

# Investment, Cash Flow and Financial Markets: Evidence from Tax Loss Carryforwards

(Job market paper)

Jonathan B. Cohn\*  
University of Michigan  
Stephen M. Ross School of Business  
cohnj@umich.edu

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## Abstract

This paper exploits 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. Taken together, these findings confirm the existence of capital constraints imposed by costs of access to external finance.

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# 1 Introduction

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 fails to obtain, and a firm's investment activity can depend on the level of internal resources that 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 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 characteristics used to classify firms as more or less constrained may themselves proxy for investment opportunities, and that including *a priori* specified controls for investment opportunities in regressions may not adequately address this problem (Poterba 1988; Erickson and Whited 2000; Alti 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 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

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

<sup>2</sup>The cost of accessing external financing may be affected by frictions arising from adverse selection (Jaffee and Russell 1976; Stiglitz and Weiss 1981; Greenwald, Stiglitz and Weiss 1984; Myers and Majluf 1984) or 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).

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

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 investment 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 this 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 \$0.18 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 by approximately \$0.62 for each \$1 of 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 example, 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

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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).

<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

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 how outflows to claimants vary with 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, especially if they are more highly leveraged.

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 investment in response to windfalls from lawsuits unrelated to existing 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 in 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, 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

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Purnanandam 2006).

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 relationships 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 Lamont (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 *underestimate* the causal effect.<sup>8</sup> My estimate of an \$0.18 response of capital expenditures to a \$1 change in cash flow from carryforward tax savings, on the other hand, is less than 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 design 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

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<sup>8</sup>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.

and Roberts (2007) finds 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 financing variables 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, and am also able to show that the effect depends on how close the firm is likely to be to its debt capacity.

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.

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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).

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 Background and methodology

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 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 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 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 surveys 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

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

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-income 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

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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).

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.<sup>13</sup> Consistent with this argument, Erickson and Whited (2000) find that systematic investment-cash flow 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 an instrument 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 existing 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>14</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

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<sup>13</sup>See also Altı (2003).

<sup>14</sup>In a paper somewhat related to these, Holtz-Eakin, Joulfaian and Rosen (1994) find that an entrepreneur who receives an inheritance is more likely to have a greater probability of continuing to operate as a sole proprietor in the future and will be larger, conditional on surviving, than an entrepreneur who does not receive an inheritance.

investment. Such a strategy also allows me to examine in greater detail the importance of capital market imperfections for investment decisions.

## 2.2 Tax liability terminology and relationships

A publicly-traded corporation operating 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 differs 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 subtracting claimed and allowable NOL deductions.<sup>16</sup> Thus,

$$TaxableIncome = Profits - NOLDeductions. \quad (2)$$

The amount of NOL deductions is limited by the level of profits available for the year. That is,

$$NOLDeductions = \min\{Profits, CarryforwardsAvailable\}. \quad (3)$$

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

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

<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

applying the tax schedule to taxable income:

$$ActualTaxLiability = \tau(TaxableIncome). \quad (4)$$

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

$$ProFormaTaxLiability = \tau(Profits). \quad (5)$$

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

$$NOLTaxSavings = ProFormaTaxLiability - ActualTaxLiability. \quad (6)$$

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. That is,

$$TaxSavingsCapacity = \tau(CarryforwardsAvailable) \quad (7)$$

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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.

<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).

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 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 additional \$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,

$$\frac{\partial ActualTaxLiability}{\partial ProFormaTaxLiability} = \begin{cases} 0 & \text{if } ProFormaTaxLiability \\ & < TaxSavingsCapacity \\ 1 & \text{if } ProFormaTaxLiability \\ & \geq TaxSavingsCapacity. \end{cases} \quad (8)$$

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

$$NOLTaxSavings = \min\{ProFormaTaxLiability, TaxSavingsCapacity\}. \quad (9)$$

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

$$\frac{\partial NOLTaxSavings}{\partial ProFormaTaxLiability} = \begin{cases} 1 & \text{if } ProFormaTaxLiability \\ & < TaxSavingsCapacity \\ 0 & \text{if } ProFormaTaxLiability \\ & \geq TaxSavingsCapacity. \end{cases} \quad (10)$$

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 1 presents a graphical depiction of the relationships among the tax variables.

— Insert Figure 1 here —

### 2.3 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

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

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 as

$$\begin{aligned} CashFlow &= PreTaxCashFlow - ActualTaxLiability \\ &= PreTaxCashFlow - ProFormaTaxLiability + NOLTaxSavings. \end{aligned} \quad (11)$$

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

$$\begin{aligned} NOLTaxSavings &= \min\{ProFormaTaxLiability, TaxSavingsCapacity\} \\ &= \min\{ProFormTaxLiability, \tau(CarryforwardsAvailable)\}. \end{aligned} \quad (12)$$

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 coincides 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 (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:

$$\begin{aligned}
Investment_{i,t} = & \alpha_i + \gamma_t + \beta_{Savings}NOLTaxSavings_{i,t} \\
& + \beta_{Carryforwards}CarryforwardsAvailable_{i,t} \\
& + \beta_{ProFormaTaxLiability}ProFormaTaxLiability_{i,t} \\
& + \beta_{PTCF}PreTaxCashFlow_{i,t} + \beta_Q Q_{i,t-1} + \epsilon_{i,t}, \quad (13)
\end{aligned}$$

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 2a and 2b.

— Insert Figures 2a and 2b here —

In figures 2a and 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 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, a result of 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 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 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, investment is expected to change 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 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 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

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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.

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.<sup>22</sup>

### 3 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>23</sup> Tax rate data come from the U.S. federal corporate income tax schedules.<sup>24</sup> I supplement these data sources with data on corporate bond yields from the Federal Reserve's website, on economic recessions from the National Bureau of Economics (NBER), and on a firm's geographic scope from the

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<sup>22</sup>See Welch (1977) for a useful discussion of Classen's (1977) approach and results.

<sup>23</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>24</sup>Source: Internal Revenue Service Publication 542, "Marginal Rates of the Federal Corporation Income Tax, 1942-2003."

COMPUSTAT segments database. In the rest of this section, I describe how I construct my variables of interest and how I form my sample.

### 3.1 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). As described in the previous section, investment is the dependent variable in the primary regression equation. Investment can take many forms. Consistent with the 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.

## 3.2 Sample construction

I begin with all observations in the COMPUSTAT database from 1969 through 2005 for which beginning-of-year total assets exceeds \$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 provides 37 years of data which span a number of macroeconomic cycles. The minimum size requirement reduces the noise created by small denominators in the scaling of the variables.<sup>28</sup> I eliminate all observations for which any of the variables described above are missing.

I 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) is 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 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 main results do not change qualitatively. By far the largest source of reduction from the full COMPUSTAT database is missing data, especially current tax expense and NOL carryforwards.

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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 of carryforwards obtained through an acquisition to the product of the value of the acquired firm's stock before the acquisition and the long-term tax exempt rate.

<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.

The resulting panel consists of 52,409 observations for 7,785 firms. I winsorize all of the variables at the 1% and 99% levels to limit the impact of possible outliers.<sup>31</sup> For estimates obtained using first differences regressions, which require consecutive years in the sample, I am limited to using 39,519 observations (average of approximately 1,068 observations per year) for 5,754 firms. For regressions with firm fixed effects, I am able to use 50,878 observations for 6,254 firms.

Figure 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 included in COMPUSTAT during this period.

Third, the number of firms in the sample using NOL carryforwards exhibits cyclicity, with peaks in 1976, 1987 and 2003. Finally, the savings generated by carryforwards for firms in the sample increases dramatically beginning in 2002. Firms suffered tremendous tax losses in 2000 and 2001, which for many that survived have resulted in large tax savings after they returned to profitability in 2002.<sup>32</sup>

— Insert Figure 3 here —

Table 1 presents summary statistics for the full sample of 52,409 observations. This sample represents a broad cross-section of COMPUSTAT firms.

## 4 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

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<sup>31</sup>I have replicated the paper's results using trimming instead of winsorization.

<sup>32</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.

(section 4.1). This indicates that a firm's capital expenditures are causally affected by its internal resources. The effect is shown to be smaller than the association between capital expenditures and total cash flow for the same sample, suggesting an upward bias in traditional investment-cash flow regressions. 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). While I do not take a stand on the validity of these proxies, I find that investment is generally more sensitive to cash flow for firms that these measures predict to be more financially constrained.

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, with a recession indicator used as a supplemental measure suggested by the literature. 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 as well as borrowing and debt repayment. I find that neither dividend payouts nor share repurchases respond to NOL tax savings (section 4.5). I also 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 (section 4.6). This only holds for leveraged firms, which are more likely to face borrowing capacity limitations.

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

I begin by examining the impact of cash flow on capital expenditures. The results are summarized in table 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. Each of the regressions is run in first differences to control for firm fixed effects, and also includes year effects. Heteroskedasticity-robust standard errors, clustered at the firm level, are reported below each point estimate. Consistent with previous investment-cash flow sensitivity papers, lagged Tobin's Q is included in all regressions, though its exclusion has little effect on the results.

I begin by verifying that capital expenditures are positively associated with total cash flow. In column 1, the only independent variable is total cash flow. A \$1 increase in total cash flow is associated with a highly statistically significant \$0.274 increase in capital expenditures. This is similar to existing estimates.<sup>33</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. In column 2, the only right-hand side variable is actual tax liability. The coefficient on actual tax liability is positive, large (0.311), and highly statistically significant. Pre-tax cash flow is added in column 3. The coefficient on actual tax liability becomes *negative*, large and statistically significant. Since actual tax liability is a function of tax-book income, and tax and accounting income are likely to be highly correlated, it is not surprising that tax liability is highly correlated with pre-tax cash flow (estimated correlation of 0.82). Once the book measure of pre-tax cash flow is included in the regression, actual tax liability appears to reduce investment. While this is consistent with a cash flow effect of taxation, actual tax liability may continue to be endogenous even after controlling 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 4 contains the results from estimating the primary regression equation in (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

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<sup>33</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.

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 \$0.179 that is not contaminated by a firm's investment opportunity set.

The coefficient on pro forma tax liability is -0.265 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 \$1 of pro forma tax liability that is not shielded by loss carryforwards is associated with a fall in investment of \$0.265, while \$1 of pro forma tax liability that is shielded from taxation is associated with a fall in investment of only \$0.086.

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 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 negatively associated with capital expenditures if the amount of tax savings is not included in the regression. NOL tax savings appear to subsume this effect.

It has long been understood that cash flow is likely to predict investment opportunities and therefore, as a result of the omitted variables problem, regressions of investment variables on cash flow are likely to yield biased results. If higher cash flow predicts a better investment opportunity set, as would be the case in the event of a permanent demand or productivity shock, then the bias should be unambiguously upward. Regression of capital expenditures on total cash flow yields a coefficient of 0.274 (column 1), while regression of capital expenditures on NOL tax savings, with the appropriate controls included to identify the cash flow effect, yielded an estimate of 0.179 (column 4). To the extent that the latter represents a pure cash flow effect, the difference between these two coefficients (0.095) provides an estimate of the bias in estimates of the effect of total cash flow on investment. As

expected, the bias is positive.

As mentioned in the introduction, there is a large literature that has examined the effect of marginal tax rates on investment behavior. 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 are presented in column 5. The coefficient on ending NOL carryforwards is statistically insignificant. The tax savings coefficient actually increases slightly in this specification to 0.198 and remains statistically significant at the 1% level. The effect of NOL tax savings on marginal tax rates does not appear to be driving this paper's main result.

Returning to the paper's main specification, 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 4 presented results based on this specification, the controls need not be linearly related to investment opportunities. As NOL tax savings is 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 6. The coefficient on NOL tax savings decreases slightly to 0.174 from the estimate in column 4, but it remains statistically significant at the 5% level (p-value of 0.028). 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.

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 expendi-

tures 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 effects. 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. See section 2.2 for a 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. At a *DistanceToKink* of 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.

—Insert Figure 4 here—

The results of the kernel regression appear in figure 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* is 0. Consistent with the results in table 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.

## 4.2 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 3, I present results from estimation of the primary regression equation, where the dependent variables are investment variables other than capital expenditures. All specifications include year effects and are estimated in first differences. 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. All dependent variables are scaled by beginning-of-year assets. 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>34</sup> The NOL tax savings coefficient is positive and statistically significant at the 10% 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 internal resources.<sup>35</sup> Research and development, on the other hand, does not appear to respond to an increase to internal resources.

### 4.3 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

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<sup>34</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 value is missing in COMPUSTAT.

<sup>35</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.

constraints.<sup>36</sup> The second is a firm’s net cash position, which is cash and equivalents (COMPUSTAT item 1) less debt (the sum of COMPUSTAT items 9 and 34), scaled by total assets. This variable is essentially negative debt. The third proxy is common dividends scaled by beginning-of-year total assets. The fourth is an indicator for whether the firm has a Standard and Poor’s credit rating.

I measure each of the proxies at the beginning of each year. I then interact each with the right-hand side variables in the primary regression equation, and estimate the primary regression equation with each of these interaction terms added one at a time. The variable of interest in each regression is the interaction of NOL tax savings and the financing constraint proxy. The results are presented in table 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 NOL tax savings coefficient and its interactions are presented in the interest of conserving space. All of the interactions have the expected sign. Firm investment is more responsive to NOL tax savings for firms predicted to be more constrained by the Kaplan-Zingales index, firms with less cash relative to debt, firms that pay fewer dividends, and firms that do not have credit ratings.

The Kaplan-Zingales index and credit rating proxies appear to have the most explanatory power over the sensitivity of investment to cash flow. The latter 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.

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<sup>36</sup>The Kaplan-Zingales 4-variable financing constraint index is computed as

$$-1.002 \frac{CF_{it}}{Assets_{i,t-1}} - 39.368 \frac{Div_{it}}{Assets_{i,t-1}} - 1.315 \frac{Cash_{it}}{Assets_{i,t-1}} + 1.319 Lev_{it}, \quad (14)$$

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).

#### 4.4 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>37</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 using the spread between Baa- and Aaa-rated corporate bonds, as rated by Moody's.<sup>38</sup> Widening of this spread indicates a decline in the external financial market's willingness to fund risky investment. 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 by interacting each of the explanatory variables with the spread.

The results are presented in column 1 of table 5. The dependent variable is capital expenditures scaled by beginning-of-year assets. First differences estimation with year effects is used. 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, which ranges between 60 and 233 basis points during the sample period, increases the response of capital expenditures to a \$1 increase in cash flow by almost \$0.05. The fitted estimates of the annual sensitivity of investment to the NOL tax savings show that an incremental \$1 of cash flow has no effect on capital expenditures on average in the 9 years (approximately 25% of the years in the sample) with the smallest spreads. In the 9 years with the largest spreads, an incremental \$1 of cash flow results in a \$0.45 increase in capital expenditures on average.

I supplement this test using a measure of capital market conditions suggested by the

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<sup>37</sup>For example, loss of access to inexpensive debt financing appears to have drastically curtailed mergers and acquisitions activity in mid-2007.

<sup>38</sup>Source: Federal Reserve website.

literature. Kashyap, Lamont and Stein (1994) and Gertler and Gilchrist (1994) examine investment decisions during recessions and conclude that recessions are characterized by inaccessibility of external finance. One possible explanation of this is that recessions may be driven by tight monetary policy, which restricts the flow of capital. Another explanation is that the enhanced probability of firm failure during recessions increases adverse selection in the financial markets.

I construct a recession indicator variable that takes a value of 1 if the U.S. economy is in recession for the year and 0 if not. The economy is defined to be in recession for a year if the economy is classified by the NBER to be in recession for at least 6 months of that year. In column 2 of table 5, I replicate the test presented in column 1, but interact the explanatory variables with the recession indicator instead of the bond spread. The coefficient on the interaction of NOL tax savings and the recession indicator is statistically significant at the 10% level (p-value of 0.054) and indicates that investment is almost three times as sensitive to cash flow during a recession as it is in a non-recession year.

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 regressions from table 5, but include also triple interactions of the credit rating indicator with NOL tax savings and the capital market condition variables. The results of these regressions are presented in table 6. For brevity, only the coefficients on NOL tax savings and its interactions are shown. The triple interaction terms are negative and statistically significant for both capital market condition variables. This indicates that the sensitivity of investment-cash flow dependence to the bond spread and the state of the economy is greater for firms that lack credit ratings.

The results presented in tables 5 and 6 indicate that the dependence of a firm's investment on its internal resources varies systematically with the cost of accessing external

capital. This provides validation that the observed sensitivity of investment to cash flow is indeed being driven by difficulty in accessing external capital.

#### 4.5 NOL tax savings and outflows to claimants

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. Outflows can take the form of distributions to shareholders or repayment of outstanding debt. I test the effect of NOL tax savings on these outflows by estimating the primary regression equation, with distribution variables and change in debt substituted for investment.

The results for distributions to shareholders are presented in table 7. Estimation continues to be performed in first differences with year effects. The dependent variable in column 1 is dividends (COMPUSTAT item 21) scaled by beginning-of-year assets. The dependent variable in column 2 is dollars spent on repurchases (item 115) scaled by beginning-of-year assets. The dependent variable in column 3 is the sum of dividends and repurchases, scaled by beginning-of-year assets. The coefficient on NOL tax savings is statistically insignificant and actually slightly negative in all three specifications. The evidence does not support a causal connection between cash flow and distributions to shareholders. This supports the thesis that firms face cash constraints in their investment plans.

The results for change in debt are presented in table 8. The dependent variable in all specifications is change in debt scaled by beginning-of-year assets, where debt is the sum of long-term debt (COMPUSTAT item 9) and debt in current liabilities (COMPUSTAT item 34). The first column presents results from first differences estimation with year effects. The NOL tax savings coefficient is positive and statistically significant at the 1% level. This suggests that firms actually *increase* debt in response to additional cash flow from NOL tax savings. This is difficult to reconcile with a perfect capital markets interpretation, but 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.

To further investigate this possible explanation, I augment the specification in column 1 by creating triple interactions with net cash, which is a (negative) measure of a firm's leverage. Recall that net cash is defined as cash less debt, scaled by beginning-of-year assets. *Ceteris paribus*, firms with high leverage are more likely to be at their debt capacity. The more likely a firm is to be at its debt capacity, the more it should respond to additional pledgable assets by increasing debt. Consistent with this argument, column 2 shows that the effect of NOL tax savings on change in debt is decreasing in net cash (increasing in leverage). This is indicated by the negative, statistically significant (p-value of 0.073) coefficient on the interaction of NOL tax savings and net cash. Firms with zero net leverage (net cash of 0) do not increase debt when they generate cash through NOL tax savings, as indicated by the small, statistically insignificant coefficient on NOL tax savings by itself.

Finally, as a robustness check, I re-estimate the results shown in column 1 using firm fixed effects instead of first differences. These results are presented in column 3. I find that the coefficient on NOL tax savings falls to 0.404, but remains statistically significant at the 1% level. In unreported results, I verify that the findings shown in column 2 continue to hold with fixed effects.

Taken as a whole, the results do not support the prediction of a perfect capital markets model that firms disgorge excess cash. If anything, firms appear to generate positive financing flows in response to additional cash flow. This is more consistent with capital market imperfections constraining the ability of firms to raise external capital.

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

I return now to the general effect of cash flow from NOL tax savings on capital expenditures explored in section 4.1. I present results from tests of a number of alternative specifications in table 9 to ensure that the results presented in table 2 are robust. As in table 2, all specifications include year fixed effects. Heteroskedasticity-robust standard errors,

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

I first show that the results in table 2 are robust to alternative empirical models. 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 1 replicates column 4 of table 2 estimated 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 -0.29, suggesting that autocorrelation in the simple first differences regressions is potentially an issue. However, the coefficient on NOL tax savings actually increases slightly to 0.198 in this specification, and remains statistically significant at the 1% level.

In column 2, I re-estimate the primary specification using firm fixed effects instead of first differences. The coefficient on NOL tax savings jumps noticeably to 0.374. The sample is slightly larger than in the first differences case because the requirement for inclusion is multiple appearances of the firm in the sample instead of appearances in consecutive years. In unreported results, I find that the estimated effect becomes even larger when fixed effects estimation is applied to the smaller sample available for first differences instead.

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 ensure that the results are not being produced by measurement error in the tax variables, I apply, one at a time, three filters designed to reduce the incidence of measurement error. First differences regressions are then run on the resulting samples. First, all firms with less than \$200 million of beginning-of-year assets in 2005 dollars are removed. This is motivated by the finding of Dworin (1985) that current federal income tax expense overestimates federal income tax liability significantly for smaller firms. This reduces the usable sample to 21,838 observations. The results are presented in column 3 of table 9. The coefficient on NOL tax savings increases to 0.343, which is statistically

significant at the 5% level.<sup>39</sup>

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 segments data. The results using this second filter are presented in column 4. Removing firms with foreign segments increases the NOL tax savings coefficient to 0.299, which is statistically significant at the 1% level.

Finally, the manner in which NOL tax savings are computed 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. The results after this third filter is imposed are presented in column 5. The coefficient on NOL tax savings is 0.163 and remains statistically significant at the 5% level (p-value of 0.027).

## 5 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 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

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<sup>39</sup>Tightening the restriction by increasing the minimum size for inclusion further results in higher estimates of the coefficient on NOL tax savings, though the standard error of the estimate increases as well.

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. In fact, a firm that is likely to be near its borrowing capacity leverages additional cash to increase its debt level. The results of this paper indicate that capital market imperfections play a significant role in shaping investment and financing decisions.

## A 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>40</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.

### A.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.

### A.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

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<sup>40</sup>COMPUSTAT gathers tax data from firm financial statements. Much of the detailed data is extracted from the footnotes to the financial statements.

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>41</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>41</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.

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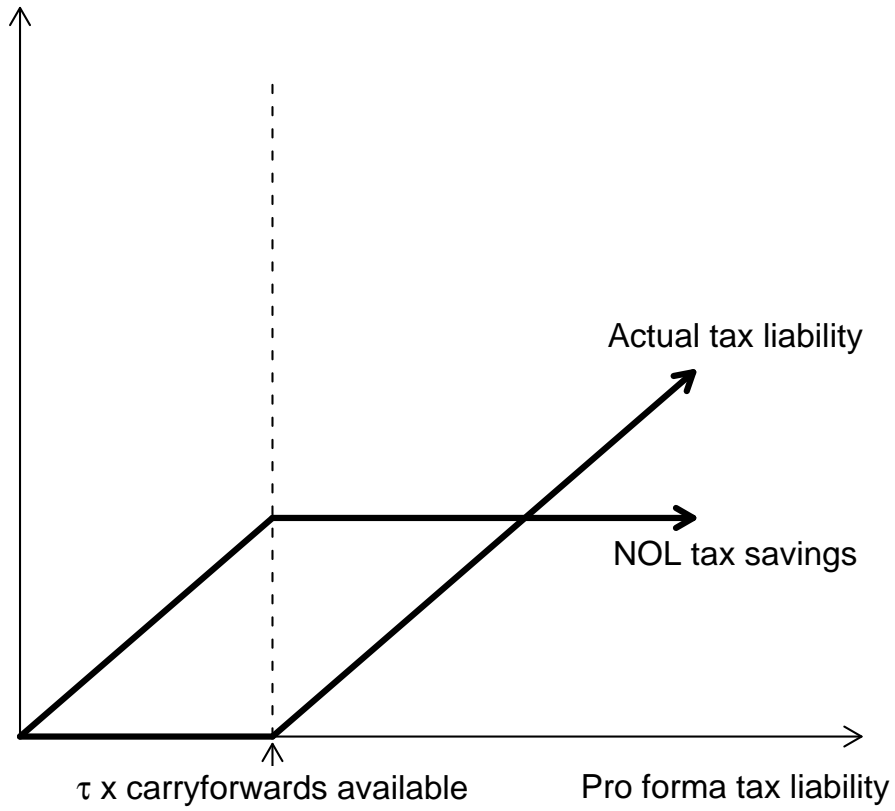


Figure 1: Kink in the NOL tax savings function

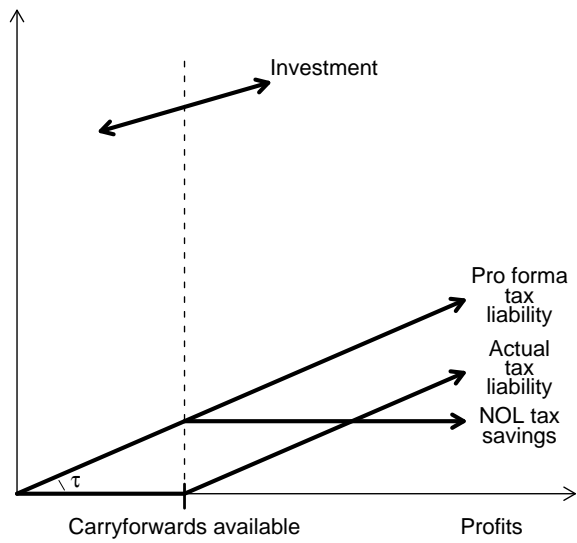


Figure 2a: Investment is not affected by tax-related cash flow

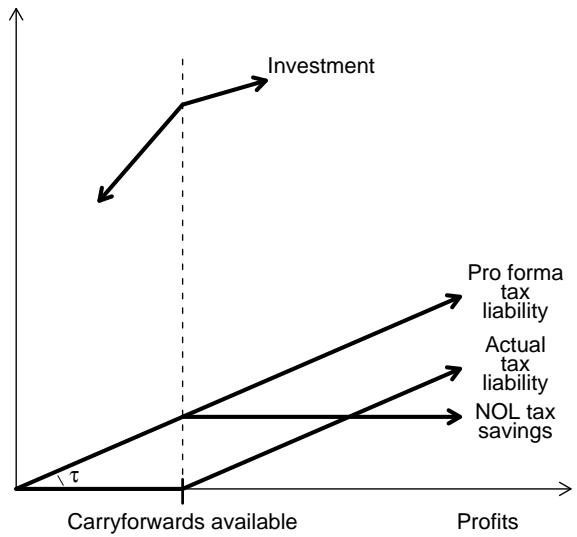


Figure 2b: Investment is affected by tax-related cash flow

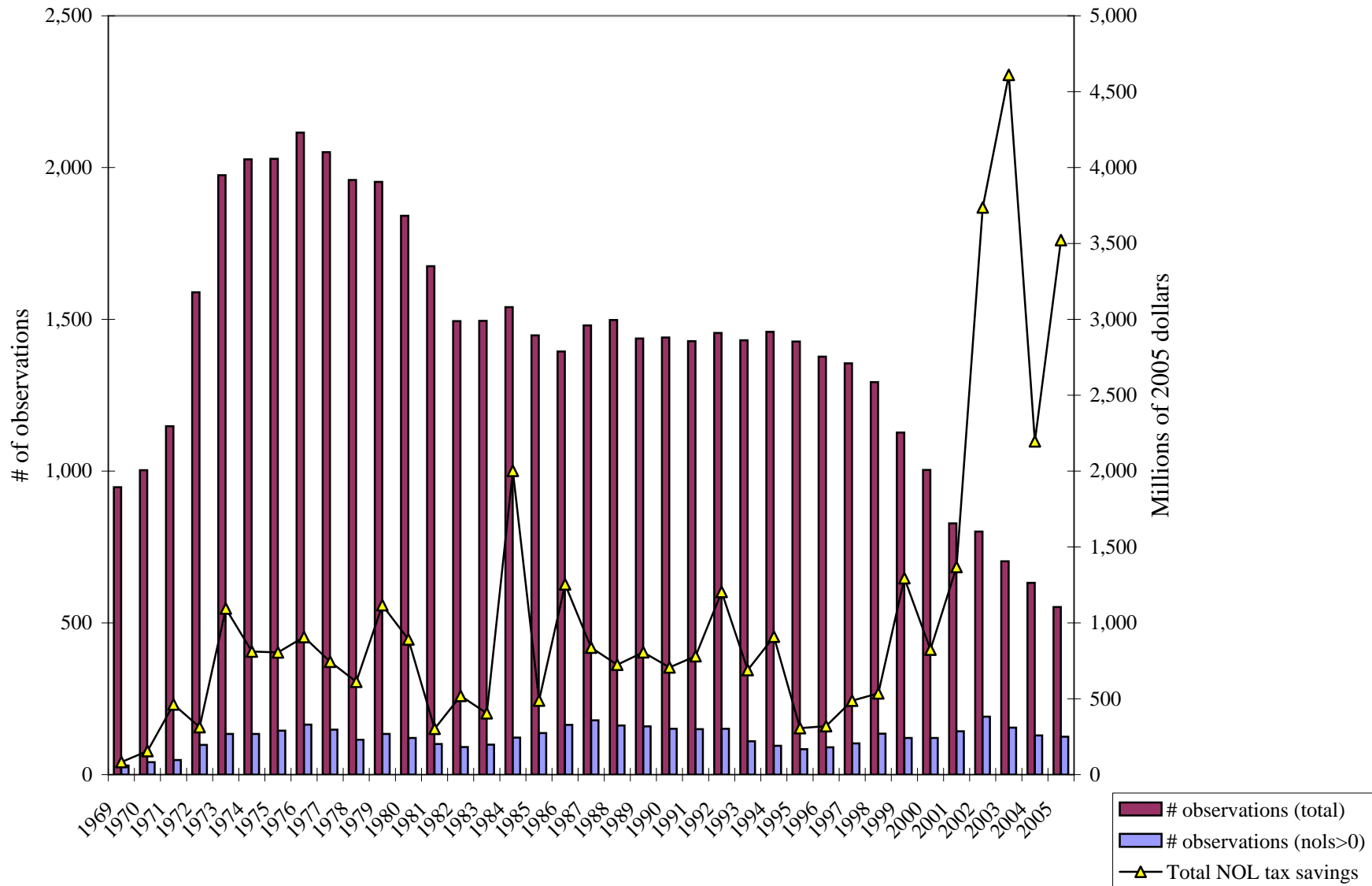


Figure 3. Observations and tax savings by year

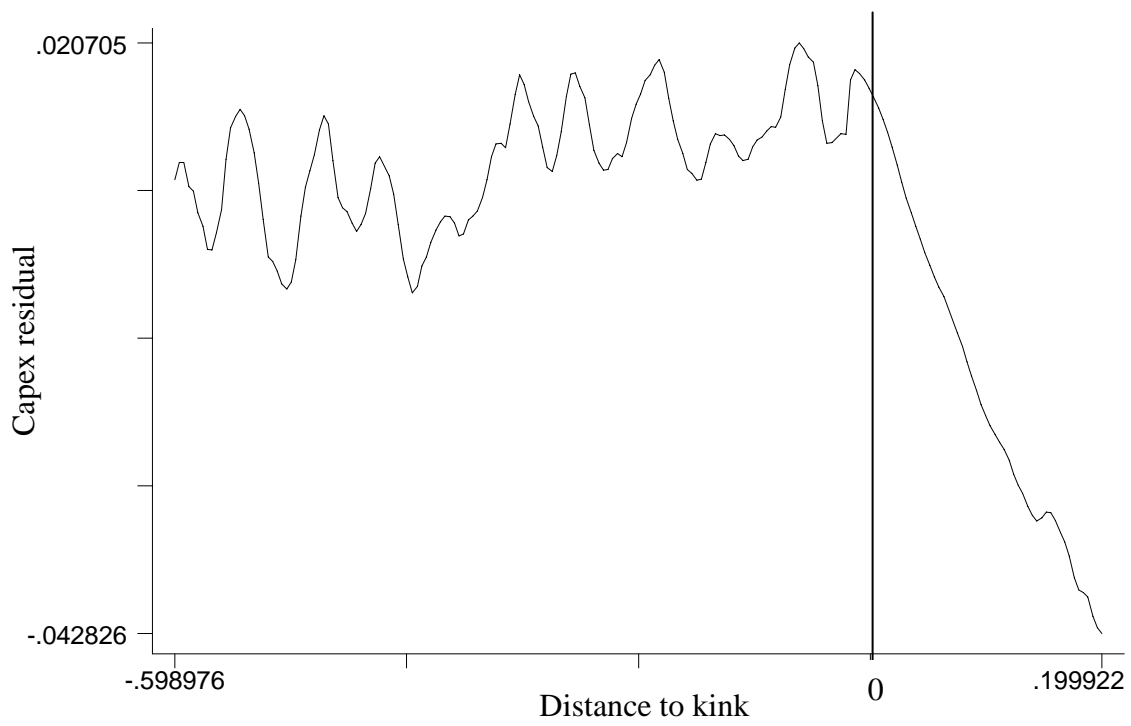


Figure 4. Non-parametric results

**Table 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. All variables are scaled by beginning-of-year assets, except for Tobin's Q, and are winsorized at the 1% and 99% levels. See section 3.2 for a discussion of how the sample was constructed. 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).

	Mean	Std.	Min	Percentile					Max
		dev.		1st	25th	50th	75th	99th	
Capital expenditures	0.090	0.085	0.000	0.003	0.036	0.066	0.114	0.494	0.494
Actual tax liability	0.045	0.041	0.000	0.000	0.014	0.035	0.064	0.207	0.207
NOL carryforwards available	0.051	0.358	0.000	0.000	0.000	0.000	0.000	1.362	1.362
Total cash flow	0.129	0.084	-0.108	-0.108	0.084	0.121	0.167	0.399	0.399
Pre-tax cash flow	0.174	0.116	-0.104	-0.014	0.105	0.158	0.227	0.570	0.570
Pro forma tax liability	0.049	0.046	0.000	0.000	0.017	0.037	0.066	0.228	0.228
NOL tax savings	0.003	0.019	0.000	0.000	0.000	0.000	0.000	0.086	0.086
Tobin's Q	1.607	1.194	0.095	0.546	0.929	1.220	1.811	6.947	6.947

**Table 2: Capital expenditures and NOL tax savings**

This tables presents a series of first differences 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.

	(1)	(2)	(3)	(4)	(5)	(6)
NOL tax savings				0.179*** (0.066)	0.198*** (0.067)	0.174** (0.079)
Cash flow	0.274*** (0.011)					
Pre-tax cash flow			0.264*** (0.016)	0.265*** (0.016)	0.264*** (0.016)	0.286*** (0.016)
Actual tax liability		0.259*** (0.018)	-0.265*** (0.038)			
Pro forma tax liability				-0.265*** (0.038)	-0.264*** (0.038)	-0.385*** (0.057)
(Pro forma tax liability) <sup>2</sup>						-0.279 (0.495)
(Pro forma tax liability) <sup>3</sup>						2.738** (1.306)
NOL carryforwards available				-0.002 (0.008)	-0.007 (0.009)	-0.003 (0.034)
(NOL carryforwards available) <sup>2</sup>						0.003 (0.014)
(NOL carryforwards available) <sup>3</sup>						-0.001 (0.001)
Lagged Tobin's Q	0.012*** (0.001)	0.014*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)	0.012*** (0.001)
Ending NOL carryforwards					0.025 (0.030)	
Observations	39519	39519	39519	39519	39519	39519
Number of firms	5754	5754	5754	5754	5754	5754
Adjusted R-squared	0.074	0.051	0.080	0.080	0.080	0.083

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

Superscripts denote exponents.

**Table 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.

	( $\Delta$ WC)	(Acquisitions)	(Advertising)	(Rent)	(R&D)
NOL tax savings	0.215* (0.129)	0.241*** (0.079)	0.150** (0.074)	0.037** (0.019)	-0.010 (0.025)
Pro forma tax liability	-0.115* (0.070)	-0.206*** (0.047)	0.007 (0.021)	-0.015 (0.010)	0.030** (0.014)
NOL carryforwards available	0.039** (0.017)	0.009 (0.012)	-0.003 (0.005)	0.008*** (0.002)	0.006 (0.005)
Pre-tax cash flow	0.540*** (0.030)	0.202*** (0.023)	0.061*** (0.008)	0.040*** (0.004)	0.009 (0.006)
Lagged Tobin's Q	0.007*** (0.001)	0.003*** (0.001)	0.001*** (0.000)	0.000* (0.000)	0.001*** (0.000)
Observations	38411	34729	15491	31433	39335
Number of firms	5648	5572	2875	5201	5724
Adjusted R-squared	0.135	0.018	0.080	0.060	0.019

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

**Table 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, net cash (cash less liabilities) scaled by beginning-of-year assets, common dividends scaled by beginning-of-year assets, and an indicator for whether the firm has a credit rating. All are measured at the beginning of the year. See the text for more details about these variables. For brevity, only NOL tax savings and its interactions with the financing constraint proxies are reported.

	(1)	(2)	(3)	(4)
NOL tax savings	0.240*** (0.077)	0.087 (0.072)	0.158** (0.070)	0.210*** (0.068)
NOL tax savings $\times$ KZ4	0.089** (0.041)			
NOL tax savings $\times$ net cash		-0.349 (0.214)		
NOL tax savings $\times$ dividends			-5.169 (8.072)	
NOL tax savings $\times$ $I_{hasrating}$				-0.497** (0.212)
Observations	39152	39231	39318	39519
Number of firms	5699	5717	5722	5754
Adjusted R-squared	0.082	0.127	0.082	0.081

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

**Table 5: Capital expenditures, NOL tax savings, and capital market conditions**

The dependent variable in both specification is capital expenditures scaled by beginning-of-year assets. Both 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. In addition, column 1 contains interactions of each of these explanatory variables with the spread between the yields on Baa- and Aaa-rated bonds, as reported by Moody's. Column 2 contains interactions of each of the explanatory variables with an indicator that takes a value of 1 in a recession year and 0 otherwise.

	(1)	(2)
NOL tax savings	-0.330** (0.156)	0.135* (0.070)
Pro forma tax liability	0.120* (0.068)	-0.229*** (0.039)
NOL carryforwards available	-0.005 (0.015)	-0.002 (0.008)
Pre-tax cash flow	0.082*** (0.029)	0.249*** (0.016)
Lagged Tobin's Q	0.011*** (0.002)	0.012*** (0.001)
NOL tax savings $\times$ bond spread	0.478*** (0.129)	
Pro forma tax liability $\times$ bond spread	-0.378*** (0.056)	
NOL carryforwards available $\times$ bond spread	0.003 (0.013)	
Pre-tax cash flow $\times$ bond spread	0.183*** (0.027)	
Lagged Tobin's Q $\times$ bond spread	0.001 (0.002)	
NOL tax savings $\times I_{recession}$		0.240* (0.128)
Pro forma tax liability $\times I_{recession}$		-0.246*** (0.043)
NOL carryforwards available $\times I_{recession}$		0.011 (0.008)
Pre-tax cash flow $\times I_{recession}$		0.112*** (0.020)
Lagged Tobin's Q $\times I_{recession}$		0.001 (0.001)
Observations	39519	39519
Number of firms	5754	5754
Adjusted R-squared	0.084	0.083

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

**Table 6: Capital expenditures, NOL tax savings, capital market conditions, and credit ratings**

The dependent variable in both specifications is capital expenditures scaled by beginning-of-year assets. Both 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. In addition, column 1 contains interactions of each of these explanatory variables with the spread between the yields on Baa- and Aaa-rated bonds, as reported by Moody's, and triple interactions with an indicator variable taking a value of 1 if the firm has a credit rating and 0 otherwise. Column 2 contains interactions of each of the explanatory variables with an indicator that takes a value of 1 in a recession year and 0 otherwise, and triple interactions with an indicator variable taking a value of 1 if the firm has a credit rating and 0 otherwise. For brevity, only NOL tax savings and its interactions are shown in the table.

	(1)	(2)
NOL tax savings	-0.304*	0.136*
	(0.157)	(0.070)
NOL tax savings $\times$ bond spread	0.473***	
	(0.130)	
NOL tax savings $\times I_{recession}$		0.230*
		(0.134)
NOL tax savings $\times$ bond spread $\times I_{hasrating}$	-0.355*	
	(0.211)	
NOL tax savings $\times I_{recession} \times I_{hasrating}$		-1.574***
		(0.593)
Observations	39519	39519
Number of firms	5754	5754
Adjusted R-squared	0.084	0.083

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

**Table 7: 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 (COMPUSTAT item 115), scaled by beginning-of-year assets. The dependent variable in specification 3 is the sum of dividends and share repurchases, scaled by beginning-of-year assets.

	(Div)	(Repur)	(Div+repur)
NOL tax savings	-0.009 (0.008)	-0.037 (0.027)	-0.046 (0.028)
Pro forma tax liability	0.003 (0.005)	0.019 (0.012)	0.022* (0.014)
NOL carryforwards available	-0.001* (0.000)	-0.000 (0.002)	-0.001 (0.002)
Pre-tax cash flow	0.014*** (0.002)	-0.013** (0.006)	0.001 (0.006)
Lagged Tobin's Q	0.000*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Observations	39519	39519	39519
Number of firms	5754	5754	5754
Adjusted R-squared	0.036	0.008	0.009

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

**Table 8: Change in debt and NOL tax savings**

All regressions in this table include year effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate. The dependent variable in each specification is change in debt scaled by beginning of year assets, where debt is defined as long-term debt (COMPUSTAT item 9) plus debt in current liabilities (item 34). The first two specifications are estimated using first differences. The third is estimated using firm fixed effects.

	(1)	(2)	(3)
NOL tax savings	0.612*** (0.185)	0.068 (0.214)	0.404*** (0.115)
Pro forma tax liability	-0.797*** (0.104)	-0.291** (0.115)	-0.535*** (0.067)
NOL carryforwards available	0.041 (0.033)	0.054* (0.028)	-0.003 (0.008)
Pre-tax cash flow	0.535*** (0.048)	0.523*** (0.055)	0.312*** (0.030)
Lagged Tobin's Q	0.018*** (0.002)	0.031*** (0.003)	0.011*** (0.001)
NOL tax savings $\times$ net cash		-1.368* (0.764)	
Pro forma tax liability $\times$ net cash		2.069*** (0.580)	
NOL carryforwards available $\times$ net cash		-0.167*** (0.053)	
Pre-tax cash flow $\times$ net cash		-2.096*** (0.274)	
Lagged Tobin's Q $\times$ net cash		-0.108*** (0.011)	
Model	FD	FD	FE
Observations	39240	39215	50522
Number of firms	5717	5716	6212
Adjusted R-squared	0.039	0.252	0.129

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

**Table 9: 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 is estimated in first differences using the model of Prais and Winsten (1954) to control for AR(1). Specification 2 is estimated using firm fixed effects. Specifications 3 through 5 are estimated using first differences. For specification 3, the sample is restricted to all firms with total assets of \$200 million or more in 2005 dollars. For specification 4, the sample is restricted to all firms with no assets reported in non-domestic segments in the COMPUSTAT SEGMENTS data. For specification 5, observations before 1981 for which the firm had positive NOL carryforwards five years before are excluded.

	(1)	(2)	(4)	(5)	(6)
NOL tax savings	0.198*** (0.066)	0.374*** (0.058)	0.343** (0.151)	0.299*** (0.079)	0.163** (0.074)
Pro forma tax liability	-0.277*** (0.037)	-0.420*** (0.038)	-0.339*** (0.061)	-0.328*** (0.053)	-0.242*** (0.038)
NOL carryforwards available	-0.005 (0.008)	-0.006 (0.004)	0.019 (0.059)	-0.002 (0.008)	-0.002 (0.009)
Pre-tax cash flow	0.270*** (0.015)	0.320*** (0.016)	0.284*** (0.025)	0.290*** (0.022)	0.255*** (0.016)
Lagged Tobin's Q	0.013*** (0.001)	0.012*** (0.001)	0.014*** (0.001)	0.012*** (0.001)	0.012*** (0.001)
Model	Prais-Winsten	Firm	FD	FD	FD
Filter	None	None	Assets ≥\$200M	No foreign segments	No stale NOLs
Observations	39519	50878	21838	22670	37996
Number of firms	5754	6254	2877	3734	5607
Adjusted R-squared		0.571	0.099	0.076	0.080

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