Investment Incentives and Corporate Tax Asymmetries

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Abstract

Recent facts on the importance of corporate losses motivate more careful study of the impact of tax incentives for investment on firms that lose money. I model firm investment decisions in a setting featuring financing constraints and carrybacks and carryforwards of operating losses. I estimate investment responses to tax incentives allowing effects to vary with cash flows and taxable status. Results suggest that asymmetries in the corporate tax code could have made recent bonus depreciation tax incentives at most 4% less effective than they would have been if all firms were fully taxable. Cash flows have more important effects on the impact of tax incentives. Recent declines in cash flows would predict a 24% decrease in the effectiveness of bonus depreciation. Results thus suggest that tax incentives have the smallest impact on investment exactly when they are most likely to be put in place—during downturns in economic activity when cash flows are low.

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1 Introduction

In 2002, U.S. corporations that lost money reported $418 billion in losses on their tax returns. This amount is more than 60% of the $676 billion in profits reported by profitable corporations. Also in 2002, President Bush signed the Job Creation and Worker Assistance Act, which included "bonus depreciation" provisions that allowed firms to deduct a larger portion of their spending on new capital equipment from their taxable income. Similar incentives were enacted in response to recession in 2008 and remained in place through the end of 2009. Bonus depreciation was intended to encourage firms to increase their investment, but several observers have found that it had little effect.[1] In this paper, I model and estimate how corporate losses may mitigate the impact of tax incentives like bonus depreciation.

I adapt the tax-adjusted Q model of Hayashi [1982] and Summers [1981] to a setting featuring financing constraints and carrybacks and carryforwards of operating losses. I consider the effects of investment incentives on two groups of firms. The first, taxable firms, pay the statutory tax rate on a marginal increase in income, either in the form of an increased tax liability or a decreased carryback refund. The second, nontaxable firms, face a tax rate of zero on a marginal increase in income. I show how investment choices depend on a familiar tax-adjusted Q expression, modified by the shadow values to the firm of carrybacks and carryforwards and by the presence of a binding financing constraint. Investment responses to tax incentives may differ between taxable and nontaxable firms, and they may be dampened by a binding financing constraint.

I present empirical estimates of the asymmetry in investment responses between taxable and nontaxable firms, using carefully constructed measures of taxable status for firms in the Compustat panel. Results suggest that nontaxable firms respond about 55% as strongly to tax incentives as do taxable firms. However, this observed asymmetry depends importantly on the cash flows earned by both groups of firms. Firms are considerably more responsive to investment incentives when their ratio of cash flows to assets is high. Including controls for cash flows considerably dampens the estimated effects of taxable status on the impact of tax incentives. With these controls, estimates suggest that bonus depreciation was at most 4% less effective than it would have been if all firms had been fully taxable.

I am not the first to infer measures of taxable status from financial statement data, and one might worry that the variables constructed in this paper measure taxable status poorly relative to those constructed by others. I conduct similar tests of the effects of taxable status using measures developed by Plesko [2003] and Graham [1996], and they perform no better than the ones I develop. It is still possible that errors in measuring taxable status attenuate its importance in these results. Proponents of prior measures claim, however, that these variables do quite well in measuring taxable status when compared with actual tax returns (Plesko [2003], Graham and Mills [2008]). Measurement error therefore appears unlikely to drive results. I conclude that there is little evidence that asymmetries in the corporate tax

[1] Cohen and Cummins [2006] find no effect of the incentives on investment quantities by comparing aggregate investment in assets most and least affected by the incentives. Edgerton [2009] finds no evidence for any effect of the incentives on the relative prices of new and used construction machinery, where used machinery did not qualify for the incentives. Knittel [2007] documents that firms making a substantial fraction of investments that qualified for bonus depreciation did not even claim the benefits to which they were entitled. See House and Shapiro [2008] for a dissenting view.

code played an important role in mitigating investment responses to bonus depreciation.

Cash flows, however, are much more successful in predicting firm responses to investment incentives. The aggregate ratio of cash flows to assets across all Compustat firms fell to 0.06 around the 2001 recession from an average near 0.11 before 1985. Applying coefficient estimates to this change in cash flows suggests that firms were 24% less responsive to bonus depreciation around the 2001 recession than they would have been if cash flows remained near historical averages.

Results thus suggest that tax incentives have the smallest impact on investment exactly when they are most likely to be put in place—during downturns in economic activity when cash flows are low. These results do not, however, prove a causal relationship between cash flows and responsiveness to tax incentives. In fact, these results could be generated by models that do not involve a financing constraint or a direct effect of cash flows on investment.

I discuss three models of investment that could explain this positive association between cash flows and the effectiveness of tax incentives. The model developed in this paper shows that these results could arise when firms face binding financing constraints. Caballero and Engel [1999] show that they could arise in a model where firms face a fixed cost of adjusting their capital stock. Bloom, Floetotto, and Jaimovich [2009] show how time-varying uncertainty could futher reduce the sensitivity of investment to tax incentives during downturns. I then present simple empirical tests intended as a horse race among these models. Results provide some evidence that financing constraints do matter for the effectiveness of incentives, but, in fact, the Caballero and Engel [1999] mechanism receives the most support from the data used here. More research into the causes and consequences of business cycle variation in the impact of tax incentives would be welcome.

The following section further motivates the paper by documenting the prevalence of losses among U.S. corporations in recent years, reviewing their treatment under the tax code, and reviewing related literature. Section 3 presents a model of firm investment decisions incorporating financing constraints and the tax treatment of losses. Section 4 describes the Compustat sample of financial statements and details the calculation of proxies for tax-related variables. Section 5 presents regression results, and section 6 concludes.

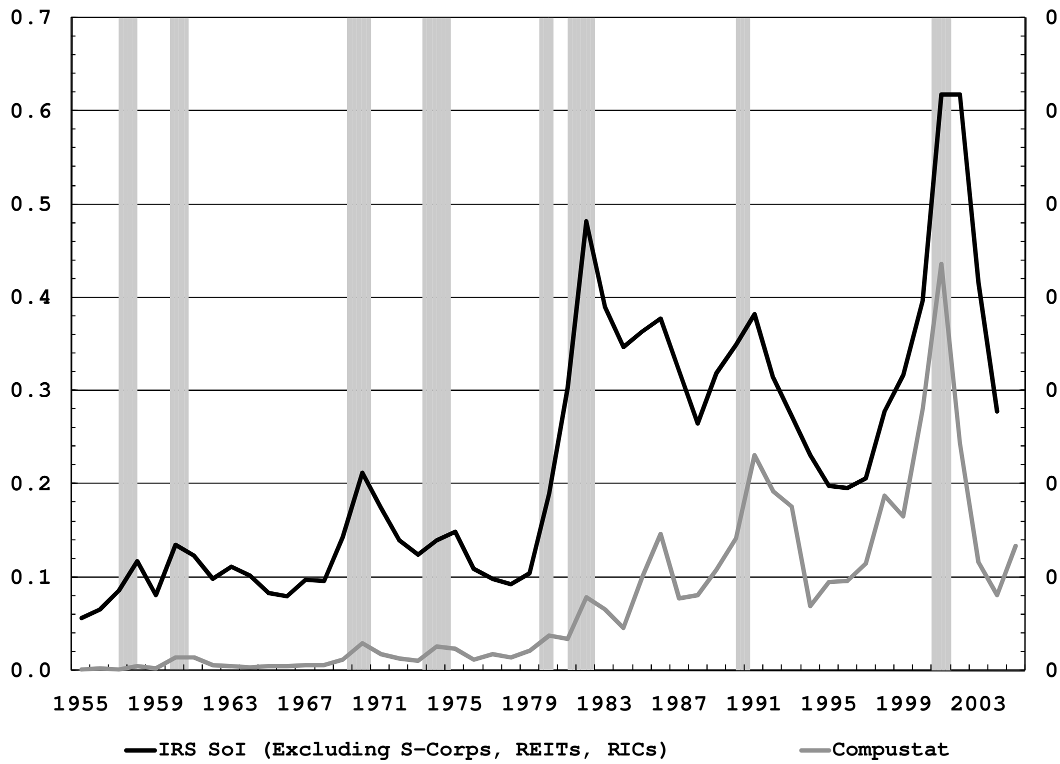
2 Motivation

2.1 Facts on Corporate Losses

I discuss two stylized facts on corporate losses in the United States. First, I document that corporate losses have been quite large relative to positive profits during recent recessions.[2] Second, most losses are not used quickly to offset profits through carrybacks or carryforwards, but tend to be carried forward for several years or expire unused. Together, these facts suggest that the asymmetric treatment of losses could have important effects on investment

[2] Altshuler, Auerbach, Cooper, and Knittel [2008] have also recently documented this fact and explored in more detail the behavior of losses among subsets of firms. Interestingly, available Compustat data from 2008 also suggest that the peak of the loss-to-profit ratio will be lower during the "Great Recession" than it was during the far milder 2001 recession. There were no 2008 tax return data yet available at the time of this writing.

Figure 1: Ratio of U.S. Corporate Losses to Net Income

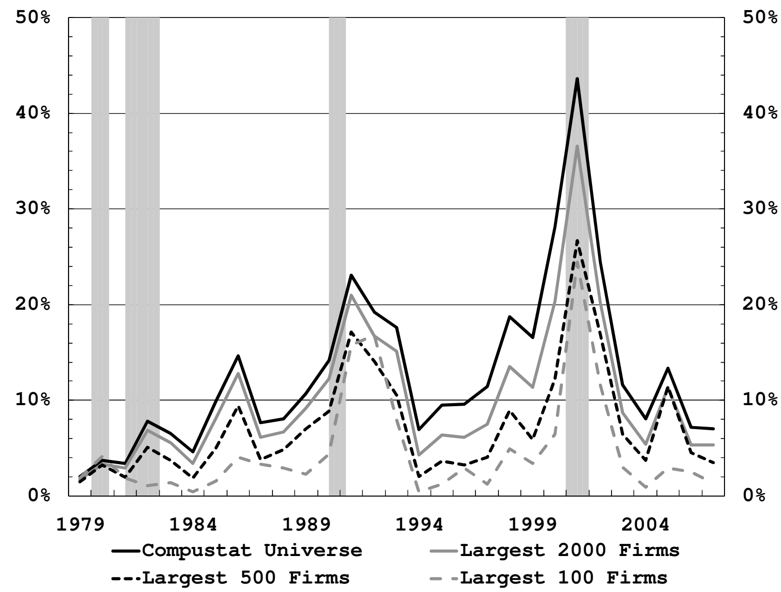


decisions.

Figure 1 plots two historical measures of the ratio of corporate losses to corporate income in the United States. The numerator in this ratio is the sum of losses across all corporations that report a loss. The denominator is the sum of positive profits across all corporations that report a positive profit. The black line shows this loss ratio calculated from the Internal Revenue Service's Statistics of Income data for all firms that file corporate income tax returns. The grey line shows the loss ratio calculated for all nonfinancial, U.S.-incorporated firms in Standard and Poor's Compustat dataset. Details on this calculation appear in Appendix B.

The underlying IRS and Compustat data differ in several ways. The IRS data include tax income for all firms that file corporate income tax returns. In 2003, there were over two million such firms, even after excluding subchapter S corporations, Real Estate Investment Trusts, and Regulated Investment Companies. The Compustat data include book income for large, publicly-traded firms. The number of U.S. firms included in the Compustat sample has grown from less than 1,000 in 1955 to more than 5,000 today. The IRS ratio in Figure 1 persistently exceeds the Compustat ratio for two reasons. First, the Compustat sample is composed primarily of large firms, which realize losses less frequently than smaller firms. Second, book income as reported in Compustat typically exceeds tax income as reported to

Figure 2: Loss Ratios by Firm Size



the IRS.[3]

Despite these differences, the two series share important features. The levels of both series increase dramatically between the first half of the sample and today. The loss ratio in the IRS data averaged 0.12 from 1973 to 1977, while it averaged 0.47 from 1999 to 2003, an increase of 280 percent.[4] Both five-year periods include a single recession. A second notable feature of both the IRS and Compustat loss ratio series is the height of their peaks near the relatively mild 1990 and 2001 recessions. Both series peaked at over 0.2 in the early 1990s and over 0.4 in the early 2000s. Figure 2 plots similar ratios for subsets of the firms in Compustat sorted by the book value of their assets. Even among the 100 largest industrial firms in the United States, the ratio of losses to profits peaked at more than 0.25 in 2001, much higher than in previous recessions.

2.2 Tax Treatment of Corporate Losses

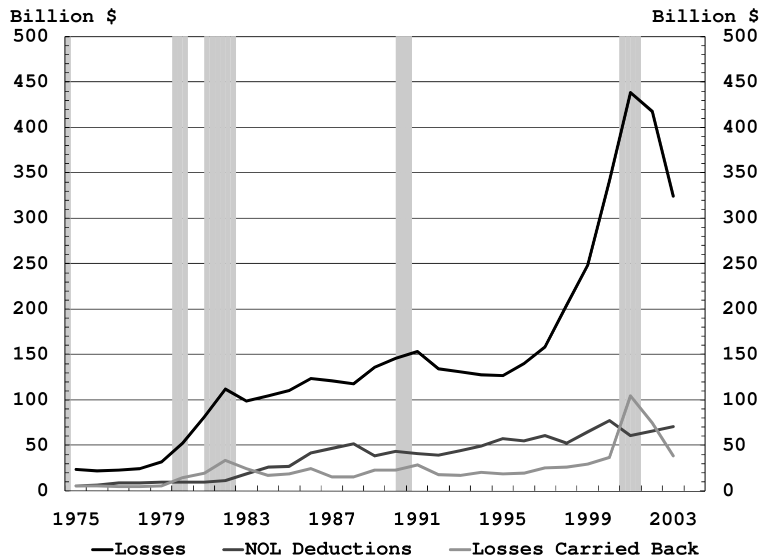
A firm earning positive profits typically must pay a percentage of its profits in tax, while a firm running a loss need not receive an immediate refund. In the United States, losses may be carried back to offset profits in prior years which have not yet been offset. The carryback period, or the length of time for which a prior profit may be used to offset a loss, is currently two years.[5] If there are no profits in the prior two years which may be used to

[3]See Hanlon [2003] for more on the differences between tax and book income.

[4]The average loss ratio in the Compustat data rose from 0.02 to 0.25 between these periods, although this 1,300 percent increase can be attributed largely to the expansion of the Compustat sample to include more smaller firms.

[5]JCWAA extended the carryback period to five years for losses realized in 2001 and 2002. A similar provision was almost included in the American Recovery and Reinvestment Act of 2009, but ultimately the

Figure 3: Losses, NOL Deductions, and Losses Carried Back



offset a current loss, then the loss may be carried forward and used to offset future profits. The carryforward period, or the length of time for which a prior loss may be used to offset a profit, is currently twenty years. Losses carried forward do not earn interest and are not protected against inflation.

The U.S. rules allowing immediate tax refunds in the form of carrybacks are generous relative to those in many countries. Canada and France allow losses to be carried back for three years; Ireland, the Netherlands, the U.K., and Japan allow carrybacks only to the previous year. Most other countries do not permit carrybacks or strictly limit their size. In countries that do not allow carrybacks, we should expect all loss-making firms to be nontaxable, meaning that marginal increases in income have no effect on current-year tax payments or refunds. When many firms run losses, tax incentives for investment could thus be particularly ineffective in these countries.

Some countries also have quite ungenerous carryforward rules. Countries with short carryforward periods of 3 or 5 years include Greece, Italy, Poland, Turkey, Argentina, Indonesia, South Korea, Taiwan, and Thailand. On the other hand, losses may be carried forward indefinitely in many countries, including France, Germany, Belgium, Norway, Sweden, the U.K., Israel, Brazil, Chile, Australia, and Hong Kong.[6] The longer is the carryforward period, the more valuable is a further deduction from taxable income for a firm already making losses. Thus we would expect tax incentives to have the largest impact on investment among nontaxable firms in countries where carryforward periods are longest.

In fact, evidence from the U.S. shows that a large fraction of realized losses expire unused

five-year carryback was made available only to small businesses.

[6]These facts are from `http://itrworldtax.com/` and Dwenger [2008]. Some countries have also introduced temporary changes to their carryback rules in response to the recent crisis and recession. The U.K., for example, has allowed a three-year carryback limited to £50,000.

or remain unused for many years. Figure 3 presents data on the amount of losses realized each year, the amount of these losses carried back, and the amount of prior years' losses used to offset current profits. For example, in 2001, U.S. corporations realized $438 billion in losses and were able to immediately carry back about $105 billion to receive a refund of about $37 billion.[7] Sixty billion dollars of profits realized in 2001 were offset with losses from prior years. By subtracting the latter two series from the first series, one can create a measure of the annual net flow into the stock of unused carryforwards. A glance at Figure 3 suggests that this flow is always positive and has been quite large since at least the early 1980s. Calculating this flow for each year since 1988 and summing over the 15 years from 1988 to 2002 produces a sum of $1.9 trillion. Since losses realized in 1988 could be carried forward up to 15 years, this figure represents a lower bound on the amount of losses that would have been available to offset 2003 profits, if none had been lost in bankruptcies or acquisitions. Total profits realized by profitable firms in 2003 were $780 billion. Thus the stock of unused potential loss offsets was about 2.5 times as large as all realized profits. This ratio highlights the magnitude of unused losses and hence the potential importance of the tax treatment of losses relative to profits.

Cooper and Knittel [2006] present data compiled from a sample of confidential tax returns that corroborate these aggregates. Of the losses realized by firms in their sample in 1993, the first year for which data are available, 13 percent were used immediately as carrybacks, and 38 percent had been used as carryforwards by 2003, the last year in their sample. Another 18 percent remained oustanding for potential future use, while 31 percent were lost from the sample as firms went out of business or were taken over by other firms. Some fraction of these 31 percent may have been used subsequently by acquiring firms or may remain outstanding for future use, but the authors are unable to measure these amounts.[8] These figures suggest that important fractions of losses are realized by firms who will remain unprofitable for many years or even cease to exist before they are able to make use of their losses.

Thus, I have documented that corporate losses in the U.S. have been large relative to profits in recent years and that they are used slowly, if at all, to offset profits. These facts suggest that the tax treatment of losses and the behavior of loss-making firms are potentially quite important for understanding the effects of the tax code on investment decisions. In particular, the effects of investment incentives like bonus depreciation may be blunted when firms are losing money or when they hold stocks of net operating losses from prior years.

2.3 Existing Literature

Most of the vast theoretical and empirical literature on taxes and investment has ignored carryforward and carryback provisions and assumed symmetric treatment of profits and losses.[9] There do, however, exist a number of papers that have explicitly studied the effects

[7]The carryback figures are based on data in Cooper and Knittel [2006] for 1993 to 2003 and on data provided by Greg Key of the Bureau of Economic Analysis for earlier years.

[8]See Sections 381 and 382 of the Internal Revenue Code and the separate return year limitation (SRLY) rules for more on the limitations on the use of carryforwards and carrybacks by acquiring firms.

[9]Seminal examples include Hall and Jorgenson [1967], Hayashi [1982], and Summers [1981], who developed models of the user cost of capital and Tobin's Q adjusted for the effects of taxes. This theory inspired a great deal of empirical work that also ignored the carryforward and carryback provisions. Examples include

of the system of carryforwards and carrybacks on firm behavior. Auerbach [1986] and Mayer [1986] present dynamic models of investment with the stock of loss carryforwards as a state variable. Majd and Myers [1987] calculate net present values of example projects to example firms facing asymmetric taxes, assuming exogenous processes for firm and project cash flows. Auerbach and Poterba [1987] calculate effective tax rates on investment in new equipment and structures, assuming riskless cash flows but an exogenous process for taxable status. Altshuler and Auerbach [1990] calculate effective tax rates on current income under a similar assumption of exogenous, stochastic taxable status. MacKie-Mason [1990] presents empirical evidence that carryforward stocks influence the decision to issue new debt or equity. Graham [2000] computes effective tax rates on current income for each firm-year in the Compustat panel, assuming an exogenous process for earnings. None of these papers provide empirical evidence of any effect of the system of carryforwards and carrybacks on observed investment behavior by firms.

Empirical evidence on the effects of tax asymmetries on investment decisions is scarce. Devereux, Keen, and Schiantarelli [1994] run tax-adjusted Q and user cost investment regressions on a panel of UK firms, attempting to adjust their tax variables for carryforward provisions. They conclude that "[c]areful modelling of asymmetries does not noticeably improve the empirical performance of these equations." The results in the present paper are most similar in form to a specification presented by Cummins, Hassett, and Hubbard [1995], where separate user cost coefficients are estimated for firms with and without carryforward stocks under the Compustat definition. Little attention is paid to the determination of taxable status, the importance of cash flows, or implications for the effectiveness of investment incentives.

Empirical specifications measuring the effects of tax incentives on investment typically include controls for cash flows. However, modeling a firm facing financing constraints produces the additional insight that these constraints can mitigate the effectiveness of tax incentives, as well as directly influence the level of investment. In a paper written contemporaneously with and independently of this one, Keuschnigg and Ribi [2009] study a detailed theoretical model of the the effects of taxes on a firm facing financing constraints. I am not aware of any empirical work that allows for this interaction between tax incentives and measures of firm performance like cash flows.

3 A Model of the Firm

This section introduces a model that will motivate the empirical specifications to follow and notation that will be directly useful in describing the construction of tax-related variables. A wide variety of theoretical and empirical frameworks can be found in the literature on business investment. In this paper, I modify the tax-adjusted Q model of Hayashi [1982] and Summers [1981] to incorporate financing constraints and carrybacks and carryforwards of operating losses. I adopt this model for three primary reasons. First, it elegantly incorporates firm optimizing behavior and explicit modeling of adjustment costs to produce an

Poterba and Summers [1985], Bernanke, Bohn, and Reiss [1988], Auerbach and Hassett [1991], and Cummins, Hassett, and Hubbard [1994]. Prominent recent papers on investment incentives like Desai and Goolsbee [2004] and House and Shapiro [2008] make no mention of the tax treatment of losses.

empirical specification consistent with economic theory. Second, it has a long history in the literature on taxes and investment. Public economists familiar with this literature can easily compare my results to those of Summers [1981], Poterba and Summers [1985], Desai and Goolsbee [2004], and others. Finally, and most importantly, the model produces an empirical specification that takes the form of a simple and intuituve linear investment equation. Even if the model developed here is terribly misspecified, OLS estimation of this equation will produce an estimate of the minimum mean square error linear approximation to whatever function might actually determine the relationship of the included variables to the expected value of investment (Angrist and Pischke [2008]). Any economist can easily interpret these results and understand any biases that might arise in the context of the current application.

A firm chooses how much to invest in each year in order to maximize the present discounted value of its after-tax cash flows.[10] The firm's cash flows before taxes in year t, $F(K_t, x_t)$, depend on its current capital stock, K_t, and a firm-level stochastic shock, x_t. The capital stock, K_t, evolves according to,

$$K_{t+1} = (1 - \delta)K_t + I_t$$

where δ is physical depreciation and I_t is investment in year t. In the United States and elsewhere, the deduction from taxable income attributed to depreciation is allowed to be larger than actual physical depreciation. Thus the stock of capital not yet depreciated for tax purposes, $\tilde{K}_t$, evolves separately from the physical capital stock, according to,

$$\tilde{K}_{t+1} = (1 - \tilde{\delta})\tilde{K}_t + (1 - z_t^0)p_t I_t,$$

where $\tilde{\delta}$ is the depreciation rate allowed for tax purposes, z_t^0 is the fraction of new investment deductible in its first year, and p_t is the price of physical capital in year t. The firm bears a cost of adjustment, $\psi(I_t, K_t)$, which may represent costs from shutting down production to install new machinery or retraining workers to use new software. It is assumed to be tax deductible.

The firm's taxable income, that is, the income measure that will determine its tax liability, is then,

$$TI_t = F(K_t, x_t) - p_t\psi(I_t, K_t) - z_t^0 p_t I_t - \tilde{\delta}\tilde{K}_t.$$

Along with TI_t and the statutory tax rate, τ_t, the firm's tax liability or tax refund will be determined by any available investment tax credits, other tax credits, carryforwards, and carrybacks. A firm making investment I_t is entitled to investment tax credits in the amount $p_t I_t ITC_t$. Other tax credits, ranging from the research and experimentation credit to the Indian employment credit, are assumed to be exogenous to debt and investment choices and in the amount CR_t.

Carryforwards and carrybacks expire if unused after T_t^F and T_t^B years, respectively, where T_t^F and T_t^B are currently twenty and two in the United States. A carryforward earned s years ago has a lower value to the firm than a carryforward earned $s - 1$ years ago, since it is somewhat more likely to expire unused. To solve the firm's investment problem, one should track the entire vectors of T_t^F carryforwards and T_t^B carrybacks, plus any more distant carryforwards and carrybacks that might become relevant if T^F or T^B were to increase in the

[10]It is straightforward to extend the model to include debt, but little additional insight is gained.

future.[11] I abstract from this complication in the case of carryforwards, but respect it in the case of carrybacks. I assume that carryforwards last forever, so that a scalar variable, CF_t, is sufficient to track the potential carryforwards available to the firm in year t. I track the entire vector of carrybacks, $\mathbf{CB}_t \in \mathbb{R}^{T_t^B}$, where $\mathbf{CB}[s]_t$ represents the carryback available in year t from taxes paid s years ago, in year $t-s$. Let $\tilde{CB}_t$ be the total amount of carrybacks available to the firm in year t,

$$\tilde{CB}_t = \sum_{i=1}^{T_t^B} \mathbf{CB}[i]_t. \tag{1}$$

To write the firm's tax liability or refund in year t, first define the variable NT_t, a dummy variable indicating that the firm is nontaxable,

$$NT_t = \mathbf{1}\left(\tau_t(TI_t - CF_t) - CR_t - p_t I_t ITC_t > -\tilde{CB}_t\right),$$

where the function $\mathbf{1}(\mathit{condition})$ takes the value of one if *condition* is true and zero otherwise. With this notation, the tax bill in year t, TB_t, can be written,

$$TB_t = \begin{cases} \tau_t(TI_t - CF_t) - CR_t - p_t I_t ITC_t & \text{if } 1 - NT_t \\ -\tilde{CB}_t & \text{if } NT_t. \end{cases} \tag{2}$$

A negative tax bill indicates a carryback refund. Note that I classify a firm as taxable ($NT_t = 0$) when a \$1 increase in taxable income causes a \$$\tau_t$ increase in the tax bill. When the firm is nontaxable ($NT_t = 1$), a \$1 increase in taxable income has no effect on the tax bill in the current year. This notation compactly nests a number of special cases.[12] For example, a firm is considered taxable if it has negative taxable income and receives a carryback refund less than its largest possible carryback.

The dynamics of the carryback stock may be written,

$$\mathbf{CB}[1]_{t+1} = \mathrm{Max}(TB_t, 0) \tag{3}$$

$$\mathbf{CB}[s|s>1]_{t+1} = \begin{cases} \mathbf{CB}[s-1]_t & \text{if } -TB_t < \sum_{i=s}^{T_t^B} \mathbf{CB}[i]_t \text{ or } s > T_t^B + 1 \\ TB_t + \sum_{i=s-1}^{T_t^B} \mathbf{CB}[i]_t & \text{if } \sum_{i=s}^{T_t^B} \mathbf{CB}[i]_t \le -TB_t < \sum_{i=s-1}^{T_t^B} \mathbf{CB}[i]_t \\ 0 & \text{if } \sum_{i=s-1}^{T_t^B} \mathbf{CB}[i]_t \le -TB_t. \end{cases}$$

If the firm uses no carrybacks in year $t+1$, then $\mathbf{CB}[2]_{t+2}$ is equal to the full amount of taxes paid in year t, or $\mathbf{CB}[1]_{t+1}$, as in the second case above. If the firm uses its entire stock of

[11] Legislative changes in the carry period lengths have come in two forms—one which extends the life of carry stocks already earned, and the other which applies only to newly earned carry stocks.

[12] In the first case in (2), when the firm is taxable, it may have positive taxable income (TI_t) exceeding its NOL deduction (CF_t) and few enough credits ($CR_t + p_t I_t ITC_t$) that it pays positive taxes. Or, it may have negative taxable income that does not exceed exceed the amount it may carry back, even after further deducting tentative credits, so that it receives a carryback refund. Or, it may have positive taxable income, but enough credits to more than offset potential taxes and thus to receive carrybacks. In the second case in (2), when the firm is nontaxable, the firm may have positive taxable income that is exceeded by its available carryforwards, resulting in a tax bill of zero. Or, it may have negative taxable income that exhausts its available carrybacks, resulting in a refund of the full carryback amount. Or, it may have positive or negative taxable income that exhausts its available carrybacks only when combined with credits.

carrybacks in year $t+1$, then $\mathbf{CB}[2]_{t+2}$ is equal to zero, as in the final case. The third case above captures the situation when some, but not all, carrybacks are used.

The dynamics of the scalar carryforward stock are simpler,

$$CF_{t+1} = \begin{cases} 0 & \text{if } 1 - NT_t \\ -TI_t + CF_t + (CR_t + p_t I_t ITC_t)/\tau_t - \tilde{CB}_t & \text{if } NT_t. \end{cases}$$

If the firm is taxable, it can have no losses or credits to carry forward, as it would have either used them to reduce its taxes further or to receive a larger carryback. If the firm is nontaxable, it carries forward the excess of losses or credits over any amount that was available to carry back.

Note that I have ignored the limits on credit usage that allow firms to offset only 75% of tentative tax liability with general business credits.[13] Also note that I track carryforwards in pre-tax income amounts, but carrybacks in the amount of taxes paid.[14] Finally, I have assumed that firms always carry back any excess loss or credit, although, in fact, firms may elect either to carry back or to carry forward.[15]

Finally, I add a constraint on the firm's financing activities in each year. Namely, I require that the firm's cash flows exceed 0,

$$F(K_t, x_t) - p_t I_t - p_t \psi(I_t, K_t) - TB_t \geq 0. \tag{4}$$

In this setting, where I have not allowed for debt or issuance of new equity, this constraint ensures limited liability for equity holders, that is, dividends must be nonnegative in every year.

[13] Altshuler and Auerbach [1990] treat this issue in detail. Its importance has likely declined in the years since their sample period due to the elimination in 1987 of the investment tax credit, a key component of the general business credit. The foreign tax credit, now far larger in magnitude, can offset 100% of income before credits.

[14] I judge this treatment to be the best simple way to handle situations where tax rates change. It correctly relates the amount of carrybacks available at any time to the amount of taxes paid under rates in effect in prior years, and it correctly allows the carryforward of losses regardless of any future rate changes. The amount carried back by taxable firms, however, should be related to rates in effect in prior years rather than the current rate, and credit carryforwards as I have written them should be adjusted for future rate changes. Tracking the vector of tax rates in effect when each carryback or credit was earned would require burdensome additional notation so I abstract from these complications.

[15] There are two reasons why a firm might choose to carry forward without first carrying back. First, a loss carried back is, in practice, used to recalculate the net operating loss deduction on a prior year's tax return. The NOL deduction is applied prior to the calculation of any applicable credits. It may be the case that applying the NOL deduction reduces taxes before credits to a level lower than the amount of credits available. If the newly displaced credits cannot be immediately carried back or forward to a prior return, then they must be carried forward to a future return. It is thus possible that a firm might opt not to carry back losses to a return on which it had claimed credits, if those credits cannot be used immediately on another return and are close enough to expiration that they have little value as carryforwards. This is a rather special case, and it is unlikely that I lose much by abstracting from it. A second situation in which firms might choose to carry forward occurs if they expect the statutory tax rate to rise in the future. There has not been a substantial increase in the top statutory rate in the United States since 1949 to 1951, when it rose from 42% to 52%, and recent debate has focused more on the possibility of further rate decreases. There is no reason to expect that firms currently expect any rate increase or that they expected a rate increase at any time in the period covered by the Compustat data.

Subject to the financing constraint in (4), plus the dynamics of physical capital, capital for tax purposes, carrybacks, and carryforwards discussed above, the firm solves,

$$\max_{\{I_t, B_t\}} \mathbb{E}_0^* \left[\sum_{t=0}^{\infty} \frac{1}{(1+r)^t} [F(K_t, z_t) - p_t I_t - p_t \psi(I_t, K_t) - TB_t] \right],$$

where $\mathbb{E}_0^*$ is the expectation operator under the risk-neutral, or Martingale, measure, and r is the risk free rate.[16]

Consider the first-order condition with respect to I_0, investment in the current year. In effect, there are four different first-order conditions, one for non-taxable firms, and one each for firms determining on the margin the levels of each of the three different vintages of carrybacks. For non-taxable firms,

$$p_0(1+\psi_{I0})(1+\eta_0) = \lambda_0 + (1-z_0^0)p_0\tilde{\lambda}_0 + \gamma_0^F p_0(z_0^0 + ITC_0/\tau_0 + \psi_{I0}), \tag{5}$$

where η_0 is the multiplier on the financing constraint, λ_0 is the multiplier on the capital accumulation equation, $\tilde{\lambda}_0$ is the multiplier on the tax capital accumulation equation, and γ_0^F is the multiplier on the carryforward accumulation equation. I have arranged terms so that costs of marginal investment appear on the left side, and benefits on the right. Costs include the price of the marginal unit of capital, p_0, plus its marginal impact on adjustment costs, ψ_{I0}, and an additional shadow cost, η_0, if the financing constraint binds. Benefits include the shadow value of capital in the next year, λ_0, and the shadow value of capital for tax purposes in the next year, $(1-z_0^0)p_0\tilde{\lambda}_0$. The last term is most interesting. In a model with symmetric taxation, γ_0^F would be replaced by τ_0, and the term would represent the immediate tax savings associated with first-year depreciation allowances, investment tax credits, and adjustment expenses. Nontaxable firms under a system of carryforwards do not receive these immediate tax benefits from the marginal investment, but receive instead only the shadow value, γ_0^F, of associated carryforwards.

The first order condition for taxable firms is,

$$p_0(1+\psi_{I0})(1+\eta_0) = \lambda_0 + (1-z_0^0)p_0\tilde{\lambda}_0 + (1-\gamma_0^{Bi} + \eta_0)p_0\tau_0(z_0^0 + ITC_0/\tau_0 + \psi_{I0}). \tag{6}$$

Note that a taxable firm does receive the immediate tax benefits associated with the marginal investment, as well as the shadow value, η_0, of the loosening of the finance constraint by those tax benefits. Note, however, that the value of the tax benefits is also reduced by the shadow value of a carryback, γ_0^{Bi}, where the i indexes the vintage of the carrybacks foregone by realizing the tax benefits. When a firm reduces positive tax payments by qualifying for tax incentives, it foregoes the opportunity to carry future losses back against those tax payments. When a firm is already carrying back, a further reduction in its taxable income uses up carrybacks that might otherwise have been available in subsequent years.

[16] Under the risk-neutral measure, the probability of each state of nature is adjusted for its Arrow-Debreu state price in such a way that it is appropriate to discount expected values at the risk-free rate. See Duffie [2001], Chapters 1 and 2 for details. Working with the risk-neutral measure obviates the need to specify appropriate discount rates for different components of cash flows.

3.1 Investment Responses to Tax Incentives

With symmetric taxation, nonbinding financing constraints, and a familiar assumption on the form of the adjustment cost function,[17] solving the first-order conditions in (5) and (6) for the adjustment cost derivative produces,

$$\frac{I}{K} = a + c\left[\frac{\frac{\lambda}{p} - (1 - \tau z - ITC)}{1 - \tau}\right], \tag{7}$$

where I have suppressed the time-zero subscript on all terms and defined z as the present value of depreciation allowances in a symmetric setting,

$$z \equiv z^0 + (1 - z^0)\sum_{i=1}^{\infty}\frac{(1-\tilde{\delta})^{i-1}}{(1+r)^i}\tilde{\delta}.$$

The expression in brackets in (7) is known as "tax-adjusted Q," because it consists of marginal Q, or λ/p, adjusted for the effects of tax rates, depreciation allowances, and investment tax credits. Several authors, including Poterba and Summers [1985] and Desai and Goolsbee [2004], have estimated equations like this, ignoring any differences between taxable and nontaxable firms.

When estimating a and c from (7), some measure of the market value of a firm divided by the replacement cost of its capital has been used as a proxy for marginal Q. The poor performance of these measures in investment equations, particularly when compared to cash flow variables, has inspired many attempts to solve the potential problem of measurement error in marginal Q. Examples include Cummins, Hassett, and Hubbard [1994], Erickson and Whited [2000], and Cummins, Hassett, and Oliner [2006].

Desai and Goolsbee [2004] take a particularly simple and transparent approach to dealing with this measurement error. They observe that,

$$\frac{\frac{\lambda}{p} - (1 - \tau z - ITC)}{1 - \tau} = \frac{\frac{\lambda}{p}}{1-\tau} - \frac{1 - \tau z - ITC}{1 - \tau},$$

and they estimate,

$$\frac{I_{it}}{K_{i,t-1}} = \beta_1\left[\frac{\frac{\lambda_{ti}}{p_t}}{1-\tau_t}\right] + \beta_2\left[\frac{1 - \tau_t z_{tj} - ITC_{tj}}{1-\tau_t}\right] + \beta_3\left[\frac{CashFlow_{ti}}{K_{i,t-1}}\right] + \alpha_i + \epsilon_{ti},$$

where subscripts index firm i in industry j in year t in the Compustat panel. That is, they simply allow different coefficient estimates on the "Q" and "tax term" components of tax-adjusted Q, so that problems measuring Q do not contaminate estimates of the effects of the tax variables. I will proceed similarly, with additional focus on differences by taxable status.

[17]Namely, that the adjustment cost function takes the form

$$\psi(I_t, K_t) = \frac{1}{2c}\left[\frac{I_t}{K_t} - a\right]^2 K_t,$$

where c is a parameter governing the convex component of adjustment costs.

Respecting the difference between taxable and nontaxable firms developed above would lead one to replace (7) with,

$$\frac{I}{K} = a + c\left[\frac{\frac{\lambda}{p} - \left(1 - (1-\gamma^B)\tau(z^0 + ITC/\tau) - (1-z^0)\tilde{\lambda}\right)}{1-(1-\gamma^B)\tau}\right], \tag{8}$$

for taxable firms, and,

$$\frac{I}{K} = a + c\left[\frac{\frac{\lambda}{p} - \left(1 - \gamma^F(z^0 + ITC/\tau) - (1-z^0)\tilde{\lambda}\right)}{1-\gamma^F}\right], \tag{9}$$

for nontaxable firms. The response of the investment ratio to, say, a change in the investment tax credit, would be,

$$\frac{d(I/K)}{d(ITC)} = c\frac{\gamma^F/\tau}{1-\gamma^F},$$

for nontaxable firms, and

$$\frac{d(I/K)}{d(ITC)} = c\frac{1-\gamma^B}{1-(1-\gamma^B)\tau},$$

for taxable firms.[18] I dub the ratio of these quantities the "response ratio" of nontaxable firms to taxable firms and note that it is determined by the shadow values of carryforwards and carrybacks.

I will assess the empirical relevance of this predicted response ratio in a simple and transparent way, easily comparable to prior literature, by estimating equations of the form,

$$\frac{I_{it}}{K_{i,t-1}} = \beta_1\left[\frac{1-\tau_t z_{jt} - ITC_{jt}}{1-\tau_t}\right] + \beta_2\left[NT_{it}\frac{1-\tau_t z_{it} - ITC_{it}}{1-\tau_t}\right]$$
$$+ \beta_3\left[\frac{CashFlow_{it}}{K_{i,t-1}}\right] + \beta_4\left[\frac{\frac{\lambda_{it}}{p_t}}{1-\tau_t}\right] + \beta_5 NT_{it} + \alpha_i + \epsilon_{it},$$

where I allow different coefficients on standard tax variables for currently taxable and nontaxable firms. The estimated ratio $(\beta_1+\beta_2)/\beta_1$ provides a measure of the relative responsiveness of nontaxable and taxable firms.

Consider also the case of a nontaxable firm when the financing constraint does bind. In this case, the response of the investment ratio to a change in the investment tax credit is,

$$\frac{d(I/K)}{d(ITC)} = c\frac{\gamma^F/\tau}{1-\gamma^F+\eta}.$$

Thus the effectiveness of investment incentives like the ITC or bonus depreciation is decreasing in η, the shadow value of loosening the financing constraint. When financing constraints are tight, investment incentives are less effective. A similar result would apply for taxable

[18] Recall that I have defined the shadow value of carryforwards in pre-tax income amounts, but carrybacks in the amount of taxes paid.

firms if investment incentives do not loosen the financing constraint one-for-one—for example, if firms must pay or borrow the full price of capital up front and can only later claim the tax deductions or credits. I will thus estimate equations of the form,

$$\begin{aligned}\frac{I_{it}}{K_{i,t-1}} &= \beta_1 \left[\frac{1-\tau_t z_{jt} - ITC_{jt}}{1-\tau_t}\right] + \beta_2 \left[NT_{it}\frac{1-\tau_t z_{jt} - ITC_{jt}}{1-\tau_t}\right] \\ &+ \beta_3 \left[\frac{CashFlow_{it}}{K_{i,t-1}} \times \frac{1-\tau_t z_{jt} - ITC_{jt}}{1-\tau_t}\right] + \beta_4 \left[\frac{CashFlow_{it}}{K_{i,t-1}}\right] \\ &+ \beta_5 \left[\frac{\frac{\lambda_{it}}{p_t}}{1-\tau_t}\right] + \beta_6 NT_{it} + \alpha_i + \epsilon_{it},\end{aligned}$$

where the effect of tax incentives can vary with both taxable status and cash flows. In the model developed here, β_3 would be interpreted as a measure of the importance of financing constraints for the impact of tax incentives, but other interpretations are also possible. In the final set of results, I introduce additional interactions with the tax terms to test alternative models that could explain the importance of the cash flow interaction.

4 Data

Standard and Poor's gathers financial statements from firms that are traded publicly in the United States or Canada. They code the information reported by each firm into a standardized set of income, cash flow, balance sheet, and supplementary data items. The resulting panel dataset is known as the Compustat North America Database. In 1967, the first year for which all relevant data items are widely available, about 1,100 U.S. firms appear in the dataset with nonmissing data.[19] The sample has expanded over time and now includes all firms traded on American and Canadian stock exchanges, including American Depository Receipts for foreign firms, as well as many firms traded over-the-counter and some firms that file financial statements even though they are not publicly traded. In recent years, almost 5,000 U.S. firms reporting all relevant data items have appeared in the sample. Appendix A discusses my efforts to ensure that firms appearing in the sample used in this paper are relevant entities for U.S. federal taxation. I exclude from the estimation sample all firms in North American Industry Classification System sectors 52, Finance and Insurance, and 22, Utilities. I include all years from 1967 to 2005.

All publicly-traded firms must report the data items used in this paper on their accounting statements. Firms that appear in the data with missing items were typically not publicly-traded in any years with incomplete data. Firms that do not appear at all were privately held or too small to be included by Compustat in its early years. It seems most likely that private firms would be more likely to face financing constraints than public firms, given their inability to raise funds for investment in the equity market. Small, growing firms may also be more likely to face financing constraints than large firms. Thus by excluding small and private firms, results could understate the importance of cash flows in determining the impact of tax incentives for investment.

[19] The limiting "relevant data item" is usually the share price needed to construct measures of Q, as described below.

Tax laws have changed repeatedly in the United States over the last several decades. Legislation changed corporate tax rates in 1964, 1968, 1970, 1979, and 1987. There were important changes to depreciation rules in 1962, 1971, 1981, and 1987, and bonus depreciation was in place from 2002 through 2004 and in 2008 and 2009. The investment tax credit was introduced in 1962, repealed in 1969, reinstated in 1971, increased in 1975, and repealed in 1986. These changes have often differentially affected investments in different assets in rather arbitrary ways. For example, the Tax Reform Act of 1986 changed the investment tax credit available for trucks from 10% to 0%, while it changed the ITC available for cars from 6% to 0%.[20]

I follow Cummins, Hassett, and Hubbard [1994] and Desai and Goolsbee [2004] in using this variation in the tax treatment of different kinds of assets to identify the impact of tax variables on investment. I thank Dale Jorgenson for providing data on investment tax credits and the present value of depreciation deductions available in each year for each asset type. These variables are matched to the 1997 Capital Flows table from the Bureau of Economic Analysis, which records the amount of investment made by each industry in each asset category.[21] I construct depreciation deduction values and investment tax credit rates at the industry level by taking a weighted average across the assets purchased by each industry, with the weights equal to the percentage of the industry's spending accounted for by each asset. I then construct the tax term component of tax-adjusted Q,

$$\text{Tax term}_{it} \equiv \frac{1 - \tau_t z_{jt} - ITC_{jt}}{1 - \tau_t},$$

for firm i in industry j and year t. The tax term is constructed separately for equipment investment and structures investment. Note that the tax term does not vary across firms within each industry-year combination, so it is not possible to control for variation at the industry-year level nonparametrically by including industry-year dummies in regressions. Results are quite robust, however, to including industry-specific linear or quadratic trends.

Tax terms constructed in this manner depend only on statutory variables like the corporate tax rate, depreciation schedules, and investment tax credit parameters.[22] These variables are averaged at the industry level using a set of weights that are fixed over time and do not vary with any (possibly tax-induced) changes in the mix of assets employed by a given industry. Thus, there is no mechanical relation between the decisions of firms in Compustat and changes in the tax variables that are included in regression results. Further, all specifications presented in this paper include year fixed effects to deflect concerns about policy endogeneity that would arise, for example, when investment incentives become more

[20]See Brazell, Dworin, and Walsh [1989], Cummins, Hassett, and Hubbard [1994], or Gravelle [1994] for more on the history of relevant tax policy.

[21]There are 28 equipment categories, with examples including Computers and Peripheral Equipment, Metalworking Machinery, and Autos. There are 23 structures categories, with examples including Industrial Buildings, Railroads, and Petroleum Pipelines. There are 123 industries, which are roughly at the three-digit NAICS level. Examples include Coal Mining, Plastic and Rubber Products Manufacturing, and Air Transportation.

[22]I ignore any progressivity in the corporate tax rate schedule that would create different marginal rates in a narrow range of incomes near zero. The present value of depreciation deductions also varies somewhat over time with the interest rates used to do the discounting. These calculations were done by Dale Jorgenson using the after-tax BAA rate.

generous exactly when investment is low. With year fixed effects included, identification of the effects of tax variables comes only from differences across industries in changes in the tax treatment of the assets that they purchase (with the bundle of assets held fixed) and not from time series variation in the generosity of tax incentives.

4.1 Construction of Taxable Status Variables

Although the tax terms just described have been used by others in the literature, I develop new measures of taxable status for each firm-year observation in Compustat. I pay careful attention to the availability of carrybacks, the corporate alternative minimum tax, and other nuances of the corporate tax code. To fix terminology and review the computation of the corporate income tax, Table 1 presents book measures of corporate income that appear in Compustat and their relationship to tax variables that would appear on the corporate tax return. The top half of the table presents the items that would be necessary to reconcile book pretax income, as it appears in Compustat item pi170,[23] with taxable income that would appear on Line 28 of the corporate income tax return, setting aside any differences in consolidation for book and tax purposes. The second half of the table presents the steps necessary to compute the firm's ultimate current tax liability or refund, after accounting for special deductions, credits, and carrybacks. Acronyms refer to items preceding them in a straightforward way.

The items related to tax credits in lines (15) through (18) deserve a few comments. First, the general business credit, of which the investment credit and the research and experimentation credit are the most important components, can offset only 75% of income tax liability above $25,000,[24] and any excess must be carried back or carried forward. As previously discussed, I ignore this percentage limit, assuming instead that credits can be used to offset 100% of tax liability. Second, I have written the items related to credits in the convoluted manner of lines (14) through (18) to highlight which component of credits is observable in Compustat. Only credits used to offset positive taxes, as in line (17), appear in itci51. Credit carrybacks that contribute to a tax refund, as in line (11), do not appear.[25]

4.1.1 Taxable Income

Below, I will use a measure of Taxable Income after Dividend Deduction (TIDD), or line (10) of Table 1, to identify firms making Alternative Minimum Tax payments and to calculate an alternative measure of outstanding carryforward stocks. No direct measure of this quantity

[23] For many years Compustat variables were identified with data item numbers. Recently, Compustat switched to a system of nonnumeric mnemonics. When referring to Compustat variables in this paper, I will use their new mnemonic appended to their old data item number. For pretax income, for example, the new mnemonic is pi and the old item number was 170, so I refer to the variable as pi170.

[24] These parameters have changed over time, and the percentage limit has been as high as 85% in the past.

[25] Even this is only accurate for firms using the flow-through method of accounting for tax credits. Firms using the deferral method allocate the entire amount of a credit earned to a balance sheet account, which is then amortized over the life of the asset, with the amortization amount appearing in data51 each year. Of the observations with itci51 > 0, the related footnote in afnt8 shows that 52% are reported using the flow-through method, 8% using the deferral method, and the remaining 40% using some combination of the two methods.

Table 1: Relationship Between Book and Tax Variables

Pretax Income from Continuing Operations	(1)	[Compustat pi170]
+ Permanent Tax-Book Differences in PICO	(2)	
+ Temporary Tax-Book Differences in PICO	(3)	
+ Extraordinary Items and Discontinued Operations, Net of Tax	(4)	[Compustat xido48]
+ Tax Provision for EIDO	(5)	
+ Permanent Tax-Book Differences in EIDO	(6)	
+ Temporary Tax-Book Differences in EIDO	(7)	
= Taxable Income before Special Deductions	(8)	[IRS Form 1120, Line 28]
− Dividends Received Deduction	(9)	[Line 29b]
= Taxable Income after Dividend Deduction	(10)	
− Net Operating Loss Deduction	(11)	[Line 29a]
= Taxable Income after NOL Deduction	(12)	[Line 30]
$\times\ \tau$	(13)	
= Tentative Tax Before Credits	(14)	
+ Max(−TTBC − Carryback Stock, 0)	(15)	
= Taxes Before Credits	(16)	
− Max(Min(TBC, Credit,) 0)	(17)	[Compustat itci51]
− Max(Min(Credit, TTBC + CBS), 0) +Max(Min(TBC, Credit,) 0)	(18)	
= Tax Bill	(19)	
−Tax Bill Allocated to EIDO	(20)	
= Tax Bill for Continuing Operations	(21)	[Compustat txfed63]

appears in Compustat, so I attempt to infer it from available data.[26] I work down to a measure of line (10) starting from the Compustat items at the top of Table 1. I screen for alternative minimum tax payments on income from continuing operations using pi170 alone, and I construct carryforward stocks using

$$TIDD_t = \text{pi170} + \text{xido48}.$$

[26]Other authors have constructed a taxable income measure using txfed63, the current U.S. federal tax liability allocated to continuing operations, and its foreign equivalent, txfo64, along with Compustat's measure of outstanding carryforwards, tlcf52. In effect, they attempt to work up from the bottom of Table 1 to reach the taxable income variables in the middle. Hanlon, Laplante, and Shevlin (2005) construct,

$$\text{Taxable Income } = \frac{\text{txfed63}_t + \text{txfo64}_t}{\tau_t} + \text{tlcf52}_{t-1} - \text{tlcf52}_t,$$

where they use the change in the Compustat measure of the carryforward stock, tlcf52, as a measure of NOL deductions in line (11). My aim in constructing a taxable income measure is to make small adjustments to txfed63 and to recalculate tlcf52, so these measures are inappropriate for my purposes.

I discuss each of these in more detail below.[27]

4.1.2 Adjustments for the Alternative Minimum Tax

There is one group of firms whose data I adjust before proceeding with the calculations of taxable status and the carryback and carryforward stocks. The corporate Alternative Minimum Tax permits NOL deductions only up to 90% of AMT taxable income. Thus we observe some firms with carryforwards large enough to offset the entirety of their taxable income who still pay small positive taxes. These firms are taxable on marginal AMT income at a rate of 2%, i.e. 10% of the AMT rate of 20%. Because 2% is closer to 0% than to 35%, I classify these firms as nontaxable. I construct a dummy for AMT status, AMT_t equal to 1 when the firm has tax payments (txfed63) plus credits utilitzed (itci51) less than or equal to 2% of taxable income (pi170), Less than 3% of observations in the eventual estimation sample are classified as AMT payments by this criterion. I then construct a measure of the tax bill excluding these small AMT payments as,

$$TB_t = \text{txfed63}_t \times (1 - AMT_t).$$

See Appendix A for more detail on the corporate AMT.

4.1.3 Carryback Stocks

Measuring the potential federal income tax carrybacks available to a firm in a given year is relatively straightforward given the tax bill information constructed above. Using the notation introduced earlier, where $\mathbf{CB}[s]_t$ represents the potential carryback in year t still remaining from taxes paid in year $t - s$, I first construct,

$$\mathbf{CB}[s]_0 = \text{Max}(TB_0, 0) \quad \forall s,$$

that is, in each firm's first year in the sample I set its potential carrybacks from each prior year to equal its tax payment in the year, if and only if it is nonnegative. Then I evolve the carryback stocks forward using each year's tax bill, exactly as written above in equations (3) and (1).

4.1.4 Taxable Status

I classify firms as taxable if they currently face the marginal income tax rate, either by paying positive taxes or receiving carrybacks. I construct the nontaxable dummy,

$$NT_t = 1 - \mathbf{1}(TB_t > 0 | (0 > TB_t > -\tilde{CB}_t)).$$

[27] I also adjust extraordinary items and special items for recent accounting changes, as discussed in Appendix 2.

4.1.5 Carryforward Stocks

I also construct a measure of the firm's outstanding carryforward stocks based on its history of tax bills, taxable incomes, and carryback stocks. In a firm's second year in the sample, I set its carryback amount at the beginning of the year to the Compustat-reported NOL amount at the end of the previous year,

$$CF_1 = \text{tlcf52}_0.$$

Then I evolve the carryforward stock forward using the data constructed above. I set,[28]

$$CF_{t+1} = \begin{cases} 0 & \text{if } TB_t > 0 \\ 0 & \text{if } TB_t = 0 \text{ and } CR_t + p_t ITC_t > 0 \\ \text{Max}(0, CF_t - TIDD_t) & \text{if } TB_t = 0 \text{ and } CR_t + p_t ITC_t = 0 \\ 0 & \text{if } 0 > TB_t > -\tilde{CB}_t \\ \text{Max}(0, -TIDD_t + TB_t/\tau_t) & \text{if } 0 > TB_t \text{ and } -\tilde{CB}_t \geq TB_t. \end{cases}$$

4.1.6 Internal Consistency Checks

The three variables I have constructed are taxable status, carryforward stock, and carryback stock, or NT_t, CF_t, and CB_t, respectively. If constructed correctly, these variables should be related in certain ways. Whenever $CF_t > 0$, we should see $NT_{t-1} = 1$ and $CB_t = 0$. And we should never see $CF_t > 0$ when $NT_{t-1} = 0$ or $CB_t > 0$. In Table 2, I present the percent of relevant observations that fail each of these four checks. The first column performs the checks using the carryforward stocks that I constructed. The second uses the carryforward data provided by Compustat in tlcf52.

[28] In the first case, when the firm pays positive taxes (excluding any small AMT payments as discussed above) I conclude that the firm has exhausted its carryforwards and will carry none into the following year. In the second case, the firm pays no taxes, but indicates that it offset positive Taxes Before Credits by using a credit, implying that Taxable Income after NOL Deductions was positive and that any carryforwards were exhausted. I exclude credits reported using the deferral or combination methods of accounting when making this determination, since these need not represent actual credit offsets in the current year. In the third case, the firm pays zero taxes and reports zero credit offsets. In this case, the firm may have had either positive taxable income fully offset by carryforwards, or negative taxable income that it was unable to carry back. If taxable income is positive, it is subtracted from the carryforward stock. If taxable income is negative, its absolute value is added to the carryforward stock. Because my measures of taxable income and carryforward stocks are both imperfect, there are observations where the taxable income measure exceeds the carryforward stock measure, but no tax payments are reported. In this case, I set the following year's carryforward stock to zero.

In the fourth case, the firm receives carrybacks that do not exceed its stock of potential carrybacks. Since it had potential carrybacks at the beginning of the year, it should not have had carryforwards at the beginning of the year. And since its losses did not exhaust its carrybacks, it creates no new carryforwards for the following year. In the fifth case, the firm's losses exhaust its carrybacks, and new carryforwards are created. The new carryforward is the firm's (negative) taxable income, reduced by the portion carried back. It is feasible that the firm's taxable income was not negative enough to exhaust its carryback (and perhaps even positive), but its credits were large enough to bring it to carryback exhaustion. There is no way to measure any excess of credits over the carryback limit, since only credits offsetting positive income are reported in Compustat. In this case, as well as any case where poor measures of taxable income and carrybacks would produce a negative carryforward, I set the following year's carryforward to zero.

Table 2: Observations with Inconsistent Tax Variables

Inconsistency	*CF*	tlcf52
$NT_{t-1} = 0$ given $CF_t > 0$	0%	38.6%
$CF_t > 0$ given $NT_{t-1} = 0$	0%	13.6%
$CB_t > 0$ given $CF_t > 0$	8.5%	44.9%
$CF_t > 0$ given $CB_t > 0$	2.3%	16.4%

Figures represent the percent of observations with internally inconsistent tax variables. Column CF uses the measure of carryforward stocks that I constructed as described in the text. Column tlcf52 uses the unedited Compustat item tlcf52.

The second column demonstrates that the Compustat NOL data from tlcf52 are often inconsistent with the Compustat tax data in txfed63. In 38.6% of the observations where Compustat reports the presence of a carryforward, Compustat also reports that the firm paid positive taxes or received a refund not exceeding its potential carryback in the prior year. Hand comparisons of randomly selected observations with the original financial statements show that the Compustat tlcf52 variable lumps together carryforwards for federal, state, and foreign purposes and sometimes contains pure coding errors.

The absence of any inconsistencies in the upper left cells of the table is by construction. I constructed NT_t and CF_t from the underlying txfed63 information in such a way that they cannot conflict. The 8.5% and 2.3% inconsistencies in the lower left come from inconsistencies in the underlying txfed63 information itself, for example, in situations where a firm pays positive taxes for some time, then reports negative taxable income accompanied by zero taxes paid, instead of the carrybacks that one would expect.

I follow prior literature in constructing the several other tax and financial variables that enter the estimation results below. See Appendix A for more detail on the construction of these variables and for a table of descriptive statistics.

Table 3: Regressions of investment to capital stock ratio on tax variables and controls

	All Firms	All Firms	Largest 3500	Largest 3500	Largest 2500	Largest 2500	Largest 1500	Largest 1500	Largest 500	Largest 500	Largest 100	Largest 100
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Equipment Tax Term (ETT)	-.842	-.846	-.663		-.524		-.342		-.465		-.079	
	(.326)***	(.323)***	(.315)**		(.282)*		(.270)		(.344)		(.469)	
ETT × Taxable dummy				-.663		-.524		-.342		-.465		-.079
				(.315)**		(.282)*		(.270)		(.344)		(.469)
ETT × Nontaxable dummy		.133	.222	-.441	.272	-.252	.226	-.116	.144	-.321	.214	.135
		(.091)	(.091)**	(.331)	(.086)***	(.301)	(.090)**	(.286)	(.117)	(.342)	(.118)*	(.497)
Nontaxable dummy		-.238	-.316	-.316	-.346	-.346	-.288	-.288	-.179	-.179	-.247	-.247
		(.094)**	(.094)***	(.094)***	(.089)***	(.089)***	(.094)***	(.094)***	(.124)	(.124)	(.126)**	(.126)**
Structures Tax Term	-.052	-.043	-.020	-.020	.019	.019	.001	.001	-.101	-.101	-.098	-.098
	(.046)	(.046)	(.044)	(.044)	(.036)	(.036)	(.038)	(.038)	(.052)*	(.052)*	(.078)	(.078)
Q / $(1-\tau)$	.038	.038	.050	.050	.052	.052	.040	.040	.022	.022	.021	.021
	(.001)***	(.001)***	(.002)***	(.002)***	(.002)***	(.002)***	(.003)***	(.003)***	(.003)***	(.003)***	(.006)***	(.006)***
CashFlow / PPE	-.008	-.009	.00004	.00004	.021	.021	.039	.039	.084	.084	.076	.076
	(.001)***	(.001)***	(.002)	(.002)	(.004)***	(.004)***	(.007)***	(.007)***	(.018)***	(.018)***	(.029)***	(.029)***
Response Ratio	.	.842	.665	.665	.482	.482	.34	.34	.69	.69	.	.
Firms	14720	14720	13365	13365	9628	9628	5573	5573	1611	1611	282	282
Observations	137046	137046	122097	122097	93748	93748	57869	57869	19500	19500	3900	3900
R^2	.357	.361	.398	.398	.433	.433	.448	.448	.487	.487	.572	.572

This table presents estimated equations of the form,

$$\frac{I_{it}}{K_{i,t-1}} = \beta_1 \left[\frac{1-\tau_t z_{jt} - ITC_{jt}}{1-\tau_t}\right] + \beta_2 \left[NT_{it} \times \frac{1-\tau_t z_{jt} - ITC_{jt}}{1-\tau_t}\right] + \beta_3 NT_{it} + \beta_4 \left[\frac{\frac{\lambda_{it}}{p_t}}{1-\tau_t}\right] + \beta_5 \left[\frac{CashFlow_{it}}{K_{it}}\right] + \alpha_i + \phi_t + \epsilon_{it}.$$

Columns 1 and 2 include all Compustat firms with non-missing data in tax years 1967 to 2005. Columns 3 through 12 include only the n largest firms by assets in the sample in each year if the number of firms is larger than n, where n is specified in the column header. The response ratio line reports the ratio of the responsiveness of nontaxable firms to that of taxable firms. In the even-numbered columns (except 2), this is simply the ratio of the coefficients in the third and second rows. All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.
*** indicates statistical significance at the 1% level, ** at 5%, and * at 10%.

5 Results

Table 3 presents baseline regressions of I/K on the tax term, Q, and cash flows. In all regressions that follow, I include firm and year fixed effects and cluster standard errors at the firm level.[29] Results in Column 1 of Table 3 are very similar to those in Desai and Goolsbee [2004]. The coefficient on the tax term for equipment is statistically significant and economically important.

Columns 2 through 12 of Table 3 allow responses to the tax term to differ between taxable and nontaxable firms. Column 2 and the odd-numbered columns include the equipment tax term and its interaction with the dummy for nontaxable status, and thus the standard error on this interaction term can be used to test whether nontaxable firms respond differently to tax incentives than taxable firms. The other even-numbered columns include the tax term interacted with dummies for both taxable and nontaxable status, allowing one to test the hypotheses that tax responses in each group of firms are statistically different from zero.

Column 2 shows that responses of taxable and nontaxable firms are not statistically different in the full sample of firms. Columns 3 through 12 successively restrict the sample to include the largest 3500, 2500, 1500, 500, and 100 firms by assets in the sample in each year. Since the distribution of assets and investment across firms is highly skewed, responses at the top of the firm distribution will be most important in determining the response of aggregate investment. In recent years, the largest 2500 firms by prior-year assets have accounted for more than 95% of aggregate capital expenditures reported in Compustat, with the largest 500 firms accounting for almost 80% and the largest 100 firms for 50%.[30]

The Response Ratio line in the table displays the estimated ratio of the responsiveness of nontaxable firms to taxable firms. This ratio takes the values of .67, .48, .34, and .69 in the sample of the top 3500, 2500, 1500, and 500 largest firms, respectively. Estimates are most precise for the samples with larger numbers of firms. As the mean of these numbers is .55, I conclude that nontaxable firms are about 55% as responsive to tax incentives as fully taxable firms. Standard errors in the odd-numbered columns suggest taxable and nontaxable firm responses are statistically different from each other in the largest 3500, 2500, and 1500 firm samples.

It is worth noting that the magnitude of the coefficient estimates on the tax terms declines as the sample is restricted to larger and larger firms, suggesting that the effect of tax incentives may be least important in exactly those firms that matter most for aggregate investment. It is true, however, that the tax variables calculated at the industry level may be most poorly measured for large firms active in many industries. These large firms are also likely to make many investments in other countries, where the U.S. tax variables calculated here may not be the relevant ones.

[29] Standard errors rise when clustered by industry. I present results clustered by firm for comparability to the vast literature that also does so, notably Desai and Goolsbee [2004]. The paper's key conclusion—that taxable status has little impact on the effectiveness of investment incentives when cash flow interactions are also included—is not altered by this choice.

[30] The aggregate amount of capital expenditures reported by the sample of nonfinancial, US-incorporated firms used in this paper has in recent years been between one-third and one-half of aggregate private nonresidential fixed investment as reported by the Bureau of Economic Analysis in the National Income and Product Accounts. Note, however, that capital expenditures figures include expenditures by these firms made abroad.

Table 4: Regressions of investment to capital stock ratio on tax variables and controls, with cash-flow interactions

	Largest 3500	Largest 3500	Largest 3500	Largest 3500	Largest 2500	Largest 2500	Largest 2500	Largest 2500
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Equipment Tax Term (ETT)	-.663	-.609	-.507	-.224	-.524	-.497	-.380	-.031
	(.315)**	(.316)*	(.311)	(.314)	(.282)*	(.283)*	(.278)	(.282)
ETT × Nontaxable dummy	.222	.008	.215	-.091	.272	.072	.275	-.010
	(.091)**	(.098)	(.089)**	(.099)	(.086)***	(.095)	(.086)***	(.094)
ETT × CashFlow / PPE		-.294				-.471		
		(.078)***				(.107)***		
ETT × CashFlow / Assets				-2.396				-3.172
				(.459)***				(.508)***
CashFlow / PPE	.00004	.306			.021	.512		
	(.002)	(.082)***			(.004)***	(.112)***		
CashFlow / Assets			.296	2.782			.455	3.754
			(.021)***	(.478)***			(.027)***	(.529)***
Nontaxable dummy	-.316	-.094	-.286	.031	-.346	-.139	-.332	-.036
	(.094)***	(.102)	(.093)***	(.103)	(.089)***	(.099)	(.089)***	(.097)
Structures Tax Term	-.020	-.023	-.014	-.006	.019	.008	.037	.043
	(.044)	(.043)	(.043)	(.042)	(.036)	(.036)	(.034)	(.034)
Q / $(1-\tau)$	.050	.050	.049	.049	.052	.052	.047	.048
	(.002)***	(.002)***	(.002)***	(.002)***	(.002)***	(.002)***	(.002)***	(.002)***
Firms	13365	13365	13365	13365	9628	9628	9628	9628
Observations	122097	122097	122097	122097	93748	93748	93748	93748
R^2	.398	.399	.405	.406	.433	.435	.441	.442

Columns 1 through 4 include only the largest 3500 firms by prior-year assets in years when there are at least that many firms. Columns 5 through 8 include only the largest 2500 firms.
All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.
*** indicates statistical significance at the 1% level, ** at 5%, and * at 10%.

Altshuler and Auerbach [1990] calculate average values of γ^B and γ^F, the shadow values of carrybacks and carryforwards, from estimates of second-order transition probabilities among taxable status states in a panel of tax returns from 2,808 firms from 1971 to 1982. The range of estimated shadow values reported in their paper and the current statutory tax rate of 0.35 together imply a range of response ratios from 0.40 to 0.57. The estimated response ratios in Table 3 are centered around this range. Thus, the shadow values estimated by Altshuler and Auerbach imply response ratios broadly consistent with what I estimate from observed investment decisions.[31]

One could be concerned, however, that the observed asymmetry in responsiveness to tax incentives might not be driven by the shadow values of carrybacks and carryforwards, but by unrelated firm characteristics that are correlated with taxable status. In the model discussed above, for example, binding financing constraints could produce a lower sensitivity of investment to tax incentives. If nontaxable firms are more likely to face binding financing constraints, we could observe nontaxable firms responding less to tax incentives even if they ignore the shadow values of carrybacks and carryforwards. In this situation, the estimates above might still be relevant for forecasting short-run responses by nontaxable and taxable firms to changes in depreciation allowances. They would not be relevant, however, for predicting the effect of new policies that change the shadow values, such as changes in the carryback and carryforward periods.

Table 4 presents results suggesting that this concern is quite relevant. Results are presented only for the samples of the largest 3500 and largest 2500 firms in each year, for which an asymmetry between taxable and nontaxable firms seemed apparent in Table 3. Column 1 replicates Column 3 of Table 3, and Column 2 introduces an interaction between the cash flow to capital stock ratio and the equipment tax term, in addition to the interaction between the tax term and nontaxable status. The coefficient on the cash flow interaction is statistically significant at the one percent level, while the nontaxable status interaction term is close to zero and no longer significant at conventional levels. The point estimate of the response ratio of nontaxable to taxable firms in the sample of the 3500 largest firms rises from 0.67 in Table 3 to a bit above 1 in Table 4, suggesting that low cash flows in nontaxable firms drive their sluggish response to tax incentives more than nontaxable status itself. Columns 5 and 6 of Table 4 contain similar estimates for the sample of the 2500 largest firms. The point estimate of the response ratio in this sample rises from 0.48 in Table 3 to 0.86 in column 6 of Table 4, again suggesting that cash flows are more important than nontaxable status itself.[32] Columns 3 and 4 and 7 and 8 present specifications similar to those just described, but using total assets in place of the capital stock as a scaling variable for cash flows. Again, the nontaxable status interaction term becomes unimportant when cash flow interaction terms are introduced.

[31] Of course, the estimation sample in this paper includes data that extends beyond that available to Altshuler and Auerbach [1990], so the relevant transition probabilities may have changed. The Althsuler and Auerbach shadow values were also calculated under the 1982 tax rules, when the carryback period was three years and the carryforward period was fifteen years. In 1997, these numbers changed to two and twenty years, respectively. The decrease in the carryback period would tend to decrease the response ratio while an increase in the carryforward period would increase the ratio.

[32] This number is equal to $(-.524+.072)/-.524$, or the ratio of the responsiveness of nontaxable to taxable firms at the mean cash flow ratio.

5.1 Alternative Measures of Taxable Status

This paper has emphasized my careful attempt to construct measures of taxable status from the financial statement data available in Compustat. One might wonder, however, if other available measures of taxable status might perform better than those that I have constructed. Results in Table 5 test this proposition. Column 1 replicates column 6 of Table 4 where the nontaxable interaction term still had the correct sign in the presence of the cash flow interaction term.

Columns 2 through 6 supplement or replace the nontaxable dummy with other measures of tax status. Column 2 includes an interaction of my measure of a firm's stock of carryforwards (scaled by its capital stock) with the tax term. One might worry that firms that have deeper stocks of carryforwards might be less responsive to tax incentives in a way that is obscured by focusing only on the average responsiveness of nontaxable firms. The carryforward interaction term in column 2, however, is statistically insignificant, of the wrong sign, and economically small given historical variation in this variable. Thus, a more careful focus on carryforward amounts in place of the binary nontaxable variable does little to affect results.

Columns 3 and 4 replace the nontaxable dummy developed in this paper with variables based on the "Binary" and "Trichotomous" measures of taxable status suggested by Plesko [2003]. The Binary variable takes the value of one when a firm has both negative taxable income and a positive carryforward stock, and zero otherwise. The Trichotomous variable is similar, but takes the value of one-half when only one of these conditions is true. The estimated coefficients on interactions of the tax term with these variables are somewhat larger than that of the nontaxable dummy, but not close to statistical significance.

Column 5 replaces the nontaxable dummy with a variable based on the simulated marginal tax rate measure developed by Graham [1996] and provided to me by John Graham. This variable is calculated as $1 - \tau_{Graham}/\tau_{Statutory}$, so it takes the value of zero when the Graham tax rate is equal to the statutory tax rate and one if the Graham tax rate is zero. This variable is only available beginning in 1980 and is not available for all firms, so column 6 fills in missing values using the Plesko binary measure, which was found to be most highly correlated with the Graham tax rate in Plesko [2003].[33] The interaction coefficient in columns 5 and 6 are small and statistically insignificant.

Thus, using alternative measures of taxable status developed by other authors does not change the conclusion that taxable status has little apparent effect on firm responsiveness to tax incentives when controlling for cash flows. It is impossible to be certain that this conclusion is not driven by measurement error in the indicators of taxable status employed here. As actual taxable status is only observable on confidential tax returns, these measures must be computed from financial statement data, and some error is introduced in this process.[34]

[33] Graham and Mills [2008] provide coefficient estimates that could also be used to fill in missing values, but these were estimated over a period when the statutory tax rate was 0.35. Thus they are not useful for imputing tax rates prior to 1980.

[34] One might be particularly concerned about using financial statement data reported on a worldwide basis to measure taxable status for U.S. federal purposes. In fact, it seems most likely that any bias introduced by this practice would work against producing the results that I find. The cash flow variables used for estimation refer to worldwide cash flows. As investments made abroad need not face the same tax treatment as those made domestically, one might expect measured cash flows to have a smaller effect on the impact of U.S. tax incentives than if it were possible to isolate U.S. cash flows. My taxable status variable, however,

Table 5: Regressions of investment to capital stock ratio on tax variables and cash-flow interactions, with alternative calculations of tax status

	(1)	(2)	(3)	(4)	(5)	(6)
Equipment Tax Term (ETT)	-.497 (.283)*	-.485 (.285)*	-.466 (.283)*	-.492 (.281)*	-.851 (.521)	-.465 (.283)
ETT × Nontaxable dummy	.072 (.095)	.089 (.097)				
ETT × Plesko Binary			.117 (.138)			
ETT × Plesko Trichotomous				.158 (.120)		
ETT × Graham MTR					.038 (.118)	
ETT × Graham-Plesko MTR						.061 (.095)
ETT × CashFlow / PPE	-.471 (.107)***	-.469 (.106)***	-.473 (.108)***	-.453 (.110)***	-.443 (.161)***	-.451 (.108)***
ETT × Carryforwards / PPE		-.030 (.023)				
CashFlow / PPE	.512 (.112)***	.510 (.110)***	.514 (.112)***	.490 (.114)***	.483 (.169)***	.490 (.112)***
Carryforwards / PPE		.032 (.024)				
Nontaxable dummy	-.139 (.099)	-.156 (.100)				
Plesko Binary			-.203 (.144)			
Plesko Trichotomous				-.278 (.126)**		
Graham MTR					-.109 (.123)	
Graham-Plesko MTR						-.136 (.098)
Structures Tax Term	.008 (.036)	.004 (.036)	.010 (.035)	.022 (.035)	-.112 (.067)*	.024 (.036)
Q / $(1-\tau)$	.052 (.002)***	.052 (.002)***	.052 (.002)***	.051 (.002)***	.057 (.003)***	.052 (.002)***
Firms	9628	9541	9628	9628	7254	9628
Observations	93748	91771	93748	93748	49905	93748
R^2	.435	.44	.435	.438	.506	.436

All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.
*** indicates statistical significance at the 1% level, ** at 5%, and * at 10%.

Proponents of prior measures developed in the literature, however, have been able to compare their measures to actual tax returns. They claim that these measures do quite well in

is based on the information in the txfed63 variable, which refers only to U.S. federal taxes. It seems then that the use of worldwide financial data would be most likely to give the taxable status variable an unfair advantage relative to cash flows. My finding that cash flows are more important than taxable status is thus unlikely to be driven by the use of worldwide data.

measuring true taxable status (Plesko [2003], Graham and Mills [2008]). While measurement error cannot be completely ruled out, it thus seems unlikely to be driving results.

5.2 Investigating the Importance of Cash Flows

The finding that the effectiveness of tax incentives for investment may vary with firm cash flows is potentially quite important for understanding both the impact and incidence of these incentives. I briefly discuss three potential explanations for these results and present some simple regression results to distinguish among them. The model developed in this paper suggests that financing constraints could cause firms to be less responsive to tax incentives. This mitigation of incentives' effects would occur when firms are in a loss position and realize the cash benefits of tax incentives only in future years. But, it could also occur among taxable firms if cash benefits of tax incentives are realized only after investments have been made.

At least two other papers have also developed models of investment that could have the property of increased sensitivity to incentives when cash flows are high. Both are based on firms that face some fixed cost of adjusting their capital stock. In such a model, firms do not immediately make an investment upon receiving a positive productivity shock unless the shock is large enough that the benefits of investment overcome the fixed cost of adjustment. As firms receive more positive shocks, they get closer to the threshold at which they are willing to make an investment. They are thus more likely to be moved across the threshold by an additional shock—for example, an investment incentive. Caballero and Engel [1999] develop and estimate a generalized version of the simple (s, S) model just described, and they find that the sensitivity of investment to shocks is highly procyclical. That is, they find that investment incentives would be most effective during good times, when firm cash flows are also high. Note that this property is absent from the models that have dominated the public finance literature on investment, as can be seen, for example, in equation (7) above.

Bloom, Floetotto, and Jaimovich [2009] show how changes in uncertainty about future productivity could further affect firm responsiveness to investment incentives. In a model with fixed adjustment costs, an increase in uncertainty raises the threshold productivity level at which firms are willing to make further investments. An increase in uncertainty makes firms less likely to be on the margin of investment and thus less responsive to tax incentives. It is possible that the cash flow effects estimated thus far could actually be driven by uncertainty if cash flows are low when uncertainty is high.

Table 6 presents simple regressions that take a first pass at distinguishing among these hypotheses. All columns include the full sample of Compustat firms. Column 1 presents a baseline regression of the investment ratio on the tax term and its interaction with the cash flow ratio. Again, cash flows are estimated to have large and statistically significant effects on the impact of tax incentives.

Column 2 interacts the tax term with a measure of financial constraints developed by Lamont, Polk, and Saa-Requejo [2001], based on the work of Kaplan and Zingales [1997], and used by Baker, Stein, and Wurgler [2003] and others. This variable is decreasing in a firms' dividend payouts and cash holdings, and increasing in its leverage. Construction of this variable is detailed in the appendix. If financing constraints are driving the estimated coefficient on the cash flow interaction term, one would also expect this financing constraint variable to weaken the impact of investment incentives. That is, one would expect a positive

Table 6: Regressions of investment to capital stock ratio on tax variables and cash-flow interactions, exploring alternative explanations for the importance of cash flows

	(1)	(2)	(3)	(4)	(5)
Equipment Tax Term (ETT)	-.829	-.895	-.839	-.656	-.746
	(.327)**	(.327)***	(.328)**	(.331)**	(.332)**
ETT × CashFlow / PPE	-.250	-.245	-.250	-.260	-.257
	(.057)***	(.058)***	(.057)***	(.057)***	(.058)***
ETT × K-Z Constraint Index		.042			.020
		(.025)*			(.026)
ETT × B-F-J Uncertainty Index			.008		.012
			(.016)		(.016)
ETT × Q				-.063	-.061
				(.023)***	(.023)***
CashFlow / PPE	.253	.247	.252	.263	.259
	(.060)***	(.060)***	(.060)***	(.060)***	(.061)***
K-Z Constraint Index		-.061			-.039
		(.026)**			(.027)
Structures Tax Term	-.055	-.067	-.055	-.055	-.067
	(.046)	(.046)	(.046)	(.046)	(.046)
Q / $(1-\tau)$	.038	.037	.038	.104	.100
	(.001)***	(.001)***	(.001)***	(.024)***	(.025)***
Firms	14720	14424	14720	14720	14424
Observations	137046	135810	137046	137046	135810
R^2	.358	.36	.358	.358	.36

All specifications include firm and year fixed effects. Standard errors are clustered at the firm level.
*** indicates statistical significance at the 1% level, ** at 5%, and * at 10%.

coefficient on an interaction of the financing constraint variable with the equipment tax term. Indeed, the coefficient estimate in Column 2 is positive, although it is statistically significant only at the 10% level and its magnitude is small given the standard deviation of this variable in the data.

Column 3 interacts the tax term with an annual aggregate uncertainty index constructed in Bloom, Floetotto, and Jaimovich [2009] from various measures of uncertainty.[35] The estimated coefficient on this interaction term has the expected positive sign, but it is close to zero and statistically insignificant. Including it has little impact on the coefficient on the cash flow interaction when compared to results in column 1.

Column 4 interacts the tax term with the same measure of Q included separately in all previous regressions. The estimated coefficient on this term is negative and statistically significant, suggesting that indeed tax variables have more impact on investment when Q is high. In column 5, all three of the interaction terms just discussed terms are included together, and only this Q interaction term is statistically significant. Including this term has little impact, however, on the coefficient on the cash flow interaction, and its own coefficient is relatively small in magnitude. It is likely, though, that the magnitude of the Q interaction coefficient estimate is depressed by the same sort of measurement error that has long been

[35]These data were downloaded from `http://www.stanford.edu/~nbloom/index_files/Page315.htm`.

thought to attenuate the coefficients on Q terms in investment regressions.

In summary, these results are most supportive of a model with a fixed cost of adjustment where firms are most responsive to investment incentives after positive shocks have left them close to their threshold of adjustment. Both cash flows and Q could proxy for positive shocks, and, indeed, both are associated with an increase in the impact of tax variables on firm investment. Column 2 provides rather weak evidence that an alternative measure of financing constraints may also have some effect on the impact of tax variables. There is little evidence of any effect of the uncertainty index on the impact of taxes. Nonetheless, these tests are based on only one measure of financing constraints and one measure of uncertainty. There may well be times or situations where these factors do have important effects on investment and the effectiveness of tax incentives.[36] Further empirical research into variation over time in the impact of investment incentives would be very welcome.

5.3 Implications for the Effectiveness of Bonus Depreciation

Estimates presented thus far suggest that variation in cash flows is associated with considerable variation in the impact of tax incentives for investment. The within-firm standard deviation of the cash flow to capital stock ratio in the sample of the 2500 largest firms is 1.09, while the equivalent figure for cash flow to total assets ratio is 0.09.[37] The means are 0.31 and 0.09, respectively. Thus the results in column 8 of Table 4 suggest that a one standard deviation increase from the mean of cash flows to assets would change the derivative of the investment ratio with respect to the tax term from -0.65 to -1.16, an increase in magnitude of 80%. Using instead the cash flow to capital stock ratio estimates from column 4 produces a an increase of 76%. Thus it seems that variation in cash flows over time would be associated with very large differences in the responsiveness of individual firms to tax incentives.

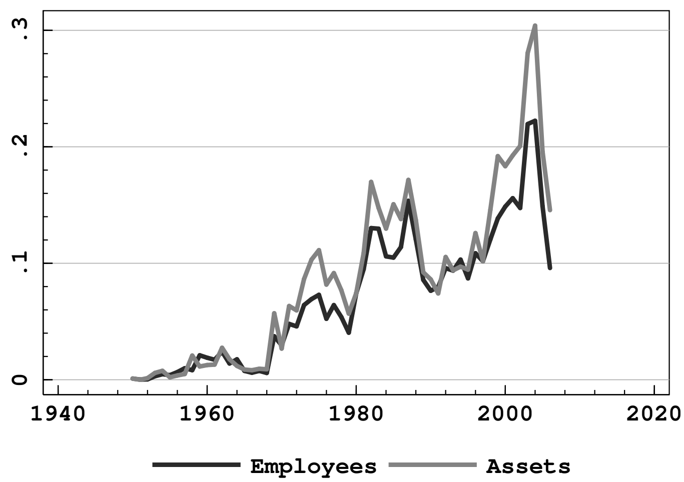
Figure 4 presents data useful in assessing the potential importance of taxable status and cash flows in mitigating the aggregate effectiveness of bonus depreciation. The top panel indicates that the fraction of aggregate assets owned by nontaxable firms peaked in 2003 and 2004 at around 0.3. If we use the Table 3 average estimate that nontaxable firms are 55% as responsive to tax incentives, we might conclude that bonus depreciation was about 14% less effective than it would have been had these firms been taxable. If instead we use the Table 4 column 6 estimate that nontaxable firms are 86% as responsive as taxable firms, we would conclude that bonus depreciation was about 4% less effective than it would have been had all firms been fully taxable. Thus it seems that taxable status alone can do relatively little to explain any lack of response to bonus depreciation.

The bottom panel of Figure 4 plots the aggregate ratio of cash flows to assets for all Compustat firms from 1950 to 2007. Restricting the sample to the largest 3500 or 2500 firms

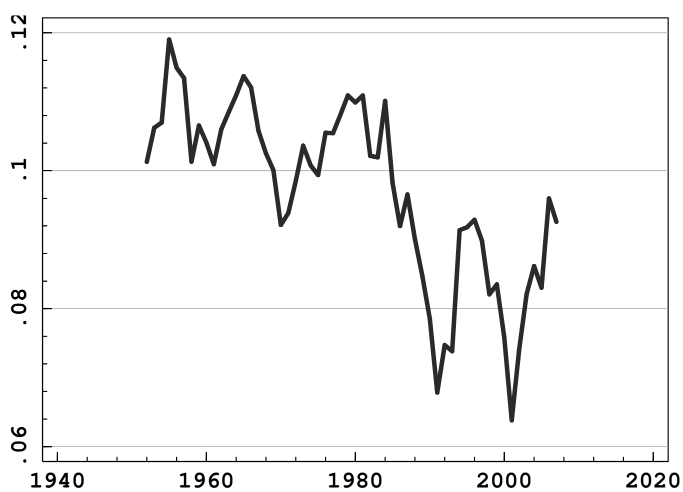
[36] Rauh [2006] and Faulkender and Petersen [2009], for example, have recently presented evidence supporting the claim that financing constraints can affect investment among particular subsets of firms. Of course, others have argued that financing constraints are unlikely to be important for investment in other subsets of firms (e.g. Kaplan and Zingales [1997]). Even if one did not believe that financing constraints are always and everywhere an important determinant of investment, one could believe that they might matter at some times for some firms, as the Rauh [2006] and Faulkender and Petersen [2009] results would suggest. I suggest that this is also likely to be true for the impact of financing constraints on the effectiveness of tax incentives.

[37] That is, the root mean squared error in a regression of the cash flow ratio on a set of firm fixed effects.

Figure 4: Nontaxable Firms and Cash Flows



(a) Fraction of Assets and Employees in Nontaxable Firms



(b) Aggregate Cash Flow / Assets

in each year produces a very similar figure, because income and assets are highly concentrated among the largest firms. The figure shows that the aggregate ratio averaged 0.11 from 1950 to 1985, before falling as low as 0.06 in 2001 and 0.08 in 2003. Applying the estimates in Table 4 column 8 to a drop in the cash flow to assets ratio from 0.11 to 0.06 suggests that the decline in the ratio of aggregate cash flows to assets could explain a 24% decrease in the sensitivity of investment to tax incentives. Applying the estimates in column 4 would imply a 19% decrease.

6 Conclusions

I have modeled and estimated how firms' responsiveness to tax incentives for investment can vary with their taxable status and cash flows. Implications of changes in taxable status for the aggregate effectiveness of recent bonus depreciation tax incentives are relatively modest. Estimates suggest that corporate tax asymmetries could have made bonus depreciation after the 2001 recession at most 4% less effective than it would have been if all firms were fully taxable. Declines in aggregate cash flows suggest that bonus depreciation was 24% less effective than it would have been if cash flow ratios had remained at their historical norms.

One cannot rule out, however, the possibility that difficulties in measuring firms' taxable status drive the relative unimportance of taxable status observed in the Compustat data. There are many differences between accounting rules for book and tax purposes that may lead to mismeasurement of taxable status and attenuate its importance in the results presented here. While other authors have found that proxy variables constructed from financial statement data can do quite well in measuring actual tax status, using tax return data where related variables are directly observable could add much to our understanding of the issues discussed in this paper.

Results have provided considerable evidence that firms are more responsive to tax incentives for investment when their cash flows are high. There is some evidence that this relationship could be driven by financing constraints, but a model based on fixed costs of adjustment receives more support from the data used here. This distinction may have important policy implications. For example, bonus depreciation in 2002 was accompanied by an extension of the carryback period, which could have made bonus depreciation more effective both by making more firms taxable and by alleviating financing constraints. If results in this paper are driven by fixed costs of adjustment and not by financing constraints, however, it is less likely that cash-flow-increasing policies like the carryback extension would provide much extra boost to bonus depreciation. In this case, one might be resigned to the rather pessimistic conclusion that attempts to stimulate investment would be relatively ineffective until business conditions improve and more firms are close to their thresholds of adjustment. A deeper understanding of the causes and consequences of business cycle variation in the impact of tax incentives would be a worthwhile goal for future research.

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A Data Construction

A.1 Consolidation Issues in Compustat

Compustat includes financial statements for many entities that are not appropriate entities for computing U.S. tax variables. I attempt to eliminate from the sample as many of these as possible. I drop all observations designated by Compustat as "pro forma" statements, which are primarily fictitious statements for entities created by merger, added retroactively to the dataset for years prior to the merger. I also drop all observations designated as "pre-SFAS #94" statements, which appear when firms reported one set of results under the new accounting rules in Statement of Financial Accounting Standards (SFAS) 94, and a separate set of results under the rules they used prior to the adoption of SFAS 94 in 1987.

Differences in consolidation rules for tax and financial reporting purposes mean that some financial statements that appear Compustat in do not correctly represent entities that file corporate income tax returns. I drop all statements from entities designated by Compustat as wholly-owned subsidiaries of other entities. I also drop all statements designated by Compustat as consolidated financial statements for groups who are not themselves publicly traded, but whose subsidiaries include two or more firms that are publicly traded. In case of wholly-owned subsidiaries, I always drop the appropriate entity, as wholly-owned subsidiaries do not file their own tax returns. Instead their income flows through to the consolidated tax return filed by their parent. In the case of nonpublic consolidated groups, I may sometimes drop the parent, when it would be more appropriate to drop the subsidiaries. Groups of corporations may file consolidated financial statements when 50% or more of each subsidiary is owned by the parent. However, a consolidated tax return may be filed only when 80% or more of each subisidiary is owned by the parent. By dropping parents instead of subsidiaries, I correctly handle cases where subsidiaries are 50% to 80% owned, but I may mishandle cases where subsidiaries are more than 80% owned. In this case, I act as if the subsidiaries each file a tax return, where in fact the parent files a single consolidated tax return.

Other firms whose status as a taxable entity might be misclassified include groups whose parent and subsidiaries are all publicly traded and whose parent files a consolidated financial statement. The parent and subsidiary entities will all appear in Compustat. When subsidiaries are 50% to 80% owned, I will correctly identify the subidiaries as taxpaying units, but I will incorrectly assume that the parent pays taxes on the income of its subsidiaries. When subsidiaries are more than 80% owned, I will correctly assume that the parent pays taxes on the income of subsidiaries, but I will incorrectly identify the subsidiaries as taxpaying units. There is no way to disentangle all of these relationships with the data available in Compustat. See Hanlon (2003) for more details on differences in consolidation for tax and financial reporting purposes.

A.2 The Alternative Minimum Tax

The corporate alternative minimum tax (AMT) presents a few surmountable complications for my analysis. AMT provisions require firms to compute an alternative measure of taxable income, from which fewer deductions are permitted. A 20% rate is then applied to this income, and fewer credits are allowed to offset the resulting tax liability. Notably, the depreciation allowances allowed under the AMT are less accelerated than under the regular tax, and the General Business Credit cannot offset AMT liability.[38] If the firm's AMT liability is larger than its regular income tax liability, it must pay the AMT amount. AMT payments are then carried forward as AMT credits, which can be used to offset regular income tax liability if the firm returns to regular income tax eligibility. Alternatively, there exists a parallel system of carrybacks and carryforwards of AMT NOLs, so if a firm makes an AMT payment in year t, and runs an AMT loss in year $t+1$, it can carry back the AMT loss and receive a refund on its prior AMT payment.

Firms that are "permanent" AMT payers fit well into the model developed in the text, as they operate entirely within this system of AMT NOL carrybacks and carryforwards, with the exception that they face a lower marginal rate when taxable and enjoy less accelerated depreciation. Firms that alternate between AMT eligibility and eligibility for the regular income tax are more problematic. When they make an AMT tax payment, they acquire a potential carryback of future AMT losses, as well as a credit carryforward against future regular tax liability. I do not capture any effects of the AMT credit carryforward. The text discusses my efforts to screen out small AMT payments by firms that would otherwise be nontaxable.

A.3 Construction of Other Variables

I follow prior literature in constructing the several financial and tax variables used in estimation. The dependent variable in all regressions is the investment to capital stock ratio easily observed in Compustat,

$$\frac{I_t}{K_{t-1}} = \frac{\text{capx128}_t}{\text{ppent8}_{t-1}},$$

the ratio of reported Capital Expenditure in the current year to Property, Plant, and Equipment, Net of Accumulated Depreciation, observed at the end of the prior year.

I follow Kaplan and Zingales [1997] in constructing a measure of Q, which is intended to proxy for the increase in the value of the firm's cash flows created by a marginal dollar of capital, or λ_t/p_t. Desai and Goolsbee [2004] show that this "corporate finance Q" performs better in investment regressions than the "public finance Q" constructed a bit differently by Salinger and Summers [1984] and Cummins, Hassett, and Hubbard [1994]. I construct,

$$Q_t = \frac{\text{prcc199}_t \times \text{csho25}_t + \text{at6}_t - \text{ceq60}_t - \text{txdb74}_t}{\text{at6}_t}.$$

In essence, this ratio is the market value of equity plus the book value of liabilities, excluding deferred taxes, divided by the book value of assets. This variable appears in regressions divided by $1-\tau_t$, for τ_t the current statutory tax rate, in accordance with the model presented in the text.

[38] Whereas the MACRS provides 200% double declining balance depreciation with an optimal switchover to straight line, only 150% double declining balance with the optimal switchover is allowed for AMT purposes. Special provisions in the JCWAA did allow bonus depreciation deductions from AMT income. For details on the corporate AMT, see IRS Form 4626 and its instructions.

Table 7: Descriptive Statistics

	All Firms Median (1)	All Firms Mean (2)	All Firms Std. Dev. (3)	Largest 2500 Median (4)	Largest 2500 Mean (5)	Largest 2500 Std. Dev. (6)
Investment / Capital Stock	.222	.350	.448	.218	.309	.344
Equipment Tax Term (ETT)	1.050	1.039	.044	1.049	1.039	.047
ETT × Nontaxable dummy	0	.330	.485	0	.204	.412
ETT × CashFlow / PPE	.278	-.252	3.694	.311	.325	1.710
ETT × Carryforwards / PPE	0	3.882	40.488	0	.421	8.922
ETT × CashFlow / Assets	.089	.023	.379	.101	.092	.130
ETT × Carryforwards / Assets	0	.365	2.549	0	.040	.264
ETT × Plesko Binary	0	.145	.361	0	.082	.281
ETT × Plesko Trichotomous	0	.299	.377	0	.213	.329
ETT × Graham MTR	.288	.493	.480	.050	.393	.465
ETT × Graham-Plesko MTR	0	.332	.462	0	.243	.416
ETT × K-Z Constraint Index	.442	.412	1.754	.484	.447	1.530
ETT × B-F-J Uncertainty Index	1.099	1.115	.220	1.105	1.135	.228
ETT × Q	2.299	3.346	3.268	2.187	2.852	2.175
CashFlow / PPE	.268	-.240	3.543	.299	.314	1.641
Carryforwards / PPE	0	3.730	38.961	0	.405	8.498
CashFlow / Assets	.086	.022	.364	.098	.089	.125
Carryforwards / Assets	0	.350	2.456	0	.038	.255
Nontaxable dummy	0	.322	.467	0	.197	.398
Plesko Binary	0	.140	.347	0	.079	.271
Plesko Trichotomous	0	.288	.362	0	.205	.316
Graham MTR	.279	.475	.462	.053	.380	.449
Graham-Plesko MTR	0	.320	.445	0	.234	.402
K-Z Constraint Index	.425	.397	1.684	.467	.431	1.467
B-F-J Uncertainty Index	1.046	1.075	.215	1.049	1.093	.221
Structures Tax Term	1.282	1.277	.109	1.285	1.284	.119
Q / $(1-\tau)$	2.214	3.216	3.131	2.109	2.734	2.044

The sample in columns 1 through 3 includes all observations available in Compustat. The sample in columns 4 through 6 includes only the largest 2500 firms by assets in years when there are at least that many firms.

I again follow Kaplan and Zingales [1997] in constructing a cash flow measure,

$$CashFlow_t = \frac{\text{ib18}_t + \text{dp14}_t}{\text{ppent8}_{t-1}}.$$

This ratio is Income Before Extraordinary Items plus Depreciation and Amortization, scaled by the capital stock at the beginning of the year. I also present results for a cash flow measure scaled by Total Assets, at6, rather than PPE. Following Desai and Goolsbee [2004] and others, I truncate the sample at the 1st and 99th percentiles of I/K, Q, and $CashFlow$. Table 7 contains descriptive statistics for the full sample of Compustat firms with nonmissing observations from tax years 1967 to 2005, along with the sample of the largest 2500 firms by prior-year assets in each year that is used in some estimation results.

The "K-Z Index" of financial constraints used in Table 6 is constructed as,

$$kz_{it} = -39.368 \times \frac{\text{dvp19}_{it} + \text{dvc21}_{it}}{\text{at6}_{i,t-1}} - 1.315 \times \frac{\text{che1}_{it}}{\text{at6}_{i,t-1}} + 3.139 \times \frac{\text{dltt142}_{it} + \text{dlc34}_{it}}{\text{dltt142}_{it} + \text{dlc34}_{it} + \text{seq144}_{it}}$$

The kz variable is winsorized at the 1st and 99th percentiles before being used in regressions. Note that Lamont, Polk, and Saa-Requejo [2001] and Baker, Stein, and Wurgler [2003] also sometimes include terms involving cash flows and Q in this sum, but I exclude these variables because they enter the regressions separately.

B Accounting Changes and the Ratio of Losses to Profits

In June 2001, the Financial Accounting Standards Board issued its Statement No. 142, which changed the way that firms accounted for goodwill. Prior to FAS 142, acquiring firms would recognize an amount of goodwill on their balance sheet essentially equal to the difference between the purchase price of an acquired firm and the value at which the acquirer would carry the acquired firms' assets on the acquirer's balance sheet. This goodwill would then be slowly amortized (depreciated) over time.

FAS 142 instead required that firms conduct an initial and then annual review of the value of their goodwill to determine whether changing market conditions had "impaired" its value. Many firms conducting such impairment reviews in 2001 and 2002 discovered significant impairments to the goodwill that they had acquired by purchasing firms during the dotcom boom. Many of these firms recorded these impairment charges as "Special Items," which appear on the income statement as deducted from Earnings Before Interest and Taxes in the calculation of Pre-tax Income. Other firms recorded these impairments as "Extraordinary Items," which appear on the income statement after the subtraction of taxes in the calculation of Net Income. Firms report and Compustat records the component of Special Items accounted for by goodwill impairment as a separate variable, although the breakdown of Special Items has only appeared in Compustat since the late 1990s. Compustat also includes a measure of the component of Extraordinary Items attributable to accounting changes, of which goodwill impairment is one example.

Figure 5 displays the aggregates across all Compustat firms of Special Items, Goodwill Impairments, Other Write-downs, Extraordinary Items, and Accounting Changes. Extraordinary Items and Accounting Changes move almost one-for-one, suggesting that the vast majority of the \$247 billion in extraordinary items booked in 2002 is explained primarily by the goodwill accounting change. The Goodwill Impairments item, however, is considerably smaller than Special Items. About \$348 billion in Special Items were booked in 2001, but only \$102 billion of this was recorded by Compustat as related to goodwill impairments. An additional \$120 billion was related to non-cash write-downs of other assets. The majority of the remainder of the deductions recorded as Special Items relate to cash restructuring costs like employee severance and facility shutdowns.

Figure 6 displays Compustat aggregate ratios of the negative income earned by firms with negative income to positive income earned by firms with positive income for several different

Figure 5: Compustat Aggregate Special and Extraordinary Items

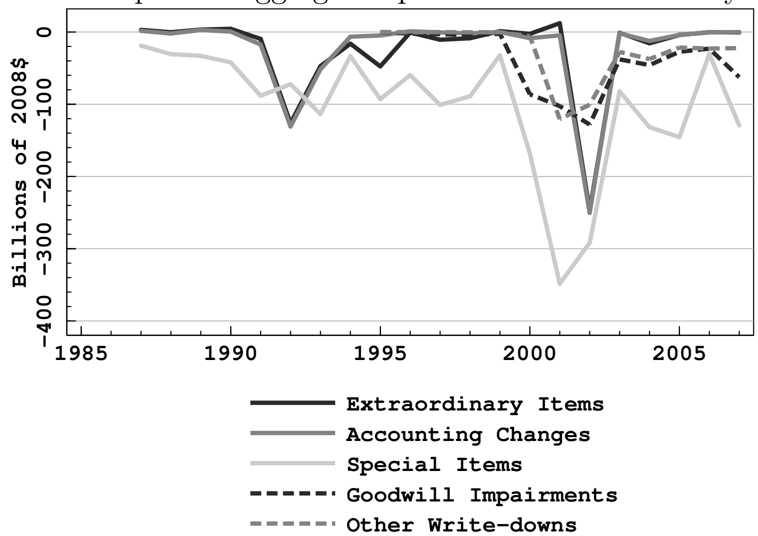
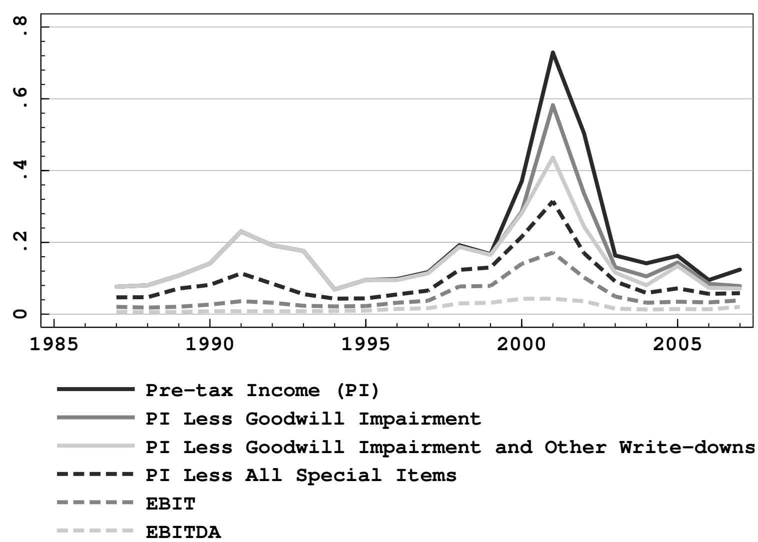


Figure 6: Compustat Aggregate Ratio of Losses to Positive Profits for Different Measures of Income



measures of income. The treatment of Goodwill Impairment and Other Write-downs indeed makes a material difference to this ratio, although even income measures that exclude these items still achieve historical highs around 2001. The middle measure—book pre-tax income, with non-cash charges for goodwill and other asset impairments added back in—seems the most appropriate to compare to similar ratios constructed from IRS data on taxable income. Series constructed in this way appear in Figures 1 and 2 in the text.