

# Essays in Corporate Finance

by

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## Chapter I

### Introduction

Corporations grow and create value by investing. Corporate investment decisions are impacted by, among other things, capital availability, the regulatory environment, and internal agency conflicts. This dissertation explores how these various factors influence corporate investment. Each of the three papers that comprise the dissertation explores how one of these three considerations affects investment decisions.

Chapter II examines the importance of capital market imperfections by investigating the dependence of a firm's investment on its internal resources. I exploit the tax loss carryforward feature of the tax code to establish that corporate investments are causally affected by the internal resources available to the firm. The degree of dependence, in turn, is affected by the costliness of debt market financing. Distributions to shareholders are not affected by incremental internal resources, and borrowing actually increases with incremental internal resources. Firms retain a significant portion of incremental cash flow. Taken together, these findings confirm the existence of capital constraints imposed by costs of access to external finance.



Chapter III focuses on the regulation of financial reporting and its consequences for the efficiency of investment in the economy. There is a significant body of evidence indicating that firms inflate their performance reports prior to raising capital. I argue that such inflation may actually allow cash-poor firms to signal better the quality of their investment opportunities and, therefore, lessen their cost of financing. I show that separation is more complete if the penalty for fraudulent disclosure is neither too lenient nor too severe and that allowing for greater separation reduces incentives for costly overinvestment. In equilibrium, investment efficiency is maximized when the penalty for fraudulent disclosure is moderate. Ex post investigation of disclosure fraud dominates ex ante auditing of the firm's accounts.

One dimension of investment that is likely to be important to corporate managers is the risk that it entails. Risk aversion can cause undiversified managers to make investment decisions that are not in the best interests of a firm's non-management shareholders. Chapter IV presents an explanation for the commonly-observed link between managerial pay and stock price over the short term that focuses on managerial risk-taking incentives. It is well accepted that aligning managerial incentives with those of stock holders enhances shareholder value. In theory models, such alignment is usually modeled as giving managers a stake in the realized cash flows of the firm's projects. However, such a stake, which entails a manager holding on to her equity position until all cash flow uncertainty is resolved, can lead a risk averse manager to turn down risky positive NPV projects. This chapter argues that equity-linked incentives can mitigate the manager's bias

against assuming risk, provided the manager is allowed the flexibility of trading out her equity position early. Thus, allowing managers to hedge away partially the risks associated with their firm's stock price may actually be in the shareholders' best interests.

## Chapter II

### Investment, Cash Flow and Financial Market

#### Conditions: Evidence from Tax Loss Carryforwards

The assumption of perfect capital markets is a bedrock of much of modern corporate finance theory.<sup>1</sup> Under this assumption, a firm makes decisions regarding investment and financing policies separately. Capital market imperfections can, however, drive a wedge between the costs of internal and external financing. As a consequence, separation of investment and financing decisions breaks down, and a firm's investment activity can depend on the level of internal resources it has available.<sup>2</sup>

An important stream of research has endeavored to examine the link between internal resources and investment activity, with an eye to attributing such dependence to capital market imperfections. However, establishing causality in this setting is a challenge, as economic shocks are likely to affect both a firm's current cash

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<sup>1</sup>E.g. Modigliani and Miller (1958); Modigliani and Miller (1961); Stiglitz (1969).

<sup>2</sup>Frictions that may affect the cost of accessing external financing include adverse selection (Jaffee and Russell (1976); Stiglitz and Weiss (1981); Greenwald, Stiglitz and Weiss (1984); Myers and Majluf (1984)), incentive problems (Jensen and Meckling (1976); Grossman and Hart (1982); Stulz (1990); Hart and Moore (1995); Holmstrom and Tirole (1997); ch. 3 of Tirole (2006)), and simple transactions costs.

flow and its investment opportunity set. A number of papers, starting with the influential work of Fazzari, Hubbard and Petersen (1988a), have confronted the endogeneity problem by trying to show that, in the cross-section, investment is more sensitive to cash flow for firms predicted to be more financially constrained a priori. This approach has been criticized on the grounds that cash flow may be a better proxy for investment opportunities for the types of firm that are typically classified as more financially-constrained, even after controlling for proxies for investment opportunities (Poterba (1988); Erickson and Whited (2000); Altı (2003)).

In this paper, I re-examine the dependence of investment decisions on cash flow, using the net operating loss (NOL) carryforward provisions of the U.S. Federal Income Tax code to construct a measure of cash flow that is purged of correlation with investment opportunities. Corporate tax filers in the U.S. can carry federal tax losses forward to offset against future taxable income.<sup>3</sup> As a result, a profitable firm with NOL carryforwards enjoys a greater cash flow than an otherwise identical firm without such carryforwards. However, such a firm loses its distinctiveness on this account as soon as it exhausts its loss carryforwards. This abrupt change in its cash flow status allows me to examine how a firm's investment behavior changes as it goes from availing itself of such deductions to a situation in which it has completely exhausted such deductions.

Recognizing that the savings arising from the use of carryforwards represents a source of cash flow allows for a new approach to testing the dependence of in-

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<sup>3</sup>Firms are required to deduct such carryforwards against taxable income or face expiration of their carryforwards.

vestment on internal resources.<sup>4</sup> These savings are a sharply nonlinear deterministic function of (a) the stock of carryforwards a firm has available and (b) its tax profitability during the year. Controlling for these two variables, therefore, purges the cash flow created by these savings of possible correlation with the firm's investment opportunity set.<sup>5</sup> The effect of this de-contaminated component of cash flow on investment provides a clean estimate of the sensitivity of investment to internal resources.<sup>6</sup>

Applying this approach to a large sample of firms covering the period 1969 through 2005, I find that investment is heavily dependent on a firm's internal resources. Capital expenditures increase by an estimated \$0.35 for each \$1 of internal resources generated. Non-parametric evidence shows a sharp decline in the relationship between capital expenditures and a firm's tax liability in the absence of carryforwards at the point at which carryforwards are exhausted. I also find that other forms of investment, including working capital investment, cash acquisitions, and advertising expenditures, increase substantially with internal resources generated.

This evidence strongly supports the idea that investment is dependent on internal resources. This effect need not be constant over time, however. For ex-

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<sup>4</sup>This source of cash flow is significant. For example, total savings due to NOL deductions in 2003 totalled an estimated \$24.5 billion according to Internal Revenue Service (IRS) figures. NOL deductions totalled approximately \$70 billion, or 14% of total tax-book income (source: <http://www.irs.gov/pub/irs-soi/03co18tr.xls>). The savings is estimated using the maximum statutory tax rate for 2003 of 35%.

<sup>5</sup>For further discussion of the loss carryforward provisions of the tax code, see Graham (1996a, 1996b) and Scholes et al (2005).

<sup>6</sup>Rauh (2006) uses a similar testing methodology which takes advantage of a firm's mandatory pension contribution requirements. The approach also has similarities to the regression discontinuity approach used in labor economics (van der Klaauw (1996); Angrist and Lavy (1999); and Angrist and Krueger (1999)).

ample, investment and financing decisions may be made separately when capital market conditions are conducive to raising resources, but become linked when capital market conditions are adverse.<sup>7</sup> To assess the importance of capital market conditions, I examine how the dependence of investment on cash flow from carryforward savings varies over time with the spread between Baa- and Aaa-rated corporate bonds. I find that the sensitivity of investment to this source of cash flow increases with the bond spread. In fact, while capital expenditures are highly sensitive to cash flow when the bond spread is high, they are *insensitive* when the bond spread is low.

Finally, I examine other ways firms might use cash flow from carryforward savings. With perfect capital markets, firms should distribute cash in excess of their investment needs to their claimants. This should induce a positive relationship between internally-generated cash flow and outflows to claimants. Further refuting the perfect capital markets hypothesis, I find that distributions to equityholders are insensitive to cash flow. Moreover, firms actually *increase* debt in response to additional cash flow. Finally, consistent with the conclusion of Almeida, Campello and Weisbach (2004) that firms retain cash to reduce the probability of future cash shortfalls, I find that cash holdings increase with additional cash flow.

My findings complement the results of other papers that have employed quasi-natural experiments to identify the dependence of investment on internal resources. Blanchard, Lopez-de-Silanes and Shleifer (1994) show that plaintiff firms increase

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<sup>7</sup>Consistent with this idea, a small literature has found that shocks to the capital market's ability to supply capital affect firm decisions (e.g. Lemmon and Roberts (2007); Sufi (2007); Leary (2005); Chava and Purnanandam (2006)).

investment in response to windfalls from lawsuits unrelated to their ongoing lines of business. Lamont (1997) shows that investment by non-oil divisions of conglomerates owning oil-producing divisions fell in response to a negative shock to oil prices in 1986. Both of these papers, however, use very small, specialized samples. In contrast, Rauh (2006) studies a larger sample of firms sponsoring defined benefits pension plans and also finds that investment responds positively to cash flows. While my paper's test methodology is closely related to that adopted by Rauh (2006), my sample is even broader-based, since all firms are subject to federal taxation whereas all firms do not have defined benefit pension plans. In addition, because of the length of my sample period, I am able to examine how the investment-cash flow relationship varies with capital market conditions and establish that the perfect markets benchmark may be quite a reasonable characterization when the cost of accessing external finance is low.

While these quasi-natural experiments have generally found that investment is affected by cash flow, two other recent papers have failed to find a dependence of investment on cash flow, even for firms that are *a priori* most exposed to higher costs of external financing (Erickson and Whited (2000); Pulvino and Tarhan (2007)). These papers estimate empirical models specifically designed to confront omitted variables problems that may affect direct tests of the investment-cash flow relationship like those of Fazzari, Hubbard and Petersen (1988a). Like Rauh's (2006), my quasi-experimental set-up allows me to avoid many of the omitted variables problems that are inherent in the direct approach to testing the importance of cash flows to investment.

In addition to providing fresh evidence regarding the relevance of internal resources to investment activity, my paper makes three additional contributions to the literature. First, my results help to pin down the magnitude of the effect of cash flow on investment. It is difficult to infer this magnitude from investment-cash flow regressions in early studies, since an economic shock that increases a firm's cash flow is also likely to improve its investment opportunities. The small, specialized samples that Blanchard, Lopez-de-Silanes and Shleifer (1994) and Lammont (1997) use in their quasi-natural experiments limit their ability to shed light on the magnitude of the effect. Rauh (2006), in his large-sample quasi-natural experiment, estimates that \$1 of cash flow leads to between \$0.50 and \$0.80 of additional investment. These estimates are surprisingly large, not least because they suggest that traditional investment-cash flow regressions severely *underestimate* the causal effect.<sup>8</sup> My estimate of a \$0.35 response of capital expenditures to a \$1 change in cash flow from carryforward tax savings, on the other hand, is in line with my estimate of the association of capital expenditures to total cash flow for the same sample.

Second, my finding that investment is more sensitive to cash flow when capital market conditions are poor suggests that the magnitude of capital market imperfections is important for investment decisions. This result provides direct confirmation that the sensitivity of investment to cash flow in my research de-

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<sup>8</sup>If economic shocks that increase cash flow simultaneously improve investment opportunities, as is often conjectured, then investment-cash flow regressions should *overestimate* the effect of cash flow on investment. Rauh (2006) finds that a \$1 increase in total cash flow is associated with an increase in capital expenditures of just \$0.11. He argues that traditional investment-cash flow regressions may underestimate the causal effect if, for example, profitable investment opportunities arrive sporadically and generate cash flow with a lag.



sign is, in fact, being driven by capital market imperfections. It also connects the investment-cash flow sensitivity literature to the growing literature that looks at the effect of capital supply on firm decisions. For example, Lemmon and Roberts (2007) find that non-investment grade firms decreased investment in response to an exogenous contraction in the supply of below-investment-grade credit in 1989. Sufi (2007) finds that firms that obtain a syndicated bank loan rating after the introduction of these ratings in 1995 increased their investment. Leary (2005) examines the credit crunch of 1966 and finds that bank-dependent borrowers tend to substitute equity for debt when bank lending is tight. Finally, Chava and Purnanandam (2006) find that bank-dependent U.S. firms suffered negative abnormal returns when U.S. banks suffered an adverse shock due to the Russian financial crisis of 1998, indicating that lack of access to capital constrains firm decision-making.

Third, I provide large-sample evidence that other uses of cash do not respond to cash flow in a manner consistent with perfect capital markets. The fact that outflows to claimants do not increase with cash flow suggests that firms do not disgorge capital in excess of their immediate financing needs. The fact that firms actually take on more debt in response to additional cash flow is consistent with a particular form of capital market imperfections - that of financing capacity constraints driven by a firm's pledgable assets (e.g. Holmstrom and Tirole (1997); ch. 3 of Tirole (2006)). Blanchard, Lopez-de-Silanes and Shleifer (1994) find a similar effect in their small-sample setting. I am able to establish this result in a large-sample setting. The fact that cash balances increase with cash flow is consistent with firms retaining cash to hedge against future cash flow shortfalls.

Finally, my paper has important public policy implications. There is a large public finance literature that has examined the effect of taxation on firm investment decisions.<sup>9</sup> The focus of this literature has been on the effect of future marginal tax rates on investment incentives. Mine is, to the best of my knowledge, the first paper to examine the response of investment to the effects of taxation on *contemporaneous* cash flow.<sup>10</sup> The results suggest that investment can be stimulated not only by permanent reductions in the tax rate, but also by temporary reductions in tax-related cash outflows, such as tax holidays, temporary tax cuts, or deferred payment of taxes in low-investment periods.

The remainder of the paper is organized as follows. Section 2 provides background information, develops some terminology, and describes the methodology used in the paper. In section 3, I provide detail about the variables used in the empirical tests to follow and describe the sample. Section 4 presents the paper's results. Section 5 concludes.

## **2.1 Background and methodology**

Examining the sensitivity of investment to cash flow has long been used to investigate the importance of capital market imperfections for real investment decisions. I begin by discussing the historical development of this approach in order

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<sup>9</sup>See Hassett and Hubbard (2002) for a detailed review.

<sup>10</sup>Fazzari, Hubbard and Petersen (1988b) make the argument that, if firms have difficulty accessing external capital, taxes should have a contemporaneous effect on investment because they affect cash flow. See also Fazzari, Hubbard and Petersen (1988a) and Hubbard (1998).

to place my research design in context.<sup>11</sup> I then discuss essential aspects of the U.S. tax code and develop the terminology used in the paper. Finally, I describe the methodology used in the paper more fully.

### **2.1.1 Investment and cash flow**

How important are capital market imperfections for investment decisions by firms? With perfect capital markets, internal and external funds should be perfect substitutes, and investment and financing decisions independent. Capital market imperfections that introduce a wedge between the cost of internal and external funds can induce a dependence of investment on the availability of internal resources. Therefore, establishing a link between investment and internal resources can shed light on the importance of capital market imperfections.

Cash flow represents an accretion to a firm's internal resources and hence should be a determinant of investment if investment is dependent on internal resources. However, productivity and demand shocks are likely to affect both cash flow and a firm's investment opportunity set. Thus cash flow may be a predictor of investment opportunities. As a result, a simple test of the relationship between investment and cash flow would suffer from an omitted variable bias. Different strategies have been used in the literature in an attempt to isolate the causal effect of cash flow on investment.

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<sup>11</sup>Since the discussion is aimed at providing a foundation for the methodology employed in this paper, it is not intended to be comprehensive. See the survey of Hubbard (1998) for a more detailed discussion of the literature.

One approach to establishing a cash flow effect is to examine how investment-cash flow sensitivity varies cross-sectionally with variables indicating the likelihood of a firm being financially constrained: If capital market imperfections cause investment to respond to cash flow, then the relationship between investment and cash flow should be stronger for firms that are more likely to be constrained. Along these lines, Fazzari, Hubbard and Petersen (1988a) examine the relationship between investment and cash flow for subsets of firms formed on the basis of their dividend payout ratios. For each of these subsets, they estimate the effect of cash flow (*CF*) on capital expenditures (*capex*) using Tobin's *Q* as a control for the firm's investment opportunities. The model that they take to the data is

$$Capex_{i,t} = \alpha_i + \gamma_t + \beta_{CF}CashFlow_{i,t} + \beta_QTobin'sQ_{i,t-1} + \epsilon_{i,t}, \quad (2.1)$$

where the subscript *i* identifies the firm and *t* the time period. They predict that firms with lower dividend payout ratios - which they argue are more likely to be financially constrained - will exhibit stronger investment-cash flow sensitivity. Consistent with this prediction, they report  $\beta_{CF}$ 's of 0.254, 0.349 and 0.670 for groups of firms with high, medium and low dividend payout ratios respectively.

Both the underlying hypothesis and the empirical methodology used by Fazzari, Hubbard and Petersen (1988a) have been subject to critical scrutiny. Kaplan and Zingales (1997) argue that the assumption underlying Fazzari, Hubbard and Petersen's (1988a) hypothesis - that investment-cash flow sensitivity should be greater for more constrained firms - need not be correct. They show that, with a

concave production function and convex external capital costs, predictions about the effect of the level of a firm's internal resources on the sensitivity of investment to incremental internal resources can be ambiguous. In addition, they find that, among firms with the lowest dividend payout ratios identified by Fazzari, Hubbard and Petersen (1988a), those that appear less financially constrained based on management discussions in financial reports exhibit stronger investment-cash flow sensitivities.<sup>12</sup> Given these issues, Almeida, Campello and Weisbach (2004) argue that financing constraints are better investigated by examining the cash flow sensitivity of cash rather than investment.

Whether Fazzari, Hubbard and Petersen's (1988a) methodology adequately controls for cross-sectional differences in investment opportunity sets has also been disputed. Poterba (1988) points out that there are reasons to believe that the extent to which empirical Tobin's Q proxies for investment opportunities is likely to vary systematically with firm characteristics like dividend payout ratios. He argues that this could lead to spurious differences in the investment-cash flow sensitivity for subsamples formed on the basis of firm characteristics. Alti (2003) simulates data from a model in which there are no financing constraints and confirms that spurious correlation can produce results quantitatively similar to those of Fazzari, Hubbard and Petersen (1988a). Consistent with Poterba's (1988) argument, Erickson and Whited (2000) find that systematic investment-cash flow

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<sup>12</sup>Cleary (1999) provides large sample confirmation of the results of Kaplan and Zingales (1997). For further discussion, see also Fazzari, Hubbard and Petersen (2000), Kaplan and Zingales (2000), Gomes (2001), Moyen (2004), and ch. 3 of Tirole (2006).

sensitivity differences disappear when measurement error-consistent estimators are used, even for firms they expect are most likely to be financially constrained.

A cleaner alternative to the Fazzari, Hubbard and Petersen (1988a) approach is to utilize a quasi-natural experiment. This involves using cash flow variation that is plausibly exogenous to a firm's investment opportunity set to identify the effect of cash flow on investment. Blanchard, Lopez-de-Silanes and Shleifer (1994) find that firms receiving lawsuit windfalls unrelated to their ongoing lines of business usually increase investment in the same year. Lamont (1997) finds that the capital expenditures of non-oil subsidiaries of conglomerates with oil-producing subsidiaries fell in response to a large negative shock to oil prices. Rauh (2006) shows that a firm's investment is depressed by its mandatory pension contributions, controlling for the funding status of its pension plans. Since mandatory pension contributions are determined solely by funding status, controlling for funding status can be used to identify the cash flow effect of the mandatory contribution.<sup>13</sup>

My study also takes advantage of a quasi-natural experiment, using exogeneity introduced by the U.S. federal tax code to identify the direct effect of cash flow on investment. While cash flow as a whole is likely to proxy for investment opportunities, my approach allows me to isolate a component of total cash flow that is arguably free of such contamination. This enables me to obtain a relatively clean estimate of the effect of cash flow on investment. Such a strategy also allows me

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<sup>13</sup>In a paper somewhat related to these, Holtz-Eakin, Joulfaian and Rosen (1994) find that an entrepreneur who receives an inheritance has a greater probability of continuing to operate as a sole proprietor in the future and have larger operations, conditional on surviving, than an entrepreneur who does not receive an inheritance.

to examine in greater detail the importance of capital market imperfections for investment decisions.<sup>14</sup>

### 2.1.2 Tax liability terminology and relationships

A publicly-traded corporation in the United States maintains two sets of accounting books. While the financial statements of the firm are intended to convey a firm's financial state and performance, a firm's tax books are designed for the calculation of its federal income tax burden. Accounting and tax treatment differ for many items, so financial and tax measures of profitability are generally different. For this study, the relevant measures need to be drawn from the tax books. To avoid unnecessary confusion, in what follows I clearly define the variables that I need to implement the methodology used in this paper.

I define *profits* as the difference between a firm's tax-book revenues and expenses for the year.<sup>15</sup> *Taxable income*, on the other hand, is the amount of income that is subject to taxation by the Internal Revenue Service (IRS). In years in which a firm incurs a loss on its tax books, it is allowed to carry forward the loss for possible offset against future profits. These *NOL carryforwards* give rise to *NOL deductions* in later years. In general, taxable income is derived from profits by

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<sup>14</sup>My paper focuses on the effect of internal sources of finance on investment. Papers that examine the effect of external sources of finance on investment include those by Pulvino and Tarhan (2006) and Kim and Weisbach (2008).

<sup>15</sup>Expenses include operational and financial expenses.

subtracting claimed and allowable NOL deductions.<sup>16</sup> Thus,

$$\text{TaxableIncome} = \text{Profits} - \text{NOLDeductions}. \quad (2.2)$$

The amount of NOL deductions is limited by the level of profits earned during the year. That is,

$$\text{NOLDeductions} = \min\{\text{Profits}, \text{Carryforwards Available}\}. \quad (2.3)$$

A firm's actual tax liability is computed by applying the tax rate schedule to taxable income. Let  $\tau(\cdot)$  denote the tax schedule function.<sup>17</sup> A firm's actual tax liability is computed by applying the tax schedule to taxable income:

$$\text{ActualTaxLiability} = \tau(\text{TaxableIncome}). \quad (2.4)$$

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<sup>16</sup>There are actually two categories of deductions that are subtracted - NOL deductions and special deductions. Special deductions are deductions for dividend income. I ignore this form of deduction here. In addition, NOL deductions can include both carryforward and carryback deductions. The latter occur because the tax code allows losses to be carried backwards for up to 3 years to offset past tax profits. I focus on carryforward deductions in this paper.

<sup>17</sup>U.S. federal corporate income tax rates are, and have traditionally been, graduated. For example, at present, corporations are taxed at a rate of 15% for the first \$50,000 of taxable income, 25% for income between \$50,000 and \$75,000, 34% for income between \$75,000 and \$100,000, 39% for income between \$100,000 and \$335,000, and 34% again for income between \$335,000 and \$10,000,000, 35% for income between \$10,000,000 and \$15,000,000, 38% for income between \$15,000,000 and \$18,333,333, and finally 35% again for income above \$18,333,333. The rate schedule has varied over time.



I define *pro forma tax liability* as the taxes due if profits were taxed without applying NOL deductions first. Thus,

$$ProFormaTaxLiability = \tau(Profits). \quad (2.5)$$

This reflects tax liability driven solely by current year profits, irrespective of the amount of carryforwards available as a result of historical tax losses.<sup>18</sup> The difference between pro forma tax liability and actual tax liability is, then, solely attributable to NOL deductions. Compared to an otherwise identical firm with no NOL deductions, this difference corresponds to an actual extra cash flow that is available for investment or distribution. The amount of this extra cash flow is called *NOL tax savings*, where

$$NOLTaxSavings = ProFormaTaxLiability - ActualTaxLiability. \quad (2.6)$$

A firm's carryforwards available represents a stock that is augmented as the firm experiences further tax losses and depleted as NOL deductions are used or the carryforwards expire.<sup>19</sup> The stock of carryforwards at any point in time, then, places a ceiling on the amount of tax savings a firm can realize. I refer to this ceiling as the firm's *tax savings capacity*, which is calculated as the amount of NOL tax savings realized when a firm's current profits just equal its carryforwards available.

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<sup>18</sup>Equivalently, this would be the tax liability of an alternative firm with the same operations which did not enjoy the tax benefits of loss carryforwards.

<sup>19</sup>Firms are currently permitted to carry losses forward for up to 20 years. This was increased from 15 to 20 years in 1997, and from 5 to 15 years in 1981. The use of carryforwards is governed by Internal Revenue Code §172(b)(1)(A).

That is,

$$\text{TaxSavingsCapacity} = \tau(\text{CarryforwardsAvailable}) \quad (2.7)$$

An example helps fix ideas. Suppose that a firm enters the year with \$100 of carryforwards available from prior tax losses and that the tax rate is a constant 40%. I consider three profit levels: \$75, \$100, and \$125. The calculations of pro forma tax liability, actual tax liability and NOL tax savings for each of these three profit levels are below:

Profits	\$75	\$100	\$125
Tax rate	40%	40%	40%
Pro forma tax liability	\$30	\$40	\$50
Current year profits	\$75	\$100	\$125
NOL deductions	\$75	\$100	\$100
Taxable income	\$0	\$0	\$25
Tax rate	40%	40%	40%
Actual tax liability	\$0	\$0	\$10
Pro forma tax liability	\$30	\$40	\$50
Actual tax liability	\$0	\$0	\$10
NOL tax savings	\$30	\$40	\$40

Pro forma tax liability increases at the tax rate (40%) with profits. Actual tax liability is \$0 when profits are \$75 or \$100, since the amount of carryforwards available (\$100) is greater than or equal to the amount of profits, but is \$10 when profits are \$125. This \$10 represents the tax on profits in excess of the amount of carryforwards available. Actual tax liability only increases with profits for the amount of profits that exceeds carryforwards available. NOL tax savings are \$30 when profits are \$75. They increase to \$40 when profits increase to \$100, as an ad-

ditional \$10 of savings are enjoyed (pro forma tax liability increases by \$10 while actual tax liability remains the same). However, they do not increase again as profits increase to \$125, as the firm's carryforwards are already fully exhausted, and pro forma and actual tax liability both increase by \$10.

The connection between pro forma and actual tax liability is key to the methodology used in this paper. An incremental dollar of pro forma tax liability results in an additional dollar of actual tax liability only if pro forma tax liability exceeds a firm's tax savings capacity. Formally,

$$\frac{\partial ActualTaxLiability}{\partial ProFormaTaxLiability} = \begin{cases} 0 & \text{if } ProFormaTaxLiability \\ & < TaxSavingsCapacity \\ 1 & \text{if } ProFormaTaxLiability \\ & \geq TaxSavingsCapacity. \end{cases} \quad (2.8)$$

NOL tax savings are the complement of actual tax liability. Holding fixed pro forma tax liability, if NOL tax savings increase by \$1, then actual tax liability decreases by \$1, and vice versa. NOL tax savings can alternatively be written as

$$NOLTaxSavings = \min\{ProFormaTaxLiability, TaxSavingsCapacity\}. \quad (2.9)$$

The sensitivity of NOL tax savings to pro forma tax liability is

$$\frac{\partial \text{NOLTaxSavings}}{\partial \text{ProFormaTaxLiability}} = \begin{cases} 1 & \text{if } \text{ProFormaTaxLiability} \\ & < \text{TaxSavingsCapacity} \\ 0 & \text{if } \text{ProFormaTaxLiability} \\ & \geq \text{TaxSavingsCapacity}. \end{cases} \quad (2.10)$$

The sharp nonlinearity in the relationship between NOL tax savings and pro forma tax liability forms the basis for the empirical approach of this paper.<sup>20</sup> Figure 2.1 presents a graphical depiction of the relationships among the tax variables.

### 2.1.3 Investment and NOL tax savings methodology

With the basic terminology introduced, I can now proceed to explain the methodology employed in this paper. As mentioned earlier, estimates of investment-cash flow sensitivity derived from firm data suffer from the problem that current cash flow may be correlated with investment opportunities. As a result, obtaining a significant coefficient on cash flows in such regressions is not sufficient to establish a *causal* relationship between cash flows and investment.

In order to distinguish a causal effect, I construct a measure of cash flows that is purged of associations with investment opportunities. As a first step to understanding this methodology, note that the total cash flows of a firm can be written

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<sup>20</sup>This nonlinearity takes the specific form of a kink.

as

$$\begin{aligned} \text{CashFlow} &= \text{PreTaxCashFlow} - \text{ActualTaxLiability} \\ &= \text{PreTaxCashFlow} - \text{ProFormaTaxLiability} + \text{NOLTaxSavings}. \end{aligned} \tag{2.11}$$

Pre-tax cash flow and pro forma tax liability may both be correlated with investment opportunities if economic shocks affect both current profitability levels and investment opportunities. NOL carryforwards available may also predict investment opportunities if past economic shocks affect both past profitability and current investment opportunities.

I use the calculated NOL tax savings as a measure of cash flows that are not contaminated by investment opportunities. Recall that this measure is entirely determined by (a) pro forma tax liability and (b) NOL carryforwards available, according to the formula

$$\begin{aligned} \text{NOLTaxSavings} &= \min\{\text{ProFormaTaxLiability}, \text{TaxSavingsCapacity}\} \\ &= \min\{\text{ProFormTaxLiability}, \tau(\text{CarryforwardsAvailable})\}. \end{aligned} \tag{2.12}$$

That is, when NOL carryforwards are not exhausted during the course of a year, NOL tax savings are exactly equal to pro forma tax liability. However, as soon as pro forma tax liability exceeds tax savings capacity, which is determined by the amount of carryforwards available, NOL tax savings do not increase any further.

It is this sharp discontinuity in slopes that I exploit to achieve clean identification of the effect of cash flow on investment.

To see how this can be done, note first that investment is potentially related to pro forma tax liability for two reasons: (a) profits affect investment directly and (b) profits are related to investment opportunities. Since pro forma tax liability is a monotonic transformation of profits, a regression of capital expenditures on pro forma tax liability should produce a non-zero coefficient if profits are related to investment. A similar outcome should be expected for NOL carryforwards since they reflect past profitability.

As a result, an investment equation estimated with pro forma tax liability, NOL carryforwards and pre-tax cash flow as explanatory variables may be expected to have significant explanatory power. To the extent that NOL tax savings coincide with pro forma tax liability, NOL tax savings would be redundant in the investment equation. However, NOL tax savings do not always coincide with pro forma tax liability, as can be seen from (2.12). The sharply nonlinear relationship implies that a non-zero coefficient on NOL tax savings can be attributed purely to cash flow effects, unconnected with investment opportunities. This is because, first, NOL tax savings *are* cash flows, and second, since pro forma tax liability and NOL carryforwards available are in the investment equation, they already account for any relationship NOL tax savings may have with investment opportunities. Based

on this reasoning, the primary regression equation estimated in this paper is

$$\begin{aligned}
 Investment_{i,t} = & \alpha_i + \gamma_t + \beta_{Savings} NOLTaxSavings_{i,t} \\
 & + \beta_{Carryforwards} CarryforwardsAvailable_{i,t} \\
 & + \beta_{ProFormaTaxLiability} ProFormaTaxLiability_{i,t} \\
 & + \beta_{PTCF} PreTaxCashFlow_{i,t} + \beta_Q Q_{i,t-1} + \epsilon_{i,t} \quad (2.13)
 \end{aligned}$$

where  $\alpha_i$  and  $\gamma_t$  represent firm and year effects respectively, and beginning Tobin's Q is included as a proxy for investment opportunities. The hypothesis that I test using this specification is that cash flow causally affects investment. The null hypothesis that investment is independent of cash flow can be written as  $\beta_{Savings} = 0$ . An estimate of  $\beta_{Savings} > 0$  indicates that firms, on average, respond to an increase in internal resources by increasing investment. The identification scheme can be interpreted graphically. Observe figures 2.2a and 2.2b.

In figures 2.2a and 2.2b, pro forma tax liability is shown as an increasing function of profits. The angle of this curve is determined by the tax rate, which is assumed to be flat in the figures for simplicity. In figure 2.2a, the investment curve is smooth as it passes through the point at which profits equal carryforwards available. This, in turn, indicates a smooth relationship between investment and pro forma tax liability. The relationship between investment and pro forma tax liability could arise due to either a direct effect of cash flows on investment, cash flow proxying for investment opportunities, or both. Although the investment curve is pictured as linear and increasing, neither of these assumptions need be true.

In figure 2.2b, the slope of the investment curve abruptly decreases as the curve passes through the point at which profits equal carryforwards available. This, in turn, indicates that the relationship between investment and pro forma tax liability changes sharply exactly at the point at which NOL carryforwards are exhausted and no further tax savings are realized.<sup>21</sup> Unless the relationship between investment and profits exhibits such a sharp change on its own, then the change in slope must be related to the exhaustion of NOL carryforwards. Since the only economic change that happens at this point is the cessation of cash flows generated through the utilization of tax shields, this change of slope can be attributed to this effect alone.

NOL tax savings increase one-for-one with pro forma tax liability up to the point at which carryforwards are exhausted, but do not change with pro forma tax liability beyond that point. Ignoring the other variables in the regression equation, as pro forma tax liability changes up to the point at which carryforwards are exhausted, expected investment changes at a rate of  $\beta_{ProFormaTaxLiability} + \beta_{Savings}$ . However, beyond this point, it only changes at a rate of  $\beta_{ProFormaTaxLiability}$ . If  $\beta_{Savings}$  is non-zero, then the slope of the relationship between expected investment and pro forma tax liability changes abruptly. This abrupt change identifies the effect of NOL tax savings.

The presence of both controls (pro forma tax liability and carryforwards available) in the investment equation allows for clean identification of NOL tax savings

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<sup>21</sup>This reaching of capacity is reflected in a change in the slope of the NOL tax savings curve from positive to 0.



as a pure cash flow effect. However, it is not guaranteed that the entire effect of these controls on investment is captured by the linear specification employed. For example, their total effects on the dependent variable may be better captured by non-linear forms. Hence it is necessary to check whether the identification of cash flow effects through NOL tax savings is robust to allowing for more complicated forms of dependence of investment on the controls. In what follows, I allow significant scope for non-linear representations of the control variables to ensure that my identification strategy survives such perturbations.

The methodology employed in this paper is related to the approach of Rauh (2006), who also investigates the effect of a cash flow variable that is a nonlinear deterministic function of other variables. It is also related to the approach used by Classen (1977) in investigating the effect of unemployment benefits on unemployment duration. Classen is able to disentangle the independent effect of unemployment benefits by taking advantage of the fact that unemployment benefits are typically capped, so that they do not increase with pre-job loss income beyond a specified point. If unemployment duration is related to the level of unemployment benefits, independently of any relationship through pre-job loss income, then the relationship between unemployment duration and pre-job loss income will exhibit a kink at the point of the cap. The sharpness of the kink measures the independent effect of unemployment benefits on unemployment duration.

## 2.2 Data and sample construction

The firm data used in this paper come from the COMPUSTAT database of annual financial filings by publicly-traded firms. My sample period extends from 1969 through 2005. Pre-1969 data is not used because COMPUSTAT's apparent coding practice for the pre-1969 period limits its usefulness for my purposes.<sup>22</sup> Tax rate data come from the U.S. federal corporate income tax schedules.<sup>23</sup> I supplement these data sources with data on corporate bond yields from the Federal Reserve's website, on seasoned equity issuance activity from Securities Data Corporation (SDC) Platinum's Global Issue database, on GDP growth from the National Bureau of Economics (NBER), and on a firm's geographic scope from the COMPUSTAT segments database. In the rest of this section, I describe how I construct my variables of interest and how I form my sample.

### 2.2.1 Variable construction

All of the variables described below are scaled by beginning-of-year total assets (item 6, where item hereafter refers to COMPUSTAT item number).<sup>24</sup> As described in the previous section, investment is the dependent variable in the primary regression equation. Investment can take many forms. Consistent with the

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<sup>22</sup>Prior to 1969, current tax expense is only broken out into federal, state and foreign current tax expense if the firm did not end the year with unused NOL carryforwards. When current tax expense is disaggregated, NOL carryforwards are missing. As I need data on both carryforwards and current federal tax expense, I begin my analysis with 1969.

<sup>23</sup>Source for 1969-2003: Internal Revenue Service Publication 542, "Marginal Rates of the Federal Corporation Income Tax, 1942-2003." Source for 2004 and 2005: <http://www.smbiz.com/sbrl001.html>.

<sup>24</sup>Results do not vary qualitatively if variables are scaled by total plant, property and equipment instead.

existing literature, I focus primarily on capital expenditures (item 128). However, I also examine the effect of NOL tax savings on other forms of investment, which are defined later.

Total firm cash flow is the sum of net income before extraordinary items (item 18) and depreciation and amortization (item 14). Since tax books are unavailable, I use current federal income tax expense (item 63) to measure actual tax liability.<sup>25</sup> Pre-tax cash flow is simply the sum of total cash flow and actual tax liability. Carryforwards available are item 52. I discuss some of the known issues with using COMPUSTAT current tax expense and carryforward data in the appendix.

Pro forma tax liability is calculated by grossing up actual tax liability to compute taxable income, adding to this reductions in carryforwards during the year, and then computing the hypothetical tax on this amount.<sup>26</sup> NOL tax savings are then the difference between pro forma and actual tax liability. Finally,  $Q$  is calculated as the quotient of the market and book values of a firm's assets. Market value (the numerator) is book assets (item 6) plus the market value of equity (the product of items 199 and 25) minus book equity (item 60) minus deferred taxes (item 74). Book value (the denominator) is simply book assets (item 6).

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<sup>25</sup>Current federal income tax expense is commonly used as an estimate of federal income tax liability in corporate tax studies.

<sup>26</sup>This computation ignores the possibility that NOL carryforwards may simply expire. This issue is acute prior to 1981, when carryforwards expired after only 5 years. As a robustness check, I remove all pre-1981 observations for firms that reported positive carryforwards 5 years before the year of the observation.

### 2.2.2 Sample construction

I begin with all observations in the COMPUSTAT database from 1969 through 2005 for which beginning-of-year total assets exceed \$10 million in 2005 dollars, excluding firms in the financial industry (SIC code between 6000 and 6999) and utilities (SIC code between 4900 and 4999).<sup>27</sup> This initial sample contains 171,248 observations. The minimum size requirement reduces the noise created by small denominators in the scaling of the variables.<sup>28</sup> I then eliminate all observations for which any of the variables described above are missing, which leaves 85,407 observations.

I next apply several screens to ensure the internal consistency of the data and its appropriateness for my study. Observations for which current federal income tax expense is less than 0 are eliminated, as these observations likely represent either unprofitable firms using NOL carrybacks or encoding errors. Observations for which current federal income tax expense is greater than 0 but ending NOL carryforwards (item 52) are also greater than 0 are eliminated. Unless there are restrictions on the use of carryforwards, either because they are foreign or because they are acquired and subject to a section 382 limitation, a firm should not pay taxes until all of its carryforwards are consumed.<sup>29</sup>

Observations for which current federal income tax expense is equal to 0 and carryforwards increase during the period are eliminated. These likely represent

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<sup>27</sup>Total assets are converted to the 2005 dollars using the consumer price index as a deflator.

<sup>28</sup>The results are very similar if a size filter is not imposed.

<sup>29</sup>After 1986, section 382 of the Internal Revenue Code limits the use in any year of carryforwards obtained through an acquisition to the product of the value of the acquired firm' stock before the acquisition and the long-term tax exempt rate.

cases in which a firm has suffered a tax loss and is accruing new carryforwards. Pro forma tax liability is meaningless in this case and hence I do not include these observations. Finally, observations are eliminated if both current federal income tax expense and end-of-period carryforwards are 0.<sup>30</sup> To test the importance of these restrictions, I have in unreported results relaxed each individually and all simultaneously, and verified that the paper's results do not change qualitatively.

What remains is a sample of tax-profitable firm-year observations. For some of these observations, the firm possess tax loss carryforwards with which to offset some or all of its profits. The resulting panel consists of 52,409 observations for 7,785 firms. To reduce the influence of possible outliers, I winsorize capital expenditures and lagged Q at the 99% level. Because of the deterministic mathematical relationships among carryforwards available, pro-forma tax liability, actual tax liability and pre-tax cash flow, I trim rather than winsorize these variables at the 99th percentile (and at the 1st percentile in the case of pre-tax cash flow, which can take on negative values).<sup>31</sup> This trimming reduces the sample to 50,967 observations for 7,369 firms. These data cover 37 years (approximately 1,377 observations per year) spanning multiple macroeconomic cycles. To take advantage of the panel structure of the data, I employ first differences regressions throughout the study. The first differenced data consists of 38,442 observations for 5,573 firms.<sup>32</sup>

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<sup>30</sup>In principle, it is possible that a firm experiences pro forma tax liability just sufficient to exactly consume all of its carryforwards, but this razor's edge scenario seems unlikely, and encoding error seems a more plausible explanation.

<sup>31</sup>I have re-obtained the paper's results using various approaches to mitigating the potential effects of outliers.

<sup>32</sup>First differencing requires that a firm be in the sample in consecutive years. This eliminates 5,967 observations. The first differencing itself reduces the sample size by another 8,000 observations.

Figure 2.3 summarizes the distribution of the sample over time. Several features are noteworthy. First, there is a decline in the total number of observations from the 1970s to the 1980s. While the number of firms in COMPUSTAT increases over this period, the proportion of firms with missing values reported for NOL carryforwards (item 52) or current federal tax expense (item 63) also increases. Second, there is a steady decline in total observations beginning in the late 1990s. This is driven by a decrease in the number of firms reported by COMPUSTAT during this period.

Third, the number of firms in the sample using NOL carryforwards exhibits some cyclicality, with peaks in 1976, 1987 and 2002. Finally, the savings generated by carryforwards for firms in the sample increases sharply in 2002, and remains high afterwards. Firms suffered tremendous tax losses in 2000 and 2001, which for many that survived resulted in large tax savings after they returned to profitability in 2002.<sup>33</sup>

Panel A of table 2.1 presents summary statistics for the full sample of 50,967 observations. This sample represents a broad cross-section of COMPUSTAT firms. Panel B compares observations in the sample for firms with NOL carryforwards available to those lacking carryforwards. Loss carryforward firms are, on average, younger, smaller, less profitable, and more highly-leveraged than firms lacking carryforwards. The relatively low profitability is not surprising since carryforward firms by definition have suffered losses - at least on a tax basis - in the recent

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<sup>33</sup>In unreported results, I have verified that the paper's results are very similar if observations in years after 2001 are excluded from the sample.

past. It is also apparent that many of the carryforward firms in the sample have only been publicly-traded for a short time. Interestingly, though, Tobin's Q does not vary substantively between the two subsamples. This, combined with the fact that all firms in the sample are profitable on a tax basis in the current year by construction, suggests that carryforward firms in the sample cannot be readily categorized as "distressed" firms. In robustness checks, I apply filters to the sample to ensure that the results obtained in the paper are not driven by relatively recent IPOs or small firms.

## **2.3 Results**

This section presents the paper's results. The methodology developed in section 2 is employed throughout. I begin by showing that capital expenditures respond positively to NOL tax savings, controlling for pro forma tax liability and carryforwards available (section 4.1). This indicates that a firm's capital expenditures are causally affected by its internal resources. I also show that several other measures of investment also respond positively to an increase in cash flow (section 4.2). I then investigate whether the sensitivity of investment to cash flow varies with firm-specific characteristics that have been used in the literature as proxies for accessibility of external capital (section 4.3). I find, with one notable exception, that these proxies do not reliably predict investment-cash flow sensitivities in the cross-section.

Next, I investigate whether the sensitivity of investment to cash flow varies with capital market conditions (section 4.4). I use the spread between Moody's Baa- and Aaa-rated corporate bond yields to measure capital market conditions. I show that the sensitivity of capital expenditures to cash flow from NOL tax savings increases as capital market conditions worsen. In fact, capital expenditures are generally *insensitive* to cash flow when capital market conditions are at their most favorable. I also show that capital market conditions matter more for firms that are less established in capital markets - those with no credit rating.

Finally, I examine the effect that cash flow has on distributions to shareholders and cash retentions, as well as borrowing and debt repayment (section 4.5). I find that neither dividend payouts nor share repurchases respond to NOL tax savings. Consistent with the arguments of Almeida, Campello and Weisbach (2004) and others that firms retain cash flow in anticipation of future financing constraints, NOL tax savings result in growth in cash balances. Last, I find that, not only do firms forgo using additional cash flow to repay debt, but they actually *increase* debt levels in response to greater cash flow from NOL tax savings.

### **2.3.1 NOL tax savings and capital expenditures**

I now present the paper's results in detail. Most of these results are obtained through regression analysis. As a preliminary note, all regressions throughout the paper include year effects. Unless otherwise noted, all regressions are run in first differences to account for firm fixed effects. Heteroscedasticity-robust standard



errors, clustered at the firm level, are reported in parentheses below each point estimate.

I begin by examining the impact of cash flow on capital expenditures. The results are summarized in table 2.2. The dependent variable in all regressions in this table is capital expenditures scaled by beginning-of-year assets. All explanatory variables are also scaled by beginning-of-year assets, except for Tobin's Q. Consistent with previous investment-cash flow sensitivity papers, lagged Tobin's Q is included in all regressions, though its exclusion has no qualitative effect on the results.

As a starting point, I verify that capital expenditures are positively associated with total cash flow. In column 1, the only explanatory variable is total cash flow. A \$1 increase in total cash flow is associated with a highly statistically significant \$0.313 increase in capital expenditures. This is similar to existing estimates.<sup>34</sup>

Next, I investigate the relationship between capital expenditures and actual tax liability. Total cash flow can be disaggregated into pre-tax cash flow and actual tax liability. Along with lagged Q, these are the explanatory variables in column 2. Controlling for pre-tax cash flow, the coefficient on actual tax liability is negative, large and statistically significant. While this is consistent with a cash flow effect of taxation, actual tax liability may continue to be endogenous even after controlling

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<sup>34</sup>Fazzari, Hubbard and Petersen (1988) estimate that a \$1 increase in cash flow is associated with increases in capital expenditures of \$0.67, \$0.35 and \$0.25 for three different groups of firms during the period 1970-1984. Rauh (2006) estimates that a \$1 increase in cash flow is associated with a \$0.11 increase in capital expenditures for a set of firms during the period 1990-1998. I obtain similar estimates to those of Fazzari, Hubbard and Petersen (1988) and Rauh (2006) if I restrict my sample to the same years included in each of their studies respectively.

for pre-tax cash flow. Thus it may not be a good instrument for examining the effect of tax-related cash flow on investment.

I now implement the identification strategy using NOL carryforwards described in section 2. Column 3 contains the results from estimating the primary regression equation in (2.13) for capital expenditures. The variable of primary interest is the NOL tax savings variable. Controlling for pro forma tax liability, NOL carryforwards available, pre-tax cash flow and lagged Tobin's Q, the coefficient on NOL tax savings is positive and statistically significant at the 1% level. The coefficient indicates that a \$1 increase in internal resources results in an estimated increase in capital expenditures of \$0.345 that is not contaminated by a firm's investment opportunity set. Comparing this estimate to the coefficient on total cash flow in column 1 suggests that estimates from simple investment-cash flow regressions are not substantively biased upwards or downwards.

The coefficient on pro forma tax liability is -0.638 and is highly statistically significant. Because this variable may be endogenous, it is not clear how one should interpret this coefficient in isolation. However, what can be said is that, controlling for pre-tax cash flow, \$1 of pro forma tax liability that is not shielded by loss carryforwards is associated with a fall in investment of \$0.638, while \$1 of pro forma tax liability that is shielded from taxation is associated with a fall in investment of only \$0.293.

Capital expenditures do not appear to vary with the amount of NOL carryforwards a firm has available. Auerbach and Poterba (1986) argue convincingly that the predicted effect of NOL carryforwards on investment is ambiguous. The

availability of NOL carryforwards reduces the firm's marginal tax rate, thereby increasing after-tax returns to investment, which provides stronger incentives to invest. On the other hand, capital expenditures generate depreciation tax shields. To the extent that these are substitutes for NOL tax shields, incentives to invest are weakened when a firm has significant carryforwards. In unreported results, carryforwards available are positively but weakly associated with capital expenditures if the amount of tax savings is not included in the regression. NOL tax savings appear to subsume this effect.

The inclusion of pro forma tax liability and carryforwards available is intended to purge the coefficient on NOL tax savings of any spurious correlation through investment opportunities. While column 3 presented results based on this specification, the controls need not be linearly related to investment opportunities. As NOL tax savings are determined by these controls, nonlinearities in the underlying relationships could bias the coefficient on NOL tax savings. I confront this possibility by adding the second and third powers of pro forma tax liability and carryforwards available to the main specification. The results are presented in column 4. The coefficient on NOL tax savings increases to 0.408 when the higher powers of the control variables are added, and remains statistically significant at the 1% level. Adding additional powers of pro forma tax liability and NOL carryforwards available has negligible effect. Nonlinear relationships between investment opportunities and the variables that determine NOL tax savings do not appear to be driving the paper's results.

A sufficient assumption for unbiased estimation using first differences is that the error term in the true model follows a random walk. If this assumption is violated, then first differences estimates could be biased because first differences regressions will yield autocorrelated residuals. For example, negative autocorrelation of the residuals in the first differences model is expected to occur if the error term is independently distributed. Column 5 replicates column 3 using the Prais-Winsten transformation (see Prais and Winsten 1954) to allow for the possibility of first-order autocorrelation in the residuals. The estimated autocorrelation coefficient from the regression is -0.30, suggesting that autocorrelation in the simple first differences regressions is potentially an issue. However, the coefficient on NOL tax savings actually increases slightly to 0.368 in this specification, and remains statistically significant at the 1% level.

In column 6, I re-estimate the primary specification using firm fixed effects instead of first differences. For comparability with the first differences results, I include an observation only if an observation for the same firm is available in either the year before or year after. The coefficient on NOL tax savings jumps in the firm fixed effects regression to 0.582 and is statistically significant at the 1% level.

I turn next to non-parametric analysis to further investigate the response of capital expenditures to cash flow created by NOL tax savings. I begin by regressing capital expenditures on a number of non-tax variables that one would expect to be important determinants of investment, including pre-tax cash flow, lagged Tobin's Q, and firm and year fixed dummies. I then use the residuals

from the first stage as a dependent variable in a kernel regression, with a variable that I call *DistanceToKink* as the independent variable. *DistanceToKink* is defined as  $(ProFormaTaxLiability - TaxSavingsCapacity)$ , scaled by beginning-of-year total assets. *TaxSavingsCapacity* is the maximum amount of tax that can be avoided in the period using loss carryforwards. See section 2.2 for a formal definition of *TaxSavingsCapacity*. If *DistanceToKink* is negative, then the firm does not exhaust its carryforwards in the current year and therefore pays no taxes. The closer this value is to 0, the closer the firm is to completely exhausting its carryforwards. When *DistanceToKink* is 0, the firm just exhausts its carryforwards. *DistanceToKink* is positive if the firm's carryforwards are insufficient to fully shield the firm from tax liability.

The results of the kernel regression appear in figure 2.4. The kernel regression employs the Epanechnikov kernel, with a bandwidth of 0.02. A sharp downward kink is readily observed at the point at which *DistanceToKink* equals 0. Consistent with the results in table 2.2, an increase in pro forma tax liability that does not actually result in a cash outflow has little effect on capital expenditures. An increase in pro forma tax liability that actually creates tax liability has a dampening effect on investment. The effect of crossing the threshold from one regime to the other appears to be quite sharp.

### **2.3.2 NOL tax savings and other forms of investment**

While empirical models of investment typically focus on capital expenditures, corporate investment activity can take many other forms. For example, a firm can

invest in working capital, use cash to acquire another firm, undertake research and development, or invest in market share by advertising. It can also increase its production capacity by leasing additional production assets. Existing evidence of the dependence of these forms of investment on the availability of internal resources is limited. I now test whether the availability of internal resources impacts the pursuit of these other forms of investment.

In table 2.3, I present results from estimation of the primary regression equation, where the dependent variables are investment variables other than capital expenditures. The dependent variable varies by column. The number of observations varies based on the availability of data for each of the dependent variables in COMPUSTAT. The dependent variables are change in working capital (column 1), cash acquisitions (column 2), advertising expense (column 3), rental expense (column 4), and research and development expense (column 5).<sup>35</sup> All dependent variables are scaled by beginning-of-year assets. The NOL tax savings coefficient is positive and statistically significant at the 5% level or better in the working capital investment, acquisitions, advertising expenses, and rental expenses regressions.

This indicates that each of these forms of investment is dependent on a firm's in-

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<sup>35</sup>Change in working capital is defined as working capital at the end of the current year less working capital at the end of the previous year, where working capital is inventory (COMPUSTAT item 3) plus accounts receivable (item 2) less accounts payable (item 70). Cash acquisitions are item 129. Advertising expense is item 45. Rental expense is item 47. Research and development is item 46, with zero substituted if the the value is missing in COMPUSTAT.

ternal resources.<sup>36</sup> Research and development, on the other hand, does not appear to respond to an increase in internal resources.<sup>37</sup>

### 2.3.3 NOL tax savings and capital expenditures in the cross-section

The results presented thus far indicate that cash flow has a significant positive effect on investment for the full sample. Researchers have developed a number of proxies for the extent to which any individual firm is financially constrained in an effort to test whether investment is more sensitive to cash flow for more constrained firms. While I take no position on the reasonableness of these proxies, I now investigate whether these characteristics predict which firms exhibit greater sensitivity of investment to cash flow. I continue to use NOL tax savings to identify the effect of cash flow.

The first proxy is the commonly-used Kaplan-Zingales 4-variable index of financing constraints.<sup>38</sup> The second is the index of Whited and Wu (2006). This index is computed using quarterly data. I use the mean quarterly value of the

<sup>36</sup>The finding that working capital investment is sensitive to cash flow is consistent with the finding of Fazzari and Petersen (1993) that working capital and fixed investment compete for funding from a firm's pool of available finance. Blanchard, Lopez-de-Silanes and Shleifer (1994) report evidence that acquisitions respond to cash flow.

<sup>37</sup>Evidence in the literature on the response of research and development to internal resources is mixed. For example, Himmelberg and Petersen (1994) find a positive association between spending on R&D and cash flow for a sample of very small firms. On the other hand, a number of earlier papers found no evidence of such a relationship for a broader sample of firms.

<sup>38</sup>The Kaplan-Zingales 4-variable financing constraint index is computed as

$$-1.002 \frac{CF_{i,t}}{Assets_{i,t-1}} - 39.368 \frac{Div_{i,t}}{Assets_{i,t-1}} - 1.315 \frac{Cash_{i,t}}{Assets_{i,t-1}} + 1.319 Lev_{i,t},$$

where  $CF$  is cash flow (item 14 + item 18),  $Div$  is common and preferred dividends paid (item 19 + item 21),  $Cash$  is cash balance (item 1),  $Assets$  are total book assets (item 6), and  $Lev$  is book leverage ((item 9 + item 34)/(item 9 + item 34 + item 216)). The higher the value of the index, the greater the predicted likelihood that a firm faces financing constraints. The index was first used as an instrument for measuring financing constraint severity by Baker, Stein and Wurgler (2003). It is derived from work by Kaplan and Zingales (1997) and Lamont, Polk and Saa-Requejo (2001).

index for the year.<sup>39</sup> The third is a firm's net leverage, which is debt (the sum of COMPUSTAT items 9 and 34) less cash and equivalents (COMPUSTAT item 1), scaled by total assets. The fourth proxy is an indicator variable that takes a value of 1 if the firm paid dividends in the most recent year and 0 if it did not. The fifth is an indicator for whether the firm has a Standard and Poor's credit rating. I measure each of the variables at the beginning of each year.

I begin by re-estimating the primary regression equation, adding the Kaplan-Zingales index and its interaction with each of the right-hand side terms of the primary regression equation as additional explanatory variables. I then repeat the exercise using each of the other proxies for financing constraints in place of the Kaplan-Zingales index. The variable of interest in each of the resulting five regressions is the interaction of NOL tax savings and the financing constraint proxy. The results are presented in table 2.4. The number of observations in each column varies slightly with the availability of data in COMPUSTAT for computing the financing constraint proxies. Only the coefficients on NOL tax savings, the financing constraint proxies, and their interactions are presented in the interest of conserving space.

The financing constraint proxies on the whole appear to have little predictive power over the response of investment to cash flow from NOL tax savings. Only

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<sup>39</sup>The Whited and Wu (2006) index is computed as

$$-0.091 \frac{CF_{i,t}}{Assets_{i,t}} - 0.062 DIVPOS_{i,t} + 0.021 \frac{LTD_{i,t}}{Assets_{i,t}} - 0.044 \ln(Assets_{i,t}) + 0.102 ISG_{i,t} - 0.035 SG_{i,t},$$

where *DIVPOS* equals 1 if the firm pays a dividend and 0 if it does not, *LTD* is long-term debt (item 9), *ISG* is industry sales growth rate, and *SG* is firm sales growth rate.



one - the credit rating indicator - has an effect that is statistically significant at the 5% level. Consistent with the findings of Whited (1992), investment appears to be significantly more sensitive to cash flow for firms lacking credit ratings. This suggests that ready access to the public debt market is important in providing a firm with the flexibility to undertake investments. I show shortly that this is especially true when credit market conditions are poor.

#### **2.3.4 NOL tax savings, investment and capital market conditions**

Following Fazzari, Hubbard and Petersen (1988a), it has been customary to test whether investment-cash flow sensitivity varies systematically with characteristics believed to proxy for the degree to which a firm is financially constrained. This is, however, an indirect way of testing whether sensitivity depends on the costs of accessing financial markets. In principle, one could also take advantage of the fact that costs of accessing external capital markets seem to vary dramatically over time.<sup>40</sup> If my identification strategy has power, then it should also have explanatory power with respect to time-varying costs of access to capital markets.

I measure the cost of accessing external capital annually using the average spread for the year between Baa- and Aaa-rated corporate bonds, as rated by Moody's.<sup>41</sup> Widening of this spread indicates a decline in the external financial market's willingness to fund risky investment. The spread ranges between 0.60% and 2.33% during the sample period. To simplify interpretation, I subtract 0.60%

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<sup>40</sup>For example, loss of access to inexpensive debt financing appears to have drastically curtailed mergers and acquisitions activity starting in mid-2007.

<sup>41</sup>Source: Federal Reserve website. The yield series are provided on a monthly basis.

from the spread in each year, so that the spread variable is the spread relative to the lowest spread during the sample period. To investigate how the sensitivity of investment to cash flow varies with the cost of accessing external capital, I augment the paper's main specification with the spread and its interaction with each of the explanatory variables.

The results are presented in column 1 of table 2.5. The dependent variable is capital expenditures scaled by beginning-of-year assets. For brevity, only the coefficients on NOL tax savings, the spread, and the interaction between the two are shown in the table. The coefficient on the interaction of NOL tax savings with the bond spread shows that the sensitivity of capital expenditures to cash flow is sharply increasing in the bond spread. A 10 basis point increase in the spread increases the response of capital expenditures to a \$1 increase in cash flow by more than \$0.06. The coefficient on NOL tax savings itself indicates that investment is insensitive to cash flow when the bond spread is low.

The cost of accessing external finance is unlikely to affect all firms equally. Firms that are established in the capital markets are less likely to face adverse selection, while unestablished firms may face substantial barriers to raising capital when conditions are unfavorable. The effect of the cost of accessing external capital on the dependence of investment on cash flow should be greater for relatively unestablished firms.

I use as a proxy for how established a firm is in the credit market an indicator variable that takes a value of 1 if a firm has a credit rating and 0 if it does not. I then replicate the regression in column 1, but include also triple interactions of

the credit rating indicator with NOL tax savings and bond spread. The results of this regression are presented in column 2. The coefficient on the triple interaction term is negative and statistically significant. This indicates that the sensitivity of investment-cash flow dependence to the bond spread is greater for firms that lack credit ratings.

The spread between high- and low-grade bonds directly measures the cost of obtaining risky capital through external markets. The evidence shows that investment is more sensitive to cash flow when this spread is high. I supplement this result using an alternative measure of capital market accessibility based on aggregate SEO issuance activity. When the cost of accessing external capital is high, firms should avoid or delay secondary equity issues, and aggregate SEO activity should be low. The variable inverse SEO intensity is determined by the total number of SEOs reported by SDC during the year of the observation. The variable takes a value of 0 in the 12 years with the most SEOs, 2 in the 12 years with the fewest SEOs, and 1 in the 13 intermediate years.

I replicate the test presented in column 1, with inverse SEO intensity in place of bond spread. The results are shown in column 3. The coefficient on NOL tax savings indicates a relatively small, statistically insignificant average investment-cash flow sensitivity of 0.163 when aggregate SEO intensity is high. The coefficient on the interaction of NOL tax savings and inverse SEO intensity is positive and statistically significant at the 10% level (p-value of 0.061). This shows that investment becomes more sensitive to cash flow when SEO issuance activity declines. The point estimate indicates that moving from a high SEO intensity to a low SEO

intensity year increases investment-cash flow sensitivity by 0.332, or more than 200% of the estimated sensitivity in high SEO intensity years. This result further supports the idea that investment-cash flow sensitivity increases when accessing capital markets is more costly.

Capital market conditions are likely to co-vary with economic conditions. Investment-cash flow sensitivities may respond to economic conditions as well as capital market conditions. This could complicate interpretation of results connecting capital market conditions to investment-cash flow sensitivities. I remove this source of possible contamination by augmenting the regressions presented in columns 1 and 3 of table 2.5. Specifically, I add real GDP growth and its interactions with the right-hand side variables of the primary regression equation. The results are presented in columns 4 and 5 respectively. The coefficients on the interactions of NOL tax savings with bond spread and SEO intensity maintain their sign and statistical significance, and are of virtually the same magnitude, when the GDP growth variables are added. This indicates that the relationship between capital market conditions and investment-cash flow sensitivities is not driven by changes in economic conditions.<sup>42</sup>

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<sup>42</sup>It has been argued that poor economic conditions are associated with low capital market accessibility. This could occur because tight monetary policy both retards economic growth and limits capital availability, or because adverse selection in the capital market worsens during economic downturns. Kashyap, Lamont and Stein (1994) and Gertler and Gilchrist (1994) find evidence that recessions are characterized by inaccessibility of external finance. The negative coefficient on the interaction of NOL tax savings and GDP growth in columns 4 and 5 supports this argument.

### 2.3.5 NOL tax savings and outflows to claimants

The evidence presented thus far suggests that investment responds to cash flow, which is inconsistent with perfect capital markets. Investment, though, is just one of many possible uses of incremental cash flow. Further insight into the importance of capital market imperfections can be obtained by examining other ways firms can use incremental cash flows.

If capital markets are perfect, excess cash flow is simply distributed to a firm's claimants, creating a mechanical relationship between outflows to claimants and cash flow. This relationship may not hold in the presence of capital market imperfections, however, as extra cash is either invested by financially-constrained firms or saved for use in the future. I now investigate how outflows to claimants and cash balances respond to cash flow. I again use the specification in (2.13) to isolate the cash flow effects of NOL tax savings, with outflow variables and cash balance replacing investment as the dependent variable. The results are presented in table 2.6.

I first investigate whether firms distribute additional cash flow to their shareholders. The dependent variables in the first two columns of table 2.6 are dividends (item 21) and share repurchases (item 115) respectively, both scaled by beginning-of-year assets. The coefficient on NOL tax savings is small and statistically insignificant in both specifications. The evidence does not support a causal connection between cash flow and distributions to shareholders.

Rather than increase distributions to shareholders, firms with additional cash may forgo issuing equity that they would otherwise issue. In this case, equity issuance would decline with cash flow. This possibility is investigated in column 3, where the dependent variable is equity issuance (item 108), scaled by beginning-of-year assets. If firms reduce equity issuance in response to additional cash flow, then the coefficient on NOL tax savings should be negative. Column 3 shows that this coefficient is actually positive, though it is statistically insignificant. Firms do not appear to reduce equity issuance in response to additional cash flow.

Another way in which firms can return additional cash to claimants is by reducing debt. The dependent variable in column 4 is change in debt scaled by beginning-of-year assets, where debt is the sum of long-term debt (item 9) and debt in current liabilities (item 34). If firms use additional cash to reduce debt, the coefficient on NOL tax savings in this regression should be negative. Instead, the coefficient is positive and statistically significant at the 5% level. This suggests that firms actually *increase* debt in response to additional cash flow, which is difficult to reconcile with a perfect capital markets interpretation.<sup>43</sup>

The results in columns 1 through 4 suggest that firms do not respond to additional cash flow by returning cash to equity or debt claimants or by raising less

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<sup>43</sup>Firms increasing debt in response to additional cash flow is consistent with a particular form of capital market imperfections. Firms may have limited external borrowing capacity because they have a limited stock of pledgable assets. This limit may arise because of the need of the firm's insiders to maintain at least a certain stake to mitigate moral hazard (Holmstrom and Tirole 1997; see also ch. 3 of Tirole 2006). Additional cash creates pledgable assets, and therefore increases external financing capacity. This loosens the external financing constraint. A firm operating at its debt capacity may therefore respond by taking on additional debt. Blanchard, Lopez-de-Silanes and Sheifer (1994) find similar results in their study of 11 firms receiving lawsuit windfalls. My results extend these findings to a large sample.

external capital. If accessing capital markets is costly, firms may retain additional cash to reduce the likelihood of needing to access the capital market to finance future investment. Such an argument is the motivation for Almeida, Campello and Weisbach's (2004) study of the cash flow sensitivity of cash. The dependent variable in column 5 is the firm's cash balance (item 1), scaled by beginning-of-year assets. If firms retain cash as a buffer against future cash shortfalls, then the coefficient on NOL tax savings should be positive, which it indeed is. The result indicates that firms in the sample save, on average, \$0.415 out of each additional \$1 of cash flow. This effect is statistically significant at the 1% level.

Taken as a whole, the results in table 2.6 do not support the predictions of a perfect capital markets model that firms disgorge excess cash. If anything, firms appear to retain additional cash and to generate positive financing flows in response to additional cash flow. These findings are more consistent with capital market imperfections constraining the ability of firms to raise external capital.

### **2.3.6 NOL tax savings and capital expenditures - robustness**

Section 4.1 showed that capital expenditures respond to cash flow, using a measure of cash flow that is purged of the influence of unobserved investment opportunities. I now return to this result and present several tests designed to ensure its robustness. The results of these tests appear in table 2.7. The dependent variable in all of the tests is capital expenditures scaled by beginning-of-year assets.

I begin by showing that the results are not driven by NOL tax savings capturing information about marginal tax rates, which might themselves affect investment decisions. Tax loss carryforwards affect a firm's marginal tax rate in the current year and in future years. Controlling for beginning-of-year carryforwards available and pro forma tax liability should account for the effect of loss carryforwards on the current year marginal tax rate. To verify that the effect of carryforwards on *future* marginal tax rates does not unduly influence my results, I add end-of-year carryforwards remaining to the specification. The amount of tax savings potentially affects future marginal tax rates only because it reduces carryforwards remaining at the end of the year. Thus end-of-year carryforwards are a sufficient statistic for future marginal tax rates with respect to NOL tax savings.

The results of the augmented test are presented in column 1. The coefficient on ending NOL carryforwards is statistically insignificant. The tax savings coefficient actually increases in this specification to 0.855. Because NOL tax savings, carryforwards available, and ending carryforwards are highly collinear, the estimated effect of NOL tax savings is much less precisely estimated in this specification. The standard error of the NOL tax savings coefficient more than quadruples from 0.094 in column 3 of table 2.2 to 0.420. Nevertheless, this coefficient remains statistically significant at the 5% level. The effect of NOL tax savings on marginal tax rates does not appear to be driving the paper's main result.

I now apply four filters and re-obtain the main result to ensure that the result is not being driven by particular types of firms. One potential concern is that firms have an incentive to manage their earnings in order to maximize the value of the



net operating loss asset. For example, Maydew (1997) shows that firms shifted revenues and expenses to increase tax loss carrybacks immediately after the 1986 Tax Reform Act (TRA). This allowed firms to generate tax savings at the higher pre-TRA corporate tax rate instead of at the lower post-TRA rate. To reduce the potential effects of earnings management, I calculate abnormal discretionary current accruals using the approach of Teoh, Wong and Rao (1998) and Teoh, Welch and Wong (1998). I then remove observations in the top and bottom deciles of discretionary accruals and re-run the capital expenditures regression. The results when this filter is applied are presented in column 2. The coefficient on NOL tax savings increases slightly to 0.371. Firms that engage in a high degree of earnings management do not appear to be driving the results in the paper.<sup>44</sup>

Young, growing firms that have recently gone public often report significant accounting losses. Those that survive are likely to begin generating profits when they reach maturity. Not surprisingly, then, many of the firms in my sample that are using tax loss carryforwards are relatively young firms. To ensure that these firms alone are not driving the results, I exclude from the sample all observations for firms listed in COMPUSTAT for five years or less and re-run the capital expenditures regression. This reduces the number of observations to 32,917. The results when this second filter is applied are shown in column 3. The coefficient on NOL tax savings increases slightly to 0.398 and remains statistically significant at the

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<sup>44</sup>Note that the number of observations decreases by more than 20% when this filter is applied because of the first differencing.

1% level. Thus the results are not driven by firms that have gone public in the very recent past.

A related potential concern is that many of the loss carryforward firms in the sample are small. For example, panel B of table 2.1 shows that the median loss carryforward firm has total beginning-of-year assets (in 2005 dollars) of \$76 million while the median firm without carryforwards has total assets of \$231 million. To ensure that the results are not being driven by only small firms, I exclude all observations for which beginning-of-year assets in 2005 dollars are less than \$200 million and re-run the capital expenditures regression. This reduces the number of observations to 21,984. The results when this third filter is applied are presented in column 4. The coefficient on NOL tax savings increases to 0.567 for this subsample. Thus the results are not being driven by small firms.<sup>45</sup>

Finally, as discussed in the appendix, while COMPUSTAT tax data are the primary source for most empirical corporate taxation research, there are known issues with reliability of the data. To reduce the incidence of measurement error, I apply two filters. First differences regressions are then run on the resulting samples. Measurement error in the COMPUSTAT NOL carryforward data can occur because the data capture all carryforwards, including foreign carryforwards, instead of only U.S. federal income tax carryforwards. To obtain more accurate NOL carryforward amounts, I remove from the sample all firms with positive identifiable assets in a foreign or non-domestic segment using the COMPUSTAT

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<sup>45</sup>The result continues to hold if the threshold for inclusion is increased to \$1 billion instead. The result also continues to hold if a minimum size threshold based on sales or employment is used.

segments data. The results when this fourth filter is applied are presented in column 5. Removing firms with foreign segments increases the NOL tax savings coefficient to 0.567, which is statistically significant at the 1% level.

Finally, the way I calculate NOL tax savings may be a concern. The amount of income offset by carryforwards in a given year is calculated as the decrease in carryforwards from the beginning of the year to the end of the year. However, carryforwards can also fall because they expire unused. This is a significant concern before 1981, when carryforwards expired after only 5 years, which can cause NOL tax savings to be mis-measured. To ensure that this does not overly influence my results, I remove all pre-1981 observations for which the firm reported a positive carryforward exactly 5 years before the observation.<sup>46</sup> The results after this filter is imposed are presented in column 6. The coefficient on NOL tax savings is 0.245 and remains statistically significant at the 5% level.

## 2.4 Conclusion

The impact of capital market imperfections on real firm behavior is one of the most important issues in corporate finance. A commonly-investigated implication of capital market imperfections is the dependence of investment on internal resources. However, estimation of this dependence is bedeviled by a problem of omitted variables. This paper uses a feature of the tax code to shed new light

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<sup>46</sup>Note that this approach is conservative. A firm that possessed carryforwards five years before may have used these carryforwards to offset profits in some years and generated new carryforwards through losses in others. These new carryforwards would be available to the firm and would not expire in the current year.

on this effect. Firms generate a real cash savings by using tax loss carryforwards from prior periods to offset taxable income in the current period. Controlling for the tax loss carryforwards a firm has available and the amount of tax it would have paid in the absence of carryforwards enables me to identify the cash flow effect of the savings. Estimating an empirical model based on this insight, I show that investment of various forms increases with the cash flows available to the firm. The impact of capital market conditions on the estimated investment-cash flow sensitivity is shown to be in line with the notion that internal resources are significantly cheaper than external resources.

Distributions, on the other hand, do not respond in a similar fashion, suggesting that they are not merely the residual in a static investment optimization problem. Firms also increase take advantage of the extra cash to increase cash balances. The results of this paper indicate that capital market imperfections play a significant role in shaping investment and financing decisions.

## 2.5 Appendix: Discussion of COMPUSTAT tax data

Since the IRS has restrictions on the release of individual corporate income tax returns data, studies focusing on the effects of corporate income taxes have typically used tax data available through COMPUSTAT.<sup>47</sup> This study relies on two tax variables from COMPUSTAT - current federal income tax expense (item 63) and NOL carryforwards (item 52). I discuss what is known about each of these variables in turn.

### 2.5.1 Issues with current federal tax expense

Corporate taxation studies typically use a firm's current federal tax expense as a proxy for federal tax liability. Dworin (1985) investigates the reasonableness of current tax expense as a proxy for tax liability using confidential tax return data for 1979-1981. He shows in general that current tax expense reported by COMPUSTAT is 5% to 8% larger on average than income tax liability. The disparity is very large for regulated utilities, which are not included in my sample. The disparity also appears to be a significantly greater issue for smaller firms. In robustness tests, I purge my sample of firms with less than \$200 million of total assets at the beginning of the year (in 2005 dollars) and show that the results hold (and in fact become larger in magnitude) for this sample of larger firms.

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<sup>47</sup>COMPUSTAT gathers tax data from firm financial statements. Much of the detailed data is extracted from the footnotes to the financial statements.

## 2.5.2 Issues with NOL carryforwards

COMPUSTAT NOL carryforward data has been used in numerous academic studies (e.g. Mackie-Mason 1990, Shevlin 1990, Givoly, Hahn, Ofer, and Sarig 1992, Graham 1996a, 1996b, Auerbach and Poterba 1986). Mills, Newberry and Novack (2003) use confidential firm-level U.S. federal tax return data to assess the quality of COMPUSTAT NOL carryforward data. While they cannot observe the actual NOL carryforwards a firm has available, they can observe whether or not a firm uses carryforwards to offset income in a given year. This information allows them to determine the frequency with which COMPUSTAT reports a positive NOL carryforward when none is actually available as well as the opposite case. They find that COMPUSTAT reports a carryforward balance when no carryforward exists per the tax return 9.4% of the time, and that COMPUSTAT reports no carryforward balance when a carryforward does exist per the tax return 3.3% of the time.

COMPUSTAT item 52 may fail to accurately capture the NOL carryforwards available for offsetting taxable income for at least three reasons. First, item 52 does not always capture carryforwards for tax purposes. Item 52 is populated from the tax footnote of financial statements. This footnote may show carryforwards for tax purposes, carryforwards for financial accounting purposes, or both. If only NOL carryforwards for financial accounting purposes are provided, or if both are provided, COMPUSTAT reports carryforwards for financial accounting purposes. To the extent that only carryforwards for tax purposes have cash flow

implications, differences in the amounts of NOL carryforwards for tax purposes and NOL carryforwards for financial accounting purposes potentially create measurement error in the tax-related variables used in this paper.<sup>48</sup>

The second relevant issue with COMPUSTAT NOL carryforward data is the presence of coding errors. Kinney and Swanson (1993) report that, in a sample of 266 firm-years, there are 28 cases in which item 52 is missing but a carryforward for tax purposes is reported in the tax footnote, and 5 cases in which item 52 is populated but there is no carryforward at all reported in the tax footnote. Manzon (1994) reports similar error rates. The presence of coding errors creates additional noise which adds to the measurement error of any variables constructed using item 52.

The third issue with COMPUSTAT NOL carryforward data is that the carryforwards reported by firms in their tax footnotes, whether book or tax carryforwards, can contain carryforwards not available for offsetting U.S. federal taxable income. Multinational firms can generate carryforwards in foreign countries that cannot be used to offset domestic income. In addition, after 1986, section 382 of the U.S. Internal Revenue Code places restrictions on the amount of carryforwards obtained through acquisitions that can be used to offset income in any particular year. Mills, Newberry and Novack (2003) find that of 241 cases in which there is a COMPUSTAT NOL carryforward but no tax return carryforward, foreign carryforwards were disclosed in the tax footnote in 168 cases, and acquired carryforwards were found in 23 cases.

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<sup>48</sup>See Kinney and Swanson (1993).

Mills, Newberry and Novack (2003) recommend considering firms to have carryforwards only if COMPUSTAT reports a positive carryforward balance (item 52  $> 0$ ) and no U.S. current income tax (item 63  $\leq 0$ ). This reduces the frequency of cases in which an NOL carryforward is reported but no tax NOL exists from 9.4% to 1.5%. This restriction is imposed for inclusion in my sample. This filter should remove cases in which a firm owns acquired NOLs subject to the section 382 limitation. For robustness, I also remove all firms reporting identifiable assets in foreign segments and re-obtain the paper's main results.



Figure 2.1: Kink in the NOL tax savings function

Figure 2.1 depicts the kink in NOL tax savings as a function of pro forma tax liability, under the assumption of a flat tax rate  $\tau$ . Pro forma tax liability is the tax liability a firm would incur if it had no tax loss carryforwards available. Actual tax liability is the amount tax liability the firm actually incurs. NOL tax savings is the difference between pro forma and actual tax liability.

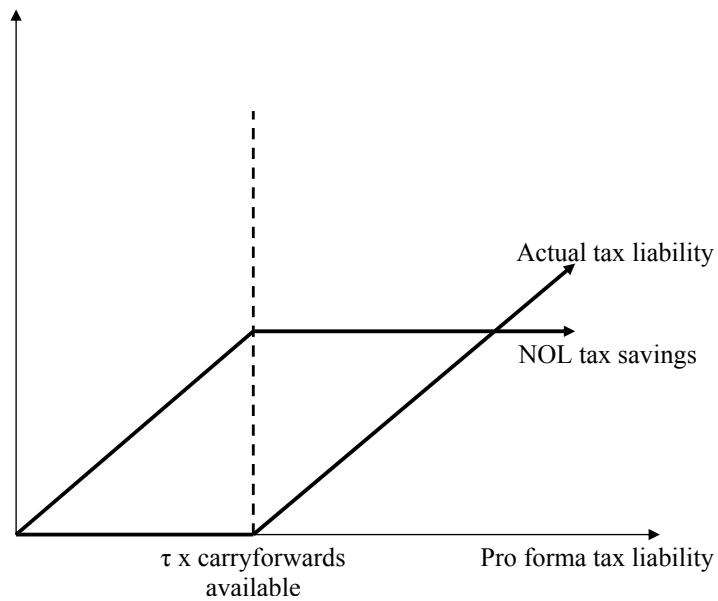
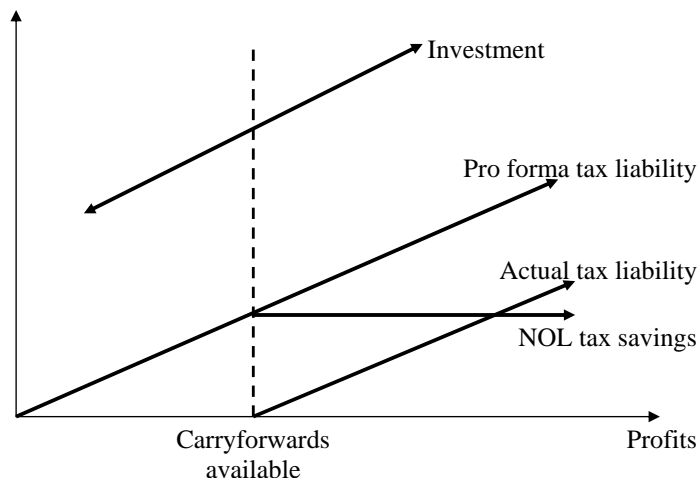
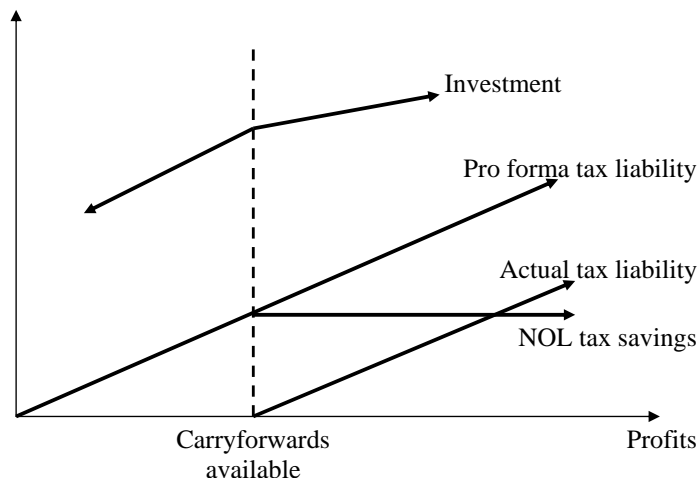


Figure 2.2: Equilibrium mixed strategy probabilities

Figure 2.2a depicts the relationship between investment and profits under the assumption that tax-related cash flows do not affect investment. The smooth nature of the investment curve at the point at which profits equal carryforwards available (where carryforwards are exhausted) indicates that investment does not respond to cash flow. Figure 2.2b depicts the relationship between investment and profits under the assumption that tax-related cash flows do affect investment. The downward kink in the investment curve at the point at which profits equal carryforwards available (where carryforwards are exhausted) indicates that investment does respond to cash flow.



(2a)



(2b)

Figure 2.3: Observations and tax savings by year

Figure 2.3 shows, for each year in the sample, the number of observations in the sample, the number of observations in the sample with positive beginning-of-year carryforwards available, and the tax savings from using tax loss carryforwards (in millions of 2005 dollars) for observations in the sample.

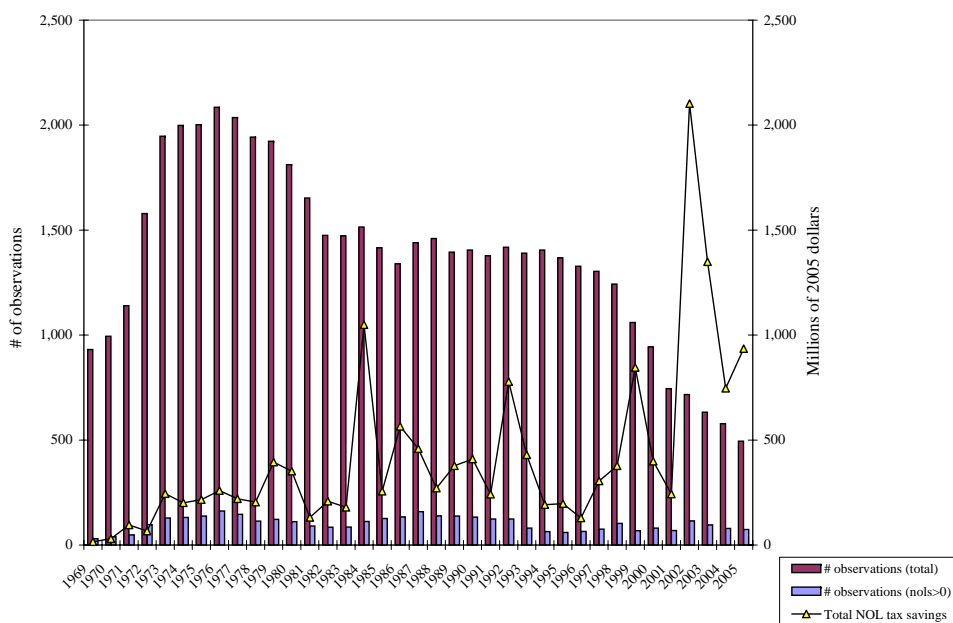
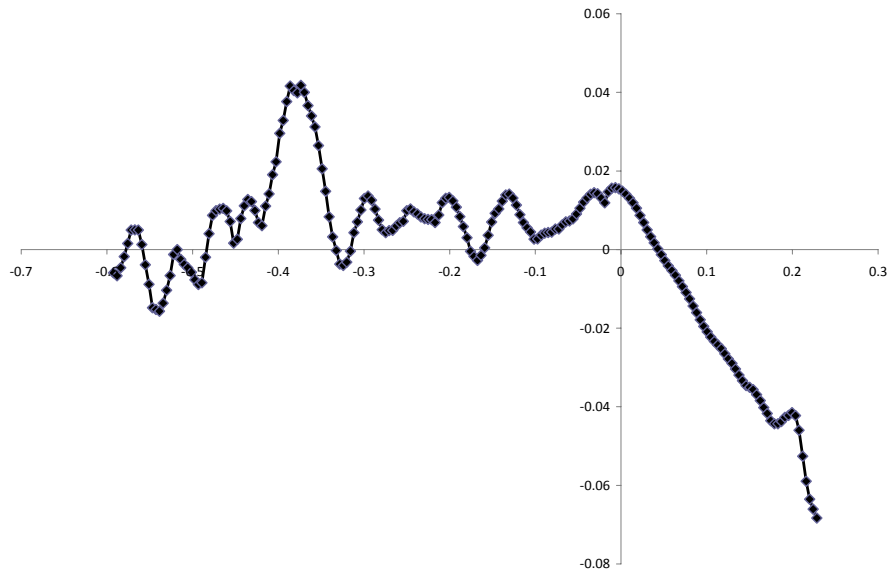


Figure 2.4: Capex residual and distance to kink

Figure 2.4 depicts the results of kernel regression. Capital expenditures are regressed using OLS on carryforwards available, pre-tax cash flow, lagged Tobin's  $Q$ , and firm and year dummies. The dependent variable in the kernel regression is the residual from this OLS regression. The independent variable is the distance to the kink in the tax function resulting from the availability of tax loss carryforwards. This distance is defined as a firm's pro forma tax liability less its tax savings capacity. Pro forma tax liability is the tax liability a firm would incur if it had no tax loss carryforwards available. Tax savings capacity is the maximum amount of tax a firm can avoid using tax loss carryforwards. The kernel regression uses the Epanechnikov kernel, with a bandwidth of 0.02.



**Table 2.1: Summary Statistics**

This table presents summary data for the sample studied in this paper. The sample consists of firm-year observations during the period 1969-2005. See section 3.2 for a discussion of how the sample was constructed. Panel A summarizes the distribution of the main variables used in the paper. All variables are scaled by beginning-of-year assets, except for Tobin's Q. Capital expenditures are COMPUSTAT item 128. Actual tax liability is item 63 (current federal income tax expense). NOL carryforwards available is the lagged value of item 52. Total cash flow is net income (item 18) plus depreciation (item 14). Pre-tax cash flow is total cash flow plus actual tax liability. Pro forma tax liability is computed by backing out taxable income from actual tax liability using the federal corporate income tax schedule for the year in question, adding the amount of NOL carryforwards used during the year (change in item 52), and then applying the federal corporate income tax schedule. NOL tax savings are the difference between pro forma tax liability and actual tax liability. Tobin's Q is the quotient of the market and book values of a firm's assets. Market value (the numerator) is book assets (item 6) plus the market value of equity (the product of item 199 and item 25) minus book equity (item 60) minus deferred taxes (item 74). Book value (the denominator) is book assets (item 6). Capital expenditures are winsorized at the 1st and 99th percentiles. Capital expenditures and Tobin's Q are winsorized at the 99th percentile. The other variables are trimmed at the 99th percentile (and 1st percentile for pre-tax cash flow). Panel B compares the distributions for the subsample that have NOL carryforwards available at the beginning of the year ("NOL Firms") and the subsample that doesn't ("Non-NOL Firms").

*Panel A: Summary Statistics for Whole Sample*

	Mean	Std. dev.	Min	Percentile					Max
				1st	25th	50th	75th	99th	
Capital expenditures	0.090	0.084	0.000	0.003	0.036	0.066	0.114	0.467	0.467
Total cash flow	0.130	0.069	-0.221	-0.012	0.085	0.121	0.166	0.342	0.540
Pre-tax cash flow	0.174	0.098	-0.104	-0.006	0.106	0.158	0.226	0.474	0.570
NOL carryforwards available	0.018	0.100	0.000	0.000	0.000	0.000	0.000	0.559	1.358
Pro forma tax liability	0.046	0.038	0.000	0.000	0.017	0.037	0.064	0.174	0.228
NOL tax savings	0.002	0.010	0.000	0.000	0.000	0.000	0.000	0.051	0.228
Actual tax liability	0.044	0.038	0.000	0.000	0.015	0.035	0.063	0.171	0.228
Tobin's Q	1.561	1.101	0.103	0.548	0.924	1.208	1.774	6.373	6.373

*Panel B: NOL Firms and Non-NOL Firms*

	NOL Firms			Non-NOL Firms		
	Mean	Median	Std. dev.	Mean	Median	Std. dev.
Assets (millions of 2005 dollars)	479	76	2,655	2,112	231	11,964
Sales (millions of 2005 dollars)	564	94	2,434	2,379	368	9,373
No. of employees	2,923	575	10,614	11,487	2,190	35,953
Tobin's Q	1.492	1.136	1.166	1.567	1.215	1.100
Net PPE/assets	0.321	0.257	0.232	0.328	0.293	0.199
Net book leverage	0.211	0.256	0.308	0.089	0.121	0.246
Capital expenditures	0.083	0.047	0.101	0.091	0.068	0.082
Total cash flow/assets	0.093	0.082	0.084	0.133	0.123	0.066
Pre-tax cash flow	0.105	0.088	0.099	0.180	0.163	0.095
NOL carryforwards available	0.237	0.120	0.286	0.000	0.000	0.000
Pro forma tax liability	0.036	0.023	0.039	0.047	0.038	0.038
NOL tax savings	0.024	0.012	0.031	0.000	0.000	0.000
Actual tax liability	0.012	0.000	0.026	0.047	0.038	0.038
Observations		3,749			48,333	

**Table 2.2: Capital expenditures and NOL tax savings**

This table presents a series of regressions for an unbalanced panel of firms from 1969 through 2005. The dependent variables in each specification is capital expenditures. All explanatory variables except lagged Tobin's Q are scaled by beginning-of-year total assets as well. All regressions include year effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate. The first five columns present results from first differences regressions. Of these, the first four are estimated using ordinary least squares, while the fifth is estimated using the method of Prais and Winsten (1954) to account for first order autocorrelation. The sixth column presents results from a firm fixed effects regression.

	(1)	(2)	(3)	(4)	(5)	(6)
Total cash flow	0.313*** (0.012)					
Actual tax liability		-0.632*** (0.041)				
NOL tax savings			0.345*** (0.094)	0.408*** (0.099)	0.368*** (0.092)	0.582*** (0.098)
Pro forma tax liability			-0.638*** (0.042)	-0.807*** (0.071)	-0.648*** (0.040)	-0.893*** (0.046)
(Pro forma tax liability) <sup>2</sup>				2.455*** (0.840)		
(Pro forma tax liability) <sup>3</sup>				-8.872*** (3.211)		
Pre-tax cash flow		0.402*** (0.018)	0.404*** (0.018)	0.405*** (0.018)	0.411*** (0.017)	0.512*** (0.020)
NOL carryforwards available			0.034 (0.035)	-0.069 (0.068)	0.023 (0.034)	-0.025 (0.019)
(NOL carryforwards available) <sup>2</sup>				0.359** (0.173)		
(NOL carryforwards available) <sup>3</sup>				-0.257** (0.110)		
Lagged Tobin's Q	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.013*** (0.001)	0.011*** (0.001)
Observations	38,442	38,442	38,442	38,442	38,442	46,442
Number of firms	5,573	5,573	5,573	5,573	5,573	5,573
Adjusted R-squared	0.086	0.091	0.091	0.092		0.606

\*\*\*, \*\* and \*: significant at 99%, 95% and 90% levels respectively.  
Superscripts denote exponents.

**Table 2.3: Other forms of investment and NOL tax savings**

All regressions in this table are run in first differences and include year effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate. The dependent variable in specification 1 is change in working capital, which is working capital in year  $t$  less working capital in year  $t - 1$ . Working capital is defined as inventory (COMPUSTAT item 3) + accounts receivable (item 2) - accounts payable (item 70). The dependent variables in specifications 2 through 5 respectively are acquisitions (item 129), advertising expense (item 45), rental expense (item 47), and research and development (item 46). Research and development is assumed to be 0 if the value is missing in COMPUSTAT. All dependent variables are scaled by beginning-of-year total assets and are winsorized at the 99th percentile (and the 1st percentile for change in working capital).

	( $\Delta$ WC)	(Acquisitions)	(Advertising)	(Rent)	(R&D)
NOL tax savings	0.424** (0.170)	0.227** (0.116)	0.125** (0.050)	0.077*** (0.022)	0.023 (0.024)
Pro forma tax liability	-0.673*** (0.072)	-0.451*** (0.062)	-0.057*** (0.019)	-0.061*** (0.009)	-0.011 (0.014)
NOL carryforwards available	0.104** (0.052)	0.075** (0.038)	0.012 (0.011)	0.012** (0.005)	0.006 (0.005)
Pre-tax cash flow	0.778*** (0.031)	0.323*** (0.029)	0.077*** (0.008)	0.058*** (0.004)	0.022*** (0.006)
Lagged Tobin's Q	0.006*** (0.001)	0.003*** (0.001)	0.001*** (0.000)	0.000 (0.000)	0.000** (0.000)
Observations	37,369	33,753	15,027	30,588	38,263
Number of firms	5,476	5,398	2,793	5,047	5,545
Adjusted R-squared	0.137	0.025	0.063	0.058	0.014

\*\*\*, \*\* and \*: significant at 99%, 95% and 90% levels respectively.

**Table 2.4:** Capital expenditures, NOL tax savings, and firm characteristics

The dependent variable in all specification is capital expenditures scaled by beginning-of-year assets. All regressions in this table are run in first differences and include year effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate. The explanatory variables in each specification are NOL tax savings, Pro forma tax liability, NOL carryforwards available, and pre-tax cash flow, all scaled by beginning-of-year assets, and lagged Tobin's Q, as well as the interactions of each of these with an observation-specific proxy for severity of financing constraints. The constraint proxy varies by column. The constraint proxies are the Kaplan-Zingales 4-variable index, the Whited and Wu (2006) index, net debt (liabilities less cash) divided by assets, an indicator for whether the firm has a credit rating, and an indicator for whether the firm paid dividends. All are measured at the beginning of the year. See the text for more details about these variables. For brevity, only coefficients for NOL tax savings, the constraint proxies, and the interaction terms are reported.

	(1)	(2)	(3)	(4)	(5)
NOL tax savings	0.375*** (0.096)	0.658*** (0.186)	0.474*** (0.115)	0.389*** (0.097)	0.264*** (0.101)
Kaplan-Zingales (KZ) index	-0.011*** (0.001)				
NOL tax savings $\times$ KZ	0.002 (0.082)				
Whited-Wu (WW) index		0.040* (0.022)			
NOL tax savings $\times$ WW		1.276 (0.912)			
Net debt			-0.170*** (0.007)		
NOL tax savings $\times$ net debt			-0.038 (0.295)		
$I_{hasrating}$				0.013*** (0.004)	
NOL tax savings $\times I_{hasrating}$				-0.487** (0.244)	
$I_{divpayer}$					-0.000 (0.003)
NOL tax savings $\times I_{divpayer}$					0.151 (0.344)
Observations	36,838	37,265	38,166	38,442	38,442
Number of firms	5,436	5,480	5,539	5,573	5,573
Adjusted R-squared	0.096	0.092	0.137	0.093	0.092

\*\*\*, \*\* and \*: significant at 99%, 95% and 90% levels respectively.



**Table 2.5: Capital expenditures, NOL tax savings, and capital market conditions**

The dependent variable in each specification is capital expenditures scaled by beginning-of-year assets. All regressions in this table are run in first differences and include year effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate. The explanatory variables in each specification include NOL tax savings, pro forma tax liability, NOL carryforwards available, and pre-tax cash flow, all scaled by beginning-of-year assets, and lagged Tobin's Q. Bond spread is the spread between the yields on Baa- and Aaa-rated bonds, as reported by Moody's, less the lowest value of the spread in the sample.  $I_{hasrating}$  is an indicator variable that takes a value of 1 if the firm had a credit rating at the end of the preceding year and a 0 otherwise. Inverse SEO intensity takes a value of 0 for observations in the 12 years in the sample with the most SEOs as reported by SDC, 2 for observations in the 12 years with the fewest SEOs, and 1 for the intermediate 13 years.  $\Delta$  GDP is the real GDP growth rate reported by NBER.

	(1)	(2)	(3)	(4)	(5)
NOL tax savings	-0.343 (0.246)	-0.319 (0.247)	0.163 (0.149)	-0.261 (0.283)	0.337* (0.172)
Bond spread (BS)	-0.018*** (0.003)	-0.018*** (0.003)		-0.017*** (0.003)	
NOL tax savings $\times$ BS	0.619*** (0.187)	0.623*** (0.188)		0.603*** (0.189)	
NOL tax savings $\times$ BS $\times I_{hasrating}$		-1.369*** (0.509)			
Inverse SEO intensity			-0.004** (0.001)		-0.003** (0.001)
NOL tax savings $\times$ Inv SEO int			0.166* (0.088)		0.175** (0.087)
$\Delta$ GDP				0.000 (0.000)	0.000 (0.000)
NOL tax savings $\times \Delta$ GDP				-1.718 (3.245)	-6.267** (3.040)
Observations	38,442	38,442	38,442	38,442	38,442
Number of firms	5,573	5,573	5,573	5,573	5,573
Adjusted R-squared	0.094	0.095	0.094	0.095	0.095

\*\*\*, \*\* and \*: significant at 99%, 95% and 90% levels respectively.

**Table 2.6: Distributions to shareholders and NOL tax savings**

All regressions in this table are run in first differences and include year effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate. The dependent variable in specification 1 is common dividends (COMPUSTAT item 21), scaled by beginning-of-year assets. The dependent variable in specification 2 is share repurchases (item 115), scaled by beginning-of-year assets. The dependent variable in column 3 is equity issuance (item 108). The dependent variable in specification 4 is change in debt scaled by beginning of year assets, where debt is defined as long-term debt (item 9) plus debt in current liabilities (item 34). The dependent variable in column 5 is change in cash scaled by beginning of year assets, where cash is item 1.

	(Div)	(Repur)	(Equity iss.)	( $\Delta$ Debt)	( $\Delta$ Cash)
NOL tax savings	0.011 (0.012)	-0.034 (0.034)	0.146 (0.131)	0.488** (0.239)	0.415*** (0.158)
Pro forma tax liability	-0.011** (0.005)	0.040** (0.016)	-0.341*** (0.060)	-1.525*** (0.112)	-0.077 (0.083)
NOL carryforwards available	-0.004 (0.004)	-0.001 (0.009)	0.089** (0.043)	0.243*** (0.080)	0.087* (0.049)
Pre-tax cash flow	0.021*** (0.002)	-0.019** (0.007)	0.386*** (0.027)	0.836*** (0.051)	0.496*** (0.037)
Lagged Tobin's Q	0.000*** (0.000)	0.001** (0.000)	0.008*** (0.002)	0.019*** (0.002)	-0.007*** (0.002)
Observations	38,442	38,442	35,570	38,173	38,252
Number of firms	5,573	5,573	5,461	5,538	5,545
Adjusted R-squared	0.038	0.008	0.062	0.051	0.069

\*\*\*, \*\* and \*: significant at 99%, 95% and 90% levels respectively.

**Table 2.7: Capital expenditures and NOL tax savings - robustness**

The dependent variables in each specification is capital expenditures scaled by beginning-of-year total assets. All specifications include year effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate. Specification 1 includes ending NOL carryforwards. Specification 2 is estimated in first differences using the model of Prais and Winsten (1954) to control for AR(1). Filters are applied to the sample in specifications 2 through 5. Observations with abnormal accruals, computed using the method of Teoh, Welch and Wong (1998) and Teoh, Wong and Rao (1998), in the lowest and highest deciles in the sample are excluded in specification 2. Observations for the first five years a firm is reported in COMPUSTAT are excluded in specification 3. Observations with less than \$200 million in total assets (in 2005 dollars) are excluded in specification 4. Observations reporting a foreign or non-domestic segment in the SEGMENTS data are excluded in specification 5. Observations prior to 1981 for which NOL carryforwards were greater than 0 five years prior to the observation are excluded in specification 6.

	(1)	(2)	(3)	(4)	(5)	(6)
NOL tax savings	0.855** (0.420)	0.371*** (0.135)	0.398*** (0.102)	0.412** (0.179)	0.567*** (0.110)	0.245** (0.119)
Pro forma tax liability	-0.639*** (0.042)	-0.619*** (0.052)	-0.646*** (0.046)	-0.679*** (0.058)	-0.781*** (0.060)	-0.605*** (0.042)
Pre-tax cash flow	0.405*** (0.018)	0.374*** (0.022)	0.394*** (0.021)	0.390*** (0.026)	0.464*** (0.026)	0.389*** (0.018)
NOL carryforwards available	-0.180 (0.176)	0.049 (0.052)	0.025 (0.037)	-0.017 (0.050)	0.002 (0.034)	0.030 (0.046)
Lagged Tobin's Q	0.012*** (0.001)	0.012*** (0.001)	0.013*** (0.001)	0.014*** (0.001)	0.012*** (0.001)	0.012*** (0.001)
Ending NOL carryforwards	0.217 (0.175)					
Filter		No large abnormal accruals	No recent IPOs	Assets ≥\$200M	No foreign segments	No stale NOLs
Observations	38,442	26,271	32,917	20,575	21,984	36,970
Number of firms	5,573	4,593	4,570	2,659	3,606	5,427
Adjusted R-squared	0.091	0.070	0.086	0.105	0.087	0.090

\*\*\*, \*\* and \*: significant at 99%, 95% and 90% levels respectively.

## Chapter III

### Financial Fraud and Investment Efficiency

In a well-known paper, Myers and Majluf (1984) establish that cash-poor firms may forgo positive NPV investments when asymmetric information about their assets already in place creates adverse selection in the capital market. Their result suggests that the financial accounting system can play a valuable economic role by increasing the information content of reports capturing value-relevant information about assets in place. One way it can do so is by making it more difficult and/or costly for firms to inflate their performance reports. The Sarbanes-Oxley Act of 2002 represents a recent legislative attempt to accomplish this. Preventing firms from reporting inflated accounting results can alleviate the underinvestment problem by reducing adverse selection in the capital market.

However, I show in this paper that curtailing performance inflation comes at a cost if there are also informational asymmetries about firms' investment opportunity sets. When there is asymmetric information about investment opportunities, firms with investments of differing quality are pooled in the capital market. As a result, a firm with only negative NPV investments, finding its shares overvalued,

may invest in its value-destroying projects in order to sell overpriced equity. This inefficiency could be alleviated if a firm with better investments had a means of signaling this information. A key result of this paper is that a firm may be able to send such a signal by inflating its performance report, even though such a report is in principle designed to capture only information about assets already in place. The resulting separation reduces overvaluation and therefore overinvestment. As a result, leaving firms some wiggle room in reporting through restrained auditing requirements and temperate penalties for misreporting can actually enhance value creation.

To understand the effects of financial reporting on investment decisions, I build a simple asymmetric information model with costly state falsification. In the model, a firm has assets in place and a single, indivisible investment project. The firm's management, which acts in the interest of current shareholders, privately observes the quality of both. A firm can have either a good (positive NPV) project or a bad (negative NPV) project. The firm has no cash to finance its project but can raise new capital to do so by issuing equity.<sup>1</sup> Before issuing equity, the firm is required to report publicly the quality of its assets in place.<sup>2</sup> It can inflate this report at a cost. The cost could take the form of prospective fines and penalties for mis-reporting as well as a waste of resources to evade auditors.

Inflating its report benefits a firm's current shareholders by reducing the share of the firm that must be given to new investors in exchange for capital. A firm

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<sup>1</sup>I also briefly consider the case of debt financing.

<sup>2</sup>One can think of this report as a prospectus, but it could also take the form of a regularly scheduled financial accounting report.

inflates its report if this benefit exceeds the cost. A key result of the paper is that this benefit is greater for a firm with a good project, since the savings from reducing the share of the firm that must be given to new investors increases with expected firm value. Because of this gap, a firm with a good project may be able to signal by inflating its report about its assets in place.<sup>3</sup>

Whether such signaling occurs in equilibrium depends on the cost of performance inflation. If this cost is very high or very low, signaling fails, since it is too costly in the former case and imitation is too cheap in the latter. In the absence of signaling, firms with projects of differing quality are pooled in the capital market. The result can be underinvestment by firms with negative NPV projects, as in Myers and Majluf (1984), overinvestment by firms with negative NPV projects that take advantage of their overpriced equity, or both.

If instead the cost of performance inflation is in a moderate range, signaling does indeed occur in equilibrium. As a result, firms with bad projects are at least partially separated out. Forced to internalize the cost of value-destroying investment, they refrain from investing. Therefore increasing the cost of performance inflation beyond a moderate level actually reduces investment efficiency.<sup>4</sup>

A key assumption of the model is that firms are not permitted to simply report the quality of their investment projects. If firms can credibly report such infor-

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<sup>3</sup>I also briefly explore a second possible reason why a firm with a good investment project might have an advantage in inflating its report. Since a firm that experiences high future cash flow is less likely to have inflated information about its assets in place today, such a firm is less likely to be investigated for reporting falsely. Since a firm with a good project is more likely to have high future cash flow, it is less likely to be investigated and therefore finds inflating its report less costly.

<sup>4</sup>Note that this argument is very different from arguments for limited penalties in the optimal law enforcement literature, which emphasize the cost of enforcement (see Garoupa 1997 for a review) or the benefits of inducing the choice of less harmful crimes (Mookherjee and Png 1994).

mation directly, then there is clearly no need to communicate it through a costly signal. However, I argue that firms cannot realistically be held accountable for the accuracy of such reports (or at least are unlikely to be so), robbing them of credibility. This highlights a key distinction between assets in place and investment opportunities. The former generates ongoing, measurable information in the form of profits and cash flows. Auditing practices and penalties for mis-reporting can imbue reports of such information with credibility. As-of-yet-unpursued investment opportunities, on the other hand, do not generate measurable performance metrics.

The inability of firms to credibly communicate direct information about their investment opportunities creates a trade-off in reducing information asymmetries about assets in place. Reducing these information asymmetries is potentially beneficial because it makes reported information about assets in place more accurate. However, it also reduces the potential of firms to signal the quality of their investment opportunities. Thus it makes reported information about assets in place less informative about investment opportunities.<sup>5</sup>

It would be difficult to quantify based on the results of this paper optimal auditing policies and penalties for performance inflation for a real market regulator. However, the results are still important because they suggest a downside to mak-

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<sup>5</sup>Interestingly, Povel, Singh and Winton (2007) argue that if firms are motivated by financing costs to report falsely, making disclosure more precise may actually lead to more inflated reports. The reason is that greater precision causes investors to place greater weight on disclosures in forming their posterior beliefs, increasing the incentives of firms to influence investor beliefs by disclosing fraudulently. Their focus is on how the incentives of all firms to inflate reports vary with the fraud penalty, while the focus of my paper is on how the effect of performance inflation costs varies across firms with different investment opportunities.

ing performance inflation more costly that has been overlooked. For example, my analysis shows that an overlooked potential cost of the Sarbanes-Oxley Act of 2002 is that it leaves insufficient wiggle room in financial reporting, resulting in significant overinvestment.

Firms in my model inflate their performance reports in order to improve the terms on which they can raise capital. There is a large body of evidence that firms do, in fact, manipulate their earnings for this reason. For example, DuCharme (1994), Friedlan (1994), and Shivakumar (2000) show that a firm's accounting accruals tend to be abnormally high in periods immediately preceding securities issuance. Accruals then tend to decrease immediately after securities issuance (Rangan 1998 and Teoh, Wong and Rao 1998). These results are further supported by the finding of DuCharme, Malatesta and Sefcik (2004) that accounting accruals around the time of stock offers tend to be especially high for firms that are subsequently sued over their offers. Finally, there is evidence of a positive relationship between a firm's need for external financing and the likelihood of it being accused of financial fraud (Dechow, Sloan and Sweeney 1995 and Erickson, Hanlon and Maydew 2006).

In addition to improving the terms on which capital can be raised, other motives for performance inflation have been established. One established motive is the ability of managers to profit from temporary overvaluation of their firms' equity. A manager may over-report firm performance to inflate the firm's stock price because her compensation is tied directly to short-term performance (Goldman and Slezak 2006, Hertzberg 2003, Bolton, Scheinkman and Xiong 2006) or because



she is able to profit by selling overvalued stock (Bar-Gill and Bebchuk 2003). Positive empirical relationships have been established between equity-based compensation and financial fraud actions and prosecutions (Johnson, Ryan and Tian 2005; Li 2005)<sup>6</sup>, earnings restatements (Burns and Kedia 2006) and accounting accruals (Bergstresser and Philippon 2006). Accruals have also been linked to trading by insiders (Beneish and Vargus 2002, Bergstresser and Philippon 2006).

A small set of papers argues, as I do, that performance manipulation may be in the interest of a firm's shareholders. Dye (1988) shows that current shareholders benefit from performance inflation at the expense of prospective shareholders in an overlapping generations model. Bolton, Scheinkman and Xiong (2006) go a step further by arguing that shareholders may want to give managers short-term incentives in order to induce them to commit financial fraud so that shareholders can sell their holdings at favorable prices. Finally, Arya, Glover and Sunder (1998) argue that performance inflation by management overcomes limits to the ability of shareholders to commit to an ex ante optimal firing policy. My model can easily accommodate the possibility of decision-making by self-interested managers who bear a personal cost if the firm is found to have reported fraudulently. In my setting, a manager would benefit from the short-term effect on the stock price only because it impacts the value of her claims in the long term.

Section 2 describes the model. The model is then analyzed in section 3. Section 4 concludes.

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<sup>6</sup>However, Erickson, Hanlon and Maydew (2006) find no evidence of a relationship between equity-based compensation and financial fraud.

### 3.1 A model of investment and capital-raising under asymmetric information

In this section, I describe a simple asymmetric information model featuring disclosure, capital-raising and investment. A firm begins with assets in place and access to a single, indivisible investment project that it can undertake in the future. Undertaking this project requires a one-time, fixed capital outlay of  $K$ . However, the firm lacks cash and the firm's current shareholders are assumed to be either unable or unwilling to finance further investment. So in order to invest in its project, the firm must raise capital from outside investors. It can do so by issuing new equity claims to outside investors, who form rational expectations and operate in a perfectly competitive capital market.<sup>7</sup> All agents in the model are risk neutral. The firm's management acts in the interests of its shareholders at any point in time.

The quality of the firm's assets in place is denoted  $p$ . Assets in place can be either good ( $p = p_G$ ) or bad ( $p = p_B$ ). The quality of the firm's investment project is denoted  $q$  and can also be either good ( $q = q_G$ ) or bad ( $q = q_B$ ). Firms vary only in the quality of their assets in place and projects. Thus a firm's type can be fully described by the pair  $(p, q)$ , with four possible types:  $(p_B, q_B)$ ,  $(p_B, q_G)$ ,  $(p_G, q_B)$  and  $(p_G, q_G)$ . I denote by  $\rho_{ij} \in (0, 1)$  for  $i, j \in \{B, G\}$  the unconditional probability that a firm's type is  $(p_i, q_j)$ , with  $\sum_{i \in \{B, G\}, j \in \{B, G\}} \rho_{ij} = 1$ . Management observes the firm's type, while outside investors know only the prior distribution of types.

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<sup>7</sup>I briefly consider the case of debt financing in section 5.

At some point in the future (I will make the timing clear shortly), the firm generates a single cash flow. This cash flow can be either high ( $x = x_H$ ) or low ( $x = x_L$ ). The quality of the firm's assets in place and the quality of its project, if this project is undertaken, together determine the distribution of the cash flow. Specifically, the probability of a high cash flow is  $p + q$  if the firm has undertaken its project and  $p$  if it has not. Thus the project serves to increase the probability of a high cash flow.<sup>8</sup> A firm with good assets in place is more likely to realize a high cash flow than one with bad assets in place:  $p_G > p_B \geq 0$ . Likewise, a good project, if undertaken, increases the probability of a high cash flow more than a bad project does:  $q_G > q_B \geq 0$ . I assume that  $p_G + q_G \leq 1$  to keep the probability of each of the two cash flows bounded between 0 and 1.

I denote the difference in the two possible cash flows as  $\Delta x \equiv x_H - x_L$ . Let  $R_j$  denote the expected gross rate of return on a project of quality  $q_j$ ,  $j \in \{B, G\}$ . The expected return rate is  $R_j = q_j \Delta x / K$ . The good project is assumed to create value:  $R_G > 1$ . The bad project, on the other hand, is assumed to destroy value:  $R_B < 1$ . Finally, I denote the expected cash flow of a firm of type  $(p_i, q_j)$ , conditional on investment in its project, as  $v_{ij}$ , with  $v_{ij} = x_L + (p_i + q_j) \Delta x$ .

At time  $t = 0$ , the firm announces whether or not it will invest in its project. I assume that this decision is irreversible. At time  $t = 1$ , a firm that intends to raise capital must report the quality of its assets in place. It need not, however, report this characteristic truthfully. I refer to this report as a performance report

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<sup>8</sup>Other cash flow distributions yield similar results, but this simple binary distribution proves the most parsimonious.

since performance measures reflect the quality of a firm's balance sheet. Letting  $r \in \{r_B, r_G\}$  denote the report, the firm reports truthfully by reporting  $r_B$  when  $p = p_B$  and by reporting  $r_G$  when  $p = p_G$ . The firm inflates its performance by reporting  $r_G$  when  $p = p_B$ . Current shareholders bear a cost  $c$  if the firm inflates its performance. This cost represents anticipated sanctions for mis-reporting as well as resources, including managerial attention, that must be devoted to evading auditor oversight. In principle the firm could also disclose information about its investment project at this time. However, since this information can never be verified, the firm cannot be punished for reporting it falsely. As a result, such disclosure has no credibility and would be ignored.

At time  $t = 2$ , the firm can raise capital by issuing equity claims to outside investors. The share of a firm reporting  $r_k$  for  $k \in \{B, G\}$  that must be given to outside investors in exchange for  $K$  units of capital is denoted  $1 - \alpha_k$ . Current shareholders retain the remaining proportion of shares  $\alpha_k$ . Since capital markets are perfectly competitive, investors break even in expectation. Thus the expected value of the share of the firm received by outside investors when a firm raises capital must equal  $K$ . This requires that

$$(1 - \alpha_k)E[x|r_k] = K.$$

At time  $t = 3$ , the firm invests in its project if it announced its intention to do so at  $t = 0$ . Finally, at time  $t = 4$ , the firm receives cash flow  $x$  and ceases to

operate. This cash is apportioned to the firm's original shareholders and its new investors, if any, in accordance with their share of the firm's equity.

### 3.1.1 Strategies and equilibrium definition

A firm makes two choices in the game: 1) whether or not to invest, and 2) if it does decide to invest, whether to report that it has good or bad assets in place.<sup>9</sup> A firm's strategy is a probability distribution over three possible combinations of investment and reporting decisions: 1) report  $r_B$  and invest; 2) report  $r_G$  and invest; and 3) do not invest. Let  $\sigma_{ij}^k$  denote the probability that a firm of type  $(p_i, q_j)$  reports  $r_k$  and invests, with  $0 \leq \sigma_{ij}^k \leq 1$ . The probability that a firm of type  $(p_i, q_j)$  does not invest is simply  $1 - \sigma_{ij}^B - \sigma_{ij}^G$ .

In principle, there are eight mixed strategy probabilities to track: two for each type of firm (one for each of the two possible reports about assets in place if the firm invests). However, a firm has no incentive to under-report the quality of its assets in place. So a firm with good assets in place never reports that it has bad assets in place. That is,  $\sigma_{Gj}^B = 0$  for  $j \in \{B, G\}$ . This leaves six remaining probabilities that must be tracked.

Outside investors provide capital to finance investment. They do so on terms that allow them to break even in equilibrium. Their beliefs about firms' mixed strategies establish the share of the firm ( $1 - \alpha_B$  or  $1 - \alpha_G$ , depending on the firm's report) that they require in exchange for capital  $K$ . These beliefs must be correct

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<sup>9</sup>The choice to raise capital is determined by the investment decisions and is therefore not an independent choice.

in equilibrium. The share of the firm that outside investors must receive to break even in expectation solves

$$(1 - \alpha_k) \left\{ x_L + \left[ \sum_{i \in \{B,G\}} \sum_{j \in \{B,G\}} \rho_{ij} \sigma_{ij}^k (p_i + q_j) \right] \Delta x \right\} = K, \quad (3.1)$$

for  $k \in \{B, G\}$ . Thus the initial shareholders of a firm reporting  $r_k$  and raising capital retain a share of the firm,

$$\alpha_k = 1 - \frac{K}{x_L + [\sum_{i \in \{B,G\}} \sum_{j \in \{B,G\}} \rho_{ij} \sigma_{ij}^k (p_i + q_j)] \Delta x}. \quad (3.2)$$

Finding an equilibrium involves identifying a set of mixed strategy probabilities that are incentive compatible for firms and terms of raising capital that allow outside investors to break even in expectation, given firms' strategies. The equilibrium concept is Perfect Bayesian Equilibrium.

### 3.2 Analysis of the model

In this section, I derive the equilibrium of the game described in section 2. I focus on how the equilibrium and investment efficiency vary with the cost of inflating performance. Before analyzing the equilibrium, I describe the first best outcome.

### 3.2.1 First best

Since  $R_G > 1 > R_B$ , it is efficient for a firm to invest if and only if  $q = q_G$ . Reporting is important in the model because it affects investor perceptions of firm value. This, in turn, affects the cost of raising capital in equilibrium and therefore the payoff to the firm's initial shareholders. However, a firm's report does not have any direct value consequences. It therefore does not impact the first best outcome.

In terms of the notation, the first best outcome is achieved when  $\sigma_{BB}^B = \sigma_{BB}^G = \sigma_{GB}^B = 0$  and  $\sigma_{GG}^G = \sigma_{BG}^B + \sigma_{BG}^G = 1$ . The irrelevance of reporting in the first best outcome is reflected in  $\sigma_{BG}^B + \sigma_{BG}^G = 1$ . That is, whether a firm with bad assets in place but a good investment project reports good or bad assets in place does not matter, as long as it invests. I can now use this first best outcome as a benchmark against which to assess the efficiency of any equilibrium. Before examining the equilibrium, I make three technical assumptions that ensure that underinvestment and overinvestment are both potential features of the equilibrium.

### 3.2.2 Underinvestment and overinvestment

To examine how investment efficiency varies with the cost of inflating performance, the model needs to allow for the possibilities of underinvestment and overinvestment. As Myers and Majluf (1984) show, when firms with assets in place of differing quality are pooled, a firm with better assets in place may forgo investment, even if investment would create value, rather than sell overpriced eq-

uity. On the other hand, when firms with differing project quality are pooled, a firm with a negative NPV investment may invest in order to sell overpriced equity.

I first make an assumption that ensures that underinvestment occurs in the model when firms with similar projects but differing assets in place are pooled.

**Assumption 1.**

$$R_G < \frac{(x_L + p_G \Delta x)(\rho_{BG} + \rho_{GG})}{\rho_{BG} v_{BG} + \rho_{GG} v_{GG} - (\rho_{BG} + \rho_{GG})K}. \quad (3.3)$$

It can be shown that the expression on the right is greater than 1, so this assumption does not conflict with the assumption that  $R_G > 1$ . If  $R_G$  is sufficiently high, then a firm with a good project finds investment so rewarding that it is willing to undertake it in spite of the cost that selling underpriced equity to finance it imposes on current shareholders. Assumption 1 rules out this possibility, as I now show formally.

**Lemma 1.** *Suppose that  $(p_B, q_B)$  and  $(p_G, q_G)$  firms are pooled in the capital market. If assumption 1 holds and  $(p_B, q_B)$  firms invest with probability 1, then  $(p_G, q_G)$  firms do not invest.*

While the appropriate assumption about  $R_G$  ensures the possibility of underinvestment when firms with assets in place of differing quality are pooled, one about  $R_B$  ensures that overinvestment is possible when firms with projects of differing quality are pooled.

**Assumption 2.** *For  $i \in \{B, G\}$ ,*

$$R_B > \frac{x_L + p_i \Delta x}{v_{iG} - K}. \quad (3.4)$$



If  $R_B$  is sufficiently low, then a firm with a bad project finds investing too costly, even though investing allows the firm to sell overpriced equity. Assumption 2 rules out this possibility. Finally, it is useful for the purpose of examining comparative statics to have a firm with a bad project invest with probability less than 1 when pooled with similar firms possessing good projects. The following assumption ensures this possibility:

**Assumption 3.** For  $i \in \{B, G\}$ ,

$$R_B < \frac{(\rho_{iB} + \rho_{iG})(x_L + p_i \Delta x)}{\rho_{iB} v_{iB} + \rho_{iG} v_{iG} - (\rho_{iB} + \rho_{iG})K}. \quad (3.5)$$

The following lemma formally establishes that assumptions 2 and 3 are sufficient for the desired mixing to occur when firms with projects of differing quality are pooled.

**Lemma 2.** Suppose that, for  $i \in \{B, G\}$ ,  $(p_i, q_B)$  and  $(p_i, q_G)$  firms are pooled in the capital market (and pooled with no other type). If assumptions 1 and 2 hold, then a firm with a bad project mixes between investing and not investing.

I assume going forward that assumptions 1 through 3 hold. I now analyze equilibrium behavior. The character of the equilibrium depends on how costly performance inflation is. Therefore, I examine equilibrium behavior for (three) different ranges of  $c$ . I begin with the case when  $c$  is low, in which underinvestment is likely to be a problem.

### 3.2.3 Equilibrium when report inflation is cheap

Myers and Majluf (1984) show that firms may forgo positive NPV investments when there is asymmetric information about assets already in place. In my model, reporting with costly state falsification can reduce information asymmetries. However, if the cost of report inflation is small, then underinvestment is a feature of my model as well.

To see why, suppose that report inflation is cheap (I will be precise about how cheap it must be shortly) and that a  $(p_G, q_G)$  firm invests in equilibrium with probability 1. In this case, a  $(p_B, q_G)$  firm can improve the terms on which it raises capital by reporting  $r_G$  and pooling with  $(p_G, q_G)$  firms. Since the cost is low, it does so with probability 1. However, from lemma 2, this cannot be an equilibrium, since a  $(p_G, q_G)$  strictly prefers not to invest when pooled with  $(p_B, q_G)$  firms. An equilibrium in which a  $(p_G, q_G)$  firm mixes between investing and not investing is also unsustainable, since the average value of firms in the pool is even lower when it mixes than when it invests with probability 1, further exacerbating underpricing. In fact, as I now show, a  $(p_G, q_G)$  firm never invests when  $c$  is sufficiently low.

**Proposition 1.** *If  $c < c^U$ , where*

$$c^U \equiv \left[ 1 - \frac{(\rho_{BG} + \rho_{GG})v_{BG}}{\rho_{BG}(v_{BG} + 1 - K) + \rho_{GG}(v_{GG} + 1 - K)} \right] \frac{v_{BG}}{v_{GG}} \quad (3.6)$$

*then  $\sigma_{GG}^G = 0$ .*

There are multiple possible equilibria when  $c < c^U$  and the nature of these depends on, among other things, the actual value of  $c$ . What proposition 1 shows is that, when  $c$  is low, a  $(p_G, q_G)$  firm never invests in any equilibrium. The problem is that such a firm finds itself undervalued and hence is reluctant to issue stock to finance investment. As  $c$  increases, the cost to a firm with  $p_B$  assets in place of reporting  $r_G$  increases. As such a firm reports  $r_G$  with lower probability in response, underpricing of a  $(p_G, q_G)$  firm lessens. The threshold  $c^U$  is the lowest  $c$  at which equilibrium underpricing is mild enough that a  $(p_G, q_G)$  firm finds investing worthwhile.

The key implication of proposition 1 is that if the cost of performance inflation is sufficiently low, then the economy is plagued by underinvestment. This suggests a role for the accounting system in making report inflation difficult - that is, establishing policies that make  $c$  large. I investigate this further by examining how the equilibrium changes when  $c$  increases above  $c^U$ .

### 3.2.4 Equilibrium when report inflation cost is moderate

I now show that increasing  $c$  from a level below  $c^U$  to a level above  $c^U$  eliminates the underinvestment problem. To do so, I need to derive the equilibrium for a range of possible  $c$ 's greater than  $c^U$ . To build intuition for the equilibrium, I first explore the incentives of a firm with bad assets in place to inflate its report.

Consider a firm with bad assets in place. Reporting  $r_G$  benefits the firm's current shareholders by reducing the share of the firm that must be given to outside investors in exchange for new capital. The cost of reporting  $r_G$  when  $p = p_B$  is

simply  $c$ . The net benefit, which is negative if  $c$  is large enough, of reporting  $r_G$  instead of  $r_B$  is the difference between the benefit and the cost:

$$(\alpha_G - \alpha_B)[x_L + (p_B + q)\Delta x] - c. \quad (3.7)$$

Assuming that  $\alpha_G > \alpha_B$ , as must be true in equilibrium, (3.7) is greater if  $q = q_G$  than if  $q = q_B$ . The benefit of reducing the share of the firm that must be given to outside investors is greater when the expected value of the firm is greater. Since the firm's expected cash flow, and therefore its expected value, is greater when  $q = q_G$ , the net benefit of falsely reporting  $r_G$  is greater when the firm has a good project. The next proposition follows directly.

**Proposition 2.** *If  $\sigma_{BB}^G > 0$ , then  $\sigma_{BG}^G = 1$ . If  $\sigma_{BG}^G < 1$ , then  $\sigma_{BB}^G = 0$ .*

This result suggests that  $(p_B, q_G)$  firms may be able to at least partially separate from  $(p_B, q_B)$  firms and to pool with  $(p_G, q_G)$  firms by reporting  $r_G$ . As I now show, when  $c > c^U$ , the cost to a  $(p_B, q_G)$  firm of reporting  $r_G$  is high enough that  $\sigma_{BG}^G < 1$ . From proposition 2,  $\sigma_{BB}^G = 0$  when  $\sigma_{BG}^G < 1$ . Outside investors understand the equilibrium, so

$$\alpha_B = 1 - \frac{(\rho_{BG}\sigma_{BG}^B + \rho_{BB}^B\sigma_{BB}^B)K}{\rho_{BG}\sigma_{BG}^B v_{BG} + \rho_{BB}^B\sigma_{BB}^B v_{BB}} \quad (3.8)$$

and

$$\alpha_G = 1 - \frac{(\rho_{GG} + \rho_{GB}\sigma_{GB}^G + \rho_{BG}\sigma_{BG}^G)K}{\rho_{GG}v_{GG} + \rho_{GB}\sigma_{GB}^G v_{GB} + \rho_{BG}\sigma_{BG}^G v_{BG}}. \quad (3.9)$$

If a  $(p_B, q_B)$  firm mixes between investing and not investing, then its payoff from the two actions must be equal:

$$\alpha_B v_{BB} = x_L + p_B \Delta x. \quad (3.10)$$

Substituting (3.8) into (3.10) and solving for  $\sigma_{BB}^B$  yields the following:

$$\sigma_{BB}^B = \left[ \frac{R_B v_{BG} - v_{BB}}{(1 - R_B) v_{BB}} \right] \left( \frac{\rho_{BG}}{\rho_{BB}} \right) \sigma_{BG}^B. \quad (3.11)$$

Assumptions 2 and 3 ensure that  $\sigma_{BB}^B \in (0, 1)$ . Because  $\sigma_{BB}^B$  is a linear function of  $\sigma_{BG}^B$ , and  $\alpha_B$  is determined by the proportion of the two types that report  $r_B$  and invest,  $\alpha_B$  does not change with  $\sigma_{BG}^B$  in equilibrium. This pins down the equilibrium value of  $\alpha_B$ , which can be found by substituting (3.11) into (3.8), which yields

$$\alpha_B = \frac{x_L + p_B \Delta x}{x_L + (p_B + q_B) \Delta x}. \quad (3.12)$$

A  $(p_B, q_G)$  firm, which always invests, mixes between reporting truthfully and inflating its report only if it is indifferent between the two - that is, if

$$(\alpha_G - \alpha_B) v_{BG} = c. \quad (3.13)$$

A  $(p_G, q_B)$  type firm, which always reports truthfully, mixes between investing and not investing only if it likewise indifferent:

$$\alpha_G v_{GB} = x_L + p_G \Delta x. \quad (3.14)$$

But  $\alpha_G$  cannot, in general, satisfy both (3.13) and (3.14) simultaneously. Therefore only one of the types  $(p_B, q_G)$  and  $(p_G, q_B)$  plays a mixed strategy in equilibrium. Assumption 1 ensures that it is the  $(p_B, q_G)$  firm that plays a mixed strategy, while a  $(p_G, q_B)$  firm never invests. Thus  $\sigma_{BG}^G$  can be found by setting  $\sigma_{GB}^G = 0$  in (3.9), substituting (3.9) and (3.12) into (3.13), and solving. This yields

$$\sigma_{BG}^G = \frac{(p_B + q_G)(R_B v_{GG} - v_{BB})K - v_{BB} v_{GG} c}{(p_B + q_G)(R_B v_{BG} - v_{BB})K - v_{BB} v_{BG} c}. \quad (3.15)$$

The resulting mixed strategy equilibrium holds as long as  $c$  is not too large. If  $c$  is large enough, then even a  $(p_B, q_G)$  firm finds it too costly to report  $r_G$ , and so  $\sigma_{BG}^G = 0$ . The following proposition describes the equilibrium and defines the range over which it holds:

**Proposition 3.** *If  $c^U < c < c^T$ , where  $c^U$  is as in (??) and*

$$c^T \equiv \frac{[(p_G - p_B)\Delta x](KR_B)v_{BG}}{v_{BB}v_{GB}}, \quad (3.16)$$

*then  $\sigma_{GG}^G = 1$ ,  $\sigma_{GB}^G = 1$ ,  $\sigma_{BB}^B = 0$ ,  $\sigma_{BG}^G$  is given by (3.15), with  $\sigma_{BG}^B = 1 - \sigma_{BG}^G$ , and  $\sigma_{BB}^B$  is given by (3.11).*

The threshold  $c^T$  is the lowest  $c$  for which all firms report truthfully in equilibrium, as I show shortly. Proposition 3 shows that an increase in the cost of performance inflation from below to above  $c^U$  does, as anticipated, mitigate the underinvestment problem by making reports more accurate, since  $\sigma_{GG}^G = 1$ .<sup>10</sup> Thus making report inflation more costly can deliver an improvement in investment efficiency. As I show now, however, further increases in  $c$  beyond  $c^U$  degrade investment efficiency by increasing overinvestment.

**Proposition 4.** *For  $c \in (c^U, c^T)$ , investment in  $q_B$  projects increases with  $c$ .*

This result follows directly from (3.11) and (3.15). As  $c$  increases above  $c^U$ , inflating performance becomes more costly. As a result, a  $(p_B, q_G)$  firm reports  $r_G$  with lower probability. It therefore reports  $r_B$  with greater probability. This increases the potential for a  $(p_B, q_B)$  firm to take advantage of overpricing by investing. It therefore invests with greater probability. Since investing in the bad project destroys value, overinvestment increases as  $c$  increases. This is true as long as  $c < c^T$ . I next consider what happens when  $c > c^T$ .

### 3.2.5 Equilibrium when report inflation is expensive

If the cost of inflating reports is sufficiently high, then all firms report the quality of their assets in place truthfully with probability 1. Firms with assets in place of the same quality but investment projects of differing quality are pooled in the capital market. A firm with a good project invests with probability 1, while one

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<sup>10</sup>While overinvestment occurs in this equilibrium, overinvestment also occurs in some of the equilibria that exist when  $c < c^U$  as well.

with a bad project mixes between investing and not investing. Mixing requires that the payoff to investing and not investing be equal for each  $p_i$ :

$$\alpha_i v_{iB} = x_L + p_i \Delta x. \quad (3.17)$$

The fraction  $\alpha_i$  of the firm retained by current shareholders when the firm raises capital is determined by outside investors' beliefs about the probability that a firm with a bad project invests. These beliefs must be correct in equilibrium since outside investors form rational expectations. This results in

$$\alpha_i = 1 - \frac{K}{x_L + \left( p_i + \frac{\rho_{iB} \sigma_{iB}^i q_B + \rho_{iG} q_G}{\rho_{iB} \sigma_{iB}^i + \rho_{iG}} \right) \Delta x}. \quad (3.18)$$

for  $i \in \{B, G\}$ . The solution is found by substituting (3.18) into (3.17) for each  $p_i$ , and then solving for  $\sigma_{iB}^i$ .

**Proposition 5.** *If  $c > c^T$ , then  $\sigma_{iG}^i = 1$  and*

$$\sigma_{iB}^i = \left[ \frac{R_B v_{iG} - v_{iB}}{(1 - R_B) v_{iB}} \right] \left( \frac{\rho_{iG}}{\rho_{iB}} \right) \quad (3.19)$$

for  $i \in \{B, G\}$ .

When all firms report truthfully in equilibrium, a firm with a good project invests with probability 1 and one with a bad project invests with probability given by (3.19). However, when  $c > c^T$ , not only do  $(p_B, q_B)$  firms invest in their negative NPV projects, but so do  $(p_G, q_B)$  firms. They do so because, when firms report



truthfully,  $(p_B, q_G)$  firms are excluded from the set of firms reporting  $r_G$ . The resulting increase in the expected value of firms in the pool raises  $\alpha_G$  and hence makes investment attractive to  $(p_G, q_B)$  firms since they can sell overpriced equity. Thus  $c > c^T$  results in substantial overinvestment by two types of firm.

### 3.2.6 Investment efficiency and the cost of performance inflation

Having now examined equilibrium behavior for all possible values of  $c$ , I next examine how investment efficiency varies with  $c$ . While the multiplicity of possible equilibria when  $c < c^U$  makes it difficult to compare investment efficiency between the  $c < c^U$  and  $c^U < c < c^T$  cases, the relationship between investment efficiency and  $c$  when  $c > c^U$  is straightforward.

**Proposition 6.** *For  $c > c^U$ , investment efficiency decreases in  $c$ . Investment efficiency does not vary with  $c$  when  $c > c^T$ .*

To better understand proposition 6, observe figure 1. This figure depicts the relationship between equilibrium strategies and  $c$  for  $c > c^U$ . Starting on the right, when  $c > c^T$ , both  $(p_B, q_B)$  and  $(p_G, q_B)$  firms invest in their negative NPV projects with positive probability. For  $c > c^T$ , a decrease in  $c$  does not affect the equilibrium. When  $c$  falls just below  $c^T$ , two things happen which both reduce overinvestment and hence improve efficiency. First,  $(p_B, q_G)$  firms begin to report  $r_G$  with positive probability. The resulting degradation of the pool of firms reporting  $r_G$  drives out  $(p_G, q_B)$  firms, which no longer find it optimal to invest. Second, since  $(p_B, q_G)$  firms report  $r_B$  less often, the ability of  $(p_B, q_B)$  firms to sell

overpriced equity by pooling with these firms falls, and they invest with lower probability.

As  $c$  continues to fall below  $c^T$ ,  $(p_B, q_G)$  firms report  $r_G$  with higher probability. This further diminishes the ability of  $(p_B, q_B)$  firms to sell overpriced equity, and they therefore invest less often. Thus investment efficiency continues to rise as  $c$  falls, at least until  $c$  reaches  $c^U$ . A moderate (rather than high)  $c$  is desirable because it provides flexibility for firms with good projects to signal by reporting  $r_G$ , which in turn reduces overpricing of firms with bad projects. So if a regulator can determine the cost of performance inflation through policy choices, it should set the cost low enough to permit some flexibility for firms to inflate performance.

### 3.2.7 Conditional investigation or penalty

A final consideration is the possibility that the cost of inflating performance depends on the firm's ultimate cash flow realization. I have thus far assumed that  $c$ , the cost of inflating performance, does not depend on this cash flow realization. While this keeps the analysis simple, one might imagine that the cost would indeed be state-varying. For example, since a firm with bad assets in place is more likely to experience the low cash flow than one with good assets in place, a market regulator might optimally investigate reporting accuracy more often when a firm receives a low cash flow after reporting good assets in place.

In this case, the expected cost of performance inflation would vary by the cash flow realization. Let  $c_L$  denote the cost when cash flow is low, and  $c_H$  be similarly defined for high cash flow. More frequent investigation when cash flow is low

implies  $c_L > c_H$ . The net benefit of performance inflation becomes

$$(\alpha_G - \alpha_B)[x_L + (p_B + q)\Delta x] - [(p_B + q)c_H + (1 - p_B - q)c_L]. \quad (3.20)$$

I have already shown that a firm with a good investment project has an advantage in inflating its performance report. This advantage makes signaling the quality of its investment project feasible if the penalty for performance inflation is neither too high nor too low. When  $c_L > c_H$ , a firm with a good investment project actually has two distinct advantages in inflating its performance report. Not only does improving the terms on which capital can be raised benefit such a firm more, but it also faces a lower cost since it is less likely to experience a low cash flow. Thus allowing for the possibility of a conditional cost strengthens the paper's results.

### 3.3 Conclusion

Conventional wisdom holds that performance inflation is inherently damaging to a financial economy. I have shown that this need not be the case. Firms can signal the quality of their investment opportunities by fraudulently inflating disclosures about variables driven by assets in place. Such signaling reduces overinvestment. While increasing the cost of inflating performance reduces underinvestment when this cost is low, it increases overinvestment when the cost is higher. Therefore, policies that reduce misreporting can also reduce investment efficiency.

### 3.4 Appendix. Proofs of lemmas and propositions

#### 3.4.1 Proof of lemma 1

Suppose to the contrary that  $(p_G, q_G)$  firms do invest with positive probability when assumption 1 holds. Then it must be that

$$\alpha_G[x_L + (p_G + q_G)\Delta x] \geq x_L + p_G\Delta x,$$

or equivalently

$$R_G \geq \frac{1}{\alpha_G K}(x_L + p_G\Delta x)(1 - \alpha_G), \quad (3.21)$$

recalling that  $R_G = q_G\Delta x/K$ . Outside investors' breakeven condition requires that

$$\alpha_G \leq 1 - \frac{(\rho_{GG} + \rho_{BG})K}{\rho_{GG}v_{GG} + \rho_{BG}v_{BG}}. \quad (3.22)$$

Note that this would be an equality if  $(p_G, q_G)$  firms invest with probability 1, but is an inequality if they invest with probability less than 1. Substituting (3.22) into (3.21) yields

$$R_G \geq \frac{(x_L + p_G\Delta x)(\rho_{BG} + \rho_{GG})}{\rho_{BG}v_{BG} + \rho_{GG}v_{GG} - (\rho_{BG} + \rho_{GG})K},$$

which contradicts assumption 1.

### 3.4.2 Proof of lemma 2

A  $(p_i, q_B)$  firm invests with positive probability if

$$\alpha_i v_{iB} > x_L + p_i \Delta x$$

or equivalently

$$R_B > \frac{1}{\alpha_i K} (x_L + p_i \Delta x) (1 - \alpha_i), \quad (3.23)$$

where

$$\alpha_i = 1 - \frac{K}{v_{iG}}. \quad (3.24)$$

Substituting (3.24) into (3.23) yields (3.4). A  $(p_i, q_B)$  invests with probability less than 1 if

$$R_B \leq \frac{1}{\alpha_i K} (x_L + p_i \Delta x) (1 - \alpha_i), \quad (3.25)$$

where

$$\alpha_i \leq 1 - \frac{(\rho_{iB} + \rho_{iG})K}{\rho_{iB} v_{iB} + \rho_{iG} v_{iG}}. \quad (3.26)$$

Substituting (3.26) into (3.25) yields (3.5).

### 3.4.3 Proof of proposition 1

I first show that  $\sigma_{GG}^G = 1$  is impossible when  $c < c^U$ . Suppose that  $c < c^U$  and  $\sigma_{GG}^G = 1$ . Lemma 2 rules out the possibility that  $\sigma_{GB}^G = 0$  and  $\sigma_{BG}^G = 0$ . Suppose that  $\sigma_{GB}^G \in (0, 1)$  and  $\sigma_{BG}^G = 0$ . Then  $\sigma_{GB}^G$  is determined by (3.19). For  $\sigma_{BG}^G = 0$ , it

must be the case that

$$(\alpha_G - \alpha_B)v_{BG} < c,$$

where

$$\alpha_i = \frac{x_L + p_i \Delta x}{v_{iB}}$$

since the  $(p_i, q_B)$  type must be indifferent between investing and not investing.

This requires that

$$\left( \frac{x_L + p_G \Delta x}{v_{GB}} - \frac{x_L + p_B \Delta x}{v_{BB}} \right) v_{BG} < c,$$

which contradicts  $c < c^U$ . Now suppose that  $\sigma_{GB}^G \in (0, 1)$  and  $\sigma_{BG}^G \in (0, 1)$ . This possibility is ruled out in the proof of proposition 3. Finally, suppose that  $\sigma_{GB}^G = 0$  and  $\sigma_{BG}^G \in (0, 1)$ . Suppose that  $\sigma_{GG}^G = 1$ . This requires that

$$\alpha_G v_{GG} \geq x_L + p_G \Delta x. \quad (3.27)$$

For a  $(p_B, q_G)$  firm to be indifferent between reporting  $r_B$  and  $r_G$ , it must be the case that

$$(\alpha_G - \alpha_B)v_{BG} = c, \quad (3.28)$$

or equivalently when

$$\alpha_G = \frac{c + \alpha_B v_{BG}}{v_{BG}}, \quad (3.29)$$

where

$$\alpha_B = \frac{x_L + p_B \Delta x}{v_{BB}}. \quad (3.30)$$

Substituting (3.29) into (3.27) and rearranging yields

$$R_G \geq \frac{v_{BG}(1 - \alpha_B) - c}{\alpha_B v_{BG} + c} (x_L + p_G \Delta x). \quad (3.31)$$

For the equilibrium to be possible, the expression in (3.31) must be less than the expression in (3.3). Noting that

$$\alpha_B = \frac{x_L + p_B \Delta x}{v_{BB}}, \quad (3.32)$$

this requirement can be written as  $c > c^U$ . Thus  $\sigma_{GG}^G = 1$  is impossible. Now suppose that there is an equilibrium with  $\sigma_{GG}^G \in (0, 1)$ . Then there must also be an equilibrium in which  $\sigma_{GG}^G = 1$  since  $\alpha_G$  is increasing in  $\sigma_{GG}^G$ . Since no such equilibrium exists, there cannot be an equilibrium in which  $\sigma_{GG}^G \in (0, 1)$ . ■

#### 3.4.4 Proof of proposition 2

Suppose that  $\sigma_{BB}^G > 0$ . This requires that

$$(\alpha_G - \alpha_B)v_{BB} \geq c$$

Since  $v_{BG} > v_{BB}$ ,

$$(\alpha_G - \alpha_B)v_{BG} > c.$$

So  $\sigma_{BG}^G = 1$ . That  $\sigma_{BG}^G < 1$  implies  $\sigma_{BB}^G = 0$  follows from the contrapositive argument.

### 3.4.5 Proof of proposition 3

Suppose that the equilibrium is as proposed. For  $\sigma_{BB}^B \in (0, 1)$  as given by (3.11) to hold, we must have

$$\alpha_B v_{BB} = x_L + p_B \Delta x. \quad (3.33)$$

Substituting from (3.12) into this expression shows that the equality holds. For  $\sigma_{BB}^G = 0$ , we must have

$$x_L + p_B \Delta x > \alpha_G v_{BB} - c. \quad (3.34)$$

Substituting from (3.9) shows that this holds. Consider now a  $(p_B, q_B)$  firm. For  $\sigma_{GB}^G = 0$  to hold, we must have

$$x_L + p_G \Delta x > \alpha_G v_{GB}. \quad (3.35)$$

Substituting from (3.9) shows that this holds. Consider now a  $(p_G, q_G)$  firm. For  $\sigma_{GG}^G$  to hold, we must have

$$\alpha_G v_{GG} \geq x_L + p_G \Delta x. \quad (3.36)$$

Substituting from (3.9) shows that this holds as long as  $c > c^U$ . Finally, consider a  $(p_B, q_G)$  firm. For  $\sigma_{BG}^B \in (0, 1)$ , with  $\sigma_{BG}^B = 1 - \sigma_{BG}^G$ , where  $\sigma_{BG}^G$  is given by (3.15), to hold, we must have

$$\alpha_B v_{BG} > x_L + p_B \Delta x. \quad (3.37)$$



Substituting from (3.12) shows that this holds. Finally, for  $\sigma_{BG}^G$  given by (3.15) to hold, we must have

$$(\alpha_G - \alpha_B)v_{BG} = c. \quad (3.38)$$

Substituting from (3.12) and (3.9) shows that this holds for  $c < c^T$ . ■

### 3.4.6 Proof of proposition 5

Suppose that the equilibrium holds. For  $\sigma_{iG}^G = 1$ , we must have

$$\alpha_i v_{iG} > x_L + p_i \Delta x \quad (3.39)$$

for  $i \in \{B, G\}$ . For  $\sigma_{iB}^i \in (0, 1)$ , we must have

$$\alpha_{iB} = \frac{x_L + p_i \Delta x}{v_{iB}}. \quad (3.40)$$

Substituting from (3.40) into (3.39) results in  $v_{iG}/v_{iB} > 1$ , which must hold. For  $\sigma_{iB}^i \in (0, 1)$  given by (3.19), we must have

$$\alpha_i v_{iB} = x_L + p_B \Delta x. \quad (3.41)$$

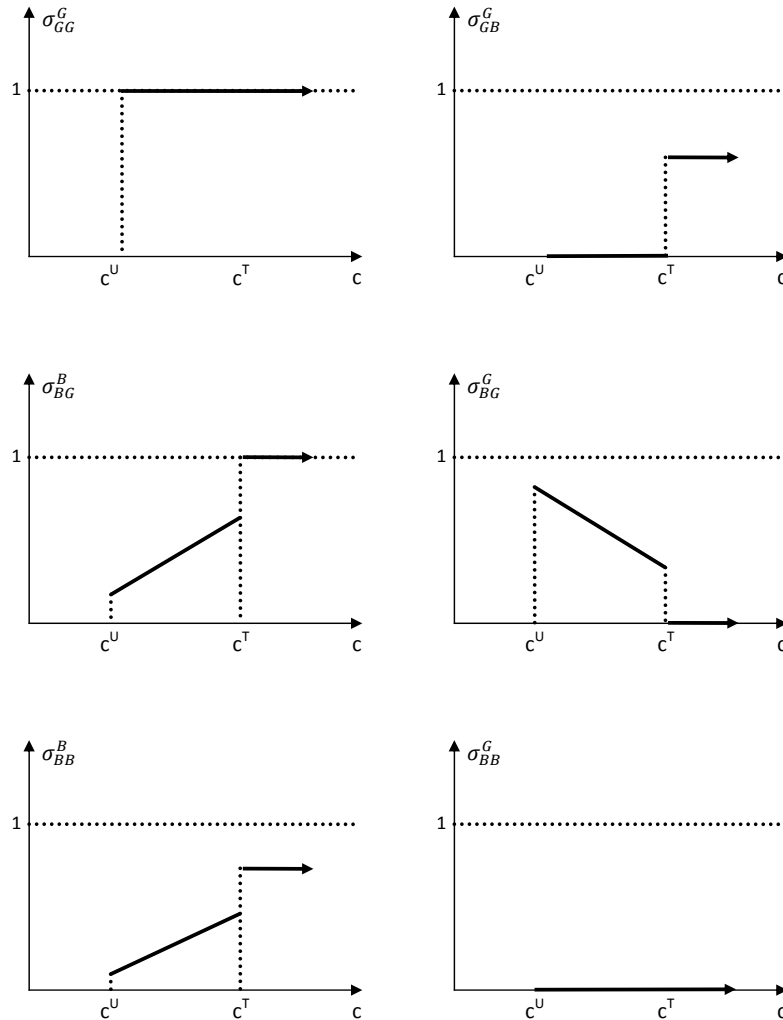
Substituting  $\sigma_{iB}^i$  from (3.19) into (3.18) yields (3.40). This is the value of  $\alpha_i$  that solves (3.41). Finally, for  $\sigma_{BG}^G = 0$ , we must have

$$(\alpha_G - \alpha_B)v_{BG} < c. \quad (3.42)$$

Substituting (3.40) in shows that this expression is true if  $c > c^U$ . By proposition 2,  $\sigma_{BB}^G = 0$  must also hold. ■

Figure 3.1: Equilibrium mixed strategy probabilities

This figure depicts equilibrium mixed strategy probabilities as a function of the expected fraud penalty  $c$ .



## Chapter IV

### Temporal Structure of Executive Compensation

Aligning manager and shareholder interests through the grant of managerial equity stakes reduces moral hazard costs (Jensen and Meckling 1976, Harris and Raviv 1978, Holmstrom 1979, Shavell 1979, Jensen 1986). However, aligning incentives this way also carries a cost: Undiversified managers whose fortunes are tied to firm value are forced to bear a substantial amount of risk. Such risk would predispose a risk-averse manager to choose less risky projects than what other, better diversified shareholders might prefer (Treynor and Black 1976, Amihud and Lev 1981, May 1995). These arguments apply with even greater force to owner-managers who own significant stakes in their companies. While outside shareholders may benefit from such holdings in terms of alignment of incentives, they may also suffer from the manager passing up positive NPV projects simply due to the risk they entail.

Companies run by managers who already own significant stakes in their firms often reward them with stock price-based bonuses as well as stock and option grants that vest immediately or in the very near future. It is unlikely that such

grants are intended to align managerial interests even more with those of long-term shareholders, since such awards can be locked in or consumed in the short-run. In addition, if such grants are not liquidated or hedged, they also increase the manager's exposure to undiversified, firm-specific risk. Besides, rewarding her on short-term stock price performance may very well also give her incentives to engage in stock price manipulation and divert her attention from long-term value maximization. Such grants, therefore, have been seen in the literature as attempts by managers to appropriate resources from outside shareholders (Bebchuk and Fried 2003, 2004). In this paper, we seek to examine in greater detail the incentive and risk effects of short-term equity-based compensation.

We argue in this paper that, unlike long-term shareholdings, short-term stock price-based compensation may actually attenuate a manager's bias against taking on riskier projects. Thus, short-term stock-based compensation could be a crucial ingredient in ensuring a better alignment of managerial and shareholder interests. The role of the market reaction to managerial choice is crucial in our analysis since market prices will react positively to the choice of value-increasing risky projects. Thus, making managerial compensation contingent on short-term stock price movements may make it possible to induce greater risk-taking without simultaneously diluting managerial incentives to maximize long-term shareholder value by avoiding risky projects. Thus, we establish another route through which making managerial compensation dependent on stock price performance can lead to greater value generation.

To explore the role of the temporal aspect of compensation, we analyze a very simple investment model. A risk-averse manager, endowed with a long-term equity stake in a firm, has to choose the level of riskiness of a project to undertake. The expected payoffs to projects are assumed to increase with the level of risk undertaken, up to a point. While the level of riskiness of the project undertaken by the manager is observable, it is assumed to be non-contractible. In this context, we first confirm that a larger long-term equity stake makes a risk-averse manager take on lower levels of risk. This, in turn, compromises her mission of generating the maximum value for her risk-neutral outside shareholders. Because she chooses too little risk in equilibrium, an increase in risk increases the expected long-term value of the firm. Since the stock market forms prices rationally, this, in turn, increases the short-term stock price. Linking the manager's pay to short-term stock price therefore increases her incentive to take risk, leading to a more efficient risk choice. However, the manager continues to choose less than the first best level of risk, no matter how strong short-term incentives are.

We then show that the optimal managerial contract contains both short- and long-term incentives. In our simple model, long-term incentives are needed to reduce inefficient private benefits consumption by the firm's manager. Given the long-term incentives in the contract, it is optimal to include short-term incentives as well to improve the manager's risk-taking behavior. The less efficient the stock market, the lower the optimal strength of short-term incentives. As stock market efficiency falls, the noise in the short-term stock price increases. This increases the

cost of providing short-term incentives, as these expose the manager to greater risk.

We then relax the assumption that the risk-reward tradeoff of projects available to the manager is common knowledge. Thus, the manager gets to privately observe the return to risk, and chooses a risk level conditional on this relationship. This private information cannot be credibly communicated to the financial markets. However, financial markets can observe the risk characteristics of the project she chooses. As before, such information cannot be contracted on directly. A long-term stake in the project payoff, again, introduces bias into the process of managerial project selection: all else equal, the manager prefers to choose a project with lower risk. However, the information asymmetry magnifies the effect of short-term incentives on risk-taking. The stock market reacts positively to risk not only because the marginal return to risk is positive, but also because higher risk signals that the return to risk is greater. Sufficiently strong short-term incentives in this case can actually lead managers to attempt to influence short-term valuations by taking excessive risk, reducing long-term value in the process.

Our analysis sheds some light on the widely noted empirical refutations of one of the main predictions in the moral hazard model of Holmstrom (1979). In the standard analysis of moral hazard, the principal tradeoff is between incentives and risk. As a result, a higher managerial equity stake is optimal only when the risk associated with revenues is lower. Yet, studies in fields as diverse as franchising, entrepreneurship and managerial compensation have found that the use of revenue sharing and equity compensation is much more prevalent in riskier envi-

ronments. While models based on asymmetric information have been constructed to explain these puzzling empirical findings (Lafontaine and Bhattacharyya 1995, Pendergast 2002), the analysis to date has ignored the role of the temporal distribution of such incentives. Our analysis points out that, even in a relatively standard moral hazard context, it may be possible for managerial stake and risk to be positively related, as long as the managerial stake is not restricted to be entirely long-term in nature. As a result, our analysis suggests that allowing managers to liquidate or to hedge away a part of their equity-based risks may be an integral part of optimal managerial compensation.

Our analysis has major implications for risk choices undertaken by managers in a wide variety of contexts. For example, while Amihud and Lev (1981) argue that managers with greater equity stakes should exhibit a bias towards diversification, Aggarwal and Samwick (2003) find that managers with greater equity-based compensation are not more likely to engage in diversification. As we show in this paper, managerial incentives to diversify depend critically on the temporal nature of the manager's equity-based compensation. If the manager stands to benefit in the short-run from such movements in stock prices, then the extent of her bias toward diversification can be significantly attenuated. Thus, a proper test of the diversification incentives of managers needs to take into account the temporal distribution of managerial incentives.

Our analysis of the asymmetric information setting is related to the analysis of fund manager compensation in Bhattacharyya and Nanda (2007). In their paper, they show that when a fund manager's trading activity is not directly observable,



it is optimal for long-term shareholders to offer compensation to fund managers based on short-term performance. While our analysis shares similar intuitions, we focus explicitly on the tradeoffs between short- and long-term incentives. In particular, we are able to focus on the relative merits of short-term stock-based compensation for managers with differential equity holdings in the companies they run.

The rest of the paper proceeds as follows. Section 2 presents a simple model of managerial investment. In this section, we analyze the effect of short- and long-term incentives on risk-taking, derive results regarding the optimal managerial contract, and examine the effect of introducing asymmetric information regarding the return to risk. Section 3 presents an application of our model to the issue of corporate diversification. Section 4 concludes.

#### **4.1 A model of managerial risk choice**

We build a very simple stylized model of investment to illustrate how short-term incentives affect a manager's choice of risky projects to undertake. The key feature of the model is a deterministic relationship between risk and expected payoff. Linking managerial compensation to firm value is beneficial because it reduces wasteful private benefits consumption. However, as a consequence of such incentives and managerial risk aversion, the shareholders' optimal level of risk may not be implemented.

### 4.1.1 Description of the model

Consider the case of a publicly-traded, all-equity firm managed by a single risk-averse manager. The shareholders of the firm are comprised of the manager and a set of risk-neutral outside investors. The stock price at any point in time is determined rationally by the beliefs of the outside investors. Denote by  $v$  the firm's terminal value. No dividends are paid in this model and the risk-free rate is normalized to zero. As a result, the value of the firm at any point of time is the expected terminal value of the firm. Letting  $\Omega_t$  denote outside investors' information set at time  $t$ , the stock price is  $p_t = E[v|\Omega_t]$ .

The manager is assumed to have a mean-variance utility over terminal wealth  $\xi$ ,

$$EU(\xi) = E[\xi] - \frac{1}{2}r \text{var}(\xi), \quad (4.1)$$

where  $r$  is a coefficient of risk aversion. The manager begins with 0 wealth and her incremental wealth is the sum of compensation  $w$  and the value  $B$  of any private benefits that she consumes. Thus the manager's terminal wealth is  $\xi = w + B$ . The manager does not face a wealth constraint and has reservation expected utility  $\bar{U}$ .

The manager makes two decisions. The first decision is a choice of project in which to invest. The manager chooses one project from among a continuum of projects with variance  $\sigma_x^2 \in [0, \infty]$  and mean  $\mu(\sigma_x^2)$ . The expected payoff is increasing in the risk of the project up to a point, but at a decreasing rate, and decreasing in risk beyond that point. In terms of notation, we have  $\mu' > 0$  for  $\sigma_x^2 < \hat{\sigma}_x^2$ ,  $\mu' = 0$  for  $\sigma_x^2 = \hat{\sigma}_x^2$ ,  $\mu' < 0$  for  $\sigma_x^2 > \hat{\sigma}_x^2$ ,  $\mu'(0) = \infty$ , and  $\mu'' < 0$ . We assume initially

that the mapping of risk to expected payoff  $\mu$  is known by both management and outside shareholders. We later examine the effect of asymmetric information by making this relationship the private information of the firm's management.

The second choice the manager makes is the level of private benefits  $B$  to consume. Private benefit consumption reduces the value from the project payoff  $x$  to a level of  $v = x - \phi(B)$ . Private benefit consumption is assumed to be inefficient and this is captured by our assumptions that  $\phi' \geq 1$ ,  $\phi'(0) = 1$ ,  $0 < \phi'' < \infty$ , and  $\phi(0) = 0$ . We assume that the noise in the realized payoffs makes forcing contracts infeasible and, therefore, that managers can consume private benefits.

There are three dates. The manager begins at  $t = 0$  with a compensation contract in place. This compensation contract is initially taken as exogenously given, though in subsequent analysis we investigate the issue of its optimality. At  $t = 1$ , the manager chooses a project. Project choice is observable, and the stock price updates accordingly to  $p$ . At  $t = 2$ , the manager consumes private benefits  $B$  and project payoff  $x$  is realized, and the manager is paid in accordance with her contract.

The manager's possible compensation contract is assumed to be of the form of a triple  $(\alpha, \beta_1, \beta_2)$ . The first term is a fixed wage component, the second the weighting on the  $t = 1$  stock price  $p$ , and the third the weighting on the terminal value  $v$ . Thus the manager's realized compensation is

$$w = \alpha + \beta_1 p + \beta_2 v. \tag{4.2}$$

### 4.1.2 First best outcome

We begin by establishing the first best choice of project and private benefits consumption as a benchmark. By assumption, expected project payoff  $\mu$  increases with project variance  $\sigma_x^2$  up to the point  $\hat{\sigma}_x^2$  and then decreases subsequently. Thus the first best project has payoff variance  $\hat{\sigma}_x^2$ . Since the marginal cost of private benefits consumed,  $\phi'(B)$ , is greater than 1 for all  $B$ , no private benefits are consumed in the first best outcome. The following lemma captures the first best:

**Lemma 3.** *In the first-best, project variance is chosen to maximize expected project payoff ( $\sigma_x^2 = \hat{\sigma}_x^2$ ) and no private benefits are consumed ( $B = 0$ ).*

Private benefits consumption is inefficient. However, a manager whose pay is not closely-linked to the value of the firm fails to internalize this inefficiency and does indeed consume private benefits. This moral hazard problem can be addressed by linking the manager's pay to the firm's terminal value. However, such long-term incentives expose the risk averse manager to undiversified risk, which potentially distorts her project choice. We investigate the effect of long-term incentives now.

### 4.1.3 Effect of long-term incentives

We analyze here the effect of the long-term incentive ( $\beta_2$ ) on the manager's private benefits consumption and investment decisions in the absence of short-term incentives (that is,  $\beta_1 = 0$ ). For now, we assume that the manager suffers from no wealth constraints so that her maximization problem coincides with the

maximization of total surplus<sup>1</sup> The manager's optimization problem is, then,

$$\max_{B, \sigma_x^2} \left\{ B + \beta_2 [\mu(\sigma_x^2) - \phi(B)] - \frac{1}{2} r \beta_2^2 \sigma_x^2 \right\}. \quad (4.3)$$

The first order conditions for the choice of  $B$  and  $\sigma_x^2$  respectively are

$$\phi'(B) = \frac{1}{\beta_2} \quad (4.4)$$

and

$$\mu'(\sigma_x^2) = \frac{1}{2} r \beta_2. \quad (4.5)$$

Totally differentiating (4.4) results in

$$\frac{dB}{d\beta_2} = -\frac{1}{\phi''(B)\beta_2^2}. \quad (4.6)$$

Since  $\phi'' < 0$ , private benefits consumption is decreasing in the manager's stake in the firm. This is not surprising, as increasing the manager's stake forces her to internalize more of the cost of private benefits consumption. As  $\mu'' < 0$ , the riskiness of the project chosen by the manager decreases in the manager's stake in the firm. This is also not surprising, as an increase in the manager's stake increases her exposure to the risk of terminal cash flows. Because she is risk-averse, the manager chooses a project risk level lower than that preferred by her risk-neutral outside shareholders. Increasing long-term incentives therefore diminishes the

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<sup>1</sup>We explore the issue of optimal managerial contracts in the presence of managerial wealth constraints via a numerical example later on in the paper. A full analysis of the problem with managerial wealth constraints is left for a later version of the paper.

manager's moral hazard with respect to private benefits consumption, but intensifies her moral hazard with respect to project risk choice.

#### 4.1.4 Effect of short-term incentives

As has long been understood, and as we have just shown formally, long-term incentives tend to mute risk-taking. What, then, about short-term incentives? By definition, the long-term component of the manager's wage is sensitive to the realization of terminal cash flows. The short-term component, however, exposes the manager to variations in the stock price due to changes in market expectations of final cash flows. With short-term compensation, the manager's problem becomes

$$\max_{B, \sigma_x^2} \{B + \beta_2[\mu(\sigma_x^2) - \phi(B)] + \beta_1 p - \frac{1}{2} r \beta_2^2 \sigma_x^2\}. \quad (4.7)$$

Note that the manager, in her optimization decision, takes the market price to be a function solely of the choices observed by the market. The  $t = 1$  stock price  $p$  is affected by the manager's equilibrium level of private benefits consumption  $\hat{B}$ , where this is correctly conjectured by investors. However, the manager's choice of  $B$  is not observed by the stock market at  $t = 1$ . Therefore the  $t = 1$  stock price  $p$  is not affected by the manager's actual private benefits consumption decision. As a result, the first order condition with respect to the choice of private benefit levels remains the same as in our earlier derivation. As we now show, long-term incentives continue to dampen the risk chosen after short-term incentives are in-

roduced. However, short-term incentives themselves have the opposite effect on risk choice.

**Proposition 7.** *The manager's choice of risk decreases in the strength of long-term incentives and increases in the strength of short-term incentives.*

**Proof.** The first order condition for the manager's choice of project risk is now

$$\beta_2 \mu'(\sigma_x^2) + \beta_1 \frac{dp}{d\sigma_x^2} - \frac{1}{2} r \beta_2^2 = 0 \quad (4.8)$$

The  $t = 1$  stock price is given by

$$p = \mu(\sigma_x^2) - \phi(\hat{B}), \quad (4.9)$$

Therefore,

$$\frac{dp}{d\sigma_x^2} = \mu'(\sigma_x^2). \quad (4.10)$$

Substituting this in to the first order condition for the risk choice and re-arranging yields

$$\mu'(\sigma_x^2) = \frac{r \beta_2^2}{2(\beta_1 + \beta_2)}. \quad (4.11)$$

Totally differentiating this while holding  $\beta_1$  constant yields

$$\frac{d\sigma_x^2}{d\beta_2} = \frac{r \beta_2 (\beta_2 + 2\beta_1)}{\mu''(\sigma_x^2) (\beta_1 + \beta_2)^2}, \quad (4.12)$$

which is negative for all  $\beta_2$  because  $\mu'' < 0$ . Totally differentiating the first order condition while holding  $\beta_2$  constant yields

$$\frac{d\sigma_x^2}{d\beta_1} = -\frac{r\beta_2^2}{2\mu''(\sigma_x^2)(\beta_1 + \beta_2)^2} \quad (4.13)$$

which is positive for all  $\beta_1$  because  $\mu'' < 0$ . ■

The intuition behind the effect of long-term incentives on risk-taking remains the same. More long-term incentives means greater exposure to project payoffs, which induces the risk averse manager to choose less risky projects. The intuition behind the effect of short-term incentives on risk-taking is simple in this context. If the manager is exposed to the short-term stock price, she has an incentive to increase the the stock price. The way to do this is to select a project with a higher level of risk. This gives the manager an incentive to take on more risk.

A comparison of the effects of short-term and long-term incentives is useful. A marginal increase in either leads to an identical increase in the expected payoffs to the manager from increasing risk. However, the long-term component exposes her to the risk associated with terminal cash flows, while the short-term component exposes her to the interim stock price, the riskiness of which is not affected by project choice. Thus long-term incentives are costly in terms of risk levels, while short-term incentives are not. Because her utility is concave, increasing the manager's long-term incentives has a greater impact on the cost of risk to her than on the benefit, and she reduces risk. Since increasing short-term incentives only



affects the manager's benefit from increasing risk, doing so leads to a straightforward increase in risk chosen.

Long-term incentives cause the manager to choose an inefficiently low level of risk. Proposition 1 demonstrates that equilibrium project risk increases with short-term incentives. Is it possible that sufficiently strong short-term incentives actually lead the manager to destroy value by taking on excessive risk? The answer is no, as shown in the following proposition.

**Proposition 8.** *For any given level of long-term incentives, the manager chooses inefficiently low project risk, regardless of the strength of short-term incentives.*

**Proof.** From (4.11),  $\mu' > 0$  for any  $\beta_2 > 0$ , so  $\sigma_x^2 < \hat{\sigma}_x^2$ . ■

Intuitively, short-term incentives force the manager to take greater account of the expected payoff of the project in her project choice decision. Expected project payoff is maximized when the chosen payoff variance is  $\hat{\sigma}_x^2$ . Increasing the variance beyond this point not only increases the risk faced by the manager due to her long-term incentives, but also reduces expected project payoff. Therefore, short-term incentives, no matter how strong, do not induce the manager to take on excessive risk. Note that the model is characterized by full symmetric information. We show later that, in the presence of asymmetric information about the return to risk, sufficiently strong short-term incentives can in fact induce the manager to destroy value by taking on too much risk as she seeks to communicate to outside investors favorable information about the return to risk.

Long-term incentives are needed to mitigate private benefits consumption but can bias the manager against taking risk. Adding short-term incentives to the manager's contract can benefit shareholders by improving managerial risk-taking. However, the resulting increase in risk imposes a cost on the manager, for which she must be compensated. Whether including short-term incentives in the manager's contract is optimal depends on the tradeoff between the benefit of improved risk-taking and the cost of imposing more risk on the manager. We now investigate this tradeoff and show that it is indeed optimal to include short-term incentives in the manager's contract.

#### 4.1.5 Optimal short- and long-term incentives

We proceed in two steps. In the first, we take the long-term incentive component of the manager's contract,  $\beta_2$ , as given and investigate the optimal level of short-term incentives,  $\beta_1$ . We then allow the long-term component of the contract to be chosen optimally and derive the resulting optimal contract. Taking  $\beta_2$  as given, shareholders' problem is

$$\max_{\beta_1} \{ \mu(\sigma_x^2) - \frac{1}{2} r \beta_2^2 \sigma_x^2 \}. \quad (4.14)$$

The first order condition for maximization is

$$\mu'(\sigma_x^2) = \frac{1}{2} r \beta_2^2. \quad (4.15)$$

Substituting for  $\mu'$  from (4.11), we have as the solution to shareholders' problem:

$$\beta_1 = 1 - \beta_2. \quad (4.16)$$

To understand this result, note that the inefficiency created by long-term incentives arises from the fact that, while the manager takes full account of the marginal cost of the risk imposed on her, she only takes into account a fraction  $\beta_2$  of the marginal value created by taking on more risk. When short-term incentives are included in the contract, she instead internalizes a fraction  $\beta_1 + \beta_2$  of the marginal value created. By setting  $\beta_1 + \beta_2 = 1$ , shareholders are able to induce the manager to fully internalize the marginal value creation, and the constrained first best obtains. That is,  $\beta_1 = 1 - \beta_2$  yields the most efficient outcome possible given the cost imposed by the inclusion of long-term incentives in the contract.

This result is, perhaps, better understood in the context of a manager-owned firm which is facing a project choice problem. In this context, the result says that the manager should keep in her possession only the amount of shares that are necessary to optimally assure the outside shareholders about her incentives to consume private benefits. The rest of the shares should, then, be sold off in an IPO, since they would be valued more highly by risk-neutral outside shareholders. Put another way, this result can be interpreted as saying that managers should consider choosing the risk levels of projects prior to undertaking an IPO as opposed to reserving the choice for later on. However, the result assumes that managers do not have wealth constraints which preclude them from taking on any projects

prior to doing an IPO. In later versions of the paper, we will incorporate the effect of managerial wealth constraints directly.

We now consider the optimal level of both short- and long-term incentives in the manager's contract. Formally, shareholders' problem is

$$\max_{\beta_1, \beta_2} \left\{ \mu(\sigma_x^2) - \frac{1}{2} r \beta_2^2 \sigma_x^2 + B - \phi(B) \right\}. \quad (4.17)$$

We now show that the optimal contract includes both short- and long-term incentives.

**Proposition 9.** *The optimal contract includes both short- and long-term incentives.*

**Proof.** The first order condition for the strength of short-term incentives is as given by (4.15). The first order condition for the strength of long-term incentives is

$$\left[ \mu'(\sigma_x^2) - \frac{1}{2} r \beta_2^2 \right] \frac{d\sigma_x^2}{d\beta_2} + [1 - \phi'(B)] \frac{dB}{d\beta_2} = r \beta_2 \sigma_x^2. \quad (4.18)$$

Substituting from (4.4), (4.6) and (4.15) into (4.18), we have

$$\frac{1 - \beta_2}{\phi''(B) \beta_2^3} = r \beta_2 \sigma_x^2. \quad (4.19)$$

As  $\beta_2 \rightarrow 0^+$ , the left-hand side goes to  $\infty$  while the right-hand side goes to 0. As  $\beta_2 \rightarrow 1^-$ , the left-hand side goes to 0, while the right-hand side goes to  $r\sigma_x^2$ , which is greater since (4.15) and the assumption that  $\mu'(0) = \infty$  imply that  $\mu > 0$  for

any  $\beta_2 < \infty$ . Given the continuity of  $\phi$ , it must be that the solution  $\beta_2 \in (0,1)$ . Therefore,  $\beta_1 = 1 - \beta_2$  must also lie in  $(0,1)$ . ■

In the absence of long-term incentives, the manager consumes unlimited private benefits. Because the marginal cost of private benefits increases with private benefits consumed, it is worth providing some long-term incentives to reduce their consumption. In the absence of short-term incentives, the manager takes into account only a fraction  $\beta_2$  of the benefit of increasing risk but all of the cost. Thus she chooses too little risk, even taking into account the cost of the risk imposed on her, for which she must be compensated. Thus it is optimal to provide some short-term incentives to improve risk-taking.

We have, to this point, assumed that the stock market perfectly forecasts the long-term value of the firm, making  $p$  a deterministic function of  $\sigma_x^2$ . To allow for the possibility of stock market forecasting error, we now let the stock price at  $t = 1$  be  $p = E[v|\Omega_1] + \epsilon_p$ , where  $\epsilon_p$  is an independent error term with mean 0 and variance  $\sigma_p^2$ . The manager cannot affect the realization of this error term, and the error term is uncorrelated with the error in project payoff. Therefore, once the manager's contract is in place, the addition of this error term does not affect her choices of project risk and private benefits consumption. That is, the results captured by propositions 1 and 2 continue to hold unchanged. However, incorporating short-term incentives now imposes a direct cost on the manager, for which she must be compensated, because it exposes her to noise in the short-term

stock price. The shareholders' problem now becomes

$$\max_{\beta_1, \beta_2} \left\{ \mu(\sigma_x^2) - \frac{1}{2} r (\beta_1^2 \sigma_p^2 + \beta_2^2 \sigma_x^2) + B - \phi(B) \right\}. \quad (4.20)$$

We show now that both short- and long-term incentives continue to be a part of the optimal contract, but noise in the stock price reduces the overall strength of the optimal incentives.

**Proposition 10.** *When the short-term stock price is noisy, the optimal contract includes both short- and long-term incentives. The short- and long-term incentive components in the optimal contract sum to less than unity.*

**Proof.** The first order conditions for  $\beta_1$  and  $\beta_2$  respectively are

$$\left[ \mu'(\sigma_x^2) - \frac{1}{2} r \beta_2^2 \right] \frac{d\sigma_x^2}{d\beta_1} = r \beta_1 \sigma_p^2 \quad (4.21)$$

and (4.18). Substituting from (4.6), (4.12) and (4.21) into (4.18) yields

$$\frac{1 - \beta_2}{\phi''(B) \beta_2^3} = r \beta_2^3 \sigma_x^2 + 2r \beta_1 \beta_2 (2\beta_1 + \beta_2) \sigma_p^2. \quad (4.22)$$

As  $\beta_2 \rightarrow 0^+$ , the left-hand side goes to  $\infty$  while the right-hand side goes to 0. As  $\beta_2 \rightarrow 1^-$ , the left-hand side goes to 0 while the right-hand side is positive. Given the continuity of  $\phi$ , there must exist a solution  $\beta_2 \in (0, 1)$ . Substituting from (4.11)

and (4.13) into (4.21) and rearranging, we have

$$\beta_1 + \beta_2 = 1 - \frac{4\mu''(\sigma_x^2)\beta_1(\beta_1 + \beta_2)^2\sigma_p^2}{r\beta_2^4}. \quad (4.23)$$

Since  $\beta_2 < 1$ , (4.23) implies that  $\beta_1 > 0$ . Since  $\beta_2 > 0$ , (4.23) implies that  $\beta_1 < 1$ .

Finally,  $\beta_1 > 0$  and (4.23) together imply that  $\beta_1 + \beta_2 < 1$ . ■

To understand the result in terms of the IPO interpretation presented earlier, this says that the second-best project choice in this context needs to have the manager seek outside financing prior to doing her IPO. Otherwise, by definition, her total stake in the firm's shares would add up to 1. Note, however, that in either case, the manager does not keep for the longer term a stake in the firm that is greater than what is required to optimally reassure outside shareholders about the extent of her private benefit consumption.

The analysis thus far has proceeded under the assumption of symmetric information about project payoff. In fact, the expected payoff function is assumed to be deterministic. We now investigate the effect of introducing asymmetric information about the expected return to risk.

#### 4.1.6 Short-term incentives and asymmetric information

The model remains the same, except that the relationship between risk and expected return is now uncertain. Let  $z$  denote a random state variable that measures the expected return to risk. When  $z$  is high, taking on risk creates significant value. When  $z$  is low, high risk is undesirable.

Outside shareholders do not observe  $z$  at any point. The manager observes  $z$  at  $t = 1$ , before choosing project variance  $\sigma_x^2$ . Expected project payoff is now  $\mu(\sigma_x^2; z)$ . The relationship between  $\mu$  and  $\sigma_x^2$  is assumed to have the same properties as before. A high return to risk is good news, so  $\mu_z > 0$ . Since the return to risk increases with  $z$ , we assume  $\mu_{\sigma_x^2 z} > 0$ . It follows directly that  $\hat{\sigma}_x^2$  is increasing in  $z$  - that is, the efficient level of risk is higher in states where the return to risk is greater. We also assume that the expected project payoff of the risk-free project is not affected by the state:  $\mu_z(0; z) = 0$ .

The manager's problem remains as in the symmetric information case, except for the additional parameter in the expected project payoff function  $\mu$ :

$$\max_{B, \sigma_x^2} \{B + \beta_2[\mu(\sigma_x^2; z) - \phi(B)] + p - \frac{1}{2}r\beta_2^2\sigma_x^2\}. \quad (4.24)$$

The first order condition of this problem is

$$\beta_2\mu_{\sigma_x^2} + \beta_1\frac{dp}{d\sigma_x^2} = \frac{1}{2}r\beta_2^2. \quad (4.25)$$

In the symmetric information case, the stock price was simply equal to the expected project payoff associated with the chosen risk level less anticipated private benefits cost. In the asymmetric information case, on the other hand, investors do not directly observe the state variable that determines the return to risk. So while they continue to observe the risk choice  $\sigma_x^2$ , they can no longer be certain of the associated expected project payoff. However, investors may be able to infer



something about this state variable from the manager's risk choice. In a fully separating equilibrium, this inference is perfect, and we can write  $z = z(\sigma_x^2)$ . Suppose that such an equilibrium exists. Since the  $t = 1$  stock price  $p$  is the expected value of the firm, we must have

$$p = \mu(\sigma_x^2, z(\sigma_x^2)) - \phi(\hat{B}). \quad (4.26)$$

One would expect that the manager would choose a higher level of risk when the return to risk is higher. In this case, outside shareholders should infer a more favorable return to risk when they observe a higher level of risk being chosen. One would expect then that  $z'(\sigma_x^2) > 0$ . We now show how asymmetric information affects the manager's choice of risk when outside investors make such an inference.

**Proposition 11.** *Suppose that there exists a fully-separating equilibrium in which the risk chosen by the manager increases with the return to risk. Then, for any given positive level of short- and long-term incentives, the manager chooses a higher level of risk under asymmetric information than under symmetric information.*

**Proof.** The derivative of the short-term stock price function is

$$\frac{dp}{d\sigma_x^2} = \mu_{\sigma_x^2} + \mu_z z'(\sigma_x^2). \quad (4.27)$$

Substituting into the first order condition of the manager's problem and re-arranging yields

$$\mu_{\sigma_x^2} = \frac{r\beta_2^2 - 2\beta_1\mu_z z'(\sigma_x^2)}{2[(\beta_1 + \beta_2)]}. \quad (4.28)$$

Since  $\mu_z > 0$  and  $z' > 0$ , the equilibrium  $\sigma_x^2$  is greater than in the symmetric information case, which can be found in (4.11). ■

Intuitively, asymmetric information amplifies the effect of short-term incentives on risk-taking. Short-term incentives give the manager an incentive to increase the short-term stock price. In both the symmetric and asymmetric information cases, increasing risk increases the short-term stock price because equilibrium return-to-risk is positive. However, in the case of asymmetric information, investors also infer the risk-return relationship from the manager's risk choice. Since investors infer a greater return-to-risk from a higher level of risk, and this has a positive effect on expected project value, the manager has an extra incentive to increase risk in the asymmetric information case.

How strong is this extra incentive? In the symmetric information case we showed that, while short-term incentives increase risk chosen, the manager always chooses an inefficiently low level of risk. However, one might conjecture that the incentive to signal return to risk in the asymmetric information case could lead to excessive risk-taking if short-term incentives are sufficiently strong. In this case, strong short-term incentives might make the manager willing to destroy value by increasing risk beyond the optimal level. We investigate this possibility

now. To make the problem more tractable, we assume a specific functional form for expected project payoff  $\mu$  that results in a fully separating equilibrium.

#### 4.1.7 Specific example

We now assume a specific functional form for the relationship between risk and expected payoff:  $\mu(\sigma_x^2; z) = z\sigma_x - \frac{1}{2}\sigma_x^2$ . This functional form satisfies all of our assumptions about  $\mu$ . The first best level of risk is  $\hat{\sigma}_x^2 = z^2$ . The manager's maximization problem is now

$$\max_{B, \sigma_x^2} \{B + \beta_2[z\sigma_x - \frac{1}{2}\sigma_x^2 - \phi(B)] + \beta_1 p - \frac{1}{2}r\beta_2^2\sigma_x^2\}. \quad (4.29)$$

We begin by investigating the solution to the manager's problem in the symmetric information case as a benchmark. Since investors know the value of the state variable  $z$ , price is calculated simply as  $p = \mu = z\sigma_x - \frac{1}{2}\sigma_x^2 - \phi(\hat{B})$ . The straightforward solution to the manager's problem is

$$\sigma_x^2 = \gamma_S^2 z^2, \quad (4.30)$$

where

$$\gamma_S = \frac{\beta_1 + \beta_2}{\beta_1 + \beta_2 + r\beta_2^2}. \quad (4.31)$$

As in the general case, the manager chooses too little risk for  $\beta_2 > 0$ , regardless of  $\beta_1$ , since  $\gamma_S < 1$  for any  $\beta_2 > 0$ . The solution to the manager's problem under asymmetric information is slightly more complicated because investors infer the

value of the state variable  $z$  from risk choice  $\sigma_x^2$ . This affects the relationship between risk choice and the intermediate stock price. The solution to the manager's risk choice problem is

$$\sigma_x^2 = \gamma_A^2 z^2, \quad (4.32)$$

where

$$\gamma_A = \frac{2\beta_1 + \beta_2}{\beta_1 + \beta_2 + r\beta_2^2 - 2r\beta_1\beta_2}. \quad (4.33)$$

Since  $z = \sigma_x / \gamma_A$ , the equilibrium is fully separating. Equilibrium short-term stock price is

$$p(\sigma_x^2) = (\gamma_A - \frac{1}{2})\sigma_x^2. \quad (4.34)$$

First, note that  $\gamma_A > \gamma_S$ . As shown in proposition 5, for any return to risk  $z > 0$ , the manager chooses a greater level of risk under asymmetric information than under symmetric information. This reflects the incentive to signal a high return-to-risk state by choosing a high level of risk. Second, note that, unlike  $\gamma_S$ ,  $\gamma_A$  need not be less than 1. Since the first best level of risk is  $\sigma_x^2 = z^2$ , this implies that the manager may actually chooses too much risk, destroying firm value in the process. Whether the manager chooses too little or too much risk in the asymmetric information case depends on the relative intensity of short- and long-term incentives. This is captured in the following proposition:

**Proposition 12.** *Under asymmetric information, the manager chooses inefficiently low risk if  $\beta_1 < \frac{r\beta_2}{1+2r\beta_2}$  and inefficiently high risk if  $\beta_1 > \frac{r\beta_2}{1+2r\beta_2}$ .*

**Proof.** Too little risk is chosen if  $\gamma_A < 1$ , which is true if  $\beta_1 < \frac{r\beta_2}{1+2r\beta_2}$ . Too much risk is chosen if  $\gamma_A > 1$ , which is true if  $\beta_1 > \frac{r\beta_2}{1+2r\beta_2}$ . ■

Asymmetric information amplifies the effect of short-term incentives on risk-taking. If these incentives are sufficiently strong, then the manager is willing to destroy long-term value in order to signal a high return to risk.

To get a greater sense of the strength of the incentives in the optimal contract, we next examine a numerical example.

#### 4.1.8 Numerical example

For the numerical example, we confine our analysis to the case where the relationship between expected return and risk is deterministic and common knowledge. We assume that  $\mu = 10\sigma_x - \frac{1}{2}\sigma_x^2$ . We further assume that  $r = 3$ ,  $\sigma_p^2 = 25$ , and  $\phi = B + 5B^2$ . The solution to this numerical example will clearly change with the assumptions we make about these primitives. Our objective is not to examine all possible cases, but rather to show that reasonable assumptions result in an optimal contract with reasonable sensitivities of managerial compensation to short- and long-term stock price.

The first best level of project variance is  $\sigma_x^2 = 100$ , which yields expected project value of  $\mu = 50$ . The first best level of private benefits is  $B = 0$ . This first best outcome provides a benchmark against which the efficiency loss of second best outcomes can be measured. Suppose first that only long-term incentives are available ( $\beta_1 = 0$ ). Then the optimal contract entails  $\beta_2 = 0.120$ . With this sensitivity to long-term performance, the manager chooses  $\sigma_x^2 = 54.07$ . This reduces

the expected payoff on the project from the first best 50 to  $\mu = 46.50$ . The manager consumes private benefits of  $B = 0.73$ . Total surplus is 41.91.

Now suppose that short-term incentives can also be included in the contract. The optimal level of long-term incentives is now  $\beta_2 = 0.127$ . However, the optimal contract now also includes  $\beta_1 = 0.108$ . With this contract in place, the manager chooses  $\sigma_x^2 = 68.40$ , which yields  $\mu = 48.50$ . This represents an improvement of 2.00 to the expected payoff on the project from the case in which short-term incentives are unavailable. However, since the manager faces more risk, both because short-term incentives themselves are risky and because she chooses a higher level of project risk, total surplus increases by a slightly smaller (but still considerable) amount to 43.39. The manager consumes private benefits of  $B = 0.68$ .

Suppose now that the manager has a reservation utility of 9.302. Then, when short-term incentives are not available, she receives a fixed wage of  $\alpha = 4.403$  in the optimal contract. This fixed wage allows her to earn exactly her reservation utility when  $\beta_2 = 0.120$ . If short-term incentives are allowed in the contract, then her fixed wage falls to  $\alpha = 0$  in the new optimal contract. That is, when  $\beta_2 = 0.128$  and  $\beta_1 = 0.107$ ,  $\alpha = 0$  ensures that the manager earns exactly her reservation utility in equilibrium. Thus it is optimal in this case for outside shareholders to completely eliminate the manager's fixed wage in order to give her the optimal level of short-term incentives.

Suppose now that  $\sigma_p^2 = 0$  instead of  $\sigma_p^2 = 25$ . This, obviously, does not change the optimal  $\beta_2$  when the contract includes only long-term incentives. Suppose that the firm's shareholders are constrained to provide a contract that holds the

manager to reservation utility of 9.302 and non-negative fixed wage ( $\alpha \geq 0$ ). By construction, the optimal contract when  $\sigma_p^2 = 25$  satisfies these two constraints. However, when  $\sigma_p^2 = 0$ , the optimal contract that satisfies these two constraints sets  $\beta_1 = 0.102$  and  $\beta_2 = 0.123$ .

Thus the optimal contract that satisfies the manager's reservation utility constraint with equality and the non-negative wage constraint provides the manager with a higher ownership of stock at time 0 when the short-term stock price variance is higher. This is somewhat striking. One of the chief predictions of principal-agent theory is that an agent's incentives should be weaker when risk is greater. A lengthy empirical literature has failed to find support for this prediction. In this example, the agent's incentives measured at time 0 can, indeed, be argued to be stronger when risk in the short-term stock price is higher. This suggests that one possible explanation for the failure of the predicted incentive-risk relationship of the principal-agent model is that empirical research has ignored the temporal structure of incentives. While the example is only suggestive, it is our conjecture that this feature is quite general. In the next version of the paper, proving this conjecture will be a central goal.

The fact that ignoring the temporal distribution of equity-based incentives can lead to possibly wrong conclusions can be illustrated also in other contexts. In the next section, we examine a specific strategic decision that impacts firm risk: how much to diversify the firm's assets.

## 4.2 Diversification decisions and short-term incentives

We have shown that the temporal structure of a manager's compensation contract affects her incentives when she makes choices that determine the risk of her firm's cash flows. One particular choice that affects cash flow risk is the degree of diversification in the firm's operations. Combining operations that generate imperfectly-correlated cash flows reduces total cash flow risk. Thus, a manager whose compensation is highly-dependent on the firm's stock price, may have an incentive to reduce the risk she faces through diversification of her firm's operations. This insight has formed the basis for papers examining the relationship between corporate conglomeration and the sensitivity of managerial pay to stock price performance (e.g. Amihud and Lev 1981, May 1995, Aggarwal and Samwick 2003). These papers test the hypothesis that an increase in the sensitivity of managerial pay to stock price, other things being equal, leads to more conglomeration.

However, our analysis in the previous section suggests that this hypothesis may not well-founded since such it ignores the time dimension associated with such stock-based incentives. As we have shown, whether an increase in the sensitivity of managerial pay to stock price predisposes the manager to take on less or more risk depends on whether the added incentives are linked to the long- or short-term stock price. This suggests that a test of the link between conglomeration and pay-performance sensitivity which ignores the temporal structure of compensation is incomplete.



To further explore this idea, we modify the model of the previous section to examine a manager's incentives to diversify her firm. Specifically, we re-cast the manager's risk choice as an allocation problem. The firm has access to 1 unit of capital. The manager chooses an allocation of this capital between a good project, which we call project G, and a bad project, which we call project B. Any amount between 0 and 1 unit of capital can be allocated to each of these projects, with the amounts allocated to the two projects summing to 1. We omit the private benefits consumption choice in this section since we will not try to derive the optimal contract. Thus, the allocation of resources between the projects is the manager's only choice in this section.

Let  $\delta$  denote the amount of capital allocated to project G. Then  $1 - \delta$  units of capital are allocated to project B. The timing of the model remains the same as in the previous section, except that there are now two project payoffs at time  $t = 3$  instead of one. The payoff of projects G and B are  $x_G$  and  $x_B$  respectively. The total payoff of the firm's investments is simply  $x = x_G + x_B$ . Since there are no private benefits, this is also the terminal value of the firm:  $v = x$ . The payoffs of the two projects have the same constant *per unit* variance  $\sigma^2$ . For simplicity, the project payoffs are assumed to be uncorrelated. Thus the total variance of the payoff from the firm's investments is

$$\text{var}(x) = [\delta^2 + (1 - \delta)^2]\sigma^2. \quad (4.35)$$

The expected payoffs of projects G and B are  $\mu_G(\delta)$  and  $\mu_B(1 - \delta)$  respectively. Both projects are assumed to exhibit declining returns to scale:  $\mu'_i > 0$  and  $\mu''_i < 0$  for  $i \in \{G, B\}$ . The only distinction between the two projects is that the good one has a higher marginal return at any level of capital  $k$ :  $\mu'_G(k) > \mu'_B(k)$ . Since the good project exhibits a higher marginal return to investment, the efficient investment policy allocates more than 1/2 of a unit of capital to the good project and, since the allocations must sum to one, less than 1/2 of a unit to the bad project. The efficient investment policy entails choosing  $\delta$  to satisfy

$$\mu'_G(\delta) = \mu'_B(1 - \delta). \quad (4.36)$$

Since the good project has a higher marginal return at any level of capital, the solution to (4.36) must satisfy  $\delta > 1/2$ . To ensure that the efficient allocation  $\delta$  is interior on  $(0, 1)$ , we assume that  $\mu'_B(0) > \mu'_G(1)$ .

Risk-neutral outside shareholders care only about the expected total payoff from the firm's investments. The risk-averse manager, however, cares also about the variance of the total payoff if her compensation is exposed to it. The availability of two projects provides the manager a means of reducing firm risk through diversification. This can be seen by taking the derivative of (4.35) with respect to the allocation to project G:

$$\frac{dvar(x)}{d\delta} = 2(1 - 2\delta)\sigma^2. \quad (4.37)$$

The expression in (4.37) is negative when  $\delta > 1/2$ . Since efficient investment requires  $\delta > 1/2$ , reducing risk through diversification involves shading the amount of capital invested in project G downward towards  $1/2$ , and, complementarily, shading the amount of capital invested in project B upward towards  $1/2$ .

We now examine how the structure of the manager's compensation contract affects her incentive to engage in such diversification of the firm's cash flows. Formally, the manager's problem is

$$\max_{\delta} \{ \beta_2 [\mu_A(\delta) + \mu_B(1 - \delta)] + \beta_1 p - \frac{1}{2} r \beta_2^2 [\delta^2 + (1 - \delta)^2] \sigma^2 \}. \quad (4.38)$$

The following proposition establishes how the manager's compensation structure affects the manager's choice of investment.

**Proposition 13.** *If the manager's contract includes long-term stock price-based incentives, she diversifies excessively. The extent of diversification increases with long-term incentives and decreases with short-term incentives.*

**Proof.** Outside investors observe  $\delta$  and form prices rationally, so  $p = \mu_G(\delta) + \mu_B(1 - \delta)$ . With this formula for  $p$  substituted into the manager's problem, the first order condition can be written

$$\frac{\mu'_G(\delta) - \mu'_B(1 - \delta)}{2\delta - 1} = \frac{r\beta_2^2\sigma^2}{\beta_1 + \beta_2}. \quad (4.39)$$

Let  $\delta^*$  denote the solution to (4.36) and  $\delta^{**}$  the solution to (4.39). Suppose that  $\delta < 1/2$ . Then the denominator of the left-hand side of (4.39) is negative. The

numerator must be positive since  $\mu'_G(\delta) > \mu'_G(\frac{1}{2}) > \mu'_B(\frac{1}{2}) > \mu'_B(1 - \delta)$ , where the first and third inequalities follow from the fact that  $\mu''_G < 0$  and  $\mu''_B < 0$  respectively, and the second from the fact that  $\mu'_G(k) > \mu'_B(k)$  for any capital level  $k$ . In this case, the left-hand side is negative of (4.39) is negative while the right-hand side is positive, so  $\delta$  cannot be less than  $1/2$ . Suppose instead that  $\delta = 1/2$ . Then the left-hand side of (4.39) is infinite, while the right-hand side is finite, so  $\delta$  cannot be  $1/2$ . Therefore, it must be that  $\delta > 1/2$ . Since  $\delta > 1/2$ , it must be that  $\mu'_A(\delta) > \mu'_B(1 - \delta)$ . Therefore, it must be that  $\delta^{**} < \delta^*$ . An increase in  $\beta_1$  requires a decrease in the left-hand side of (4.39), which means  $\delta$  must increase. An increase in  $\beta_2$  requires an increase in the left-hand side of (4.39), which means  $\delta$  must decrease. ■

Efficient investment entails investing more than half of the firm's capital in the good project. Taking efficient investment as the starting point, the manager can reduce the risk of the firm's cash flows by dropping the allocation to the good project below the efficient level. As in the previous section, long-term incentives predispose the manager to reduce risk. Because of the continuity of  $\mu_A$  and  $\mu_B$ , the cost of deviating a small amount from efficient investment is low. Therefore the manager indeed chooses to invest too little in the good project and, in consequence, too much in the bad project. Put differently, she reduces the firm's natural focus on its higher-return investment in order to diversify the firm's cash flows.

As her long-term incentives increase, the cost of the risk she bears increases, and she therefore diversifies more to reduce this cost. Short-term incentives again serve the role of attenuating the manager's bias against risk. When she chooses

too much diversification, a shift of capital from the bad project to the good project increases the expected total payoff of the firm's investments. Since outside investors form rational expectations, this increases the firm's short-term stock price. Therefore linking her pay to the short-term stock price reduces her bias towards diversification, making investment more efficient. However, no amount of short-term incentives will make the manager focus excessively. Increasing investment in the good project beyond the efficient level not only increases the risk faced by the manager, but also leads to a reduction in the short-term stock price.

Proposition 7 shows that how the intensity of a manager's equity-based incentives affect her disposition towards diversification depends on the time horizon of the incentives. This result confirms the importance of considering the time horizon of equity-based managerial incentives when testing the effect of such incentives of conglomeration. An increase in short-term incentives has a predicted effect on conglomeration that is the *opposite* of the predicted effect of an increase in long-term incentives.

### **4.3 Conclusion**

The importance of using stock price-based compensation to align the interests of management and shareholders is well-accepted. However, aligning incentives in this manner imposes significant risk costs on the manager which, in equilibrium, she must be compensated for. Alternatively, equity-based long-term compensation may give managers incentives to reduce risk at the expense of share-

holder value. However, optimally adjusting the temporal composition of such incentives can ameliorate the negative effects on risk choice such incentives have. This is possible because market prices will reflect the effect of the manager's incentives on her risk choices. But, in order to attain such benefits, the manager must be allowed to take advantage of short-term prices by trading out of some of her equity-linked claims. As a result, trying to rigidly align managerial compensation to those of long-term shareholders who can diversify may not be in the right interests of long-term shareholders themselves.

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