# Corporate taxes and investment: The cash flow channel

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Existing literature focuses on how corporate taxation affects firms' investment decisions by altering after-tax returns. This paper instead examines how corporate taxation affects investment by reducing the cash flow a firm has available to invest in the current period. I use a sharp nonlinearity in the mapping from pre-tax profitability to taxes created by the tax loss carryforward feature of the tax code to identify the cash flow effect of taxes. The results indicate that firms reduce investment when they pay more taxes, especially when unfavorable capital market conditions create a greater dependence of investment on internal sources of cash.

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*Keywords: investment, corporate taxation, financing constraints*

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# Corporate taxes and investment: The cash flow channel

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Existing literature focuses on how corporate taxation affects firms' investment decisions by altering after-tax returns. This paper instead examines how corporate taxation affects investment by reducing the cash flow a firm has available to invest in the current period. I use a sharp nonlinearity in the mapping from pre-tax profitability to taxes created by the tax loss carryforward feature of the tax code to identify the cash flow effect of taxes. The results indicate that firms reduce investment when they pay more taxes, especially when unfavorable capital market conditions create a greater dependence of investment on internal sources of cash.

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# 1 Introduction

How the taxation of corporate profits affects firm investment decisions is a question of great importance to economists, policy-makers and investors. It is well-understood that corporate taxation can distort investment plans by reducing the after-tax returns to new investment. A large literature, starting with Jorgensen (1963) and Hall and Jorgensen (1967), has attempted to assess the empirical relevance of such distortions. However, there is another channel through which corporate taxes can affect investment that is largely unexplored. If financing frictions make raising external capital costly, a firm's investment may be constrained by the amount of cash flow it is able to generate internally.[1] Corporate taxes then could also impact investment by reducing the amount of cash flow a firm has available to invest.

This paper examines the effect of a firm's cash outflows to corporate income taxes in a given year on its investment in the *same* year. Studying this effect is challenging because of two omitted variables problems. First, a firm's income tax is a function of its profitability, which is likely to be correlated with its investment opportunity set. Second, current period income tax is likely to be related to a firm's future marginal tax rate, which could also affect investment. So, while one could in principle simply examine the contemporaneous relationship between a firm's tax payments and its investments, it would be difficult to infer causality from this relationship.

I confront the endogeneity problem by exploiting the loss carryforward feature of the U.S. federal tax code. To understand my approach to identification, consider a flat tax rate of 40% and two firms that are identical except that one has losses carried forward from prior periods of \$1 while the other has no loss carryforwards. If the firms have identical pre-tax profits exceeding \$1, then the firm with the loss carryforward will have

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

$0.40 more after-tax cash flow than the one without. If the firms have identical pre-tax profits of less than $1, then the firm with the loss carryforward will not be able to fully use its carryforward in the period and will have additional cash flow after taxes equal to 40% of pre-tax profits.

Observe that the cash savings from using loss carryforwards increases with pre-tax profits up to the point at which carryforwards are fully used but not at all beyond this point. This makes this savings a sharply nonlinear function of pre-tax profitability and carryforwards available. A regression of investment on the tax savings from using carryforwards, controlling for pre-tax profitability and carryforwards available, then isolates the cash flow effect of these tax savings on investment under a simple and plausible assumption: that investment does not exhibit a similar sharply nonlinear relationship with these variables for other reasons, for example through changing investment opportunities or changing marginal tax rates.

I apply this approach to a large panel of firms covering the period 1970 through 2009. I find that an additional $1 of corporate taxes reduces capital expenditures in the same period by between $0.23 and $0.32, on average. However, the strength of this relationship varies considerably over time, as I am able to document given the length of my sample period. The effect is considerably stronger in years in which capital market conditions are less favorable, as reflected in a large spread between yields on low-grade and high-grade corporate bonds. This is consistent with a reduction in cash flow due to corporate taxes having a bigger effect on fixed asset investment in periods in which firms are forced to rely more on internal sources of cash to finance investment. Indeed, when capital market conditions are most favorable - in years in which the spread between yields on low-grade and high-grade bonds is in the bottom quartile during the sample period - a reduction in cash flow due to corporate taxes appears to have no effect on fixed asset investment.

One natural concern is that my regression specification is not flexible enough to account for possible nonlinearities in the relationship between investment and the variables that determine the amount of tax savings a firm realizes from using loss carryforwards. This is important because these variables could be related to investment opportunities or future marginal tax rate. I address this concern in two ways. First, I adopt a more flexible regression specification by including quadratic terms in the set of explanatory variables. Second, I include an estimate of a firm's marginal tax rate directly as a control variable in my regressions. The results are robust to these alternative specifications.

While my main tests focus on capital expenditures as a form of investment, I also study the cash flow effect of corporate taxes on four other forms of investment: acquisitions, research and development, investment in net working capital, and advertising. While taxes have a negative impact on all four of these forms of investment in the full sample period, the effect is only statistically significant for acquisitions. However, in all four cases, the effect is stronger in years in which the spread between yields on low-grade and high-grade bonds is above its median for the sample period. Indeed, the effect is statistically significant for three of the four - acquisitions, research and development and investment in net working capital - in years in which the spread is high. Thus it appears that the cash flow effect of taxes impacts investment of various forms when external capital is more costly to obtain.

Since I am getting my identification from the set of firms that has tax loss carryforwards available to reduce taxes, I am cautious about interpreting my results too broadly. For example, a firm that is consistently profitable, and therefore never generates loss carryforwards, might have a large cash balance or substantial debt capacity. A firm possessing such "financial slack" is unlikely to need to alter its investment plans if taxes reduce its cash flow below the point where it is sufficient to cover the firm's desired investment level. Nevertheless, even if my estimates apply exclusively to firms that have prior tax losses, which seems unlikely, the aggregate effect of current period taxes on current period investment in these firms alone is substantial.

This paper contributes to the literature on corporate taxation and investment. The literature examining the effects of marginal tax rates on investment is large, and includes papers by Jorgenson (1963) and Hall and Jorgenson (1967), Summers (1981), Feldstein, Dicks-Mireaux and Poterba (1983), Auerbach (1983), King and Fullerton (1984), Slemrod (1990), Auerbach and Hassett (1992), Hines and Rice (1994), Cummins, Hassett, and Hubbard (1996), Devereux, Griffith, and Klemm (2002), and Desai, Foley, and Hines (2004).[2] The general consensus is that higher marginal tax rates attenuate investment. Fazarri, Hubbard and Petersen (1988a) and Devereux and Griffith (2003) argue that *average* tax rates can also affect investment by reducing current period cash flow available to fund it. To the best of my knowledge, my paper is the first to directly test the importance of this cash flow channel. My evidence suggests that the cash flow consequences of taxation for investment are important.

More directly related to my paper, Auerbach and Poterba (1987) consider how tax loss carryforwards specifically affect investment by altering future marginal tax rates. They argue that the effect can go either way. On the one hand, the availability of carryforwards reduces a firm's marginal tax rate, thereby increasing after-tax returns to investing. This should make investment more attractive. On the other hand, the depreciation tax shield from additional fixed assets may be reduced when a firm has loss carryforwards, since these are substitute forms of tax shields. This should make investment less attractive. However, they do not consider the effect of the current period savings from *using* loss carryforwards on investment.

My paper also contributes to the literature on investment when firms face financing constraints. Fazarri, Hubbard and Petersen (1988b), and many papers that followed it, find that a firm's investment tends to be more sensitive to its cash flow when it is more likely to be financially constrained based on a priori measures. Their approach has been criticized for failing to adequately control for the quality of a firm's investment opportunities, creating an omitted variables problem that could produce spurious results (Poterba,

[2]See Hasset and Hubbard (2002) for a survey of this literature.

1988, Erickson and Whited, 2000, Alti, 2003). Moreover, Kaplan and Zingales (1997) argue on theoretical grounds that the assumption underlying Fazzari, Hubbard and Petersen's (1988b) hypothesis - that investment-cash flow sensitivity should be greater for more constrained firms - need not be correct.[3] Blanchard, Lopez-de-Silanes and Shleifer (1994), Lamont (1997), Rauh (2008) take a different approach, showing that plausibly exogenous shocks to a firm's cash flow affect its investment in general.[4] While most papers on this topic have found that investment does depend on cash flow, at least for firms that are most credit constrained, Kaplan and Zingales (1997), Cleary (1999), Erickson and Whited (2000) and Pulvino and Tarhan (2010) present contrary evidence.[5]

My paper concludes that investment is affected by cash flow - at least for cash flow related to corporate taxation. My biggest contribution to the financing constraints literature, made possible by the length of my sample period, is to show that the dependence of investment on cash flow varies substantially with capital market conditions. Specifically, when capital market conditions are unfavorable, investment is much more dependent on cash flow. This complements evidence in papers by Sufi (2007), Lemmon and Roberts (2010) and Chava and Purnanandam (2011) showing that shocks to capital market conditions affect investment *levels*.[6] Using measures of capital market conditions similar to

[3]Kaplan and Zingales (1997) 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.

[4]Blanchard, Lopez-de-Silanes and Shleifer (1994) find that firms receiving lawsuit windfalls unrelated to their ongoing lines of business usually increase investment in the same year. Lamont (1997) finds that the capital expenditures of non-oil subsidiaries of conglomerates with oil-producing subsidiaries fell in response to a large negative shock to oil prices. Rauh (2006) shows that a firm's investment is depressed by its mandatory pension contributions, controlling for the funding status of its pension plans. Since mandatory pension contributions are determined solely by funding status, controlling for funding status can be used to identify the cash flow effect of the mandatory contribution. In a paper somewhat related to these, Holtz-Eakin, Joulfaian and Rosen (1994) find that an entrepreneur who receives an inheritance has a greater probability of continuing to operate as a sole proprietor in the future and have larger operations, conditional on surviving, than an entrepreneur who does not receive an inheritance.

[5]For further discussion, see also Fazzari, Hubbard and Petersen (2000), Kaplan and Zingales (2000), Gomes (2001), Moyen (2004), and ch. 3 of Tirole (2006).

[6]Sufi (2007) finds that firms that obtain a syndicated bank loan rating after the introduction of these ratings in 1995 increased their investment. Lemmon and Roberts (2010) find that non-investment grade firms decreased investment in response to an exogenous contraction in the supply of below-investment-grade credit in 1989. Chava and Purnanandam (2011) find that U.S. firms borrowing from banks that suffered an adverse shock due to the Russian financial crisis of 1998 cut back their investment in response. In a related

mine, Hadlock and Pierce (2010) find that firms are more likely to report that they face financing constraints when capital market conditions are less favorable.

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 Methodology

The objective of this paper is to examine the cash flow effect of corporate income taxes on investment. In principle, one could attempt to estimate this effect by simply regressing measures of investment on measures of taxes paid. However, taxes paid are a function of profitability, which is likely to be highly correlated with investment opportunities. They also relate to future marginal tax rates, which could affect investment decisions as well. Thus it would be impossible to infer a causal effect of taxes paid on investment from such a regression. In this section, I develop a methodology for testing the cash flow effect of taxes on investment that takes advantage of sharp nonlinearities introduced by the tax loss carryforward provision of the U.S. federal tax code.

Section 172 of the U.S. Federal Tax Code governs the calculation and use of tax loss carryforwards and carrybacks. The code permits corporations to carry losses backwards and forwards in time to offset profits for the purpose of calculating taxable income. I focus on carryforwards rather than carrybacks in this paper because I can infer the amount of a carryforward from the change in the firm's reported stock of carryforwards. It is more difficult to estimate the amount of a loss carryback. Currently, corporations are permitted to carry net operating losses forward for up to 20 years. The carryforward limitation was 15 years from 1981 through 1997, and five years prior to 1981.

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paper, Leary (2009) examines the credit crunch of 1966 and finds that bank-dependent borrowers tend to substitute equity for debt when bank lending is tight.

Now, observe that a firm's total after-tax cash flow ($AfterTaxCashFlow$) in any period is equal to its pre-tax cash flow ($PreTaxCashFlow$) less income tax ($IncomeTax$). It is well-understood that a firm's operational cash flow may proxy for its investment opportunities. One possible solution to the omitted variable problem would be to regress investment measures on $IncomeTax$, controlling for $PreTaxCashFlow$. However, $IncomeTax$ could capture information about investment opportunities or future marginal tax rates that is incremental to the information contained in $PreTaxCashFlow$. So it would be difficult to infer causality from the results of such a regression.

Carryforwards affect a profitable firm's cash flow by reducing its income taxes. Define $TaxOnPreNOLIncome$ as the amount of income tax that a firm would have paid in the current period if it had had no net operating losses carried forward from prior periods with which to offset current period income. Further, define $TaxSavings$ as the amount by which the firm's current period tax bill is reduced by the application of any net operating losses carried forward from prior periods. Then income tax can be written as $IncomeTax = TaxOnPreNOLIncome - TaxSavings$.

To further illustrate these concepts, suppose that the tax rate is a flat 40% and that a firm earns a profit of \$100 before taxes in the current period but has carried forward past losses of \$40. Then $TaxOnPreNOLIncome$, the tax due ignoring the carryforward offset, is 40% of \$100, or \$40. However, income tax is computed on income after the application of the carryforward offset, which is \$100 - \$40 = \$60. So $IncomeTax$ is 40% of \$60, or \$24. The \$16 difference between the amount of taxes that would have been due absent the carryforward, \$40, and actual income tax, \$24, is $TaxSavings$, the savings that the firm realizes because it has tax losses carried forward from prior periods.

Since $IncomeTax$ is $TaxOnPreNOLIncome$ less $TaxSavings$, $AfterTaxCashFlow$ can be written as

$$AfterCashFlow = PreTaxCashFlow - TaxOnPreNOLIncome + TaxSavings. \tag{1}$$

Consider the last two terms of the right-hand side expression. If a firm has not completely exhausted its loss carryforwards, then an incremental dollar of *TaxOnPreNOLIncome* translates into an incremental dollar of *TaxSavings* (and no incremental effect on *IncomeTax*). If, instead, the firm has already exhausted all of its loss carryforwards (or if it entered the period with no loss carryforwards), then an incremental dollar of *TaxOnPreNOLIncome* does not have any effect on *TaxSavings*. Thus the relationship between *TaxSavings* and *TaxOnPreNOLIncome* is sharply nonlinear (more specifically, kinked). This sharp nonlinearity occurs at the point at which the firm's income is just high enough that it exactly exhausts any loss carryforwards that the firm brings into the period.

One can also think about this nonlinearity in terms of the relationship between *TaxSavings* and the amount of loss carryforwards with which the firm begins the period (*CarryforwardsAvailable*). An increase in *CarryforwardsAvailable* results in an increase in *TaxSavings* if *CarryforwardsAvailable* are less than income before carryforwards are applied. The rate at which *TaxSavings* increases with *CarryforwardsAvailable* in this case is just the marginal tax rate. If *CarryforwardsAvailable* exceed income before carryforwards are applied, then an increase in *CarryforwardsAvailable* does not result in additional *TaxSavings*. Thus one can also think of the relationship between *TaxSavings* and *LagCarryforwards* as being sharply non-linear - again, kinked - with the sharp nonlinearity occurring at the point at which *TaxOnPreNOLIncome* is just high enough that there is no additional tax to avoid by having an extra dollar of *CarryforwardsAvailable*.

More generally, *TaxSavings* is a component of after-tax cash flow that is a sharply nonlinear function of *CarryforwardsAvailable* and *TaxOnPreNOLIncome*. Under the plausible assumption that the relationship between investment and these two variables does not exhibit similar sharp nonlinearities, the relationship between *TaxSavings* and investment, controlling for *CarryforwardsAvailable* and *TaxOnPreNOLIncome*, identifies the effect on investment of additional cash flow due to a reduction in taxes. My main regression specification, then, involves a regression of investment measures on the three components of cash flow identified above, plus $CarryforwardsAvailable$. I include empirical Tobin's Q ($Tobin'sQ$) as a control in the regression for consistency with the literature, though excluding it has no impact on my conclusions. My main regression specification then is

$$\begin{aligned} Investment_{i,t} &= \alpha_i + \gamma_t + \beta_1 TaxSavings_{i,t} + \beta_2 CarryforwardsAvailable_{i,t} \\ &\quad + \beta_3 TaxOnPreNOLIncome_{i,t} + \beta_4 PreTaxCashFlow_{i,t} \\ &\quad + \beta_5 Tobin'sQ_{i,t-1} + \epsilon_{i,t}, \end{aligned} \tag{2}$$

where $\alpha_i$ and $\gamma_t$ represent firm and year effects respectively. The coefficient $\beta_1$ captures the effect on investment of a reduction in taxes due to the use of tax loss carryforwards. An equivalent interpretation is that $-\beta_1$ captures the effect of additional current period taxes on investment.

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.

# 3 Data and sample construction

The firm data used in this paper come primarily from the COMPUSTAT database of annual financial filings by publicly-traded firms. My sample period extends from 1970 through 2009. Pre-1970 data is not used because not all of the relevant tax variables are available prior to 1970. Tax rate data come from the U.S. federal corporate income tax schedules. I supplement these data sources with data on corporate bond yields from the Federal Reserve's website, on GDP growth from the National Bureau of Economics (NBER), and on a firm's geographic scope from the COMPUSTAT SEGMENTS database. I also use data on firms' marginal tax rates supplied by John Graham. In the rest of this section, I describe how I operationalize the variables that I described in the previous section and how I form my sample.

## 3.1 Variable construction

All of the variables described below are scaled by beginning-of-year total assets (COMPUSTAT $at$).[7] 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 ($capx$). However, I also examine the effect of $TaxSavings$ on other forms of investment, including acquisitions ($aqc$), research and development ($xrd$), advertising ($xad$), and net working capital investment, which is change in accounts receivable ($rect$), plus change in investment ($invt$), minus change in accounts payable ($ap$).

$AfterTaxCashFlow$ is the sum of net income before extraordinary items ($ib$) and depreciation ($dp$). Since tax books are unavailable, I follow the literature and define $IncomeTax$ as current federal income tax expense ($txc$)).[8] I back into $PreTaxCashFlow$ by summing

[7] Results do not vary qualitatively if variables are scaled by total plant, property and equipment instead.

[8] Dworin (1985) investigates the reasonableness of current tax expense as a proxy for income 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

$AfterTaxCashFlow$ and $IncomeTax$. $CarryforwardsAvailable$ are COMPUSTAT $tlcf$, lagged one year.[9]

$TaxOnPreNOLIncome$ is calculated in three steps. I first back out federal taxable income from $IncomeTax$ using the full federal corporate income tax rate schedule. I then add to this any reductions in carryforwards from the end of the prior year to the end of the current year. And finally, I compute the income tax that the firm would have paid had it had this amount of income, again using the full federal corporate income tax rate schedule. $TaxSavings$ is the difference between $TaxOnPreNOLIncome$ and $IncomeTax$, and is always non-negative.

My approach to calculating $TaxOnPreNOLIncome$ assumes that any reduction in tax loss carryforwards in a given year represents the use of carryforwards to reduce taxable income. This ignores the possibility that NOL carryforwards may decrease simply because some of these carryforwards expire, which could result in measurement error in $TaxOnPreNOLIncome$ and $TaxSavings$. As a robustness check, I eliminate all observations that have had positive tax loss carryforwards for the $N$ consecutive prior years, where $N$ is the maximum number of years a firm is allowed to carry forward losses (five years prior to 1981, 15 years between 1981 and 1997, and 20 years after 1997).

regulated utilities, which are not included in my sample. The disparity also appears to be a bigger issue for smaller firms. In untabulated robustness tests, I purge my sample of firms with total assets below various thresholds (e.g., $100 million, $500 million, $1 billion) and find that the paper's results continue to hold.

[9]NOL carryforwards as reported in COMPUSTAT are noisy estimates of U.S. federal tax-book carryforwards for three reasons: 1) COMPUSTAT often captures financial-book rather than the tax-book carryforwards, 2) COMPUSTAT makes coding errors in capturing this variable, and 3) the amount of loss carryforwards reported in COMPUSTAT can include federal, state, and foreign carryforwards. Using confidential firm-level U.S. federal tax return data, Mills, Newberry and Novack (2003) find that COMPUSTAT reports a carryforward balance when no carryforward exists per the tax return 9.4% of the time, and that COMPUSTAT reports no carryforward balance when a carryforward does exist per the tax return 3.3% of the time. Kinney and Swanson (1993) report that, in a sample of 266 firm-years, there are 28 cases in which tax loss carryforwards are missing in COMPUSTAT but a carryforward for tax purposes is reported in the tax footnote, and 5 cases in which tax loss carryforwards are populated in COMPUSTAT but there is no carryforward at all reported in the tax footnote. Manzon (1994) reports similar error rates. Mills, Newberry and Novack (2003) recommend considering firms to have carryforwards only if COMPUSTAT reports a positive carryforward balance and no U.S. current income tax. 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. For robustness, I also remove all firms reporting identifiable assets in foreign segments and re-obtain the paper's main results.

Finally, $Tobin'sQ$ is calculated as the quotient of the market and book values of a firm's assets. Market value (the numerator) is book assets (*at*) plus the market value of equity ($prccf * csho$) minus the book value of equity (*ceq*) minus deferred taxes (*txdb*). Book value (the denominator) is simply book assets (*at*).

## 3.2 Sample construction

I begin with all observations in the COMPUSTAT database from 1970 through 2009, excluding firms in the financial industry (SIC code between 6000 and 6999) and utilities (SIC code between 4900 and 4999). This initial sample contains 278,677 observations. I then eliminate all observations for which any of the variables described above is missing, which leaves 91,041 observations.

I next apply several screens to ensure the internal consistency of the data and its appropriateness for my study. Specifically, I eliminate the following observations:

1. Observations for which *IncomeTax* is negative. A negative current federal income tax expense likely indicates that a firm is carrying losses back to offset against prior profits. It is unclear in this case what values I should assign to *IncomeTax*, *TaxOnPreNOLIncome*, and *TaxSavings*, so I omit these observations.

2. Observations for which both *IncomeTax* and end-of-year carryforwards are positive. Unless there are restrictions on using carryforwards to offset income for federal income tax purposes, a firm should not pay taxes until all of its carryforwards are consumed. Restrictions might exist either if reported carryforwards apply to non-federal taxes or if carryforwards were obtained in an acquisition and are subject to a section 382 limitation.[10] Eliminating these observations should reduce measurement error in my variables.

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

3. Observations for which *IncomeTax* is zero and carryforwards increase from the beginning to the end of year are eliminated. These likely represent cases in which a firm has suffered a tax loss and is accruing new carryforwards. Again, it is difficult to determine what values to assign to *IncomeTax*, *TaxOnPreNOLIncome*, and *TaxSavings* in this case.

4. Observations for which both *IncomeTax* and end-of-year carryforwards are zero. In principle, it is possible that a firm's profits are just the right amount to exactly offset all of the firm's profits but not to lead to the accumulation of new carryforwards. However, these knife's edge cases should be rare, and these cases are more likely to result from encoding errors.

These screens conform directly to the recommendations of Mills, Newberry and Novack (2003), who show that considering firms to possess loss carryforwards only if COMPUSTAT reports a positive end-of-year carryforward balance and zero current federal income tax expense minimizes the misclassification of firms with and without carryforwards. The application of these screens leaves 57,187 observations, or approximately 1,430 observations per year. In unreported results, I have relaxed these screens and attempted to construct appropriate measures of *IncomeTax*, *TaxOnPreNOLIncome*, and *TaxSavings*. I obtain qualitatively similar results to those that I report in the paper when I do so.

As a final step, I trim the sample to reduce the risk that outliers unduly influence my results. Specifically, I delete observations for which any of the variables in specification (2) have values above the 99th percentile for the sample, or, for variables that are not bounded below by zero, below the 1st percentile for the sample.[11] The resulting panel consists of 55,105 observations for 8,540 firms.

Figure 1 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

[11] I have re-obtained the paper's results using various approaches to mitigating the potential effects of outliers.

the 1980s. While the number of firms in COMPUSTAT increases over this period, the proportion of firms for which COMPUSTAT reports missing tax loss carryforwards or current federal tax expense 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 savings generated by carryforwards for firms in the sample increase sharply in 2002, and remain high afterwards. Firms suffered tremendous tax losses in 2000 and 2001, which for many that survived resulted in large tax savings after they returned to profitability in 2002.[12]

Table 1 presents summary statistics for the sample of 55,105 observations used in the paper. Panel A summarizes characteristics of the full sample, while Panel B compares firms with NOL carryforwards available to those lacking carryforwards. Loss carryforward firms are, on average, smaller and less profitable than firms lacking carryforwards. Their relative lack of profitability is not surprising since carryforward firms by definition have suffered losses - at least on a tax basis - in the recent past. Interestingly, though, Tobin's Q does not vary substantively between the two subsamples. This, combined with the fact that all firms in the sample are profitable on a tax basis in the current year by construction, suggests that carryforward firms in the sample cannot be readily categorized as "distressed" firms.

# 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 tax savings from the use of carryforwards, and that this result is robust to a variety of specifications, including those in which marginal tax rate is a control variable. I then show that the sensitivity of capital expenditures to this tax savings is stronger when capital

[12] 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.

market conditions are less favorable. Finally, I show that this tax savings also lead to increases in other forms of investment, especially when capital market conditions are unfavorable.

## 4.1 NOL tax savings and capital expenditures

I now present the paper's results in detail. All of the regression specifications used in the paper include firm and year fixed effects, unless otherwise noted. T-statistics are reported in parentheses below each point estimate, and are computed from standard errors that are heteroskedasticity-robust and clustered at the firm level. I begin by examining the effects of the incremental cash flow resulting from the use of tax loss carryforwards on a firm's capital expenditures in a series of OLS regressions. The results are summarized in Table 2. The dependent variable in all of the regressions presented in Table 2 is capital expenditures scaled by lagged total assets.

As a starting point, I regress capital expenditures on $AfterTaxCashFlow$, controlling for lagged $Tobin'sQ$. The results, shown in column 1, indicate that capital expenditures are positively associated with $AfterTaxCashFlow$ after controlling for lagged $Tobin'sQ$. This is consistent with findings in the financing constraints literature, though it is difficult to infer causality from this relationship.

I then proceed with the disaggregation of cash flow into non-tax and tax components, as described in (1), and estimate regression equation (2). The basic results, shown in column 2, indicate a positive and highly statistically significant relationship between capital expenditures and $TaxSavings$, after controlling for $TaxOnPreNOLIncome$, $CarryforwardsAvailable$, $PreTaxCashFlow$ and lagged $Tobin'sQ$. As discussed in detail in Section 2, this relationship identifies the effect on capital expenditures of the incremental cash flow created by the use of tax loss carryforwards to reduce income tax. Thus the results indicate that a \$1 savings created by the use of tax loss carryforwards results in a \$0.33 increase in capital expenditures.

Capital expenditures are positively associated with *PreTaxCashFlow* and negatively associated with *TaxOnPreNOLIncome* in this regression. This suggests that increases (decreases) in cash flow in general are accompanied by increases (decreases) in fixed asset investment. However, making causal interpretations of the coefficients on these variables would be difficult because of the endogeneity problem. Capital expenditures do not exhibit a statistically significant relationship with *CarryforwardsAvailable*. This could indicate that there is no relationship or that there are confounding relationships that cancel each other out on average. Indeed, Auerbach and Poterba (1986) argue that the effect of having carryforwards on investment could go either way.

To provide some assurance that a violation of the identifying assumption about nonlinearities is not producing a spurious relationship between capital expenditures and *TaxSavings*, I next adopt a more flexible regression specification. Specifically, I add the squares of *TaxOnPreNOLIncome* and *CarryforwardsAvailable*, the variables that determine *TaxSavings*, to the regression. The results are presented in column 3. Neither of the squared terms is statistically significant, and the coefficients on the non-squared *TaxOnPreNOLIncome* and *CarryforwardsAvailable* are similar to those shown in column 2. More importantly, the coefficient on *TaxSavings* remains almost unchanged, decreasing from 0.326 to 0.321, and continues to be statistically significant at the 1% level.

One might reasonably be concerned that quantifying the effect of *TaxSavings* on capital expenditures is asking "too much" of the data, since my estimate of this amount is based on book rather than tax measures of tax loss carryforwards and hence is somewhat crude. To address this, I define *PositiveCarryforwards* to be an indicator variable taking a value of one if the firm has tax loss carryforwards available and zero otherwise. For any given level of *TaxOnPreNOLIncome*, the firm should have more after-tax cash flow available to invest if it has loss carryforwards available than if it doesn't. I therefore substitute the interaction between between *TaxOnPreNOLIncome* and *PositiveCarryforwards* for *TaxSavings* and re-run the regression. The results are shown in column 4. I find a positive relationship between capital expenditures and this interaction term, which again indicates that the tax savings from the use of carryforwards has a positive effect on capital expenditures.

Finally, while I include firm fixed effects in the regressions to absorb unaccounted for cross-sectional heterogeneity among firms, the true fixed effects could change considerably during my sample period, given its length (40 years). To address this possibility, I next re-run the regression from column 2 using first differences rather than including firm fixed effects. The number of usable observations drops from 55,105 to 41,442 because an observation can only be included if the firm was in the sample in the previous year as well. The results of this regression, shown in column 5, indicate a $0.23 increase in capital expenditures in response to an additional $1 of tax savings from the use of loss carryforwards. This is smaller than the effect in the firm fixed effects estimation, but the relationship remains statistically significant at the 1% level.

Having established that this tax savings has a positive effect on investment in Table 2, I next perform a series of robustness checks. The first involves adding *MarginalTaxRate*, which is the marginal tax rate from Graham (1996a,b), as a control variable. The results are presented in Table 3. Because marginal tax rate is only available starting in 1980, the sample that I use in this estimation is smaller than the one used in Table 2.

I begin by simply re-estimating the specification in column 2 of Table 2 using only observations for which *MarginalTaxRate* is available, not including *MarginalTaxRate* in the regression. This will allow me to compare results with and without including *MarginalTaxRate* as a control for the same sample of firms. The results are presented in column 1. The estimated effect of *TaxSavings* on capital expenditures is almost identical to that from column 2 of Table 2, and the other coefficients are similar as well. I then add *MarginalTaxRate* as a control. The results, shown in column 2, indicate a positive association between marginal tax rate and investment. This could indicate that marginal tax rate proxies for investment opportunities or that firms with a higher marginal tax rate benefit more in the short-run from establishing new depreciation or interest tax shields. The coefficient on *TaxSavings* remains almost unchanged and continues to be statistically significant at the 1% level.

Finally, in column 3, I add the indicator *ZeroMTR*, which takes a value of one if the firm has a marginal tax rate of zero and one otherwise. I include this variable because marginal tax rate is zero for a fairly large fraction of firms. The coefficient on this indicator is not statistically significant, and the other coefficients are virtually unchanged after this variable is included.

After showing that my results do not change after controlling for *MarginalTaxRate*, I next present a series of robustness checks that address possible concerns about the construction of my sample. The results of these tests are shown in Table 4. One potential concern is that firms have an incentive to manage their earnings in order to maximize the value of the net operating loss asset. For example, Maydew (1997) shows that firms shifted revenues and expenses to increase tax loss carrybacks immediately after the 1986 Tax Reform Act (TRA). This allowed firms to generate tax savings at the higher pre-TRA corporate tax rate instead of at the lower post-TRA rate. Firms managing earnings to minimize taxes might also alter their investment plans for the same reason. To reduce the potential effects of earnings management, I calculate abnormal discretionary current accruals using the modified Jones (1991) model. I then remove observations in the top and bottom quartiles of discretionary accruals and re-run the capital expenditures regression. This leaves 27,006 observations. The results when this filter is applied are presented in column 1. The coefficient on *TaxSavings* increases to 0.471 and remains statistically significant at the 1% level. Firms that engage in a high degree of earnings management do not appear to be driving the results in the paper.

Young, growing firms that have recently gone public often report significant accounting losses. Those that survive are likely to begin generating profits when they reach maturity. Not surprisingly, then, many of the firms in my sample that are using tax loss carryforwards are relatively young firms. To ensure that these firms alone are not driving the results, I exclude from the sample all observations for firms listed in COMPUSTAT for five years or less and re-run the capital expenditures regression. This reduces the number of observations to 45,432. The results when this second filter is applied are shown in column 2. The coefficient on *TaxSavings* increases slightly to 0.345 and remains statistically significant at the 1% level. Thus the results are not driven by firms that have gone public in the very recent past.

Another concern is the manner in which I calculate *TaxSavings*. 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. To address this concern, I eliminate from the sample any firm that has reported positive tax loss carryforwards for the N consecutive years leading up to the year of that observation, where N is the number of years a firm can carry forward a loss before it expires and is equal to five years before 1981, 15 years from 1981 through 1997, and 20 years after 1997. This is a conservative approach, since it results in eliminating observations where a firm might able to use carryforwards to offset profits. Its effect on the sample size, however, is small, leaving 52,799 usable observations. The results after this filter is imposed are presented in column 3. The coefficient on *TaxSavings* is virtually unchanged at 0.327 and remains statistically significant at the 1% level.

Finally, note that I use tax loss carryforwards as reported by COMPUSTAT to construct several variables used in the study. In addition to concerns about whether these book carryforward measures reflect the availability of carryforwards on the tax books, which I cannot address, these carryforwards are reported in aggregate, without respect to whether they arise from past federal, state or foreign tax losses. This is potentially problematic, as I use *federal* current tax expense as my proxy for income taxes. To at least partially address this concern, I eliminate all firms that report a foreign segment in COMPUSTAT's SEGMENTS database. Applying this filter reduces the sample size to

25,917 observations. The results are presented in column 4. The coefficient on *TaxSavings* changes only slightly, to 0.299, and remains statistically significant at the 1% level.

In summary, firms invest more in fixed assets in a year when they pay less in taxes during that year, other things being equal. This result appears to be quite robust. If the result is being driven by a relaxation of a financing constraint, then it should be stronger when alternatives to internal financing are more limited, i.e., when capital market conditions are less favorable. I test this prediction next.

## 4.2 NOL tax savings, capital expenditures, and capital market conditions

I measure capital market conditions annually using the average spread for the year between yields on Baa- and Aaa-rated corporate bonds, as rated by Moody's (*BaaAaaSpread*). While no measure of capital market conditions is perfect, this measure directly reflects the willingness of external financial markets to fund risky investment. It also has the advantage of being available during my entire 40 year sample period. I focus on a debt-based measure of capital market conditions, since debt is the primary source of external financing for fixed asset investment. The spread ranges from a low of 0.60% to a high of 2.33% during the sample period.

To investigate how the sensitivity of investment to the cash flow effects of corporate taxation varies with capital market conditions, I sort the observations in my sample into quartiles based on *BaaAaaSpread* in the year of the observation. I then estimate regression equation (2) for each of these subsamples separately. The results are shown in Table 5.

As the table shows, the strength of the relationship between capital expenditures and *TaxSavings* increases monotonically from the lowest to highest *BaaAaaSpread* subsamples. Indeed, the relationship is statistically insignificant in the lowest spread quartile. These results are consistent with the current period cash flow consequences of taxes having a greater effect when capital market conditions are less favorable.

The magnitudes of the coefficients on *TaxOnPreNOLIncome* and *PreTaxCashFlow* also increase monotonically from the lowest to highest spread quartile. This is consistent with investment depending more on internal cash flow in general when accessing external finance is more difficult, and is therefore consistent with variation over time in the observed effect of *TaxSavings*.

Next, in Table 6, I present results from including *BaaAaaSpread* and its interactions with *TaxSavings* and the other explanatory variables in my capital expenditures regression for the entire sample. Note that I do not include year effects in the regression, since *BaaAaaSpread* does not vary across observations within year. The results are presented in column 1. The coefficient on the interaction of *TaxSavings* and *BaaAaaSpread* is positive and statistically significant at the 1% level. This again suggests that the sensitivity of capital expenditures to *TaxSavings* is higher when external finance is more difficult to obtain.

One concern is that credit market conditions are likely to be correlated with the state of the economy, which is a potential determinant of overall investment opportunities. Therefore, in column 2, I also include interactions of annual change in real GDP with the explanatory variables as controls. These interactions do have explanatory power over capital expenditures. However, the interaction of *TaxSavings* and *BaaAaaSpread* continues to have a positive and statistically significant coefficient of similar magnitude to the one in column 1. Thus it does not appear that the effects I ascribe to time variation in capital market conditions is attributable to changing macroeconomic conditions.

## 4.3 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 use cash to acquire another firm, undertake research and development, invest in working capital, or invest in market share by advertising. I next estimate equation (2) using measures of investment other than capital expenditures as dependent variables. The results are presented in Table 7. The number of observations varies based on the availability of data for each of the dependent variables. The dependent variables are cash acquisitions (column 1), research and development (column 2), change in working capital (column 3), and advertising expense (column 4). In each case, the sample is trimmed at the 1st and 99th percentiles to reduce the influence of possible outliers. All dependent variables are scaled by beginning-of-year assets.

*TaxSavings* is positively related to all four forms of investment in the regressions. However, the coefficient on *TaxSavings* is only statistically significant in the regression where the dependent variable is acquisitions. A $1 increase in *TaxSavings* results in an estimated increase in expenditures on acquisitions of about $0.10.

This evidence supports only a weak effect of income tax- related cash flow on forms of investment other than capital expenditures, on average. However, as Tables 5 and 6 show, the sensitivity of capital expenditures to savings from tax loss carryforwards varies substantially with capital market conditions. I next show that this is true for other forms of investment as well. I divide the sample period into years when *BaaAaaSpread* is above median and years when it is below median. I then re-run each of the regressions from Table 7 separately for each of these two subsamples. The results are presented in Table 8.

As the table shows, in the years in which *BaaAaaSpread* is above median, *TaxSavings* has a positive and statistically significant effect on three of the four measures of investment (acquisitions, research and development, and change in working capital). Moreover, the coefficient on *TaxSavings* is higher in years in which *BaaAaaSpread* is above median than when it is below median in all four cases. This suggests that capital market conditions are important in determining the response of many forms of investment (not just capital expenditures) to the cash flow effects of income taxes.

## 5 Conclusion

This paper has provided evidence that corporate taxation affects firms' investment levels by altering after-tax cash flows available to finance this investment internally. It has also shown that this effect is stronger when capital market conditions are less favorable, indicating that time series variation in the severity of financing constraints is important. Overall, the results suggest that the "cash flow" channel is an important channel through which corporate taxation affects investment.

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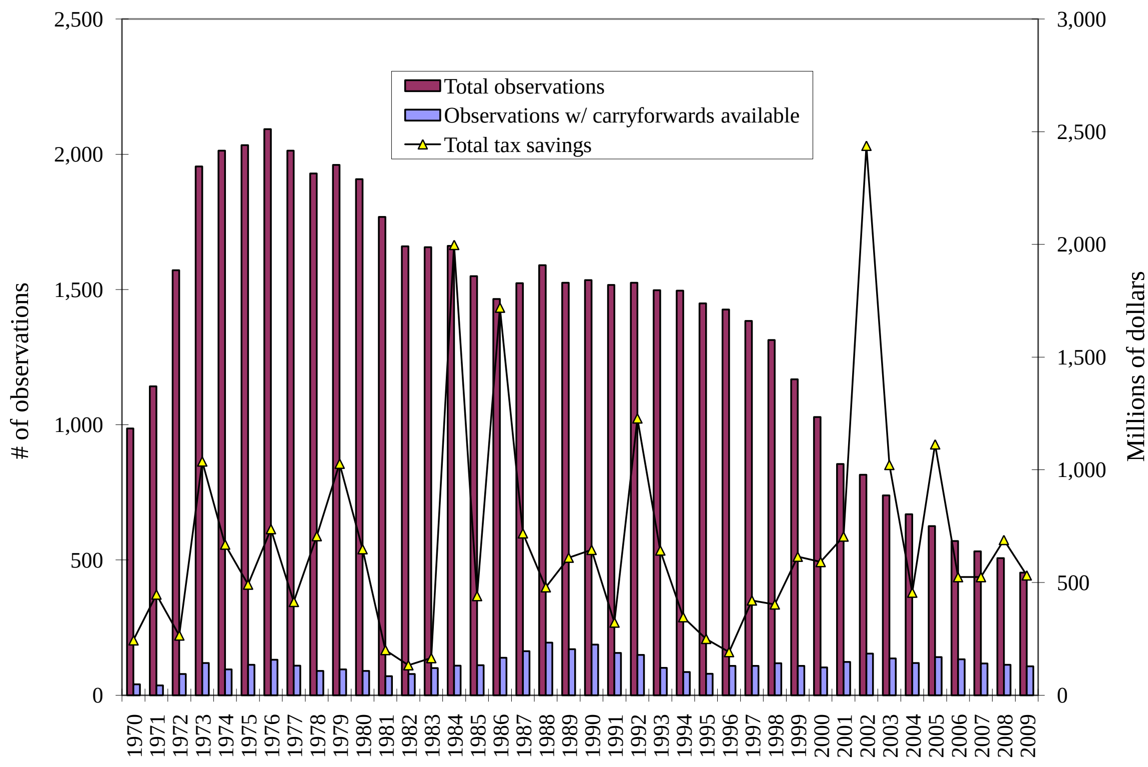
Figure 1: Observations and tax savings by year

This figure shows, for each year in the sample period, the number of observations in the sample, the number of observations in the sample with positive beginning-of-year carryforwards available, and the tax savings from using tax loss carryforwards (in millions of 2009 dollars) for observations in the sample.



## Table 1: Summary Statistics

This table presents summary data for the sample studied in this paper. The sample consists of 55,105 firm-year observations during the period 1970-2009. See section 3 for a discussion of how the sample was constructed. Panel A summarizes the distribution of the main variables used in the paper. All variables are scaled by beginning-of-year assets, except for Tobin's Q. Capital expenditures are COMPUSTAT $capx$. $AfterTaxCashFlow$ is the sum of net income before extraordinary items ($ib$) and depreciation ($dp$). $IncomeTax$ is current federal income tax expense ($txc$)). $PreTaxCashFlow$ is backed into by summing $AfterTaxCashFlow$ and $IncomeTax$. $CarryforwardsAvailable$ are COMPUSTAT $tlcf$, lagged one year. $TaxOnPreNOLIncome$ is calculated by backing out federal taxable income from $IncomeTax$ using the full federal corporate income tax rate schedule, adding to this any reductions in carryforwards from the end of the prior year to the end of the current year, and computing the income tax that the firm would have paid had it had this amount of income. $TaxSavings$ is the difference between $TaxOnPreNOLIncome$ and $IncomeTax$. $Tobin'sQ$ is calculated as the quotient of the market and book values of a firm's assets. Market value (the numerator) is book assets ($at$) plus the market value of equity ($prccf * csho$) minus the book value of equity ($ceq$) minus deferred taxes ($txdb$). Book value (the denominator) is simply book assets ($at$). Panel B compares the distributions for the subsample of firms that have loss carryforwards available at the beginning of the year ("Carryforward Firms") and the subsample of those that don't ("Non-Carryforward Firms").

***Panel A: Summary Statistics for Whole Sample***

| | | Std. | Percentile | | | | |
|---|---|---|---|---|---|---|---|
| | Mean | dev. | 1st | 25th | 50th | 75th | 99th |
| $CapitalExpenditures$ | 0.086 | 0.079 | 0.001 | 0.034 | 0.064 | 0.112 | 0.399 |
| $AfterTaxCashFlow$ | 0.124 | 0.084 | -0.148 | 0.081 | 0.119 | 0.165 | 0.348 |
| $PreTaxCashFlow$ | 0.177 | 0.118 | -0.145 | 0.107 | 0.164 | 0.237 | 0.519 |
| $IncomeTax$ | 0.053 | 0.046 | 0.000 | 0.018 | 0.043 | 0.075 | 0.209 |
| $TaxOnPreNOLIncome$ | 0.057 | 0.048 | 0.001 | 0.022 | 0.045 | 0.078 | 0.223 |
| $CarryforwardsAvailable$ | 0.084 | 0.754 | 0.000 | 0.000 | 0.000 | 0.000 | 2.171 |
| $TaxSavings$ | 0.004 | 0.022 | 0.000 | 0.000 | 0.000 | 0.000 | 0.097 |
| $Tobin'sQ$ | 1.576 | 1.094 | 0.533 | 0.925 | 1.218 | 1.805 | 6.260 |

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

| | Carryforward Firms | | | Non-Carryforward Firms | | |
|---|---|---|---|---|---|---|
| | Mean | Median | Std. dev. | Mean | Median | Std. dev. |
| $TotalAssets$ (millions of 2009 dollars) | | | | | | |
| $CapitalExpenditures$ | 0.073 | 0.040 | 0.090 | 0.088 | 0.066 | 0.077 |
| $AfterTaxCashFlow$ | 0.053 | 0.075 | 0.159 | 0.130 | 0.122 | 0.070 |
| $PreTaxCashFlow$ | 0.068 | 0.082 | 0.174 | 0.187 | 0.170 | 0.107 |
| $CarryforwardsAvailable$ | 1.016 | 0.243 | 2.431 | 0.000 | 0.000 | 0.000 |
| $TaxOnPreNOLIncome$ | 0.058 | 0.035 | 0.068 | 0.057 | 0.046 | 0.046 |
| $TaxSavings$ | 0.043 | 0.019 | 0.064 | 0.000 | 0.000 | 0.000 |
| $IncomeTax$ | 0.015 | 0.000 | 0.033 | 0.057 | 0.046 | 0.046 |
| $Tobin'sQ$ | 1.792 | 1.288 | 1.436 | 1.556 | 1.213 | 1.056 |
| Observations | | 4,567 | | | 50,538 | |

# Table 2: Capital expenditures and NOL tax savings

This table presents a series of OLS regressions in which the dependent variable is capital expenditures, scaled by beginning-of-year total assets. All explanatory variables are contemporaneous except $Tobin'sQ$, which is lagged one year. All explanatory variables are scaled by beginning-of-year total assets except $Tobin'sQ$ . All regressions include year fixed effects. The specifications shown in columns 1 through 4 all include firm fixed effects. The specification in column 5 is run in first differences. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $AfterTaxCashFlow$ | 0.242*** | | | | |
| | (26.149) | | | | |
| $TaxSavings$ | | 0.326*** | 0.321*** | | 0.227*** |
| | | (7.932) | (7.857) | | (4.861) |
| $TaxOnPreNOLIncome \times PositiveCarryforwards$ | | | | 0.255*** | |
| | | | | (4.549) | |
| $TaxOnPreNOLIncome$ | | -0.377*** | -0.401*** | -0.281*** | -0.276*** |
| | | (-12.449) | (-10.118) | (-10.810) | (-8.859) |
| $TaxOnPreNOLIncome^2$ | | | 0.117 | | |
| | | | (0.983) | | |
| $PreTaxCashFlow$ | | 0.278*** | 0.280*** | 0.243*** | 0.236*** |
| | | (20.574) | (20.364) | (20.365) | (16.397) |
| $CarryforwardsAvailable$ | | 0.002 | 0.001 | 0.005*** | 0.000 |
| | | (1.322) | (0.563) | (3.206) | (0.009) |
| $CarryforwardsAvailable^2$ | | | 0.000 | | |
| | | | (0.118) | | |
| $PositiveCarryforwards$ | | | | -0.010* | |
| | | | | (-1.821) | |
| $Tobin'sQ$ | 0.011*** | 0.011*** | 0.011*** | 0.011*** | 0.011*** |
| | (15.802) | (16.585) | (16.512) | (16.489) | (15.980) |
| Observations | 55,105 | 55,105 | 55,105 | 55,105 | 41,442 |
| Number of firms | 8,540 | 8,540 | 8,540 | 8,540 | 6,095 |
| Adjusted R-squared | 0.573 | 0.574 | 0.574 | 0.573 | 0.067 |

***, ** and *: significant at 1%, 5% and 10% levels respectively.

## Table 3: Capital expenditures, NOL tax savings, and Marginal Tax Rates

This table presents a series of OLS regressions in which the dependent variable is capital expenditures, scaled by beginning-of-year total assets. All explanatory variables are contemporaneous except *Tobin′sQ*, which is lagged one year. All explanatory variables are scaled by beginning-of-year total assets except *Tobin′sQ* and *MarginalTaxRate*. All regressions include firm and year fixed effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate.

| | (1) | (2) | (3) |
|---|---|---|---|
| *TaxSavings* | 0.324*** | 0.344*** | 0.349*** |
| | (5.037) | (5.404) | (5.458) |
| *TaxOnPreNOLIncome* | -0.381*** | -0.384*** | -0.389*** |
| | (-8.952) | (-9.093) | (-9.155) |
| *PreTaxCashFlow* | 0.259*** | 0.252*** | 0.253*** |
| | (14.524) | (14.115) | (14.146) |
| *CarryforwardsAvailable* | -0.001 | -0.000 | -0.000 |
| | (-0.286) | (-0.141) | (-0.062) |
| *Tobin′sQ* | 0.012*** | 0.012*** | 0.012*** |
| | (12.645) | (12.762) | (12.748) |
| *MarginalTaxRate* | | 0.028*** | 0.039*** |
| | | (4.114) | (3.948) |
| *ZeroMTR* | | | 0.006 |
| | | | (1.466) |
| Observations | 28,080 | 28,080 | 28,080 |
| Number of firms | 5,621 | 5,621 | 5,621 |
| Adjusted R-squared | 0.600 | 0.600 | 0.600 |

***, ** and *: significant at 1%, 5% and 10% levels respectively.

## Table 4: Capital expenditures and NOL tax savings: Robustness

This table presents a series of OLS regressions in which the dependent variable is capital expenditures, scaled by beginning-of-year total assets. All explanatory variables are contemporaneous except $Tobin'sQ$, which is lagged one year. All explanatory variables are scaled by beginning-of-year total assets except $Tobin'sQ$. All regressions include firm and year fixed effects. Observations for which discretionary accruals above the 75th percentile or below the 25th percentile of the entire sample are removed in the specification in column 1. Observations with an IPO date within the past five years are removed in the specification in column 2. Observations for firms that have reported positive carryforwards for the past N consecutive years, where N=5 before 1981, N=15 between 1981 and 1996, and N=20 after 1996, are removed in the specification in column 3. Observations for which a foreign segment is reported in the COMPUSTAT SEGMENTS data are removed in column 4. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Filter | No large abnormal accruals | No recent IPOs | No stale NOLs | No foreign segments |
| *TaxSavings* | 0.471*** | 0.345*** | 0.327*** | 0.299*** |
| | (5.118) | (7.371) | (5.435) | (5.240) |
| *TaxOnPreNOLIncome* | -0.495*** | -0.391*** | -0.475*** | -0.316*** |
| | (-9.100) | (-11.091) | (-14.171) | (-7.258) |
| *PreTaxCashFlow* | 0.338*** | 0.279*** | 0.326*** | 0.246*** |
| | (13.745) | (17.517) | (21.326) | (13.310) |
| *CarryforwardsAvailable* | 0.008 | 0.002 | 0.004* | 0.000 |
| | (1.525) | (1.119) | (1.805) | (0.085) |
| *TobinsQ* | 0.009*** | 0.010*** | 0.011*** | 0.014*** |
| | (8.824) | (12.824) | (15.599) | (12.643) |
| Observations | 27,006 | 45,432 | 52,779 | 25,917 |
| Number of firms | 6,225 | 6,884 | 7,476 | 6,281 |
| Adjusted R-squared | 0.599 | 0.578 | 0.577 | 0.583 |

***, ** and *: significant at 1%, 5% and 10% levels respectively.

## Table 5: Capital expenditures, NOL tax savings, and Capital Market Conditions

This table presents a series of OLS regressions in which the dependent variable is capital expenditures, scaled by beginning-of-year total assets. All explanatory variables are contemporaneous except $Tobin'sQ$, which is lagged one year. All explanatory variables are scaled by beginning-of-year total assets except $Tobin'sQ$. All regressions include firm and year fixed effects. The sample is divided into quartiles based on the value of $BaaAaaSpread$ in the year of the observation. Each column represents a different quartile, from the lowest quartile in the first column to the highest quartile in the last column. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate.

| $BaaAaaSpread$ quartile | Lowest | Q2 | Q3 | Highest |
|---|---|---|---|---|
| $TaxSavings$ | 0.048 | 0.344** | 0.413*** | 0.690*** |
| | (0.466) | (2.381) | (3.069) | (4.641) |
| $TaxOnPreNOLIncome$ | -0.121** | -0.345*** | -0.535*** | -0.708*** |
| | (-1.993) | (-4.453) | (-6.741) | (-9.294) |
| $PreTaxCashFlow$ | 0.145*** | 0.256*** | 0.381*** | 0.463*** |
| | (5.893) | (7.466) | (9.991) | (12.164) |
| $CarryforwardsAvailable$ | -0.004 | 0.003 | 0.000 | 0.000 |
| | (-0.514) | (1.520) | (0.065) | (0.035) |
| $Tobin'sQ$ | 0.013*** | 0.009*** | 0.008*** | 0.014*** |
| | (9.020) | (6.560) | (5.681) | (7.271) |
| Observations | 14,146 | 12,397 | 13,901 | 14,661 |
| Number of firms | 5,385 | 5,438 | 5,254 | 4,638 |
| Adjusted R-squared | 0.635 | 0.606 | 0.598 | 0.622 |

***, ** and *: significant at 1%, 5% and 10% levels respectively.

## Table 6: Capital expenditures, NOL tax savings, Capital Market Conditions, and Economic Conditions

This table presents a series of OLS regressions in which the dependent variable is capital expenditures, scaled by beginning-of-year total assets. All explanatory variables are contemporaneous except *Tobin'sQ*, which is lagged one year. All explanatory variables are scaled by beginning-of-year total assets except *Tobin'sQ*, *BaaAaaSpread* and *RealGDPGrowth*. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate.

| | (1) | (2) |
|---|---|---|
| *TaxSavings* | -0.049 | -0.604*** |
| | (-0.491) | (-4.057) |
| *TaxSavings* × *BaaAaaSpread* | 0.352*** | 0.314*** |
| | (3.931) | (3.395) |
| *TaxSavings* × *RealGDPGrowth* | | 0.086*** |
| | | (6.721) |
| *TaxOnPreNOLIncome* | -0.117* | 0.692*** |
| | (-1.927) | (8.048) |
| *TaxOnPreNOLIncome* × *BaaAaaSpread* | -0.243*** | -0.340*** |
| | (-4.744) | (-6.926) |
| *TaxOnPreNOLIncome* × *RealGDPGrowth* | | -0.109*** |
| | | (-14.518) |
| *PreTaxCashFlow* | 0.129*** | -0.309*** |
| | (4.774) | (-8.462) |
| *PreTaxCashFlow* × *BaaAaaSpread* | 0.141*** | 0.189*** |
| | (5.753) | (8.393) |
| *PreTaxCashFlow* × *RealGDPGrowth* | | 0.060*** |
| | | (17.061) |
| *CarryforwardsAvailable* | 0.001 | -0.004 |
| | (0.176) | (-0.600) |
| *CarryforwardsAvailable* × *BaaAaaSpread* | 0.001 | 0.002 |
| | (0.337) | (0.447) |
| *CarryforwardsAvailable* × *RealGDPGrowth* | | 0.001 |
| | | (1.483) |
| *TobinsQ* | 0.009*** | 0.010*** |
| | (5.935) | (4.477) |
| *TobinsQ* × *BaaAaaSpread* | 0.002 | 0.002* |
| | (1.585) | (1.794) |
| *TobinsQ* × *RealGDPGrowth* | | -0.000 |
| | | (-0.780) |
| *BaaAaaSpread* | -0.016*** | -0.046*** |
| | (-5.689) | (-11.251) |
| *RealGDPGrowth* | | -0.000 |
| | | (-1.094) |
| Observations | 55,105 | 55,105 |
| Number of firms | 8,540 | 8,540 |
| Adjusted R-squared | 0.576 | 0.587 |

***, ** and *: significant at 1%, 5% and 10% levels respectively.

## Table 7: Other forms of investment and NOL tax savings

This table presents a series of OLS regressions in which the dependent variables are various investment measures, scaled by beginning-of-year total assets. All explanatory variables are contemporaneous except $Tobin'sQ$, which is lagged one year. All explanatory variables are scaled by beginning-of-year total assets except $Tobin'sQ$. All regressions include firm and year fixed effects. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate.

| | (Acquisitions) | (R&D) | (Δ Working Capital) | (Advertising) |
|---|---|---|---|---|
| $TaxSavings$ | 0.103*** | 0.022 | 0.053 | 0.046 |
| | (3.252) | (1.241) | (0.582) | (1.211) |
| $TaxOnPreNOLIncome$ | -0.084*** | -0.019* | -0.163*** | 0.001 |
| | (-4.312) | (-1.856) | (-3.057) | (0.051) |
| $PreTaxCashFlow$ | 0.079*** | 0.021*** | 0.307*** | 0.049*** |
| | (8.767) | (4.736) | (13.944) | (5.552) |
| $CarryforwardsAvailable$ | -0.001 | 0.003** | -0.013*** | 0.002 |
| | (-0.962) | (2.105) | (-2.840) | (0.839) |
| $TobinsQ$ | 0.002*** | 0.001*** | 0.002 | 0.001*** |
| | (3.369) | (3.227) | (1.318) | (2.611) |
| Observations | 51,266 | 54,835 | 53,674 | 22,630 |
| Number of firms | 8,375 | 8,444 | 8,328 | 4,238 |
| Adjusted R-squared | 0.193 | 0.876 | 0.641 | 0.849 |

***, ** and *: significant at 1%, 5% and 10% levels respectively.

# Table 8: Other forms of investment, NOL tax savings, and Capital Market Conditions

This table presents a series of OLS regressions in which the dependent variables are various investment measures, scaled by beginning-of-year total assets. All explanatory variables are contemporaneous except $Tobin'sQ$, which is lagged one year. All explanatory variables are scaled by beginning-of-year total assets except $Tobin'sQ$. All regressions include firm and year fixed effects. The observations in the sample are divided into two subsamples based on whether the level of $BaaAaaSpread$ in the year of the observation is above or below the median $BaaAaaSpread$ for the sample period. For each dependent variable, separate regressions are estimated for the subsamples of years below and above the median. Heteroskedasticity-robust standard errors clustered at the firm level are reported below each point estimate.

| | (Acquisitions) | | (R&D) | |
|---|---|---|---|---|
| Bond Spread | Low | High | Low | High |
| $TaxSavings$ | 0.024 | 0.243*** | -0.007 | 0.047** |
| | (0.473) | (3.217) | (-0.225) | (2.046) |
| $TaxOnPreNOLIncome$ | -0.025 | -0.149*** | 0.016 | -0.056*** |
| | (-0.709) | (-4.888) | (1.023) | (-4.176) |
| $PreTaxCashFlow$ | 0.061*** | 0.108*** | 0.005 | 0.041*** |
| | (4.017) | (7.448) | (0.786) | (6.436) |
| $CarryforwardsAvailable$ | -0.000 | -0.003 | 0.003* | 0.001 |
| | (-0.673) | (-1.147) | (1.670) | (0.915) |
| $Tobin'sQ$ | 0.002*** | 0.000 | 0.001** | 0.001** |
| | (2.590) | (0.497) | (2.024) | (2.098) |
| Observations | 25,201 | 26,065 | 26,362 | 28,473 |
| Number of firms | 6,562 | 6,401 | 6,626 | 6,474 |
| Adjusted R-squared | 0.218 | 0.129 | 0.897 | 0.881 |

| | (Δ Working Capital) | | (Advertising) | |
|---|---|---|---|---|
| Bond Spread | Low | High | Low | High |
| $TaxSavings$ | -0.147 | 0.279* | 0.031 | 0.090 |
| | (-1.067) | (1.705) | (0.281) | (1.451) |
| $TaxOnPreNOLIncome$ | 0.011 | -0.395*** | 0.018 | -0.021 |
| | (0.146) | (-4.885) | (0.371) | (-0.747) |
| $PreTaxCashFlow$ | 0.258*** | 0.398*** | 0.038** | 0.065*** |
| | (8.403) | (10.987) | (2.188) | (5.628) |
| $CarryforwardsAvailable$ | -0.012** | -0.012 | 0.005 | -0.003 |
| | (-2.373) | (-0.940) | (1.042) | (-0.420) |
| $Tobin'sQ$ | -0.000 | 0.003* | 0.001* | 0.002** |
| | (-0.304) | (1.738) | (1.890) | (2.322) |
| Observations | 25,875 | 27,799 | 10,138 | 12,492 |
| Number of firms | 6,558 | 6,344 | 3,190 | 3,338 |
| Adjusted R-squared | 0.665 | 0.657 | 0.847 | 0.863 |

***, ** and *: significant at 1%, 5% and 10% levels respectively.