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Abstract

This thesis consists of three essays.

In the first essay, we examine the option compensation problem of how to optimally set the option exercise price when options have conflicting roles in both inducing management effort and encouraging management cheating. In the risk-neutral setting with both hidden information and hidden actions, we establish that the larger the information gap between the principal and the manager is, the lower the option exercise price should be set. In a dynamic extension that involves at-the-money options only, we prove that it is optimal to grant more options even following a bad stock performance. Further, we prove that the strategy of granting short-term options dominates that of granting long-term options and then repricing, if options become out of money.

In the second essay we analyze the agency problems caused by the tax timing conflict of interest in Umbrella Real Estate Investment Trusts (UPREITs). The tax timing conflict arises if management's tax basis is lower than that of REIT shareholders. Management may be reluctant to sell the properties because it may trigger large build-in capital gains tax for them. After having controlled for the difference in tax basis and various other factors, we find that the UPREIT share price suffers additional discount. This finding is consistent with that UPREITs suffer additional agency problems related to tax timing conflict of interest. Moreover, we also demonstrate that it can be optimal not to defer tax in real estate transactions when the income tax rate is higher than the capital gains tax rate.

In the third essay we examine how the pricing differences between the public (securitized) and private real estate markets along with other factors may influence

REITs' property selling decisions. Current research supports the conclusion that REITs actively arbitrage only if real estate pricing in public market is higher than in private market. Using a large sample of REIT property holding data, we however find that REITs are also active in exploiting price differences when real estate pricing in public market is lower. Furthermore, we identify a series of important factors in REITs' property selling decisions.

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Chapter I Stock Options, Truth Telling, and Incentives: Setting the Optimal Exercise Price and Options Granting Strategy

I.1 Introduction

To a large degree, modern economics is a matter of incentives. In the case of a firm, where agency problems frequently arise, a central issue that concerns all shareholders is how to motivate and offer incentives to managers through appropriate compensation, particularly, stock-based compensation. To be sure, there are many other ways that shareholders can incentivize management. For example, Fama (1980) argues that managers' reputations in the labor market can serve as an incentive mechanism, while Hart and Moore (1995) show how the role of hard claims, such as debts, can constrain management from diverting too many resources for private benefits. Additionally, auditing (costly state verification) technologies, and the threat of termination are also employed (see Khalil, 1997; Shleifer and Vishny, 1986; and Stiglitz & Weiss, 1983). Nevertheless, none of those mechanisms can work on a manager's bottom line as directly as performance-based compensation such as stock and option compensation. Even when compared with other performance-based compensation such as bonus plans, stock-based compensation still has the advantage of having more credibility to the grantees because it minimizes the human involvement once it is awarded. Consequently, stock-based compensation has experienced explosive growth in term of both quantities awarded and participants involved in the last two decades. The compensation package of CEOs alone in year 2000 grew to an average 7.89% of corporate profits among the firms in the 1500-company ExecuComp dataset (Balsam, 2002, p.262).

Until recently, academic research on compensation has typically utilized the standard moral hazard model, in which the manager's actions are hidden to the principal. In the standard moral hazard (or hidden actions) framework,[1] the principal (hereafter she)

[1] Moral hazard and hidden actions are used interchangeably throughout the paper.

prefers the risk-averse manager (hereafter he) to work harder and yet the principal can't observe the manager's effort. With his effort level hidden to the principal, the manager then would like to shirk the effort to minimize his cost. To induce the manager to exert valuable effort, the principal has to link the manager's pay to the firm's performance. As the risk-averse manager is now forced to take the risk of random performance, this creates an inefficiency cost. The optimal compensation design problem is to trade off the incentive benefits against inefficient risk sharing by optimally choosing the contract inputs such as option exercise prices and shares of options awarded.[2]

The standard moral hazard framework is a powerful paradigm, albeit a highly simplified one for many business problems.[3] Specifically, in most modern firms where the absentee owners delegate the daily management to the manager, the manager is likely to have private information on both his actions (or effort) and firm's value (or expected future cash flows). To the extent that the principal is less informed than the manager on the true value of the firm, the manager may well behave opportunistically. One way the manager can exploit his private information is by manipulating the markets' perception of the firm through earnings management. For our purposes, earnings management broadly refers to managing and manipulating financial and accounting reporting in a way that is misleading to shareholders, although the methods of earnings management used may well be permitted by the Generally Accepted Accounting Principles (GAAP). If the market can fully see through earnings management, it will have no consequence for stock prices. Empirical evidences and anecdotal examples, however, suggest that the market doesn't fully capture the effects of earnings management. See Sloan (1996), Collins & Hribar (2000), Louis (forthcoming), and Barth and Hutton (2004) for evidences. Depending on

[2] We consider stock a special option with the exercise price set at zero.

[3] The standard moral hazard view of compensation is challenged by the *skimming view* arguing that CEOs skim the shareholders by capturing the pay-setting process. The observation that most option plans do not index exercise prices to filter out price rises that are unrelated to the manager's performance is considered by some to be consistent with the skimming view. Oyer (2004), however, presents a contracting model in which options plans that award "luck" are optimal if adjusting the compensation contract is costly and the employees' outside opportunities are correlated with firm's performance. Additionally, Garvey & Milbourn (2003) document evidence that average executives are able to remove the influence of market-wide factors in their private portfolio so that inefficiency associated with non-indexed options is removed. Consequently, the existence of non-indexed option compensation may be not inconsistent with the contracting view. *Skimming view*, however, does hold many valid points. See Bebchuk & Fried (2003), Bertrand & Mullainathan (2000, 2001), and Shivdasani & Yermack (1999) for more on the skimming view.

the objective, the manager may wish to manage the reported earnings up or down.[4] For example, the manager can report higher current earnings to temporarily push up stock prices if he needs to sell his position in the firm stocks. Alternatively, the manager can disclose the bad news or simply delay the good news to temporally suppress stock prices before receiving new option grants. The reality is, even with strengthened rules and regulations since the Enron scandal, managers still enjoy great discretion in deciding accounting reporting and the timing of disclosure. Benabou and Laroque (1992) present a model in which the private information is noisy, as is typically the case, and the opportunistic individuals can manipulate prices repeatedly without losing credibility to the market by ascribing misrepresentations as honest errors. Additionally, Yablon & Hill (2002) provides a legal review of many techniques available that allow managers to "play it safe" yet still enable them to time corporate disclosures to maximize the remuneration. As there exist both the motivations and the means, it is probably not surprising that a series of empirical research has found strong evidence that option compensation may generate unintended incentives for the management to conduct earnings management, to time the information disclosure, and to game the compensation system. See Bergstresser & Philippon (2004), Baker et al. (2004), Erickson et al. (2003), and Burns & Kedia (2004) for evidence of link between stock option compensation and earnings management. Refer also to Aboody & Kasnik (2000), Chauvin and Shenoy (2001), and Yermack (1997) for evidences that managers opportunistically time the release of good and bad news in order to increase the value of their option awards.

In this paper we develop a model that explicitly recognizes the constraints on implementation of contracts imposed by the private information environment, in which the principal observes neither the manager's effort level (***hidden actions***) nor the true value of firm (***hidden information***). The principal's problem is to maximize her profit by providing the required incentives through option compensation while also recognizing the effect of options on the risk-neutral manager's incentive to cheat. The challenge of this problem lies in the many different ways that the manager can take advantage of his

[4] Major methods of earnings management include income shifting (through accrual management and securitizations) and expense reporting along with unusual and nonrecurring items that usually are given less importance by analysts.

private information on the state of the firm. The revelation principle, however, allows us to significantly simplify the problem. Specifically, the revelation principle ensures that there is no loss of generality in confining the principal in using incentive compatible mechanisms that are both direct and truthful (giving reward or punishment in a way that the manager finds it in his own interest to report the true state of the firm). In this paper, our focus is on determining the optimal policy of setting the exercise prices and shares of options in the presence of both hidden information and hidden actions. The analysis in this paper indicates that the optimal exercise price should be set low, or even at zero, when hidden information is more severe. Setting the exercise price below the grant-date stock market price, however, disqualifies the firm for favorable accounting and tax treatments. So, in practice, it is possible that firms may choose only to issue at-the-money options for tax and accounting considerations.

An empirical implication of our analysis is that the upper management, who has more opportunities to falsify the firm value, shall be granted options with lower exercise price than that of the average employees. In practice, the fact that most options are granted at the same price, i.e., at-the-money, regardless of who receives them, this means that top executives should be granted relatively more stocks than options. This prediction has been supported by empirical evidence in Barron & Waddell (2004) who show that relatively more stocks are used when the executive is more important at the firm. Additionally, our analysis indicates that, as long as there exists an information gap between the principal and the manager, even the perfectly competitive labor markets and the best corporate governance cannot prevent executives from enjoying exorbitant compensation. Another implication of our analysis is that, when there exists pooling equilibrium, applying option valuation model mechanically without accounting for the manager's private information can lead to a substantial underestimation of the true economic cost of option compensation. This happens even when the stock market correctly values the firm given the available information.

Moreover, our model provides an explanation for the mixed results obtained in the empirical tests of the standard moral hazard model that predicts a negative trade-off between risk (e.g., stock volatility) and incentives (e.g., equity compensation). It will be clear later in this paper that while volatility serves as a proxy for business uncertainty, it also implies higher option compensation in our joint hidden information and hidden action setting. Therefore, the net effect of volatility on incentives is ambiguous.

In a later section, we extend the model to a two-period setting and restrict options to be granted at-the-money only. The principal's problem is to decide the optimal shares of at-the-money options to grant over time. Importantly, our analysis finds theoretical support for granting more options following either bad or good firm performance, a pattern that is documented in Hall & Knox (2004). Moreover, we explore the connection between our dynamic model and the option repricing problem. We argue that option repricing problem is a specific case of our model. Lastly, our analysis also establishes that granting long-term options is never optimal.

The setting of our paper is most closely related to that of Bernardo et al (2001), Grenadier & Wang (2004), and Crocker & Slemrod (2004), all of who examine agency problems in the setting where the manager has private information on the true state of the firm. Like us, these papers assume all parties are risk neutral and managers can improve the future cash flow through exertion of costly effort that is unobservable to the principal. Unlike us, none of them examines the question of how option compensation shall be optimally structured. Bernardo et al (2001) solve a capital allocation problem in which the principal needs to efficiently allocate capital and to induce manager's effort. Incentive mechanisms used by the principal in their paper are a linear compensation contract and a capital allocation scheme. Grenadier & Wang (2004) model an investment under uncertainty problem as a real option where the manager chooses the exercise time of real option to maximize his own reward. They use a combination of wage and real option exercise prices as incentive mechanism. However, the compensation contract in their paper involves no stock option. Similarly, Crocker & Slemrod (2004) develop an optimal earnings management model that balances both the need to induce effort and the need to provide a disincentive for the manager to falsify the earnings report. Again, their general compensation scheme does not specifically consider the structures involved in the option compensation.

Our paper is also closely related to a few studies that specifically consider the optimal option compensation. However, all of these papers consider this problem only under the setting of standard moral hazard (hidden actions), but not under the setting of hidden information. Holding the value of compensation constant, Murphy & Hall (2000) find that setting the option exercise price to the grant-date stock market price is optimal since it maximizes the risk-averse manager's compensation sensitivity to firm performance. However, when the manager is risk-neutral, they conclude, "*the optimal granting policy would be to grant an infinite number of options at an infinite exercise price*." Consequently, their results are driven by the assumption that the manager is risk-averse. Feltham & Wu (2001) examine option compensation in a standard moral hazard setting with a risk-averse manager. However, the manager in their model has unlimited personal wealth, thus can buy out the entire firm if necessary to increase his incentive to work harder. Given that options' payoff is always riskier than that of stocks when holding the value of compensation constant, it is not surprising that Feltham & Wu find stocks dominate options in the optimal contract, i.e., the optimal exercise price is zero. Their result, however, does not extend to the cases of risk-neutrality and/or the limited wealth/liability. Barron & Waddell (2004) investigate option compensation problem in the multi-task moral hazard setting where the risk neutral manager has to perform two different tasks: providing effort and selecting an investment project. Their result shows that the optimal exercise price is finite in this setting. Their analysis therefore "identifies a rationale of finite exercise price that does not rely on a risk aversion on the part of executives."[5] **Table I-1** gives a summary of contracting settings and related results on the optimal exercise price for three studies cited above.

Table I-1 The Optimal Exercise Price Under Moral Hazard Setting

Studies	Moral Hazard Setting	Manager	Contract	Optimal Exercise Price
Murphy & Hall (2000)	Pure	Risk averse	Limited liability[#]	Near the current market price
Feltham & Wu (2001)	Pure	Risk-averse	Enough personal wealth	Zero
Barron & Waddell (2004)	Multi-tasking	Risk-neutral	Limited liability[#]	>0

The limited liability refers to the contract feature that all compensation in cash, stocks, and options to the manager must be non-negative.

The remainder of the paper is organized as follows. In the second section we discuss the model setup with respect to information structure and contracting variables.

[5] See also Lambert & Larcker (2004) and Palmon et al. (2004) for additional options incentive studies under the moral hazard setting that are still on going.

The third section presents and solves the agency model. The fourth section extends the model to a dynamic setting where we consider the problem of how at-the-money options should be optimally granted over time. A final section concludes and discusses directions for future research.

I.2 Model Setup

We eliminate any concerns for risk sharing by assuming that the principal and the manager are both risk-neutral. We consider a firm whose present value (S_0) before compensating the manager is equal to the mean of the firm's random future value (S_t).[6] Let θ represents the firm value when the manager makes no effort. That is, θ is the portion of firm value attributable to the firm's innate profitability.[7] We assume θ can take on two possible values: h or l with $h > l$. If θ is h, we call this firm a *high type firm*. Alternatively, if θ is l, we call the firm a *low type firm*. Similarly, the manager of the high type firm is called the *high-type manager*; while the manager of the low-type firm is called the *low-type manager*. Let a represents the portion of the firm value attributable to the manager's effort. We assume the random variable S_t follows the distribution $F(S_t \mid \theta, a)$ with density function $f(S_t \mid \theta, a)$, where $f(S_t \mid \theta, a) > 0 \ \forall \ \theta$ and a. We also assume that making more effort improves the future value of business (S_t) and therefore its mean S_0. Since a typical firm only has the limited liability, the different distributions of $F(S_t \mid \theta, a)$ share the same lower limit at $S_t = 0$. Additionally, the different distributions also share the same upper limit at $S_t = +\infty$. Under the full information, the firm's total value at time zero before paying the compensation is given by

$$S_0(\theta, a) = \int_0^{+\infty} S_t \cdot f(S_t \mid \theta, a) \cdot dS_t = \theta + a \, .$$

Although the future value of the business S_t will be learned by the principal (as well as the market in general) at the end of the game, the principal does not directly

[6] We assume zero discount rate.

[7] We can think of the high profitability firm as having higher future cash flows or more opportunities. The manager possesses superior information about the firm's future cash flows or opportunities.

observe the type of the firm (θ), which is private information to the manager (hidden information). This is because the manager makes daily management decisions and thus holds superior information. But as time passes by, the principal will learn the true type of the firm. We assume, however, that the principal is knowledgeable that θ takes on value h with probability v and l with possibility $(1-v)$.

Similarly, the manager's effort a is also not directly observable by the principal (hidden actions). We assume that the level of the manager's effort can take on two possible values: a zero effort level and a positive effort of $\bar{a}$: a in $\{0,\bar{a}\}$. Exerting effort a implies a disutility for the agent that is in dollar terms equal to $k(a)$ with $k(0)=0$ and $k(\bar{a})=\varphi$. Further, we normalize the manager's opportunity cost (reservation utility) to zero ($u_r=0$).

Under the hidden information and the hidden actions and assuming the manager makes effort $\bar{a}$, the market price of the firm is given by $P_0 = v \cdot S_0(h,\bar{a}) + (1-v) \cdot S_0(l,\bar{a})$.

In what follows, we also assume that the principal always finds it better to employ the manager and to induce the level of effort $\bar{a}$.[8]

I.2.1 Information Structure

If the manager's effort and the type of the firm are observable by the principal, the contracting problem between the principal and the manager is straightforward. The principal specifies the optimal level of effort for a given type of the firm, and the optimal contract simply compensates the manager for his cost based on the actual effort. The principal is free to award the manger in any form as long as the value of award compensates the manager for his effort disutility φ.

When the true type of the firm (θ) and the manager's effort (a) are not directly observable to the principal, the principal has both the hidden information and hidden action problems. The hidden information problem is that the manager may have the incentive to lie about the true type of the firm. For example, the manager can report that

[8] Our focus is not on determining the conditions under which the second-best optimal contract involves only the high type manager.

the firm is of low-type when it actually is of high-type, and then the manager can take a free ride of stocks when the market gradually learns its type. Alternatively, the manager can report that the firm is of high-type when it is actually of low-type to allow the manager to sell his stocks or options before the stock prices go down. The hidden action problem is that the manager may shirk the costly effort and thus influence the future realization of S_t. Since business value (S_t) is only stochastically determined by the firm type and the manager's effort, the principal can't infer the initial business types (θ) by observing S_t.[9] So even if a benevolent court of law is available, it is very difficult if not impossible for the principal to prove a lie and to take legal actions to punish the manager[10]. In this mixed environment of hidden actions and hidden information, the principal must rely on some incentive mechanisms to induce the manager to do what she wants him to do. Because the manager possesses private information before contracting, the direct revelation mechanism can be applied in search for the optimal contract. (Myerson, 1982). This mechanism recognizes explicitly the constraints on the implementation of contracts imposed by the private information environment. It is cast in a "fictional" two-step process where in the first step the manager sends a report regarding his type ($\hat{\theta}$) to the principal, and in the second step the manager is assigned the contract based on the reported type $\hat{\theta}$. In order for type θ manager to reveal truthfully his type (so $\hat{\theta} = \theta$), the assigned contract needs to be compatible with the incentives so that the manager finds it is in his own interest to report truthfully. Note that in this environment, the direct revelation mechanism is just a theoretical construct used to characterize the optimal contract. The revelation principle ensures that there is no loss of generality in restricting the principal to use only direct revelation mechanism having at most as many contracts as the cardinality of the type space. Since there are only two types of managers in our setting, the optimal incentive mechanism needs to include at most two compensation contracts from which the manager of each type can choose: one that is intended for the manager of high type, and one that is intended for the manager of low

[9] In other words, the profitability type θ remains perpetually unobservable by the principal.
[10] The difficulty of proving breach of contract by the manager has been exemplified by the recent cases involving Tyco, Enron and MCI CEOs.

type. The information structure of the model is illustrated by the sequence of events depicted in **Figure I-1**.

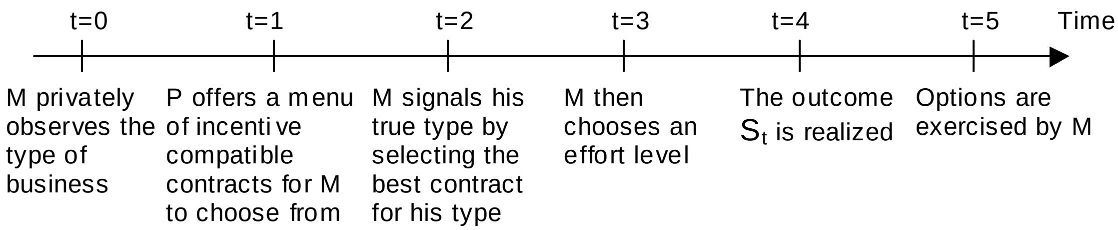

Figure I-1: Time Line

I.2.2 Contracting Variables

We assume that the compensation consists of options and a cash component such as base salary. Stocks are treated as special options with a zero exercise price. All options are the same and this allows us to focus on the main goal of the paper of how to set the optimal exercise price and number of options without being pulled away by portfolio considerations where options with different exercise prices can interact to form the optimal contract. Following many other studies, we further assume that the compensation contract possesses the limited liability feature[11], i.e., cash compensation cannot be negative. This can be justified if the manager has only limited personal wealth. This feature also precludes contracts that "sell the company" to the manager.[12] Moreover, we also assume that the limited liability constraint on cash compensation is binding in the optimal contract, i.e., the optimal salary is always zero. This is because, unlike options and stocks, the fixed salary provides no incentive for the manager to work harder. In our

[11] That the manager has only limited wealth is also explicitly or implicitly assumed in other related studies such as Barron & Waddell (2004), Murphy & Hall (2000), Lambert & Larcker (2004), and Palmon et al. (2004).

[12] It is worth noting here that a well-known result in the moral hazard problem states that, if the manager is risk neutral and has enough personal wealth, the first-best optimal contract will have the principal sell out the firm to the manager. However, in the environment of hidden information and hidden actions, Bernardo et al. (2001) has shown that this will not generally be true if the manager knows the true value of firm before being offered the contracts. The intuition is that the manager has incentive to lie about the true value of the business and then divert the difference in value for private benefit. The second-best optimal contract in this case has to trade off the benefit of effort against the information rent given up to the manager in addition to the cost of effort.

assumed risk-neutral setting, a positive salary only serves as an equalizer to meet the manager's participation requirement. Note that the very reason that triggered the widespread use of employee options in the last two decades is the ability of options to provide leveraged incentives. Given that the manager is risk-neutral, the existence of the fixed salary in the optimal compensation contract implies that providing incentives is not an issue. The assumption of zero salary in the optimal contract allows us to concentrate on the more interesting case where providing incentives to work harder is a concern. It, however, shall be pointed out that our results are robust to the alternative assumption that the manager has some wealth or financing resources so that the optimal cash compensation is negative in the optimal contract (e.g., in the optimal contract the manager purchases a portion of firm using his own fund). As long as the limited liability constraint on cash is binding in the optimal contract, all our results will continue to hold.

Two practical observations also motivate our assumption of zero cash salary in the optimal contract. First, Internal Revenue Code Section 162(m) limits the tax deductibility of non-performance related pay, e.g. salary, to be no more than $1 million. Consequently, executives' base salaries at most firms are set at below $ 1 million. Using S&P ExecuComp database for the period of 2001-2002, we find that 97.7% of firm's top five executives in 1500 S&P index have their base salaries set below $1 million.[13] The average base salary of $380K is relatively small compared to the average total compensation of $2,300K. Second, the Sarbanes-Oxley Act of 2002 (which became effective on August 29, 2002) makes corporate-sponsored executive loans unlawful for any public company. This makes borrowing to increase stock ownership more difficult than before.

Since cash component of compensation in the optimal contract is always zero, each individual contract in the optimal menu of contracts is now determined by a pair of variables describing options awarded: $\{X(\hat{\theta}), \beta(\hat{\theta})\}$, where $X(\hat{\theta})$ and $\beta(\hat{\theta})$ are, respectively, the option exercise price and the number of options awarded *as a percentage* of outstanding shares for each reported profitability type ($\hat{\theta}$). Usually the

[13] The company can choose to pay the manager a base salary more than $1 million, but most companies choose not to lose the tax deduction benefit, and to avoid the political risk of paying too much cash to executives.

manager may not have the appropriate incentives to report the firm type honestly, i.e., $\hat{\theta}$ is not necessarily equal to θ. However, the incentive compatible constraints we apply will ensure that a manager who privately observes h type will report h and a manager who privately observes l type will report l. To simplify the notation, we write $X(\hat{\theta})$ as $X_{\hat{\theta}}$ and $\beta(\hat{\theta})$ as $\beta_{\hat{\theta}}$. Let M be the set of feasible compensation designs that are based on the manager's reported type of business ($\hat{\theta}$). Formally, we have $M = \{(X_{\hat{l}}, \beta_{\hat{l}}); (X_{\hat{h}}, \beta_{\hat{h}}) : X_{\hat{l}}, X_{\hat{h}}, \beta_{\hat{l}}, \beta_{\hat{h}} \in R_+\}$. This menu of compensation contracts is set before the manager chooses his actions. The manager, however, already learns the type of the firm before being offered this menu of contracts. We also make the standard assumption that the principal can commit to the compensation terms once the manager reveals his private information by picking the contract. Absent this commitment, the manager will not report truthfully.

The expected value of option compensation received by the manager when the business is of type θ and the manager reports the type $\hat{\theta}$ and makes effort a is given by

$$\pi(\theta, \hat{\theta}, a) = \beta_{\hat{\theta}} \cdot C(S_0(\theta, a), X_{\hat{\theta}}) = \beta_{\hat{\theta}} \cdot \int_{X_{\hat{\theta}}}^{+\infty} [S_t - X_{\hat{\theta}}] \cdot f(S_t \mid \theta, a) \cdot dS_t,$$

where $C(S_0(\theta, a), X_{\hat{\theta}})$ is the call option on the value of business $S_0(\theta, a)$ with the exercise price $X_{\hat{\theta}}$. When the manager reports truthfully (i.e., $\hat{\theta} = \theta$) and makes the high effort ($a = \overline{a}$), we further simplify the notation of $\pi(\theta, \hat{\theta}, \overline{a})$ as $\pi_{\hat{\theta}}$. If S_t follows the lognormal distribution, its distribution can be completely described by the mean $S_0(\theta, a)$ and the volatility σ. We assume σ is constant across the different types of firms. Our result, however, is robust to the alternative assumption that the high type firm has higher volatility. The results are exactly the same as the case of constant volatility. The case where the high type firm has lower volatility is more complicated because the difference in volatility between the firms causes a new type of adverse selection that is opposite the direction of that caused by the difference in the firm value. While it is out of the scope of this paper, we intend to pursue this problem in the future research.

The value of call option $C(S_0(\theta, a), X_{\hat{\theta}})$ can be readily determined using Black-Scholes model by $C(S_0(\theta, a), X_{\hat{\theta}}) = S_0(\theta, a) \cdot \Phi(d_1) - X_{\hat{\theta}} \cdot \Phi(d_2)$,[14]

where

$$d_1 = \frac{\ln[\frac{S_0(\theta, a)}{X_{\hat{\theta}}}] + \frac{\sigma^2 \cdot t}{2}}{\sigma \cdot \sqrt{t}},$$

$$d_2 = \frac{\ln[\frac{S_0(\theta, a)}{X_{\hat{\theta}}}] - \frac{\sigma^2 \cdot t}{2}}{\sigma \cdot \sqrt{t}} = d_1 - \sigma \cdot \sqrt{t},$$

$\Phi(\cdot)$ is the cumulative probability distribution function for a standardized normal variable.

I.3 Optimal Contracts Under Hidden Information and Hidden Actions

Since the principal offers a menu of contracts without knowing the firm type, she will compute the benefit in expected terms. The Principal's problem can be written as

$$\underset{\beta_{\hat{h}} \geq 0, X_{\hat{h}} \geq 0, \beta_{\hat{l}} \geq 0, X_{\hat{l}} \geq 0}{Max} \quad v \cdot [S_0(h, \bar{a}) - \pi_{\hat{h}}] + (1-v) \cdot [S_0(l, \bar{a}) - \pi_{\hat{l}}]$$

Subject to

$$\pi_{\hat{h}} - \varphi \geq \underset{a \in (o, \bar{a})}{Max}\, \pi(h, \hat{l}, a) - k(a) \qquad (1)$$

$$\pi_{\hat{l}} - \varphi \geq \underset{a \in (0, \bar{a})}{Max}\, \pi(l, \hat{h}, a) - k(a) \qquad (2)$$

$$\pi_{\hat{h}} \geq \varphi \qquad (3)$$

$$\pi_{\hat{l}} \geq \varphi \qquad (4)$$

$$\pi_{\hat{h}} - \pi(h, \hat{h}, 0) \geq \varphi \qquad (5)$$

$$\pi_{\hat{l}} - \pi(l, \hat{l}, 0) \geq \varphi \qquad (6)$$

Inequalities (1) and (2) are the manager's adverse selection incentive constraints. Without these two conditions, the manager of the high type firm may want to report that the firm is of low type (possibly through earnings management or through the release of bad news), and vice versa for the manager of low type business. These two constraints

[14] We assume a zero discount rate.

are complex in that they need to ensure the truthful reporting regardless of the manager's choice of effort. Inequalities (3) and (4) are the *ex ante* participation constraints, and (5) and (6) are the *ex ante* moral hazard incentive constraints after the manager has reported his type truthfully to the principal. In equilibrium, the adverse selection and moral hazard incentives apply so that the manager reports truthfully and makes the instructed level of effort. Consequently, in the objective function, the principal assumes the truthful reporting and expands the expected level of effort.

I.3.1 General Properties of the Solution

Before we actually solve the principal's problem, we first characterize the feasible solutions in what follows.

Lemma 1. *The high type manager always receives more compensation than the low type manager, i.e.,* $\pi_{\hat{h}} \geq \pi_{\hat{l}}$.

Proof. First, by definition, $\pi(h,\hat{l},\bar{a}) = \beta_{\hat{l}} \cdot C(S_0(h,\bar{a}), X_{\hat{l}}) = \pi_{\hat{l}} \cdot \dfrac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})}$. Given our assumption $h \geq l$, it is apparent that $\pi(h,\hat{l},\bar{a}) \geq \pi_{\hat{l}}$. Second, from the adverse selection incentive constraint (1) we know $\pi_{\hat{h}} \geq \pi(h,\hat{l},\bar{a})$. We have $\pi_{\hat{h}} \geq \pi_{\hat{l}}$. ■

This result is straightforward to understand. Note that the high type manager has the ability to misrepresent the true type of the firm. Since the high type manager manages a more valuable business, for each option awarded to the low type manager at any exercise price, the true option value is always higher if the manager who receives it is actually the high type manager, i.e., $\pi(h,\hat{l},\bar{a}) > \pi_{\hat{l}}$ for $h > l$. Since $\pi_{\hat{l}} \geq \varphi$ by the constraint (4), this ability of the high type manager to misrepresent establishes an increased threat point more than φ in the compensation game and allows him to collect information rent of $\pi(h,\hat{l},\bar{a}) - \varphi$. The principal needs to either compensate him this amount in addition to φ, or the high type manager can make the same amount himself by disguising the high type firm as the low type firm. Thus we have $\pi_{\hat{h}} \geq \pi_{\hat{l}}$.

Lemma 2. *The exercise price of the high type manager is higher than that of the low type manager, i.e.,* $X_{\hat{h}} \geq X_{\hat{l}}$.

Proof. The constraints (1) and (2) also imply an implementability condition on the exercise price of the low type manager. Note first that by definition $\pi(h,\hat{l},a) = \pi_{\hat{l}} \cdot \frac{C(S_0(h,a),X_{\hat{l}})}{C(S_0(l,\overline{a}),X_{\hat{l}})}$ and $\pi(l,\hat{h},a) = \pi_{\hat{h}} \cdot \frac{C(S_0(l,a),X_{\hat{h}})}{C(S_0(h,\overline{a}),X_{\hat{h}})}$. Now focusing on the case where $a = \overline{a}$, the constraints (1) and (2) imply the following:

$$\pi_{\hat{h}} \geq \pi_{\hat{l}} \cdot \frac{C(S_0(h,\overline{a}),X_{\hat{l}})}{C(S_0(l,\overline{a}),X_{\hat{l}})} \tag{1”}$$

$$\pi_{\hat{l}} \geq \pi_{\hat{h}} \cdot \frac{C(S_0(l,\overline{a}),X_{\hat{h}})}{C(S_0(h,\overline{a}),X_{\hat{h}})} \tag{2”}$$

Solving for $\frac{\pi_{\hat{h}}}{\pi_{\hat{l}}}$ in both constraints (1”) and (2”) and then combining the results, we get the following:

$$\frac{C(S_0(h,\overline{a}),X_{\hat{l}})}{C(S_0(l,\overline{a}),X_{\hat{l}})} \leq \frac{\pi_{\hat{h}}}{\pi_{\hat{l}}} \leq \frac{C(S_0(h,\overline{a}),X_{\hat{h}})}{C(S_0(l,\overline{a}),X_{\hat{h}})}$$

By Appendix B Proposition B.3, $\frac{C(S_0(h,\overline{a}),X)}{C(S_0(l,\overline{a}),X)}$ is monotonously increasing in X. Thus the implementability condition implies $X_{\hat{h}} \geq X_{\hat{l}}$. ■

The intuition for this result can better be illustrated from the $\beta \sim X$ universe. In **Figure I-1**, two curves stand for the indifference curves that meet the participation requirements of the high type and low type managers, respectively. In a separating equilibrium, one contract, $(X_{\hat{h}}, \beta_{\hat{h}})$, is offered in the curve segment BC, and the other one, $(X_{\hat{l}}, \beta_{\hat{l}})$, at the curve segment AB. Each is only selected by its intended type of the manager. In a pooling equilibrium, both $(X_{\hat{h}}, \beta_{\hat{h}})$ and $(X_{\hat{l}}, \beta_{\hat{l}})$ can be offered at node B. In either case, we can see $X_{\hat{h}} \geq X_{\hat{l}}$ is held.[15]

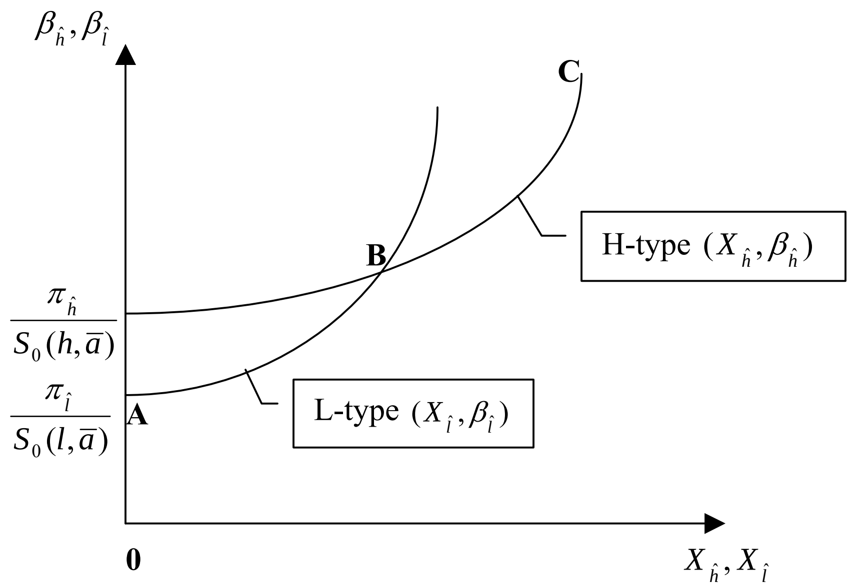

Figure I-2: High Type and Low Type Manager Indifference Curves

Lemma 3. *The high type manager gets more shares of options than the low type manager, i.e.,* $\beta_{\hat{h}} \geq \beta_{\hat{l}}$.

Proof. The value of call option is a decreasing function of the exercise price. Since $\pi_{\hat{h}} \geq \pi_{\hat{l}}$ and $X_{\hat{h}} \geq X_{\hat{l}}$, it must be the case that $\beta_{\hat{h}} \geq \beta_{\hat{l}}$. ■

I.3.2 Model Solution: Optimal Compensation Contracts

The major technical difficulty of the principal's problem, and more generally of the constrained incentive problem, is to determine which of the many constraints are relevant.

To simplify this analysis, we first rewrite the principal's problem in terms of $\pi_{\hat{l}}, X_{\hat{l}}, \pi_{\hat{h}}$, and $X_{\hat{h}}$.

[15] The proofs that the compensation indifference curve is convex and that it has the *single-crossing* or *Spence-Mirrlees* property (with the high type manager's indifference curve flatter than that of the low type) are available upon request.

$$\underset{\pi_{\hat{h}}, X_{\hat{h}} \geq 0, \pi_{\hat{l}}, X_{\hat{l}} \geq 0}{Max} \quad -[v \cdot \pi_{\hat{h}} + (1-v) \cdot \pi_{\hat{l}}]$$

Subject to

$$\pi_{\hat{h}} - \varphi \geq \underset{a \in \{0, \overline{a}\}}{Max} \pi_{\hat{l}} \cdot \frac{C(S_0(h,a), X_{\hat{l}})}{C(S_0(l,\overline{a}), X_{\hat{l}})} - k(a) \tag{1'}$$

$$\pi_{\hat{l}} - \varphi \geq \underset{a \in \{0, \overline{a}\}}{Max} \pi_{\hat{h}} \cdot \frac{C(S_0(l,a), X_{\hat{h}})}{C(S_0(h,\overline{a}), X_{\hat{h}})} - k(a), \tag{2'}$$

$$\pi_{\hat{h}} \geq \varphi, \tag{3'}$$

$$\pi_{\hat{l}} \geq \varphi, \tag{4'}$$

$$\pi_{\hat{h}} \cdot [1 - \frac{C(S_0(h,0), X_{\hat{h}})}{C(S_0(h,\overline{a}), X_{\hat{h}})}] \geq \varphi, \tag{5'}$$

$$\pi_{\hat{l}} \cdot [1 - \frac{C(S_0(l,0), X_{\hat{l}})}{C(S_0(l,\overline{a}), X_{\hat{l}})}] \geq \varphi, \tag{6'}$$

It is relatively easy to see that the participation constraints (3’) and (4’) are never binding as they are guaranteed by (5’) and (6’).

As we see earlier in the paper, the constraints (1’) and (2’) are complex in that the manager may change the effort level when he decides to lie about the firm type. Proposition 1 below establishes that, as long as the low type manager has the incentive to exert effort, the high type manager definitely exerts effort when he decides to lie about the true state of the firm. This result follows naturally from the fact that, in our model, the high type manager is no different from the low type manager except for the type of the firm they manage. If the high type manager lies and disguises the firm as the low type firm, he will get a compensation package ($\beta_{\hat{l}}, X_{\hat{l}}$), exactly the same as that of the low type manager. Since the low type manager is guaranteed to make the effort given the moral hazard incentive constraint (6’), the high type is guaranteed to make the effort too. The following proposition summarizes this reasoning

Proposition 1. *If the moral hazard incentive constraint (6') is satisfied for the low type manager, the high type manager always exerts the effort $\bar{a}$ when he decides to lie about the firm type.*

Proof. In order for the manager of h type to exert the high effort $\bar{a}$ when he lies, the following condition has to be met

$$C(S_0(h,\bar{a}), X_{\hat{l}}) - C(S_0(h,0), X_{\hat{l}}) \geq \frac{\varphi}{\beta_{\hat{l}}} \tag{7}$$

But by inequality (6), we also have

$$C(S_0(l,\bar{a}), X_{\hat{l}}) - C(S_0(l,0), X_{\hat{l}}) \geq \frac{\varphi}{\beta_{\hat{l}}} \tag{6*}$$

Denote the left hand sides of (7) and (6*), respectively, as ΔC_h and ΔC_l. By Appendix C, $C(S_0, X)$ is an increasing and convex function in S_0 with $S_0(\theta, a) = \theta + a$. Thus, we have $\Delta C_h \geq \Delta C_l$. (6*) then implies $\Delta C_h \geq \frac{\varphi}{\beta_{\hat{l}}}$ is satisfied. ■

With Proposition 1, we can replace the constraint (1") by

$$\pi_{\hat{h}} \geq \pi_{\hat{l}} \cdot \frac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})} \tag{1*}$$

Similar logics as in Proposition 1 can be applied to get rid of the high type's moral hazard incentive constraint (5'). Our starting point is again the low type's moral hazard incentive constraint (6'). Since the high type's option package is more powerful in inducing effort, the satisfaction of the constraint (6') of the low type manager guarantees the constraint (5') of the high type manager. The result is summarized in Proposition 2.

Proposition 2. *If the constraint (6') is satisfied, the incentive constraint (5') is not a relevant constraint.*

Proof. Denote the left hand side of (5') as Γ. Substituting the adverse selection incentive constraint (1*) into moral hazard incentive constraint (5') for $\pi_{\hat{h}}$, we have

$$\Gamma \geq \pi_{\hat{l}} \cdot \frac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})} \cdot [1 - \frac{C(S_0(h,0), X_{\hat{h}})}{C(S_0(h,\bar{a}), X_{\hat{h}})}].$$

By Appendix B Proposition B.3, we know $\frac{d}{dX}[1-\frac{C(S_0(h,0),X)}{C(S_0(h,\bar{a}),X)}]>0$. With $X_h \geq X_l$ by Lemma 2, it follows that

$$\Gamma \geq \pi_{\hat{l}} \cdot \frac{C(S_0(h,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})} \cdot [1-\frac{C(S_0(h,0),X_{\hat{l}})}{C(S_0(h,\bar{a}),X_{\hat{l}})}] = \pi_{\hat{l}} \cdot [\frac{C(S_0(h,\bar{a}),X_{\hat{l}})-C(S_0(h,0),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}] \tag{8}$$

Since call option is increasing and convex in the underlying asset value S_0 as proved in Appendix C and $S_0(\theta+a)=\theta+a$, it follows that

$$C(S_0(h,\bar{a}),X_{\hat{l}})-C(S_0(h,0),X_{\hat{l}}) \geq C(S_0(l,\bar{a}),X_{\hat{l}})-C(S_0(l,0),X_{\hat{l}}).$$

Substituting the above into (8), we have

$$\Gamma \geq \pi_{\hat{l}} \cdot [1-\frac{C(S_0(l,0),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}]$$

Since the constraint (6') already implies $\pi_{\hat{l}} \cdot [1-\frac{C(S_0(l,0),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}] \geq \varphi,$ we have $\Gamma \geq \varphi$. ■

Next, we further refine the constraint (1*).

Proposition 3. *The high type manager's adverse selection incentive constraint (1*) must be binding.*

Proof. Note first that we have already eliminated the constraints (3'), (4'), and (5'). $\pi_{\hat{h}}$ appears only in the constraints (1*) and (2'). Now suppose that the constraint (1*) is not binding, then the principal can always reduce $\pi_{\hat{h}}$ to increase profit until (1*) is binding, while still satisfying the constraint (2'). Therefore, the constraint (1*) must be binding and we have

$$\pi_{\hat{h}} = \pi_{\hat{l}} \cdot \frac{C(S_0(h,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}. \tag{1**}$$

■

Examining (1**), we note that the compensation for the high type manager is always a multiple of the compensation for the low type manager with the multiplier being a function of the exercise price for the low type manager $X_{\hat{l}}$. Note that this multiplier, the call option ratio $\frac{C(S_0(h,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}$, is always larger than one if $h > l$. The information rent for the high type manager is given by

$$\pi_{\hat{l}} \cdot \frac{C(S_0(h,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})} - \varphi .$$

Since $\frac{d}{X_{\hat{l}}}[\frac{C(S_0(h,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}] > 0$ as shown in Appendix B Proposition B.3, the high type manager's information rent is increasing in $X_{\hat{l}}$ when holding $\pi_{\hat{l}}$ constant. This result is crucial in our investigation of the optimal exercise price and options granting strategy.

Note also that, after eliminating constraints (3'), (4'), and (5'), $X_{\hat{h}}$ only appears in the constraint (2'). By Lemma 4 in Section 3.2.3 later, (2') can always be satisfied by setting $X_{\hat{h}}$ equal to $X_{\hat{l}}$ or above. Thus, this constraint is not relevant. So we have the following:

Proposition 4. *The low type manager's truth-telling incentive constraint (2') is not a real constraint.*

Applying Proposition1-4, we only have the constraints (1**) and (6') remaining. But (6') must be binding otherwise the principal can do better for herself by reducing $\pi_{\hat{l}}$. Rewriting (6'), we obtain a reduced principal's program with only $X_{\hat{l}}$ as the decision variable:

(P): $$\underset{X_{\hat{l}} \geq 0}{Min} \quad -[v \cdot \pi_{\hat{h}} + (1-v) \cdot \pi_{\hat{l}}]$$

Subject to

$$\pi_{\hat{h}} = \pi_{\hat{l}} \cdot \frac{C(S_0(h,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})} . \tag{1**}$$

$$\pi_{\hat{l}} = \frac{\varphi}{[1 - \frac{C(S_0(l,0),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}]} \tag{6''}$$

In what follows, we discuss the solutions for the principal's problem under the two mutually exclusive situations.

I.3.2.1 Hidden Actions Only (Benchmark)

If there is only one business type, that is when $h = l$ so that $\frac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})} = 1$, or $v = 0$, then there exists no hidden information problem. The principal's problem (P) reduces to a standard moral hazard problem:

$$\underset{X_{\hat{l}} \geq 0}{Min} \quad \frac{\varphi}{[1 - \frac{C(S_0(l,0), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})}]}$$

Since $\frac{d}{dX}[\frac{C(S_0(l,0), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})}] < 0$, we have $X_{\hat{l}}^* = +\infty$. A similar result is argued by Feltham & Wu (2001)[16] and Hall and Murphy (2000)[17] when they also assume the risk-neutral manager and a pure moral hazard setting. In the next section, we assume $h > l$ and $0 < v < 1$, so the hidden information problem always exists.

I.3.2.2 Hidden Information and Hidden Actions

When the manager has private information on firm valuation, setting the exercise price higher to increase incentive leverage of options may have the unintended consequences of encouraging the high type manager to cheat. The effect of $X_{\hat{l}}$ on the high type manager's incentive to cheat can be better seen in equations (1**) and (6") where $\pi_{\hat{h}}$ is an increasing function of $X_{\hat{l}}$ and $\pi_{\hat{l}}$, while $\pi_{\hat{l}}$ itself is a decreasing function of $X_{\hat{l}}$. The net effect of $X_{\hat{l}}$ on $\pi_{\hat{h}}$ depends on the relative sensitivity of $\pi_{\hat{h}}$ to $X_{\hat{l}}$ directly and indirectly through $\pi_{\hat{l}}$. Next, we formally established that optimal exercise is always above zero.

Remark 1. *In the case of joint hidden information and hidden actions, the optimal exercise price is always above zero, i.e.,* $X_{\hat{l}}^* > 0$ *so that stock compensation is never optimal.*

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[16] See Feltham & Wu (2001) endnote 12 for further details.
[17] See Hall & Murphy (2001) p.213.

Proof: Substituting $\pi_{\hat{l}}$ and $\pi_{\hat{h}}$ from (1**) and (6"), the principal's problem becomes

$$\underset{X_{\hat{l}}\geq 0}{Min} \quad \underbrace{\{\frac{\varphi}{1-\frac{C(S_0(l,0),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}}\}}_{Hidden\ \ Action\ \ Cost} \cdot \underbrace{\{v\cdot\frac{C(S_0(h,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})}+(1-v)\}}_{Hidden\ \ Information\ \ Cost} \tag{9}$$

Note the first item in the objective function captures hidden action cost, which is decreasing in $X_{\hat{l}}$. The second item measures the hidden information cost, which is increasing in $X_{\hat{l}}$. The optimal exercise price reflects the tension between increasing option incentive leverage and reducing the manager's information rent. Rewriting (9) yields

$$\underset{X_{\hat{l}}\geq 0}{Min} \quad [\frac{v\cdot C(S_0(h,\bar{a}),X_{\hat{l}})+(1-v)\cdot C(S_0(l,\bar{a}),X_{\hat{l}})}{C(S_0(l,\bar{a}),X_{\hat{l}})-C(S_0(l,0),X_{\hat{l}})}]\cdot\varphi \tag{10}$$

Next, we prove that $X^*_{\hat{l}} > 0$. Denote $C(S_0(\theta,a),X_{\hat{l}})$ as $C_{\theta+a}$ and $\int_{X_{\hat{l}}}^{+\infty} dF(S_t|\theta,a)$ as $\bar{F}_{\theta+a}$.

The first-order condition of the objective function with respect to $X_{\hat{l}}$ yields:

$$\frac{dL}{dX_{\hat{l}}} = \frac{-[v\cdot\bar{F}_{h+\bar{a}}+(1-v)\cdot\bar{F}_{l+\bar{a}}]}{C_{l+\bar{a}}-C_{l+0}} + \frac{[v\cdot C_{h+\bar{a}}+(1-v)\cdot C_{l+\bar{a}}]\cdot[\bar{F}_{l+\bar{a}}-\bar{F}_{l+0}]}{(C_{l+\bar{a}}-C_{l+0})^2}$$

If $X_{\hat{l}}=0$, options are the same as stocks, i.e., $C_{\theta+a}\big|_{X_{\hat{l}}=0} = S_0(\theta,a)$ and $\bar{F}_{\theta+a}\big|_{X_{\hat{l}}=0}=1$ for all $\theta\in\{h,l\}$ and $a\in\{0,\bar{a}\}$. It is straightforward to show $\left.\frac{dL}{dX_{\hat{l}}}\right|_{X_{\hat{l}}=0} = \frac{-1}{S_0(l,\bar{a})-S_0(l,0)} < 0$. Therefore, $X_{\hat{l}}$ is not binding. So it must be that $X_{\hat{l}} > 0$. ■

It is also apparent that the optimal exercise price $X^*_{\hat{l}}$ in the joint hidden information and hidden actions case must also be lower than $X^*_{\hat{l}}$ in the hidden actions only case. Having characterized $X^*_{\hat{l}}$, we next need to characterize $\beta^*_{\hat{l}}$, $X^*_{\hat{h}}$, and $\beta^*_{\hat{h}}$.

I.3.2.3 Pooling vs. Separating Equilibrium

To determine whether the pooling equilibrium exists, we need to examine whether the constraint (2') is satisfied by setting $X_{\hat{h}}^* = X_{\hat{l}}^*$. We now prove that (2') is satisfied by setting $X_{\hat{h}}^* = X_{\hat{l}}^*$.

Lemma 4. *In the case of joint hidden information and hidden actions, there exists a pooling equilibrium where* $X_{\hat{h}}^* = X_{\hat{l}}^*$ *and* $\beta_{\hat{h}}^* = \beta_{\hat{l}}^*$.

Proof. For convenience, we first assume the low type manager will make effort $\bar{a}$ if he is indifferent between making and not making the high effort. From the above, we know both constraints (1**) and (6') are binding. Thus, $\pi_{\hat{h}}$ can be written in terms of $X_{\hat{l}}$ as the following

$$\pi_{\hat{h}} = \varphi \cdot \frac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}}) - C(S_0(l,0), X_{\hat{l}})}. \tag{11}$$

The condition for the low type manager to continue to make high effort $\bar{a}$ even when lying about the type of business is the following:

$$\pi_{\hat{h}} \frac{C(S_0(l,\bar{a}), X_{\hat{h}})}{C(S_0(h,\bar{a}), X_{\hat{h}})} - \varphi \geq \pi_{\hat{h}} \cdot \frac{C(S_0(l,0), X_{\hat{h}})}{C(S_0(h,\bar{a}), X_{\hat{h}})}. \tag{12}$$

Substituting for $\pi_{\hat{h}}$ from (11) and rewriting the condition (12) yields:

$$\frac{\varphi \cdot C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}}) - C(S_0(l,0), X_{\hat{l}})} \cdot [\frac{C(S_0(l,\bar{a}), X_{\hat{h}}) - C(S_0(l,0), X_{\hat{h}})}{C(S_0(h,\bar{a}), X_{\hat{h}})}] \geq \varphi$$

It is apparent that setting $X_{\hat{h}}$ equal to $X_{\hat{l}}$ satisfies the above condition. With this result on hand, the constraint (2') can be simplified as

$$\pi_{\hat{l}} \geq \pi_{\hat{h}} \cdot \frac{C(S_0(l,\bar{a}), X_{\hat{h}})}{C(S_0(h,\bar{a}), X_{\hat{h}})}. \tag{2*}$$

Substituting for $\pi_{\hat{h}}$ from the binding constraint (1**), it is easy to see that $X_{\hat{h}}^* = X_{\hat{l}}^*$ can satisfy the constraint (2*). Additionally, with $\beta_{\hat{l}} = \frac{\pi_{\hat{l}}}{C(S_0(l,\bar{a}), X_{\hat{l}})}$ and

$\beta_{\hat{h}} = \dfrac{\pi_{\hat{h}}}{C(S_0(h,\overline{a}), X_{\hat{h}})}$ by definition and $\pi_{\hat{h}} = \pi_{\hat{l}} \cdot \dfrac{C(S_0(h,\overline{a}), X_{\hat{l}})}{C(S_0(l,\overline{a}), X_{\hat{l}})}$ by the constraint (1**), we have $\beta^*_{\hat{h}} = \beta^*_{\hat{l}}$. ■

The important implication of having a pooling equilibrium is that the market will not learn the true type of the business even after the manager has selected his compensation package. So the stock market price will remain the same as before, that is $P_0 = v \cdot S_0(h,\overline{a}) + (1-v) \cdot S_0(l,\overline{a})$.

Separating equilibrium always exists in our model as long as $X^*_{\hat{h}}$ is set higher than $X^*_{\hat{l}}$ as indicated by Lemma 2. Referring back to **Figure I-2**, node B is where the optimal contract of low type manager should be. The high type manager's indifference curve that goes through node B stands for the payoff that the high type manager can get by misrepresenting and disguising the high type firm as the low type firm. To ensure that the low type manager does not want the high type manager's option contract, the optimal contract for the high type manager has to be located to the right of node B on the curve BC or on node B itself. Regardless of whether it is a pooling or separating equilibrium, the principal is indifferent because the high type manager is only being offered a contract that is on his indifference curve.

I.3.3 Comparative Statics

In this section, we explore the comparative statics with respect to parameters h, l, $\overline{a}$, σ, and v.

Lemma 5. *The optimal expected option compensation* $E(\pi^*)$ *is decreasing in* $\overline{a}$ *, and increasing in* v*, and* h*. That is* $\dfrac{\partial E(\pi^*)}{\partial \overline{a}} < 0$, $\dfrac{\partial E(\pi^*)}{\partial v} > 0$ *and* $\dfrac{\partial E(\pi^*)}{\partial h} > 0$.

Proof. Using the envelope theorem, it is easy to show that taking partial derivatives of objective function with respect to $\overline{a}$, v, and h give the above relationships. ■

Intuitively, as $\overline{a}$ increases, the low type manager becomes increasingly more effective in enhancing the firm's value. This implies he needs fewer options to cover the same cost of effort (φ). In addition, the option ratio $\frac{C(S_0(h,\bar{a}),\sigma_h,X_{\hat{l}})}{C(S_0(l,\bar{a}),\sigma_l,X_{\hat{l}})}$ in the hidden information component of cost also gets smaller as $\bar{a}$ increases so that high type manager's information rent is also reduced. Both effects help to reduce $E(\pi^*)$. The other parameters v and h appear only in the hidden information component of cost. A higher value of h helps the high type manager establish a higher threat point, so it is not surprising that we have $\frac{\partial E(\pi^*)}{\partial h} > 0$. Similarly, a higher v increases the possibility of paying information rent to the high type manager, which makes raising exercise price more costly, so we have $\frac{\partial E(\pi^*)}{\partial v} > 0$.

The signs of $\frac{\partial E(\pi^*)}{\partial l}$ and $\frac{\partial E(\pi^*)}{\partial \sigma}$ are difficult to determine because, as l and σ increase, the hidden action cost goes up while the hidden information cost goes down. So their signs depend on the net effect of these two forces.

The comparative statics of the optimal exercise price ($X_{\hat{l}}^*$) with respect to parameters ($\bar{a}$, v, h, l, and σ) are even more difficult to explicitly determine since it involves taking partial derivatives on the first-order condition. As an alternative, we employ a numerical technique to simulate the impact on the optimal exercise price $X_{\hat{l}}^*$ as well as the expected option cost $E(\pi^*)$ for representative ranges of values of respective parameters. It is important to note that the objective function is homogenous of degree one with respect to the parameters $h, l, \bar{a}$, and variable $X_{\hat{l}}$.[18] Thus, only the relative values (vs. absolute values) among these coefficients and variable are important.

Since the objective function is homogenous of degree one with respect to $h, l, \bar{a}$, and $X_{\hat{l}}$, we fix the parameter h arbitrarily at $h = 30$ and let the other parameters vary.

[18] It is well know that Black-Scholes option formula is homogenous of degree one in $S_0(\theta, a)$ and $X_{\hat{l}}$. Along with $S_0(\theta,a) = \theta + a$, it follows the objective function in (10) above is also homogenous of degree one in $h, l, \bar{a}$, and $X_{\hat{l}}$.

The innate value of a low type firm (l) is assumed to be either 1/3, ½, or 2/3 of the innate value of a high type firm (h) to represent the alternative cases where the hidden information is more or less severe. We also suppose the highest value created by the manager ($\bar{a}$) can be 1/15, 1/3, or 100% of the innate value of a high type firm (h). The higher the percentage is, the more effective the manager's effort is creating value. Volatility of the innate firm value (σ) can be 20%, 50%, or 100%. We also assume that the possibility of having a high type firm (v) can be 10%, 50%, or 90%. Table I-2 presents our simulation results. For the detailed variables definitions used in simulation, see Appendix A.

Our simulation confirms all the results in Lemma 5 (except that $\frac{\partial E(\pi^*)}{\partial h} > 0$ because we fix the parameter h in simulation). Moreover, simulation confirms the mixed sign prediction of $\frac{\partial E(\pi^*)}{\partial l}$. For example holding $h = 30$, $\bar{a} = 2$, $\sigma = 20\%$, and $v = 0.1$ constant, as l increases from 10 to 15 then to 20, the optimal expected option compensation $E(\pi^*)$ first increases from 2.93φ to 3.00φ, then decreases to 2.89φ. If l further increases toward h, the situation will look more like the pure moral hazard problem in which case $E(\pi^*) = \varphi$. For higher v such as $v = 0.5$ or $v = 0.9$, however, $E(\pi^*)$ is monotonously decreasing in l. This pattern is expected given that v only appears in the hidden information component of cost. When v is small, the improvement in hidden information multiplied by a small v may not offset the increase in hidden action component of cost.

Slightly surprisingly but reasonable, we find $\frac{\partial E(\pi^*)}{\partial \sigma} > 0$ for all the cases simulated. This result suggests that the hidden action cost increases faster than the reduction of hidden information cost when σ increases. The net effect of σ on $E(\pi^*)$ is positive.

The impacts of the parameters v and l on the optimal exercise price ($X_{\hat{l}}^*$) are of single direction. Particularly, simulation indicates that $\frac{\partial X_{\hat{l}}^*}{\partial v} < 0$ and $\frac{\partial X_{\hat{l}}^*}{\partial l} > 0$. Both results seem reasonable. As v increases, the principal has a higher possibility of having the high type firm disguising as the low type firm. The principal optimally adjusts down the exercise price to reduce the information rent that she now more frequently pays. Furthermore, as l increases relative to h, the value gap between high type and low type firm becomes smaller, so the situation is more like the hidden actions only case where the optimal exercise price is infinite. In addition, the simulation also suggests that the directions of the impact of parameters $\overline{a}$ and σ on the optimal exercise price ($X_{\hat{l}}^{*}$) are mixed and the signs depend on the values of other parameters. For example, holding $h = 30$, $l = 20$, $\sigma = 20\%$, and $v = 0.1$ constant as $\overline{a}$ moves higher from 2 to 30, $X_{\hat{l}}^{*}$ increases from 21.91 to 27.40. However, holding $h = 30$, $l = 20$, $\sigma = 50\%$, and $v = 0.1$ constant as $\overline{a}$ moves higher from 2 to 30, $X_{\hat{l}}^{*}$ decreases from 50.35 to 48.24. The similar examples can be found for σ.

In summary, we find that $\frac{\partial E(\pi^*)}{\partial h} > 0$, $\frac{\partial E(\pi^*)}{\partial \overline{a}} < 0$, $\frac{\partial E(\pi^*)}{\partial \sigma} > 0$, $\frac{\partial E(\pi^*)}{\partial v} > 0$, $\frac{\partial X_{\hat{l}}^{*}}{\partial l} > 0$, and $\frac{\partial X_{\hat{l}}^{*}}{\partial v} < 0$ while the signs of $\frac{\partial E(\pi^*)}{\partial l}$, $\frac{\partial E(\pi^*)}{\partial l}$, and $\frac{\partial X_{\hat{l}}^{*}}{\partial \sigma}$ are mixed.

I.3.4 Discussion and Implications

An important implication of our analysis in Section 3.3 is that, when hidden information is severe, the optimal exercise price shall be set lower than otherwise is the case. This result is robust to the alternative assumption that the manager is risk-averse. It is well known, holding the value of compensation constant, that options payoff is riskier when the exercise price is increased. With risk-aversion, this is one more factor in addition to hidden information that weighs against raising the exercise price. Furthermore, since top executives have more opportunities to falsify the reports, an empirical prediction of our analysis is that options granted to top executives should have lower exercise prices than those granted to average employees who typically do not control the reporting process. In practice, because most options are granted at the same price, i.e., at-the-money, regardless of who receives options, this means that top executives should be granted relatively more stocks than options (to reduce the average exercise price of the top executives). This prediction have been confirmed in a related study by Barron & Waddell (2004) who provide evidence that "executives who are relatively more influential with their respective firm are less likely to have a given dollar of equity compensation awarded in the form of stock options." Since their equity compensation consists of only stocks and options, fewer options imply more stocks.

Simulations in Table I-2 also provide useful insights on where the optimal exercise price ($X_{\hat{i}}^*$) falls relative to the market price (P_0). Like Murphy & Hall (2000), our optimal exercise price $X_{\hat{i}}^*$ can be either above or below the stock market price P_0. Unlike them, we rely on hidden information, not on the manager's risk-aversion to produce the outcome that the optimal exercise price may be below the grant-date market price. Moreover, Murphy & Hall find that "*the incentive loci are relatively flat around the maximum: exercise prices in the range of 60-100 percent of the stock price generate incentives within 1 percent of the maximum*." (Murphy & Hall, 2000, p. 212) Thus, they conclude that setting exercise price at (or near) the grant-date market price maximizes incentives for risk-averse, undiversified executives. Our simulation, however, indicates that the optimal exercise price is frequently below P_0 (2 out of 9)[19] and, more importantly, the expected option cost is highly sensitive to the loci of the exercise price. This is clearly demonstrated in Table I-2 by looking at the column titled "$\frac{E(\pi^A)-E(\pi^*)}{E(\pi^*)}$," where it summarizes the percentage increases of expected option costs if the exercise price is set at the grant-date stock market price P_0 rather than at the optimal exercise price. The difference can range from 0% to 16,155,437%. Thus, it is clear that the practice of setting options at-the-money to gain favorable accounting and tax treatments can be extremely costly, especially when the hidden information is more severe. The fact that most options are issued at-the-money may suggest that management may try to extract more information rent from the shareholders. Our result therefore

[19] If risk-aversion is assumed instead, it is likely to have the optimal exercise prices below P_0 in even more cases.

contrasts sharply with that of Hall & Murphy (2000) who wrote: "*Our analysis suggests that, in general, avoiding the accounting charge (by setting exercise price at-the-money) is not likely to be very costly to companies in terms of providing incentives*." (Hall & Murphy, 2000, p.213)

An additional implication of our previous analysis is that the manager's remuneration is determined endogenously as well as exogenously. As it is clear from the (9) above, the expected option compensation is an endogenously determined multiple of the exogenously given cost of effort (φ). In our model, the manager of each type is exactly the same except for the type of firm each manages. The high type manager manages a high value firm while the low type manages a low value firm. In the optimal contract, both exert effort level $\bar{a}$. Yet the high type manager consistently enjoys a higher remuneration than the low type manager (note $\pi^*_{\hat{h}} > \pi^*_{\hat{l}}$ in all cases simulated in Table I-2). Apparently, this difference in remuneration is due to the information rent, rather than more effort. As long as there exists information gap between the principal and the manager, the information rent always exists and it cannot be eliminated by introducing more competition in the labor market or mitigated by better corporate governance if corporate governance does nothing to reduce the information gap.

An interesting outcome of our model is that the manger of low type firm shares some of the high type manager's information rent. It can be readily confirmed from Table I-2 that the low type manager's option compensation ($\pi^*_{\hat{l}}$) is always larger than his cost φ. The result is driven by the fact that the hidden information cost in (9) depends positively on the low type manager's exercise price. By giving the low type manager the information rent with lower exercise price, it reduces the high type manager's information rent even more. Consequently, in our model both types of managers enjoy the benefit of the high type manager's private information.

It is also important to note the low type manager in our model does not benefit from his own private information. This is because, although the low type manager can also disguise the low type firm as the high type firm, the principal can always freely raise the high type manager's exercise price $X_{\hat{h}}$ in order to reduce the low type manager's adverse selection incentive enough so that the low type manager cannot establish a threat point that is higher than his cost of effort φ. Consequently, the low type manager derives no information rent from his private information. This is consistent with Proposition 5 that we established earlier in the paper that shows that the low type manager's adverse selection constraint is not a real constraint.

Additionally, our analysis in Table I-2 indicate that, under the pooling equilibrium, even the fair market value models such as Black-Scholes may underestimate the cost of option compensation relative to its true economic costs. To see this, consider the case where the market correctly values the firm given the available information as $P_0 = v \cdot S_0(h+\bar{a}) + (1-v)\cdot S_0(l+\bar{a})$. It is well established that the option is convex in the underlying value of the asset, so we have

$$v \cdot C(S_0(l+\bar{a}), X) + (1-v)\cdot C(S_0(h+\bar{a}), X) \geq C(P_0, X), \tag{13}$$

where the left hand side of (13) stands for the expected option compensation cost. Further, since the observed historical volatility of the firm is σ,[20] the right hand side of (13) presents the option cost recognized in accounting. Consequently, applying Black-Scholes model mechanically to estimate the cost of option compensation can underestimate the true option cost. The convexity of option is illustrated in **Figure I-3**. The distortion effect of convexity is very small if the options are deeply in-the-money. For example, Table I-2 shows that, in the case where the optimal exercise price X_l^* is set low relative to the P_0, the expected option costs $E(\pi^*)$ and the recognized option accounting costs Π^* are very close. However, the distortion is much larger if the options are issued at-the-money. Table I-2 further shows that, in the case of an at-the-money option contract, the recognized option accounting costs (Π^A) are clearly below the true economic costs $E(\pi^A)$. It is important to note that the distortion of cost only exists for the case of pooling equilibrium. For the separating equilibrium, because the manager

[20] To see why the observed historical volatility σ_{Hist} is equal to σ, assume the high profitability firm value (S_{th}) and the low profitability firm value (S_{tl}) follow the geometric Brownian processes, so that $dS_{th} = \mu \cdot S_{th} \cdot dt + \sigma \cdot S_{th} \cdot d\tilde{z}$ and $dS_{tl} = \mu \cdot S_{tl} \cdot dt + \sigma \cdot S_{tl} \cdot d\tilde{z}$. It is easy to see that the expected value [$v \cdot S_{th} + (1-v)\cdot S_{tl}$] also follows the geometric Brownian process $d(v \cdot S_{th} + (1-v)\cdot S_{tl}) = \mu \cdot (v \cdot S_{th} + (1-v)\cdot S_{tl}) \cdot dt \quad + \sigma \cdot (v \cdot S_{th} + (1-v)\cdot S_{tl}) \cdot d\tilde{z}$, the volatility of which is σ.

reveals the true stock value by his selection of compensation contract, there is no distortion when using a fair market value model such as Black-Scholes.

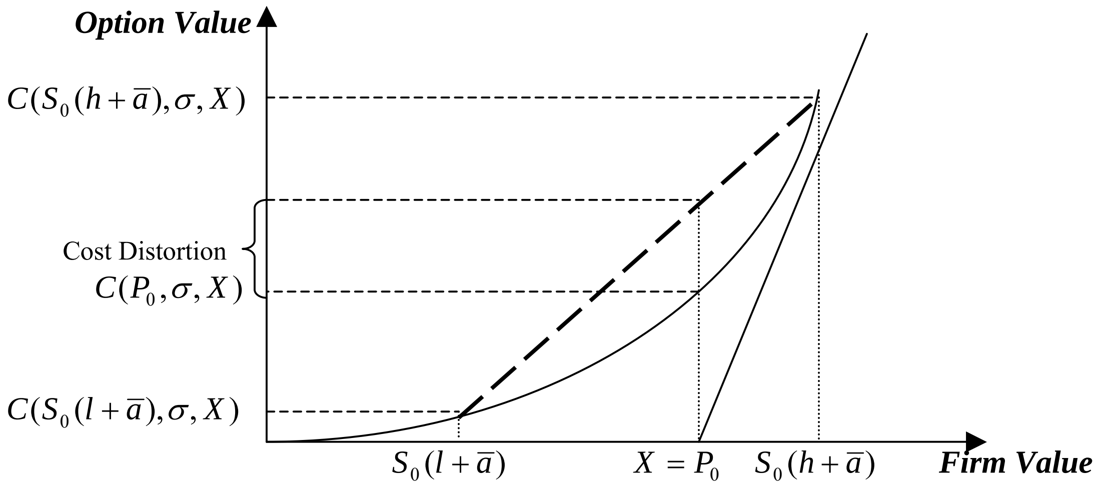

Figure I-3: Distortion of Option Accounting Cost by Option Convexity ($X = P_0$)

Finally, our analysis also provides some explanations for the mixed results experienced so far in empirical testing of standard moral hazard model. Standard moral hazard model predicts a negative trade-off between risk (σ) and incentives (the level of equity-based compensation). Prendergast (2002), however, argues that the existing empirical work testing for a negative trade-off between risk and incentives has not had much success, and suggests that uncertainty may motivate the principal to delegate task selection (in a multi-tasking setting) to an agent to avoid costly mistakes but constrains the agent's choice in that setting by basing pay on performance. Our analysis in this paper contributes to the literature by showing that the incentives may be positively associated with the risk (σ) even in the single-tasking setting. Depending on the types of contract, in this paper incentives can be measured as $E(\pi^*)$, $\Pi^*, E(\pi^A)$, or Π^A.[21] The Section 3.4 already establishes $\frac{\partial E(\pi^*)}{\partial \sigma} > 0$. With additional examination in Table I-2, we also find that $\frac{\partial \Pi^*}{\partial \sigma} > 0$ while the signs of $\frac{\partial E(\pi^A)}{\partial \sigma}$ and $\frac{\partial \Pi^A}{\partial \sigma}$ are mixed. These results

[21] Refer to Appendix A for more detailed definitions for these variables.

illustrate the difficulty involved in testing empirically risk-incentive relationship without appropriately controlling the information environment.

I.3.5 Downward vs. Upward Stock Manipulations

We point out in the last section that only the high type manager has been successful in hardening his adverse selection constraint by mimicking the low type manager. The low type manager, however, is not successful in hardening his adverse selection constraint to extract information rent, thus he receives no information rent from his private information. This seems inconsistent with the reality where the low type manager has the incentive to manipulate the stock price up to benefit his own stock selling. This contradiction can be easily dealt with if the optimal contract incorporates the prior stock holdings of the manager. Assume that the low type manager also holds significant proportion of outstanding stocks from the previous years, out of which he sells a relatively small potion β_0 either right before or after the option grant date.[22] The selling price the low-type manager will get depends on whether he is truthful or not. If he decides to be truthful, he will always sell before his selection of contract. In this case, the market has not learned the true value of the firm, so the price is P_0. However, if he decides to lie, he will always sell after the option grant date so that he can sell at inflated price $S_0(h,\overline{a})$. Note that we must have a separating equilibrium here, otherwise stock manipulation is not very successful. Since the remaining ownership (after selling β_0 portion) is still significant, we assume that the manager has enough incentives to make the high effort $\overline{a}$ in all scenarios. This simplifies the analysis significantly because we get rid of the moral hazard incentive constraints. Moreover, this also ensures that either type of manager still makes the high effort $\overline{a}$ when he decides to lie about the firm type. With this simplification, the constraint (2'), the adverse selection incentives constraint of low type manager, can be rewritten as

[22] Selling all previous ownership would signal to the market the stock is overvalued, but selling a small portion may be regarded neutral for reasons such as liquidity, diversification, etc.

$$\underbrace{\pi_{\hat{l}} + \beta_0 \cdot P_0}_{Reward\ \ if\ Honest} \geq \underbrace{\pi_{\hat{h}} \cdot \frac{C(S_0(l,\bar{a}), X_{\hat{h}})}{C(S_0(h,\bar{a}), X_{\hat{h}})} + \beta_0 \cdot S_0(h,\bar{a})}_{Reward\ \ if\ \ Disguising\ \ As\ \ High\ \ Type} \tag{14}$$

As in the earlier part of paper, $X_{\hat{h}}$ shows up only in (14), and can be set to infinite ($X_{\hat{h}}^* = +\infty$) so that $\frac{C(S_0(l,\bar{a}), X_{\hat{h}})}{C(S_0(h,\bar{a}), X_{\hat{h}})}$ in the right hand side of (14) can be minimized. The low type manager's new adverse selection constraint then becomes

$$\pi_{\hat{l}} \geq \pi_{\hat{h}} \cdot \frac{C(S_0(l,\bar{a}), +\infty)}{C(S_0(h,\bar{a}), +\infty)} + \beta_0 \cdot [S_0(h,\bar{a}) - P_0] \tag{14'}$$

The high type manager will not sell any stocks because $S_0(h,\bar{a})$ is larger then either P_0 or $S_0(l,\bar{a})$. Thus, the adverse selection incentive constraint for the high type remains the same as before. Joining the rest of the constraints, the principal's problem (P) in the above now becomes

$$\underset{X_{\hat{l}} \geq 0}{Min} \ \ [v \cdot \pi_{\hat{h}} + (1-v) \cdot \pi_{\hat{l}}]$$

Subject to

$$\pi_{\hat{h}} = \pi_{\hat{l}} \cdot \frac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})}. \tag{1**}$$

$$\pi_{\hat{l}} \geq \pi_{\hat{h}} \cdot \frac{C(S_0(l,\bar{a}), +\infty)}{C(S_0(h,\bar{a}), +\infty)} + \beta_0 \cdot [S_0(h,\bar{a}) - P_0] \tag{14'}$$

$$\pi_{\hat{l}} \geq \varphi, \tag{4'}$$

Either (14') or (4') must be binding. In the case that the prior stock holdings are high so that β_0 is large or when $[S_0(h,\bar{a}) - P_0]$ is large, (14') may be binding, instead of (4'). In this case, the low type manager derives the information rent from his own private information. This suggests that cautions are needed regarding the conventional wisdom of managerial ownership. Since $\frac{d}{dX_{\hat{l}}}\{\frac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})}\} \geq 0$, it is obvious that the optimal exercise price $X_{\hat{l}}^*$ is zero ($X_{\hat{l}}^* = 0$) when (14') is binding.

Interestingly, the high type manager also benefits from the low type manager getting the information rent because the high type's compensation is always a multiple of that of the low type through the binding constraint (1**), $\pi_{\hat{h}} = \pi_{\hat{l}} \cdot \dfrac{C(S_0(h,\bar{a}), X_{\hat{l}})}{C(S_0(l,\bar{a}), X_{\hat{l}})}$. In summary, when the low type manager has already accumulated significant positions in stocks from the previous years, stocks rather than options shall be granted at the optimum.

I.4 Dynamic Extension (At-The-Money Options)

In the previous sections, we focused on the optimal option compensation in a single period. However, in practice, options are granted over time and mostly at the money. To examine what these features in the current compensation practice might imply for the optimal contract, we extend the base model to a two-period setting and restrict the options to be granted at-the-money only. It will be helpful to refer to **Figure I-4** while going through the description of the model.

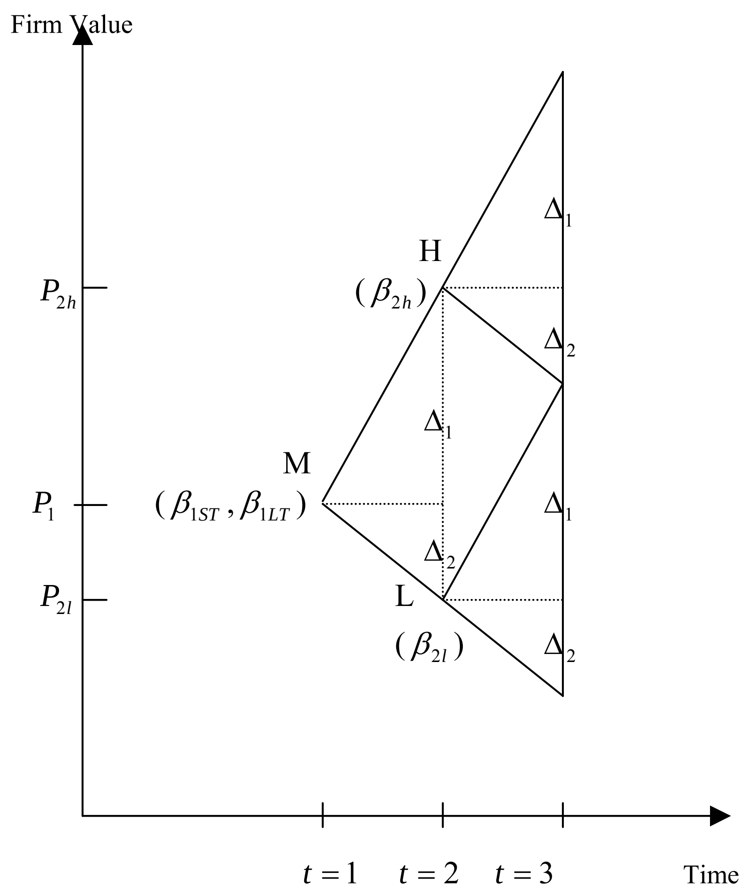

Figure I-4: Evolution of Information and Distribution of True Firm Values ($\Delta_1 \geq \Delta_2$)

I.4.1 Model Setup

As before, we continue to assume the manager's effort level can be either high or zero. If the high effort is made, it costs the manager φ in dollar term. As in the static model, the principal finds she is always better off to employ the manager and to induce the high effort from the manager. The manager's reservation and the discount rate are normalized to zero. Due to the uncertainty, the firm valuation may move up or down following the binary distribution. The exact probability of an upside move is a function of the manager's effort. Let v_1 denote the probability that firm value moves up when an effort is made at a fixed dollar cost of φ. Similarly, let v_0 denote the probability that the firm value moves up when no effort is made. It follows $v_1 > v_0$. Additionally, the firm valuation at each node (node M, H, and L in Figure I-4) should incorporate all available information so that the expected value of the upside move exactly offsets the expected value of the downside move. For example, if the compensation contract ensures the high effort level, then the firm value at any node should be just high or low enough so that $v_1 \cdot \Delta_1 = (1 - v_1) \cdot \Delta_2$, where and Δ_1 and Δ_2, respectively, are the sizes of upside and downside moves of firm value. The principal hires the manager at time one ($t = 1$) when the manager has no private information. However, in the interim stage at the time 2 ($t = 2$), the manager learns the private information on the true value of the firm before he decides his effort for the second period. The manager is free to quit at any time. At the time 3 ($t = 3$), the business closes down by selling off the assets. As such, the information gap between the principal and the manager disappears in the end. At the beginning of each time period, the principal awards the manager new options. Short-term options can be awarded at both $t = 1$ and $t = 2$. These options become vested and expire in one time period. Once vested, the manager must either cash in the difference between the vest-date market price and the exercise price, or options become worthless. At $t = 1$, the principal can also grant the manager long-term options that become vested and expire exactly after two time periods at $t = 3$. The principal's problem is to maximize her profit by deciding the optimal shares of at-the-money short-term and long-term options at time $t = 1$ or $t = 2$, i.e., β_{1ST}, β_{1LT}, β_{2h}, and β_{2l}, where subscripts $1ST$ and $1LT$ refer, respectively, to the 1st period short-term and long-term option grants, while the subscripts $2h$ and $2l$ refer to the 2nd period option grants when the firm values are, respectively, high and low. We continue to assume that the principal can commit to the promised option compensation once the manager has revealed information. In the rest of the section, we concentrate on the case when $\Delta_1 \geq \Delta_2$. The alternative case of $\Delta_1 < \Delta_2$ is simpler while the conclusions are exactly the same. So we exclude that derivation for brevity.

Lemma 6. *The short-term options awarded increase in the 2nd period following either good or bad firm performance in the 1st period. More short-term options are awarded following good performance than bad performance. That is* $\beta_{2h} \geq \beta_{2l} \geq \beta_{1ST}$.

Proof. Assume that short-term option grant β_{1ST} expires right after the manager has revealed private information on the true state of the firm (by selecting the preferred option grants β_{2h} or β_{2l} at $t = 2$). So the market price will reflect the true value of the firm at the time the manager exercise his options (we show later at the end of Section 4.2 that the pooling equilibrium in the dynamic scenario is impossible). For the manager to be truthful about the state of the firm at $t = 2$, the options must be awarded in a way that provides the manager incentives not to lie.

First, we consider if the true state of the firm is at node L. The option package the manager gets at node L must be worth more than if he disguises the firm (probably through earnings management) to be at node H, exercises options β_{1ST} and sells stocks at the inflated price P_{2h}. Expected option compensation for two alternatives shall have the following relationship for the manager to be truthful (we check <u>*ex post*</u> if the manager changes his supply of effort when lying about the state of the firm):

$$\underbrace{\beta_{2l} \cdot v_1 \cdot \Delta_1 + \beta_{1LT} \cdot v_1 \cdot (\Delta_1 - \Delta_2)}_{\text{Reward If Honest}} \geq \underbrace{\beta_{1ST} \cdot \Delta_1 + \beta_{1LT} \cdot v_1 \cdot (\Delta_1 - \Delta_2)}_{\text{Reward If Disguise as High Type}} \tag{15}$$

Note that option grant β_{2h} does not appear on the right hand side of (15). This is because option grant β_{2h} will never be in the money when the true state is at node L. Similarly, β_{1ST} does not appear on the left hand side of (15) since it is already out of the money at the expiration of 1st period. Simplifying (15) yields:

$$\beta_{1ST} \leq v_1 \cdot \beta_{2l} \tag{15'}$$

Since $0 \le v_1 \le 1$, it is apparent that $\beta_{2l} \ge \beta_{1ST}$.

Second, we consider if the true state of firm is at node H. For the manager to be honest, expected option compensation for the two alternatives shall have the following relationship (we check *ex post* if the manager changes his supply of effort when lying):

$$\underbrace{\beta_{1ST} \cdot \Delta_1 + \beta_{2h} \cdot v_1 \cdot \Delta_1 + \beta_{1LT} \cdot \Delta}_{\text{Reward if Honest}} \ge \underbrace{\beta_{2l} \cdot (\Delta_1 + \Delta_2) + \beta_{1LT} \cdot \Delta_1}_{\text{Reward if Disguise as High Type}} \quad (16)$$

Substituting Δ_2 from $v_1 \cdot \Delta_1 = (1 - v_1) \cdot \Delta_2$ yields:

$$\frac{\beta_{2l}}{1 - v_1} \le \beta_{1ST} + v_1 \cdot \beta_{2h} \quad (16')$$

Using $\beta_{2l} \ge \beta_{1ST}$, we then have $\beta_{2h} \ge \beta_{2l}$. ■

I.4.2 Optimal Contracts and Solutions

To analyze the principal's problem, we need to fully specify the moral hazard and participation constraints at nodes M, H, and L. In addition, we also need to use adverse selection incentive constrains (15'), (16') and to make sure the manager will not change his supply of effort when he lies about the state of the firm. It is challenging to solve a model with so many constraints (8 constraints). Fortunately, given the constraints (15'), (16'), and (17), all the other constraints can be shown, although very tediously, to be just slacks. This significantly simplifies our analysis. The principal's problem[23] now becomes:

$$\underset{\beta_{1ST}, \beta_{1LT}, \beta_{2h}, \beta_{2l} \ge 0}{Min} \quad v_1 \cdot \Delta_1 \cdot [\beta_{1ST} + v_1 \cdot \beta_{2h} + 2(1 - v_1) \cdot \beta_{1ST} + (1 - v_1) \cdot \beta_{2l}]$$

Subject to

$$\beta_{1ST} \le v_1 \cdot \beta_{2l} \quad (15')$$

$$\frac{\beta_{2l}}{1 - v_1} \le \beta_{1ST} + v_1 \cdot \beta_{2h} \quad (16')$$

$$(\Delta_1 - \Delta_2) \cdot \beta_{1LT} + \Delta_1 \cdot \beta_{2l} \ge \frac{\varphi}{v_1 - v_0} \quad (17)$$

where (17) is the moral hazard incentive constraint at node L.

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[23] Long-term option value is by definition given by $\beta_{1ST} \cdot [v_1^2 \cdot 2\Delta_1 + 2v_1 \cdot (1 - v_1) \cdot (\Delta_1 - \Delta_2)] = \beta_{1ST} \cdot v_1 \cdot \Delta_1 \cdot 2(1 - v_1)$. See Figure I-4 for reference.

Note that the constraint (16’) must be binding; otherwise the principal can do better for herself by reducing β_{2h}. Similarly, the constraint (17) must also be binding; otherwise the principal can make more by reducing β_{1ST}. Substituting for ($\beta_{1ST} + v_1 \cdot \beta_{2h}$) from (16’) and for β_{2l} from (17), the principal’s problem is simplified to

$$\underset{\beta_{1LT} \geq 0}{Min} \; v_1 \cdot \Delta_1 \cdot [(\frac{1}{1-v_1} + 1 - v_1) \cdot (\frac{\varphi}{\Delta_1 \cdot (v_1 - v_0)}) + (1 - \frac{1-2v_1}{(1-v_1)^2}) \cdot \beta_{1LT}]$$

Since $1 - \frac{1-2v_1}{(1-v_1)^2} > 0$ for all $0 \leq v_1 \leq 1$, we have $\beta_{1LT}^* = 0$. This result is summarized below.

Lemma 7. *The optimal contract grants zero share of long-term option.*

Using the constraint (15’), (16’) and (17), we derive the rest of solutions as following

$$0 \leq \beta_{1ST}^* \leq v_1 \cdot \beta_{2l}^*$$

$$\beta_{2l}^* = \frac{\varphi}{\Delta_1 \cdot (v_1 - v_0)}$$

$$\beta_{2h}^* = \frac{\frac{\beta_{2l}^*}{1-v_1} - \beta_{1ST}^*}{v1}$$

Apparently, these solutions satisfy Lemma 6. Note that the pooling equilibrium ($\beta_{sl}^* = \beta_{2h}^*$) is impossible because even setting β_{1ST}^* to the largest possible value, β_{2h}^* is still larger than β_{2l}^*.

I.4.3 Discussions of the Results

The long-term options work longer but are also more expensive to use. Even more important, however, is that when the state of the firm is at node L, the incentive power of long-term options decreases dramatically. This is particularly clear when $\Delta_1 \leq \Delta_2$. The long-term options, in this case, lose all of their incentive power since they will never be in the money again in the future. Even when $\Delta_1 > \Delta_2$, in order to maintain the incentives at node L for the 2nd period, the principal is forced to grant more long- term options at date 1 and this leads to a significant waste of resources at other nodes such as H and M. It is therefore cheaper to grant only the short-term options over time.

It is worth mentioning the connection our dynamic model has with the option repricing problem in general. The option repricing literature, focusing on the optimality of resetting options, typically approaches the issue as a standard moral hazard problem while implicitly restricting $\beta_{1ST} = 0$ and $\beta_{2h} = 0$ (e.g., Acharya, et al. 2000). When using these specific assumptions, our model can also predict that option repricing is an optimal strategy, i.e., $\beta_{1LT}^* > 0$ and $\beta_{2l}^* > 0$.[24] However, in the more general setting as we have maintained (i.e., $\beta_{1ST} \geq 0$, $\beta_{2h} \geq 0$, and hidden information and hidden action), the option repricing strategy is sub-optimal because long-term options are less efficient as argued in the previous paragraph. The optimal way to grant options is to grant only the short-term options period by period.

Lemma 6 and 7 together also indicate that the firm always should grants more options in the 2nd period regardless of whether the firm's value moves up (the firm performs well) or down (the firm performs bad) in the first period. The manager does get more shares of options in the 2nd period when the firm value has moved up in the first period than it has moved down. The fact that the firm grants more options than before even after the firm has performed badly may seem counter intuitive. Nevertheless, granting options this way extracts the manager's private information that is needed for designing the optimal contract and minimizes the total compensation cost. By the revelation principle, there is no loss in generality in restricting the search for the optimal contract this way. Interestingly, our theoretical predictions are supported by the empirical evidence from Hall & Knox (2004) who report that "*Executives receive the largest option grants following large stock price decreases and large stock price increases, creating a V shape in the relationship between future grant size and stock performance*." (Hall & Knox 2004, Page 403)

[24] A proof is available from authors by request.

I.5 Conclusion

The prior research on option compensation and earnings management provides strong evidence that option compensation, while motivating managers to exert effort, may have also had the perverse incentive of encouraging earnings management for managers' personal gains. The previous research, however, is silent on how to balance these two conflicting incentive effects of option compensation. The importance of this paper is not the introduction of this dichotomy, but rather how option compensation can be designed to optimally balance the intended and unintended incentive effects. We study this problem by explicitly modeling the manager's private information environment in which the self-interested manager has private information on firm value as well as private information on costly effort. The focal contribution of this paper is to demonstrate that, if private information on the value of firm is substantial, the optimal strategy of the principal is to set the exercise price lower, or even to zero. This insight is not well understood in practice. A popular belief among academia and shareholder rights proponents is that in-the-money options and at-the-money options create high rewards for mediocre performance, so they propose that the exercise price should be set out-of-the money (see Rappaport 1999). Additionally, consider the following proposal by the AFL-CIO contained in the Chubb corporation proxy statement filed with the Securities and Exchange Commission on March 24, 1999:

> That the shareholders of The Chubb Corporation (The "Company") urge the board of directors to adopt an executive compensation policy that all future stock option grants to senior executive shall be performance-based. For the purposes of this resolution, a stock option is performance-based if its exercise price is either 1) linked to an industry index, such as Standard and Poor's Property-Casualty Insurance Index; or 2) *significantly above the current market price of the stock at the grant date*.

To the contrary, our research in this paper indicates that this strategy of out-of-the-money options may backfire.

As an extension, we also develop a two-period model to investigate how at-the-money options shall be optimally granted over time. The major insight we gain is that the manager gets the larger option grants following either firm value decrease or firm value increase, which is supported by the evidence in Hall & Knox (2004). In addition, we highlight the connection our dynamic model has with the option repricing problem.

In the dynamic model, we predict that granting long-term options is never optimal. This is not consistent with what we observe in practice. A natural direction for future research would explore the circumstances where long-term options may be optimal and examine the robustness of our dynamic model in general.

Table I-2: Simulated Relationship Between Optimal Contract and Parameters (h, l, $\bar{a}$, σ, and v)

For variable definitions, see Appendix A **Table I-3**. The principal's problem is to maximize expected profit when she observes neither the type of the firm nor the manager's effort, although it is common knowledge that the probability that firm is of the high type is v. The present value of the firm before compensation is either ($h+\bar{a}$) or ($l+\bar{a}$). The cost of each option is calculated using the Black-Scholes model assuming the volatilities of firm value of either type are the same at 20% ($\sigma = 20\%$), one time period, and zero discount rate. We normalize the manager's reservation to zero ($u_r = 0$). Variables Π^* and Π^A only apply in a pooling equilibrium. All option costs (Columns 7-12) are measured in the multiple of the φ.

						Optimal Contract					At-the-Money Contract ($X_{\hat{l}} = P_0$)		
h	l	$\bar{a}$	σ	v	P_0	$X_{\hat{l}}^*$	$\pi_{\hat{h}}^*$	$\pi_{\hat{l}}^*$	$E(\pi^*)$	Π^*	$E(\pi^A)$	Π^A	$\frac{E(\pi^A)-E(\pi^*)}{E(\pi^*)}$
30	10	2	20%	0.1	14.0	9.52	14.32	1.66	2.93	2.87	7.43	3.95	154%
30	10	2	20%	0.5	22.0	8.05	12.67	2.10	7.38	7.38	4,653.82	1,620.77	62,960%
30	10	2	20%	0.9	30.0	7.59	12.58	2.28	11.55	11.55	1,865,964.58	1,377,661.52	16,155,437%
30	10	2	50%	0.1	14.0	10.52	17.05	2.41	3.87	3.59	4.09	3.39	6%
30	10	2	50%	0.5	22.0	6.50	14.14	3.18	8.66	8.60	23.60	16.88	173%
30	10	2	50%	0.9	30.0	5.48	13.98	3.49	12.93	12.92	80.64	73.88	524%
30	10	2	100%	0.1	14.0	24.00	19.42	2.94	4.59	4.11	4.70	4.46	2%
30	10	2	100%	0.5	22.0	6.57	15.25	4.04	9.64	9.50	10.95	9.96	14%
30	10	2	100%	0.9	30.0	4.20	15.03	4.47	13.97	13.96	19.17	18.70	37%
30	10	10	20%	0.1	22.0	11.45	3.47	1.04	1.28	1.28	3.0	2.04	134%
30	10	10	20%	0.5	30.0	9.61	3.23	1.11	2.17	2.17	133.40	62.08	6,047%
30	10	10	20%	0.9	38.0	8.99	3.22	1.14	3.01	3.01	3,857.87	3,083.46	128,068%
30	10	10	50%	0.1	22.0	13.56	4.08	1.15	1.44	1.41	1.57	1.43	9%
30	10	10	50%	0.5	30.0	8.52	3.52	1.30	2.41	2.41	5.24	4.30	117%
30	10	10	50%	0.9	38.0	7.18	3.49	1.37	3.28	3.28	12.69	12.01	287%
30	10	10	100%	0.1	22.0	33.89	4.68	1.24	1.59	1.52	1.60	1.56	1%
30	10	10	100%	0.5	30.0	9.50	3.79	1.49	2.64	2.61	2.89	2.75	9%
30	10	10	100%	0.9	38.0	6.07	3.73	1.59	3.52	3.52	4.47	4.41	27%
30	10	30	20%	0.1	42.0	13.12	1.75	1.00	1.08	1.08	1.67	1.42	55%
30	10	30	20%	0.5	50.0	11.10	1.72	1.01	1.36	1.36	9.84	6.72	624%
30	10	30	20%	0.9	58.0	10.36	1.71	1.02	1.64	1.64	43.98	39.06	2,582%
30	10	30	50%	0.1	42.0	17.64	1.91	1.02	1.11	1.11	1.20	1.16	8%
30	10	30	50%	0.5	50.0	11.66	1.79	1.05	1.42	1.42	2.25	2.09	58%
30	10	30	50%	0.9	58.0	9.87	1.78	1.07	1.71	1.71	3.73	3.65	118%
30	10	30	100%	0.1	42.0	45.43	2.13	1.04	1.15	1.14	1.15	1.14	0%
30	10	30	100%	0.5	50.0	14.59	1.89	1.11	1.50	1.50	1.60	1.57	7%
30	10	30	100%	0.9	58.0	9.60	1.87	1.15	1.80	1.80	2.11	2.10	17%

Table I-2: Simulated Relationship Between Optimal Contract and Parameters (h, l, $\bar{a}$, σ, and v) (Continued)

For variable definitions, see Appendix A **Table I-3**. The principal's problem is to maximize expected profit when she observes neither the type of the firm nor the manager's effort, although it is common knowledge that the probability that firm is of the high type is v. The present value of the firm before compensation is either ($h+\bar{a}$) or ($l+\bar{a}$). The cost of each option is calculated using the Black-Scholes model assuming the volatilities of firm value of either type are the same at 20% ($\sigma = 20\%$), one time period, and zero discount rate. We normalize the manager's reservation to zero ($u_r = 0$). Variables Π^* and Π^A only apply in a pooling equilibrium. All option costs (Columns 7-12) are measured in the multiple of the φ.

						Optimal Contract					At-the-Money Contract ($X_{\hat{l}} = P_0$)		
h	l	$\bar{a}$	σ	v	P_0	$X^*_{\hat{l}}$	$\pi^*_{\hat{h}}$	$\pi^*_{\hat{l}}$	$E(\pi^*)$	Π^*	$E(\pi^A)$	Π^A	$\frac{E(\pi^A)-E(\pi^*)}{E(\pi^*)}$
30	15	2	20%	0.1	18.50	15.06	12.97	1.89	3.00	2.84	3.84	2.75	28%
30	15	2	20%	0.5	24.50	12.68	10.83	2.47	6.65	6.62	85.91	43.05	1192%
30	15	2	20%	0.9	30.50	11.93	10.70	2.73	9.90	9.90	1,442.14	1,175.91	14467%
30	15	2	50%	0.1	18.50	21.61	16.52	2.65	4.04	3.57	4.09	3.78	1%
30	15	2	50%	0.5	24.50	12.52	12.73	3.68	8.21	8.02	10.45	8.84	27%
30	15	2	50%	0.9	30.50	10.32	12.49	4.15	11.66	11.63	21.14	20.15	81%
30	15	2	100%	0.1	18.85	123.63	19.18	3.01	4.62	3.92	5.66	5.55	23%
30	15	2	100%	0.5	24.50	24.63	14.10	4.41	9.25	8.86	9.25	8.86	0%
30	15	2	100%	0.9	30.50	14.21	13.75	5.10	12.89	12.83	13.37	13.21	4%
30	15	10	20%	0.1	26.50	17.43	3.13	1.06	1.27	1.26	1.88	1.52	48%
30	15	10	20%	0.5	32.50	14.76	2.82	1.15	1.99	1.99	16.48	10.27	728%
30	15	10	20%	0.9	38.50	13.84	2.80	1.19	2.64	2.64	104.46	90.41	3857%
30	15	10	50%	0.1	26.50	25.02	3.94	1.18	1.46	1.40	1.46	1.40	0%
30	15	10	50%	0.5	32.50	14.95	3.22	1.38	2.30	2.28	2.97	2.69	29%
30	15	10	50%	0.9	38.50	12.41	3.17	1.48	3.00	3.00	5.23	5.07	74%
30	15	10	100%	0.1	26.50	135.21	4.58	1.25	1.58	1.48	1.76	1.74	11%
30	15	10	100%	0.5	32.50	29.15	3.54	1.54	2.54	2.49	2.54	2.48	0%
30	15	10	100%	0.9	38.50	17.12	3.46	1.70	3.29	3.28	3.41	3.39	4%
30	15	30	20%	0.1	46.50	20.03	1.61	1.00	1.06	1.06	1.38	1.26	30%
30	15	30	20%	0.5	52.50	17.09	1.57	1.02	1.29	1.29	4.25	3.41	229%
30	15	30	20%	0.9	58.50	16.00	1.56	1.03	1.51	1.51	11.02	10.26	630%
30	15	30	50%	0.1	46.50	29.44	1.83	1.02	1.10	1.10	1.13	1.11	3%
30	15	30	50%	0.5	52.50	19.04	1.67	1.07	1.37	1.37	1.71	1.65	25%
30	15	30	50%	0.9	58.50	16.09	1.66	1.10	1.60	1.60	2.44	2.41	53%
30	15	30	100%	0.1	46.50	134.02	2.08	1.04	1.15	1.13	1.18	1.17	3%
30	15	30	100%	0.5	52.50	36.14	1.80	1.12	1.46	1.45	1.47	1.45	1%
30	15	30	100%	0.9	58.50	22.46	1.77	1.17	1.71	1.71	1.78	1.78	4%

Table I-2: Simulated Relationship Between Optimal Contract and Parameters (h, l, $\bar{a}$, σ, and v) (Continued)

For variable definitions, see Appendix A **Table I-3**. The principal's problem is to maximize expected profit when she observes neither the type of the firm nor the manager's effort, although it is common knowledge that the probability that firm is of the high type is v. The present value of the firm before compensation is either ($h+\bar{a}$) or ($l+\bar{a}$). The cost of each option is calculated using the Black-Scholes model assuming the volatilities of firm value of either type are the same at 20% ($\sigma = 20\%$), one time period, and zero discount rate. We normalize the manager's reservation to zero ($u_r = 0$). Variables Π^* and Π^A only apply in a pooling equilibrium. All option costs (Columns 7-12) are measured in the multiple of the φ.

						Optimal Contract					At-the-Money Contract ($X_{\hat{l}} = P_0$)		
h	l	$\bar{a}$	σ	v	P_0	$X_{\hat{l}}^*$	$\pi_{\hat{h}}^*$	$\pi_{\hat{l}}^*$	$E(\pi^*)$	Π^*	$E(\pi^A)$	Π^A	$\frac{E(\pi^A)-E(\pi^*)}{E(\pi^*)}$
30	20	2	20%	0.1	23.0	21.91	11.15	1.97	2.89	2.62	2.92	2.53	1%
30	20	2	20%	0.5	27.0	18.24	8.75	2.63	5.69	5.59	12.01	8.56	111%
30	20	2	20%	0.9	31.0	17.06	8.59	2.94	8.02	8.01	41.01	36.88	411%
30	20	2	50%	0.1	23.0	50.35	14.55	2.46	3.67	3.11	4.43	4.31	21%
30	20	2	50%	0.5	27.0	25.19	10.64	3.55	7.09	6.72	7.11	6.66	0%
30	20	2	50%	0.9	31.0	19.87	10.35	4.12	9.73	9.66	10.46	10.25	8%
30	20	2	100%	0.1	23.0	1364.87	16.20	2.60	3.96	3.25	6.73	6.69	70%
30	20	2	100%	0.5	27.0	144.15	11.69	3.87	7.78	7.18	8.78	8.64	13%
30	20	2	100%	0.9	31.0	69.40	11.33	4.60	10.65	10.53	10.97	10.91	3%
30	20	10	20%	0.1	31.0	24.20	2.73	1.07	1.24	1.22	1.39	1.27	12%
30	20	10	20%	0.5	35.0	20.50	2.38	1.17	1.78	1.77	4.27	3.43	140%
30	20	10	20%	0.9	39.0	19.23	2.36	1.22	2.24	2.24	11.04	10.28	393%
30	20	10	50%	0.1	31.0	48.83	3.55	1.16	1.40	1.33	1.46	1.44	4%
30	20	10	50%	0.5	35.0	26.50	2.81	1.37	2.09	2.05	2.14	2.06	2%
30	20	10	50%	0.9	39.0	21.34	2.75	1.49	2.62	2.62	2.97	2.93	13%
30	20	10	100%	0.1	31.0	847.80	4.00	1.19	1.47	1.37	1.96	1.95	33%
30	20	10	100%	0.5	35.0	118.67	3.08	1.46	2.27	2.19	2.41	2.39	6%
30	20	10	100%	0.9	39.0	61.23	3.00	1.62	2.86	2.84	2.88	2.88	1%
30	20	30	20%	0.1	51.0	27.40	1.45	1.01	1.05	1.05	1.19	1.15	13%
30	20	30	20%	0.5	55.0	23.63	1.41	1.02	1.21	1.21	2.25	2.04	86%
30	20	30	20%	0.9	59.0	22.21	1.40	1.03	1.36	1.36	3.92	3.79	188%
30	20	30	50%	0.1	51.0	48.24	1.69	1.02	1.09	1.08	1.09	1.08	0%
30	20	30	50%	0.5	55.0	29.92	1.53	1.07	1.30	1.30	1.39	1.37	7%
30	20	30	50%	0.9	59.0	24.99	1.52	1.10	1.47	1.47	1.74	1.73	18%
30	20	30	100%	0.1	51.0	471.32	1.89	1.03	1.12	1.10	1.22	1.22	9%
30	20	30	100%	0.5	55.0	101.82	1.64	1.11	1.38	1.36	1.39	1.39	1%
30	20	30	100%	0.9	59.0	58.83	1.62	1.16	1.57	1.57	1.57	1.57	0%

I.6 Appendix A.

This appendix summarizes the variables and parameters used in simulation that generates Table2. Except variables Π^* and Π^A, all other variables and parameters apply in both the separating equilibrium and the pooling equilibrium.

Table I-3: Parameters for Equilibrium Simulations in **Table I-2**

Variables	**Name**	**Definition and Others**
1) Agent Characteristics		
u_r	Manager's reservation in dollar terms	We assume $u_r = 0$ in simulations
φ	Manager's cost of effort in dollar terms	
2) Firm Characteristics		
σ	Volatility of firm value	
h	Value of the high type firm when the manager makes no effort	
l	Value of the low type firm when the manager makes no effort	$h > l$
$\bar{a}$	Additional firm value created by the manager's effort	
v	Probability that the firm is of high type	
P_0	Market price of the firm before the market learns the true type of the firm. In a ***pooling equilibrium***, the market does not learn the true type of the firm even after the manager has selected the contract.	$P_0 = v \cdot (h + \bar{a}) + (1 - v) \cdot (l + \bar{a})$
$C(P, X)$	Black-Scholes option value with the current price P and exercise price X. Volatility σ is constant across the types of firm, one time period, and zero discount rate	
3) Endogenous Variables		
A) Optimal Contract		
$X_{\hat{l}}^* \, (X_{\hat{h}}^*)$	Optimal exercise price if the manager reports the firm is of low (high) type	$X_{\hat{l}}^* = X_{\hat{h}}^* = X^*$
$\pi_{\hat{l}}^* \; (\pi_{\hat{h}}^*)$	Optimal option compensation if the manager reports the firm is of low (high) type	
$\beta_{\hat{l}}^* \, (\beta_{\hat{h}}^*)$	Optimal shares of options (as a percentage of the outstanding shares) if the manager reports the firm is of low (high) type	$\beta_{\hat{l}}^* = \dfrac{\pi_{\hat{l}}^*}{C(l + \bar{a}, X_{\hat{l}}^*)}$ $\beta_{\hat{h}}^* = \dfrac{\pi_{\hat{h}}^*}{C(h + \bar{a}, X_{\hat{h}}^*)}$
$E(\pi^*)$	Expected option compensation	$v \cdot \pi_{\hat{h}}^* + (1 - v) \cdot \pi_{\hat{l}}^*$
Π^*	Options cost recognized by accounting in the ***pooling equilibrium***	$\beta^* \cdot C(P_0, X^*)$

B) At-The-Money Contract (*Exercise price has to be the current stock price*)		
$\pi_{\hat{l}}^{A}$ ($\pi_{\hat{h}}^{A}$)	At-the-money option compensation if the manager reports the firm is of low (high) type	
$\beta_{\hat{l}}^{A}$ ($\beta_{\hat{h}}^{A}$)	Shares of at-the-money options (as a percentage of the outstanding shares) if the manager reports the firm is of low (high) type	$\beta_{\hat{l}}^{A}=\dfrac{\pi_{\hat{l}}^{A}}{C(l+\bar{a},P_0)}$ $\beta_{\hat{h}}^{A}=\dfrac{\pi_{\hat{h}}^{A}}{C(h+\bar{a},P_0)}$
$E(\pi^{A})$	Expected at-the-money option compensation	$v\cdot\pi_{\hat{h}}^{A}+(1-v)\cdot\pi_{\hat{l}}^{A}$
Π^{A}	At-the-money options cost recognized by accounting in the ***pooling equilibrium***	$\beta^{A}\cdot C(P_0,P_0)$

I.7 Appendix B.

In this appendix we investigate an important property of the *Option Ratio* defined below and its implications.

Let $S_0(h)$ and $S_0(l)$ denote, respectively, the means of two random variables S_h and S_l with $S_0(h)>S_0(l)$. The cumulative distribution functions for each of the random variable S_h and S_l are defined, respectively, by F_h and F_l. We can think of S_h and S_l as representing the future values of two businesses. Both random variables are bounded below at zero, i.e., S_h and S_l $\in[0,+\infty)$. We choose the lower bound at zero to capture the limited liability nature of the firm. Many probability distributions have this form of bound, including the lognormal, standard exponential, Gamma, Weilbull, Chi-Squared, Chi, and F distributions.

Note that in an efficient market, market prices of two businesses would be equal to $S_0(h)$ and $S_0(l)$ respectively. Additionally, define the conditional means $E(S_h\mid S_h\geq X)=\dfrac{\int_X^{+\infty}S_h\cdot dF_h}{\int_X^{+\infty}dF_h}$ and $E(S_l\mid S_l\geq X)=\dfrac{\int_X^{+\infty}S_l\cdot dF_l}{\int_X^{+\infty}dF_l}$, where X is the option exercise price. Define the *Option Ratio* as $G(X)=\dfrac{C(S_{0h},X)}{C(S_{0l},X)}=\dfrac{\int_X^{+\infty}(S_h-X)\cdot dF_h}{\int_X^{+\infty}(S_l-X)\cdot dF_l}$.

We want to examine if $G(X)$ is a monotone increasing function of exercise price X, i.e., $\frac{dG(X)}{dX} \geq 0$. This is a crucial property that we use throughout this paper.

$$\frac{dG(X)}{dX} = \frac{-(\int_X^{+\infty} dF_h) \cdot \int_X^{+\infty} (S_l - X) \cdot dF_l + (\int_X^{+\infty} dF_l) \cdot \int_X^{+\infty} (S_h - X) \cdot dF_h}{(\int_X^{+\infty} (S_l - X) \cdot dF_l (S)^2}$$

$$= \frac{-\int_X^{+\infty} dF_h \cdot \int_X^{+\infty} S_l \cdot dF_l + \int_X^{+\infty} dF_l \cdot \int_X^{+\infty} S_h \cdot dF_h}{(\int_X^{+\infty} (S - X) \cdot dF_l)^2}$$

It is apparent that $\frac{dG(X)}{dX} \geq 0$ if and only if $\frac{\int_X^{+\infty} S_h \cdot dF_h}{\int_X^{+\infty} dF_h} \geq \frac{\int_X^{+\infty} S_l \cdot dF_l}{\int_X^{+\infty} dF_l}$. So we have

Proposition B.1. $\frac{dG(X)}{dX} \geq 0$ *if and only if* $E(S_h \mid S_h \geq X) \geq E(S_l \mid S_l \geq X)$.

In words, for $\frac{dG(X)}{dX}$ to be non-negative, the conditional mean of S_h needs to be larger than the conditional mean of the distribution S_l for any given X. Our goal next is to prove this pre-condition is satisfied by the lognormal distribution.

Proposition B.2. *I If the random variables S_h and S_l follow the lognormal distributions with the same volatility and the different means ($S_{0h} \geq S_{0l}$), then* $E(S_h \mid S_h \geq X) \geq E(S_l \mid S_l \geq X)$.

Proof. Assume a random variable (S) with mean S_0 follows the lognormal distribution with volatility σ. By definition, this means that the annualized asset return (r) must follow the normal distribution $N[-\frac{\sigma^2 \cdot t}{2}, \sigma\sqrt{t}]$, where t is the time period.[1] The asset return for the time interval can be determined using $\tilde{r} \cdot t = \ln(\frac{S}{S_0})$. The conditional mean of S is given by

[1] Consistent with the rest of the paper, we assume the discount rate is zero.

$$\frac{\int_X^{+\infty} S \cdot dF}{\int_X^{+\infty} dF} = \frac{\int_{\ln(\frac{X}{S_0})}^{+\infty} S_0 \cdot e^{\tilde{r}\cdot t} \cdot \frac{1}{\sqrt{2\pi}\cdot\sigma\sqrt{t}} \cdot e^{-\frac{\tilde{r}\cdot t+\frac{\sigma^2\cdot t}{2}}{2\cdot\sigma^2\cdot t}} \cdot d(\tilde{r}\cdot t)}{\int_{\ln(\frac{X}{S_0})}^{+\infty} \frac{1}{\sqrt{2\pi}\cdot\sigma\sqrt{t}} \cdot e^{-\frac{\tilde{r}\cdot t+\frac{\sigma^2\cdot t}{2}}{2\cdot\sigma^2\cdot t}} \cdot d(\tilde{r}\cdot t)} = \frac{S_0 \cdot \Phi(\alpha_1)}{\Phi(\alpha_2)},$$

where $\alpha_1 = \frac{\ln(\frac{S_0}{X}) + \frac{\sigma^2 \cdot t}{2}}{\sigma \cdot \sqrt{t}}$, $\alpha_2 = \frac{\ln(\frac{S_0}{X}) - \frac{\sigma^2 \cdot t}{2}}{\sigma \cdot \sqrt{t}} = \alpha_1 - \sigma \cdot \sqrt{t}$, and $\Phi(\cdot)$ is the cumulative probability distribution function for a standardized normal variable. Now let $\phi(\cdot)$ be the standard normal probability density function and $\lambda(\alpha) = -\frac{\phi(\alpha)}{\Phi(\alpha)}$.

Differentiating the conditional mean with respect to the mean (S_0)

$$\frac{d}{dS_0}[\frac{S_0 \cdot \Phi(\alpha_1)}{\Phi(\alpha_2)}] = \frac{[\Phi(\alpha_1) + \frac{\phi(\alpha_1)}{\sigma\sqrt{t}}] \cdot \Phi(\alpha_2) - \frac{\Phi(\alpha_1)\cdot\phi(\alpha_2)}{\sigma\sqrt{t}}}{\Phi^2(\alpha_2)}$$

$$= \frac{\frac{\Phi(\alpha_1)\cdot\Phi(\alpha_2)}{\sigma\cdot\sqrt{t}}[\sigma\sqrt{t} + \frac{\phi(\alpha_1)}{\Phi(\alpha_1)} - \frac{\phi(\alpha_2)}{\Phi(\alpha_2)}]}{\Phi^2(\alpha_2)}$$

$$= \frac{\frac{\Phi(\alpha_1)\cdot\Phi(\alpha_2)}{\sigma\cdot\sqrt{t}}[\sigma\sqrt{t} - (\lambda(\alpha_1) - \lambda(\alpha_2))]}{\Phi^2(\alpha_2)},$$

Since $\frac{d\lambda(\alpha)}{d\alpha} < 1$[2] for all α and $\alpha_1 - \alpha_2 = \sigma\sqrt{t}$, this implies $\sigma\sqrt{t} - (\lambda(\alpha_1) - \lambda(\alpha_2)) > 0$, hence we conclude $\frac{d}{dS_0}[\frac{S_0 \cdot \Phi(\alpha_1)}{\Phi(\alpha_2)}] > 0$. Since $S_{0h} \geq S_{0l}$, we then have $E(S_h \mid S_h \geq X) \geq E(S_l \mid S_l \geq X)$. ■

2

$$\frac{d\lambda(\alpha)}{d\alpha} = \frac{d}{d\alpha}[\frac{-\phi(\alpha)}{\Phi(\alpha)}] = \frac{[-\frac{d\phi(\alpha)}{d\alpha}]\cdot\Phi(\alpha) + \phi^2(\alpha)}{\Phi^2(\alpha)} = \frac{\alpha\cdot\phi(\alpha)}{\Phi(\alpha)} + \frac{\phi^2(\alpha)}{\Phi^2(\alpha)} = \lambda(\alpha)\cdot[\lambda(\alpha) - \alpha]$$

Combining Proposition B.1 and B.2, we have

Proposition B.3. *If random variables* S_h *and* S_l *follow the lognormal distributions with same volatility and different means (* $S_{0h} \geq S_{0l}$ *), then* $\frac{dG(X)}{dX} = \frac{d[\frac{C(S_{0h}, X)}{C(S_{0l}, X)}]}{dX} \geq 0$.

I.8 Appendix C

Proposition C.1. *If random variables* S *follow the lognormal distribution with volatility* σ *and mean* S_0 *, then the call option* $C(S_0, X) = \int_X^{+\infty} (S - X) \cdot dF(S \mid S_0)$ *, is monotonously increasing and convex in* S_0.

Proof. Using Black-Scholes, it is well established that $\frac{dC(S_0, X)}{dS_0} = \Phi(\alpha_1) \geq 0$, where $\alpha_1 = \frac{\ln(\frac{S_0}{X}) + \frac{\sigma^2 \cdot t}{2}}{\sigma \cdot \sqrt{t}}$ and $\Phi(\cdot)$ is the standardized cumulative normal distribution. $\frac{d^2 C(S_0, X)}{d^2 S_0} = \phi(\alpha_1) \cdot \frac{\frac{1}{X}}{\sigma\sqrt{t} \cdot (\frac{S_0}{X})} \geq 0$, where $\phi(\cdot)$ is standardized normal density function

■

. Greene (2000) (see p. 899) maintains $0 < \lambda(\alpha) \cdot [\lambda(\alpha) - \alpha] < 1$. It follows that $0 < \frac{d\lambda(\alpha)}{d\alpha} < 1$.

Note that the relationship $\frac{d\phi(\alpha)}{d\alpha} = -\alpha \cdot \phi(\alpha)$ is used in the proof.

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Chapter II Do UPREITs Suffer Tax-Timing Conflict of Interest and More? [1]

The major cause of management's breach of fiduciary duty is the misalignment of interest between management and shareholders. In the case of Umbrella Real Estate Investment Trusts (UPREITs), a frequently cited cause of the conflict of interest is tax timing. UPREITs' tax timing conflict arises if management's tax basis is lower than that of REIT shareholders. Management may be reluctant to sell the properties because of the negative personal tax implication that may result (Sagalyn, 1996). Furthermore, the UPREIT structure may suffer other unique conflict of interest problems. In this study, we conduct an investigation on these claims and tax-deferred property contribution in general. Our primary results are: it can be optimal to pay tax earlier rather than later (defer tax); and we provide evidence that the UPREIT share prices are discounted after controlling for various factors, which are consistent with the hypothesis that UPREITs suffer unique agency problems.

II.1 Background on UPREITS and Literature

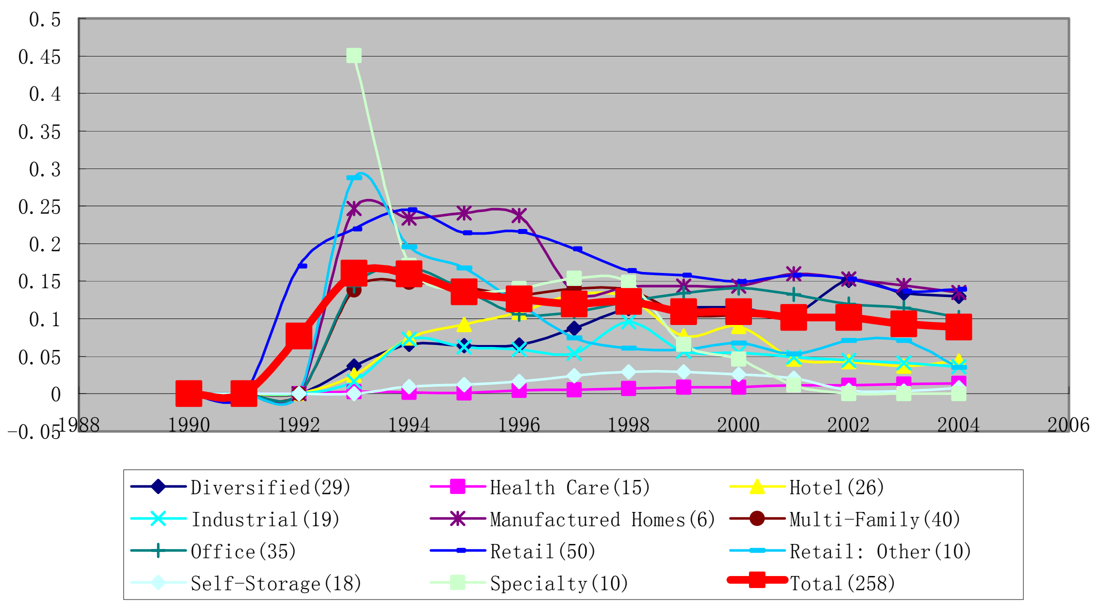
An UPREIT is a structure where a REIT owns substantially all of the assets of the REIT through an Operating Partnership (OP) composed of the REIT as general partner and the others as limited partners. Partnership interests in the OP are generally referred to as "OP Units." The two-tiered structure of UPREIT has been adopted to take advantage of the tax deferred property transactions of partnership. Unlike selling real properties directly to a REIT which is usually a taxable event, selling properties to OP in exchange for OP Units is generally not a taxable event as the transaction can be structured as admitting a new partner by OP.[2] This is true even if OP units are exchangeable one-for-

[1] An earlier version of this paper was circulated under the title "DO UPREITS Suffer Tax-Timing Conflict of Interest?" (with Abdullah Yavas). We thank the Real Estate Research Institute for funding. We also express our great appreciation to Jacqueline Hoppe and Green Street Advisor, Inc. for providing the NAV data for our study.

[2] Other forms of consideration such as cash, common stocks, or assumption of the seller's pre-contribution debt by the OP are taxable to the extent of such consideration in excess of the seller's adjusted tax basis in the contributed properties. For instance, when the contributed properties are encumbered by debts, the

one into common stocks of REIT after an initial lock-up period. For real estate that has been held for a long time, the tax-deductible depreciation together with appreciation in property value can generate very large built-in capital gains. Consequently, UPREIT structure provides a distinct tax advantage to the property sellers over non-UPREITs by allowing them to sell the properties tax-deferred. Figure II-1 shows that the use of OP units grew tremendously in 1992 and 1993 when the UPREIT structure was first introduced into the REIT industry.

Figure II-1: Percentage of REIT Common Equity Owned by Operating Partnership Interests By Segment



Source: The numbers in parenthesis are the numbers of REIT firms included in each group. OP interests are computed as OP unit market value /(OP unit market value + stock market value)

In principle, the sellers' tax liability can be deferred indefinitely as long as OP continues to hold the contributed properties and the original sellers don't convert OP units to other considerations such as cash (including debt reduction, which is deemed as cash distribution) or REIT common stocks. If any of these conditions are violated, the

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seller needs to make sure the reduction in his shares of liabilities as a result of the contribution of encumbered property (or property interest) to OP is not in excess of his adjusted tax basis in the property. Breach of this condition causes the excess of debt reduction over the adjusted tax basis to be taxable. IRS deems debt reduction as cash distribution (IRS Internal Revenue Code Section 752).

contributing partner (previous property seller) must pay previously deferred tax. In the meantime, OP receives a step-up in tax basis in the amount of deferred tax now payable by the contributing partner.[3, 4] Tax timing problems arise when the contributing partner also serves as REIT's management or board director who may have significant direct, or indirect, control over the Operating Partnership's decisions regarding property dispositions. Since selling the contributed property triggers a much larger share of capital gains tax for the contributing partner, the contributing partner is much less willing to sell properties than REIT common shareholders. This creates a conflict of interest because a given property disposition transaction, while being undesirable to the contributing partner, can be financially advantageous for REIT common shareholders.

In addition to tax-timing agency problem, the REITs may suffer other agency problems unique to the UPREIT structure. For example, Sagalyn (1996) points to the possibility that decisions regarding certain major transactions (such as mortgage refinancing) and rights of first refusal, first offer, or buy-sell provisions may be dependent upon the approval of contributing partners whose interests may not be aligned with REIT shareholders. The other possibilities may be that contributing partners serving as management act on their own interests and fail to enforce the terms of agreement underlying the acquisition of property portfolio from individual partnerships in which contributing partners either serve or control as general partners.[5] Above all, the legal and accounting complexity may, in addition to the agency problems mentioned, generate monitoring cost and this, when compounded with other conflicts of interest, may generate much more serious problems.

Given the above conflicts, one may ask whether some of these conflicts can be mitigated by better incentive contracting. Regarding the tax-timing agency problem, for example, it may be argued that this conflict can be avoided by letting contributing partners enter a lock-up agreement with UPREIT obligating OP not to sell the property

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[3] Although REITs do not pay tax at corporate level, the tax basis is still very important to REITs because shareholders pay individual taxes on dividends. With a higher tax basis, a larger fraction of the dividends can be classified as a tax-free return of capital.

[4] If it is a taxable transaction, properties are taken into REITs with a stepped-up basis and with UPREIT taking full depreciation on that new basis upfront.

[5] Examples include indemnification provisions and the remedy provision for breaches of representations and warranties.

for a specific number of years. OP is compensated for signing the agreement based on the length of the term, but the breach of the lockup agreement by OP to dispose property earlier calls for the OP to compensate the contributing partner for the loss due to accelerated tax. The contributing partner, on the other hand, expecting property prices to reflect on this, only defers their tax liability if their benefits from the tax deferral are larger than OP's loss from it. Since the contributing partner is now made even by the lockup agreement regardless of when the property is disposed, he can then act in the best interests of OP. Consequently, the tax-timing conflict between the two parties is internalized and the agency problem disappears.

The above argument, however, ignores the possibility that, in the UPREIT formation transaction such as IPO, the founding partner may strategically choose not to enter a lockup agreement if he believes he can influence the property deposition decisions later on. Given the complexity in determining whether there are conflicts of interest, in this study we turn to market for the answer, as an efficient market will price the relative severity of the conflict problem at the IPO and subsequently, through market-trading differentials.

General interests in real estate taxation and capital markets have led to a burgeoning literature focusing on REIT related tax matters. Sinai and Gyourko (2000) examine how the stock prices of REITs and UPREITs responded to the capital gain tax rate change caused by the introduction of the Taxpayer Relief Act of 1997. They provide evidence that the tax rate change was substantially capitalized into share prices. A recent work by Gentry, Kemsley, and Mayer (2003) also examines how shareholder-level dividend taxes are incorporated into share prices. Using accounting asset book value as a proxy for tax basis, their research finds strong evidence that REIT shareholders value the tax benefits of depreciation deductions. Finally, Gyourko and Sinai (1999) estimate the net tax benefits of REIT as a corporate format to be no more than 2%-5% of industry equity market capitalization. In addition, they find the total tax benefits of the REIT format can be double if tax exempt/deferred investment in REITs increases to 40%.

II.2 Illustration of the Tax Benefits

The benefits of the tax-deferred property contribution to partnerships as a way to dispose real estate are widely discussed in both the academic and the professional literature. What are not clear is how the market prices of the contributed properties reflect the tax effect and when the tax should be deferred rather than paid. To develop a better understanding of these issues, we first gauge the potential benefit that a tax-deferred property contribution (to a partnership) may have on both the buyer and the seller. Consider a commercial property sold for cash at MV, of which 100% is depreciable due to a ground lease. Suppose an investor/buyer expects to hold this property for its statutory depreciation period of 39-years[6] and sells it for at least what she paid for it.[7] Let the investor's marginal income tax rate to be τ and the depreciation recapture capital gains tax rate to be τ_r. The buyer's tax shield benefit from taking depreciation can be expressed as follows:

$$Tax \quad Shield = \sum_{n=1}^{39} \frac{(MV/39)\cdot\tau}{(1+r)^n} - \frac{MV\cdot\tau_r}{(1+r)^{39}}, \tag{1}$$

where r is the after-tax discount rate. In contrast, if the same property with zero tax basis is purchased in a tax-deferred contribution to OP, the buyer (OP) will not be able to take the tax-deductible depreciation until 5-12 years later when the lock-up agreement is expired. The buyer's net loss due to the delayed tax benefit (L_b) is given by:

$$L_b = \{1 - \frac{1}{(1+r)^k}\}\cdot Tax \quad Shield\ , \tag{2}$$

where k is the term of the lock-up agreement.

On the other hand, the seller's benefit from deferring the capital gains tax of the zero tax basis property is:

$$B_s = \{1 - \frac{1}{(1+r)^k}\}\cdot\{\tau_r \cdot P + \tau_g(MV - P)\}, \tag{3}$$

[6] Apartment properties are depreciated on a schedule of 27.5 years, instead of 39 years.
[7] The property may be sold at a later date for more than what the buyer has paid for it. However, it is not relevant for computing the PV of the depreciation tax shields.

where τ_g is the capital gains tax rate, and *P* is the seller's historical purchase price for the property. To simplify the analysis, we assume $\tau_r = \tau_g$, then Equation (3) becomes

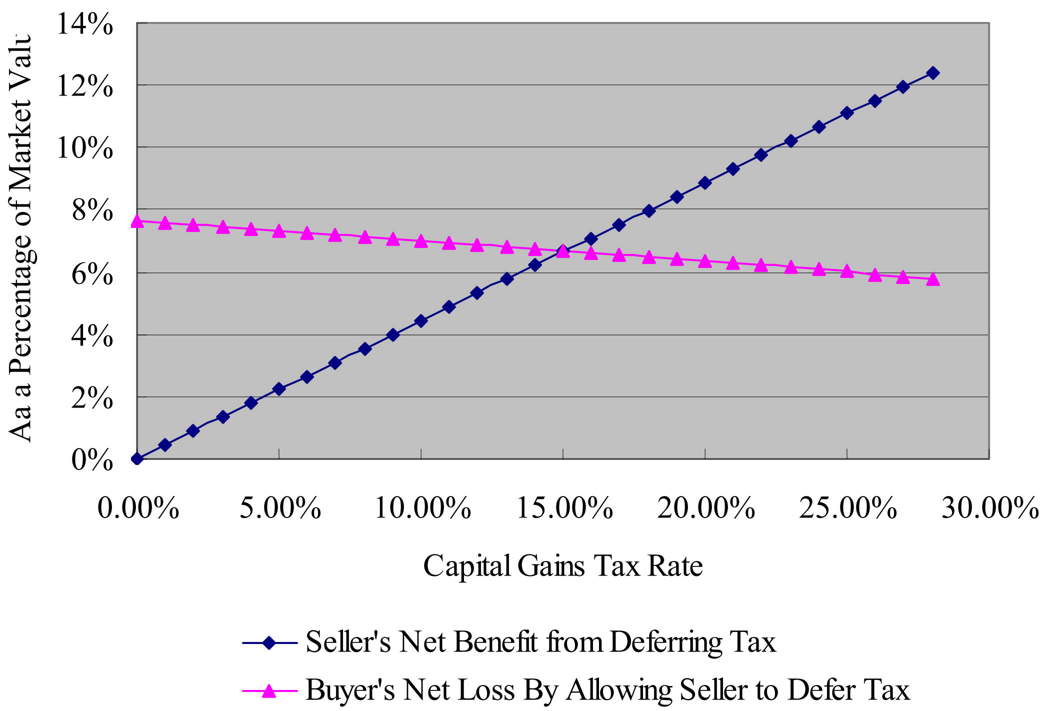
$$B_s = \{1 - \frac{1}{(1+r)^k}\} \cdot \tau_g \cdot MV \qquad (4)$$

An interesting case arises when the OP unit holder dies immediately after the tax-deferred property transaction. Tax law allows the property to receive an automatic step-up in the tax basis. This is equivalent to setting $k = \infty$ for the seller and setting $k = 0$ for the buyer. In this case, the seller's tax benefit is maximized to $\tau_g \cdot MV$, while the buyer's tax loss is reduced to zero. As such the upper bound of price discount is $\tau_g = 28\%$ for the pre-1997 period or some combination of $\tau_r = 25\%$ and $\tau_g = 20\%$ depending on the composition of taxable gains for the post-1997 period.

It is interesting to point out that it is not always better to defer the capital gains tax. When the capital gains tax rate is lower relative to the individual's income tax rate, it becomes attractive to realize the tax gains immediately so that the buyer can take depreciation at the higher tax rate. To see the above analysis in an example, Assume the property is 100% depreciable, $\tau = 39.6\%$, $r = 5.5\%$, and $k = 12$ years, and let $\tau_r = \tau_g$ to vary from 0% to 28%. We can obtain how L_b/MV and D_s/MV change with respect to $\tau_r = \tau_g$. In Figure II-2, we illustrate that when the capital gains tax rate falls to 15%, it is no longer optimal to defer the capital gains tax through property contribution to a partnership. This is consistent with the observations in Figure II-1, which shows that the percentage of REIT common equity owned by OP Interests falls as capital gains tax rate is reduced from 28% to 20% and then to 15%.

Depending on the relative bargaining power of the buyer and the seller, the transaction price in a tax-deferred property contribution will have a price discount that splits the total gains of $(B_s - L_b)$ between the buyer and the seller. In Figure II-2, for $\tau_r = \tau_g = 20\%$, B_S/MV is 9.5% and L_B/MV is 6.5%; while for $\tau_r = \tau_g = 28\%$, B_S/MV is 13.3% and L_B/MV is 6.0%. So it is reasonable to expect the price discount in a tax-deferred property contribution to be in the range of 6.5% to 13.3%. These numbers assume property is 100% depreciable. If land accounts for 25% of the property value, then observed price discount should be in the range of 4.9% to 10%. If the contributed property still has some depreciable tax basis instead of zero, we expect the observed price discount to be even lower than 4.9% to 10%.

Figure II-2: Benefit of Tax-Deferred Contribution of Property vs. Capital Gains Tax Rate



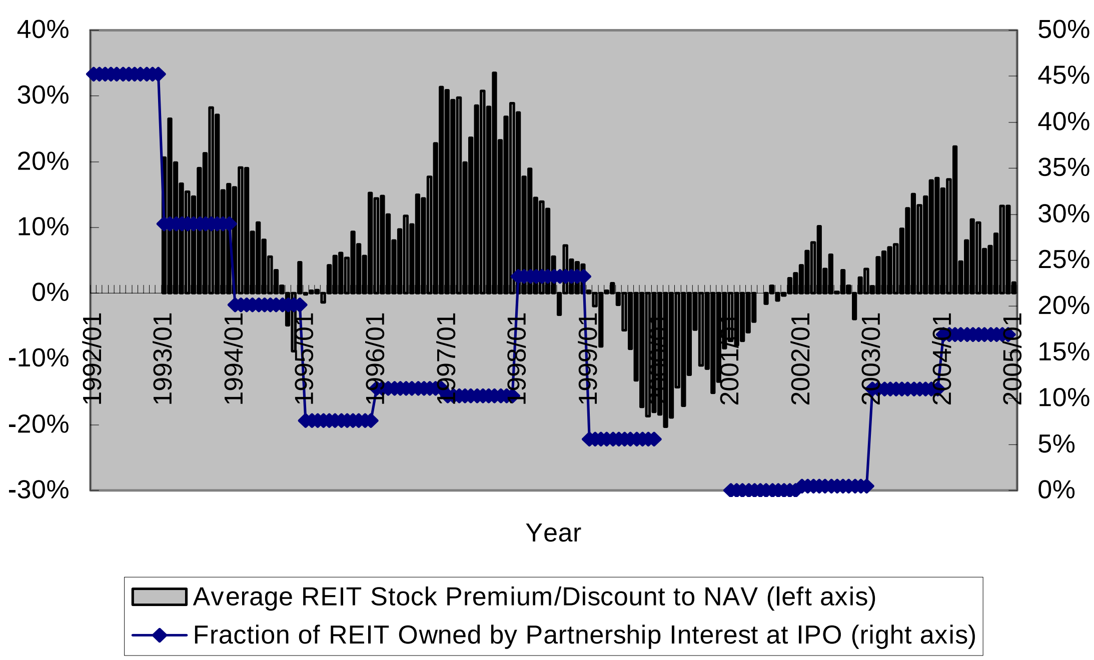
It shall be noted that the price discount discussed in the above applies only to individual property transactions. The UPREIT share price discounts due to lower tax basis are likely to be smaller since UPREIT may also acquire properties in taxable transactions.

II.3 Measuring Tax Basis

Measuring the tax basis in REIT is important as it allows us to isolate the price discount due to UPREIT agency problems from that caused by lower tax basis. Unlike accounting information, however, the firm's tax information is not publicly available. In practice, the investors have to infer the tax basis using other sources of information. In the next, we discuss three proxies for the tax basis that the market may use. Measurement errors in the tax basis caused by using proxies should not be a problem as long as the market can only use these three proxies to infer the tax basis.

The first tax basis proxy is the book value in financial statements. Gentry, Kemsley, & Mayer (2003) use this approach and they find, conditional on NAVs, the share price is a positive function of the book value. The proxy, however, may not work as well in the UPREIT case because the tax basis of the contributed property typically stays far below its fair market value at the time of transaction.

Figure II-3: The Portion of OP Units Market Value in REIT IPO Year vs. Green Street NAV Premium / Discount Estimates



Alternatively, we can use the percentage of the firm owned by the OP partnership interest (*OP Ratio*) to measure the tax basis. Because OP units are used to defer taxes, high partnership ownership ratio is an indicator of a low tax basis. Figure II-3 shows that the fraction of REIT owned by partnership interests in IPOs is positively linked to price premium/discount in the REIT stock market. As an extra piece of evidence, capital gains tax rate was reduced from 28% to 20% in 1997 as per the Taxpayer Relief Act.

Consistent with this tax rate reduction, Figure II-3 shows a corresponding breakdown of pattern in 1997 and a downward shift of OP unit usage after 1997.

Using the variable *OP Ratio* to measure the tax basis, however, has three shortcomings. First, the number of OP units outstanding for a REIT tends to stay where it was at the time of the IPO. In years subsequent to the IPO, the *OP Ratio* changes very little. Comparing Figure II-3 to Figure II-1, it is clear that the *OP Ratio* moves far more sluggishly in years subsequent to the IPO. This creates an estimation problem in the fixed effects estimation, as *OP Ratio* may not have enough within-firm variations. Second, UPREIT can receive step-up in tax basis if tax-deferred properties are disposed. This increases UPREIT's tax basis without decreasing the number of outstanding OP units. So the relationship between the use of OP units and tax basis may be weaker in the years subsequent to IPOs. Finally, the Internal Revenue Code Sec. 704 (c) requires, to the extent possible (subject to the ceiling rule), the non-contributing partners be put in the same position they would have been in had the property had tax bas is equal to fair market value. This can be achieved, for example, by allocating the contributing partners' share of depreciation to non-contributing partners even if the total tax basis is smaller. If the curative allocation method is used,[8] UPREIT shareholders might be allocated just as much depreciation as in a taxable transaction. If this is the case, UPREIT share prices may not discount at all even if the *OP Ratio* is high. Frequently, the other two allocation methods are used and the amount of depreciation allocated to noncontributing partners may be less than that in a taxable transaction. UPREIT share prices can still be discounted. On average, we should expect the hypothesized price effect to be weaker due to the adoption of IRC Sec. 704 c) requirements.

Our third tax basis proxy is the percentage of dividends that are classifies as tax-free return of capital. This information is available on the IRS Form 1099-DIV that

[8] There are in general three depreciation allocation methods under Treasury Reg. Section 1.704-3: 1) the traditional method, 2) the remedial allocation method, 3) the traditional method with curative allocations. Among the three methods, the traditional method and curative allocation method are, respectively, the least and the most favorable depreciation methods to the non-contributing partners. For more details, see Rubin and Whiteway (2004) and Manolakas and Anderson (1990).

summarizes dividends.[9] Given the REIT's pre-tax income[10], REITs that pay dividends with a high proportion of tax-free return of capital may be a sign of high tax basis. However, many other factors may also contribute to a high proportion of dividends being tax-free return of capital. Among them, tax-deductible interest payment, tax credit, tax deduction due to exercising employee stock options, and low earning quality.

In our investigation, we will use all three measures as tax basis controlling variables.

II.4 Empirical Specifications and Analysis

To investigate whether UPREIT suffers unique agency problems, we regress the market value of equity on the market value of assets, UPREIT dummy, three measures of tax basis and other controlling variables. If UPREIT suffers unique agency problems, we shall expect the sign of the coefficient for the UPREIT dummy to be negative. The basic model used here is developed in Gentry, Kemsley, and Mayer (2003). We begin by assuming the market value of equity (MVE) equals the market value of assets (MVA) less the market value of debt (D) as follows:

$$MVE = MVA - D. \tag{1}$$

MVA reflects property appraisals that represent the fair market values of comparable properties that outside investors would be willing to pay for with full tax basis at MVA. In contrast to outsider investors, REITs shareholders don't have full tax basis in their properties for three reasons. First, they have exhausted some of the depreciation tax deductions from the properties; Second, property values may have changed since their purchase; Third, tax-deferred property contributions give REITs a small tax basis to begin with. Given that MVA reflects the market value of assets for outside investors, the after-tax value of the assets to REIT shareholders (MVE) should be reduced by the present value of the incremental tax burden and a discount associated specifically with being an UPREIT. Therefore, equation (1) can be rewritten as:

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[9] The form 1099-DIV information on each REIT is provided by the National Association of Real Estate Investment Trusts (NAREIT) on its website. Additionally, SNL also collects information on tax-free return of capital.

[10] Real estate appraisals use the net operating income (NOI) that is before income tax, financing, and depreciation.

$$MVE = MVA - D - \tau \cdot (MVA - TB) - UPREIT\ , \tag{2}$$

where τ is the capitalized effective tax rate for the marginal investor, and *TB* is REIT's tax basis in the assets.

Because REIT research analysts typically focus on the market value of net assets (NAV) rather than the market value of gross assets (MVA), we substitute MVA with NAV+D in equation (2), and this results in:

$$MVE = (1 - \tau) \cdot NAV + \tau \cdot (TB - D) - UPREIT\ . \tag{3}$$

If we use book value of total assets (*BVA*) as a proxy for *TB* and note that the book value of common shareholder's equity (*BVCE*) equals *BVA - D,* then we have:

$$MVE = (1 - \tau) \cdot NAV - UPREIT + \tau \cdot BVCE\ . \tag{4}$$

Given the valuation model above, we translate equation (4) into the following empirical equation:

$$\begin{aligned} MVE_{it} = \alpha_0 + \alpha_1 \cdot NAV_{it} + \alpha_2 \cdot UPREIT_{it} + \alpha_3 \cdot BVCE_{it} + \alpha_4 \cdot OP\_Ratio_{it} \\ + \alpha_5 \cdot \mathrm{Re}turn\_of\_Capital_{it} - \sum_j \alpha_j \cdot X_{jit} + \phi_i + \omega_t + \mu_{it}\ , \end{aligned} \tag{5}$$

where i and t refer to firms and time periods, respectively. *UPREIT* equals one if a REIT has a positive number of OP units outstanding for a specific time period; zero otherwise. X_{jit} is the jth other controlling variable, ϕ_i is the firm fixed effect, and ω_t is the time fixed effect.

If an UPREIT suffers unique agency problems, then we would expect α_2 to be negative after controlling for other factors. Since UPREITs tend to have a small tax basis, which can cause lower UPREIT share price alone, it is important to control for tax basis. *BVCE*, *OP Ratio*, and *Return of Capital* are three controlling variables measuring tax basis. The variable *OP Ratio*, defined as the number of OP units outstanding as a percentage of the total number of OP units plus common shares outstanding. The variable *Return of Capital* is the fraction of dividends that are tax-free return of capital as a percentage of the total dividends.

Because OP units are convertible one-to-one to shares of common stocks and REITs use both shares and OP units to finance asset side of balance sheet, we measure *MVE* as common share price times the number of common shares outstanding plus the number of OP units outstanding. Similarly, in measuring NAV, we multiply the NAV per share estimates from Green Street by the number of common shares outstanding plus the number of OP units outstanding. Additionally, to be consistent with the definition of *MVE* and NAV, *BVCE* includes not only book value of common share equity but also book value of OP units (recorded as OP minority interests in financial statements).

Estimating equation (4) can be sensitive to the omitted variable problem, the classic measurement error, and the specification problem. We, however, take four measures to mitigate and control it. First, we add more control variables to mitigate omitted variable problem (X_{jit}). For example, REIT with a higher general administration expense (GAE) may sell at a discount relative to a firm with lower GAE. So, we add control variable *Expense Ratio.* We also include the variable *Debt Leverage*, defined as the book value of total debt as a percentage of *MVCE*,[11] and real estate asset as a percentage of total assets (*RE Ratio*) for each firm-year observation. Additionally, stock valuation can change year over year and factors that drive it can be difficult to determine. For this reason, we add year dummies as control variables.

Second, some firm-specific effects may be unobservable but are fixed over time (ϕ_i). If these unobservable effects are correlated with other explanatory variables, random effects estimation can be biased. To avoid the problem, we take first differences to get rid of the fixed effects and then run the regression based on the first differenced data.

Third, the first difference estimator can also be biased if the regressors are correlated with the idiosyncratic error. This is why the first difference requires the strict exogeneity assumption on the explanatory variables. If our primary control variable NAV is correlated to idiosyncratic error due to either measurement error or unobservable time-varying effects, then our result can be biased. To control for the potential endogeneity problem, we run a 2-stage least square regression (i.e., instrumental variable estimation) to clean up the potential endogeneity. The instrumental variables are selected from lagged regressors (first-differenced) with year dummies. We also conduct an endogeneity test to examine if the endogeneity problem is severe.

[11] Total debt also includes the redemption value of preferred equity as they are debt-like from common shareholders' perspective.

Finally, adjusting variables for accumulative inflation is important, as the relationship may not be stable between dollar-dominated variable (e.g., *MVE*) and dummy variables (e.g., *UPREIT*) or ratio type variables (e.g., *Debt Ratio*) over time. Rather than adjusting data by the deflation factors, we log-transform the variables. By doing the log transformation, we not only adjust the accumulative inflation, but also allow the estimated coefficient to vary by year without the need to interact that variable with the year dummy. To see this, let CPI_{06} and γ_{06} denote, respectively, the deflation factor and the stock market premium in the year t. Then

$$\log\left(\frac{(1+\gamma_t)\cdot NAV_{it}}{CPI_t}\right) = \log NAV_{it} + \{\log(1+\gamma_t) - \log(CPI_t)\}.$$

While NAV_{it} differs across firms, $\{\log(1+\gamma_t) - \log(CPI_t)\}$ does not. Therefore, $\{\log(1+\gamma_t) - \log(CPI_t)\}$ will be absorbed into the intercept for the year *t* and can be estimated with the intercept for the year t.

II.5 Data and Sample Selection

The data used in this study covers the period from 1990-2004. The data came from three sources--SNL Financial, CRSP, and Green Street Advisor. The SNL Financial provides the company-level accounting data and the split-adjusted number of common shares and OP units outstanding for each REIT covered. We obtain information on common stock splits and prices from CRSP. The NAV estimates[12] came from Green Street Advisor, which is well known for the carefulness and accuracy of its NAV estimates in the REIT industry. For example, in deriving NAV estimates, Green Street marks debt to market value, adjusts partial year of operations, includes pro rata share of income/loss and assets/liabilities from joint ventures, and considers the impact of dividends and inflation on the growth rate and cap rate.

[12] Green Street NAV estimates measure the market value of net assets held by REIT on a per share basis unadjusted for subsequent stock splits. This is why we need to get the historical stock split information.

Data from all three sources are merged into a company-level panel data set.[13] We use the year-end stock prices to calculate the REIT market values. Correspondingly, we use the December NAV estimates to calculate real estate value in the private market. The annual accounting data are typically reported on March next year. However, in any case, this lack of timely accounting information might not be as severe a problem because information in the annual report might be released to investors earlier through alternative channels such as corporate news, conference, and the quarterly reports. Additionally, we exclude observations with missing data, with negative earnings, or with the debt leverage extremely high at 20 or above.[14] The final merged data consists of 733 REIT-year observations from 98 different REITs. The average time a REIT stays in our sample is about 7.5 years.

Table II-1: List of Variables

This table reports summary statistics for the sample used in the analysis. The sample involves 737 observations. Dollar figures are in thousands. The variable MVE is the market value of common equity (including the value of OP units in UPREITS). *NAV* is the net market value of assets. *BVCE* is the sum of the book values of common equity and OP minority interests, which is a proxy for tax basis in assets. *UPREIT* is a dummy variable that equal to 1 if the REIT has a positive number of OP units outstanding for a given year. A straight REIT might convert to UPREIT structure during the time period we model. *OP Ratio* is the number of OP units outstanding divided by the sum of the number of OP units outstanding and the number of common shares outstanding. This variable measures the fraction of the REIT that is owned by OP minority interests, and is a proxy for tax basis unique to UPREITs. *Return of Capital* measures the percent of common dividends that are voluntarily tax-free return of capital. *RCR Dummy* equals to one if *Return of Capital* has missing value. *Debt Leverage* is the book value of total debt divided by *BVCE*. *RE Ratio* is the percentage of the total assets that are real estate. *Expense Ratio* is general administration expense as a percentage of total assets. All year dummies are for each specific year.

	N	MEAN	MIN	MAX	STD
MVE	737	1,599,803	31,811	18,188,431	1,999,722
NAV	737	1,490,638	40,324	15,749,995	1,812,538
UPREIT	737	0.70	0	1	0.46
BVCE	737	860,937	25,473	11,868,276	1,225,675
OP Ratio	737	0.11	0	0.65	0.13
Return of Capital	737	0.17	0	1	0.22
Dummy-Missing Value in Return of Capital	737	0.17	0	1	0.38

[13] CRSP, Green Street, and SNL do not use the same firm identifier. To match datasets, we search CUSIP numbers for each firm covered by Green Street and SNL, and then match them with CRSP data using CUSIP number.

[14] Debt leverage is the book value of total debt divided by of the book value of common equity and OP interests. The total debt includes preferred stocks because they are debt-like from shareholders' perspective.

Debt Leverage	737	2.14	0.01	19.57	2.25
RE Ratio	737	0.94	0.51	0.99	0.05
Expense Ratio	737	0.01	0.00	0.19	0.01
Yr90	737	0.03	0	1	0.16
Yr91	737	0.03	0	1	0.17
Yr92	737	0.03	0	1	0.17
Yr93	737	0.05	0	1	0.21
Yr94	737	0.06	0	1	0.24
Yr95	737	0.08	0	1	0.27
Yr96	737	0.08	0	1	0.28
Yr97	737	0.08	0	1	0.28
Yr98	737	0.08	0	1	0.28
Yr99	737	0.08	0	1	0.27
Yr00	737	0.08	0	1	0.27
Yr01	737	0.08	0	1	0.28
yr02	737	0.08	0	1	0.27
yr03	737	0.08	0	1	0.27
yr04	737	0.07	0	1	0.26

The summary statistics of variables are provided in Table II-1. On average, the stock market value of equity interests is 1.86 times of its book value and 1.07 times of the market value of net assets (NAV). The list of REITs in the final sample is provided in the Appendix.

II.6 Empirical Results

In Table II-2, we report results from estimating the equation (5) using the first difference estimation and then the first-difference estimation with IV correction for NAV (to guard against the potential endogeniety problem.) We can see the results in two estimations are similar. The major difference is that the coefficient on NAV estimated using IV is statistically less significant than if without IV correction. This is expected as instrumental variables tend to have larger variance. We also did an endogeneity test as suggested by Wooldridge (2006) by including residuals from the 1st stage in 2nd stage regression. The coefficient is not statistically significant, which indicating the endogeniety caused by NAV is minor.

Based on the IV model, the estimated UPREIT coefficient is negative and statistically significant at 90% confidence level, which is consistent with the hypothesis that REIT investors capitalize unique UPREIT agency problems into share prices. The coefficient of –0.055 means UPREIT structure reduces the share price by 5.5%. Our findings of negative coefficient on the variable *UPREIT* is the opposite of what is reported in Gentry, Kemsley, and Mayer (2003). The resulting difference could be due to the fact that the *UPREIT* variable used in Gentry et al's study reflects only the most recent status of a REIT and thus it is time-invariant.[15] Many REIT studies follow this treatment when the research focus is on something else but need to use the UPREIT status as a control variable, which is indeed the case in Gentry, Kemsley, and Mayer (2003). The variable UPREIT in our study, however, is time-variant because a straight REIT may convert to an UPREIT over time. This allows us to test the coefficient on UPREIT using more convincing first difference estimation, which is particularly important, as the the firm-specific effect can significantly bias the result. Additionally, we draw some comfort in this result from using a larger sample covering more time periods, using more flexible specifications in dealing with inflation and allowing coefficients to vary by year. The average number of years a REIT stays in our sample is 7.5 years vs. 4.6 years in their study (the overall time span: 15 years in our study vs. 8 years in Gentry et al).

The coefficient on the variable *Log (BVCE),* our first variable measuring tax basis, is positive and statistically significant at 99% confidence level. The estimated coefficient of 0.077 in the fixed effects means the price elasticity of *BVCE* is a positive 7.7%. For example, if a REIT has the fair market value of $1 billion and the tax basis of $500 millions, then an increase in the tax basis to the fair market value will approximately increase REIT share price by 7.7%.

Table II-2: Regressions Measuring the Effect of UPREIT

The table reports the results from first difference estimation (FD) and FD estimation with IV correction. The first-stage estimation is not reported here, but can be provided upon the request. All variables are first differenced. The dependent variable is log (*MVE*), where MVE is the market value of common equity (including the value of OP units in UPREITS). The symbol *** denotes estimated coefficients that are statistically different from zero at the 99% confidence level; ** denotes estimated coefficients that are statistically different from zero at 95% confidence level; and * denotes estimated coefficients that are statistically different from zero at 90% confidence level. All regressions include the year effects, although they are not reported. *NAV* is the net market value of assets. *BVCE* is the sum of the book values of common equity and OP minority interests, which is a proxy for tax basis in assets. *UPREIT* is a dummy variable that equals 1 if the REIT has a positive number of OP units outstanding for a given year; 0

[15] We infer this because Gentry et al reports coefficient on UPREIT only for OLS and the random effects estimation, but not for the fixed effects estimation.

otherwise. A straight REIT may convert to the UPREIT structure during the time period we model. *OP Ratio* is the number of OP units outstanding divided by of the sum of the number of OP units outstanding and the number of common shares outstanding. This variable measures the fraction of the REIT that is owned by OP minority interests, and is a proxy for tax basis unique to UPREITs. *Return of Capital* is the percent of common dividends that are tax-free return of capital. *RCR Dummy* equals to one if *Return of Capital* has missing value. *Debt Leverage* is the book value of total debt divided by *BVCE*. *RE Ratio* is the percentage of the total assets that are real estate. *Expense Ratio* is general administration expense as a percentage of total assets. The R-squared is defined as the correlation squared between the predicted and actual values of the dependent variable, accounting for the reported variables, the year effects, but not the random or fixed effects.

	First Difference (FD)	FD with IV Corrections
	Coefficient	Coefficient
Intercept	0.236***	0.244***
Log (NAV)	0.855***	0.937**
UPREIT	-0.043**	-0.055**
Log (BVCE)	0.086***	0.077***
OP Ratio	0.021	0.059
Return of Capital	-0.058***	-0.081**
RCR Dummy	-0.013	0.008
Debt Leverage	0.002***	0.003***
RE Ratio	0.068	0.045
Expense Ratio	0.126	0.113
Residual from 1st stage		0.015

The coefficient on the variable *OP Ratio*, our second variable measuring tax basis, is not significant. This is not unexpected given the shortcomings we discussed earlier in the paper.

Finally, the coefficient on the variable *Return of Capital*, our third variable measuring tax basis, is negative and statistically significant at the 90% confidence level. The negative coefficient is not expected if we believe that high tax-free return of capital signals high tax basis and low taxable income. The estimated coefficient of –0.081 suggests that for every 10 percentage points increase (e.g., from 20% to 30%) in *Return of Capital*, share price decreases by 0.81%.

Taking together, we find that, after controlling for various variables, the negative sign on the coefficient of UPREIT remains.

II.7 Summary

In this study, we investigate the agency problems in Umbrella Real Estate Investment Trusts (UPREITs), particularly those caused by the conflict of interest in tax timing. UPREITs' tax timing conflict arises if management's tax basis is lower than that of REIT shareholders. Management may be reluctant to sell the properties because of the negative personal tax implication that may result.

To investigate the problem, we first show that UPREIT share price should be discounted even without agency problems (due to lower tax basis). We then design tests to examine whether UPREITs still suffer price discounts in stock market after controlling for tax basis and other factors. Controlling for tax basis and other factors, we find that the *UPREIT* share prices on average are discounted by 5.5% relative to a straight REIT. The result is both economically and statistically significant. This finding is consistent with the hypothesis that UPREITs suffer unique agency problems.

Additionally, we also show that it can be optimal to pay capital gains tax earlier rather than later (defer tax) in real estate transactions. This finding is in contrast to conventional wisdom. Although accelerating tax has the shortcoming of increasing the present value of tax liability, it can be more than offset by the increase in buyer's tax shield. This result is driven by the fact that the income tax rate is much higher than the long-term capital gain tax rate. If the buyer's gain is more than the seller's loss, then the seller should consider selling the property not tax-deferred.

II.8 Appendix: List of REITs in the Sample

Table II-3: List of REITs in the Sample

	Company Name	Ticker	Years
1	Associated Estates Realty Corporation	AEC	11
2	Apartment Investment and Management Company	AIV	5
3	AMB Property Corporation	AMB	8
4	AMLI Residential Properties Trust	AML	11
5	Arden Realty Inc.	ARI	9
6	Archstone-Smith Trust	ASN	15
7	AvalonBay Communities Inc.	AVB	11
8	Avalon Properties, Inc.	AVN	5
9	Beacon Properties Corporation	BCN	3
10	Burnham Pacific Properties, Inc.	BPP	6
11	BRE Properties, Inc.	BRE	15
12	Berkshire Realty Company, Inc.	BRI	3
13	Boston Properties, Inc.	BXP	8
14	CBL & Associates Properties, Inc.	CBL	12
15	Crescent Real Estate Equities Company	CEI	7
16	Mack-Cali Realty Corporation	CLI	7
17	Colonial Properties Trust	CLP	12
18	CenterPoint Properties Trust	CNT	4
19	Copley Properties, Inc.	COP	2
20	Chelsea Property Group, Inc.	CPG	9
21	Chateau Communities, Inc.	CPJ	9
22	Cornerstone Properties, Inc.	CPP	3
23	Camden Property Trust	CPT	12
24	CarrAmerica Realty Corporation	CRE	12
25	CRT Properties, Inc.	CRO	2
26	Cousins Properties Incorporated	CUZ	13
27	Crown American Realty Trust	CWN	6
28	Developers Diversified Realty Corporation	DDR	9
29	Duke Realty Corporation	DRE	10
30	Equity Lifestyle Properties, Inc.	ELS	10
31	Equity Office Properties Trust	EOP	8
32	Equity Residential	EQR	12
33	Extended Stay America, Inc.	ESA	2
34	Essex Property Trust, Inc.	ESS	2
35	Evans Withycombe Residential, Inc.	EWR	3
36	FelCor Lodging Trust Incorporated	FCH	6
37	Federal Realty Investment Trust	FRT	15
38	First Union Real Estate Equity and Mortgage Invts.	FUR	3
39	Gables Residential Trust	GBP	11
40	General Growth Properties, Inc.	GGP	11
41	Horizon Group, Inc.	HGI	2
42	Highwoods Properties, Inc.	HIW	9

43	Host Marriott Corporation	HMT	7
44	Heritage Property Investment Trust, Inc.	HTG	3
45	Irvine Apartment Communities, Inc.	IAC	5
46	IRT Property Company	IRT	13
47	JP Realty, Inc.	JPR	8
48	Kimco Realty Corporation	KIM	14
49	Kilroy Realty Corporation	KRC	8
50	Kranzco Realty Trust	KRT	5
51	Liberty Property Trust	LRY	11
52	Macerich Company	MAC	10
53	Mid-America Realty Investments, Inc.	MDI	3
54	MGI Properties	MGI	3
55	MeriStar Hospitality Corporation	MHX	5
56	Mills Corporation	MLS	11
57	Maguire Properties, Inc.	MPG	2
58	Merry Land & Investment Company, Inc.	MRY	6
59	New Plan Excel Realty Trust, Inc.	NXL	9
60	Oasis Residential, Inc.	OAS	5
61	Paragon Group, Inc.	PAO	3
62	Property Capital Trust	PCT	2
63	Pennsylvania Real Estate Investment Trust	PEI	6
64	ProLogis	PLD	10
65	Pan Pacific Retail Properties, Inc.	PNP	4
66	Prentiss Properties Trust	PP	9
67	Post Properties, Inc.	PPS	12
68	Public Storage, Inc.	PSA	9
69	Reckson Associates Realty Corporation	RA	10
70	Rockefeller Center Properties, Inc.	RCP	3
71	Real Estate Investment Trust of California	RCT	4
72	Regency Centers Corporation	REG	9
73	Rouse Company	RSE	7
74	Santa Anita Realty Enterprises, Inc.	SAR	3
75	Security Capital Atlantic Incorporated	SCA	2
76	Shurgard Storage Centers, Inc.	SHU	10
77	Sizeler Property Investors, Inc.	SIZ	3
78	Tanger Factory Outlet Centers, Inc.	SKT	11
79	Summit Properties Inc.	SMT	10
80	Simon Property Group, Inc.	SPG	5
81	Spieker Properties, Inc.	SPK	8
82	Charles E. Smith Residential Realty, Inc.	SRW	4
83	Sovran Self Storage, Inc.	SSS	7
84	Sun Communities, Inc.	SUI	8
85	Storage USA, Inc.	SUS	7
86	South West Property Trust, Inc.	SWP	3
87	Taubman Centers, Inc.	TCO	12
88	Town and Country Trust	TCT	9
89	Trizec Properties, Inc.	TRZ	3

90	TrizecHahn Corporation	TZH	4
91	United Dominion Realty Trust, Inc.	UDR	15
92	Urban Shopping Centers, Inc.	URB	7
93	Vornado Realty Trust	VNO	11
94	Western Properties Trust	WIR	6
95	Weeks Corporation	WKS	5
96	Washington Real Estate Investment Trust	WRE	15
97	Weingarten Realty Investors	WRI	15
98	Wellsford Residential Property Trust	WRP	5

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Chapter III Do REITs Arbitrage In One Direction Only? REIT Property Selling Decisions

III.1 Introduction

There is no question that the tremendous growth in REITs during the last 10 years has generated a great deal of interest in studying this important investment vehicle. Although many aspects of REITs have been investigated, so far less knowledge has been gained on how REITs make their property disposition decisions. An investigation of this matter is important for two reasons. First, several recent REIT studies (e.g., Hartzell et al, 2005 and Buttimer et al, 2005), found that when securitized real estate in the stock market held price premiums over the underlying real asset market, the market participants were quick to exploit the price difference. During such "hot" time periods, the number of REIT initial public offerings (IPO) and seasoned equity offerings (SEO) increased significantly. In REIT IPOs, the private property owners assemble property portfolios in the physical real estate market at cheaper prices and then sell the portfolios on the stock market to take advantage of the price premium. Similarly, in a SEO, publicly traded REITs raise additional capital from the stock market at a premium price and then use proceeds to acquire more properties in the cheaper physical real estate market. Gentry & Mayer (2002), however, found that REITs respond differently to price premium and discounts. Specifically, they found that when securitized real estate held price premium over physical real estate, REITs increase their real estate investments aggressively. However, when a price discount exists, REITs don't disinvest. This is puzzling as it suggests that market participants such as REITs exploit the price gap only in one direction. While Gentry and Mayer (2002) hypothesized that the inertia to disinvest may be caused by the high adjustment costs of real estate investment, they provide no empirical evidence for their hypothesis. In this paper, we study the puzzle from a different vantage point by directly linking REITs' property selling decisions to the price premium/discount. In doing so, we avoid potential measurement problems in Gentry & Mayer (2002) and are able to provide an explanation for this puzzle.

Second, from an investment perspective, it is also noteworthy to investigate the factors that might motivate REITs' property selling. For instance, properties might be sold to finance REIT dividends if profits from continuing operations are insufficient for maintaining the current level of dividends. If this is the case, the strategy of investing for high-dividends may backfire, as net property liquidation is not sustainable in the long term. To find out whether REITs finance high dividends by property selling, we need to gain a better understanding of REIT's selling decisions.

So far little research has been done on property's selling decisions. The only work we could found was conducted by Fisher et al (2004) on pension fund's property selling decisions. Their study, however, did not examine whether or not market participants arbitrage either in one or both directions. Furthermore, their work was constrained by the lack of corporate-level data on pension funds. Thus, important hypotheses regarding how corporate and ownership characteristics may impact property selling decisions are not tested in their study. For example, the hypotheses related to debt burden, management contract types, stock liquidity, and REIT financial conditions were not examined in Fisher et al (2004). Finally, REITs may or may not behave similar to public pensions. Selling properties has tax consequences for REIT shareholders.[1] However, the same is not true for pension holders.

By focusing on publicly traded REITs, this study benefits from publicly available accounting information and high quality market data. Our study provides strong evidence that REITs are responsive to the price gap between public and private markets *in both directions*. If the prices of securitized real estate are discounted relative to the underlying real asset, REITs will liquidate more properties to arbitrage the price difference. Furthermore, we identify a series of unique factors that are useful in predicting REITs' selling decisions. For example, the REITs' debt burden, liquidity position and management contract are found to be closely linked to REITs' property selling decisions. With these findings, this study therefore contributes to our understanding of REITs and their property's selling decisions.

[1] Although REITs are exempted from corporate income tax if they paid out 100% of the taxable income, dividends distributed by REITs are fully taxable to shareholders if dividends are of income, capital gain, or section 1250 gain nature.

The paper is organized as follows. In the next section we develop hypotheses, and in the third section, we present the empirical model. The data and empirical results are described in the next 2 sections. The final section offers some concluding remarks.

III.2 Hypotheses

REITs' property disposition decisions are potentially related to many factors. Classical investment theory by Tobin (1969) predicts that if the market value of an incremental project exceeds its replacement value, the firm will want to invest until the difference in values disappears. This is the well-known Tobin's q theory of investment where q is measured as the ratio of the market value to the replacement value. Applied to the REIT case, this implies that if the price of securitized real estate assets is higher than that of physical real estate assets, the REITs will expand investments by buying more properties at the real estate asset market (or the physical real estate market). Alternatively, if the price of securitized real estate assets is discounted (relative to that in the physical market), REITs will want to sell off properties in the physical real estate market and decrease the size of investments. The empirical testing of Tobin's q theory is very difficult due to measurement problems. Gentry and Mayer (2002), however, taking advantage of better quality data available in real estate, find strong support for this theory. They find that REITs increase their investments (measured as the change in the book value of either the total assets or real estate assets) when q ratio, the ratio of securitized property value in stock market to value in the real estate asset market, is greater than one. Interestingly, they also find REITs' response to q to be not symmetric in that when q is smaller than 1, REITs do not disinvest. They hypothesize that the asymmetric response to q could be caused by the high adjustment cost of real estate investments. We, however, conjecture that the problem may be due to how real estate investment is measured. Particularly, the investment in their study is proxied by the total assets reported in the REIT's balance sheets. Based on this definition, selling properties just convert one class of asset (real estate) into another (cash), but total assets reported on accounting books may not decrease due to real estate disinvestment.[2] The problem persists even if the investment is alternatively proxied by "*net investment in real estate*"[3]. This is because REITs may reinvest property sales proceeds in other real estate assets such as real estate loans, mortgage-based securities, real estate partnerships, and land, all of which are still part of "net investment in real estate".

Based on the analysis above, we propose to measure disinvestment by analyzing whether or not REITs sell off the individual property. So our first hypothesis is:

H1: *The selling probability of the individual property is negatively related to REIT's q.*

Our next hypothesis is motivated by the conclusion in Rady and Ortalo-Mange (2001), in which they indicate that financially constrained buyers affect the home selling frequency. It is possible that institutional investors may be similarly affected. Fisher et al (2004) test the selling decisions of pension real estate investors using the NCREIF portfolio of commercial properties. However, they do not have sufficient data to test if the selling decisions of pension investors are affected by their financial constraints[4]. Our 2nd hypothesis is as following:

H2: *Financially or liquidity constrained REITs will sell properties more frequently*.

Existing REIT studies have shown that externally managed REITs suffer significant agency problems. The external management makes money by charging their fees based on the size of assets under management. This creates distorted incentives for external managers to increase properties or at least not to sell properties even if it is in the principals' best interests (Capozza and Seguin, 2000). More and more REITs now manage their properties internally. Yet there are still REITs that continue to manage their properties externally. For this reason, we test the following hypothesis:

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[2] Total assets reported on accounting books are not likely to increase too much. It is true that real estate properties typically have large built-in capital gains. Once the properties are sold, the capital gains are recognized on the accounting books. Thus, one may believe that the total assets reported in the accounting books can increase. However, REITs are forced to pay out taxable gains to avoid corporate-level tax. The net effect of capital gains and dividends paid is that total assets reported probably will not increase (if the availability of tax credits, depreciation, and other tax deductions stays relatively constant).

[3] As defined in SNL DataSource used by Gentry and Mayer (2002).

[4] In the footnote 9 of Fisher et al (2004), the authors note that: "As described in the data section, we unfortunately do not have sufficient data to examine this possible effect."

H3: *Externally managed REITs sell properties less often*.

In 1992, a new REIT structure came into existence. Under the new structure, the REIT owns properties only through the operating partnership. This 2-tier structure allows the properties' sellers the advantage of selling properties tax-deferred, provided that the considerations received are operating partnership (OP) units. Based on the tax rules, the deferred tax can be further deferred until the properties are sold by a REIT-controlled operating partnership. This implies that tax-deferred properties are less likely to be sold. However, whether or not a particular property was acquired on a tax-deferred bass is not publicly known, we therefore use the percentage of the firm (REIT with the consolidated OP partnerships)[5] owned by OP unit-holders as a proxy. We expect that REITs with OP unit-holders owning a larger portion of the combined firm will have less incentive to sell. However, it shall be noted that the proxy used here can be a noisy one. This is because a majority of tax-deferred property transactions were made at the time of IPOs or REIT merger & acquisitions (M&A). Yet the final sample in this study excludes all such properties (reasons to be discussed later). So the validity of the predication is an empirical matter. With this in mind, our 4th hypothesis is stated as following:

H4: *The larger the portion of the combined company is owned by unit-holders, the less likely the REIT will sell the properties.*

Economies of scale studies suggest that REITs can create value by specializing (Capozza and Seguin, 1999) and increasing scale or size of operations (Ambrose, Highfield, and Linneman, 2005). This implies that if a property is of different type than the one REIT specializes in, the property will have a higher chance of being sold.

H5: *If an individual property is of a property type that is not the REIT's specialty, it is more likely to be sold.*

Additionally, Fisher et al (2004) have shown that the age of a building (encumbrance) can positively (negatively) impact the property selling decisions of

[5] Under the GAAP rule (SFAS 94), all entities in which the parent controls (directly or indirectly) more than 50% of the voting shares of the subsidiary must be consolidated in the financial statements reported by the parent. Since a vast majority of REITs with the UPREIT structure control more than 50% of the voting shares of their operating partnership subsidiaries, they all report the operating results on a consolidated basis.

pension investors. Given the possibility that REITs will behave similarly, we test the following two hypotheses:

H6: O*lder properties are more likely to be sold by REITs.*

H7: *If the property is mortgaged or jointly owned, it is less likely to be sold by REITs.*

Finally, property size, REIT size, and ground lease may play roles in the property selling decisions. While we do expect larger properties to have lower liquidity and thereby be more difficult to sell, we have no expectation on the impact of the REIT size and ground lease on property selling decisions. In the model, we use these factors to control for other effects.

III.3 Model

Similar to Fisher et al (2004), our empirical testing utilizes the Probit analysis. The probability of property selling is assumed to be a function of corporate and property characteristics after controlling for property type, region, and year. The model is expressed as:

$$Pr(Sale_{j,t})=f((REIT_{j,t}, PROPERTY_{j,t}, YEAR_{t}, TYPE_{j}, REGION_{j}), \qquad (1)$$

where Pr(Salej,t) represents the probability that property j will be sold in year t. $REIT_{j,t}$ denotes a set of variables describing REIT that owned the underlying property j in year t. $PROPERTY_{j,t}$ denotes a set of variables describing the property j in year t. $YEAR_t$, $TYPE_j$, and $REGION_j$ are all dummy variables.

Although not discussed in Fisher et al (2004), it is important to note that multiple observations (property-year) are created for each property. This creates the concern that those observations are not independent, thereby violating a basic assumption used to construct the likelihood function. Wooldridge (2002), however, suggests a simple testing procedure where the lagged errors are added as additional variable in the probit model. If the coefficient on the lagged error is insignificant, then all the usual statistics from Probit analysis are still valid.

III.4 Data

Following many REIT studies, we collect REIT corporate financial data from the SNL DataSource. Additionally, we obtain net asset value (NAV) estimates from Green Street Advisor Inc. We also obtain REIT property information from a separate database contained in the SNL DataSource. As pointed out by Reeder (2001), few existing studies take advantage of this unique property-level information. This is surprising as, unlike in the residential markets, the data on commercial real estate are generally difficult or at least expensive to get. For example, NCREIF is an excellent source of commercial real estate data. Yet public access to it is quite limited due to its proprietary nature. SNL DataSource subscribed by many Universities, on the other hand, collects a wealth of information on REIT properties from REITs' SEC public filings (such as 10-K, 10-Q, and other supplemental documents), particularly the Schedule III Table in 10-K. SNL Property information includes 74 cross-section variables providing the information on such items as most recent owner, most recent purchase & selling terms, property location, type, year built, tenants, etc. In addition, the property information has 37 time-series variables describing property rents, vacancy, size, cost and collateralization going back as far as 10 years. As of Q1 of 2005, SNL DataSource collected information on 44,389 commercial properties owned by REITs and real estate operating companies. Among them, approximately 14,682 of these properties were sold, and the remaining properties (29,705) consist of the existing REIT property portfolios. We estimated that the book value of the existing portfolio amounts to $468 billion.[6] This number is much larger than the NCREIF's appraised value of $145 billion (4100 properties) at 2005:1. The properties held by REITs consist primarily of four types: Office (21%), industrial (30%), multi-family (21%), and retail (28%). The weights of each property type held by REITs are similar to that NCREIF reported by Fisher et al. (2004) of 29%, 29%, 24%, and 18% respectively.

Although SNL provides a wealth of information on REIT properties, using SNL property data can be tricky. Two problems needed to be addressed here. First, whenever there is a REIT merger or acquisition (M&A), the SNL moves all acquiree's properties

[6] About 51% of properties in SNL DataSource have missing information on book values. To estimate the book value of REITs, we sum the available book values and then divide them by 51%.

(both those still owned at the time of the M&A and those that were sold before the M&A) and reports them under the acquirer's name. If a REIT makes multiple acquisitions, this creates our first problem - *the owner identification problem*, as we no long know who owned the properties before M&As.[7] The owner identification problem compounds, as the acquiree might previously acquire other REITs.

Second, for the properties that are still owned by acquirees at the time of M&A, there exists a second problem of how we compute the holding period. One approach is to calculate the holding period under the acquirer only. Alternatively, it can be argued that the holding period under the acquiree should also be included.[8] As both approaches have shortcomings, it is not clear which approach is better.

Since both problems are associated with the properties acquired in M&As, to simplify the matter, we exclude from the final sample all properties acquired through REIT M&As. As only around 4300 out of 44389 properties were acquired through mergers & acquisitions, we expect the impact would be limited.

Further, we also exclude from the final sample all properties acquired before IPOs because no corporate-level information is available before the IPO dates.

The SNL property-level information became available only in 1995. Since the property and corporate information from the prior year are used to predict the selling decision for a given year, the earliest selling decisions modeled are in 1996. Additionally, the property selling made during the year when REITs were de-listed (due to, for example, merger, going private, or liquidation transactions) are excluded to avoid any complications associated with the special events. Furthermore, we exclude healthcare, multi-use, and specialty properties as their number is small. Finally, the properties that were built by REITs (i.e., properties whose built date is later than the acquisition date) are also deleted because the REITs may be partially in construction and development business. Decisions to sell properties from inventory may be quite different from that of

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[7] For example, Equity Office properties Trust (EOP) first acquired two REITs: Corner Stone Properties Inc. (CPP) on 2/11/2000 and Spieker Properties Inc. (SPK) on 7/2/2001. If the property was sold before 2/11/2000, we cannot determine whether it was SPK or CPP that sold that property. This seller identification problem compounds since SPK and CPP might each conducted M&A themselves.

[8] This is because after mergers and acquisitions the acquiree shareholders frequently stay on in the new entity.

selling investment properties. With all the observations lost due to the reasons above and due to the fact that not all REITs report the property-level information, the size of our final sample consists of 37,948 property-years observed out of 8,189 unique properties owned by 125 public equity REITs. The numbers of sold and unsold properties for each year the sample covers are reported in Table III-1.

Summary statistics of dependent and independent variables are reported in Table III-2. The dependent variable (Sold) is a dummy variable that equals 1 if the property was sold in a specific year; 0 otherwise. On average 5.5% of the properties in the sample were sold each year over the study period of 1996-2004.

Table III-1: Summary Statistics: Sold and unsold properties listed by year, 1996-2004

Year	Total	Sold	Sold %	Unsold	Unsold %
1996	548	13	2.4%	535	97.6%
1997	1086	21	1.9%	1065	98.1%
1998	1910	58	3.0%	1852	97.0%
1999	4067	201	4.9%	3866	95.1%
2000	6116	395	6.5%	5721	93.5%
2001	6105	367	6.0%	5738	94.0%
2002	6175	350	5.7%	5825	94.3%
2003	6135	386	6.3%	5749	93.7%
2004	5806	303	5.2%	5503	94.8%
Total	37948	2094	5.5%	35854	94.5%

Table III-2: Summary statistics: Dependent and independent variables, 1996-2004

Sold equals 1 if the property is sold in year t; 0 otherwise. ***Asset_Prem*** denotes (1-leverage ratio)∗average of 12 monthly Green Street NAV premiums (or discount) in year t. ***Asset_Prem_Interaction*** denotes the interaction term between asset_prem_c and dummy variable, where the dummy variable equals one if *Asset_Prem* is smaller than zero; 0 otherwise. ***PE*** denotes common stock price at the end of the year t as a multiple of annualized diluted earnings per share after extraordinary items. For values greater than 70, SNL displays NM. ***PE_Interaction*** denotes the interaction term between *PE* and dummy variable, where the dummy variable equals one if *PE* is in the lowest quartile in a specific year; 0 otherwise. ***Debt_Coverage_Ratio*** denotes the recurring earnings before interest, taxes, depreciation and Amortization (EBITDA) as a multiple of interest expense in year t. ***Credit_Facilities_Utilization*** denotes the amounts drawn as a percentage of credit lines available at the beginning of the year t. ***FFO_Payout*** denotes cash dividends paid during the year t as a percent of funds from operations, on a per share basis. ***Externally_Managed*** equals 1 if REIT is externally managed as of the end of 2004; 0 otherwise. ***OP_Ratio*** denotes the percentage of the firm (combined company/partnership) owned by the unit holders in year t. ***Lg_Total_Cap*** denotes the Log total capitalization calculated (on the beginning of the year basis) as the market cap of common equity and Operating Partnership (OP) Units + Total Debt + Preferred Equity + Redeemable Preferred + Trust Preferred + Preferred Minority Interest in OP in year t. Debt is shown at book value. All preferred interests are calculated at liquidation value. ***Lg_Age_Sale*** denotes the Log age of property in year t. ***Lg_Hper*** denotes the Log number of year since the property has been acquired in year t. ***Lg_Age_Renovated*** denotes the Log number of year property has been renovated in year t. ***Encumb_Ratio*** denotes the ratio of the aggregated 1st and 2nd mortgage principal balance to the property's historic cost in year t. ***Cross_Coll*** equals 1 if the property is cross-collateralized with other properties for mortgage loan in year t; 0 otherwise. ***Line_of_Credit*** equals 1 if the property was served as collateral for the line of credit financing in year t; 0 otherwise. ***Percent_Owned*** denotes REIT's ownership interest in a property at the time of selling or the end of 2004 if still owned. ***Not_Focused*** equals 1 if the property is the property type that is not the investment focus of a REIT self reported as of the end of 2004; 0 otherwise. ***Portfolio_Acq*** equals 1 if the property was acquired as part of a portfolio; 0 otherwise. ***Ground_Lease*** denotes the percent of initial acquisition cost attributed to land. ***Lg_Initial_Cost*** denotes the Log initial acquisition cost booked. ***Farm_Belt*** equals 1 if the property is located in WI, MN, IA, MO, NE, KS, SD, ND, or Western Counties of MI; 0 otherwise. ***Industrial_Midwest*** equals 1 if the property is located in NY, PA, WV, OH, IN, IL, or Eastern Counties of MI; 0 otherwise. ***Mid_Atlantic*** equals 1 if the property is located in NJ, DE, MD, or DC; 0 otherwise. ***Mineral_Extraction*** equals 1 if the property is located in MT, ID, WY, UT, NV, CO, NM, AK, TX, OK, or LA; 0 otherwise. ***New_England*** equals 1 if the property is located in ME, VT, NH, CT, RI, or MA; 0 otherwise. ***New_South*** equals 1 if the property is located in VA, NC, SC, GA, FL, AL, MS, TN, KY, or AR; 0 otherwise. ***N_California*** equals 1 if the property is located in WA, OR, or Northern Counties of CA; 0 otherwise. ***S_California*** equals 1 if the property is located in AZ, HI, or Southern Counties of CA; 0 otherwise.

Variable	**Observation**	**Mean**	**Std**	**Min**	**Max**
Sold	*37948*	*0.06*	*0.23*	*0*	*1*
Premium/Discount					
Asset_Prem	*22123*	*0.02*	*0.08*	*-0.13*	*0.74*
Asset_Prem_Interaction	*22123*	*-0.02*	*0.03*	*-0.13*	*0*
PE	*30828*	*20.05*	*11.46*	*0.20*	*69.40*
PE_Interaction	*30828*	*6.36*	*6.88*	*0*	*17.60*
Firm-Level					
Debt_Coverage_Ratio	*37363*	*2.55*	*1.13*	*-0.04*	*15.37*
Credit_Facilities_Utilization	*37107*	*46.13*	*27.21*	*0*	*100*
FFO_Payout	*34462*	*73.66*	*16.71*	*0*	*194.12*
Externally_Managed	*37948*	*0.10*	*0.30*	*0*	*1*
OP_Ratio	*37920*	*0.09*	*0.11*	*0*	*0.88*
Lg_Total_Cap	*37897*	*7.79*	*1.00*	*3.23*	*10.20*
Property-Level					
Lg_Age_Sale	*37948*	*2.79*	*0.56*	*1.10*	*5.31*
Lg_Hper	*37948*	*1.38*	*0.46*	*0.69*	*2.30*
Lg_Age_Renovated	*37948*	*0.21*	*0.64*	*0*	*4.55*
Encumb_Ratio	*37948*	*0.17*	*0.67*	*0*	*99.68*
Cross_Coll	*37948*	*0.08*	*0.27*	*0*	*1*
Line_of_Credit	*37948*	*0.01*	*0.10*	*0*	*1*
Percent_Owned	*37309*	*97.68*	*11.53*	*1*	*100*
Not_Focused	*37948*	*0.14*	*0.35*	*0*	*1*
Portfolio_Acq	*37948*	*0.34*	*0.47*	*0*	*1*
Ground_Lease	*37856*	*0.18*	*0.11*	*0*	*1*
Lg_Initial_Cost	*37948*	*8.81*	*1.19*	*3.69*	*14.00*
Property Type Dummy					
Hotel	*37948*	*0.10*	*0.29*	*0*	*1*
Manufactured	*37948*	*0.01*	*0.07*	*0*	*1*
Multi_Family	*37948*	*0.24*	*0.43*	*0*	*1*
Office	*37948*	*0.26*	*0.44*	*0*	*1*
Retail	*37948*	*0.15*	*0.36*	*0*	*1*
Industrial	*37948*	*0.24*	*0.43*	*0*	*1*
Region Dummy					
Farm_Belt	*37948*	*0.07*	*0.25*	*0*	*1*
Industrial_Midwest	*37948*	*0.24*	*0.43*	*0*	*1*
Mid_Atlantic	*37948*	*0.09*	*0.29*	*0*	*1*
Mineral_Extraction	*37948*	*0.13*	*0.34*	*0*	*1*
New_England	*37948*	*0.03*	*0.16*	*0*	*1*
New_South	*37948*	*0.28*	*0.45*	*0*	*1*

N_California	*37948*	*0.07*	*0.25*	*0*	*1*
S_California	*37948*	*0.09*	*0.29*	*0*	*1*
Year Dummy					
Yr_Sale_1996	*37948*	*0.01*	*0.12*	*0*	*1*
Yr_Sale_1997	*37948*	*0.03*	*0.17*	*0*	*1*
Yr_Sale_1998	*37948*	*0.05*	*0.22*	*0*	*1*
Yr_Sale_1999	*37948*	*0.11*	*0.31*	*0*	*1*
Yr_Sale_2000	*37948*	*0.16*	*0.37*	*0*	*1*
Yr_Sale_2001	*37948*	*0.16*	*0.37*	*0*	*1*
Yr_Sale_2002	*37948*	*0.16*	*0.37*	*0*	*1*
Yr_Sale_2003	*37948*	*0.16*	*0.37*	*0*	*1*
Yr_Sale_2004	*37948*	*0.15*	*0.36*	*0*	*1*

The two sets of variables are used to capture the price premium/discount relationship between securitized real estate and underlying real estate. The first set of variables take advantage of high quality net asset value (NAV) estimates provided by Green Street Advisor. The Green Street estimates REIT's NAV as the value of REIT's real estate holdings in private asset market after subtracting the market value of debt. The first price premium/discount variable, *Asset_Prem*, in this study is defined as $\frac{P + Debt}{NAV + Debt} - 1$, where P is the REIT stock price per share.[9] The sign on the variable *Asset_Prem*, however, is difficult to be determined a priori. On the one hand, higher premiums induce REITs to sell fewer properties, so the sign should be negative; on the other hand, high premiums may capture some hidden effects, which may cause more selling. This dilemma on the sign prediction, however, can be avoided if we create a dummy variable which equals to 1 if the variable *Asset_Prem* is negative and zero otherwise. We then interact this dummy variable with the variable *Asset_Prem*. The sign on this interaction variable should be unequivocally negative when prices of securitized real estate are at a discount to underlying real estate.

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[9] The variable *Asset_Prem* can also be written as $\frac{P}{NAV} \cdot (1 - Financial \quad Leverage)$. Proof is as following:

$$Asset\_Prem = \frac{P + Debt}{NAV + Debt} - 1 = \frac{P - NAV}{NAV + Debt} = \frac{P - NAV}{NAV} \cdot \frac{NAV}{NAV + Debt}$$

$$= (\frac{P}{NAV} - 1) \cdot (1 - Financial \quad Leverage)$$

The second set of variables uses the REIT price-earnings ratio (*PE*) to proxy for price premium/discount. We conjecture that a higher price-earnings ratio should in general lead to higher price premiums of securitized real estate. This conjecture is supported by the positive correlation relationship between the variable *PE* and the variable *Asset_Prem*. Similarly; the sign on the variable PE may not be determinable a priori. We create a dummy variable, which equals 1 if the variable *PE* is in the lowest quartile in a given year and 0 otherwise. We then interact this dummy variable with the variable *PE* to capture the incremental difference in selling probability. We expect the sign on this interaction variable to be unequivocally negative.

The firm-level information is captured by financial leverage and liquidity (*Debt_Coverage_Ratio*, *Credit_Facilities_Utilization* and *FFO_Payout*), management structure (*Externally_Managed* and *Op_Ratio*), and firm size (*Lg_Total_Cap*). In particular, the variable *Debt_Coverage_Ratio* denotes the recurring earnings before interest, taxes, depreciation and amortization (EBITDA) as a multiple of interest expense.[10] We believe it to be a better measure than the debt ratio because it captures not only the sizes of the loans but also the interest rate level. For example, a loan of 8% interest rate is twice more burdensome than a loan with only a 4% interest rate. Furthermore, the firm's liquidity conditions are captured by how much REITs' short-term borrowing capacity has been used (*Credit_Facilities_Utilization*) and what percentage of funds from operations (FFO) was paid out as dividends (*FFO_Payout*) to shareholders. We ignore REITs' cash position as most REITs tend to have very small cash positions. For example, the largest office REIT, Equity Office Properties Trust - has only 0.4% of its assets in cash or cash equivalent as of the end of 2004.

The property-level information includes 11 variables that can be grouped into time effects (*Lg_Age_Sale*, *Lg_Hper*, and *Lg_Age_Renovated*), collateralization (*Encumb_Ratio*, *Cross_Coll*, *Line_Of_Credit*), property size (*Lg_Initial_Cost*), lease (*Ground_Lease*), and how properties were acquired and owned (*Portfolio_Acq*, *Not_Focused*, and *Percent_Owned*).

[10] Note the *Debt Coverage Ratio* (DCR) here is different from more frequently used *Debt Service Coverage Ratio* (DSCR), in which it is defined as EBITDA as a multiple of debt service. Debt service consists of both interest expenses and amortization of principal. DSCR tends to be a better measure of liquidity. Unfortunately, we are unable to calculate it based on available information.

Any remaining effects are further controlled through the use of time, region, and property type dummy variables. The time dummy variables (Y*r_Sale_1996* - Y*r_Sale_2004*) are supposed to capture the changes in macro environment such as interest rates, tax, and GDP growth that influence all regions and segments. Regional dummy variables should control for any geographical fixed effect. Note that the setup of our region dummy variables follows Hartzell, Shulman and Wurtzebach's (1987) categorization of regions that are more economically homogenous than census definitions, while still geographically continuous. Finally, the property type dummy variables capture the systematic difference between property types.

III.5 Results

The results of the Probit analysis are presented in Table III-4 through Table III-6. Table III-4 reports the models using price-earnings ratios (*PE*) as proxy for premium/discount between securitized real estate and underlying real estate. Table III-5 reports the model that uses Green Street NAV estimates (*Asset_Prem*) as proxy. Table III-6 reports models that are individually estimated for each property type.

Although not reported here, all models using the full sample are tested for the null hypothesis that multiple property-year observations created from a single property are independent intertemporally using the method suggested by Wooldridge (2002). The results show that the null hypothesis cannot be rejected at the 5% significance level. This implies that using statistics from a Probit model that pools multi-year observations for a single property is statistically appropriate.

The pair-wise correlations between the independent variables are generally quite small as indicated in Table III-3. We also computed Variance Inflation Index (VIF) to guard against the higher order of multi-collinearity formed among multiple variables. All VIF statistics are small with our highest VIF statistics of 4, which is well below the threshold of 10 recommended by most textbooks.

The full model, the model (1) in Table III-4, is generally consistent with the expectation and its coefficients jointly are reported to be different from zero at a more than 99% confidence level. Except for the coefficients on the variables *PE, Op_Ratio, Lg_Total_Cap, and Ground_Lease* that are not determinable *a priori*, the signs on all other coefficients are as expected when they are statistically significant. Importantly, the signs on the variable *PE_Interaction* are negative. One can easily tell from the model that the selling probability in the lowest quartile is 2.82 times the rest.[11] This confirms the Hypothesis 1 that, when the prices of securitized real estate are discounted to the underlying real estate, REITs sell more properties and thus disinvestment. To examine whether or not the results are robust, we rerun the model (1) using the variable *Asset_Prem*. This variable calculated out of Green Street NAV estimates can be more reliable as they directly measure the price differences between securitized and underlying real estate markets. We again find the coefficient on the variable *Asset_Premium_Interaction* to be negative. Interestingly, the selling probability for the lowest quartile of observations is even faster at almost 8.3 times of the rest.[12] As a result, both of our models confirm that REITs do respond to price discount by disinvesting. Our results are in sharp contrast with the asymmetric results in Gentry and Mayer (2002) that REITs only respond to premium prices of securitized real estate by increasing investments, but when stock market prices of securitized properties fall below the underlying asset prices, the REITs do not respond by disinvesting.

Our results in Table III-4 and Table III-5 also confirm that the owners' financial conditions play an important role in selling decisions. When REITs have a higher debt burden (i.e., *Debt_Coverage_Ratio* is low), or have a lower liquidity (i.e., *Credit_Facilities_Utilization* is high), or have to payout higher dividends (i.e., *FFO_Payout* is high), the chance that REITs sell off the properties is increased (Hypothesis 2). This supports the idea that commercial real estate is similar to the housing market in that the owners' financial situation plays an important role in selling decisions. Since selling off properties to pay dividends can not be sustained in the long run, an important investment implication of the positive relationship between selling probability and *FFO_Payout* is that buying high dividend paying REIT stocks without paying attention to the selling activities of REITs can lead to investment disappointment. Additionally, the coefficients on the variable *Externally_Managed* are negative and

[11] The coefficient on the variable *PE* is -0.011. But if the PE is in the lowest quartile, the net coefficient is -0.011 – 0.020 = - 0.031, which is 2.82 times of -0.011.
[12] -7.630-1.050/1.050 = -8.680/1.050 = - 8.3.

statistically significant. This supports hypothesis 3 that externally-managed REITs sell properties less frequently. The level of presence of OP unit holders in REITs seems to have no predicting power. But this is not surprising given that it is a very noisy indicator of the true tax situation (Hypothesis 4). As expected, the size of REITs (*Lg_Total_Cap*), has an insignificant impact on selling decisions; this is not unreasonable as we are not aware of any economic reason why the REIT size should impact sales frequency. The variables such as *Not_Focused* and *Portfolio_Acq* capture the possibilities that a property may not fit well with the rest of the REIT portfolio. If the property type is not the main focus of REIT (i.e., *Not_Focused* =1), or if it is acquired as part of portfolio acquisition (i.e., *Portfolio_Acq* = 1*)*, the model (1) of Table III-4 shows that the selling possibility increases, which confirms Hypothesis 5. The positive coefficients on building age (*Lg_Age_Sale*) and the time passed since the latest renovation (*Lg_Age_Renovated*) confirms that REITs prefer to own newer properties (Hypothesis 6). Finally, the negative coefficients on the variables *Encumb_Ratio* and C*ross_Coll* and the positive coefficient on the variable *Percent_Owned* indicate that, if the ownership of the property is encumbered in any way through mortgage debt, cross-collateralization, or joint venture, the chances of a property selling is reduced (Hypothesis 7). In summary, our testing confirmed all of our hypotheses except hypothesis 5.

To examine the robustness of our results, we also rerun models (1) of Table III-4 using either REIT characteristics or property characteristics only. The results are reported under the model (2) and (3) in Table III-4. We find in general the coefficients for variables are very stable. This means REIT and property characteristics play independent roles. We also breakdown the sample by major property types: office, retail, multi-family, and industrial and rerun model (1) in Table III-4 so that the coefficients are not restricted to be the same for different property types. The results are presented in Table III-6. Again, we find that, except in three places (which are highlighted in Table III-6), the signs on coefficients are all consistent with those using the entire sample.

III.6 Conclusion

By 2005 Q1, REITs as a group held $468 billion of commercial real estate, the size of which dwarfs that of traditional major real estate investors such as pension funds.

Our main contribution in this paper is two-fold. First, we find strong evidence that REITs are responsive to the price gap between securitized real estate and underlying real estate *in both directions*. If the prices of securitized real estate are discounted relative to the underlying real asset, REITs sell off more properties in the asset market to arbitrage the price difference and, as a result, disinvest. These findings are in sharp contrast with the previous studies that find active arbitrage of price difference in one direction only.

Second, we identify a group of factors that are important in REIT property selling decisions. We find that selling decisions are influenced by the financial conditions of owners. For example, REITs constrained financially by debts may be forced to sell more properties. Additionally, we find evidence that high REIT dividend payout rates may be financed by liquidating assets, rather than by continuing operations. However, liquidating assets to pay dividends cannot last in the long run. This implies that the investment strategy based purely on high dividends may backfire. Furthermore, management contracts play an important role in selling decisions. REITs that manage properties externally sell fewer properties because management fees are based on asset size.

In addition to the REIT-level characteristics, the property-level characteristics are also very important. For instance, properties that are larger in size or encumbered by mortgages, cross-collateralization and joint ventures are less likely to be sold. To the contrary, properties that are older, or acquired in a portfolio acquisition, or not REITs' specialty are more likely to be disposed.

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Table III-3: Correlation coefficient matrix, 1996-2004

(1) ***Sold*** equals 1 if the property is sold in year t; 0 otherwise.
(2) ***Asset_Prem*** denotes (1-leverage ratio)∗average of 12 monthly Green Street NAV premiums (or discount) in year t.
(3) ***Asset_Prem_Interaction*** denotes the interaction term between asset_prem_c and dummy variable, where the dummy variable equals one if Asset_Prem is smaller than zero.
(4) ***PE*** denotes common stock price at the end of the year t as a multiple of annualized diluted earnings per share after extraordinary items. For values greater than 70, SNL displays NM.
(5) ***PE_Interaction*** denotes the interaction term between PE and dummy variable, where the dummy variable equals one if PE is in the lowest quartile in a specific year.
(6) ***Debt_Coverage_Ratio*** denotes the recurring earnings before interest, taxes, depreciation and Amortization (EBITDA) as a multiple of interest expense in year t.
(7) ***Credit_Facilities_Utilization*** denotes the amounts drawn as a percentage of credit lines available at the beginning of the year t.
(8) ***FFO_Payout*** denotes cash dividends paid during the year t as a percent of funds from operations, on a per share basis.
(9) ***Externally_Managed*** equals 1 if REIT is externally managed as of the end of 2004; 0 otherwise.
(10) ***OP_Ratio*** denotes the percentage of the firm (combined company/partnership) owned by the unit holders in year t.
(11) ***Lg_Total_Cap*** denotes the Log total capitalization calculated (on the beginning of the year basis) as the market cap of common equity and Operating Partnership (OP) Units + Total Debt + Preferred Equity + Redeemable Preferred + Trust Preferred + Preferred Minority Interest in OP in year t. Debt is shown at book value. All preferred interests are calculated at liquidation value.
(12) ***Lg_Age_Sale*** denotes the Log age of property in year t.
(13) ***Lg_Hper*** denotes the Log number of year since the property has been acquired in year t.
(14) ***Lg_Age_Renovated*** denotes the Log number of year property has been renovated in year t.
(15) ***Encumb_Ratio*** denotes the ratio of the aggregated 1st and 2nd mortgage principal balance to the property's historic cost in year t.
(16) ***Cross_Coll*** equals 1 if the property is cross-collateralized with other properties for mortgage loan in year t; 0 otherwise.
(17) ***Line_of_Credit*** equals 1 if the property was served as collateral for the line of credit financing in year t; 0 otherwise.
(18) ***Percent_Owned*** denotes REIT's ownership interest in a property at the time of selling or the end of 2004 if still owned.
(19) ***Not_Focused*** equals 1 if the property is the property type that is not the investment focus of a REIT self reported as of the end of 2004; 0 otherwise.
(20) ***Portfolio_Acq*** equals 1 if the property was acquired as part of a portfolio; 0 otherwise.
(21) ***Ground_Lease*** denotes the percent of initial acquisition cost attributed to land.
(22) ***Lg_Initial_Cost*** denotes the Log initial acquisition cost booked.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1)	1.00																					
(2)	-0.02	1.00																				
(3)	-0.02	0.71	1.00																			
(4)	-0.03	0.30	0.34	1.00																		
(5)	-0.01	-0.33	-0.27	-0.50	1.00																	
(6)	-0.08	-0.11	0.14	0.03	-0.04	1.00																
(7)	0.04	0.07	-0.04	-0.25	-0.25	-0.03	1.00															
(8)	0.01	0.02	-0.05	0.04	0.12	0.02	0.03	1.00														
(9)	-0.01	-0.12	-0.06	-0.04	-0.01	-0.10	-0.10	-0.08	1.00													
(10)	0.01	0.02	0.07	-0.14	-0.06	0.10	0.09	-0.01	-0.14	1.00												
(11)	0.00	0.11	0.00	0.02	0.21	-0.15	-0.14	-0.09	-0.36	0.05	1.00											

(12)	0.05	0.07	-0.09	0.04	0.07	-0.14	-0.05	-0.06	-0.03	0.10	0.14	1.00										
(13)	0.02	0.12	-0.21	0.18	0.32	-0.14	-0.14	0.12	-0.01	-0.08	0.16	0.18	1.00									
(14)	0.01	-0.01	-0.01	0.03	0.01	-0.07	0.00	-0.04	-0.05	0.04	0.01	0.26	0.04	1.00								
(15)	0.00	0.05	-0.04	0.00	0.04	-0.09	0.00	0.00	0.02	0.05	-0.01	0.02	-0.01	0.01	1.00							
(16)	-0.03	0.04	-0.01	-0.01	-0.01	-0.01	0.00	-0.06	0.05	0.06	-0.06	-0.01	0.05	-0.02	-0.07	1.00						
(17)	-0.01	0.02	-0.03	0.09	0.04	0.04	0.04	-0.02	0.05	0.03	-0.14	-0.05	-0.05	0.00	-0.03	-0.03	1.00					
(18)	0.03	-0.04	0.02	0.02	-0.03	0.05	-0.05	-0.02	0.05	-0.02	-0.10	-0.03	0.00	0.01	-0.05	0.02	0.01	1.00				
(19)	0.07	-0.07	-0.08	0.07	0.03	-0.04	0.00	-0.05	0.04	0.04	-0.05	0.05	-0.03	-0.05	0.02	0.01	-0.01	0.04	1.00			
(20)	0.04	0.00	0.03	-0.11	-0.07	-0.12	-0.02	-0.06	-0.05	0.08	0.13	0.08	-0.11	-0.01	0.01	0.00	-0.03	-0.04	-0.05	1.00		
(21)	0.00	-0.05	0.06	0.01	-0.01	0.13	0.05	0.07	-0.11	-0.14	-0.11	-0.03	-0.03	-0.01	-0.01	-0.06	-0.05	0.01	0.01	-0.09	1.00	
(22)	-0.05	0.05	-0.07	-0.08	0.02	-0.14	-0.04	-0.08	0.00	0.10	0.26	0.04	-0.01	0.16	0.08	-0.01	-0.02	-0.10	-0.11	0.06	-0.18	1.00

Table III-4: Probit model using PE ratio: (dependent variable=1 if property sold, 0 otherwise)

The dependent variable is ***Sold***, which equals 1 if the property is sold in year t; 0 otherwise. ***PE*** denotes common stock price at the end of the year t as a multiple of annualized diluted earnings per share after extraordinary items. For values greater than 70, SNL displays NM. ***PE_Interaction*** denotes the interaction term between PE and dummy variable, where the dummy variable equals one if PE is in the lowest quartile in a specific year. ***Debt_Coverage_Ratio*** denotes the recurring earnings before interest, taxes, depreciation and Amortization (EBITDA) as a multiple of interest expense in year t. ***Credit_Facilities_Utilization*** denotes the amounts drawn as a percentage of credit lines available at the beginning of the year t. ***FFO_Payout*** denotes cash dividends paid during the year t as a percent of funds from operations, on a per share basis. ***Externally_Managed*** equals 1 if REIT is externally managed as of the end of 2004; 0 otherwise. ***OP_Ratio*** denotes the percentage of the firm (combined company/partnership) owned by the unit holders in year t. ***Lg_Total_Cap*** denotes the Log total capitalization calculated (on the beginning of the year basis) as the market cap of common equity and Operating Partnership (OP) Units + Total Debt + Preferred Equity + Redeemable Preferred + Trust Preferred + Preferred Minority Interest in OP in year t. Debt is shown at book value. All preferred interests are calculated at liquidation value. ***Lg_Age_Sale*** denotes the Log age of property in year t. ***Lg_Hper*** denotes the Log number of year since the property has been acquired in year t. ***Lg_Age_Renovated*** denotes the Log number of year property has been renovated in year t. ***Encumb_Ratio*** denotes the ratio of the aggregated 1st and 2nd mortgage principal balance to the property's historic cost in year t. ***Cross_Coll*** equals 1 if the property is cross-collateralized with other properties for mortgage loan in year t; 0 otherwise. ***Line_of_Credit*** equals 1 if the property was served as collateral for the line of credit financing in year t; 0 otherwise. ***Percent_Owned*** denotes REIT's ownership interest in a property at the time of selling or the end of 2004 if still owned. ***Not_Focused*** equals 1 if the property is the property type that is not the investment focus of a REIT self reported as of the end of 2004; 0 otherwise. ***Portfolio_Acq*** equals 1 if the property was acquired as part of a portfolio; 0 otherwise. ***Ground_Lease*** denotes the percent of initial acquisition cost attributed to land. ***Lg_Initial_Cost*** denotes the Log initial acquisition cost booked.

	(1)			**(2)**			**(3)**		
Parameter	**Estimate**	**STD**	**Pr>Chi^2**	**Estimate**	**STD**	**Pr>Chi^2**	**Estimate**	**STD**	**Pr>Chi^2**
Intercept	-1.474	0.358	<.0001	-1.133	0.192	<.0001	-2.449	0.186	<.0001
PE	-0.011	0.002	<.0001						
PE_Interaction	-0.020	0.004	<.0001						
Debt_Coverage_Ratio	-0.397	0.032	<.0001	-0.354	0.028	<.0001			
Credit_Facilities_Utilization	0.002	0.001	0.0006	0.002	0.001	0.001			
FFO_Payout	0.004	0.001	0.0009	0.003	0.001	0.004			
Externally_Managed	-0.476	0.100	<.0001	-0.375	0.081	<.0001			
OP_Ratio	0.076	0.173	0.6617	-0.102	0.153	0.504			
Lg_Total_Cap	0.000	0.019	0.994	0.026	0.016	0.104			
Lg_Age_Sale	0.129	0.028	<.0001				0.177	0.021	<.0001
Lg_Hper	0.167	0.044	0.0001				0.103	0.025	<.0001
Lg_Age_Renovated	0.067	0.021	0.0016				0.023	0.017	0.168
Encumb_Ratio	-0.352	0.064	<.0001				0.002	0.014	0.873
Cross_Coll	-0.319	0.063	<.0001				-0.250	0.046	<.0001
Line_of_Credit	-0.250	0.180	0.1652				-0.179	0.170	0.294
Percent_Owned	0.010	0.002	<.0001				0.009	0.001	<.0001
Not_Focused	0.323	0.037	<.0001				0.330	0.034	<.0001
Portfolio_Acq	0.193	0.031	<.0001				0.196	0.023	<.0001

Ground_Lease	0.260	0.141	0.0646				-0.015	0.101	0.879
Lg_Initial_Cost	-0.133	0.015	<.0001				-0.081	0.009	<.0001
Number of Observations	28170			28740			37217		
LR Chi^2	933			452			344		
Prob.>Chi^2	<.0001			<.0001			<.0001		
"-2Log L"	9880			10585			15350		
Max-Rescaled R^2	0.102			0.0489			0.0267		

Note: The coefficients on region, year, and property type dummies are not reported.

Table III-5: Probit model using Green Street NAV: (dependent variable=1 if property sold, 0 otherwise)

The dependent variable is ***Sold***, which equals 1 if the property is sold in year t; 0 otherwise. ***Asset_Prem*** denotes (1-leverage ratio)∗average of 12 monthly Green Street NAV premiums (or discount) in year t. ***Asset_Prem_Interaction*** denotes the interaction term between asset_prem_c and dummy variable, where the dummy variable equals one if Asset_Prem is smaller than zero. ***Debt_Coverage_Ratio*** denotes the recurring earnings before interest, taxes, depreciation and Amortization (EBITDA) as a multiple of interest expense in year t. ***Credit_Facilities_Utilization*** denotes the amounts drawn as a percentage of credit lines available at the beginning of the year t. ***FFO_Payout*** denotes cash dividends paid during the year t as a percent of funds from operations, on a per share basis. ***Externally_Managed*** equals 1 if REIT is externally managed as of the end of 2004; 0 otherwise. ***OP_Ratio*** denotes the percentage of the firm (combined company/partnership) owned by the unit holders in year t. ***Lg_Total_Cap*** denotes the Log total capitalization calculated (on the beginning of the year basis) as the market cap of common equity and Operating Partnership (OP) Units + Total Debt + Preferred Equity + Redeemable Preferred + Trust Preferred + Preferred Minority Interest in OP in year t. Debt is shown at book value. All preferred interests are calculated at liquidation value. ***Lg_Age_Sale*** denotes the Log age of property in year t. ***Lg_Hper*** denotes the Log number of year since the property has been acquired in year t. ***Lg_Age_Renovated*** denotes the Log number of year property has been renovated in year t. ***Encumb_Ratio*** denotes the ratio of the aggregated 1st and 2nd mortgage principal balance to the property's historic cost in year t. ***Cross_Coll*** equals 1 if the property is cross-collateralized with other properties for mortgage loan in year t; 0 otherwise. ***Line_of_Credit*** equals 1 if the property was served as collateral for the line of credit financing in year t; 0 otherwise. ***Percent_Owned*** denotes REIT's ownership interest in a property at the time of selling or the end of 2004 if still owned. **Not_Focused** equals 1 if the property is the property type that is not the investment focus of a REIT self reported as of the end of 2004; 0 otherwise. ***Portfolio_Acq*** equals 1 if the property was acquired as part of a portfolio; 0 otherwise. ***Ground_Lease*** denotes the percent of initial acquisition cost attributed to land. ***Lg_Initial_Cost*** denotes the Log initial acquisition cost booked.

Parameter	**Estimate**	**STD**	**Pr>Chi^2**
Intercept	-0.873	0.427	0.0408
Asset_Prem	1.050	0.396	0.0081
Asset_Prem_Interaction	-7.630	1.066	<.0001
Debt_Coverage_Ratio	-0.449	0.044	<.0001
Credit_Facilities	0.001	0.001	0.084
FFO_Payout	-0.002	0.001	0.1308
Externally_Managed	0.257	0.182	0.1586
OP_Ratio	-0.385	0.299	0.1989
Lg_Total_Cap	0.012	0.028	0.6689
Lg_Age_Sale	0.085	0.034	0.0133
Lg_Hper	0.164	0.056	0.0035
Lg_Age_Renovated	0.073	0.027	0.0074
Encumb_Ratio	-0.308	0.070	<.0001
Cross_Coll	-0.375	0.084	<.0001
Line_of_Credit	-3.058	48.430	0.9497
Percent_Owned	0.009	0.002	<.0001
Not_Focused	0.318	0.047	<.0001
Portfolio_Acq	0.126	0.038	0.0009
Ground_Lease	0.460	0.170	0.0067

Lg_Initial_Cost	-0.169	0.019	<.0001
Number of observations	19598		
LR Chi^2	680		
Prob.>Chi^2	<.0001		
-2Log L	6816		
Max-rescaled R^2	0.101		

Note: The coefficients on region, year, and property type dummies are not reported.

Table III-6: Probit model: (dependent variable=1 if property sold, 0 otherwise)

The dependent variable is ***Sold***, which equals 1 if the property is sold in year t; 0 otherwise. ***PE*** denotes common stock price at the end of the year t as a multiple of annualized diluted earnings per share after extraordinary items. For values greater than 70, SNL displays NM. ***Debt_Coverage_Ratio*** denotes the recurring earnings before interest, taxes, depreciation and Amortization (EBITDA) as a multiple of interest expense in year t. ***Credit_Facilities_Utilization*** denotes the amounts drawn as a percentage of credit lines available at the beginning of the year t. ***FFO_Payout*** denotes cash dividends paid during the year t as a percent of funds from operations, on a per share basis. ***Externally_Managed*** equals 1 if REIT is externally managed as of the end of 2004; 0 otherwise. ***OP_Ratio*** denotes the percentage of the firm (combined company/partnership) owned by the unit holders in year t. ***Lg_Total_Cap*** denotes the Log total capitalization calculated (on the beginning of the year basis) as the market cap of common equity and Operating Partnership (OP) Units + Total Debt + Preferred Equity + Redeemable Preferred + Trust Preferred + Preferred Minority Interest in OP in year t. Debt is shown at book value. All preferred interests are calculated at liquidation value. ***Lg_Age_Sale*** denotes the Log age of property in year t. ***Lg_Hper*** denotes the Log number of year since the property has been acquired in year t. ***Lg_Age_Renovated*** denotes the Log number of year property has been renovated in year t. ***Encumb_Ratio*** denotes the ratio of the aggregated 1st and 2nd mortgage principal balance to the property's historic cost in year t. ***Cross_Coll*** equals 1 if the property is cross-collateralized with other properties for mortgage loan in year t; 0 otherwise. ***Line_of_Credit*** equals 1 if the property was served as collateral for the line of credit financing in year t; 0 otherwise. ***Percent_Owned*** denotes REIT's ownership interest in a property at the time of selling or the end of 2004 if still owned. ***Not_Focused*** equals 1 if the property is the property type that is not the investment focus of a REIT self reported as of the end of 2004; 0 otherwise. ***Portfolio_Acq*** equals 1 if the property was acquired as part of a portfolio; 0 otherwise. ***Ground_Lease*** denotes the percent of initial acquisition cost attributed to land. ***Lg_Initial_Cost*** denotes the Log initial acquisition cost booked.

	Office			**Retail**			**Multi-Family**			**Industrial**		
Parameter	**Estimate**	**STD**	**Pr>Chi^2**	**Estimate**	**STD**	**Pr>Chi^2**	**Estimate**	**STD**	**Pr>Chi^2**	**Estimate**	**STD**	**Pr>Chi^2**
Intercept	1.101	3.150	0.727	2.746	3.514	0.435	14.746	2.952	<.0001	-14.381	6.240	0.021
PE	-0.014	0.003	<.0001	0.007	0.007	0.250	-0.011	0.003	<.0001	-0.012	0.004	0.004
Debt_Coverage_Ratio	-0.347	0.063	<.0001	-0.599	0.098	<.0001	-0.083	0.061	0.171	-0.634	0.073	<.0001
Credit_Facilities	0.003	0.001	0.015	0.007	0.002	0.002	-0.004	0.001	0.014	0.005	0.001	0.001
FFO_Payout	0.002	0.002	0.449	-0.001	0.003	0.622	0.016	0.003	<.0001	-0.002	0.005	0.732
Externally_Managed	-0.632	0.184	0.001	-0.873	0.546	0.110	-5.073	110.600	0.963	-0.216	0.410	0.598
OP_Ratio	1.028	0.336	0.002	-1.280	0.571	0.025	-1.107	0.330	0.001	-0.450	0.674	0.504
Lg_Total_Cap	-0.338	0.284	0.233	0.035	0.080	0.659	0.046	0.042	0.279	-0.024	0.066	0.719
Lg_Age_Sale	0.173	0.062	0.005	-0.027	0.069	0.693	0.309	0.069	<.0001	0.087	0.064	0.173
Lg_Hper	0.035	0.114	0.762	0.155	0.132	0.240	0.305	0.095	0.001	0.177	0.086	0.039
Lg_Age_Renovated	0.096	0.041	0.019	-0.176	0.081	0.029	0.089	0.063	0.158	0.073	0.037	0.051
Encumb_Ratio	-0.711	0.161	<.0001	0.087	0.118	0.459	-0.313	0.098	0.001	-0.691	0.230	0.003
Cross_Coll	-0.570	0.156	0.000	0.049	0.175	0.779	-0.347	0.139	0.012	-0.312	0.120	0.010
Line_of_Credit	0.586	0.365	0.108	-3.830	228.500	0.987	-0.178	0.376	0.637	-4.067	79.36	0.959
Percent_Owned	0.017	0.008	0.029	0.007	0.005	0.219	0.008	0.002	0.001	0.046	0.052	0.378
Not_Focused	-0.050	0.091	0.584	0.962	0.149	<.0001	0.255	0.104	0.014	0.372	0.073	<.0001
Portfolio_Acq	0.229	0.062	0.000	-0.163	0.112	0.148	0.089	0.070	0.203	0.305	0.060	<.0001

Ground_Lease	1.215	0.241	<.0001	-0.086	0.358	0.811	0.170	0.469	0.718	0.061	0.321	0.849
Lg_Initial_Cost	-0.096	0.030	0.001	-0.209	0.048	<.0001	-0.093	0.043	0.032	-0.137	0.033	<.0001
Number of observations	7842	311	7531	5017	149	4868	6070	371	5699	7264	444	6820
LR Chi^2	414			204			447				484	
Prob.>Chi^2	<.0001			<.0001			<.0001				<.0001	
-2Log L	2203			1137			2346				2858	
Max-rescaled R^2	0.1813			0.1698			0.1924				0.1748	

Note: The coefficients on region, year, and property type dummies are not reported.

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