# CORPORATE TAX AVOIDANCE AND THE EFFECTIVENESS OF INVESTMENT TAX INCENTIVES

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Abstract

Clarifying the relationship between corporate tax avoidance activity and the incentive to invest is particularly important because, by most accounts, corporate tax avoidance has grown in recent years and may have contributed to the prevalence of companies in tax-loss situations. Although most analyses of corporate tax avoidance and the impact of taxation on investment have proceeded on separate tracks, the two issues are inter-related. In particular, successful tax avoidance may undermine the effectiveness of tax incentives designed to encourage investment. In this paper, we develop an integrated theoretical approach to the relationship between tax avoidance and how taxes affect the attractiveness of business investment. We then make use of panel data from corporate financial statements as reported in the Compustat database to empirically investigate the relationship by focusing on the impact of an investment incentive known as bonus depreciation that was passed into law in 2002 at the apparent height of the corporate tax-sheltering phenomenon, and expanded and extended in 2003.

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**Corporate Tax Avoidance and the Effectiveness of Investment Tax Incentives**

**Joel Slemrod, Estelle Dauchy, and Claudia Martinez**

## 1. Introduction and Motivation

Clarifying the relationship between corporate tax avoidance activity and the incentive to invest is particularly important because, by most accounts, corporate tax sheltering has grown in recent years and may have contributed to the prevalence of companies in tax-loss situations. Although most analyses of corporate tax avoidance and the impact of taxation on investment have proceeded on separate tracks, the two issues are inter-related. If tax avoidance is purely inframarginal and does not increase the probability that a corporation will enter a loss situation, then avoidance should have no price effect on the investment decision, and matter only to the extent that after-tax cash flow matters. In this case it is a windfall to companies with the inclination and opportunity to push the avoidance envelope. If, though, avoidance activity is not inframarginal, it may reduce the effective marginal tax rate on new investment, and therefore is complementary to the incentive to invest. It is, in effect, a "do-it-yourself" investment incentive. In other cases, however, such as when the avoidance increases the likelihood that a corporation will be in a tax-loss situation, tax avoidance may be a substitute for investment, and crowd it out. In this case, the availability of tax avoidance opportunities stifles investment and may render ineffective tax measures designed to stimulate investment.

A related but separate question is how the existence of tax avoidance changes the effectiveness of tax incentives for investment. Tax avoidance can undermine the effectiveness of tax incentives to invest via several avenues. First, avoidance may dampen the impact of any given statutory rate, and thus reduce the importance of any given proportional reduction in that rate. Shelters decrease the effective tax rate, and therefore reduce the ability to affect investment through tax reductions. Second, avoidance may increase the probability that corporations will be in a loss situation, rendering tax incentives less likely to be effective in increasing investment.

In this paper after providing some background information on corporate tax avoidance, we develop an integrated theoretical approach to the relationship between the tax incentive to investment and tax avoidance. We then empirically investigate the interrelationship between corporate tax avoidance and the effectiveness of investment tax incentives by focusing on the impact of an investment incentive, known as bonus depreciation, which was passed into law in 2002 at the apparent height of the corporate tax-sheltering phenomenon, and expanded and extended in 2003. We make use of panel data from corporate financial statements as reported in Compustat.

We find that the reaction of corporate investment to the bonus depreciation provisions is consistent with the notion that corporate tax avoidance reduces the effectiveness of tax incentives to invest.

## 2. Corporate Tax Noncompliance and Sheltering

### 2.1 Corporate Tax Noncompliance

Due to the nature of tax noncompliance, getting a handle on its magnitude is not easy. What we do know is based on the Internal Revenue Service (IRS) Tax Compliance Measurement Program, or TCMP, that featured intensive examinations of a random sample of tax returns filed for tax years from the early 1970's until 1988; the corporate tax gap measures are primarily based on TCMP studies done in 1977, 1980 and 1983 and on routine operational audits from the mid-1980's. By comparing these examined returns with the original returns as filed, supplemented by other evidence, the IRS estimated the total amount of underreported income and overstated subtractions in each of these years (and projections for later years) and the total loss of tax revenue--the "tax gap."

The estimates for the corporation income tax gap come from three sources. For small corporations the IRS used TCMP data, adjusted for underreporting unlikely to be detected by the TCMP. For medium-sized corporations, the gap was calculated by estimating, based on operational (i.e., non-TCMP) audits, how much tax revenue would have been generated if the IRS examined all these corporations' tax returns. Finally, for large corporations, because the IRS routinely examines a high percentage of these companies, examination results were used as the basis of estimates of the tax gap.[1] The IRS has made tax gap estimates for tax year 2001, but not later, based on a rough projection from the 15- to 20-year-old TCMP and other data, assuming that the compliance rates for each major component have not changed in the past two decades.[2] Corporate underreporting in 2001 is estimated at $29.9 billion, of which corporations with over $10 million in assets make up $25.0 billion.[3] As a benchmark for comparison, estimated individual underreporting in 2001 is $148.8 billion. Compared to estimated 2001 tax year receipts paid voluntarily and in a timely fashion of $142.4 billion and $930.1 billion for corporate and individual income tax collections, respectively, the underreporting rate (calculated as underreported tax divided by receipts plus underreported tax) is 17.4 percent and 13.8 percent for corporations and individuals, respectively.

[1] This description is based on U.S. General Accounting Office (1988). One potentially important problem with these data is that the examination reports do not distinguish between adjustments that change the *timing* of tax liability and adjustments that change the liability in a way that will not be offset in future years. For this reason it is difficult to know the present value of the recommended adjustments from IRS examinations.
[2] The tax gap numbers are drawn from Internal Revenue Service (2004a).
[3] Underreporting is only one of the three components of the total tax gap, which is estimated to be $282.5 billion. The other two components are nonfiling and underpayment. There is no estimate for corporate nonfiling, and underpayment is a quite different issue.

The Bureau of Economic Analysis (BEA) calculates an annual measure of corporate misreporting, in order to adjust the National Income and Product Accounts (NIPA) measure of corporate profits, which is based on data from corporate tax returns as filed.[4] The BEA estimate for corporations reporting a positive profit is based on actual tax settlements--the change in income recommended by the IRS examination team reduced by the overall ratio of actual settlements to recommendations.[5] For loss companies, the adjustment is calculated by multiplying total losses by an estimate of the percentage by which losses are reduced during audit. Table 1 shows the NIPA estimates of corporate tax misreporting since 1988, in total dollars and as a percentage of misreporting plus total receipts minus deductions, the tax-return-based measure that the BEA procedures begin from. This ratio was 13.8 percent in 2000, compared to the 17.4 percent figure based on the IRS methodology that extrapolates from two-decades-old data assuming no change in compliance rates. This series shows an increase in the misreporting rate since the mid-1990's, but puts the 2000 misreporting rate below the rates of the 1989 through 1992 period. The complete series (that begins in 1929) shows that this ratio never reached 10 percent until 1981, and peaked in 1983 at 17.9 percent.

## 2.2. Abusive Corporate Tax Shelters

For conceptual reasons it is impossible to measure how much corporate tax avoidance—legal actions taken to reduce tax liability--is going on. If avoidance is *anything* that corporations do to reduce their tax liability, it could include such activities as purchasing tax-exempt bonds, which is certainly legal, not at all nefarious, but also certainly done purely for tax reasons.

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[4] The BEA methodology is discussed in Petrick (2002, p. 7).

[5] In contrast, the IRS tax gap measures are based on the recommendations of the return audit, unadjusted for how much tax was ultimately assessed after any appeals process. See Slemrod (2004) for details about the differences in methodologies.

[7] U.S. General Accounting Office (2003, p. 1). The word "unintended" refers to the intentions of the legislators, not the promoters or taxpayers.

Recent attention has focused on so-called “abusive” tax transactions, including shelters. The General Accounting Office defines abusive shelters to be “very complicated transactions promoted by corporations and wealthy individuals to exploit tax loopholes and provide large, unintended tax benefits.”[7] This is as good a definition as any, but it clearly is not a precise definition. Recently an IRS contractor estimated the tax revenue loss from abusive tax shelters in 1999 to be between $14.5 and $18.4 billion, 50 percent higher than in 1993.[8] This estimate was based on IRS’s Statistics of Income data for the largest U.S. companies, Compustat financial data, and surveys of IRS field offices. Other estimates based on familiarity with the industry, but not quantitative analysis, have been in the same ballpark.[9] Extrapolating these estimates to 2001 suggests that abusive tax shelter may equal more than half of the total corporate tax gap.

There is also indirect evidence that tax shelters cost the government a large and growing amount of revenue. Several studies have documented a large and growing gap between the book income reported on public corporations’ financial statements and the tax income of corporations, which remains even after eliminating what arises from known differences in the accounting procedures used for book and tax income.[10] As the authors of these studies admit, even the adjusted difference might have nothing at all to do with either evasion or abusive tax shelters. But as of yet there is no better explanation.

[8] U.S. General Accounting Office (2003, p. 13). Several caveats to the estimates are presented there, including the warning that “Both IRS and contractor officials believe the …results are more useful to predict returns with abusive shelters than they are to value the size of the abusive shelter problem.” (p. 13)

[9] The most widely cited of such estimates is Bankman (1999), who estimated the annual revenue loss from abusive tax shelters at $10 billion. Bankman (2004) mistakenly refers to Slemrod (2004) as the source of this estimate.

[10] See U.S. Department of the Treasury (1999), Desai (2003), Manzon and Plesko (2002), and Mills, Newberry, and Trautman (2002).

## 3. An Integrated Theoretical Model

As long as there are diminishing returns to capital, the demand for capital is inversely related to the user cost. If there were no cost to changing (increasing or decreasing) a firm's capital stock, then we would expect net investment—the change in net capital--to fluctuate widely as user costs (or other conditions) change. In the seminal treatment in Jorgenson (1963) the user cost of capital determines the equilibrium stock of capital and firms gradually approach this desired stock over time with a constant rate of closing the gap between the desired stock and the existing stock. The relationship among the user cost of capital, the demand for capital, and the demand for investment was later formalized in dynamic models of firms maximizing their net present value in an environment where there are convex costs to changes in their production technologies. In these models the first-order conditions for capital at a given point of time take the form of a user-cost formulation. The first-order condition for investment has a very simple structure: at an optimal level of investment, the gain from investment (an extra unit of capital) is equal to the shadow price of capital, must equal the total marginal cost of making an investment, which includes the tax-benefit-adjusted price of purchasing the capital good plus the marginal adjustment cost of making the investment. Even for a price-taking firm, convex adjustment costs pin down the optimal amount of investment in a given period.

Our contribution in this paper is not to the dynamic specification of the business investment decision, but rather to an understanding of how tax avoidance affects the tax system's impact on the incentive to invest. To focus on this, we present a simple rental cost of capital model of the optimal capital stock.

### 3.1 The Avoidance-Facilitating Character of Income

We consider the connection between investment and tax avoidance in a rental cost of capital framework that draws on Slemrod (2001). Consider a firm that must choose its capital stock, K, and the amount of sheltering, A, in order to maximize its after-tax profits given by

$$(2)\quad F(K) - dK - rK - t(F(K) - dK - A - C(F(K)\text{-}dK, A)) - C(F(K)\text{-}dK, A).$$

Here F(K) is output, d is the (assumed exponential) rate of true economic depreciation, d is the (exponential) rate of depreciation allowed by the income tax system, r is the opportunity cost of funds, and t is the statutory tax rate imposed on taxable profits. A is the amount of avoidance the company undertakes, at a (tax-deductible) cost of C. Because the opportunity cost of funds is presumed to not be deductible, the setup implicitly assumes equity financing. Note that there must be a cost to the company of avoidance, or else it would always zero out (or, in this simple model, receive refunds for a negative taxable income) its tax liability. The cost of avoidance includes expenditures made to camouflage the behavior so as to escape IRS attention, as well as the expected costs of audit and appeal and any subsequent penalties levied by the IRS. It is crucial that the cost of avoidance may depend not only on the amount of avoidance, but also on the level of pre-tax net income. The idea is that a given level of avoidance is less costly to achieve if it is small relative to true income. Thus, it is natural to expect that $C_A > 0$, $C_F < 0$, $C_{AF} > 0$, $C_{FF} > 0$, and $C_{AA} > 0$, where, for example, $C_F$ is the derivative of C with respect to F(K)-dK.

The first-order conditions for K and A, respectively, are:

(3) K: $F'(K)=[(d+r)- td- dC_F(1- t)]/[(1- t)(1-C_F)]$

(4) A: $t = C_A(1- t)$

Note that when tax and economic depreciation are equal (d=d), the first-order condition for K becomes $F' - \delta = \frac{r}{(1-\tau)(1-C_F)}$. As long as $C_F$ is negative--earning more net income lowers the cost of sheltering a given amount of taxable income—this extra term lowers the true cost of capital for investment, exactly as the statutory tax rate does. In this case the availability of tax avoidance opportunities is equivalent to a "do-it-yourself" reduction in the marginal effective tax rate of investment, what Slemrod (2001) calls an "avoidance-facilitation" effect.

An example of the sheltering cost function is instructive. Let $C = c(F\text{-}dk)^{-g}A^{1+g}$, where c>0 and g>0. Note that this satisfies $C_A > 0$, $C_F < 0$, $C_{AF} > 0$, $C_{FF} > 0$, and $C_{AA} > 0$. In the case where d=d, the first-order condition for K can be rewritten as

(5) $$F' - \delta = \frac{r}{(1-\tau)\left(1+gc\left(\frac{A}{F}\right)\right)}$$

In this case, the reduction in the effective marginal rate of tax is simply related to (A/F), the proportion of net income sheltered: the more the avoidance, the lower the cost of capital. An exogenous decrease in c increases A/F, which in turn reduces the effective tax rate on investment.

In this model investment incentives that work through accelerated depreciation are represented by increases in the value of d. The effect of d on the equilibrium value of F' (?F'/?d), the hurdle rate for new capital investment, is $-t/(1\text{-}t)(1\text{-}C_F)$, so that $C_F$ (<0) reduces the effectiveness of investment incentives. With the Cobb-Douglas cost-of-avoidance function described above, the reduction in the effectiveness is proportional to A/F. Thus, the model predicts that the bonus depreciation provisions will be less effective at inducing investment for firms with a lower average tax rate.

### 3.2 Losses

The previous analysis assumed that the statutory rate of tax is constant. Although this assumption ignores the graduated nature of the corporation income tax, because the lower rates of tax apply only to the first $75,000 of taxable income this is not an important consideration for the large corporations that are the focus of our study. A much more important issue is that the U.S. corporate tax system does not provide a symmetric treatment of losses (i.e., it does not provide immediate payment for t times the loss). It is especially important because according to GAO (2004) between 1996 and 2000 63 percent of all U.S.-owned corporations, and 45 percent of all large[12] U.S.-owned corporations reported no tax liability, presumably because they had current-year operating losses for tax purposes, losses carried forward from preceding tax years, sufficient tax credits to offset tax liabilities, or one of many tax avoidance methods.

The corporate tax system does allow for a limited carryback and carryforward of losses. A company that has a net operating loss can carry the loss back against tax payments to the two years preceding the loss. Companies that have exhausted their carrybacks may carry unused losses forward (without interest) to offset gains for a maximum of 20 years; after that, the loss carryforward expires and can no longer be used to reduce tax liability.[13]

A company with a tax loss in a given year pays no tax in that year, but may receive a refund if it can carry the loss back against tax payments made in the previous two years. For current-loss companies in this position at the margin, bonus depreciation makes new investment

[12] To be classified as large a corporation must have at least $250 million in assets or $50 million in gross receipts.
[13] The rules about carrybacks and carryforwards have changed a number of times in the last three decades.

more attractive than otherwise. If, however, a current-loss company does not have income in the previous two years against which to carry back its losses, the additional accrued depreciation allowances do not reduce taxable income currently, and will reduce the present value of tax liability only to the extent that it expects to make use of its loss carryforwards to offset future income.

Thus, if tax avoidance makes being in a tax-loss position more likely, they generally prevent companies from taking full advantage of the increased incentive to invest otherwise provided by bonus depreciation. This is always true if it puts firms into a loss position with no carrybacks possible. One can imagine situations where avoidance makes bonus depreciation more effective, for example if a firm is currently in a taxable position but avoidance makes it more likely to be in a loss position later when the gross investment returns exceed the depreciation allowances. We expect that the former situation is much more prevalent, however.

Companies that are unable because of their tax situation might find it attractive to lease their capital from other firms, possibly firms that specialize in leasing, that are able to take full advantage of the accelerated depreciation. This will mitigate the impact of the capital-using firms' effective tax rate on their use of capital.

## 4. Previous Empirical Research

Empirical analysis of the determinants of business fixed investment has a long history. In their review of tax policy and business investment, Hassett and Hubbard (2002) discuss how aggregate analysis based on simple neoclassical models in the spirit of Jorgenson (1963) failed to explain investment fluctuations, and that models based on "Q theory" of Abel (1980) and Hayashi (1982) that incorporated explicit costs of adjusting the capital stock and made use of the market value of firms as an indicator of the user cost of capital also proved very disappointing.

They conclude that the tendency for a number of aggregate variables to move together over the business cycle makes it inherently difficult to isolate the effects of individual fundamentals in investment using time-series data. More recent attempts to identify the impact of tax policy on business fixed investment has instead focused on across-asset and across-firm studies that span tax reforms that provide truly exogenous changes in the user cost of capital.

### 4.1. Cross-Asset Analyses

Tax changes provide an exogenous variation in the incentive to invest.[14] Moreover, major tax changes may provide significant exogenous *cross-sectional* variation across capital assets in the user cost of capital or tax-adjusted q. This was certainly true about the Tax Reform Act of 1986, and several studies (Auerbach and Hassett (1991) and Cummins, Hassett, and Hubbard (1994, 1995) have tried to exploit this. Auerbach and Hassett (1991) and Cummins, Hassett, and Hubbard (1995) used vector autoregressions to forecast the investment-to-capital ratio in the year following tax reform, and then compare the forecast errors for each asset to the tax-reform-relate changes in the user cost for each asset. Both found that the forecast errors for investment by asset as negatively correlated with changes in the user cost.

Note that since these approaches are across assets, they may reflect asset substitution, so that even though the mix of assets responds to tax-induced changes in the relative attractiveness of assets, this may not necessarily suggest that tax changes cause significant changes in aggregate investment.

Auerbach and Hassett (1991) estimate reduced-form equations to explain (total, not just corporate) investment aggregated by asset and industry over the pre-tax-change period (in their

[14] Although, note that the timing of investment tax incentives is not likely to be random, being more likely to be enacted in periods of sluggish aggregate investment.

example, pre-1986), leaving out tax variables as explanatory variables.[15] Using those equations they form predictions for asset-industry investment aggregates, and relate the post-tax-change residuals from these predictions to the post-tax-change residuals in tax incentives. The tax wedge residuals come from an equation estimated over the same period using the same regressors as in the investment equation.[16]

Cummins, Hassett, and Hubbard (1994) examine investment patterns for each of 22 classes of equipment and 14 classes of structure. For each of four major tax reforms (1962, 1971, 1981, and 1986), they plot autoregressive forecast errors for each of the disaggregated investment series against a forecast error for a user cost variable, and assert that the figures illustrate a negative correlation, but do not compute a correlation coefficient or a confidence interval.

House and Shapiro (2004) examine quarterly data on investment by 37 capital goods. In a first stage they estimate for each capital good a forecasting equation that includes current and once-lagged values of investment, the relative price of the capital good, current and once-lagged values of aggregate indicators real GDP and real corporate earnings, a linear and quadratic time trend. They use data up to 2001:4 to form forecasts for 2002:1 through 2004:1, calculate the forecast errors of this equation, and then regress these forecast errors against the tax depreciation rates and a dummy variable for capital goods that did not receive bonus depreciation because they have service lives greater than 20 years. House and Shapiro (2004) find that the estimated coefficient on the dummy variable for not receiving bonus depreciation is negative and

[15] They have 36 asset classes, and a breakdown by equipment and structures only for 12 (or 14) separate industries, which they aggregate into 7 categories.
[16] Auerbach and Hassett (1991) investigate one specification which includes a variable meant to measure the ratio of tax payments to capital for each asset, smoothed for fluctuations in profitability, designed to capture the reduction in cash flow associated with tax payments in a particular year. It ends up having a coefficient that is insignificant and has the wrong sign (i.e., negative) if it measured a cash-flow effect.

significant after 2002:2. Furthermore, among the capital goods that are eligible for bonus depreciation, the negative relationship between the tax rate of depreciation and the investment residuals appears. Both relationships get stronger as time moves forward from 2002:2.

Desai and Goolsbee (2004) examine evidence across assets, industries, and firms to estimate a tax-adjusted *q* model. They conclude that, although tax policy does exert strong effects on investment, the bonus depreciation provisions changed the user cost only slightly, resulting in an increase in investment of only 1 to 2 percent.

### 4.2. Cross-firm Analyses

Cummins, Hassett, and Hubbard (1994) use a two-step approach to estimate the impact of tax changes on investment using firm-by-firm data from Compustat. In the first step, they estimate regressions to construct the deviation of investment from what it would have been without the exogenous shock to the structural variable and the deviation of the tax variable from what was expected. They characterize this approach as a "difference from own means" estimator, where individual means are replaced by individual conditional expectations. As they note, if one uses only a constant term in the first-stage projection, then the estimator is a difference-in-own-means estimator; the substitution of firm-specific conditional expectations for firm means adds power because firm means may be a poor measure of what investment would have been had there been no tax change. In the construction of the user cost, the authors assume that firms face the statutory tax parameters, thus ignoring the implications of tax-loss carryforwards, the alternative minimum tax, and other tax details. They find that subsequent to every major business tax reform from 1962 to 1988, the cross-sectional pattern of investment changed significantly, with investment spending in those firms facing the greatest change in tax incentives responding the most.

Chirinko, Fazzari, and Meyer (1999) use observations on 26,000 firm-years from 1981 to 1991, merging user cost variables defined at the industry level with Compustat firm-level data. They conclude that the user-cost elasticity of business investment spending is -0.25, much lower than earlier studies, and identify a number of econometric biases that affected earlier estimates.

## 5. The Natural Experiment: Bonus Depreciation

In an attempt to spur business investment, the Job Creation and Worker Assistance Act, passed on March 11, 2002 created a 30 percent first-year "bonus depreciation" allowance. In effect, businesses could write off immediately 30 percent of the cost of an eligible capital good, reducing the depreciable basis of the property to reflect the additional first-year depreciation deduction. The provision applied retroactively to certain business property acquired after September 11, 2001 and applied to assets purchased before September 11, 2004, and placed in service before January 1, 2005. Taxpayers who had already filed their 2001 returns before this new provision was passed could take advantage of the bonus depreciation provision by filing an amended return. On May 28, 2003 it was increased to 50 percent and extended to December 31, 2004. The bonus depreciation was allowed for both regular and alternative minimum tax purposes for the tax year in which the property was placed in service. Eligible property for this special treatment included property with a recovery period (life) of 20 years or less, water utility property, certain computer software, and qualified leasehold improvements.

As an example, consider the purchase in 2002 of equipment for use in a business costing $100,000 and assume, for expositional purposes, that absent bonus depreciation that one-fifth of the cost of the asset can be written off over the five-year tax life of the asset. Under the 2002 bonus depreciation special provision, the taxpayer would be able to deduct $30,000 of additional first-year depreciation for 2002. The regular depreciation for the equipment would be $14,000 ($70,000 x 0.2) providing a total first-year write-off of $44,000. In the second through fifth years, the depreciation allowance would be $11,200 ($56,000 x 0.2), instead of $20,000 per year in the absence of the bonus depreciation.

Several aspects of the bonus depreciation provision are worth noting. First, it generally applied only to capital goods that have a recovery period of 20 years or less, so that it excluded both nonresidential real property and residential rental property. Second, among qualifying property, the present value of the provision was, putting aside the possibility of taxable losses, greater for capital goods with longer depreciable lives: for longer-lived goods, the offsetting decreases in depreciation allowances from the second year onward occur farther into the future, and thus have a lower present value. Finally, because the bonus depreciation provision explicitly expired (although the deadline was later extended), there was an incentive to move forward investment that might otherwise have been made after the deadline; this would be reflected in a lower cost of capital due to the expected capital gain on the capital goods purchased while the provision lasted.

## 6. Empirical Strategy

Our strategy is to explain variations in corporations' investment/capital ratios in 2002 and 2003, relative to a forecast of their investment based on data up to 2001. The basic econometric specification is to examine the determinants of the forecast error, call it E, as a function of ? c, where ? c is the tax-induced percentage change in the cost of capital of new investment due to the bonus depreciation provisions. The model of Section 2 motivates how ? c depends on non-standard variables such as indicators of the extent of tax avoidance.

To generate E, we first estimate the following relationship separately for each nonfinancial corporation in Compustat for which data exists for at least ten consecutive years prior to 2001 or 2000, depending on the fiscal year end of the corporation.[17] The purpose of these estimations is to compute the forecast values of investment-capital ratio had the bonus depreciation not been implemented. In particular we estimate

$$(10)\quad \frac{I_{i,t}}{K_{i,t-1}} = \alpha_0 + \alpha_1 \frac{I_{i,t-1}}{K_{i,t-2}} + \alpha_2 \text{Unemployment}_t + \alpha_3 \text{time trend} + u_t .$$

We then compute the forecast investment-capital ratio for 2001, 2002 and 2003, which we denote $\hat{f}_{i,2001}$, $\hat{f}_{i,2002}$ and $\hat{f}_{i,2003}$. Note that to calculate the 2003 forecast we use the predicted, not the actual, 2002 value. We then compute $E_{i,2001}$ as the difference between $(I/K)_{i,2001}$ and $\hat{f}_{i,2001}$, $E_{i,2002}$ as the difference between $(I/K)_{i,2002}$ and $\hat{f}_{i,2002}$, and $E_{2003}$ as the difference between $(I/K)_{i,2003}$ and $\hat{f}_{i,2003}$.

In the second and final stage we estimate equations of the following form:

$$(11)\quad E_t = \beta_0 + \beta_1 \Delta c + \beta_2 \Delta c * ATR + \beta_3 ATR + u$$

where ? c is the bonus-depreciation-induced percentage change in the cost of capital and ATR is a measure of the company's average tax rate.

We expect $(\beta_1 + \beta_2 ATR) < 0$ because the bigger the decrease in the cost of capital, the higher the increase in investment relative to its forecast. We have no prior reasoning about

[17] We choose the ending year to ensure that the actual investment in the last period over which the forecast is formed is not affected by bonus depreciation.

(ß$_2$?c+ß$_3$) because there is no clear reason why the level of the average tax rates should affect the change in investment, at least when holding cash flow constant.

Our paper centers on ß$_2$. According to the central model outlined in Section 3.1, we expect it to be negative. This would be consistent with the idea that a lower average tax – perhaps due to tax avoidance – mitigates the effect of tax incentives for investment.

The measurement of ? c and why it varies across firms are central to our analysis. Although the bonus depreciation provision was not written in a firm-specific way, there are two reasons why its impact on investment should have varied by firm-year observation. First, the percentage reduction in the cost of capital due to bonus depreciation was different for different classes of capital good: smaller for those capital goods for which expensing is not much better than accelerated depreciation, and zero for those capital goods not eligible for bonus depreciation

Compustat does not provide much detail about the mix of capital goods a company purchases. However, we do know the mix of capital goods purchased in 1997 by sector. Using this data we calculate the share of each type of capital asset a by sector i, call it $w_{ai}$, where

$\sum_a w_{ai} = 1$ .

We calculate the cost of capital for each asset a at time t as follows

(12) $c_{at} = (d_a + r)\,(1- t z_{at})/(1-t)$,

where r is the real opportunity cost of capital, set at .04 for all capital goods, and t is the statutory corporate tax rate, set at .35. The value of $d_a$ is taken from Fraumeni (1997, Table 3). The value of $z_{at}$ is the present value of the depreciation allowances under the depreciation regime in place at time t, discounted at a nominal rate of interest assumed to be .06[18]. The value of $z_a$ is calculated separately for each asset based on the Modified Accelerated Cost Recovery System (MACRS) schedules in place in 2001, and in 2002 and 2003 as modified by bonus depreciation.[19]

Next, we calculate the tax-induced percentage change in the cost of capital. For this we first calculate the tax-induced percentage changed in the cost of each asset, for each year, as follows:

(13a) $\Delta c_{a,2002} = \left(c_{a,2002} - c_{a,2001}\right)/c_{a,2001}$

(13b) $\Delta c_{a,2003} = \left(c_{a,2003} - c_{a,2001}\right)/c_{a,2001}$

Second, we calculate the tax-induced percentage change in the cost of capital for each firm (i.e., sector) as a weighted average of the tax-induced percentage changed in the cost of each asset, for each year, as follows:

(14) $\Delta c_{it} = \sum_a w_{ai} * \Delta c_{at}, \quad for \quad t = 2002, \quad 2003$

Tables A.1 shows the key steps in calculating ?c, assuming that the 2002 bonus depreciation provisions applied to none of 2001 investment and all of 2002 investment, and assuming that the 2003 bonus depreciation provisions applied to all 2003 investment but none of either 2001 or 2002 investment.

We also take advantage of the variation in companies' fiscal years to identify the impact of bonus depreciation on investment. Investment induced by the bonus depreciation provision

[18] This is an intermediate value for the 2002 and 2003 interest rate from the Economic Report of the President, available online: http://www.gpoaccess.gov/eop/download.html . We compute the real interest rate by taking the difference between the CPI inflation rate on all items from December to December (Table B-63) and the yield on corporate Aaa bonds (Table B-73).

[19] We assign assets to MACRS categories based on Brazell and Mackie (2000), House and Shapiro (2004) and "How to Depreciate Property", IRS Publication. The BEA identifies 51 types of assets; we were able to find the corresponding MACRS categories for 49 of them. To compute the present value of depreciation we use the half-year convention and followed the guidelines of the mentioned IRS publication.

signed by the President on March 9, 2002 would show up in the financial statements and firms with fiscal year ending in March, April or May. Similarly, if we want to see the effect of bonus depreciation enacted on May 28, 2003, this will apply to a varying fraction of the fiscal 2002 financial statement information. Because companies use a variety of fiscal years there is variation across firms, within a sector, in the duration of the period over which the pre-bonus-depreciation, 2002 bonus depreciation, and 2003 bonus depreciation provisions applies. Table A-2 provides details about this procedure.

The fiscal year heterogeneity implies that the 2002 bonus depreciation can have an effect on what is recorded as 2001 and 2002 investment, and the 2003 bonus depreciation can affect both 2002 and 2003 recorded investment. In order to correctly compute the average incentives for a given year of data we compute the average change of cost of capital that each firm faces in each year. Let $m_{is}$ be the number of months that bonus deprecation provision s (s=pre-bonus, 2002 provisions, or 2003 provisions) applied to firm i's fiscal year t. We then calculate ?c as follows:

(15a) $$\Delta c_{2001} = \frac{m_{2002}}{12} * \Delta c_{i,2002}$$

(15b) $$\Delta c_{2002} = \frac{m_{2002}}{12} * \Delta c_{i,2002}$$

(15c) $$\Delta c_{2003} = \frac{m_{2002}}{12} * \Delta c_{i,2002} + \frac{m_{2003}}{12} * \Delta c_{i,2003}$$

For example, for a firm with fiscal year ending in March, the corresponding changes will be:

(16a) $$\Delta c_{2001} = \frac{1}{12} * \Delta c_{i,2002}$$

(16b) $$\Delta c_{2002} = \frac{12}{12} * \Delta c_{i,2002}$$

(16c) $$\Delta c_{2003} = \frac{2}{12} * \Delta c_{i,2002} + \frac{10}{12} * \Delta c_{i,2003}$$

We use the capital expenditure figure from Compustat for investment, and property, plant and equipment-capital expenditures from Compustat too for (lagged) capital stock. Note that the definition of investment includes leasing.[20]

Our measure of the average tax rate (ATR) is the ratio of domestic taxes to domestic income. We consider only the current (i.e., excluding deferred taxes) portion of income tax expense. Because of the presence of unexplained extreme values, we winsorize the average tax rate measures at 2%.

Hanlon (2003) discusses three reasons why the tax expense item in financial statement disclosures can be a poor approximation of the actual tax liability of the firm. For most stock options, the firm receives a tax deduction in the exercise year. But, because this expense is not recognized as compensation for financial reporting purposes (and thus cerates a difference between taxable and book income), the tax benefits of the deduction are not included as a tax expense. Thus, to the extent there are (most) stock options exercised, the current tax expense overstates the actual taxes due in the current period.[21] In some cases, the amount of tax benefits from exercised stock options is disclosed separately on the financial statement. Secondly, when a corporation takes an aggressive tax reporting position that may not stand up to IRS scrutiny, the company can add an additional reserve (known as the tax “cushion”) to the reported tax

[20] It also includes domestic as well as foreign investment. Given that bonus depreciation affects only domestic investment, the results are contaminated by this. We intend to control for the extent of foreign operations in future work.

[21] As Hanlon (2003) notes, even if a firm elects to expense stock options at the time of granting, there is still a difference between the tax expense for book purposes and the tax liability.

expense. In certain cases the cushion must be disclosed in the accompanying notes to the financial statements, although Gleason and Mills (2002) show that of 100 large manufacturing firms only 27 percent of firms made any disclosure of contingent liabilities. Finally, current tax expenses related to discontinued operations or extraordinary items are sometimes not disclosed and, if they are, often the current and deferred portions are not disclosed separately.

When the denominator of the average tax rate measure is negative, the ratio is not comparable to other values. Since there are many firms that report negative taxable income, we run equation (11) only for firms with positive taxable income. We also pursue an alternative approach that includes loss firms but that makes use of a dummy variable defined as

$$POS_{i,t} = \begin{cases} 1 & \text{if PreTax Income}_{it} > 0 \\ 0 & \text{otherwise} \end{cases}$$

and then regresses

$$\text{(17)}\quad E_{i,t} = \beta_0 + \beta_1 \Delta c_{i,t} + \beta_2 \Delta c_{i,t} * POS_{i,t} * ATR_{i,t} + \beta_3 POS_{i,t} * ATR_{i,t} + \beta_4 \Delta c_{it} * (1 - POS_{i,t}) + \beta_5 (1 - POS_{i,t}) + \varepsilon_{i,t}$$

Putting the contemporaneous ATR on the right-hand-side of the investment equation is problematic for several reasons. First of all, there may be unobserved shocks that affect both the incentive to invest and the ATR. This makes the ATR correlated with the error in the investment equation, and makes the estimates inconsistent. For example, if bad times reduce investment and also push companies into a loss situation that registers as a zero ATR, then we will pick up a positive correlation between ATR and investment that is not symptomatic of a causal relationship between the two. Second, given the accelerated bonus depreciation, more investment will directly reduce the contemporaneous ATRs for a given amount of investment. Finally, the ATR is a choice variable that depends on things that may be correlated with unobservable influences on investment. Our solution to this problem is to use an instrument for the contemporaneous ATR that is not correlated with the unobserved things that affect investment. We focus on using the 2001 value of the ATR (or the 2000 value, depending on the fiscal year end) as an instrument for the contemporaneous ATR.[22]

We use two methods to deal with outliers of the dependent variable. The first one is winsorization at 2% (i.e., replacing values of the dependent variable above 98th percentile with the 98th percentile value, and replacing values below the 2nd percentile with the 2nd percentile value.) The second, less parametric, approach is to explain which of a broad category of change the dependent variable a firm-year observation falls in, rather than investment itself. We investigate two such non-parametric approaches. The first explains imply whether a firm's investment-capital ratio is higher or lower than the forecasted amount. The second divides the investment-capital ratio relative to forecast into four categories: E>0.1, 0.1>E>0, 0>E>-0.1, and E<-0.1.

## 7. Results and Implications of the Results

The preliminary results of these analyses are presented in Tables 3 and 4, which show the results for firm-years with positive income only and all firm-years, respectively. The central prediction of the theoretical model is upheld. In all three specifications of Table 3, the coefficient on the product of the change in the cost of capital and the average tax rate is negative. This implies that the effectiveness of bonus depreciation as an investment incentive is smaller, the smaller is the firm's average tax rate.

[22] Alternatively, in results not reported here, we use as an instrument the average value of the ATR over four years prior to 2001 (or prior to 2000, depending on the fiscal year end). We also plan to experiment with using as instruments known influences on the extent of sheltering, such as expenditures on advertising, R&D expenditures, gross margin, and multinationality.

In the continuous specification (1), the effect of a change in the cost of capital on a firm's investment is 5.6 – 78.7*ATR, which is negative only if its average tax rate exceeds 0.071 (=5.6/78.7). At the mean level of the percentage change in the cost of capital for the sample firms of -0.016, the predicted increase in the investment-capital ratio is 0.126. the effect of the level of the average tax rate itself on the investment-capital ratio relative to forecast is estimated to be -0.97 – 78.7*?c. This is always negative, and is equal to -2.23 at the mean of ?c; this implies that an increase of ATR from .10 to .15 would reduce the investment-capital ratio by 0.11.

The logit specification (2) suggests that a bonus-depreciation-induced decline in the cost of capital increases the probability that a company increase its investment-capital ratio compared to forecast, but only if the average tax rate is greater than 0.081 (=21.5/266). The fact that the non-parametric estimates come out so close qualitatively to the parametric estimates, and even produce a very similar estimate of the average tax rate tipping point (0.081 versus 0.071), is reassuring that the estimates are not the result of difficult-to-explain outliers in the measurement of the key variables. The logit estimate imply that, at the means of all the independent variables including the average tax rate, a decline in the cost of capital of -0.016 would increase the probability of a firm increasing their investment-capital ratio by 8.6, from 37.0% to 45.6%.

Specification (3) of Table 3 shows the results of an ordered logit with four categories of the dependent variable. In decreasing order, these categories are I/K>0.1, 0.1>I/K>0, 0>I/K>-0.1, and I/K<-0.1. Consistent with the other two specifications, the model predicts that the investment-inducing effect of bonus depreciation is positively related to a company's average tax rate. A decrease in the cost of capital makes it more likely that a company's investment is in a higher category, but only if the average tax rate exceeds 0.080 (=13.0/164). At the mean of all the independent variables, a decline in the cost of capital would change the probability of being in the top category by 3.8% (from 20.1% to 23.9%) and increase the probability of being in the second category by 1.6%, but decreases the probability of being in the third and fourth categories by 0.7% and 4.6%, respectively.

Table 4 shows the results of expanding the sample to include firm-years that feature a net operating loss. In all the specifications, the estimated coefficients on the three central variables are not much changed. The estimated coefficients on the product of the change in the cost of capital and the dummy variable for having non-positive income are in all cases negative. In specification (1), the estimated coefficient is -19.9, implying that the average bonus-depreciation-induced change in the cost of capital of -0.016 would increase the investment-capital ratio by 0.224 (=-0.016*(5.9-19.9)). In specification (2), the estimated effect of the mean change in the cost of capital on the probability of having investment greater than forecast for loss firms is very small, equal to -0.0048 (=0.25*(23.9-22.7)*-0.016), where 0.25 is the probability density of the logistic distribution at the mean. In specification (3), the cut in the cost of capital is estimated to increase the probability of the change in investment being in a higher category.

## 8. Conclusions

Bonus depreciation, passed in 2002 and extended in 2003 to encourage business fixed investment, was enacted in an era when corporate tax avoidance was, according to some observers, rampant. Economic theory suggests that this kind of investment incentive might be less effective for companies whose average tax rate is low. Our empirical analysis supports this hypothesis, suggesting that tax avoidance and bonus depreciation were substitutes.

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**TABLE A.1: CHANGE IN COST OF CAPITAL BY ASSET**

| Type of Asset | | Cost of Capital | | | Change in Cost of Capital (%) | |
|---|---|---|---|---|---|---|
| Tax Depreciation Period | Depreciation Method (a) | 2001 (b) | 2002 (c) | 2003 (d) | 2001 to 2002 | 2001 to 2003 |
| 5 | 200% DB | 0.370 | 0.365 | 0.361 | -1.478 | -2.463 |
| 7 | 200% DB | 0.188 | 0.184 | 0.181 | -2.040 | -3.401 |
| 10 | 200% DB | 0.111 | 0.108 | 0.106 | -2.774 | -4.623 |
| 15 | 150 %DB | 0.107 | 0.102 | 0.099 | -4.241 | -7.069 |
| 20 | 150% DB | 0.081 | 0.077 | 0.074 | -5.075 | -8.458 |
| 27.5 | SL | 0.069 | 0.069 | 0.069 | 0.000 | 0.000 |
| 39 | SL | 0.095 | 0.095 | 0.095 | 0.000 | 0.000 |

Source: Constructed by authors based on the following data:
Economic depreciation rate: Fraumeni (1997)
Tax Rate: 35%
Interest rate: 6%
Rate of return: 4%
Tax years and tax method: “How to Depreciate Property”. IRS Publication 946
House and Shapiro (2004), 2004 US Master Tax Guide, Brazell and Mackie (2000)

(a) Under declined balance method (DB) the same depreciation rate is applied every year  to the adjusted value of the property (as long as it gives grater deduction than the straight line method). This rate is the ratio of the declined balance and the tax depreciation period. Under straight line (SL), the depreciation rate is 1 over the remaining recovery years. See IRS Publication 946.

(b) 2001 means before bonus depreciation

(c) 2002 means subject to bonus depreciation rules enacted on March 9, 2002

(d) 2003 means subject to bonus depreciation rules enacted on May 28, 2003

**TABLE A-2: NUMBER OF MONTHS THAT INVESTMENT INCENTIVES ARE AFFECTED BY 2002 AND 2003**

| Fiscal year end[a] | 2002 bonus depreciation provision | | | 2003 bonus depreciation provision | | | |
|---|---|---|---|---|---|---|---|
| | Fiscal year | | | Fiscal year | | | |
| | 2001 | 2002 | 2003 | 2001 | 2002 | 2003 | 2004 |
| January | 0 | 11 | 12 | 0 | 0 | 8 | 12 |
| February | 0 | 12 | 12 | 0 | 0 | 9 | 12 |
| March | 1 | 12 | 12 | 0 | 0 | 10 | 12 |
| April | 2 | 12 | 12 | 0 | 0 | 11 | 12 |
| May | 3 | 12 | 12 | 0 | 0 | 12 | 12 |
| June | 0 | 4 | 12 | 0 | 0 | 1 | 12 |
| July | 0 | 5 | 12 | 0 | 0 | 2 | 12 |
| August | 0 | 6 | 12 | 0 | 0 | 3 | 12 |
| September | 0 | 7 | 12 | 0 | 0 | 4 | 12 |
| October | 0 | 8 | 12 | 0 | 0 | 5 | 12 |
| November | 0 | 9 | 12 | 0 | 0 | 6 | 12 |
| December | 0 | 10 | 12 | 0 | 0 | 7 | 12 |

[a] Month during which a company's fiscal year ends. For example, a company whose 2003 fiscal year ends in June has a fiscal year beginning on July 1st, 2002.

* The 2002 and 2003 bonus depreciation provisions passed respectively on March 9, 2002, and on May 28, 2003. The effect

Source: Author's calculations.

**TABLE 1: SUMMARY STATISTICS FOR REGRESSION ANALYSIS (ONLY FIRMS WITH POSITIVE PRE-TAX INCOME)**

| Variables | N | mean | sd | min | max |
|---|---|---|---|---|---|
| Forecast error[a] | 2565 | -0.0390 | 0.695 | -8.90 | 2.79 |
| Dummny for positive forecast error | 2565 | 0.456 | 0.498 | 0 | 1 |
| Dummny for forecast error in (-8 , -0.1] | 2565 | 0.286 | | | |
| Dummny for forecast error in ( -0.1 , 0] | 2565 | 0.258 | | | |
| Dummny for forecast error in (0 , 0.1] | 2565 | 0.215 | | | |
| Dummny for forecast error in ( 0.1 , 8) | 2565 | 0.241 | | | |
| Percent change in capital cost (?c)[b] | 2565 | -0.0163 | 0.00831 | -0.0398 | -0.000681 |
| ?c * ATR | 2565 | -0.00263 | 0.00429 | -0.0262 | 0.0162 |
| Average Tax Rate (ATR)[a] | 2565 | 0.172 | 0.223 | -0.408 | 0.784 |

[a] Winsorized at the 2% level

[b] Weighted sum of the percent change in each asset's capital cost

**TABLE 2: SUMMARY STATISTICS (ALL FIRMS)**

| Variables | N | mean | sd | min | max |
|---|---|---|---|---|---|
| Forecast error[a] | 4299 | -0.0810 | 0.8867433 | -8.904563 | 2.788857 |
| Dummny for positive forecast error | 4299 | 0.440 | 0.4964289 | 0 | 1 |
| Dummny for forecast error in (-8 , -0.1] | 4299 | 0.340 | | | |
| Dummny for forecast error in ( -0.1 , 0] | 4299 | 0.220 | | | |
| Dummny for forecast error in (0 , 0.1] | 4299 | 0.172 | | | |
| Dummny for forecast error in ( 0.1 , 8) | 4299 | 0.268 | | | |
| Percent change in capital cost (?c)[b] | 4299 | -0.0158 | 0.00796 | -0.0430 | -0.000681 |
| ?c * ATR | 4299 | -0.00195 | 0.00409 | -0.0312 | 0.0162 |
| Average Tax Rate (ATR)[a] | 4299 | 0.129 | 0.230 | -0.408 | 0.784 |
| Dummy for positive pre-tax income (1-LOSS) | 4299 | 0.597 | 0.491 | 0 | 1 |
| ?c * negative pre-tax income (LOSS) | 4299 | -0.00611 | 0.00877 | -0.0430 | 0 |
| ?c * (1-LOSS) * ATR | 4299 | -0.00161 | 0.00365 | -0.0312 | 0.0143 |
| (1-LOSS) * ATR | 4299 | 0.1021845 | 0.1949805 | -0.4077173 | 0.7841666 |

[a] Winsorized at the 2% level

[b] Weighted sum of the percent change in each asset's capital cost

**TABLE 3: REGRESSIONS ONLY FOR FIRMS WITH POSITIVE PTI**

| | (1) | (2) | (3) |
|---|---|---|---|
| | IV | Logit[a] | Ordered logit[a] |
| ?c | 5.57 | 21.5 | 15.09 |
| | [0.68] | [1.25] | [1.02] |
| ?c * ATR | -78.7 | -267 | -176 |
| | [1.67] | [2.65]* | [2.06]* |
| ATR | -0.972 | -2.07 | -2.39 |
| | [1.03] | [1.14] | [1.50] |
| Constant | 0.0120 | -0.175 | |
| | [0.07] | [0.51] | |
| Cut Point 1 | | | -1.11 |
| | | | (0.305) |
| Cut Point 2 | | | -0.01 |
| | | | (0.305) |
| Cut Point 3 | | | 0.967 |
| | | | (0.305) |
| Percent correctly predicted | | | |
| Root MSE | 0.710 | . | . |
| Pseudo R-squared | | 0.00740 | 0.0020 |
| Log Likelihood | | -1754.82 | -3535.01 |
| Observations | 2565 | 2565 | 2565 |

Robust t statistics in []brackets, SE in ()

* significant at 5%; ** significant at 1%

[a] A first stage is estimated for all variables with ATR using lagged ATR as instrument

**TABLE 4: REGRESSIONS WITH ALL FIRMS**

| | (1) IV | (2) Logit[a] | (3) Ordered logit[a] |
|---|---|---|---|
| ?c | 5.88 | 23.9 | 13.0 |
| | [0.77] | [1.38] | [1.05] |
| ?c * (1-LOSS) * ATR | -87.1 | -298 | -164 |
| | [1.78] | [2.67] | [2.18] |
| (1-LOSS)*ATR | -1.06 | -2.37 | -2.24 |
| | [1.11] | [1.30] | [1.56] |
| ?c*LOSS | -19.9 | -22.7 | -29.3 |
| | [2.43]* | [1.39] | [2.25]* |
| LOSS | -0.380 | -0.253 | -0.632 |
| | [2.29]* | [0.83] | [2.44]* |
| Constant | 0.0120 | -0.142 | |
| | [0.08] | [0.46] | |
| Cut Point 1 | | | -0.902 |
| | | | (0.248) |
| Cut Point 2 | | | 0.0129 |
| | | | (0.248) |
| Cut Point 3 | | | 0.778 |
| | | | (0.248) |
| Percent correctly predicted | | | |
| Root MSE | 0.890 | . | . |
| Pseudo R-squared | | 0.0059 | 0.0030 |
| Log Likelihood | | -2131.383 | -5810.21 |
| Observations | 4299 | 4299 | 4299 |

Robust t statistics in []brackets, SE in ()

* significant at 5%; ** significant at 1%

[a] A first stage is estimated for all variables with ATR using lagged ATR as instrument