The Role of Leasing in the Effectiveness of Corporate Tax Policy: Evidence from the 2002 Bonus Depreciation

Jongsang Park*
University of Michigan

Draft: May, 2012

Abstract

Firms can use capital that they either purchase or lease, but these alternatives are treated differently for tax purposes. This paper derives the demand for leased capital as a function of tax parameters, and uses the model to estimate the responsiveness of leasing to the introduction of bonus depreciation in 2002, finding strong evidence that depreciation allowances influence leasing patterns. Firms that stood to benefit the least from depreciation allowances were the most likely to lease capital after the introduction of bonus depreciation. Specifically, I find that a lessee with a marginal tax rate of zero increases the fraction of leased investment by around 12% point in response to the 2002 bonus depreciation, compared to a fully taxed lessee. This evidence carries implications for the magnitude of deadweight losses due to financing distortions introduced by the corporate tax.

JEL Codes: H25, H32, G31, G32.
Keywords: Taxes, investment, leasing, bonus depreciation.

*Email: jsngpark@umich.edu. I am grateful to Jim Hines, Matthew Shapiro, Joel Slemrod, Uday Rajan and seminar participants at the University of Michigan for their comments. I thank John Graham for generously providing me with the simulated marginal tax rate data. All errors are my own.

1 Introduction

Leasing is estimated to account for 30 percent of equipment investment in the United States according to the 1994 U.S. Industrial Outlook. A substantial amount of leasing activity is motivated by tax purposes, as leasing allows firms to trade (or transfer) tax benefits. However, despite this substantial proportion of leased assets, leasing behavior by firms has been largely underexplored in the empirical public finance literature. This is perhaps because leased investments are included in the investment data when capital goods are initially purchased. While this is the case for studies with aggregate investment data, most studies using disaggregated firm-level accounting data draw investment information from Property, Plant and Equipment (for example, Cummins et al. (1994)) or Capital Expenditure (for example, Desai and Goolsbee (2004)) items in balance sheets which do not include investment made in the form of off-balance-sheet operating lease. Rather, the transferability of tax benefits through leasing has been studied theoretically by Warren and Auerbach (1982) and Warren and Auerbach (1983) who provide normative discussions about the leasing provisions included in the Economic Recovery Tax Act of 1981 and the Tax Equity and Fiscal Responsibility Act of 1982.[1]

On the contrary, empirical relations between leasing activity and taxes are frequently studied in the corporate finance literature. Based on Smith and Wakeman (1985), using simulated marginal tax rates that take into account various aspects of U.S. corporate tax codes, Graham et al. (1998) confirm that firms with lower marginal tax rates are more likely to be lessees than firms with higher tax rates. That is, they find a negative relation between total operating lease and marginal tax rates. Interestingly, the corporate finance leasing literature has focused on the effect of tax rates within the capital structure framework, rather than the impact of tax policies on firm-level leased investment.[2] Thus, the question still remains whether temporary investment tax incentives motivate firms with lower tax rates to increase their leasing activity. Intuitively, lower-taxed firms have a greater tax incentive to lease capital goods, so they should respond to an increase in tax incentives by opting more for leasing over purchasing. However, to my knowledge, this behavioral response has not been empirically explored.

To address this question, this paper examines firm-level leased investment responses to the temporary investment tax policy enacted in 2002. Given the significant size of leased investment, this study contributes to research that investigates the tax responsiveness of business investments by considering the previously neglected choice between purchasing and leasing. Furthermore, I argue that this financing choice by firm has an important implication for tax policy, namely, that firms' responsiveness to a policy does not necessarily contribute to the effectiveness of the policy. In fact, assuming the existence of an optimal level of leasing, and taking associated adjustment

[1] They argue that the transferability created by the two tax reforms fails to implement, in a coherent way, "competitive neutrality" among firms with various types of tax liabilities, regardless of the way the competitive neutrality is defined.

[2] Leased investment is hereafter used interchangeably with off-balance-sheet investment, and is defined as new operating lease transactions.

costs into account, the responsiveness of leasing results in non-negligible deadweight losses, making the investment tax policy ultimately less effective than believed.

Specifically, in this paper, I focus on tax treatment differences across financing methods (purchasing vs leasing), and derive the demand for leased investment as a function of tax parameters. Using the model, I find evidence that the relative use of leased investment, defined as the ratio of leased investment to total investment, responds strongly to the 2002 investment tax policy. That is, firms with lower tax rates (i.e., smaller tax shields) are the most likely to lease more capital relative to purchase after the introduction of the bonus depreciation policy. The identifying assumption is, therefore, that firms with different marginal tax rates have the same leasing responsiveness to changes in depreciation allowances. However, given the relationship between marginal tax rates and financial constraints, this assumption is likely to be violated. Note that a lease contract, compared to a loan contract, reduces fears of lessees' moral hazard behavior concerning the types of capital goods in use, namely, asset-substitution problem. This non-tax advantage of reduced moral hazard costs, together with the fact that lessors receive higher priority in the event of a lessee bankruptcy, make lease contracts particularly attractive for insolvent (or near-insolvent) lessees that are also likely to have lower tax rates. These types of lessees would be less influenced by changes in tax incentives, since the extent to which *tax* incentives motivate leasing activities in the first place is lower for them, that is, those firms with larger *non-tax* incentives. Ignoring this possibility would likely bias downward estimates of leasing responses to a tax incentive.

I develop a leasing model that explicitly incorporates the interaction of financial constraints and tax status, and show that restricting the sample to firms that are considered as financially strong in the market helps eliminate this type of endogeneity. I then compare the empirical results with the full sample to the results with the restricted sample, and confirm that the estimates with the full sample are significantly lower than the restricted sample results. With this restricted sample, a 10 percent point decrease in the marginal tax rate leads to a 3.5 percent point increase in the relative use of leased investment. That is, I find that a lessee with a marginal tax rate of zero increases the relative use of leased investment by around 12 percent point in response to the 2002 bonus depreciation, compared to a fully-taxed lessee. Had this endogeneity issue been ignored, an increase in the relative use of leased investment by around 7 percent point would have been expected in the same situation.

Finally, I calculate the deadweight loss associated with the observed financing distortion in response to a temporary tax policy. Under the 2002 investment tax policy, the US government provided a larger tax saving for one dollar of investment. According to the results of this paper, a firm receives, on average, \$0.016 of additional tax saving per one-dollar investment during the temporary policy period, of which around 20% is estimated as deadweight loss associated with the financing distortion. Thus, the results imply that the responsiveness of firms' leasing behavior to the policy renders the policy case of investment tax incentives weaker than one would expect absent the consideration of leasing response.

The rest of the paper is organized as follows. Section 2 discusses the institutional background for leasing. Section 3 derives the demand for leased investment, while Section 4 discusses the empirical strategy. Section 5 describes the data, and explains my leased investment variable. Section 6 presents the empirical results and interpretations, and Section 7 discusses policy implications. Section 8 concludes.

2 Background

Background 1. Types of Leasing

In this section, I provide an explanation of how leases are handled from an accounting standpoint.[3] According to the Statement of Financial Accounting Standards (SFAS), a lease is categorized as either an operating lease or a capital lease. Operating leases, the focus of this paper, transfer to lessees only the right to use the assets that continue to be owned by the lessors. As operating lease payments are treated as an expense on income statements, lessee firms do not include operating leases on their balance sheets. Since firms looking to minimize debt would prefer to report operating leases, the Financial Accounting Standards Board (FASB) has imposed a set of strict rules to distinguish operating leases from capital leases.[4] On the contrary, in a capital lease, because the lessee is effectively borrowing cash with which to purchase an asset, the lessee's balance sheet recognizes both the asset and the liability associated with the borrowing. Indeed, a capital lease is included in the calculation of a firm's long term debt, in which sense it becomes equivalent to non-lease debt.[5]

For tax purposes, the Internal Revenue Service (IRS) distinguishes between true leases and conditional-sale contracts. The IRS rule states that nominal tax subsidies, including investment tax credits and accelerated depreciation allowances, are provided to the lessor in a true lease and to the lessee in a conditional-sale contract. Tax benefits are, therefore, transferable only through a true lease contract, but it is not publicly available information whether a lease contract is classified as a true lease or a conditional-sale contract.[6] However, as Graham et al. (1998) argues, while the FASB and the IRS use slightly different criteria, an activity classified as a true lease by the IRS is likely to be classified as an operating lease under the SFAS rule. Conversely, a capital lease as defined by the SFAS rule could be classified by the IRS as either a true lease or a conditional-sale contract. Throughout this paper, therefore, I treat operating leases, for which data are publicly available from Compustat, as true leases.[7] Thus, as lessors are the recipients

[3] Much of the institutional discussion follows Graham et al. (1998).

[4] See Graham et al. (1998) for the FASB rules.

[5] Not surprisingly, Bowman (1980) empirically shows that capital leases, like non-lease debt, have a negative impact on a lessee's financial conditions.

[6] Safe harbor leasing was briefly introduced as part of the Economic Recovery Tax Act of 1981. Specifically, safe harbor leasing allowed firms with smaller tax shields, such as loss firms, to transfer those incentives through leases not even constituted as a true lease. It was, however, repealed the following year for its abusive use. See Warren and Auerbach (1983) and Auerbach (1986) for detailed discussion about safe harbor leasing.

[7] Most studies of leasing have accepted this assumption. See Graham et al. (1998) and Yan (2006) for related

of nominal tax benefits from the government under operating leases, the tax incentives to prefer operating leasing over purchasing are greater for lower- than for higher-taxed lessees.

Background 2. Bonus Depreciation Policy

I now provide a brief discussion of depreciation allowances and the bonus depreciation policy. To calculate corporate taxable income, firms should first capitalize their capital expenditures and then depreciate these over a "recovery period" using a "balancing method," both of which are asset-specific and set by IRS rules. The recovery period specifies the amount of time an asset should be depreciated, and the balancing method determines the extent to which the depreciation allowance is front-loaded over the recovery period. The shorter the recovery period is, or the higher the balancing method, the more tax benefits a firm enjoys.

Depreciation rules have changed frequently over the years. Recently in 2002, the Jobs Creation and Worker Assistance Act of 2002 was signed into law, temporarily providing an accelerated depreciation allowance, or bonus depreciation. Under bonus depreciation, a firm that invested in qualified equipment could write off 30% of the investment (or 50% depending on the timing of the investment decision) immediately in the first year, and would then follow the regular depreciation schedule under the modified accelerated cost recovery system (MACRS) for the remaining amount. After the first bonus depreciation policy expired at the end of 2004, the second bonus depreciation was enacted in 2008.

3 Model

3.1 Tax and Leasing

Table 1 presents a comparison of cash flows between purchased and leased investments. This information is based on Smith and Wakeman (1985)'s Table 1. For simplicity, I omit the salvage value of assets, maintenance expenses, capital gains, and contracting costs, assuming that differences in these components across financing methods are either zero, or are picked up by lease payments.

[Table 1 around here]

Note that z is the present value of depreciation allowance streams and CF is the present value of cash flow streams from asset operation. Furthermore, L_R and L_i are the present value of annual lease payment streams for the lessor and lessee, respectively. In addition, D is the present value of the interest tax payments associated with any debt-financed asset purchase.[8]

As proposed in Smith and Wakeman (1985), the difference between the sum of the first column components (i.e., purchased investment) and the sum of the next two column components (i.e.,

discussions.

[8] Assuming debt financing over an infinite time period, this also corresponds to the fraction of investment that is debt-financed.

leased investment) represents the difference between the tax liability when purchasing and the tax liability when leasing. Assuming the present values of annual lease payments are the same for the lessor and the lessee, $L_R = L_i$,[9] the difference between the two tax liabilities is expressed as follows.

$$\text{Tax liability differences} = (\tau_R - \tau_i)(z + D - L_R) \equiv NAL, \tag{1}$$

that is, NAL is the net tax advantage of leasing, measured as the difference between the two tax liabilities.[10] In this equation, the first term, $(\tau_R - \tau_i)z$, measures the transferability of depreciation tax shields through leasing. Similarly, the second term, $(\tau_R - \tau_i)D$, measures the transferability of interest tax shields through leasing. The third term, $-(\tau_R - \tau_i)L_R$, measures the adverse impact of income transferred from lessee i to lessor R. Note that, when the lessee and the lessor have the same marginal tax rate, the tax liabilities are identical (i.e., $NAL = 0$).

While empirical studies on tax and leasing behavior mainly examine whether leasing activities decrease in lessee's marginal tax rates τ_i, the focus of this paper is on whether a temporary depreciation policy generates an additional incentive to lease – that is, NAL increases in z (i.e., $\frac{\partial NAL}{\partial z} > 0$) – and, furthermore, whether this impact is larger for a lower taxed lessee than for a higher taxed lessee (i.e., $\frac{\partial^2 NAL}{\partial \tau_i \partial z} < 0$).

3.2 Deriving Demand for Leased Investment

While the baseline analysis in the previous section examines the conditions under which leasing is preferred to purchasing, that analysis does not allow us to measure the *degree* to which leasing is preferred. That is, equation (1) simply states that, if and only if the net tax advantage of leasing is positive, a firm should prefer leasing to purchasing, yielding a corner solution of 100% purchasing or 100% leasing, depending on the sign of the net tax advantage of leasing. An alternative interpretation of equation (1) represents an asset-specific leasing incentive. For example, the structure in which unobserved asset-specific maintenance costs or salvage values are factored into lease payments would presumably vary across the types of assets, so that equation (1) may be positive for some types of assets, but negative for others. Then equation (1) would not imply a corner solution for firm-level leasing decisions.

Regardless of the interpretation, any firm-level analysis would require converting a discrete purchasing vs. leasing comparison into a continuous measure of leasing incentives. Intuitively, even a firm with a zero marginal tax rate, likely to have the greatest tax incentive to lease, would still purchase some equipment in a given year, so there are reasons for this "interior" solution.

[9] This assumption is equivalent to assuming the lessor and lessee have the same discount factor. I make this assumption for simplicity in this section, following Smith and Wakeman (1985). Since it carries an important implication for non-tax leasing incentives, however, I re-examine this assumption in Section 3.3.

[10] Throughout this paper, I assume that all of the net tax advantage of leasing accrue to the lessee, since it is impossible, with data currently available, to observe how much of tax saving accrues to the lessee. A sufficient condition for this assumption to be valid is a zero-profit condition for the lessors. In reality, however, the lessor and lessee likely share the net tax advantage of leasing, so that the lessee would likely end up with smaller tax incentives than assumed in this paper. This implies that the empirical results based on this assumption would make estimates for tax elasticity of leasing towards zero.

In this section, I do this by assuming that adjustment costs are incurred whenever a lessee chooses to lease beyond its non-tax optimal level of leased investment, due to inelastic substitutions with respect to types of assets used or types of financing. Presumably, some types of assets are more (or less) expensive to finance through leasing at the margin, for unobserved institutional reasons associated with industry-specific asset usage and maintenance costs. Then tax incentive of leasing distorts firms' decisions on asset-type compositions, or at the very least, on financing methods for certain types of assets. For example, suppose a transportation company, without tax-leasing consideration, plans to invest $1M, of which $600K to lease trucks and $400K to purchase computers (i.e., a relative leasing of 60%), as this company finds the 6:4 ratio optimal for itself, and it is less costly for a company in the transportation industry to lease trucks and to purchase computers at the margin. With additional tax incentive available for leasing, however, this company starts to increase its use of leasing to, say, 70%, which implies that it either changes its asset composition (i.e. the ratio of new trucks to new computers is now 7:3) keeping the asset-specific financing methods, or change its finanicing method (i.e. it starts to lease some of new computers that are cheaper to be purchased) with the asset composition unchanged. Put it differently, this company chooses to take the tax benefits from additional leasing activity, because the tax benefits outweigh the associated costs, but the existence of the associated costs – which is likely convex – prevents the company from choosing to lease all trucks *and* all computers.[11]

Another type of adjustment cost comes from certain financial covenants of existing debts which may prevent a firm from engaging in off-balance-sheet financing beyond a certain threshold. When a company is close to the threshold, the company should compare the tax benefits with the associated risk of going beyond the threshold. Adjustment costs of leasing in this paper include all these types of unobserved costs which are not expressed as cash flow components in Table 1.

The model of leasing behavior in this paper assumes a two-step decision process. A firm first decides whether to invest or not, and then decides how to finance this investment – through purchasing or leasing. This paper focuses on the second stage, where a firm makes its financing decision for one dollar of investment. In the model, I denote α as the relative use of leased investment, defined as the ratio of leased investment to total investment. That is, for each dollar of investment a firm makes, α fraction is leased and $1-\alpha$ is purchased. Since the adjustment cost, $\sigma(\alpha)$, is reasonably assumed to be convex, the marginal cost, $\sigma'(\alpha)$, is increasing in α, implying an increasing marginal cost of leasing.

Recall that the sum of the cash flow from purchasing is the sum of all items in the first column of Table 1, while the sum of the cash flow from leasing is the sum of $\sigma(\alpha)$ and all items in the next two columns. The total cash flow then becomes the weighted average of the two cash flows,

[11] If all asset-composition or financing methods were completely substitutable, then there would be no distortion of this kind, but then we would have seen that firms will lease all their capital with a very small amount of tax incentive for leasing (i.e. corner solutions from 0% leasing to 100% leasing).

with the weights being α and $(1-\alpha)$, plus adjustment costs. That is,

$$\begin{aligned}
& \text{Total cash flow from one dollar of investment} \\
= \; & (1-\alpha)\underbrace{[(1-\tau_i)CF-(1-\tau_i z-\tau_i D)]}_{\text{cash flow when purchasing}}+\alpha\underbrace{[(1-\tau_i)CF-(1-\tau_R z-\tau_R D)+(\tau_i-\tau_R)L_R]}_{\text{cash flow when leasing}}-\sigma(\alpha) \\
= \; & (1-\tau_i)CF-1+[(1-\alpha)(\tau_i z+\tau_i D)+\alpha(\tau_R z+\tau_R D-(\tau_i-\tau_R)L_R)]-\sigma(\alpha) \\
= \; & [(1-\tau_i)CF]-[1-(\tau_i z+\tau_i D)]+\left[\alpha\underbrace{(\tau_R-\tau_i)(z+D-L_R)}_{\equiv NAL}\right]-\sigma(\alpha). \qquad (2)
\end{aligned}$$

In equation (2), the first term, $(1-\tau_i)CF$, measures the after-tax cash flow from asset's operation, independent of the financing decision. The second term, $(1-(\tau_i z+\tau_i D))$, measures the after-tax acquisition cost for one dollar of investment. The third term measures the total net tax advantage of leasing, calculated as the (marginal) net tax advantage of leasing, NAL, multiplied by the fraction of leasing, α, per one-dollar of investment. Finally, the last term, $\sigma(\alpha)$, measures the leasing adjustment costs. To derive the optimal level of leased investment, the first order condition for α is given by:

$$\sigma'(\alpha)=\underbrace{(\tau_R-\tau_i)(z+D-L_R)}_{\equiv NAL}. \qquad (3)$$

Further assume that the convex adjustment cost takes a quadratic form: $\sigma(\alpha)=\frac{1}{2c_2}(\alpha-c_1)^2$, where c_1 is the optimal level of leased investment with no tax incentive and c_2 is the inverse of the size of adjustment costs, or the tax elasticity of leasing. Then, equation (3) can be expressed as:

$$\alpha=c_1+c_2\left[(\tau_R-\tau_i)(z+D-L_R)\right]. \qquad (4)$$

Recall that the bracket on the right hand side is equal to NAL, or the marginal tax saving from leasing. Thus, this equation states that the relative use of leased investment increases in the marginal benefit of leasing. In other words, this equation represents the demand function for the relative use of leased investment.

Note first that $\frac{\partial\alpha}{\partial z}=c_2(\tau_R-\tau_i)>0$, implying that, as long as the lessee's marginal tax rate is lower than that of the lessor, the lessee will increase its relative use of leased investment in response to a temporary bonus depreciation policy. This impact increases in the differences between the marginal tax rates of the lessor and lessee, as $\left.\frac{\partial^2\alpha}{\partial z\partial\tau_i}\right|_{\overline{\tau_R}}=-c_2<0$.

3.3 Source of Non-tax Financial Benefit of Leasing: Lease Payments

So far, two predictions have been made, regarding the relationship between depreciation allowances and leasing behavior: (1) a lessee will increase relative leasing after the introduction of an accelerated depreciation policy, and (2) a lower-taxed lessee will increase its leasing fraction more so than a higher-taxed lessee will. In this section, I argue that the second condition depends on the simplification that there is no non-tax financial incentive of leasing. Recall that it has been assumed that the present values of lease payments, L, are the same for both the lessor and lessee. However, the lessor's L_R may well be larger than the lessee's L_i. That is, even though the annual lease payment is the same for both parties, the present values of all lease payment streams may differ since the two parties may use different discount factors. Specifically, while the lessee would use its ordinary operating interest rate in calculating the present value of lease payments, the lessor would likely use a different discount factor in evaluating a lease contract.

To see this in a simple setting, suppose firm A decides whether to lease or debt-finance an asset from firm B, which can operate as either a lender or as a lessor (for example, a bank with a subsidiary that operates as a lessor). Suppose further that firm A is considered close to bankruptcy. Then, from firm B's perspective, a lease contract with firm A is safer than a loan contract for two reasons. First, a lease contract reduces the moral hazard associated with the type of capital used. A typical moral hazard problem in the presence of bankruptcy risk is asset-substitution, where the borrower (firm A) assumes excessive risk in its asset composition. In a lease contract, since the types of capital goods to be used are predetermined, there is less room for asset-substitution behavior. Secondly, firm B would prefer a lease contract, as such contracts hold higher priority in the event of bankruptcy. As explained by Graham et al. (1998), "Within bankruptcy, if the lease is affirmed by the court then the lessee is required to continue to make scheduled lease payments to the lessor, giving the lease priority on par with administrative expenses. In contrast, bankruptcy proceedings grant the debtor a stay on the payment of most other financial claims, including those of secured debtholders, until the bankruptcy is resolved." Hence, in this case, firm B would use a lower interest rate to evaluate a lease contract than to evaluate a loan contract. Note that the interest rate used by firm B to evaluate the loan contract would correspond to the interest rate used by firm A to discount cash flows. Therefore, firm A and firm B would use different interest rates when evaluating the same lease contract.

Since it has an important implication for my empirical analysis, I present a formal discussion of the above case in this section. First, consider the lessor's evaluation of lease payments consisting of annual payments of w over n years. That is,

$$L_R = w \left[\sum_{j=0}^{n-1} \delta_R^j \right], \tag{5}$$

where $\delta_R = \frac{1}{1+r_R}$ is the discount factor that lessor R uses to evaluate the lease contract. In fact, w can be priced assuming a competitive leasing market.[12] Note that, in Table 1, the second column consists of all the lessor's cash flows. Thus, w is priced in such a way that the sum of those cash

[12] Even though lessees may be discriminated against based on their financial conditions, there are many lessors, for any market segment, who are willing to make lease contracts with any lessee. In these situations, the lessor's profit is always zero. This implies that there is only one price which makes the lessor's profit zero.

flows is zero. That is,

$$w = \frac{1}{\sum_{j=0}^{n-1} \delta_R^j} \frac{1 - \tau_R(z + D)}{1 - \tau_R}. \tag{6}$$

Similarly,

$$L_i = w \left[\sum_{j=0}^{n-1} \delta_i^j \right], \tag{7}$$

where $\delta_i = \frac{1}{1+r_i}$ is the discount factor that lessor i uses to evaluate the lease contract. With $r_R < r_i \Leftrightarrow \delta_R > \delta_i$, given an annual payment of w, the present value of lease payments for the lessor is higher than for the lessee, generating a non-tax financial benefit of leasing.

That is, the difference in the two tax liabilities is no longer appropriately represented by equation (1), but instead is calculated as follows:

$$\begin{aligned} & \text{Tax liability differences between purchasing and leasing} \\ = \; & (\tau_R - \tau_i)(z + D) + [(1 - \tau_R)L_R - (1 - \tau_i)L_i] \\ = \; & (\tau_R - \tau_i)(z + D - L_R) + (1 - \tau_i)(L_R - L_i) \\ = \; & \underbrace{(\tau_R - \tau_i)(z + D - L_R)}_{\equiv NAL} + (1 - \tau_i)w \underbrace{\sum_{j=0}^{n-1} (\delta_R^j - \delta_i^j)}_{\equiv FW}, \end{aligned} \tag{8}$$

where the first and second terms represent tax and non-tax incentives, respectively. The second term arises from the possibility that the two parties use different discount factors, represented by a financial wedge term, $FW = \sum_{j=0}^{n-1} (\delta_R^j - \delta_i^j)$.

The financial wedge term arises because two leasing market counterparts may use different interest rates to evaluate a lease contract, thereby generating an arbitrary opportunity for the lessee. Note that the first term $\sum_{j=0}^{n-1} \delta_R^j = \sum_{j=0}^{n-1} \frac{1}{(1 + r_R)^j}$ measures the annuity factor used by the lessor to evaluate the lease contract. The second term, $\sum_{j=0}^{n-1} \delta_i^j = \sum_{j=0}^{n-1} \frac{1}{(1 + r_i)^j}$, represents the annuity factor used by lessee i for its own operations, including the issuing of bonds, and thus reflects the lessee's financial condition.

Were this a loan contract, the risk of the contract would correspond to that of the borrower ($r_i = r_R \Leftrightarrow \delta_i = \delta_R$), and the financial wedge would be zero. However, as a lease contract is likely to be less riskier for the lessor, especially with an insolvent or near-insolvent firm (i.e. financially weak firms), it is likely that $r_R \leq r_i \Leftrightarrow \delta_R \geq \delta_i$. In this case, the financial wedge provides a positive non-tax financial benefit of leasing. That is,

$$FW = \sum_{j=0}^{n-1} (\delta_R^j - \delta_i^j) \geq 0. \tag{9}$$

4 Empirical Strategy

Allowing for heterogeneous evaluation of lease payments across the two parties in a lease contract, the demand for leased investment can be given by:

$$\alpha_{it} = c_1 + c_2 \left[(\tau_R - \tau_{it})(z_t + D - L_R) + (1 - \tau_{it}) w_t \cdot FW_i \right], \tag{10}$$

where subscripts i and t indicate the firm and year, respectively. In this equation, I assume that the lessor's marginal tax rate, τ_R, and the fraction of the asset being debt-financed, D, are both time-invariant and exogenously given. In addition, the lessor's discount factor, δ_R, is time-invariant and given. Furthermore, since I use the 2002 bonus depreciation policy as an exogenous shock to z for all firms, z_t enters the empirical equation as a time variable. Consequently, the annual lease payment, w_t, is also a time dummy variable, assuming a competitive leasing market, as given by equation (6). That is, in a competitive leasing market, lessors pass all tax benefits onto lessees in the form of a smaller annual lease payment. Thus, a larger z implies a smaller w.

Including both firm and year fixed effects to control for unobserved firm-level heterogeneity and aggregate economic conditions, respectively, yields the following empirical equation:

$$\alpha_{it} = \beta_1 + \beta_2 \left[\tau_{it}(z_t + D - L_R) - (1 - \tau_{it}) w \cdot FW_i \right] + f_i + y_t + \epsilon_{it}, \tag{11}$$

where $\beta_1 = c_1 + c_2 \tau_R (D - L_R)$, $\beta_2 = -c_2$, f_i represents firm fixed effects, and y_t represents year fixed effects absorbing $\tau_R z_t$.

From this equation, note that I can test only the second prediction, namely, that a lower-taxed lessee will increase leasing more than a higher-taxed lessee under accelerated depreciation rules. The first prediction cannot be tested from this equation, because the common impact of the 2002 bonus depreciation is absorbed by the year fixed effects. Thus, I focus on the second prediction to estimate c_2 (or β_2), the coefficient on the net tax advantage of leasing, NAL.

Within this second prediction, an endogeneity concern arises from the conflict between the tax and non-tax incentives of leasing. To see this, I consider two cases separately below.

Case 1 (Baseline Case): All firms are financially "strong" ($FW = 0$)

First, suppose that the financial wedge is zero (i.e., $FW = 0$). This happens when a loan contract of firm i is as safe to the lender as a lease contract of firm i to the lessor, that is, when firm i is financially strong. Equation (11) then becomes:

$$\alpha_{it} = \beta_1 + \beta_2 \left[\tau_{it}(z_t + D + L_R) \right] + f_i + y_t + \epsilon_{it}. \tag{12}$$

As z_t is essentially a time dummy variable, I use the bonus depreciation period dummy variable, D_t^{bonus}, to indicate increases in z, so that the empirical equation is

$$\alpha_{it} = \beta_1 + \beta_2 \left(D_t^{bonus} \cdot \tau_{it} \right) + \beta_3 \tau_{it} + f_i + y_t + \epsilon_{it}. \tag{13}$$

Therefore, even though τ_i is a continuous variable, β_2 is identified in the same manner as in a difference-in-difference approach. That is, a lower-taxed lessee receives a larger treatment from the policy, compared to a higher-taxed lessee.

Case 2: There are financially weak firms ($FW > 0$) with lower tax rates

In this case, the lessee can be financially weak, then the financial wedge becomes positive. Since a weak lessee is likely to have a very low marginal tax rate, the second term in the bracket of equation (11), the non-tax incentive for leasing, would respond to changes in the depreciation allowances in the opposite direction of the first term. That is,

$$\alpha_{it} = \beta_1 + \beta_2 \left[\underbrace{\tau_{it}(z_t + D - L_R)}_{\text{tax incentive} \uparrow} - \underbrace{(1 - \tau_{it}) w \cdot FW_i}_{\text{non-tax incentive} \downarrow} \right] + f_i + y_t + \epsilon_{it}, \tag{14}$$

when z increases.

Intuitively, the non-tax incentive for leasing for a financially weak firm comes from the extent to which *future* lease payment streams are evaluated as more valuable by the lessor. Hence, a higher annual lease payment, w, implies a larger non-tax incentive for leasing. However greater depreciation allowances lead to a lower annual lease payment, assuming a competitive leasing market, which in turn reduces the non-tax benefit for leasing. Thus, changes in z move the first and second terms in opposite directions. To the extent to which lower tax rates are correlated with financial weakness, the main coefficient, β_2, will not be fully identified.

As Case 2 is more likely the case when the whole sample of firms is used in the analysis, I address this endogeneity concern by restricting the sample to financially strong firms, (i.e., firms with $FW \approx 0$). That is, I also conduct my empirical analysis with only financially strong firms, as defined in the next section. Note that I make use of the observation that financial strength is only a sufficient condition for a lower marginal tax rate. Thus, even with financially strong firms in the sample, there is enough variation in their marginal tax rates for the analysis, as illustrated in Section 6.

5 Data Description and Variable Construction

5.1 Balance-Sheet Investment

Following the literature, I define balance-sheet investment (I_t^n) as Capital Expenditure (CE) divided by start-of-year Property, Plant and Equipment (PPE):

$$I_t^n = \frac{\text{CE}_t}{PPE_{t-1}}. \tag{15}$$

5.2 Off-balance-sheet Investment, or Leased Investment

Compustat data does not directly provide information on newly-leased capital goods, especially those leased through operating leases. As explained in Graham et al. (1998), the variables related to operating leases in Compustat are Rental Expense (RE) and Rental Commitments 5 Years Total ($RC5$).[13] However, while Graham et al. (1998) measure the *stock* of operating lease as ($RE + RC5$), this study requires data on the operating lease *flow* made in a given year. To obtain this information, I first start with the stock measure ($RE_t + RC5_t$), which also contains information about operating lease contracts made *before* time t, which is included in $RC5_{t-1}$.[14] Then, I subtract the previous year's $RC5$ from the current year's $RE + RC5$, so that leased investment (I_t^f) is measured as:

$$I_t^f = \frac{RE_t + (RC5_t - RC5_{t-1})}{PPE_{t-1}}. \tag{16}$$

Assuming the length of any operating lease is less than or equal to five years, this term measures the amount of investment made through operating lease.

To illustrate the measurement procedure, see Figure 1. Suppose a firm makes leased investments A, B, C, and D at various times from time t-4 to t+1. Subscript 0 indicates the first lease payments in the year when the corresponding leased investment is made. Similarly, subscript 1 indicates the subsequent lease payments in the next year for the corresponding leased investment, and so on. In this example, the investment made through an operating lease at time t is C, so that $(C_0 + C_1)$ is the undiscounted sum of annual lease payments.[15] Note that, in time t, $RE_t + RC5_t$ is $(C_0 + A_4 + B_2) + (C1 + A_5 + B_3 + B_4 + B_5)$, but $(A_4 + A_5 + B_2 + B_3 + B_4 + B_5)$ is controlled by $RC5_{t-1}$. Thus, equation (16) gives us $(C_0 + C_1)$.

[Figure 1 around here]

[13] RE is the operating lease payments to be made by a firm in a given year, and $RC5$ is the sum of future operating lease payments committed (up to 5 years).

[14] $RC5_{t-1}$ measures the firm's total future operating lease payments known at time $t-1$, while $RE_t + RC5_t$ represents for the total operating lease payments for the next five years, known at time t.

[15] That is, the size of leased investment at time t is $\sum_{j=0}^{n-1} \frac{C_j}{(1+r)^j}$, but I approximate it at $\sum_{j=0}^{n-1} C_j$.

5.3 The Relative Use of Leased Investment

The relative use of off-balance-sheet investment is calculated as:

$$\alpha_t = \frac{I_t^f}{I_t^f + I_t^n}. \tag{17}$$

One concern with this approach is that although I_t^f and I_t^n are expected to be non-negative, measurement error reported in Compustat may render them negative. This issue of signs is especially problematic in measuring ratios. Consider, for example, a firm measured to have made a leased investment of −\$200 (a negative investment) and a balance-sheet investment of \$100. In this case, we expect the relative use of leased investment, α, to be quite low. However equation (17) measures α as 2, or 200%. To avoid this problem, I use the truncation method at 1% and 99% for the α measure, since only extreme outliers face this issue.[16]

5.4 Marginal Tax Rates

To determine the marginal tax rate for firms in this study, I use Graham's simulated marginal tax rates as τ measures. Because these marginal tax rate data are the main independent variable in the present study, I provide an overview of how the simulated data are constructed. (For a detailed discussion, see Graham and Mills (2008) or Graham et al. (1998).) Graham performed 50 simulations for each firm in each year by forecasting the firms' taxable income eighteen years into the future. This way, the marginal tax rates account for tax loss status through loss carryforwards and carrybackwards. For example, a firm with a net loss this year that carries the whole loss backward, might be able to benefit from the bonus depreciation schedule. On the other hand, if a firm has to carry the loss forward, the present value of the benefit, albeit reduced, would be far from zero, which would have been predicted if a marginal tax rate had been calculated based only on this year's financial statement. Note that before-financing marginal tax rates are used to avoid endogeneity concerns between debt level (i.e., a higher debt level indicates a lower after-financing marginal tax rate) and the use of off-balance-sheet investments. Note that the marginal tax rates in the highest bracket have been stable at 35% since 1993. Thus, variation in the tax rates comes mainly from tax loss status.

5.5 Measure of Financial Strength

Finally, a subsample of firms with $FW \approx 0$ needs to be chosen to represent firms considered as "strong" by the financial market. To identify this subsample, I use Altman's $ZScore$, an index widely used especially by practitioners and banks, in measuring the probability of a company

[16] Alternatively, I try to winsorize negative values for any of off-balance-sheet investment at zero; the results do not change much (not reported).

entering bankruptcy within a two-year period.[17]

While $Zscore$ fits perhaps perfectly the purpose of this study, I also use size-age index (or S-A index) as robustness checks. Developed by Hadlock and Pierce (2010), this index is least likely to suffer from endogenous financial decisions, as is explained in Chapter 1.[18]

5.6 Data Summary

The data consist of all Compustat Mining, Utilities, Construction, Manufacturing, Trade, and Transportation firms with SIC code between 1000 and 5999 from 1997 to 2007. As I restrict the sample to manufacturing-related industries, there would be few lessors in the sample. Focusing on firms in these industries and keeping only those with non-empty values for α, τ and the $ZScore$ around the 2002 temporary bonus depreciation period (i.e., at least from 2001 to 2005), the sample size of firm-year data reduces to 7550 with a total of 769 firms. Table 2 summarized the data for all the firm-year observations.

[**Table 2 around here**]

The left panel presents summary statistics for all firms, while the right panel presents summary statistics for the subset of financially strong firms that satisfy the following two conditions: (a) having an average $ZScore$ above 2.99; and (b) having a standard deviation of $ZScore$ below 2.5. According to Altman (1968), a firm with a $ZScore$ greater than 2.99 is considered as safe from bankruptcy. To exclude firms with their $ZScore$ fluctuating significantly over the sample years, I choose only firms with a stable $ZScore$, that is, those with a standard deviation of $ZScore$ over the sample years less than 2.5, the average across all firms.[19]

On average, the financially strong firms in my study use slightly more leased investment (.2621 vs .2491) and less purchased investment (.2592 vs .2751), compared to all firms. Consequently, their average relative use of leased investment (α) is higher than that of all firms (.3646 vs .3196). Also, their average marginal tax rate is also higher (.3221 vs .2893).

Figure 2 provides an illustration of the empirical relationship between marginal tax rates and $ZScore$s. Figure 2-1 specifically plots the marginal tax rates and $ZScore$ for all firms. Note that, for firms with a lower $ZScore$ (i.e., less than 0), marginal tax rates are mostly less than 0.1. In other words, firm-year observations in the lowest marginal tax rate bracket (from 0 to 0.1) have a disproportionately larger fraction of low $ZScore$s, implying different financial wedge values across marginal tax rates.

By contrast, Figure 2-2 plots the marginal tax rates and $ZScore$ for the subset of financially strong firms. Although the majority of marginal tax rates are greater than 0.3 for these firms,

[17] $ZScore$ is computed as the sum of 3.3*EBIT, 1.0*Sales, 1.4*Retained Earnings, 1.2*Working Capital, and 0.6*Equity(market)-to-Liabilities(book), divided by total assets.

[18] S-A index is computed as the sum of -0.737* size, 0.043* size^2, and - 0.040*age. The higher is the S-A index, the more financially constrained is the firm.

[19] Since the second condition is chosen arbitrary, I also use other thresholds of standard deviations – 1.5 and 4 – but the results are qualitatively the same (not reported).

there are still firm-level observations with a marginal tax rate below 0.3. Therefore, the financially strong firms also have enough variation in their marginal tax rates for the main analysis. Also, one can note that across the marginal tax rate brackets (0 to 0.1; 0.1 to 0.2; 0.2 to 0.3; and 0.3 to 0.4), the $ZScore$s are similarly distributed.

[Figure 2 around here]

6 Empirical Analysis

Figure 3 depicts the trends in purchased investments, leased investments, and the relative use of leased investment, for all firms and the financially strong firms, respectively. Across both sets of firms, the figures show a slight increase in relative leased investments during the sample period (1997 to 2007). Furthermore, they show that firms in general increase their leased investments relative to their purchased investments during the bonus depreciation period (2002 to 2004).

[Figure 3 around here]

It is also possible that this trend may simply reflect aggregate macroeconomic factors that affect leasing behaviors during the period, as discussed in Section 4. Thus, in estimating tax elasticity of leasing, identification comes from the higher tax incentives for leasing for lower-taxed lessees. Thus, I consider estimating the following equation:

$$\alpha_{it} = \beta_1 + \beta_2 D_t^{bonus} * \tau_{it} + \beta_3 \tau_{it} + \gamma X_{it} + f_i + y_t + \epsilon_{it}, \tag{18}$$

where α_{it} is firm i's relative use of leased investment, τ_{it} is firm i's marginal tax rate, D_t^{bonus} is a time dummy for the period 2002 to 2004 (i.e., the bonus depreciation period), X_{it} is the set of firm characteristics, f_i is the firm fixed effect, and y_t is the year fixed effect. The main coefficient, β_2, is expected to be negative, reflecting the hypothesis that lower-taxed firms have greater incentives to increase leasing activity in response to the 2002 policy period.

[Table 3 around here]

Table 3 reports the baseline estimations for the regressions. Columns (1) through (3) include all sample firms. In columns (1) and (2), the main coefficient (β_1) is estimated to be insignificant, albeit with the correct sign (-0.1567 and -0.1407). In column (3), I include industry-year fixed effects to control for industry-specific shocks over time. Since leasing activity may also be asset-specific (for example, aircraft and trucks are more likely to be leased), unobserved industry-wide shock in a certain year might lead to greater demand for leasing in a particular industry. When I control for industry-year shocks, the main coefficient becomes larger (-0.2187) and significant at the 10% level.

In columns (4) to (6), I use the financially strong firms to exclude the impact of non-tax motives of leasing, and conduct the same analysis as in columns (1) to (3). Note that for financially strong firms, all the coefficients for b_1 become larger and significant. Additional controls of both q and the $Zscore$ do not substantially change the results. In contrast, controlling for industry-specific shocks over time greatly increases both the size and significance of the main coefficient. To interpret the results based on the preferred specification (i.e., column (6)), a decrease in the marginal tax rate of one leads to a relative increase in leasing behavior of 0.3405 after the introduction of the 2002 bonus depreciation policy. That is, compared to a fully-taxed lessee (i.e., τ=0.35), a lessee with a marginal tax rate of zero (i.e., τ=0) increases the relative use of leased investment in response to the 2002 bonus depreciation by around 0.122 ($\approx$ 0.3405*0.35).

Also note that, with all sample firms used in column (3), the relative use of leased investment is expected to increase by only around 0.06 ($\approx$ 0.2187*0.35) in the same situation. This finding illustrates the severity of the endogeneity concern discussed in Section 4.

Finally, I repeat the same empirical analysis with an alternative size-age index (or S-A index) which measures financial constraints. The results, reported in Table 4, are similar quantitatively and qualitatively, so I conclude that the main results in Table 3 are not sensitive to the choice of financial strength measures.

7 Deadweight Loss and Policy Implications

The above empirical results show that firms respond to the 2002 bonus depreciation policy by increasing relative leasing of assets. In this section, I address the policy implications of this financing responsiveness for tax policies. While this paper does not attempt to investigate the effectiveness of the 2002 bonus depreciation policy in increasing total investment, I argue that the responsiveness to the tax policy in the dimension of financing implies less effectiveness of the tax policy than previously thought. In particular, I calculate the deadweight loss associated with altering financing methods after the introduction of the 2002 depreciation policy, as a fraction of additional government revenue cost per one-dollar of firm investment. The basic idea is as follows: the government attempts to offer greater tax benefits for firms at the expense of revenue cost; however its policy unintentionally distorts firms' financing incentives. The result is that firms' additional tax benefits from the tax policy, net of the deadweight loss, would be less than the government's additional revenue cost.

To illustrate this, I start with the total cash flow per one-dollar of investment given in equation (2):

$$(1-\tau_i)CF - \underbrace{\left[1 - \overbrace{[(\tau_i(z+D) + \alpha(\tau_R - \tau_i)(z+D-L) - \sigma(\alpha)]}^{\text{tax saving per one-dollar of investment}}\right]}_{\text{after-tax price per one-dollar of investment}}.$$

Note that the term inside the big bracket is the after-tax price per one-dollar of investment. Consequently, the tax saving per one-dollar of investment, the term inside the small bracket, consists of three terms: $\tau_i(z+D)$, $\alpha \cdot NAL$, and $\sigma(\alpha)$. That is,

$$\begin{aligned}\text{Tax saving per one-dollar of investment} &= 1 - \text{After-tax price per one-dollar of investment} \\ &= [\tau_i(z+D)] + \underbrace{[\alpha(\tau_R - \tau_i)(z+D-L)]}_{\equiv \alpha \cdot NAL} - \sigma(\alpha). \quad (19)\end{aligned}$$

I now examine each of the three terms.

(1) **Statutory tax saving**, $[\tau_i(z+D)]$: This term measures the statutory tax saving from depreciations and interest payments, absent of leasing consideration. Hence, a lower τ_i implies a lower statutory tax saving.

(2) **Tax saving through leasing**, $[\alpha \cdot NAL]$: This term measures the total net tax saving from leasing activity, calculated as the marginal net tax saving of leasing, multiplied by the amount of leasing. Thus, unlike the first term, a lower τ_i implies a *larger* tax saving through leasing.

(3) **Leasing adjustment costs**, $[\sigma(\alpha)]$: Finally, the third term measures leasing adjustment costs incurred by the lessee.

As mentioned, the 2002 bonus depreciation policy was enacted to temporarily provide firms with larger tax benefits per one-dollar of investment. From the government's point of view, this temporary depreciation policy implies *additional* revenue cost per one-dollar of investment. In order to calculate deadweight loss as a fraction of this additional government revenue cost, let us consider what happens to each term above after the introduction of the depreciation policy.

(1) **Additional statutory tax saving**, $\Delta[\tau_i(z+D)]$.
The only change to this term comes through an increase in z, so $\Delta[\tau_i(z+D)] = \tau_i(z_1 - z_0)$

(2) **Additional tax saving through leasing**, $\Delta[\alpha \cdot NAL]$.
In response to an increase in z, α increases as well. Thus, $\Delta[\alpha \cdot NAL] = \alpha_1 NAL_1 - \alpha_0 NAL_0 = [\alpha_1(\tau_R - \tau_i)(z_1 + D - L)] - [\alpha_0(\tau_R - \tau_i)(z_0 + D - L)]$

(3) **Additional leasing adjustment costs**, $\Delta[\sigma(\alpha)]$.
For this term, only α changes, so $\Delta[\sigma(\alpha)] = [\sigma(\alpha_1) - \sigma(\alpha_0)]$,

where subscripts 1 and 0 indicate with and without the bonus depreciation policy, respectively. Note that the first two terms (i.e., terms (1) and (2)) are just transfers between the government and firms, since a tax saving from the firm's perspective is the government's revenue loss. Hence, these terms do not generate efficiency costs. On the other hand, the third term is the source of deadweight loss, as it measures leasing adjustment costs lost along the way.

Thus, the total additional tax saving for a firm after the introduction of the bonus depreciation policy is calculated as the sum of terms (1), (2) and (3):

$$[\tau_i \Delta z] + [\alpha_1 NAL_1 - \alpha_0 NAL_0] + [\sigma(\alpha_1) - \sigma(\alpha_0)], \quad (20)$$

while the total additional revenue cost to the government is calculated as the sum of only (1) and (2):

$$[\tau_i \Delta z] + [\alpha_1 NAL_1 - \alpha_0 NAL_0]\,. \tag{21}$$

The calculation of the first term of equations (20) and (21) is straightforward. To calculate the second and third terms, see Figure 4 for the optimal level of leased investment given the amount of tax saving. In Figure 4, the y-axis reflects the net advantage (or cost) of leasing, while the x-axis reflects the relative use of leased investment, α. Since the adjustment cost of α is convex, the marginal cost, $\sigma'(\alpha)$, increases in α. That is, lessee i will equate the marginal cost to the net advantage of leasing, yielding the optimal level of α. Before the introduction, and after the expiration, of the 2002 bonus depreciation policy, lessee i chooses α_0 as a fraction of leased investment. However, during the 2002 bonus depreciation period, lessee i increases the relative use of leased investment to α_1 in response to an increased net advantage of leasing, NAL_1.

[Figure 4 around here]

Furthermore, in Figure 4, the area A+A'+C+C' measures the second term of equation (20) and (21), while the area C+C' measures the third term (i.e., the deadweight loss) of equation (20). Thus, the deadweight loss can be calculated approximately as:

$$\text{Deadweight loss} \approx (\alpha_1 - \alpha_0)NAL_1 = (\alpha_1 - \alpha_0)(\tau_R - \tau_i)(z_1 + D - L), \tag{22}$$

since the area A' is of a second-order.

To calculate the deadweight loss, I use the parameter values discussed in Table 5. I assume lessors are fully taxed at the marginal rate of 0.35; the leasing market is competitive; lessors finance 60% of asset values using debt; α_0, the relative use of leased investment before the introduction of the 2002 bonus depreciation, is 0.3; and the assets in the analysis has a seven-year recovery period under the current tax system. In addition, note that *predicted* value of α_1 is more appropriate for this purpose of deadweight loss calculation than is actual value of α_1, since $\widehat{\alpha_1}$ reflects only the impact of the accelerated depreciation on leased investment, while actual α_1 may contain other aggregate confounding factors. In this calculation, I predict $\widehat{\alpha_1} = \alpha_0 + (0.35 - \tau_i) * 0.3405$ based on the preferred specification in column (6) of Table 3.

[Table 5 around here]

Based on these parameter values, table 6 calculates each term of additional tax saving after the introduction of the 2002 bonus depreciation (i.e., equation (20)) for the three marginal tax rate brackets: 0 to 0.15; 0.15 to 0.25; and 0.25 to 0.35.

[Table 6 around here]

In Table 6, first note that the term $\Delta\,[\tau_i z]$, additional statutory tax saving, increases in the marginal tax rate. By contrast, the second term $\Delta\,[\alpha NAL]$, additional tax saving from leasing, decreases in the marginal tax rate, as higher-taxed lessees receive smaller tax benefits from the accelerated depreciation than lower-taxed lessees do. Consequently, higher-taxed lessees also have smaller additional adjustment costs, $\Delta[\sigma(\alpha)]$, or deadweight loss.

In interpreting this result, take as an example a firm in the lowest tax bracket (i.e., between 0 to 0.15). For every dollar of investment made by the firm, the 2002 accelerated depreciation policy costs the government around \$0.025 (in Column (5)). However, since the firm is taxed at a lower rate, it prefers to lease, so that the majority of the government revenue cost (\$0.018) comes from increased leased investment (in Column (2)). However the firm has lost more than half of its saving (\$0.013) while further deviating its relative use of leasing from the optimum level (in Column (3)).

Finally, deadweight loss as a fraction of additional revenue cost is calculated at approximately 5% (=0.001/0.020), 35% (=0.006/0.021) and 50% (=0.013/0.025), for firms in the high, medium and low tax brackets, respectively. In 2000, around 60%, 10%, and 30% of all firms are located in the high, medium, low tax brackets, respectively. Therefore, on average, around 20% (=5%*60% + 35% *10% + 50%*30%) of the additional revenue cost from the 2002 bonus depreciation policy is estimated to be deadweight loss.

8 Conclusion

In this paper, I study the tax responsiveness of firm leased investment to the 2002 bonus depreciation policy. To do so, I first derive the demand for leased investment as a function of tax parameters. Unlike a direct purchase, assets that a firm leases through an operating lease are not directly reported in accounting data, so I construct a leased investment measure as well. With this data, I find the relative use of leased investment responds strongly to the first bonus depreciation policy introduced in 2002. That is, firms with lower tax rates lease more capital after the introduction of the first bonus depreciation policy.

I then calculate the deadweight loss associated with this financing distortion in response to the temporary tax policy. For every dollar of investment, I find a firm receives, on average, \$0.016 of additional tax saving from the 2002 depreciation policy, of which around 20% is deadweight loss associated with the financing distortion. While I do not attempt to investigate the effectiveness of the 2002 bonus depreciation in increasing total investment, the results imply that the responsiveness of firms' leasing behavior to this policy renders the policy case for investment tax incentives weaker than one would expect absent the consideration of leased investment.

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Table 1: Comparison of purchasing vs. leasing cash flow for one dollar of investment

	Purchased Investment	Leased Investment	
Description of cash flow	User Firm i (Buyer)	Lessor R	User Firm i (Lessee)
Investment in the asset	-1	-1	
Lease payments		$+(1-\tau_R)L_R$	$-(1-\tau_i)L_i$
Cash flow from asset's operation	$+(1-\tau_i)CF$		$+(1-\tau_i)CF$
Depreciation tax shield generated by the asset	$+\tau_i z$	$+\tau_R z$	
Interest tax shield generated by the asset	$+\tau_i D$	$+\tau_R D$	

Note: Based on Smith and Wakeman (1985) Table 1, the author makes certain simplifications.

Table 2: Summary statistics

	All firms (769 firms)			Financially Strong Firms (357 firms)		
Variables	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
I^f	.2491	.0730	.5245	.2621	.0970	.4481
I^n	.2751	.1960	.3006	.2592	.2071	.2124
$\alpha\ (= \frac{I^f}{I^f+I^n})$	.3196	.2952	.3885	.3646	.3401	.2819
$ZScore$	4.3025	3.5783	20.7255	5.3668	4.7113	4.2009
Marginal Tax Rates	.2893	.3500	.1139	.3221	.3500	.0776

Note: The table presents summary statistics for all firms in the sample (left panel) and for only financially strong firms (right panel). Financially strong firms are defined as firms with an average $ZScore$ above 2.99 and a standard deviation less than 2.5 over the sample periods. The sample years extend from 1997 to 2007. Variable definitions appear in Sections 5.1 through 5.5.

Table 3: Baseline Regression Results

Sample Used:	All Samples			Financially Strong Firms		
	(1)	(2)	(3)	(4)	(5)	(6)
$D_t^{bonus} * \tau_{it}$	-.1567	-.1407	-.2187*	-.2714**	-.2723**	-.3405**
	(.1004)	(.0988)	(.1171)	(.1374)	(.1374)	(.1444)
τ_{it}	.0719	.0668	.1035	.1527	.1527	.2116*
	(.0753)	(.0744)	(.0765)	(.1160)	(.1159)	(.1202)
q		-.0020	-.0022		.0126**	.0138*
		(.0020)	(.0018)		(.0062)	(.0076)
$ZScore$		-.0010***	-.0012***		-0.0019	-.0019
		(.0003)	(.0003)		(.0012)	(.0015)
Years	1997-2007					
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-firm Fixed	No	No	Yes	No	No	Yes
Observations	7550	7550	7550	3556	3556	3556
Firms	769	769	769	357	357	357

Note: The dependent variable is the relative use of leased investment (i.e., the ratio of leased investment to total investment). The main independent variable of interest is $D_t^{bonus} * \tau_{it}$, by capturing whether a lower-taxed lessee increases the relative use of leasing even more in response to the bonus depreciation. Variable definitions appear in Sections 5.1 through 5.5. Financially strong firms are defined as firms with an average $ZScore$ above 2.99 and a standard deviation less than 2.5. All standard errors are clustered at the firm-level. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 4: Regression Results with Alternative Financial Index

Sample Used:	All Samples			Financially Strong Firms with respect to SA index		
	(1)	(2)	(3)	(4)	(5)	(6)
$D_t^{bonus} * \tau_{it}$	-.1567	-.1537	-.2290*	-.2497*	-.2704**	-.3095**
	(.1004)	(.0995)	(.1179)	(.1306)	(.1298)	(.1324)
τ_{it}	.0719	.0928	.1279*	.0460	.0742	.0924
	(.0753)	(.0744)	(.0769)	(.1151)	(.1139)	(.1038)
q		-.0010	-.0008		.0066	.0034
		(.0017)	(.0017)		(.0046)	(.0046)
SA index		.1251***	.1299***		0.1532	.1646
		(.0385)	(.0410)		(.0439)	(.0000)
Years	1997-2007					
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-firm Fixed	No	No	Yes	No	No	Yes
Observations	7550	7550	7550	3953	3953	3953
Firms	769	769	769	393	393	393

Note: The dependent variable is the relative use of leased investment (i.e., the ratio of leased investment to total investment). The main independent variable of interest is $D_t^{bonus} * \tau_{it}$, by capturing whether a lower-taxed lessee increases the relative use of leasing even more in response to the bonus depreciation. Variable definitions appear in Sections 5.1 through 5.5. Financially strong firms in this table are defined as firms with an average S-A index below -3.5. All standard errors are clustered at the firm-level. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 5: Parameter Values

Variable	Meaning	Value	How to Measure
τ_R	Lessor's tax rate	0.35	Assumed
D	Fraction of lessor debt financing	0.6	Assumed[1]
L	PV of lease payments	0.75	Calculated[2]
z_0	PV of depreciation allowances without bonus	0.88	Calculated[3]
z_1	PV of depreciation allowances with bonus	0.94	Calculated[3]
α_0	Relative use of leased investment without bonus	0.3	Assumed[4]
$\widehat{\alpha_1}$	*Predicted* relative use of leased investment with bonus	$0.3 + 0.3405 * (0.35 - \tau_i)$	Estimated in Section 6

Note: 1. According to BizStats, total liabilities in rental and leasing industries are estimated to be around 65% of total assets.

2. Assuming a competitive leasing market, $L = \frac{1-\tau_R(Z+D)}{1-\tau_R}$, based on equation (6).

3. z_1 and z_0 are calculated assuming a seven-year MACRS GDS period; and using a 5% interest rate.

4. See Figure 3.

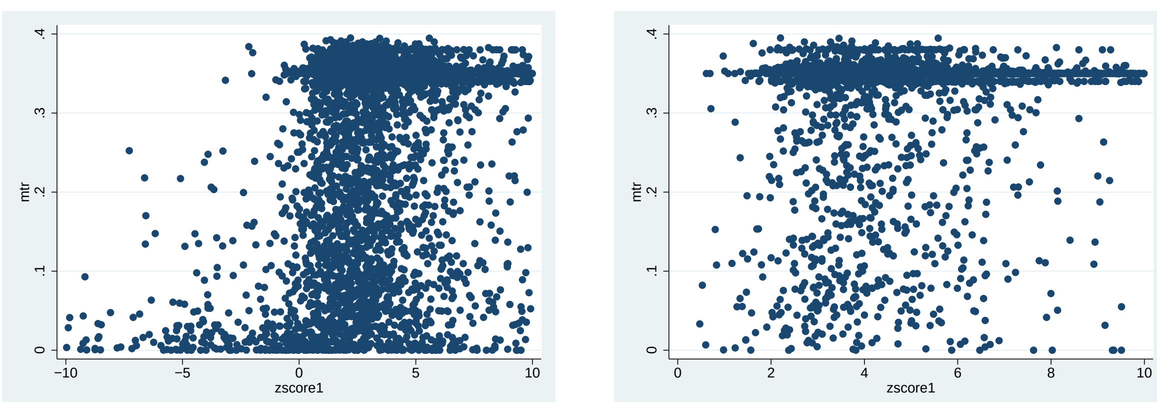
Table 6: Additional tax saving vs. additional revenue cost due to the 2002 depreciation policy per one dollar of investment

	(1)	(2)	(3)	(4)	(5)	(6)
Tax Bracket	$\Delta[\tau_i z]$	$\Delta[\alpha NAL]$	$-\Delta[\sigma(\alpha)]$	Firm Tax Saving (=(1)+(2)+(3))	Revenue Cost (=(1)+(2))	Deadweight Loss (=(5)-(4)=(3))
0 to 0.15	0.007	0.018	-0.013	0.012	0.025	0.013
0.15 to 0.25	0.012	0.009	-0.006	0.015	0.021	0.006
0.25 to 0.35	0.018	0.002	-0.001	0.019	0.020	0.001

Figure 1: Illustration of leased investment variable construction

t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5
A_0	A_1	A_2	A_3	A_4	A_5				
		B_0	B_1	B_2	B_3	B_4	B_5		
				C_0	C_1				
					D_0	D_1	D_2	D_3	D_4

Figure 2: Marginal Tax Rates and $ZScore$

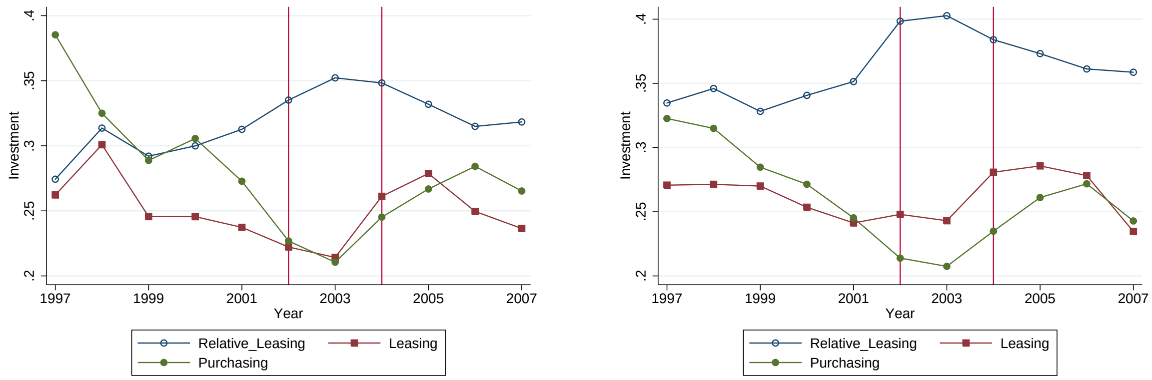


2-1. All firms

2-2. Financially strong firms

Note: These figures plot the marginal tax rates and $ZScore$s for all firms (Figure 2-1) and for solvent firms (Figure 2-2) in this study. Financially strong firms are defined as firms with an average $ZScore$ above 2.99 and a standard deviation less than 2.5. The sample years extend from 1997 to 2007.

Figure 3: Trends in purchased investment, leased investment, and the relative use of leased investment



3-1. All firms

3-2. Financially strong firms

Note: Figure 3-1 and 3-2 present the trends of leased investments, purchased investments, and the relative use of leased investment for all firms and for solvent firms, respectively, from 1997 to 2007. Variable definitions appear in Section 5.1 through 5.5. Financially strong firms are defined as firms with an average $ZScore$ above 2.99 and a standard deviation less than 2.5.

Figure 4: Determination of optimal relative use of leased investment