1979-1990, we observe that corporate boards become more independent over time, while the fraction of CEOs being COBs has not changed over time. Target firms experience sales growth of 11 percent per year.

The average ratio of market value of total assets to book value of total assets (Tobin's Q) is 1.8. The average return on assets is 4.6 percent. The average book leverage is 24 percent. The average target price runup from day 42 to day 1 relative to the bid announcement (day 0) is 7.2 percent. Using a sample of 7,522 initial control bids for public targets over the period 1980-2002, Betton et al. (2008b) report that the average price runup for target firms is 8.3 percent.

In terms of the bid characteristics, we show that 13 percent of the deals have multiple bidders. Using a much larger sample over a much longer sample period, Betton et al. (2008b) report that on average 11 percent of the bids in their sample have competing bids. We rely on the RiskMetrics Group's data to retrieve information on poison pills in the year before the bid and we show that 66 percent of the targets have the pill in place. We retrieve toehold information at the time of the bid from SDC and only 13 out of 357 bids in our sample have positive toeholds, leading to a sample average of 0.4 percent. Conditional on positive toeholds, the sample average toehold size is 11.6 percent. Betton et al. (2009) show that 1,363 bids out of their 10,806 bids over the period 1973-2002 have positive toeholds. They also show that the use of toeholds in takeovers declines over time and is more common for private bidders than for public bidders. About one fifth of the deals use only cash as the method of payment, and more than one third of the deals are pure stock swaps. One third of the deals are diversifying, i.e., the bidder and the target belong to different industry classifications as defined by Fama and French (1997). The relative rates of cash deals, stock deals, and diversifying deals in our sample are comparable to those in other research of takeovers during the 1990s (see, for example, Andrade et al. (2001); Betton et al. (2008a). The average relative size of a deal, defined as the ratio of the transaction value to the market value of total assets of the bidder, is 32 percent.

In terms of the bidder firm characteristics, we find that the average bidder CEO tenure is about 8 years. The average bidder board size is 11.5. On average, 70 percent of the bidder board members are independent directors. In about 80 percent of the bidder companies the CEO is also the COB. Bidder firms experience sales growth of 21 percent per year. The average bidder Tobin's Q is 2.2. The average return on assets is 6.2 percent. The average book leverage is 25 percent. Overall, it seems that the bidder firms in our sample enjoy faster sales growth, higher Tobin's Q, and better operating performance than the target firms.

Table 4.2: Correlation Matrix

Our sample consists of 357 merger and acquisition attempts announced during the period 1997-2007. The sample is retrieved from the SDC database and has available data from RiskMetrics/ExecuCompCRSP/Compustat. See the appendix for definition of the variables. All dollar amounts are in millions of 2007 dollars, and all percentages are in real numbers. All firm characteristics are measured at the fiscal year end prior to the bid announcement. The numbers in brackets are *p*-values for the statistical significance of each correlation.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Withdrawal	1.00																											
2	Tender Offer	0.05	1.00																										
		[0.36]																											
3	Bid Premium	0.00	0.27	1.00																									
		[0.95]	[0.00]																										
4	Bidder Male CEO is Young	0.12	-0.05	-0.04	1.00																								
		[0.02]	[0.39]	[0.50]																									
5	Target Male CEO is Young	-0.02	0.13	0.07	0.04	1.00																							
		[0.75]	[0.01]	[0.16]	[0.48]																								
6	Target Board Size	0.05	-0.14	-0.13	-0.09	-0.15	1.00																						
		[0.34]	[0.01]	[0.02]	[0.09]	[0.00]																							
7	Target Proportion of	-0.02	-0.13	-0.04	-0.06	-0.16	0.12	1.00																					
	Independent Directors	[0.65]	[0.02]	[0.48]	[0.26]	[0.00]	[0.03]																						
8	Target CEO is COB	-0.01	-0.01	0.00	-0.03	-0.14	0.09	0.13	1.00																				
		[0.80]	[0.79]	[0.95]	[0.61]	[0.01]	[0.09]	[0.01]																					
9	Target Sales Growth	0.06	-0.01	0.05	0.15	0.05	-0.02	-0.07	0.01	1.00																			
		[0.25]	[0.84]	[0.36]	[0.00]	[0.35]	[0.71]	[0.16]	[0.90]																				
10	Target Tobin's Q	0.04	-0.03	0.02	0.13	0.03	-0.16	-0.09	0.03	0.22	1.00																		
		[0.50]	[0.60]	[0.77]	[0.01]	[0.62]	[0.00]	[0.10]	[0.52]	[0.00]																			
11	Target ROA	0.02	0.01	-0.11	0.02	0.04	-0.01	-0.07	0.00	0.23	0.29	1.00																	
		[0.77]	[0.82]	[0.03]	[0.66]	[0.47]	[0.83]	[0.21]	[0.93]	[0.00]	[0.00]																		
12	Target Book Leverage	0.03	-0.05	-0.01	-0.02	-0.01	0.09	-0.03	0.14	-0.06	-0.16	-0.14	1.00																
		[0.64]	[0.32]	[0.82]	[0.68]	[0.88]	[0.10]	[0.53]	[0.01]	[0.29]	[0.00]	[0.01]																	
13	Target Runup	-0.01	0.01	0.18	0.01	0.06	-0.08	0.02	0.01	-0.07	-0.03	-0.02	-0.02	1.00															
		[0.88]	[0.80]	[0.00]	[0.83]	[0.30]	[0.15]	[0.77]	[0.85]	[0.17]	[0.52]	[0.64]	[0.77]																
14	Competing Bid	0.40	0.19	-0.03	0.00	-0.02	0.10	0.03	0.00	-0.08	0.06	0.01	0.00	0.00	1.00														
		[0.00]	[0.00]	[0.60]	[0.94]	[0.69]	[0.06]	[0.62]	[0.97]	[0.13]	[0.29]	[0.82]	[0.97]	[0.95]															
15	Poison Pill	0.04	0.00	-0.02	0.04	-0.08	0.07	0.12	0.09	-0.05	0.07	-0.04	-0.01	-0.10	0.09	1.00													
		[0.45]	[0.93]	[0.72]	[0.44]	[0.15]	[0.21]	[0.02]	[0.11]	[0.33]	[0.22]	[0.40]	[0.81]	[0.06]	[0.10]														
16	Toehold	0.02	0.23	0.03	-0.03	0.02	0.00	-0.13	0.05	-0.01	0.13	0.06	-0.04	0.01	0.00	-0.11	1.00												
		[0.74]	[0.00]	[0.62]	[0.58]	[0.66]	[0.97]	[0.02]	[0.30]	[0.82]	[0.01]	[0.26]	[0.42]	[0.90]	[0.96]	[0.03]													
17	All Cash	0.01	0.25	0.07	-0.07	0.07	-0.27	-0.08	-0.14	-0.07	0.01	0.06	-0.31	0.06	-0.06	-0.03	0.20	1.00											
		[0.82]	[0.00]	[0.17]	[0.19]	[0.17]	[0.00]	[0.15]	[0.01]	[0.22]	[0.84]	[0.26]	[0.00]	[0.24]	[0.26]	[0.51]	[0.00]												
18	All Stock	-0.01	-0.25	-0.11	0.10	-0.04	0.12	-0.05	0.14	0.12	0.13	-0.06	-0.09	0.01	-0.18	-0.04	-0.08	-0.35	1.00										
		[0.87]	[0.00]	[0.04]	[0.06]	[0.50]	[0.02]	[0.31]	[0.01]	[0.03]	[0.01]	[0.30]	[0.08]	[0.90]	[0.00]	[0.44]	[0.12]	[0.00]											
19	Diversifying	0.09	0.14	0.05	0.02	0.02	-0.08	-0.04	-0.03	0.02	0.13	0.08	-0.10	0.01	0.01	0.03	0.08	0.15	-0.11	1.00									
		[0.08]	[0.01]	[0.33]	[0.70]	[0.76]	[0.16]	[0.45]	[0.52]	[0.77]	[0.02]	[0.14]	[0.05]	[0.80]	[0.88]	[0.64]	[0.11]	[0.00]	[0.04]										
20	Relative Size	0.19	-0.12	-0.13	0.15	-0.06	0.08	0.12	0.07	0.02	0.13	0.09	0.13	-0.01	0.22	0.06	-0.06	-0.24	-0.03	0.00	1.00								

Continued on next page

Table 4.2 – continued from previous page

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
		[0.00]	[0.02]	[0.01]	[0.00]	[0.26]	[0.12]	[0.03]	[0.19]	[0.67]	[0.01]	[0.10]	[0.02]	[0.83]	[0.00]	[0.23]	[0.25]	[0.00]	[0.62]	[0.96]									
21	Bidder CEO Tenure	-0.04	0.09	0.08	-0.11	0.01	0.04	0.05	-0.02	0.05	-0.05	-0.01	-0.07	0.02	0.04	-0.01	-0.05	-0.07	0.04	-0.08	-0.09	1.00							
		[0.43]	[0.10]	[0.13]	[0.04]	[0.92]	[0.49]	[0.37]	[0.69]	[0.34]	[0.31]	[0.85]	[0.19]	[0.64]	[0.50]	[0.91]	[0.31]	[0.17]	[0.46]	[0.12]	[0.11]								
22	Bidder Board Size	-0.04	-0.03	-0.06	-0.09	-0.01	0.41	0.03	0.12	-0.06	-0.17	-0.02	0.06	-0.01	-0.01	0.03	-0.02	-0.10	0.17	-0.04	-0.27	0.09	1.00						
		[0.50]	[0.55]	[0.22]	[0.09]	[0.80]	[0.00]	[0.63]	[0.02]	[0.28]	[0.00]	[0.66]	[0.29]	[0.85]	[0.86]	[0.56]	[0.72]	[0.06]	[0.00]	[0.40]	[0.00]	[0.07]							
23	Bidder Proportion of	-0.10	-0.06	-0.15	-0.05	0.07	0.02	0.08	-0.07	-0.02	-0.03	0.02	0.02	-0.06	-0.12	-0.01	-0.04	0.12	-0.15	0.09	-0.08	-0.15	-0.03	1.00					
	Independent Directors	[0.07]	[0.28]	[0.01]	[0.33]	[0.18]	[0.65]	[0.13]	[0.20]	[0.69]	[0.64]	[0.77]	[0.72]	[0.24]	[0.02]	[0.92]	[0.40]	[0.03]	[0.01]	[0.09]	[0.11]	[0.00]	[0.59]						
24	Bidder CEO is COB	0.01	-0.04	-0.01	-0.15	-0.08	0.06	0.09	0.05	-0.02	-0.08	-0.03	0.09	0.03	0.00	-0.02	-0.13	-0.05	-0.07	-0.03	-0.12	0.18	-0.03	0.12	1.00				
		[0.86]	[0.47]	[0.88]	[0.00]	[0.13]	[0.25]	[0.08]	[0.36]	[0.75]	[0.14]	[0.55]	[0.09]	[0.52]	[0.96]	[0.70]	[0.02]	[0.33]	[0.16]	[0.54]	[0.02]	[0.00]	[0.63]	[0.02]					
25	Bidder Sales Growth	-0.03	-0.07	0.02	0.09	-0.01	0.02	0.08	-0.05	0.13	-0.01	0.03	-0.02	-0.04	0.01	0.00	-0.09	-0.13	0.12	0.05	0.13	0.04	0.10	-0.11	-0.01	1.00			
		[0.58]	[0.22]	[0.73]	[0.08]	[0.85]	[0.65]	[0.15]	[0.38]	[0.02]	[0.79]	[0.56]	[0.76]	[0.51]	[0.83]	[0.95]	[0.10]	[0.02]	[0.02]	[0.31]	[0.01]	[0.43]	[0.05]	[0.03]	[0.89]				
26	Bidder Tobin's Q	-0.02	0.05	0.17	0.14	0.06	-0.16	-0.10	-0.02	0.15	0.37	0.12	-0.13	-0.03	-0.03	0.07	0.02	0.01	0.17	0.06	0.03	0.08	-0.18	-0.12	-0.04	0.15	1.00		
		[0.76]	[0.33]	[0.00]	[0.01]	[0.23]	[0.00]	[0.05]	[0.66]	[0.00]	[0.00]	[0.03]	[0.02]	[0.54]	[0.64]	[0.19]	[0.66]	[0.83]	[0.00]	[0.24]	[0.63]	[0.12]	[0.00]	[0.02]	[0.40]	[0.01]			
27	Bidder ROA	0.03	0.08	0.02	0.04	-0.08	-0.08	-0.04	0.07	0.06	0.11	0.07	-0.08	-0.04	-0.06	0.07	0.01	0.10	-0.01	-0.02	-0.07	0.02	-0.07	0.12	-0.04	-0.14	0.22	1.00	
		[0.61]	[0.12]	[0.76]	[0.44]	[0.15]	[0.16]	[0.47]	[0.19]	[0.24]	[0.05]	[0.16]	[0.15]	[0.42]	[0.26]	[0.17]	[0.82]	[0.05]	[0.92]	[0.66]	[0.21]	[0.64]	[0.19]	[0.03]	[0.46]	[0.01]	[0.00]		
28	Bidder Book Leverage	0.06	0.00	-0.06	-0.05	-0.05	0.17	-0.04	0.04	-0.03	-0.06	-0.10	0.31	-0.02	0.07	-0.03	-0.03	-0.08	-0.10	-0.05	0.11	-0.07	0.06	-0.05	0.08	0.02	-0.24	-0.16	1.00
		[0.30]	[0.95]	[0.27]	[0.35]	[0.37]	[0.00]	[0.46]	[0.43]	[0.55]	[0.23]	[0.05]	[0.00]	[0.68]	[0.21]	[0.58]	[0.53]	[0.13]	[0.06]	[0.39]	[0.03]	[0.21]	[0.30]	[0.37]	[0.11]	[0.72]	[0.00]	[0.00]	

Before proceeding with our multivariate analysis, we examine the correlation between our three dependent variables and all right-hand-side variables. Table 4.2 presents the correlation matrix. Between pairs of the three dependent variables, there is positive and significant correlation between the use of tender offers and the bid premium. Between the three dependent variables and CEO age variables, there is positive and significant correlation between the bidder male CEO is young indicator variable and bid withdrawal, and between the target male CEO is young indicator variable and the use of tender offers. Overall, the extent of correlation among most pairs of variables raises little concern for multicollinearity in our regression analysis.

4.6 The Hormone Effect in M&As

Table 4.3 presents our probit regression results where the dependent variable is withdrawal, which is set equal to one if the bid is withdrawn, and zero otherwise. In columns (1)-(3), we run regressions following the model specification in Equation (4.1).

In column (1), we show that a young (and by implication high-testosterone) bidder male CEO, as measured by the indicator variable that the bidder male CEO is no older than 45 years, is positively and significantly associated with bid withdrawal: the null is emphatically rejected. In terms of the economic significance, the bidder male CEO being young increases the likelihood of bid withdrawal by over 20 percent, relative to the base case of the bidder male CEO being older than 45 years. This effect is statistically significant at the one-percent level. Recall that the sample frequency of bid withdrawal is 12.6 percent (Table 4.1). This finding strongly supports an association between testosterone, as proxied by the bidder male CEO age, and M&As. The target male CEO being young also increases the likelihood of bid withdrawal, in this case by less than one percent relative to the base case of the target male CEO being older than 45. However, this effect is not statistically significant.

Table 4.3: Explaining Bid Withdrawal

Our sample consists of 357 merger and acquisition attempts announced during the period 1997-2007. The sample is retrieved from the SDC database and has available data from RiskMetrics/ExecuComp/CRSP/Compustat. See the Appendix for definition of the variables. All dollar amounts are in millions of 2007 dollars, and all percentages are in real numbers. All firm characteristics are measured at the fiscal year end prior to the bid announcement. We estimate probit models and present the marginal effect of each explanatory variable on the likelihood of bid withdrawal. Columns (2) and (5) include friendly deals only. Columns (3) and (6) exclude deals withdrawn due to anti-trust, other regulatory issues, or shareholder disapproval. For the first ten explanatory variables in the table, the *p*-values correspond to the one-tailed test as suggested under our alternative hypothesis. For the remaining explanatory variables, the p-values correspond to the typical two-tailed test of the null that the corresponding coefficient is not statistically different from zero. The corresponding p-value is reported in the brackets below each coefficient. Superscripts $***$, $**$, and $*$ correspond to statistical significance at the one, five, and ten percent levels, respectively.

Dependent Variable	Withdrawal					
	(1)	(2)	(3)	(4)	(5)	(6)
Bidder Male CEO is Young	0.2165***	0.1137***	0.1067***			
	[0.001]	[0.001]	[0.001]			
Target Male CEO is Young	0.0059	0.0129*	0.0164*			
	[0.400]	[0.063]	[0.083]			
Bidder Male CEO Age from 46-50				-0.0252***	-0.0007**	-0.0010**
				[0.007]	[0.029]	[0.048]
Bidder Male CEO Age from 51-55				-0.0583***	-0.0061***	-0.0089***
				[0.000]	[0.000]	[0.000]
Bidder Male CEO Age from 56-60				-0.0456***	-0.0024***	-0.0041***
				[0.001]	[0.003]	[0.001]
Bidder Male CEO Age over 60				-0.0257**	-0.0010**	-0.0014**
				[0.025]	[0.018]	[0.023]
Target Male CEO Age from 46-50				0.0157	-0.0005	-0.0006
				[0.742]	[0.143]	[0.240]
Target Male CEO Age from 51-55				-0.0129	-0.0009**	-0.0016*
				[0.201]	[0.048]	[0.052]
Target Male CEO Age from 56-60				-0.012	-0.0013**	-0.0026**
				[0.235]	[0.030]	[0.015]
Target Male CEO Age over 60				-0.0016	-0.0004	-0.0011*
				[0.466]	[0.230]	[0.086]
Target Characteristics						
Target Board Size	0.0035	0.0000	0.0018**	0.0029	0.0000	0.0005***
	[0.138]	[0.928]	[0.010]	[0.131]	[0.800]	[0.001]

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Table 4.3 – continued from previous page

Dependent Variable	Withdrawal					
	(1)	(2)	(3)	(4)	(5)	(6)
Target Proportion of	-0.0062	0.0076	-0.0040	-0.0046	0.0017	-0.0011
Independent Directors	[0.874]	[0.141]	[0.730]	[0.880]	[0.238]	[0.666]
Target CEO is COB	-0.0202	-0.0009	-0.0019	-0.0101	-0.0006	0.0002
	[0.150]	[0.625]	[0.644]	[0.374]	[0.224]	[0.744]
Target Sales Growth	0.0923***	0.0098**	0.0230**	0.0786***	0.0027**	0.0045***
	[0.001]	[0.025]	[0.014]	[0.001]	[0.029]	[0.010]
Target Tobin's Q	-0.0076	-0.0003	-0.0031*	-0.0038	0.0001	-0.0004
	[0.246]	[0.738]	[0.088]	[0.487]	[0.507]	[0.162]
Target ROA	-0.0090	-0.0004	-0.0004	0.0098	-0.0016	0.0005
	[0.880]	[0.955]	[0.982]	[0.879]	[0.488]	[0.935]
Target Book Leverage	0.0636*	0.0047	0.0210*	0.0455	0.0012	0.0031
	[0.074]	[0.277]	[0.053]	[0.109]	[0.285]	[0.183]
Target Runup	-0.0152	0.0001	-0.0106	-0.0006	0.0004	-0.0012
	[0.469]	[0.970]	[0.108]	[0.971]	[0.642]	[0.310]
Bid Characteristics						
Competing Bid	0.5000***	0.2722***	0.4050***	0.4729***	0.2485***	0.3552***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Poison Pill	0.0063	-0.0003	0.0028	0.0033	-0.0002	0.0002
	[0.580]	[0.834]	[0.425]	[0.744]	[0.645]	[0.743]
Toehold	0.0447	0.0239*	-0.0086	0.0374	0.0086*	-0.0063
	[0.736]	[0.092]	[0.799]	[0.748]	[0.051]	[0.379]
All Cash	0.0553*	-0.0013	0.0661***	0.0343	-0.0004	0.0253***
	[0.077]	[0.481]	[0.001]	[0.152]	[0.303]	[0.001]
All Stock	0.0753***	0.0154***	0.0114	0.0452**	0.0067***	0.0010
	[0.002]	[0.002]	[0.122]	[0.018]	[0.005]	[0.457]
Diversifying	0.0699***	0.0098***	0.0397***	0.0510***	0.0031***	0.0143***
	[0.001]	[0.003]	[0.000]	[0.002]	[0.005]	[0.000]
Relative Size	0.0473***	0.0028	0.0185***	0.0336***	0.0008	0.0031***
	[0.006]	[0.143]	[0.000]	[0.007]	[0.100]	[0.001]
Bid Premium	0.0241	0.0001	0.0068	0.0297	0.0005	0.0022
	[0.318]	[0.972]	[0.326]	[0.132]	[0.542]	[0.125]
Bidder Characteristics						
Bidder CEO Tenure	-0.0003	0.0000	0.0002	-0.0006	0.0000	0.0000
	[0.726]	[0.708]	[0.400]	[0.462]	[0.446]	[0.594]
Bidder Board Size	0.0009	0.0004**	-0.0002	-0.0001	0.0001**	-0.0001
	[0.592]	[0.041]	[0.747]	[0.968]	[0.015]	[0.280]
Bidder Proportion of	-0.0636*	-0.0085**	-0.0188*	-0.0480*	-0.0021	-0.0048**

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Table 4.3 – continued from previous page

Dependent Variable	Withdrawal					
	(1)	(2)	(3)	(4)	(5)	(6)
Independent Directors	[0.079]	[0.047]	[0.090]	[0.099]	[0.110]	[0.021]
Bidder CEO is COB	0.0266***	0.0024**	0.0071**	0.0205**	0.0008**	0.0014**
	[0.010]	[0.026]	[0.013]	[0.021]	[0.020]	[0.018]
Bidder Sales Growth	-0.0462**	-0.0070**	-0.0073	-0.0337**	-0.0016	-0.0013
	[0.022]	[0.024]	[0.124]	[0.028]	[0.101]	[0.146]
Bidder Tobin's Q	-0.0131***	-0.0010**	-0.0044***	-0.0098***	-0.0003**	-0.0007***
	[0.000]	[0.018]	[0.000]	[0.000]	[0.015]	[0.000]
Bidder ROA	0.3299***	0.0262**	0.0806***	0.2194***	0.0095**	0.0103**
	[0.001]	[0.043]	[0.008]	[0.002]	[0.013]	[0.029]
Bidder Book Leverage	0.0043	0.0000	-0.0113	-0.0137	-0.0008	-0.0043**
	[0.893]	[0.998]	[0.216]	[0.612]	[0.518]	[0.026]
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	357	328	343	357	328	343
Pseudo R-squared	0.3872	0.4143	0.4573	0.4318	0.4767	0.5324

A young bidder male CEO is seen to contribute more to the likelihood of bid withdrawal. This differs from the situation in Burnham's ultimatum game where it is the responder's (or in our context the target CEO's) testosterone that matters, not the proposer's (i.e., the bidder CEO's) testosterone. Male dominance seeking behavior where there is opportunity for back-and-forth interaction, as there is with M&As, appears to be able to scuttle deals mainly from the bidder's side.

Our sample includes both friendly and unfriendly deals: 328 out of the 357 deals are friendly ones.[16] Unfriendly deals are more likely to be withdrawn. The correlation between bid withdrawal and the unfriendly deal indicator variable is 0.51, and is significant at the five-percent level (not reported). Entrenched managers in the target firm are, arguably, more likely to be unfriendly toward an acquisition bid in order to protect their positions and private benefits. In other words, executive entrenchment

[16]According to SDC, a bid is hostile if the target board officially rejects the offer but the acquirer persists with the attempted takeover. A bid is unsolicited when the acquirer makes an offer for the target without prior negotiations. Following Betton et al. (2008a), unfriendly bids are the sum of outright hostile bids and unsolicited bids. Approximately 8 percent of the acquisition bids in our sample are perceived as unfriendly.

rather than CEO testosterone levels could be the main cause of bid withdrawal for unfriendly deals. In column (2) of Table 3 we use only friendly deals to implement a cleaner test of the effect of CEO age on bid withdrawal. We find that both a young bidder male CEO and a young target male CEO are positively and significantly associated with bid withdrawal when we exclude unfriendly deals in the regression, although the effect of a young bidder male CEO becomes less economically significant.

Finally, certain withdrawals may have little to do with the testosterone of decision makers involved, such as when there is objection by regulators.[17] Following Savor and Lu (2009), we investigate every withdrawn deal in our sample using LexisNexis and Factiva and attempt to determine why it did not complete. Column (3) presents the regression result when we exclude withdrawal cases involving objection by regulators (10 deals) and objection by shareholders (4 deals). We find that there remains the strong age/testosterone effect in bid withdrawal: both a young bidder male CEO and a young target male CEO are still positively and significantly associated with bid withdrawal after removing withdrawals not directly related to CEOs' decisions.

Across columns (1)-(3), among all control variables, we find that bids made to fast-growing targets and targets with high leverage, bids with multiple bidders, bids involving all cash or all stock payment, diversifying bids, bids made to relatively large targets, bidders whose CEOs are also COBs, and bidders with high ROA are positively associated with bid withdrawal. On the other hand, bidders with more independent boards, fast-growing bidders, and bidders with high Tobin's Q are negatively associated with bid withdrawal.

We show that bid premium has no effect on bid withdrawal. Hence, it would appear that the financial terms are not a cause of withdrawal. Bidder CEO tenure also has no effect on bid withdrawal. We find that CEO age and CEO tenure are notably different in their effect on bid withdrawal, where it is age that is related to testosterone, not tenure. This helps diminish the possibility that age is proxying for experience (which is related to tenure), rather than testosterone.

As a robustness check on our main findings, columns (4)-(6) present regression results based on the model specification in Equation (2). Specifically, instead of using the single indicator variable for the male CEO being no older than 45 years, we

[17] We thank an anonymous referee for suggesting this modification to our investigation.

include the multiple indicator variables for different age brackets: 46-50, 51-55, 56-60, and over 60 years old. We find that relative to the base case of a bidder male CEO being no older than 45 years, a bidder male CEO being older, measured by the four different age indicator variables, is negatively and significantly (in all the cases and at or better than the five-percent level) associated with bid withdrawal. Relative to the base case of a target male CEO being no older than 45 years, a target male CEO being older, measured by the four different indicator variables, is less influential, being negatively and significantly (in about half of the cases and at or better than the ten-percent level) associated with bid withdrawal.

In summary, CEO age matters for bidders and targets, with the bidder CEO's age being the more powerful and significant influence in bid withdrawal. It appears that bidder CEOs' dominance challenges are more relevant than target CEOs' dominance challenges. This is perhaps not surprising when the bidder is the active proposer and the target is the passive responder in a typical M&A deal.

Table 4.4 presents the probit regression results where the dependent variable is tender offer, which is set equal to one if an acquisition takes the form of a tender offer, and zero otherwise. In column (1), we show that the presence of a young target male CEO is positively associated with the use of a tender offer. The effect is statistically significant at the ten-percent level. In terms of the economic significance, the target male CEO being young increases the likelihood of a tender offer by about two percent, relative to the base case of the target male CEO being old. Recall that 13.5 percent of the deals in our sample are tender offers (Table 4.1). Since tender offers are likely to follow unsuccessful negotiations going to the target shareholders after other negotiations have failed we would expect such a target CEO effect: cooperation is less likely from young, and by implication high-testosterone, target male CEOs whose dominance is challenged. It is the target and not the bidder male CEO who is more important for the bidder resorting to a tender offer. Using the context of the ultimatum game, it is the responder and not the proposer who is more important in determining if a cooperative resolution fails.

In recent years there are more tender offers containing the so-called Shareholder Tender Agreement (STA) whereby by signing it, a shareholder pre-commits to tender her shares to a particular bidder, forsaking the right to tender to any subsequent bidder (Bargeron, 2009). A priori, it is not clear to what extent the STA would affect our results. We collect information on STAs from the SEC's Edgar database. Column

(2) of Table 4 presents the regression results when we exclude the 9 deals with STAs. We show that the age/testosterone effect remains statistically significant although its economic significance is materially weakened. Across columns (1)-(2), among all control variables, we find that bids made to fast-growing targets, bids with multiple bidders, bids with large toeholds, bids involving all cash payment, diversifying bids, bids with high premiums, and bids made by CEOs with long tenure (indicating experience as distinct from age) are positively associated with tender offers. On the other hand, bids made to relatively large targets are negatively associated with tender offers. As a robustness check on our main findings, columns (3)-(4) present regression results based on the model specification in Equation (2). We show that relative to the base case of a target male CEO being no older than 45 years, a target male CEO being older, measured by the four different age indicator variables, is negatively and significantly (in over half of the cases and at or better than the five-percent level) associated with the use of a tender offer. We show that relative to the base case of a bidder male CEO being no older than 45 years, a bidder male CEO being older, measured by the four different age indicator variables, is negatively and significantly (at the five-percent level) associated with the use of a tender offer in only one case. In summary, we have so far presented evidence suggesting a potentially significant role of testosterone in two important aspects of M&As based on over 300 deals for which we have data. Ceteris paribus, the presence of a young bidder (or target) male CEO is positively associated with bid withdrawal, and the presence of a young target male CEO is positively associated with the use of tender offers. In the language of the ultimatum game, both the proposer and the responder (i.e., the bidder CEO and the target CEO, respectively) are influential in bid withdrawal. Tender offers depend more on the responder, as in Burnham's experiments. (Recall that Burnham (2007) finds the testosterone of the responder to influence whether a cooperative, rational equilibrium fails to be reached.)

Table 4.4: Explaining Tender Offers

Our sample consists of 357 merger and acquisition attempts announced during the period 1997-2007. The sample is retrieved from the SDC database and has available data from RiskMetrics/ExecuComp/CRSP/Compustat. See the Appendix for definition of the variables. All dollar amounts are in millions of 2007 dollars, and all percentages are in real numbers. All firm characteristics are measured at the fiscal year end prior to the bid announcement. We estimate probit models and present the marginal effect of each explanatory variable on the likelihood of a tender offer. Columns (2) and (4) exclude the 9 deals with shareholder tender agreements (STAs) in place. For the first ten explanatory variables in the table, the p-values correspond to the one-tailed test as suggested under our alternative hypothesis. For the remaining explanatory variables, the p-values correspond to the typical two-tailed test of the null that the corresponding coefficient is not statistically different from zero. The corresponding p-value is reported in the brackets below each coefficient. Superscripts $***$, $**$, and $*$ correspond to statistical significance at the one, five, and ten percent levels, respectively.

Dependent Variable	Tender Offer			
	(1)	(2)	(3)	(4)
Bidder Male CEO is Young	0.0089	0.0009		
	[0.348]	[0.129]		
Target Male CEO is Young	0.0181*	0.0004*		
	[0.094]	[0.061]		
Bidder Male CEO Age from 46-50			-0.0029	0.0000
			[0.249]	[0.931]
Bidder Male CEO Age from 51-55			-0.0021	0.0000
			[0.338]	[0.878]
Bidder Male CEO Age from 56-60			-0.0051	-0.0000**
			[0.132]	[0.033]
Bidder Male CEO Age over 60			0.0037	0.0000
			[0.679]	[0.746]
Target Male CEO Age from 46-50			-0.0016	0.0000
			[0.323]	[0.653]
Target Male CEO Age from 51-55			-0.0060***	-0.0000**
			[0.008]	[0.025]
Target Male CEO Age from 56-60			-0.0036	-0.0000**
			[0.125]	[0.035]
Target Male CEO Age over 60			-0.0049***	-0.0000***
			[0.010]	[0.007]
Target Characteristics				
Target Board Size	-0.0007	0.0000	-0.0003	0.0000
	[0.579]	[0.476]	[0.558]	[0.410]
Target Proportion of Independent Directors	-0.0118	-0.0001	-0.0096	0.0000

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Table 4.4 – continued from previous page

Dependent Variable	Tender Offer			
	(1)	(2)	(3)	(4)
	[0.526]	[0.694]	[0.170]	[0.370]
Target CEO is COB	-0.0007	0.0000	0.0013	0.0000*
	[0.916]	[0.412]	[0.571]	[0.097]
Target Sales Growth	0.0193*	0.0003**	0.0071*	0.0000**
	[0.062]	[0.021]	[0.055]	[0.035]
Target Tobin's Q	-0.0045	0.0000	-0.0014	0.0000
	[0.177]	[0.456]	[0.305]	[0.378]
Target ROA	-0.0040	-0.0004	-0.0068	-0.0001**
	[0.864]	[0.142]	[0.488]	[0.026]
Target Book Leverage	-0.0304	0.0000	-0.0143**	0.0000
	[0.131]	[0.944]	[0.049]	[0.692]
Target Runup	-0.0116	0.0000	-0.0034	0.0000
	[0.394]	[0.974]	[0.513]	[0.836]
Bid Characteristics				
Competing Bid	0.1392***	0.0164***	0.1384***	0.0124***
	[0.000]	[0.000]	[0.000]	[0.000]
Poison Pill	0.0072	0.0001*	0.0022	0.0000*
	[0.211]	[0.057]	[0.293]	[0.072]
Toehold	0.1386*	0.0018**	0.0384*	0.0002**
	[0.055]	[0.015]	[0.092]	[0.026]
All Cash	0.0304*	0.0009**	0.0164**	0.0002**
	[0.054]	[0.020]	[0.043]	[0.017]
All Stock	-0.0297**	-0.0001	-0.0151***	-0.0000*
	[0.011]	[0.236]	[0.004]	[0.086]
Diversifying	0.0241***	0.0002*	0.0111***	0.0000**
	[0.005]	[0.064]	[0.002]	[0.033]
Relative Size	-0.0236**	-0.0002**	-0.0129***	-0.0000***
	[0.028]	[0.031]	[0.001]	[0.002]
Bid Premium	0.0376***	0.0004***	0.0154***	0.0000***
	[0.001]	[0.000]	[0.000]	[0.000]
Bidder Characteristics				
Bidder CEO Tenure	0.0010**	0.0000*	0.0004***	0.0000**
	[0.013]	[0.053]	[0.008]	[0.044]
Bidder Board Size	-0.0005	0.0000	-0.0004	0.0000
	[0.667]	[0.564]	[0.440]	[0.701]
Bidder Proportion of Independent Directors	-0.0219	0.0000	-0.0067	0.0000
	[0.216]	[0.913]	[0.295]	[0.984]

Continued on next page

Table 4.4 – continued from previous page

Dependent Variable	Tender Offer			
	(1)	(2)	(3)	(4)
Bidder CEO is COB	-0.0091	-0.0002	-0.0099**	-0.0001**
	[0.295]	[0.142]	[0.037]	[0.031]
Bidder Sales Growth	0.0058	-0.0001	0.0028	0.0000
	[0.427]	[0.508]	[0.297]	[0.885]
Bidder Tobin's Q	-0.0005	-0.0001	0.0001	0.0000
	[0.754]	[0.128]	[0.816]	[0.169]
Bidder ROA	0.0316	0.0020***	0.0114*	0.0002***
	[0.123]	[0.004]	[0.089]	[0.004]
Bidder Book Leverage	0.0257	0.0003*	0.0124*	0.0000**
	[0.145]	[0.084]	[0.060]	[0.015]
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Observations	357	348	357	348
Pseudo R-squared	0.4967	0.5320	0.5453	0.5681

4.7 Additional Investigation

Confidence in the conclusions we have reached depends on whether these age-associated effects can reasonably be considered to be attributed to the behavioral consequences generally connected with testosterone. In this section, we first consider other possible effects of age such as CEO experience or length of horizon and see whether a testosterone effect survives consideration of other possibilities. We then address sample selection effects in our analyses.

4.7.1 Alternative Explanations of the Male CEO Effect

As mentioned earlier, investigating the effects of testosterone on the completion of M&A negotiations and on whether tender offers are employed should ideally be based on direct measurement of CEOs' hormone levels during the negotiation process. Since we are unable to do this in the context of historical data on M&As, we have suggested an alternative: specifically, to proxy testosterone by age. The validity of this approach clearly depends on the extent of the association of hormone levels

with age. As we have explained in Section 4.2, the literature is unambiguous on this association (see for example, Booth and Dabbs (1993)). However, this still begs the question of whether CEO age might be serving as a catch-all for something other than the bidder or target male CEO testosterone level.

Prior research such as Booth and Dabbs (1993), Gray et al. (2007a), and Gray et al. (2007b) suggests that there is a negative association between being married and testosterone, and between having children and testosterone. Due to the lack of cross-sectional variations in these measures across our sample CEOs-virtually all are married and have children-we could not implement any multivariate analysis. Marriage may also not be the correct measure since Burnham et al. (2003) show that stable relationships, not marriage, are associated with declining male testosterone levels.

We could not obtain any information regarding the medical conditions of the CEOs or prescription drugs taken by the CEOs in our sample. However, it is worth pointing out that, *ceteris paribus*, exogenous testosterone is likely to vary more across CEOs at old age than at young age; this is a direct consequence of variations in health. As a result, the heterogeneity in conditions at old age would mitigate the role of age in M&As. Despite this, we nevertheless find strong results, and consequently this strengthens our findings in the paper. Further, as we have mentioned earlier, Ferrini and Barrett-Connor (1998) show that bioavailable testosterone decreases with age independent of body size, health behavior, and chronic disease.

Could it be that CEO age is capturing the length of the horizon over which the CEO is valuing the relevance of a completed acquisition deal on his long-run career? Three possible channels may be at work through CEO horizon. First, a young CEO may care more about reputation than an older CEO, and as a result might want to avoid failure of negotiations and/or negotiations deteriorating into hostility. If this is the case we would expect fewer negotiation failures and fewer tender offers. However, we have found the opposite for both dependent variables.[18]

Second, a young bidder CEO may view the completion of an acquisition at a low valuation of the target company to have more benefit in the long run. The presence of such an effect would lead to more non-completions and unfriendly situations with young bidder male CEOs. However, this should also show up with a smaller bid

[18]An alternative argument might be that it is good for a CEO to appear tough for future deals. However, a horizon effect of this type would be more likely to show up as relating to the target CEO age instead of the bidder CEO age. Instead, we find the opposite: the bidder CEO age is more important in bid withdrawal than the target CEO age.

premium for acquisitions where the bidder male CEO is young. Alternatively, the strong desire of a young bidder CEO to gain dominance by expanding control via completing M&As might lead to a larger bid premium, something that could also happen with a young target CEO resisting a loss of dominance. In Table 4.5, we present regression results where the dependent variable is bid premium. Across all our model specifications we find no effect of the bidder or the target male CEO's age on bid premium. Furthermore, bid premium is not significantly associated with bid withdrawal (see Table 4.3).

Third, there is greater value in the option to seek (accept) other offers for younger bidder (target) CEOs because their time to maturity (i.e., retirement) is longer, causing them to withdraw (reject) offers. The option value of younger CEOs would be expected to reduce their likelihood of entering into negotiations. However, our withdrawal analysis captures situations where negotiations have already been entered into, but then subsequently fail. Option values for younger CEOs should not contribute to the breakdown of initiated negotiations.[19]

It is also possible that CEO age is serving as a proxy for experience. Perhaps an older CEO with more experience can more accurately judge the right price for an acquisition and thereby avoid the failure of the offer. This possibility is questioned by the observation that bidder CEO tenure has no material effect on bid withdrawal or bid premium. What we find is that even when we allow for CEO tenure, the bidder male CEO's age and the target male CEO's age still matter for bid withdrawal and the use of tender offers, respectively.[20]

Finally, we use the CEO age measured in terms of the number of years. This provides a continuous measure that allows us to examine whether the behavioral response to hormone levels is modified by age even if the testosterone level itself follows a linear path. We find that indeed there is a significant non-linear effect of the bidder/target male CEO age on the likelihood of bid withdrawal, and a significant

[19]We thank an anonymous referee for encouraging us to carefully consider this option value perspective of M&As.

[20]The CEO tenure is the number of years the CEO has been serving the current firm. Admittedly, this measure may not be representative of a CEO's experience in other firms. In unreported analyses, we have also included the number of directorships as a proxy for CEO experience, an alternative measure of deal quality and its interactions with the bidder/target male CEO being young, CEO pay and equity incentives, CEO ownership, CEO power, whether the bidder/target CEO is a founder, and whether the bidder/target firm is a family firm, and have controlled for institutional and board ownership. Our main results on the significant association between CEO age/testosterone and M&A outcomes remain.

non-linear effect of the bidder male CEO age on the likelihood of tender offers, suggesting that CEOs learn to modify their behavior in response to testosterone as they age (results available upon request).[21]

In summary, while we cannot rule out other possibilities in the absence of direct testosterone measurement, it would appear from the checks we have been able to conduct that age appears to be proxying for testosterone rather than experience, horizon, or some other effect.

Table 4.5: Explaining Bid Premium

Our sample consists of 357 merger and acquisition attempts announced during the period 1997-2007. The sample is retrieved from the SDC database and has available data from RiskMetrics/ExecuComp/CRSP/Compustat. See the Appendix for definition of the variables. All dollar amounts are in millions of 2007 dollars, and all percentages are in real numbers. All firm characteristics are measured at the fiscal year end prior to the bid announcement. The *p*-values correspond to the typical two-tailed test of the null that the corresponding coefficient is not statistically different from zero. The corresponding *p*-value is reported in the brackets below each coefficient. Superscripts $***$, $**$, and $*$ correspond to statistical significance at the one, five, and ten percent levels, respectively.

Dependent Variable	Bid Premium	
	(1)	(2)
Bidder Male CEO is Young	-0.0663	
	[0.206]	
Target Male CEO is Young	0.0306	
	[0.525]	
Bidder Male CEO Age from 46-50		0.0960
		[0.108]
Bidder Male CEO Age from 51-55		0.0337
		[0.546]
Bidder Male CEO Age from 56-60		0.0782
		[0.179]
Bidder Male CEO Age over 60		0.0715
		[0.219]
Target Male CEO Age from 46-50		-0.0437
		[0.443]
Target Male CEO Age from 51-55		-0.0159
		[0.765]
Target Male CEO Age from 56-60		-0.0373

Continued on next page

[21]We thank the Associate Editor for this insight.

Table 4.5 – continued from previous page

Dependent Variable	Bid Premium	
	(1)	(2)
		[0.477]
Target Male CEO Age over 60		-0.0773
		[0.153]
Target Characteristics		
Target Board Size	-0.0028	-0.0024
	[0.574]	[0.648]
Target Proportion of Independent Directors	0.0488	0.0648
	[0.581]	[0.457]
Target CEO is COB	0.0199	0.0229
	[0.517]	[0.447]
Target Sales Growth	0.1477***	0.1508***
	[0.006]	[0.006]
Target Tobin's Q	0.0107	0.0110
	[0.582]	[0.575]
Target ROA	-0.4531**	-0.4670**
	[0.044]	[0.042]
Target Book Leverage	-0.0315	-0.0594
	[0.712]	[0.508]
Target Runup	0.1512*	0.1413*
	[0.056]	[0.063]
Bid Characteristics		
Competing Bid	-0.0288	-0.0353
	[0.463]	[0.373]
Poison Pill	-0.0077	-0.0117
	[0.763]	[0.646]
Toehold	-0.3481	-0.3685
	[0.402]	[0.331]
All Cash	0.0155	0.0119
	[0.724]	[0.786]
All Stock	-0.1079***	-0.1177***
	[0.000]	[0.000]
Diversifying	0.0184	0.0158
	[0.568]	[0.627]
Relative Size	-0.1154***	-0.1155***
	[0.003]	[0.003]
Bidder Characteristics		
Bidder CEO Tenure	0.0015	0.0018

Continued on next page

Table 4.5 – continued from previous page

Dependent Variable	Bid Premium	
	(1)	(2)
	[0.459]	[0.393]
Bidder Board Size	-0.0070	-0.0064
	[0.113]	[0.170]
Bidder Proportion of Independent Directors	-0.0810	-0.0877
	[0.416]	[0.382]
Bidder CEO is COB	-0.0345	-0.0351
	[0.276]	[0.282]
Bidder Sales Growth	0.0242	0.0302
	[0.436]	[0.319]
Bidder Tobin's Q	0.0107	0.0112
	[0.170]	[0.168]
Bidder ROA	0.0446	0.0526
	[0.693]	[0.633]
Bidder Book Leverage	-0.0755	-0.0859
	[0.450]	[0.399]
Constant	0.6168***	0.5749***
	[0.000]	[0.000]
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	357	357
Adjusted R-squared	0.1748	0.1720

4.7.2 Sample Selection Effects

There are two sources of selection in our analyses thus far. First, there is a selection process to make it into the CEO position to begin with. If being a CEO in general is a position that is more likely for men with higher testosterone, this will provide a potential lower bound on testosterone levels, implying reduced variations in the testosterone levels of CEOs in our sample. This selection effect would make it more difficult for us to find any significant association between the bidder/target male CEO age and the likelihood of bid withdrawal (or tender offers). Despite the above selection effect, we are still able to identify a strong role for testosterone in M&As.

Second, the very act of choosing to make an acquisition is affected by testosterone. As a direct extension of the interpretation of bid initiation as male dominance seeking, we examine whether male CEOs, by selecting into making M&A deals, reveal relatively elevated testosterone levels. This implies that effects of male CEO age on deal initiation involve one-tailed tests. Our null and alternative hypotheses are the following:

With respect to the bid initiation likelihood:

H_0: The testosterone of the male CEO, proxied by his age, is irrelevant in whether an acquisition bid is initiated.

H_1: The higher the male CEO's testosterone, proxied by his age, the more likely an acquisition bid is to be initiated.

To explore the role of CEO hormones in initiating M&As, we run the following panel data regression focusing on the male CEO age:

$$\begin{aligned}
&\text{Bid Initiation}_{it} \\
&= \alpha_0 + \beta_1 \text{Male CEO is Young}_{it} + \beta_2 \text{Board Size}_{it} \\
&+ \beta_3 \text{Proportion of Independent Directors}_{it} + \beta_4 \text{CEO is COB}_{it} \\
&+ \beta_5 \text{Sales Growth}_{it} + \beta_6 \text{Tobin's Q}_{it} + \beta_7 \text{ROA}_{it} + \beta_8 \text{Book Leverage}_{it} \\
&+ \beta_9 \text{Cash Holding}_{it} + \beta_1 0 \text{Market Capitalization}_{it} \\
&+ \text{Other Controls} + e_{it}. \qquad (4.3)
\end{aligned}$$

As a robustness check of our main model specification, we replace the single young CEO indicator variable with the multiple age indicator variables for older CEOs. The alternative regression, where "Male CEO is Old" is measured by the multiple age indicator variables (as defined before), is specified as follows:

$$\begin{aligned}
&\text{Bid Initiation}_{it} \\
&= \alpha_0 + \beta_1 \text{Male CEO is Old}_{it} + \beta_2 \text{Board Size}_{it} \\
&+ \beta_3 \text{Proportion of Independent Directors}_{it} + \beta_4 \text{CEO is COB}_{it} \\
&+ \beta_5 \text{Sales Growth}_{it} + \beta_6 \text{Tobin's Q}_{it} + \beta_7 \text{ROA}_{it} + \beta_8 \text{Book Leverage}_{it} \\
&+ \beta_9 \text{Cash Holding}_{it} + \beta_1 0 \text{Market Capitalization}_{it} \\
&+ \text{Other Controls} + e_{it}. \qquad (4.4)
\end{aligned}$$

Because standard errors may be underestimated in panel data sets like ours (Petersen, 2009), we present results based on standard errors clustered by firm, year, and both.

To form the bid initiation sample, we merge CRSP/Compustat with the RiskMetrics Groups' corporate board and director data and the Thomson's SDC data over the period 1997-2007. The bid initiation indicator variable is set to the value of one if at least one bid is made within a fiscal year, and zero otherwise. The definition of an acquisition bid is consistent with that used in forming our M&A sample. Our final bid initiation sample consists of 12,492 firm-year observations. Panel A of Table 4.6 presents the descriptive statistics, and Panel B presents the correlation matrix.

Table 4.6: Explaining Bid Initiation

Our sample consists of 12,492 firm-year observations during the period 1997-2007. The sample is retrieved from the SDC database and has available data from RiskMetrics/CRSP/Compustat. See the Appendix for definition of the variables. All dollar amounts are in millions of 2007 dollars, and all percentages are in real numbers. All firm characteristics are measured at the fiscal year end prior to the bid announcement. Panel A presents the summary statistics. Panel B presents the correlation matrix. Panel C presents the regression results. We estimate probit models and present the marginal effect of each explanatory variable on the likelihood of bid initiation. For the first five explanatory variables in this panel, the *p*-values correspond to the one-tailed test as suggested under our alternative hypothesis. For the remaining explanatory variables in Panel C, the *p*-values correspond to the typical two-tailed test of the null that the corresponding coefficient is not statistically different from zero. The corresponding *p*-value is reported in the brackets below each coefficient. Superscripts $***$, $**$, and $*$ correspond to statistical significance at the one, five, and ten percent levels, respectively.

Panel A: Summary Statistics

Variable	N	mean	sd	p5	p50	p95
Bid Initiating Dummy	12492	0.351	0.477	0.000	0.000	1.000
Male CEO is Young	12492	0.091	0.288	0.000	0.000	1.000
Board Size	12492	9.622	2.900	6.000	9.000	15.000
Proportion of Independent Directors	12492	0.665	0.171	0.333	0.692	0.900
CEO is COB	12492	0.683	0.465	0.000	1.000	1.000
Sales Growth	12492	0.120	0.303	-0.202	0.083	0.524
Tobin's Q	12492	1.949	1.464	0.959	1.479	4.513
ROA	12492	0.047	0.109	-0.089	0.046	0.181
Book Leverage	12492	0.236	0.181	0.000	0.228	0.538
Cash Holding / Assets	12492	0.126	0.161	0.004	0.054	0.493
Logarithm of Market Equity ($MM)	12492	8413	26400	164	1749	32600

Table 4.6: Explaining Bid Initiation (Continued)
Panel B: Correlation Matrix

		1	2	3	4	5	6	7	8	9	10	11
1	Bid Initiating Dummy	1.00										
2	Male CEO is Young	0.01	1.00									
		[0.16]										
3	Board Size	0.09	-0.12	1.00								
		[0.00]	[0.00]									
4	Proportion of Independent Directors	0.00	-0.09	0.10	1.00							
		[0.61]	[0.00]	[0.00]								
5	CEO is COB	0.00	-0.16	0.06	0.11	1.00						
		[0.71]	[0.00]	[0.00]	[0.00]							
6	Sales Growth	0.07	0.01	-0.01	-0.05	0.00	1.00					
		[0.00]	[0.22]	[0.17]	[0.00]	[0.87]						
7	Tobin's Q	0.08	0.06	-0.15	-0.06	-0.04	0.16	1.00				
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]					
8	ROA	0.09	-0.04	0.00	-0.02	0.01	0.09	0.33	1.00			
		[0.00]	[0.00]	[0.95]	[0.09]	[0.56]	[0.00]	[0.00]				
9	Book Leverage	-0.05	-0.04	0.16	0.04	0.07	0.01	-0.22	-0.21	1.00		
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.12]	[0.00]	[0.00]			
10	Cash Holding / Assets	0.02	0.11	-0.30	-0.04	-0.09	0.03	0.36	-0.02	-0.36	1.00	
		[0.03]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.05]	[0.00]		
11	Logarithm of Market Equity	0.22	-0.08	0.45	0.15	0.13	0.11	0.28	0.26	0.00	-0.05	1.00
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.65]	[0.00]	

Table 4.6: Explaining Bid Initiation (Continued)
Panel C: Regression Results

Dependent Variable	Bid Initiation				
	(1)	(2)	(3)	(4)	(5)
Male CEO is Young	0.0403***	0.0403***	0.0403**	0.0403**	
	[0.005]	[0.003]	[0.023]	[0.020]	
Male CEO Age from 46-50					-0.0313*
					[0.068]
Male CEO Age from 51-55					-0.0368**
					[0.031]
Male CEO Age from 56-60					-0.0401**
					[0.027]
Male CEO Age over 60					-0.0503**
					[0.011]
Board Size	0.0011	0.0011	0.0011	0.0011	0.0012
	[0.550]	[0.606]	[0.659]	[0.686]	[0.652]
Proportion of Independent Directors	-0.0550**	-0.0550	-0.0550	-0.0550	-0.0576
	[0.033]	[0.117]	[0.127]	[0.203]	[0.183]
CEO is COB	-0.0155	-0.0155	-0.0155	-0.0155	-0.0123
	[0.106]	[0.121]	[0.217]	[0.228]	[0.352]
Sales Growth	0.0772***	0.0772***	0.0772***	0.0772***	0.0767***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tobin's Q	-0.0055	-0.0055	-0.0055	-0.0055	-0.0055
	[0.128]	[0.145]	[0.221]	[0.234]	[0.227]
ROA	0.1826***	0.1826***	0.1826***	0.1826***	0.1857***
	[0.000]	[0.001]	[0.002]	[0.005]	[0.004]
Book Leverage	-0.1095***	-0.1095***	-0.1095***	-0.1095**	-0.1099**
	[0.000]	[0.002]	[0.005]	[0.014]	[0.014]
Cash Holding / Assets	0.0545*	0.0545	0.0545	0.0545	0.0531
	[0.090]	[0.144]	[0.203]	[0.244]	[0.258]
Logarithm of Market Equity	0.0652***	0.0652***	0.0652***	0.0652***	0.0651***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cluster by Firm	No	No	Yes	Yes	Yes
Cluster by Year	No	Yes	No	Yes	Yes
Observations	12492	12492	12492	12492	12492
Pseudo R-squared	0.0431	0.0431	0.0431	0.0431	0.0432

Panel C of Table 4.6 presents the probit regression results where the dependent variable is bid initiation. Column (1) presents results from the baseline pooled probit model. Columns (2), (3), and (4) present results based on standard errors clustered by year, firm, and both, respectively. Consistent with our conjecture, we find that the bidder male CEO being young is positively and significantly associated with the probability of initiating at least one acquisition bid. In terms of the economic significance, the bidder male CEO being young increases the likelihood of a bid by four percentage points, relative to the base case of the bidder male CEO being old. Note

that the sample average frequency of making an acquisition bid is 35 percent (see Table 4.6 Panel A).

As a robustness check on our main findings, we also present regression results based on the model specification in Equation (4.4). Instead of using the single indicator variable for the male CEO being no older than 45 years, we include the multiple age indicator variables for different age brackets: 46-50, 51-55, 56-60, and over 60 years old. We show that relative to the base case of a bidder male CEO being no older than 45 years, a male CEO being older, measured by the four different age indicator variables, is negatively and significantly (in all four cases and at or better than the ten-percent level) associated with the probability of making an acquisition bid.

Chapter 5

Conclusions

5.1 Interaction between Antitakeover Provisions and Managerial Incentives

Chapter 2 investigates the impacts of antitakeover provisions on the value effect of managerial ownership and the manager's compensation contract. Antitakeover provisions enhance the bargaining position of the target firm against the acquirer and thereby raise the bid premium. An enhanced bargaining position weakens the incentive effect of managerial ownership because it encourages the target manager to rely more on the bid premium, and thus less on managerial effort, to create value for shareholders, *ceteris paribus*. Antitakeover provisions may also magnify the entrenchment effect of managerial ownership. Aware of these negative impacts of antitakeover provisions on the effect of managerial ownership on firm value, shareholders grant less ownership to the manager when there are stronger antitakeover provisions.

The impacts of antitakeover provisions on the value effect of managerial ownership are then empirically tested. I show that the effect of managerial ownership on firm value decreases significantly with the strength of antitakeover provisions. For firms with weak antitakeover provisions, managerial ownership and firm value are positively associated with each other. For firms with strong antitakeover provisions, they become negatively associated with each other. I also show that antitakeover provisions decrease the value effect of managerial ownership not only in aggregate but also individually.

The analyses with firm fixed effects and instrumental variables show that anti-

takeover provisions do not directly influence firm value: instead, they only influence firm value indirectly by decreasing the effect of managerial ownership on firm value. This indirect channel through which antitakeover provisions affect firm value sheds light on the current debate over whether the relation between antitakeover provisions and firm value is causal.[1] This indirect channel implies that antitakeover provisions have causal effects on firm value. However, unlike the studies in the preceding footnote suggest, such effects are indirect. Since managerial ownership, antitakeover provisions, and firm value might all be endogenously determined, it is difficult to establish causality between them. This paper has endeavored to deal with endogeneity using firm fixed effects, an event study, and instrumental variables. Future research is needed to shed more light on causality between them.

Managerial ownership decreases significantly with the strength of antitakeover provisions. Each additional antitakeover provision in the E index reduces the ownership of the top five executives by about 1 percentage point. However, about 90 percent of this effect is attributable to firm fixed effects.

Overall, I conclude that the findings of this chapter are consistent with the hypotheses that antitakeover provisions weaken the value effect of managerial ownership and affect the manager's compensation contract.

5.2 Information Precision and IPO Pricing

Chapter 3 investigates the role of information precision in IPO pricing. I first model the going-public process, where the issuer and the investor observe noisy signals about the IPO firm's value. This assumption deviates from other models of equity offerings and enables me to study the role of information precision in IPO pricing. A key prediction of the model is that the proportion of the information learned during the waiting period that is incorporated into the offer price increases with the precision of the information. Consistent with the model, I find that the proportion of the waiting period industry return that is incorporated into the offer price increases with a proxy for the precision of the industry return as a measure of the change in the IPO firm's value.

Information precision has attracted very little attention in the IPO literature. The

[1] See Gompers et al. (2003), Bebchuk and Cohen (2005), Chi (2005), Core et al. (2006), Lehn et al. (2007), Bebchuk et al. (2009) for this debate.

results of this paper and those of Cornelli and Goldreich (2003) suggest that information precision plays an important role in IPO pricing. Future studies on IPO pricing should take this into account.

The findings in this chapter enhance our understanding of the partial adjustment phenomenon: noisy information will be partially incorporated into the offer price. Given the difficulties in determining the fundamental value of the IPO firm, it is not surprising to observe partial adjustments. However, I should clarify that information precision alone cannot fully explain the partial adjustment phenomenon. For example, information precision does not predict asymmetric reactions of the offer price to negative versus positive information. Information precision should be viewed as being complementary to the existing explanations of the partial adjustment phenomenon such as those offered by Benveniste and Spindt (1989), Loughran and Ritter (2002), and Edelen and Kadlec (2005).

5.3 Hormones and Mergers and Acquisitions

In Chapter 4 we examine whether testosterone, which is associated with male dominance seeking and which we have proxied by male CEO age, is associated with M&A withdrawals, the use of tender offers, and bid initiation. Unlike the situation in the ultimatum game, in the case of bid withdrawals we find the bidder CEO (proposer) to be more relevant than the target CEO (responder). Specifically, the bidder male CEO being young increases the likelihood of bid withdrawal by over 20 percent. Consistent with the implications of observed outcomes of the ultimatum game, we find that young target male CEOs are positively associated with the use of a tender offer. In particular, the target male CEO being young increases the likelihood of a tender offer by about two percent. The more pervasive effect of the target male CEO's (responder's) age versus the bidder male CEO's (proposer's) age, where the former is significantly associated with resorting to tender offers, is consistent with the observations by Burnham (2007) in the ultimatum game: responders' reactions are generally more relevant than proposers' actions.

The connections we find are present even after controlling for other plausible influences on M&A outcomes. While our results remain somewhat conjectural as best we can tell, it would appear that age is not influencing merger outcomes through pathways other than testosterone. At least from the evidence we have gathered, it

would appear that male CEO age proxies for testosterone and associated male dominance seeking, and is not proxying for CEO horizon or experience related to tenure. Finally, we show that young male CEOs are positively and significantly associated with bid initiation: the bidder male CEO being young increases the likelihood of a bid by four percentage points.

M&As represent an arena in which male CEOs dominance seeking may come to the fore and influence whether cooperative outcomes can be achieved. Narratives documenting troubled encounters, often leading to withdrawn offers and tender offers, are common. After all, CEOs enjoy positions of dominance, with such dominant positions being the result of years of ambition and a desire for greater control. They represent an ideal population to investigate for such dominating behaviors, and we believe the results reported here are in line with what we would expect. However, confidence in the potential importance of what we have documented would be enhanced if hormones of decision makers are found to be influential in other corporate settings beyond the arena of M&As where "contesting" CEOs meet head to head. We hope the present work leads to such further studies, including investigations of critical business decisions based on direct measurements of testosterone. The control of vast economic resources is at stake.

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Appendix A

The Strength of Antitakeover Provisions

This section studies how shareholders determine the strength of antitakeover provisions.

The discussions in section 2.2.2 suggest that antitakeover provisions enhance the target firm's bargaining position and therefore increase the target's share of the synergy. Accordingly, assume the proportion of the synergy that accrues to the target, p, is an increasing function of the strength of antitakeover provisions of the target firm, n. That is, $p'(n) > 0$. Since there is a one-to-one mapping between n and p, choosing the strength of antitakeover provisions is equivalent to choosing the optimal bargaining position. Therefore, p is regarded as the decision variable.

Suppose the raider has to spend certain cost, δ, to acquire the target firm. The sources of such cost include information production cost, legal cost, cost to hire advisors, and time cost of the raider's managers. Antitakeover provisions reduce the share of the synergy that accrues to the raider, and thus discourage the raider from acquiring the target given the acquisition cost. On the other hand, antitakeover provisions reduce managerial effort and thus raise the amount of the potential synergy gain. This makes the target firm more attractive. The overall effect of antitakeover provisions on the attractiveness of the target depends on the magnitudes of these two opposite effects. While choosing the strength of antitakeover provisions, the target's shareholders must make sure that enough profit is left to the raider to cover the acquisition cost. Otherwise, the raider will not initiate the takeover. In other words, the raider's participation constraint must be satisfied. The raider is assumed

to be risk neutral for simplicity.

The shareholders choose the strength of antitakeover provisions to maximize their expected wealth subject to the optimal compensation contract and the raider's participation constraint. The shareholders' problem is:

$$\max_{p} \quad \psi = (1-\alpha)[e + p(\bar{v} - e)] - s \tag{A.1}$$

$$s.t. \quad e \in \arg\max \left\{ s + \alpha\,[e + p(\bar{v} - e)] - \frac{1}{2k}e^2 - \frac{\eta}{2}\alpha^2\sigma^2 \right\} \tag{A.2}$$

$$\alpha = \alpha^* \tag{A.3}$$

$$s + \alpha\,[e + p(\bar{v} - e)] - \frac{1}{2k}e^2 - \frac{\eta}{2}\alpha^2\sigma^2 = \bar{u} \tag{A.4}$$

$$\theta \equiv (1-p)(\bar{v} - e) - \delta \geq 0, \tag{A.5}$$

where the last two lines are the manager's and the raider's participation constraint, respectively. There is no closed-form solution to the strength of antitakeover provisions. The properties of the optimal strength of antitakeover provisions are stated in the following proposition.

Proposition A.1 *The shareholders are more likely to adopt antitakeover provisions when:*

1. *The potential synergy gain is greater ($\bar{v}$ is greater).*
2. *Firm value is more volatile (σ^2 is greater).*
3. *The manager is more risk-averse (η is greater).*
4. *Managerial effort is more costly (k is smaller).*

When shareholders adopt antitakeover provisions, they choose the strength at which the raider's participation constraint is binding.

Proof: See Appendix B. ■

The intuition behind Proposition A.1 can be explained as follows. The marginal benefit of antitakeover provisions increases with the amount of synergy gain. Therefore, the shareholders are more likely to adopt antitakeover provisions when synergy gain is greater. Ownership is less desirable to a manager who is more risk-averse or for whom effort is more costly. It is also less desirable if firm value is more

volatile. Thus, managerial ownership decreases with firm value volatility, the cost of managerial effort, and the degree of managerial risk-aversion. Since antitakeover provisions weaken the incentive effect of managerial ownership, it is less costly to adopt antitakeover provisions at low levels of managerial ownership. Therefore, the shareholders are more likely to adopt antitakeover provisions when firm value is more volatile, when the manager is more risk averse, and when managerial effort is more costly.

Antitakeover provisions reduce managerial effort, but the speed of such reduction slows down as antitakeover provisions become stronger. In other words, the marginal cost of antitakeover provisions decreases with their strength. On the other hand, the marginal benefit of antitakeover provisions stay constant at $\overline{v}$. Consequently, the shareholders set the optimal strength of antitakeover provisions at the level where the raider's participation constraint is binding. This is the strongest antitakeover provisions the shareholders are able to adopt without keeping the raider out of the game. If the marginal cost of antitakeover provisions outweighs the marginal befit at this level of strength, the shareholders choose not to adopt any antitakeover provisions.

Appendix B

Proofs for Chapter 2 and Appendix A

Proof of Proposition 2.1:

Proof: Solving the manager's problem yields the optimal managerial effort:

$$e^* = k\alpha(1-p). \tag{B.1}$$

In equilibrium, the shareholders offer the lowest salary to the manager so that the participation constraint is binding. Then the participation constraint becomes:

$$s + \alpha[e + (1-p)(\bar{v} - e)] = \bar{u} + \frac{1}{2k}e^2 + \frac{\eta}{2}\alpha^2\sigma^2. \tag{B.2}$$

Plugging (B.2) and (B.1) into the shareholders' objective function yields the following problem:

$$\max_{\alpha} \left[k\alpha(1-p)^2 + p\bar{v}\right] - \left[\bar{u} + \frac{k}{2}(1-p)^2\alpha^2 + \frac{\eta}{2}\alpha^2\sigma^2\right]. \tag{B.3}$$

The first-order condition of (B.3) yields the optimal managerial ownership in equilibrium:

$$\alpha^* = \frac{k(1-p)^2}{k(1-p)^2 + \eta\sigma^2}. \tag{B.4}$$

Then

$$
\begin{aligned}
e^* &= k\alpha(1-p) = \frac{k^2(1-p)^4}{k(1-p)^2+\eta\sigma^2}, && \text{(B.5)}\\
\frac{d\alpha^*}{dp} &= -\frac{2\eta\sigma^2 k(1-p)}{k(1-p)^2+\eta\sigma^2} \leq 0 && \text{(B.6)}\\
\frac{de^*}{dp} &= -\frac{2k^2(1-p)^3\left[k(1-p)^2+2\eta\sigma^2\right]}{\left[k(1-p)^2+\eta\sigma^2\right]^2} \leq 0. && \text{(B.7)}
\end{aligned}
$$

Note that the terms in the first bracket of (B.3) are the expected firm value which equals to the target's stand-alone value plus bid premium. Define the expected firm value as π. Then equation (B.3) becomes:

$$
\max_{\alpha} \pi - \left[\bar{u} + \frac{k}{2}(1-p)^2\alpha^2 + \frac{\eta}{2}\alpha^2\sigma^2\right]. \qquad \text{(B.8)}
$$

The first-order condition is:

$$
\frac{\partial \pi}{\partial \alpha} - k(1-p)^2\alpha - \eta\sigma^2\alpha = 0. \qquad \text{(B.9)}
$$

Differentiating both sides of (B.9) yields:

$$
d\left(\frac{\partial \pi}{\partial \alpha}\right) - (1-p)^2 dk - k(1-p)^2 d\alpha - 2(1-p)dp - \sigma^2\alpha d\eta - \eta\alpha d\sigma^2 - \eta\sigma^2 d\alpha = 0. \qquad \text{(B.10)}
$$

Then:

$$
\begin{aligned}
\frac{d}{dp}\left(\frac{\partial \pi}{\partial \alpha}\right) &= \left[k(1-q)^2 + \eta\alpha\sigma^2\right]\frac{d\alpha}{dp} - 2(1-p)\\
&= -\frac{2\eta\sigma^2 k(1-p)}{k(1-p)^2+\eta\sigma^2} - 2(1-p) < 0. && \text{(B.11)}
\end{aligned}
$$

■

Proof of Proposition A.1:

Proof: Plugging (B.4) into (B.3) yields the expected shareholder wealth for a given

compensation contract:

$$\begin{aligned}
\psi &= \frac{k^2(1-p)^4}{k(1-p)^2+\eta\sigma^2} + p\bar{v} - \left\{ \bar{u} + \frac{k^3(1-p)^6}{2\left[k(1-p)^2+\eta\sigma^2\right]^2} + \frac{\eta\sigma^2 k^2(1-p)^4}{2\left[k(1-p)^2+\eta\sigma^2\right]^2} \right\} \\
&= \frac{k^2(1-p)^4}{\left[k(1-p)^2+\eta\sigma^2\right]^2}\left[k(1-p)^2+\eta\sigma^2 - \frac{k}{2}(1-p)^2 - \frac{\eta}{2}\sigma^2\right] + p\bar{v} - \bar{u} \\
&= \frac{k^2(1-p)^4}{\left[k(1-p)^2+\eta\sigma^2\right]^2}\left[\frac{k}{2}(1-p)^2 + \frac{\eta}{2}\sigma^2\right] + p\bar{v} - \bar{u} \\
&= \frac{k^2(1-p)^4}{2\left[k(1-p)^2+\eta\sigma^2\right]} + p\bar{v} - \bar{u}. \qquad \text{(B.12)}
\end{aligned}$$

Therefore, the shareholders' problem becomes:

$$\max_p \quad \psi = \frac{k^2(1-p)^4}{2\left[k(1-p)^2+\eta\sigma^2\right]} + p\bar{v} - \bar{u} \qquad \text{(B.13)}$$

$$s.t. \quad \theta \equiv \bar{v} - p\bar{v} - \frac{k^2(1-p)^4}{k(1-p)^2+\eta\sigma^2} - \delta \geq 0. \qquad \text{(B.14)}$$

Let us first focus on the shareholders' objective function and solve the unconstrained problem. The first-order condition is:

$$\begin{aligned}
\frac{\partial\psi}{\partial p} &= \frac{-4k^2(1-p)^3\left[k(1-p)^2+\eta\sigma^2\right] + 2k^3(1-p)^5}{2\left[k(1-p)^2+\eta\sigma^2\right]^2} + \bar{v} \\
&= \frac{2k^2(1-p)^3\left\{-2\left[k(1-p)^2+\eta\sigma^2\right] + k(1-p)^2\right\}}{2\left[k(1-p)^2+\eta\sigma^2\right]^2} + \bar{v} \\
&= -\frac{k^2(1-p)^3\left[k(1-p)^2+2\eta\sigma^2\right]}{\left[k(1-p)^2+\eta\sigma^2\right]^2} + \bar{v} \\
&= -\frac{k^3(1-p)^5 + 2\eta\sigma^2 k^2(1-p)^3}{\left[k(1-p)^2+\eta\sigma^2\right]^2} + \bar{v} \\
&\equiv -MC + MB = 0, \qquad \text{(B.15)}
\end{aligned}$$

where MC and MB stand for the marginal cost and marginal benefit of antitakeover provisions, respectively. The marginal benefit is constant ($\bar{v}$), while the marginal cost

decreases with p:

$$\begin{aligned}\frac{dMC}{dp} &= \frac{\left[-5k^3(1-p)^4-6\eta\sigma^2k^2(1-p)^2\right]\left[k(1-p)^2+\eta\sigma^2\right]}{\left[k(1-p)^2+\eta\sigma^2\right]^4} \\ &\quad +\frac{4k(1-p)\left[k^3(1-p)^5+2\eta\sigma^2k^2(1-p)^3\right]\left[k(1-p)^2+\eta\sigma^2\right]}{\left[k(1-p)^2+\eta\sigma^2\right]^4} \\ &= -\frac{k^2(1-p)^2}{\left[k(1-p)^2+\eta\sigma^2\right]^3}\left\{\left[k(1-p)^2+\eta\sigma^2\right]^2+\eta\sigma^2k(1-p)^2+5\eta^2\sigma^4\right\}<0.\end{aligned}$$

Therefore, the shareholders will adopt the strongest antitakeover provisions as long as the raider's participation constraint is satisfied. Denote $\hat{p}$ as the p at which the raider's participation constraint is binding:

$$\theta(\hat{p}) = \overline{v}-\hat{p}\overline{v}-\frac{k^2(1-\hat{p})^4}{k(1-\hat{p})^2+\eta\sigma^2}-\delta = 0. \tag{B.16}$$

The shareholders will set the optimal antitakeover provisions at $p^* = \hat{p}$ if the marginal cost of antitakeover provisions is less than the marginal benefit at $\hat{p}$: $MC(\hat{p}) < \overline{v}$. Otherwise, they choose $p^* = 0$.

The marginal benefit of antitakeover provisions increases with $\overline{v}$, while the marginal cost decreases with η and σ^2 and increases with k:

$$\frac{dMC}{d\sigma^2} = -\frac{2k^2(1-p)^3\eta^2\sigma^2}{\left[k(1-p)^2+\eta\sigma^2\right]^3}<0 \tag{B.17}$$

$$\frac{dMC}{d\eta} = -\frac{2k^2(1-p)^3\eta\sigma^4}{\left[k(1-p)^2+\eta\sigma^2\right]^3}<0 \tag{B.18}$$

$$\frac{dMC}{dk} = \frac{k(1-p)^2\left[k^2(1-p)^4+3k(1-p)^2\eta\sigma^2+4\eta^2\sigma^4\right]}{\left[k(1-p)^2+\eta\sigma^2\right]^3}>0. \tag{B.19}$$

Therefore, the shareholders are more likely to adopt antitakeover provisions when $\overline{v}$, η, and σ^2 are greater and when k is smaller. ■

Appendix C

Variable Descriptions for Chapter 2

Variable	Definition
Measures of Managerial Ownership and Strength of Antitakeover Provisions	
Managerial ownership	The total number of shares owned by the top five executives (including restricted stocks but not options) divided by the total number of shares outstanding.
Pay-performance sensitivity (PPS)	The sensitivity of executives compensation to stock price fluctuation. For stocks, PPS is simply the percentage stock ownership; for stock options, PPS equals the number of shares underlying the options times the delta of each option divided by the total number of shares outstanding. The delta is defined as the partial derivative of option value with respect to stock price. I follows Guay (1999) and Core and Guay (2002) to calculate the delta using the ExecuComp database.
E index	An index based on six antitakeover provisions in the RiskMetrics database: staggered board, poison pills, supermajority requirement for mergers, limits to shareholder bylaw amendments, limits to charter amendments, and golden parachutes. The index value increases by one for each antitakeover provision in place.
G index	An index based on twenty-four antitakeover provisions in the RiskMetrics database. The value of the index increases by one for each antitakeover provision in place.
Accounting Variables	
Tobin's Q	The market value of total assets divided by the book value of total assets. The market value of assets is computed as the book value of total assets (data 6 in the Compustat database) plus common shares outstanding (data 25) times stock price (data 199).
Industry-adjusted Tobins Q	Tobins Q minus the median industry Tobins Q. I use the Fama-French (1997) industry classifications.
Sales	The natural log of total sales (data 12).
Sales squared	The square of Sales.

Variable Descriptions (Continued)

Variable	Definition
Tangibility	The ratio of property, plant, and equipment (data 8) to sales (data12).
Tangibility squared	The square of PPE/Sales.
Idiosyncratic risk	The standard deviation of the residuals of the CAPM model estimated using daily stock returns in the fiscal year.
Profit margin	The ratio of operating income before depreciation (data 13) to total sales (data 12).
R&D	The ratio of research and development expenses (data 46) to property, plant, and equipment (data 8).
R&D dummy	A dummy variable which takes the value of one if the R&D data are available, and zero otherwise.
Advertisement	The ratio of advertisement expenditures (data 45) to property, plant, and equipment (data 8).
Advertisement dummy	A dummy variable which takes the value of one if the advertisement expenses data are available, and zero otherwise.
Investment	The ratio of capital expenditure (data 128) to property, plant, and equipment (data 8).
	Stock returns
CARs in past three years	The cumulative abnormal stock returns over the 36-month period ending at the beginning of the fiscal year. The returns are adjusted with respect to the Fama-French three factors.
Announcement returns of manager share purchase in the open market	The cumulative abnormal return over the trading days [-1, +5] or [-1, +3] around the share purchase announcement. The returns are adjusted with the CAPM model. The estimation window for the market model is [-252,-42] days prior to the announcement.

Appendix D

Variable Descriptions for Chapter 4

Variable	Definition
Withdrawal	An indicator variable taking the value of one if the deal is withdrawn, and zero otherwise.
Tender Offer	An indicator variable taking the value of one if SDC regards the bid as a tender offer, and zero otherwise.
Bid Premium	The ratio of the final offer price to the target stock price four weeks prior to the original announcement date minus one.
Bid Initiation	An indicator variable taking the value of one if at least one mergers and acquisitions bid is made within a fiscal year, and zero otherwise. The bid shall take the form of mergers (SDC deal form M), acquisition of majority interest (AM), or acquisition of assets (AA). Also, we only include control bids where the bidder's toehold before the deal announcement is less than 50 percent, and the sum of the toehold and the percentage ownership sought in the deal is larger than 50 percent.
CEO Age	Age of the CEO.
Male CEO is Young	An indicator variable taking the value of one if the male CEO is not more than 45 years old, and zero otherwise.
Male CEO Age from 46-50	An indicator variable taking the value of one if the male CEO is between 46 and 50 years old, and zero otherwise.
Male CEO Age from 51-55	An indicator variable taking the value of one if the male CEO is between 51 and 55 years old, and zero otherwise.
Male CEO Age from 56-60	An indicator variable taking the value of one if the male CEO is between 56 and 60 years old, and zero otherwise.
Male CEO Age over 60	An indicator variable taking the value of one if the male CEO is over 60 years old, and zero otherwise.

Variable Descriptions (Continued)

Variable	Definition
CEO Tenure	The number of years the CEO has been serving the firm as CEO.
Board Size	The number of directors serving on the board.
Proportion of Independent Directors	The number of independent directors divided by the board size.
CEO is COB	An indicator variable taking the value of one if the CEO is also the Chairman of the Board (COB), and zero otherwise.
Sales Growth	The ratio of sales (Compustat data 12) in the current fiscal year to sales in the last year minus 1.
Tobin's Q	The market value of total assets divided by the book value of total assets. Market value of assets is calculated as book value of total assets (data 6) minus book value of common equity (data 60) plus common shares outstanding (data 25) times stock price (data 199).
ROA	Income before extraordinary items (data 18) divided by the book value of total assets (data 6) at the beginning of the fiscal year.
Book Leverage	The sum of debt in current liabilities (data 34) plus long-term liabilities (data 9) divided by the book value of total assets (data 6).
Target Runup	The cumulative abnormal return to the target firm's stock over the period [41, 1] days before the bid announcement. The estimation window for the market model is [252, 42] days prior to the bid announcement.
Competing Bid	An indicator variable taking the value of one if the number of bidders is larger than one in SDC, and zero otherwise.
Poison Pill	An indicator variable taking the value of one if a poison pill is in place for the target firm, and zero otherwise. The data is retrieved from the IRRC corporate governance dataset.
Toehold	The proportion of the target firm's shares owned by the bidder before the announcement.
All Cash	An indicator variable taking the value of one if only cash is used to pay for the acquisition, and zero otherwise.
All Stock	An indicator variable taking the value of one if only equity is used to pay for the acquisition, and zero otherwise.
Diversifying	An indicator variable taking the value of one if the bidder and the target are in the same Fama-French industry, and zero otherwise.
Relative Size	The transaction value divided by the market value of total assets of the bidder at the fiscal year end prior to the bid announcement. Market value of assets is calculated as book value of total assets (data 6) minus book value of common equity (data 60) plus common shares outstanding (data 25) times stock price (data 199).
Cash Holding / Assets	Cash and short-term investments (data 1) divided by book value of total assets (data 6).
Market Capitalization	Common shares outstanding (data 25) times stock price (data 199).