Three Essays in Tax Policy and Firm-Level Investment

by

Jongsang Park

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Economics)
in The University of Michigan
2012

Doctoral Committee:

Professor James R. Hines, Jr., Chair
Professor Matthew D. Shapiro
Professor Joel B. Slemrod
Associate Professor Uday Rajan

This dissertation is dedicated to my parents and to my wife, Soryun.

ACKNOWLEDGEMENTS

I owe my deepest gratitude to Jim Hines for his invaluable commitment to my research, as well as to my personal well-being, throughout the dissertation process. Our co-project, which becomes one of the chapters of the dissertation, could not have been possible without his academic insights, optimism and encouragement. I would like to thank other members of my dissertation committee: Joel Slemrod, Matthew Shapiro, and Uday Rajan for their insightful advice and continuous supports. I hope to become, someday, a great economist, as well as an excellent mentor, like my committee members.

Special thanks to Joel Slemrod and the Office of Tax Policy Research for providing "Michigan public financier" with such a great research environment. I would also like to recognize Gilbert Metcalf who first introduced me, while I was his student at Tufts, to the field of public finance, which I feel very grateful for. I am also grateful to John Graham (Duke) and Michael Roberts (UPenn) for generously providing me with their own data that greatly improved this dissertation.

I would also like to thank my friends whom I first met in Ann Arbor: especially, Roy Chen, Bert Lue, Noam Gruber, Kee Yeun Lee, Gi Hyun Kim, Jonathan Wong, David Agrawal, and KOTEF members, who helped me keep sane during this time.

I also thank my parents and my brother for their unconditional love and support. Last and most importantly, I thank my wife, Soryun Park, for always being there with the wisdom, support and love. No words can express how much I thank and love her.

TABLE OF CONTENTS

DEDICATION ii

ACKNOWLEDGEMENTS iii

LIST OF FIGURES vii

LIST OF TABLES viii

ABSTRACT ix

CHAPTER

I. Introduction 1

II. The Impact of Depreciation Savings on Investment: Evidence from the Corporate Alternative Minimum Tax 4

2.1 Introduction 4
2.2 Background 7
2.3 Literature Review 11
2.3.1 Previous Studies of Investment Incentives 11
2.3.2 Previous Studies of AMT 13
2.4 Model 14
2.4.1 Baseline Model 14
2.4.2 Introducing the AMT 15
2.4.3 Defining the AMT Year 16
2.5 Deriving the Investment Equation in the Presence of AMT . . 17
2.5.1 *Ex Ante* Expectation Regarding AMT Status 17
2.5.2 Depreciation Savings and Marginal Tax Rates in Expectation 18
2.5.3 Investment Demand Function: Tax-Adjusted q Revisited 21
2.6 Research Design and Data 24

2.6.1 Treatment and Control Groups 24
2.6.2 The Role of Expectation in Identification 25
2.6.3 AMT Status Data 29
2.6.4 Other Variables 30
2.7 Empirical Results 31
2.7.1 Baseline Regression Difference-in-Difference 32
2.7.2 The Role of the Perfect Foresight Assumption . . . 34
2.7.3 Robustness Checks 36
2.7.4 Other Explanations 37
2.8 Discussion: Estimation of the Tax-adjusted q Model 38
2.9 Conclusion 43
2.10 Appendix 57

III. Investment Ramifications of Distortionary Tax Subsidies . . 66

3.1 Introduction 66
3.2 Model 70
3.2.1 Framework 70
3.2.2 Bond Market Equilibrium 75
3.2.3 Investment Implications 76
3.2.4 Implications for Profitability 80
3.2.5 Relation to other Agency Cost Models 82
3.3 Extensions to the Model 83
3.3.1 Bond covenants 83
3.3.2 Default and bankruptcy 86
3.3.3 Timing of tax credits 86
3.4 Bond Covenants and Borrowing around the Bonus Depreciation Era 89
3.4.1 Data 90
3.4.2 Loan Covenants and Bonus Depreciation. 92
3.4.3 Bonus Depreciation and Borrowing 98
3.5 Conclusion 101
3.6 Appendix 115

IV. The Role of Leasing in the Effectiveness of Corporate Tax Policy: Evidence from the 2002 Bonus Depreciation 118

4.1 Introduction 118
4.2 Background 122
4.3 Model 124
4.3.1 Tax and Leasing 124
4.3.2 Deriving Demand for Leased Investment 125
4.3.3 Source of Non-tax Financial Benefit of Leasing . . . 129
4.4 Empirical Strategy 132
4.5 Data Description and Variable Construction 135

4.5.1 Balance-Sheet Investment 135
4.5.2 Off-balance-sheet Investment, or Leased Investment 135
4.5.3 The Relative Use of Leased Investment 136
4.5.4 Marginal Tax Rates 137
4.5.5 Measure of Financial Strength 138
4.5.6 Data Summary 138
4.6 Empirical Analysis 140
4.7 Deadweight Loss and Policy Implications 141
4.8 Conclusion 146

BIBLIOGRAPHY 155

LIST OF FIGURES

Figure

2.1	AMT years and the evolution of AMT credit carryforwards	53
2.2	10-year selection window for treatment and control groups	53
2.3	Decomposition of variations in the tax variable	54
2.4	Research design	54
2.5	Investment trends.	55
2.6	Various 10-year selection windows under perfect foresight assumption	56
3.1	Timeline of events	113
3.2	Credit-induced cost changes along an isoquant	113
3.3	Aggregate use of bond covenants: Trends of four proxies	114
3.4	Aggregate trends of number of all financial covenants	114
4.1	Illustration of leased investment variable construction	153
4.2	Marginal tax rates and Z-score	153
4.3	Trends in investment and the relative use of leased investment	154
4.4	Illustration of efficiency costs associated with leasing activity	154

LIST OF TABLES

<u>**Table**</u>

2.1 Present value of depreciation allowances z 45
2.2 Calculating an AMT bill 45
2.3 Changes in z before and after 1999 46
2.4 Size of variation in the tax variable 46
2.5 Summary statistics 47
2.6 Baseline regression of investment 48
2.7 The role of the perfect foresight assumption 49
2.8 Robustness checks 50
2.9 Testing observed heterogeneity 51
2.10 Comparison of tax term coefficients 52
3.1 Summary statistics 103
3.2 Illustration of firm-types 104
3.3 Firm characteristics comparison across firm types 105
3.4 Debt restrictiveness comparison across firm types 106
3.5 Regressions of debt covenant intensity during the 1999-2007 period . 108
3.6 Regressions of private debt market participation 110
3.7 Regressions of private debt size 111
3.8 Regressions of total debt issuance (Compustat measures) 112
4.1 Comparison of purchasing vs. leasing cash flow 148
4.2 Summary statistics 149
4.3 Baseline regression results 150
4.4 Regression results with alternative financial index 151
4.5 Parameter values for deadweight loss calculations 152
4.6 Efficiency cost calculation 152

ABSTRACT

Three Essays in Tax Policy and Firm-Level Investment

by

Jongsang Park

Chair: James R. Hines, Jr.

This dissertation concerns the impact of government tax policies on firm investment behavior, an important policy topic in light of the recent frequent use of investment-tax policies in the United States. It starts by examining the general effectiveness of an investment-tax policy and proposes an alternative explanation for the puzzling inability of such policies as countercyclical tools. It also investigates financing distortions unintentionally caused by investment-tax policies.

The first essay investigates the effectiveness of depreciation policies as investment incentives, by examining investment patterns surrounding the 1999 shortening of the Alternative Minimum Tax (AMT) depreciation recovery periods. With clean identification from the AMT, this essay provides strong evidence that firms subject to the AMT increase their investment, compared to firms subject to the regular tax. By contrast, the 2002 introduction of bonus depreciation, available both for firms subject to the regular tax and for firms subject to the AMT, appears to affect both groups of firms similarly, suggesting that the main result is not likely to be an artifact of firm heterogeneity.

The second essay, co-written with James R. Hines, Jr., examines the investment

effects of tax subsidies for which some assets and not others are eligible. The 2002 bonus depreciation encourages firms to concentrate investment in tax-favored longer-lived assets. Anticipation of asset substitution makes borrowing more expensive, which in turn discourages investment. Using detailed dataset of debt covenants in the United States, it provides evidence that firms whose investment decisions are more likely to be distorted by the policy are given more restrictive loan terms when the bonus depreciation is available.

The third essay derives the demand for leased capital as a function of tax parameters, and uses the model to estimate the responsiveness of leasing to the 2002 bonus depreciation, finding strong evidence that depreciation allowances influence leasing patterns. The deadweight loss associated with the observed financing distortion is also calculated, and 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.

CHAPTER I

Introduction

This dissertation is comprised of three essays that concern the impact of government tax policies on firm investment behavior. Each chapter uses variations in investment incentives generated by policy changes in the depreciation allowance system, which has been one of the main policy targets over the past decades in the United States. Significant efforts have been made to investigate the effectiveness of such investment tax policies by economists and policymakers, but the results reported in the literature are largely mixed, primarily due to empirical challenges surrounding such tax policies. The huge gap between the empirical evidence and the theory is so puzzling that there now is a growing concern that such depreciation policies may inevitably be ineffective for providing investment incentives, because of the way firms treat depreciation deductions. The essays in this dissertation seek to provide new evidence on the effectiveness of investment tax policies with an emphasis on depreciation policies. The dissertation starts by examining the general effectiveness of a depreciation policy in an environment where such empirical challenges are minimized. It then proposes an alternative explanation for the puzzling inability of such policies to act as countercyclical tools. It also investigates financing distortions unintentionally caused by investment-tax policies.

The first essay investigates the effectiveness of depreciation policies as investment incentives, by examining investment patterns surrounding the 1999 shortening of the Alternative Minimum Tax (AMT) depreciation recovery periods. With clean identification from the AMT, this essay provides strong evidence that firms subject to the AMT increase their investment, compared to firms subject to the regular tax. By contrast, the 2002 introduction of bonus depreciation, available both for firms subject to the regular tax and for firms subject to the AMT, appears to affect both groups of firms similarly, suggesting that the main result is not likely to be an artifact of firm heterogeneity. The estimation uses an empirical specification developed from the Summers (1981) tax-adjusted q model, and the results imply that the responsiveness of investment to the tax term is somewhat larger than previously estimated.

The second essay, co-written with James R. Hines, Jr., examines the investment effects of tax subsidies for which some assets and not others are eligible. Distortionary tax subsidies concentrate investments in tax-favored assets, thereby reducing the expected pre-tax profitability of investment and reducing payoffs to bondholders in the event of default. Anticipation of asset substitution encourages lenders to require covenants in bond contracts, which only imperfectly address asset substitution and impose their own distortions on the investment process. The result is that borrowing is made more expensive, which in turn discourages investment. Borrowing rates can react so strongly that aggregate investment may rise very little, or even fall, in response to higher tax subsidies. Bonds issued by U.S. firms in risk of default after the 2002 introduction of bonus depreciation for U.S. equipment investment contained many more covenants than in other periods, a pattern that reversed when bonus depreciation was discontinued after 2004; furthermore, it appears that firms at risk of default borrowed very little during that period.

The third essay derives the demand for leased capital as a function of tax parameters, and uses the model to estimate the responsiveness of leasing to the 2002 bonus depreciation, 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. The deadweight loss associated with the observed financing distortion is also calculated, and 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.

In sum, the results presented in this dissertation imply that firms appear to take tax incentives into account in making investment decisions, but that it is possible that the way investment tax policies are designed may generate unintended consequences in financial markets and leasing markets, making such policies less effective.

CHAPTER II

The Impact of Depreciation Savings on Investment: Evidence from the Corporate Alternative Minimum Tax

2.1 Introduction

Investment has long been recognized by both economists and policymakers as an important factor in short-run aggregate demand fluctuations as well as long-run capital accumulation. Indeed, the United States government has frequently changed the three main tax instruments – corporate tax rates, investment tax credits, and depreciation allowances – because the neoclassical investment model implies that investment responds to changes in these three instruments. However, empirical evidence has not been very supportive until recently when the focus of empirical studies was shifted to cross-sectional variations based on firm-level or asset-level data, as in Auerbach and Hassett (1991), Cummins et al. (1994), and Desai and Goolsbee (2004).

These studies use as the source of identification several tax reforms, enacted over the course of more than 30 years, that typically result in simultaneous changes to at least two of these tax instruments. One concern that arises is the possibility that these tax instruments may play asymmetric roles in describing investment incentives. As Summers (1987a) points out, the interest rates used by firms to discount future depreciation deduction streams in calculating the present value of depreciation allowances may be much higher compared to economists' likely assumptions. On the other hand, the effects of corporate tax rates and investment tax credits on the tax liability are calculated in a straightforward manner by researchers, and perhaps by firms as well. Moreover, from the perspective of a firm, investment tax credits are provided in a more immediate and salient way, relative to depreciation allowances. Then in the presence of agency problems with short-tenured managers, generous depreciation allowances may not be appreciated as much as investment tax credits, as it takes more time to recognize their benefits. In addition, Neubig (2006) argues that firms prefer lower corporate tax rates to higher depreciation allowances for other accounting and practical reasons.[1]

Nevertheless, of the three major tax instruments, depreciation allowances have changed most frequently in the United States. Especially over the past decade, in hopes of stimulating the economy, investment incentives have been provided in the form of depreciation allowances, namely, bonus depreciation.[2] So far, mixed results have been reported regarding responses to the bonus depreciation policy. Edgerton (2009) reports no evidence for effects of the policy, whereas other researchers have found that firms exploit bonus depreciation by temporarily weighting longer-lived assets more heavily (House and Shapiro, 2008) or by using more tax-favorable financing methods such as leasing (Chapter 4 of this dissertation). In any case, it still remains unclear whether *levels* of total firm-level investment are responsive to the recent changes in depreciation allowances.

There have, to my knowledge, been few attempts to investigate the responsiveness of investment to depreciation allowances, independently of other tax instruments. In

[1]Neubig (2006) argues, for example, that a generous depreciation system does not reduce the effective tax rate for accounting purposes, which matters to corporate tax directors and officers.

[2]Corporate tax rates and investment tax credits have seen almost no changes since 1986, the only exception being in 1993, when the corporate tax rate in the top bracket was increased from 34% to 35%.

this essay, I investigate whether firm investment is responsive to changes in depreciation savings by exploiting the 1999 change in the corporate Alternative Minimum Tax (AMT) depreciation rule that converged the previously disadvantaged AMT recovery period to the favorable regular depreciation recovery period.

I first extend the standard investment model to consider the conditions under which investment incentives are characterized by the AMT system. Then, from SEC 10-K filing data, I identify two groups of firms in terms of whether investment incentives are characterized by the AMT or regular tax system. Using a difference-in-difference approach, I find strong evidence that AMT firms increase investment after 1999.[3] Specifically, my empirical results show that firms subject to the AMT respond to the reform by increasing investment, measured as the ratio of capital expenditures to capital stock, by around 0.04 to 0.07. Given their average annual investment rate of approximately 0.25 during this period, the results imply a relative increase in investment of 17%-27%. To test the validity of my identifying assumption, I examine the firms' responses to the 2002 bonus depreciation available to both groups, and find similar results for both groups of firms. The estimation uses an empirical specification developed from the Summers (1981) tax-adjusted q model, and the results imply that the responsiveness of investment to the tax term is larger than previously estimated, most likely due to the new identification strategy employed in this essay.

The rest of this essay is organized as follows. Section 2.2 provides a discussion of depreciation allowances and the corporate AMT. In Section 2.3, I review the literature on corporate investment and AMT. In Section 2.4, I formally introduce AMT to the firm maximization problem. The investment equation is derived in Section 2.5. My research design and data construction are explained in Section 2.6, and the main empirical results are presented in Section 2.7. In Section 2.8, I discuss the implications of the empirical results for estimation of the tax-adjusted q model. Section 2.9

[3] Figure 2.5 summarizes the main results.

concludes.

2.2 Background

Background 1. Depreciation Allowances

In calculating corporate taxable income, firms are permitted certain deductions from revenue for the taxable year. Capital expenditure is first capitalized; and then depreciated and deducted over a certain amount of time (also known as the recovery period). In calculating the amount of annual depreciation, firms use a balancing method that specifies the extent to which the depreciation allowance is front-loaded over a given period.

US tax code assigns a recovery period and a balancing method according to the type of asset. For example, as of 2011, an asset used in the manufacture of aerospace products is depreciated over seven years using the 200% balancing method. The deduction stream allowed for this type of asset for a one-dollar purchase is illustrated in Table 2.1. The present value of depreciation allowances, typically denoted as z in the literature, measures how much of the per-dollar capital expenditure is deducted from taxable income. Consequently, depreciation saving is generally calculated as z multiplied by the corporate tax rate, τ.

Depreciation rules have changed frequently over the years. Most recently,[4] the Tax Reform Act of 1986 created the modified accelerated cost recovery system (MACRS), under which two recovery periods are assigned to each type of property, one based on the general depreciation system (GDS), and the other based on the alternative depreciation system (ADS).[5] Although most assets placed in service are depreciated under GDS, as in the example in Table 2.1, ADS is used in special cases, such as prop-

[4] A change in the depreciation rules for the corporate Alternative Minimum Tax system in 1999 is described in the following section.

[5] See Section 168(g) of the Internal Revenue Code, as well as Revenue Procedure 87-56 and 87-57.

erty used predominantly outside the United States, tax-exempt use properties, and tax-exempt, bond-financed properties. Depreciation allowances for the Alternative Minimum Tax system also used the ADS recovery period until 1999 (see Appendix 1 for GDS and ADS recovery periods for selected properties; note that, for each type of asset, recovery periods are longer under the latter than under the former).

In 2002, the US government attempted to stimulate aggregate demand through temporary increases in depreciation allowances, also known as bonus depreciation. The first bonus depreciation, signed into effect as part of the Job Creation and Worker Assistance Act (JCWAA), allowed 30% of new assets purchased after September 11, 2001 to be written off immediately, with the remaining portion to be depreciated under the regular MACRS schedule. In 2003, the first-year accelerated allowance was increased from 30% to 50%. The first bonus depreciation policy expired at the end of 2004; the second was enacted again in 2008; and, as of 2011, complete expensing (z=1) becomes temporarily available.

Background 2. Corporate Alternative Minimum Tax

The Tax Reform Act of 1986, responding to public criticism that large, profitable firms were paying too little in income tax, established the corporate AMT in its current form. The AMT requires all firms to calculate two tax bills each year, one using the regular tax rule, and the other using the AMT rule. The firm must then use whichever rule yields the larger tax liability.[6] The calculation of the AMT is illustrated in Table 2.2.

The AMT taxable income base is broadened in step 2, in which a firm adds "adjustments and preferences" to its regular taxable income to calculate its minimum taxable income. This is the step in which several types of deductions, allowed only

[6] A firm is exempt from the AMT if it qualifies as "a small corporation" under Section 55(e) of the Internal Revenue Code. As these firms are not the focus of the paper, however, I assume here that all firms are required to calculate both tax bills.

under the regular tax system, not under the AMT system, are added back in. Thus, the more adjustment and preference items a firm must add back in step 2, the more likely the AMT system will yield a larger tax liability. This also implies that, the greater the deductions, relative to revenue, claimed under the regular tax system, the more likely a firm will need to make additional tax payments. Multiplying the alternative minimum taxable income by the 20% tax rate yields the tentative minimum tax bill, which is compared to the regular tax bill to determine if a positive AMT is due.[7]

Studies by Lyon (1997) and Carlson (2005a), based on actual tax return data, show two major upward adjustments from regular taxable income to alternative minimum taxable income are: (1) the depreciation adjustment, and (2) the adjusted current earnings (ACE) adjustment. Specifically, Carlson (2005a) reports that 63.2% of total adjustments and preferences comprised the depreciation adjustment in 1999. Given that the less generous AMT depreciation allowances during the pre-reform period are a key element of the empirical study in this essay, it is not surprising that most firms required to pay the AMT have a positive depreciation adjustment.[8] The second largest adjustment, the ACE adjustment, is calculated as 75% of the difference between pre-ACE AMT income and ACE. By adding back items excluded in taxable income but included in earnings and profits (E&P) such as tax-exempt interest income, and by disallowing such deductions as dividends and drilling costs, the ACE

[7] Because both tax bills must be calculated each year, net operating loss (NOL) for both tax systems should also be calculated and maintained separately. For example, suppose in year 0, a firm has taxable income of negative $1M under both the regular and AMT tax systems. This firm's regular NOL and AMT NOL carryforwards will then both be $1M at the end of year 0. Suppose further that in year 1, this firm, with large gross revenue, has sufficient deductions allowed only under the regular tax system that its regular taxable income is $0, but the AMT taxable income (in step 3) is $1M. At the end of year 1, this firm's regular NOL carryforward is still $1M (unused), but its AMT NOL, because 90% is used in step 4, will be $0.1M. However, my empirical analysis ignores loss status, which Edgerton (2010) shows to have a small effect on investment.

[8] It may also imply that endogeneity concerns may arise from the interaction between investment and AMT status, but this concern is mitigated by the way AMT firms are selected in this study. See Section 2.6 for further discussion.

adjustment renders AMT income closer to E&P.[9]

Furthermore, in the AMT calculation, positive AMT payments are carried forward indefinitely to reduce future regular tax liability. However, these credit carryforwards cannot reduce a firm's tax liability below the tentative minimum tax against which regular tax liability is compared to determine if a positive amount of AMT is due. When the AMT credit carryforwards are exhausted, a firm returns to the regular tax system. Unless a firm's tentative minimum tax tends to be systematically higher than its regular tax, therefore, the role of the AMT is to smooth out tax bills over time rather than to discretely increase a firm's tax liability. Nonetheless, I argue in this essay that AMT status plays an important role in determining investment incentives for firms affected by the AMT for an extended period.

Whereas the AMT system used to be based on ADS, for which the recovery period is longer than for GDS, the Taxpayer Relief Act of 1997 changed the AMT recovery period for assets placed in service after 1999 from ADS to GDS. Consequently, depreciation allowances are made favorable only for the AMT system through shorter recovery periods, while the depreciation rule remains the same for the regular tax system.[10] Table 2.3 presents an illustration of increases in z for the same asset as in Table 2.1.[11]

For the purposes of the present study, a number of advantages of the AMT re-

[9]Since 1993, the three main tax instruments – marginal tax rates, investment tax credits, and depreciation allowances – are not altered through the ACE adjustment. Thus, I do not consider items of the ACE adjustment to have impacts on investment incentives. However, a firm had been required to calculate depreciation allowances under a *third* method based on the ACE depreciation system for assets placed in service, before the ACE depreciation system was repealed in 1993. See Lyon (1997) for the detailed adjustment items.

[10]Because of the requirement to calculate both tax bills every year, each firm in the study used ADS for the minimum tax bill, and GDS for the regular tax bill before 1999. In Section 2.5, I discuss the conditions under which a single depreciation system dominantly characterizes a firm's investment incentive.

[11]An asset used in the manufacture of aerospace products is chosen as an example because it resembles a representative type of capital good. That is, under MACRS, seven years is closest to the weighted average of GDS recovery periods across all types of assets. Also, assets with a 7-year GDS recovery period typically have a 10-year ADS recovery period. Thus, this type of asset, with 7-year GDS and 10-year ADS recovery periods, is representative.

form are worth noting. First, because this tax reform directly affects depreciation allowances among the three main tax instruments, it allows a transparent estimate of the role of depreciation allowances in firm investment. Second, firms under the regular tax system, for which the depreciation rule remained unchanged around the reform, can be used as a control group in a difference-in-difference study. Lastly, the policy change was implemented just three years before the 2002 bonus depreciation granted generous depreciation allowances regardless of AMT status. This affords an opportunity to test the validity of the assumption I make for the difference-in-difference approach.

2.3 Literature Review

2.3.1 Previous Studies of Investment Incentives

Hall and Jorgenson (1967) first constructed the user cost of capital that represents the return required to justify the opportunity cost of an additional unit of capital. Assuming that tax parameters and price levels remain unchanged, the after-tax acquisition cost for one-dollar of capital is one dollar minus investment tax credits and the associated depreciation saving, $(1 - ITC - \tau z)$. Hence, the after-tax opportunity cost of one-dollar of capital is $(r + \delta)(1 - ITC - \tau z)$ where the interest rate, r, and the economic depreciation rate, δ, represent the financial opportunity cost and the physical opportunity cost, respectively. Because the return from capital should compensate for the negative impact of the marginal tax rate, τ, on after-tax profits, the before-tax required return from an additional unit of capital is the after-tax opportunity cost divided by $(1 - \tau)$. That is,

$$\text{user cost of capital} = (r + \delta)\left[\frac{1 - ITC - \tau z}{1 - \tau}\right]. \tag{2.1}$$

While the user cost of capital model discussed above concerns the optimal level of capital stock, the tax-adjusted q model derived by Summers (1981) explicitly includes adjustment costs to directly derive a formula for the optimal level of investment, and thus provides the main empirical equation for the firm-level empirical studies of Cummins et al. (1994), Desai and Goolsbee (2004), and Edgerton (2010). Specifically, the tax-adjusted q model states that investment should be made up to the point at which the *after-tax* marginal adjustment cost of investment is equal to the marginal benefit of investment, $[q - (1 - ITC - \tau z)]$, which is the shadow value of capital (q) minus the after-tax acquisition cost of capital goods. Assuming adjustment costs to be fully expensed, Summers (1981) proposes that firms compare the *before-tax* marginal adjustment cost of investment to the tax-adjusted q term, or:

$$\frac{q - (1 - ITC - \tau z)}{1 - \tau} = \frac{q}{1 - \tau} - \frac{1 - ITC - \tau z}{1 - \tau}, \tag{2.2}$$

to determine their investment level.[12] Cummins et al. (1994) reports significant empirical results using several specifications, one with user cost of capital as the tax incentive, and another with the tax-adjusted q. Desai and Goolsbee (2004) and Edgerton (2010), exploiting the additivity of the two terms in equation (2.2) in an attempt to avoid possible measurement errors in q terms, also report significant estimates of the second term coefficient.

Note that these firm-level studies all include year fixed effects to control for aggregate variation (i.e., macroeconomic conditions as well as common effects of tax reforms) and constructed depreciation allowances (z) and investment tax credits (ITC) as industry-average measures. Essentially, they test whether firm investment is more likely to be increased in industries with assets that benefit more from tax reforms.

[12]Note that the second term in equation (2.2) represents the ratio of the after-tax per-dollar *acquisition* cost of capital goods $(1 - ITC - \tau z)$ to the after-tax per-dollar *adjustment* cost of capital goods $(1 - \tau)$, whereas the term inside the bracket in equation (2.1) is the after-tax per-dollar acquisition cost of capital goods modified to compensate for reduced profitability due to the corporate tax. The two tax terms look identical because of the assumption that adjustment costs are fully expensed. In the tax-adjusted q model, the reduced profitability due to τ is reflected in q.

The identifying assumption is, therefore, the same responsiveness of investment to tax policies across different assets and industries. I will come back to discussion about this assumption in Section 2.8.

Since the bonus depreciation was introduced in 2002, researchers have reported mixed results on whether firms take advantage of the depreciation subsidy. House and Shapiro (2008) shows that investment in assets with a very long tax life sharply responds to the 2002 bonus depreciation, compared to investment in assets with a short tax life. Edgerton (2009), however, provides evidence that the relative prices of new and used equipments do not respond to the bonus depreciation, although the tax policy only affects new equipments. In addition, it is noteworthy that Knittel (2007) and Kitchen and Knittel (2011) present evidence that only about half of the eligible investment was claimed for bonus depreciation, and that it is probably due to the limited use of depreciation subsidy for firms in a loss status.

2.3.2 Previous Studies of AMT

A second stream of relevant research for this study is that related to the effects of the corporate AMT. Bernheim (1989) argues that the AMT depreciation system provides more uniform investment incentives for different types of assets, and as a result, firms permanently affected by the AMT is less distorted by the tax system. Lyon (1990) numerically shows that the user costs of capital are generally higher for firms temporarily subject to the AMT than for firms permanently subject to the regular tax system. In each study, the research question revolves around whether being subject to the AMT discourages investment (or distorts investment decisions) relative to being subject to the regular tax system. By contrast, this study asks whether the investment levels increase for firms subject to the AMT after 1999.

Finally, Carlson (2005b) finds that economy-wide factors, industry fixed effects, and individual firm characteristics all have statistical powers in explaining which firms are likely to be affected by the AMT. These results, based on tax return data, are also confirmed by data collected through SEC 10-K filings in this study.

2.4 Model

2.4.1 Baseline Model

In this section, I present a baseline investment model that assumes a firm to be subject to the regular tax system. This firm maximizes its value at time t,

$$V_t = \sum_{s=t}^{\infty} \rho^{s-t} CF_s, \tag{2.3}$$

where ρ is the discount factor and CF_s is the after-tax cash flow of the firm at time s:[13]

$$\begin{aligned} CF_s = \quad & (1-\tau_s^R)F(K_s) - (1+(1-\eta\cdot\tau_s^R)\Psi)I_s \\ + \quad & \tau_s^R \left[\sum_{u=-\infty}^{s} \left(D_u^R(s-u)\right)(1+(1-\eta)\Psi)I_u \right], \end{aligned} \tag{2.4}$$

where $F(K_s)$ is the production function; τ_s^R is the regular tax rate; $\Psi(\cdot)$ is the convex adjustment costs, of which the fraction of η is expensed; and $D_u^R(s-u)$ is the time s GDS depreciation deduction of investment made at time u ($< s$).

When η is one, as in Summers (1981), the after-tax per-dollar adjustment cost is (1-τ_s^R); that is, adjustment costs are immediately deducted (or expensed). When η is zero, as in Auerbach (1989b), the adjustment costs are deducted in the same way that acquisition costs are deducted.[14] Cash flow is rearranged as:

$$CF_s = F(K_s) - (1+\Psi)I_s - \underbrace{\tau_s^R \left[F(K_s) - \eta\cdot\Psi\cdot I_s - \sum_{u=-\infty}^{s} \left(D_u^R(s-u)\right)(1+(1-\eta)\Psi)I_u \right]}_{\text{Regular Tax Bill} \equiv TB_s^R}.$$

[13] The relative price of investment to output is assumed to be unity for simplicity.

[14] Most empirical studies follow Summer's assumption ($\eta = 1$), but this generalized setup clarifies the different sources of the net-of-tax rate that appear in empirical investment equations.

2.4.2 Introducing the AMT

With the AMT system, the firm is required to calculate both the regular tax bill and the minimum tax bill.[15] The minimum tax bill is calculated as:

$$\begin{aligned} TB_s^m &= \tau_s^m \cdot TI_s^m \\ &= \tau_s^m \left[F(K_s) + G - \eta \cdot \Psi \cdot I_s - \sum_{u=-\infty}^{s} \left(D_u^m(s-u) \right) (1 + (1-\eta)\Psi) I_u \right] \end{aligned} \tag{2.5}$$

where G represents preferences and adjustments other than depreciation adjustments; and $D_u^m(s-u)$ is time s' ADS depreciation deduction of investment made at time u.[16] Note that, assuming the top tax bracket for the regular tax bill, $\tau^R = 0.35$ and $\tau^m = 0.2$. However, since the AMT tax base is broader, it is ambiguous as to which tax bill is higher.

The firm's cash flow in the presence of the AMT system is:

$$\begin{aligned} CF_s = \quad & F(K_s) - (1+\Psi)I_s - TB_s^R - \underbrace{\max\{TB_s^m - TB_s^R, 0\}}_{\text{AMT payment}} \\ + \quad & \underbrace{\min\{M_{s-1}, \max\{TB_s^R - TB_s^m, 0\}\}}_{\text{limited use of AMT credit carryforwards}}, \end{aligned} \tag{2.6}$$

where M_{s-1} represents for AMT credit carryforwards at the end of time s-1 (or at the start of time s). The evolution process of this term is:

$$M_s = max\{M_{s-1} + (TB_s^m - TB_s^R), 0\}, \tag{2.7}$$

[15] Recall from Table 2.2 that, in fact, "tentative minimum tax" is compared to "regular tax" to determine whether a firm is required to pay a positive AMT. However, I use "regular tax bill" and "minimum tax bill" in this section as they are in accord with the flow of the analysis without causing confusion.

[16] I assume G to be a firm- or industry-specific element not correlated with K_t or I_t. G includes, for example, those interest and dividend income deductions which are allowed under the regular tax system, but disallowed under the AMT system.

with $M_0 = 0$. Note that since AMT credit carryforwards are non-refundable, they are bounded by zero; that is, at any time t, $M_t \geq 0$.

2.4.3 Defining the AMT Year

Before discussing the conditions under which investment incentives are characterized by the AMT system, I first define the AMT year, or, the time during which a firm is subject to the AMT. A firm is considered to be subject to the AMT in a year when its AMT bill is the binding tax bill. Thus, in an AMT year, its current marginal tax rate is the AMT rate; and its asset recovery rule follows the AMT recovery rule.[17]

A firm's binding tax bill is its AMT bill in one of two cases: (Case 1) it currently makes a positive AMT payment, or (Case 2) it does not pay AMT, but its use of AMT credit carryforwards is limited by its minimum tax bill. In either case, it is straightforward to show that the firm's relevant tax bill is its minimum tax bill (TB_s^m) and its AMT credit carryforwards at the end of period (M_s) are strictly positive, an important key to data collection procedure.[18]

Figure 2.1 illustrates the AMT years and evolution of AMT credit carryforwards for a hypothetical firm. The white bars represent the firm's annual regular tax bills, the black bars represent its annual minimum tax bills, and the gray bars represent its AMT credit carryforwards at the end of each year. The firm is assumed not to have been subject to the AMT before year t. For example, suppose at time t, a firm's regular tax bill and minimum tax bill are \$10 and \$100, respectively. In this case, the positive AMT payment of \$90 becomes an asset (that is, it becomes AMT credit carryforwards) at the end of year t. The next year (year $t+1$), suppose that the firm's

[17] That a firm's current tax calculations are based on the AMT rules in an AMT year does not necessarily mean that the AMT system characterizes the firm's investment incentives in that year. Indeed, in Section 2.6, I argue that the AMT system characterizes investment incentives for only those firms that expect to be continuously subject to the AMT for an extended period. Nonetheless, defining an AMT year is a necessary step in the discussion.

[18] See Appendix 2 for a formal proof. Lyon (1997), Carlson (2005a) and Carlson (2005b) use these two criteria to construct aggregate measures of AMT. This section supports this insight in a formal way, and provides a bridge to the data collection procedure.

regular and minimum tax bills are \$110 and \$70, respectively. Because its regular tax bill is now higher than the minimum tax bill, the AMT credit carryforwards can be used against its tax liability, but cannot reduce the tax liability below \$70. Thus, its AMT credit carryforwards at the end of year $t + 1$ would be \$50 (=\$90 - (\$110 - \$70)).

In Figure 2.1, this firm makes positive AMT payments in years t, t+2, and t+4 (i.e., Case 1). Although in years t+1, t+3, and t+5, the firm's regular tax bill is greater than its minimum tax bill, its use of AMT credit carryforwards is limited (i.e., Case 2). Thus, from year t to t+5, the firm ends up making tax payments exactly as much as the black bars, which implies the firm's binding tax bill is the minimum tax bill, and the relevant depreciation recovery period follows the AMT depreciation rule. Note that the AMT credit carryforwards at the end of a given year are always positive in the AMT years. In years t+6 and t+7, the firm returns to the regular tax system. Because AMT credit carryforwards are neither refundable nor carried backward, the firm has zero AMT credit carryforwards in these years.

2.5 Deriving the Investment Equation in the Presence of AMT

2.5.1 *Ex Ante* Expectation Regarding AMT Status

Depreciation saving is a forward-looking variable as it is a function of a firm's future depreciation deduction schedules. Thus, a firm can derive its optimal investment based on a particular path that defines the timing and length of its future AMT years. Given uncertainty as to which path it will be on, a firm needs to assess the probability of being on each path and the corresponding optimum in order to fully derive its optimal investment behavior. By contrast, an equivalent, but simpler, approach for a researcher is to assume that a firm, by evaluating all future possibilities of the two parallel tax bills, first derives its expected path, and then calculates its optimal investment based on that path.

Following this approach, I consider a firm subject to the AMT at time t that anticipates the following scenario: it will be subject to the AMT system continuously until it begins to be subject to the regular tax system at time $t + n_1^e$; and it remains permanently in the regular tax system afterwards.[19]

Recall that binding tax bills are minimum tax bills, TB^m, in AMT years and regular tax bills, TB^R, in regular tax years. Also recall that, at time $t+n_1^e$, any leftover AMT credit carryforwards are realized. For example, for the firm in Figure 2.1, small AMT credit carryforwards at the end of year $t + 5$ are realized at time $t + 6$ to reduce the firm's tax liability. This realization is measured as the sum of annual differences between the two tax bills:

$$L_{t+n_1^e} = \sum_{s=t}^{t+n_1^e-1} (TB_s^m - TB_s^R). \tag{2.8}$$

Thus, a firm maximizes

$$V_t = \sum_{s=t}^{t+n_1^e-1} \rho^{s-t} CF_s^m + \rho^{n_1^e} L_{t+n_1^e} + \sum_{s=t+n_1^e}^{\infty} \rho^{s-t} CF_s^R, \tag{2.9}$$

which is subject to

$$K_{s+1} = (1 - \delta)K_s + I_s.$$

2.5.2 Depreciation Savings and Marginal Tax Rates in Expectation

In this section, I derive a generalized formula of a firm's expected depreciation savings and expected marginal tax rates in the presence of AMT, which, absent

[19] This simple characterization is general enough to study firm investment incentives in this study. A complete generalization is presented in Appendix 3, but for firms that are subject to one tax system for a sufficiently long time (i.e. $n_1^e = 10$ years) under my research design, it makes little difference.

consideration of AMT, would have been simply τz and τ, respectively. I assume the firm to be considering capital goods purchase at time t. In this scenario, let $\mathbb{E}\left[\Gamma_t(n_1^e)\right]$ be the total expected depreciation savings from capital goods purchased at time t by an AMT firm expecting to return to the regular tax in year t+n_1^e. Then,

$$\mathbb{E}\left[\Gamma_t(n_1^e)\right] \equiv \underbrace{\tau^m\left[z_t^m(0,n_1^e)\right] + \widetilde{\tau z}_t(0,n_1^e)}_{\substack{\text{depreciation savings} \\ \text{from year 0 to } n_1^e\text{-1}}} + \underbrace{\tau^R\left[z_t^R(n_1^e,\infty)\right]}_{\substack{\text{depreciation savings} \\ \text{from year } n_1^e \text{ to } \infty}} \tag{2.10}$$

To discuss the formula, I first note that $z_t^j(l_1,l_2)$ is the present value of the depreciation allowance stream, of investment made at time t, from time t+l_1 to time t+l_2-1 under tax system j, where j is either m for the AMT system or R for the regular tax system. Thus, the term inside the first bracket in equation (2.10) measures the present value of the depreciation allowance stream during the first AMT period (i.e., from time t to t+n_1^e-1):

$$z_t^m(0,n_1^e) \equiv \sum_{s=t}^{t+n_1^e-1} \rho^s\left(D_t^m(s-t)\right). \tag{2.11}$$

Second, I define $\widetilde{\tau z}_t(l_1,l_2)$ as the sum of *reduced* depreciation savings generated by the AMT depreciation system from time $t+l_1$ and t+l_2-1, measured as depreciation savings under the AMT system, subtracted from the amount of depreciation savings the firm would have realized under the regular tax system. Therefore, in the baseline expected path, the firm's tax bill at time t is reduced by:

$$\widetilde{\tau z}_t(0,n_1^e) \equiv \rho^{t+n_1^e}\left[\sum_{s=t}^{t+n_1^e\text{-}1}\left(\tau^R(D_t^R(s-t)) - \tau^m(D_t^m(s-t))\right)\right]. \tag{2.12}$$

This term reflects the smoothing function of the AMT, or the fact that any discrepancy between the two tax bills caused in AMT years is eventually realized, in the form of AMT credit carryforwards, in year t+n_1^e when the firm returns to the regular tax system.[20] Therefore, a shorter n_1^e reduces the impact of the AMT on investment incentives. In the polar case where a firm expects to be permanently subject to the regular tax system, $\mathbb{E}\left[\Gamma_t(0)\right]$ would be $\tau^R\left[z^R(0,\infty)\right]$.[21] By contrast, if a firm is permanently subject to the AMT, $n_1^e \to \infty$, so that $\widetilde{\tau z}(0,\infty) = 0$, indicating that the reduced saving would not be realized. Hence, for a permanent AMT firm, only the first term survives, so the depreciation savings are given by $\tau^m\left[z^m(0,\infty)\right]$.

Similarly, I define the expected marginal tax rate for a firm subject to the AMT that expects to return to the regular tax n_1^e years from now as

$$\mathbb{E}\left[\tau_t(n_1^e)\right] \equiv \tau^m + \rho^{n_1^e}(\tau^R - \tau^m),$$

that is, a weighted average of τ^m and τ^R with the weights depending on the expected duration of the AMT period. As $n_1^e \to \infty$, $\mathbb{E}\left[\tau_t(n_1^e)\right] = \tau^m$ for a permanent AMT firm, while $n_1^e = 0$ implies $\mathbb{E}\left[\tau_t(n_1^e)\right] = \tau^R$ for a regular tax firm.

Since superscript e indicates expectation, it is clear that $\tau_t(n_1^e)$ and $\Gamma_t(n_1^e)$ also measure marginal tax rates and depreciation savings in expectation, respectively, just as $\mathbb{E}\left[\tau_t(n_1^e)\right]$ and $\mathbb{E}\left[\Gamma_t(n_1^e)\right]$ do. Thus, I drop the operator $\mathbb{E}$ whenever doing so does not cause confusion.

[20]Note that this is similar to the concept of investment incentives for a loss firm. Let's ignore AMT for now and suppose a firm is in loss status with a large stock of loss carryforwards such that it will continue to be in loss status for the next five years. The firm's tax bills during that period will be zero. Thus it might seem that the firm would not receive any depreciation savings from capital goods purchases. However the firm would eventually realize whatever depreciation savings a fully taxable firm would have received, in the form of an increased (or unused) loss carryforward. That is, the marginal depreciation savings are realized at time 6 (albeit discounted) when the firm exhausts its stock of loss carryforwards. Therefore, tracking the duration of tax status is important when calculating a firm's marginal investment incentives. See Graham (1996) for discussion of the marginal tax rates for a loss firm.

[21]Recall that $D_t^j(s-t)$ is the time s depreciation allowance, under tax system j, of capital goods purchased at time t. Thus, $z_t^R(0,\infty)$ represents the present value of depreciation allowances under the regular tax system, which is the usual depreciation allowance measure in the literature. Likewise, the relevant z for a firm permanently subject to the AMT is $z_t^m(0,\infty)$.

2.5.3 Investment Demand Function: Tax-Adjusted q Revisited

In this section, I derive the investment demand from a firm's optimization problem where the cost comes from adjusting capital stock and the marginal benefit is described by the tax-adjusted q formula. I now specify the first order condition for I as:

$$\left[1 - \underbrace{[\eta\tau_t(n_1^e) + (1-\eta)\Gamma_t(n_1^e)]}_{\equiv\left[W_\eta(n_1^e)\right]_t}\right] \frac{\partial(\Psi(\cdot)I_t)}{\partial I_t} = \lambda_t \; - [1 - [\Gamma_t(n_1^e)]] \tag{2.13}$$

A firm should invest up to the point at which the marginal after-tax *adjustment* cost (left hand side) is equal to the real shadow value of capital (λ, or marginal q), net of the after-tax *acquisition* cost of capital goods.[22] Note that $W_\eta(n_1^e)$ measures the deductibility of adjustment costs, a function of η.

Following the investment literature, I assume that the convex adjustment cost takes a quadratic form: $\Psi(I,K) = \frac{1}{2b}\frac{(I/K-a)^2}{I/K}$. Then the first order condition for investment provides a closed-form solution for investment demand:[23]

$$\begin{aligned} \frac{I}{K} &= a + b\left[\frac{1-\tau(n_1^e)}{1-W_\eta(n_1^e)}\right]\left[\frac{q}{1-\tau(n_1^e)} - \frac{1-\Gamma(n_1^e)}{1-\tau(n_1^e)}\right] \\ &= a + b\underbrace{\left[\frac{q}{1-W_\eta(n_1^e)} - \frac{1-\Gamma(n_1^e)}{1-W_\eta(n_1^e)}\right]}_{\text{tax-adjusted } q} \end{aligned} \tag{2.14}$$

To avoid possible measurement error problems in q,[24] I follow Desai and Goolsbee

[22]It is straightforward to show that q is the discounted sum of marginal productivities of capital. Empirically, however, being measured by the ratio of the market value of asset to the book value of asset, q is often used as a proxy for investment opportunity available for the firm.

[23]In deriving the investment equation in this section, the time subscript t is omitted for notational simplicity. All variables are measured at time t.

[24]One type of measurement error in q, for example, is that a firm's market value observed in the stock market is not explained by the firm's expected future profitability.

(2004) in separating the tax term of acquisition costs from q, so that

$$\begin{aligned} \frac{I}{K} &= a + b\left[\frac{q}{1-W_\eta(n_1^e)} - \frac{1-\Gamma(n_1^e)}{1-W_\eta(n_1^e)}\right] \\ &= a + b_1\left[\frac{q}{1-W_\eta(n_1^e)}\right] + b_2\left[\frac{1-\Gamma(n_1^e)}{1-W_\eta(n_1^e)}\right], \end{aligned} \tag{2.15}$$

where b_2 represents the responsiveness of investment to tax variables.[25] Note that the variation used in this study is the change in depreciation savings only for AMT firms: that is, regardless of assumptions regarding the deductibility of adjustment costs, only the AMT firms in this study experience decreases in the tax variable $\left[\frac{1-\Gamma(n_1^e)}{1-W_\eta(n_1^e)}\right]$. Thus, the assumption on η does not influence the empirical strategy itself outlined in Section 2.7. Nonetheless, as the interpretation of the empirical results in the context of tax-adjusted q estimation depends on the size of the main tax variable, I discuss the role of the assumption regarding how adjustment costs are deducted.

Summers (1981) first assumes that adjustment costs are expensed (i.e., $\eta = 1$). Consequently, the investment demand equation takes the following simple form

$$\frac{I}{K} = a + b\left[\frac{q}{1-\tau(n_1^e)} - \frac{1-\Gamma(n_1^e)}{1-\tau(n_1^e)}\right]. \tag{2.16}$$

Desai and Goolsbee (2004) and Edgerton (2010) treat the second term of this equation as their main independent variable in examining the effect of taxation on investment. Comparing equations (2.15) and (2.16), it becomes clear the "expensing" assumption is equivalent to assuming that changes in tax parameters do not affect the tax treatment of adjustment costs.

Note that the assumption of fully expensed adjustment costs (i.e., $\eta = 1$) is adequate for some types of adjustment costs, such as forgone profits, but tax law dictates that even the indirect administrative costs of purchasing assets that are

[25] In fact, while b_2 measures the price elasticity of investment, it can also be interpreted as being inversely related to adjustment costs, as it is called as "adjustment cost parameter" in Desai and Goolsbee (2004).

capitalized be capitalized as well (i.e., $\eta = 0$). Thus, η may be both an unobserved firm-specific *and* asset-specific measure. Furthermore, that grey areas exist in practice makes assumptions on η even more arbitrary. When we assume capitalized adjustment costs to be dominant, η approaches zero and the main tax variable in equation (2.15) loses most of its variation. Indeed, a polar case of $\eta = 0$ yields the following investment equation:

$$\frac{I}{K} = a + b_1 \left[\frac{q}{1-\Gamma(n_1^e)} \right] + b_2 \left[1 \right],$$

with the tax term always equal to one.

In words, one issue in studying variations in the tax treatment of acquisition costs is that these may be accompanied by variations in the tax treatment of *adjustment* costs that move in the opposite direction. Thus, I separate the tax treatment of acquisition costs of capital goods from that of adjustment costs, as the time period of interest is relatively short, using a Taylor approximation:

$$\begin{aligned}
\frac{I}{K} &= a + b \left[\frac{q}{1-W_\eta(n_1^e)} - \frac{1-\Gamma(n_1^e)}{1-W_\eta(n_1^e)} \right] \\
&\approx a + b \left[\frac{q}{1-W_\eta(n_1^e)} - \left[\overline{\left(\frac{1}{1-W_\eta(n_1^e)} \right)} \cdot (1-\Gamma(n_1^e)) + \frac{1}{1-W_\eta(n_1^e)} \cdot \overline{(1-\Gamma(n_1^e))} \right] \right] \\
&\approx a + b_1 \underbrace{\left[\frac{q - \overline{(1-\Gamma(n_1^e))}}{1-W_\eta(n_1^e)} \right]}_{\substack{\text{tax-adjusted } q \\ \text{holding depreciation} \\ \text{savings fixed}}} + b_2 \underbrace{\left[\frac{1-\Gamma(n_1^e)}{\overline{1-W_\eta(n_1^e)}} \right]}_{\text{main tax variable}}, \qquad (2.17)
\end{aligned}$$

where the overline indicates the within-firm average around which a Taylor approximation is applied (in the second line).[26] The first variable in the right hand side represents the tax-adjusted q holding fixed depreciation savings from acquisition cost. The second variable, which is my main tax variable, measures the depreciation savings from capital goods acquisition, holding the tax treatment of adjustment cost fixed. I

[26] Note that a Taylor approximation is valid for a small change around a point, so that this method is appropriate for a study with a short time span, like the one in this essay.

use equation (2.17) as the basis for my empirical analysis.

2.6 Research Design and Data

2.6.1 Treatment and Control Groups

This essay examines how firms, the investment incentives of which were characterized by the AMT depreciation schedule around 1999 (the treatment group), respond to the policy change in depreciation allowances compared to firms that followed the regular depreciation schedule (the control group). Specifically I compare the three-year pre-reform period (1996 to 1998) with the three-year post-reform period (1999 to 2001).[27] Firms in the treatment group must have investment incentives dominantly characterized by the AMT system during these periods. To explore this requirement, consider the expected depreciation savings formula in equation (2.10), repeated here:

$$\Gamma_t(n_1^e) = \tau^m \left[z_t^m(0, n_1^e\text{-}1)\right] + \widetilde{\tau z_t}(0, n_1^e\text{-}1) + \tau^R \left[z_t^R(n_1^e, \infty)\right] \tag{2.10}$$

A sufficient condition for the depreciation savings to be characterized mainly by the AMT system is that a long n_1^e be chosen, so the first term in equation (2.10) dominates other terms. Then $\Gamma(n_1^e)$ becomes close to $\tau^m \left[z_t^m(0, \infty)\right]$. Hence, the treatment group in this analysis includes only firms that expect to be in AMT years for a sufficiently long period around the AMT reform. Likewise, the control group includes only firms that expect never to be subject to the AMT.[28]

[27] It is natural to pick a three-year period since the first bonus depreciation, of which the period is also three years (from 2002 to 2004), was enacted three years after the AMT reform. To be precise, the first bonus depreciation was enacted retrospectively, so that assets placed in service after September 11, 2001 were also eligible for the benefits.

[28] Note that it is possible, although unlikely, that a firm's current marginal investment may extend its AMT duration from, say, eight to nine years. Selecting only firms subject to the AMT for long periods in the treatment group mitigates the concern that a firm's current investment may affect its future AMT duration on the margin. That is, whereas a long n_1^e is crucial for the AMT system to be able to characterize investment incentives, a marginal change around the *long* n_1^e would have little effect on investment incentives, due to the continuous nature of the AMT impact.

I choose a 10-year window from 1996 to 2005 as the minimum period during which a firm must be subject to the AMT to be included in the treatment group. This means that, just before the reform takes effect (from 1996 to 1998), a firm in the treatment group is continuously subject to the AMT for at least eight more years. The treatment group firms stay in at least five more AMT years during the post-reform period.[29]

To identify a firm's expectation about their AMT status, I consider as benchmarks two possibilities: perfect foresight and adaptive expectation. Under the perfect foresight assumption, firms' *ex ante* expectations regarding their AMT status correspond to the actual AMT status *ex post*; hence $n_i^e = n_i$ for all i. For example, under the perfect foresight assumption, a firm in the treatment group that returns to the regular tax system in 2007 has correctly anticipated doing so and behaved accordingly.

On the other hand, under the adaptive expectation assumption, the treatment group firms form their expectations based on their current status, and thus behave as if they are permanently subject to the AMT.[30] In other words, for the treatment group firms during the period in analysis (1996 to 2001), $n_1^e = \infty$ under the adaptive expectation assumption. This distinction between the two benchmarks has an important implication for the empirical analysis, which I discuss in the following subsection.

2.6.2 The Role of Expectation in Identification

In this section, I discuss the size of the changes in the main tax variable around the AMT reform, depending on the expectation assumptions, and how other periods can be made use of to identify the impact of the reform.

In measuring the main tax variable, $\left[\frac{1-\Gamma(n_1^e)}{1-\overline{W}_\eta(n_1^e)}\right]$, two issues arise with depreciation savings, $\Gamma(n_1^e)$. First, it is possible that, in a perfect foresight world, another source of changing expected depreciation savings occurs for the treatment group, in addition

[29] As robustness checks, I run the regressions with other lengths of selection windows, one with 1996 to 2007 (i.e., minimum 12 years), and the other with 1996 to 2001 (i.e., minimum 6 years).

[30] This may also be a reasonable assumption because, by construction, my treatment group firms tend to generate large minimum tax bills systematically, compared to regular tax bills.

to the AMT reform. To illustrate this point, let Γ_t^{ADS} be the depreciation savings at time t under the pre-reform AMT system (i.e., the ADS recovery period) and Γ_t^{GDS} be the depreciation savings under the post-reform AMT system (i.e., the GDS recovery period). Then, the relationship $\Gamma_t^{GDS} \geq \Gamma_t^{ADS}$ reflects an increase in depreciation savings caused by the AMT reforms at a given time t. However, the actual variation in depreciation savings around the AMT reform, $\Gamma_{post}^{GDS} - \Gamma_{pre}^{ADS}$, can be decomposed as:

$$\Gamma_{post}^{GDS} - \Gamma_{pre}^{ADS} = \underbrace{\Gamma_{post}^{GDS} - \Gamma_{post}^{ADS}}_{\text{reform-induced variations}} + \underbrace{\Gamma_{post}^{ADS} - \Gamma_{pre}^{ADS}}_{\text{expectation-induced variations}},$$

where the subscripts *post* and *pre* indicate the post- and pre-reform periods, respectively. The reform-induced variations, or the main variations, are the differences between depreciation savings caused purely by the AMT reform, regardless of expectation assumptions. The expectation-induced variations, on the other hand, are mechanical increases in depreciation savings that may arise from firm expectations of being one step closer to getting out of AMT year by year.[31] For a firm that is, or behaves as if it is, permanently subject to the AMT (i.e., under the adaptive expectation assumption), this expectation-induced variation is zero, whereas for a firm that expects to be out of AMT at a certain point in the future (i.e., under the perfect foresight assumption), the size of expectation-induced increases may be non-negligible. I calculate both variations in Table 2.4.

After determining the depreciation savings variations, I next turn asset-level z measures into firm-level measures. Since firm-level asset composition information is not available, I use industry-level measures for depreciation savings, following the procedures in Cummins et al. (1994), Desai and Goolsbee (2004), and Edgerton (2010). For each type of asset, I first calculate two depreciation allowance measures, one under

[31] Depreciation savings are higher under the regular tax system than under the AMT system, because z and τ are both higher. Therefore, the closer a firm is to return to the regular tax system, the higher depreciation savings the firm can receive from marginal investment.

the regular tax system, and the other under the AMT system.[32] I then match these measures to those in the 1997 BEA Capital Flows table to construct industry-level depreciation saving measures for the two tax systems.

Table 2.4 reports the size of variations for my main tax variable. I divide the sample years into three periods: pre-reform (1996 through 1998), post-reform (1999 through 2001) and bonus depreciation (2002 through 2004). The table assumes full expensing ($\eta = 1$) for the tax treatment of adjustment costs.[33]

Panel A of Table 2.4 measures the main tax variable under the adaptive expectation assumption, where firms are assumed to behave as if they are permanently subject to the AMT. Thus, the expectation-induced variation is zero and the variation presented is entirely reform-induced. The variation observed in Panel B of Table 2.4, on the other hand, which follows the perfect foresight assumption, contains expectation-induced increases as well.

Comparing the pre- and post-reform periods, the AMT reform per se decreases the variable by 0.015 (Panel A of Table 2.4). Therefore, the size of the expectation-induced variation is as small as 0 under adaptive expectation; and as large as 0.023 (= 0.038 - 0.015) under perfect foresight. Because the control group firms do not experience any change in the tax variable, these two periods will be used for the difference-in-difference analysis in this study.[34]

[32]I use Moody's Baa rates as the discount rate when discounting depreciation savings. In my sample years, the rates are fairly stable at around 7%. There has been controversy around which interest rates to use to discount depreciation savings. Contrary to economists' belief that depreciation savings are a form of lending money to the government, and so should be considered riskless, Summers (1987a) finds that firms may use much higher interest rates. In his survey, firms report an average discount rate over 15%, which is approximately the Baa rate in the year in which the survey was conducted.

[33]Note that the same calculations with a full capitalizing ($\eta = 0$) assumption, presented in Appendix 4, are similar. The reason for the similarity is discussed in section 2.8.

[34]Note that the tax variable here is the ratio of the after-tax per-dollar acquisition cost to the *averaged* after-tax per-dollar adjustment cost. Thus, values of the variable in Table 2.4 are compared only within-firm, not across-firm, because denominators are averaged within-firm. For example, in Panel B of Table 2.4, the tax variables calculated as 1.006 for the treatment group firms, and as 1.035 for the control group firms during the bonus depreciation period do not necessarily imply that the treatment group firms enjoyed greater depreciation savings than did the control group firms. It is the changes (Δ) that matter. In the empirical analysis, this interpretation issue does not matter

The 2002 bonus depreciation, which allowed accelerated depreciation deductions for firms regardless of AMT status, decreases the tax variable for both groups. During this period, the tax variable drops by 0.034 for the control group, and by 0.021 for the treatment group due to the tax reform; additionally it drops by up to 0.028 (= 0.049 - 0.021) for the treatment group under the perfect foresight assumption. Which group benefits more from bonus depreciation depends on the expectation assumption, but, on average, the measures are quite similar. Thus, this provides us with an opportunity to test for heterogeneity in the different groups' responsiveness to tax policies. The decomposition of variation is illustrated in Figure 2.3.

The possible existence of expectation-induced variation raises concerns about whether it is possible (1) to observe the way a firm forms its expectation and (2) to separate the effects of the tax reforms on investment from the effects of expectation-induced variation. I address these concerns by using the preceding period, from 1993 to 1995, to isolate the expectation-induced variation since the expectation-induced increases in depreciation savings, $\Gamma^{ADS}_{post} - \Gamma^{ADS}_{pre}$, arise regardless of periods. Intuitively, if firms behave according to the perfect foresight assumption, any expectation-induced increases must have affected their investments in any given period. That is, $\Gamma^{ADS}_{post} - \Gamma^{ADS}_{pre} = \Gamma^{ADS}_{t+3} - \Gamma^{ADS}_{t}$ for any t. The effects of expectations would then be captured by comparing the preceding period (1993-1995) with the pre-reform period (1996-1998) for the treatment and control groups. Figure 2.4 presents a conceptual sketch of the research design.

To summarize, the main difference-in-difference analysis is conducted with the sample years from three years before to three years after the AMT reform. Given the possibility of other sources of increases in depreciation savings, the preceding period is used to isolate the impact of the AMT reform from that of those sources. Finally, bonus depreciation policy is used to check for heterogeneity in the groups' inherent

because firm fixed effects are included in all specifications.

responsiveness to tax policies.

2.6.3 AMT Status Data

Firms report their AMT status (whether they are subject to the AMT and the amount of AMT credit carryforwards they possess for the year) in the tax footnote to their financial statements. This tax footnote information, which is contained in 10-K filings to the SEC, is collected from the Morningstar database. Morningstar provides a search engine for 10-K filings, which are required by the SEC for firms with more than $10 million in assets and equity securities held by more than 500 owners. As discussed in Section 2.4, I make use of the fact that AMT credit carryforwards are positive in, and only in, AMT years. Because firms use slightly different terms in their filings, I look first for 10-K information matched with the following keywords: AMT credit, AMT credits, AMT carryforwards, AMT carry forwards, minimum tax credit, minimum tax credits, minimum tax carryforwards, and so forth. I then select for the treatment group firms that have one of these keywords in their 10-K filings for every filing from 1996 to 2005.[35]

One possibility that may impact the results is that firms are not required to mention AMT status specifically. Rather, AMT credit carryforwards are part of the deferred tax assets firms are required to report in the tax footnote collectively, and it is left to individual firm's discretion whether to break this information out. However, I believe it is reasonable to assume that sample firms listed on major stock markets,

[35]Not all of these firms are necessarily subject to the AMT for the entire period. Firms typically report the previous year's accounting information, in their annual 10-K filings. For example, a firm may report accounting information for fiscal years 2003 and 2004 in its 2004 filing. This firm may, even if it returns to the regular tax system in 2004, *mention* AMT credit carryforwards in its 2004 filing. I therefore manually look up all annual 10-K filings for the treatment group firms, and indeed find 10 firms among my 84 baseline treatment group firms that end up being subject to the regular tax system for 1 year out of the 10-year window. As the manual filtering does not alter the empirical results quantitatively or qualitatively, I omit this manual filtering in the analysis in order to ensure comparabilities with other group selections for robustness checks performed in Section 2.7. In Appendix 7, I present the list of the treatment group firms and indicate the ten firms that have deviated for one year.

such as the New York Stock Exchange, American Stock Exchange or NASDAQ, have a strong incentive to provide shareholders and investors with detailed asset information in their tax footnotes. To check this assumption, I compare the aggregate AMT information collected in 2002 with the aggregate information from actual tax return data reported in Carlson (2005a) in Appendix 5. Given that the universe of firms reporting to the SEC is a subset of the universe of firms filing tax returns, collecting data through SEC 10-K filings identifies AMT firms relatively well, especially the larger firms that comprise the bulk of my treatment group firms.

2.6.4 Other Variables

I next match AMT status information with Compustat firm-level information including capital expenditures and capital stock. Following the firm-level investment literature, investment at time t, the dependent variable, is measured as the ratio of Capital Expenditure in the current year (t) to Property, Plant and Equipment (PPE) at the end of the previous year ($t-1$).

I briefly sketch how other financial measures are constructed in this section, and provide detailed descriptions in Appendix 6.[36] I construct the q variable as equity (market value) plus liability (book value) divided by total assets (book value), and truncate the sample at the highest and lowest 1% of investment and q. Following the corporate finance literature, which argues that cash flow has explanatory powers with respect to investment for financially-constrained firms, I include a cash flow measure, a financial constraint measure, and the interaction of the two. For the financial constraint measure, I use the Size-Age index (also known as the S-A index) developed by Hadlock and Pierce (2010), since this index is least likely to suffer from endogeneous financial decisions reflected in the variables used to construct such indices, such as cash holding and leverage.[37]

[36] I follow Edgerton (2010) in constructing most of financial measures.

[37] For example, cash holding is usually entered as a negative in financial constraint measures,

I include only firms that show up in Compustat before 1996 and survive until at least 2001, so that the panel is balanced at least from 1996 to 2001. In addition, I include only firms in manufacturing-related industries (Mining, Utilities, Construction, Manufacturing, Trade, and Transportation). Recall that the treatment group includes firms subject to the AMT from 1996 to 2005, and the control group includes firms subject to the regular tax during the same period. As mentioned above, the treatment group only includes firms that report a positive amount of AMT credit carryforwards, while listed on one of major stock exchanges, during that period (from 1996 to 2005). The baseline sample consists of 84 firms in the treatment group and 1,299 firms in the control group.

Summary statistics for the two groups are presented in Table 2.5. These statistics show that the treatment group firms tend to have a lower investment rate and lower q. They also have a higher capital intensity and lower sales ratio, as suggested in Section 2.2. By construction, the K-Z index and the S-A index are higher for financially-constrained firms. This much higher K-Z index suggests that the treatment group firms are more financially-constrained across all periods, but a similar S-A index between the two groups implies the relationship reflected in the K-Z index may be spurious.

2.7 Empirical Results

In this section, I provide the results for the difference-in-difference analysis. First, the investment trends for both groups are illustrated graphically in Figure 2.5. Panel A and Panel B use the original investment measures, I/K. Panel A shows the annual investment trends, while Panel B shows the average investment for each period. Comparing the pre- and post-reform periods, the treatment group firms do not decrease

but Hadlock and Pierce (2010) find some financially-constrained firms have large cash holdings for precautionary reasons. Nonetheless, following the previous literature, I use the Kaplan-Zingales index as a robustness check; the results (not reported) do not change substantially.

investment as much as the control group firms do. The figures also show that the treatment group investments show a somewhat close movement to that of the control group after 1999.

Panel C and D construct the residuals from the following equation to show the measures of investment to be explained solely by the tax reform:

$$\frac{I_t}{K_{t-1}} = a_0 + c_1 \cdot q_{it} + c_2 \cdot X_{it} + \alpha_i + \gamma_t + e_{it}, \tag{2.18}$$

where subscript i indicates firm i and t indicates year t. q_{it} is the average q, and X_{it} is set of firm-year specific covariates, such as cash flow and the financial constraint index. α_i and γ_t are firm fixed effects and year fixed effects, respectively.[38] By controlling for firm fixed effects, year fixed effects, industry-year fixed effects,[39] and other covariates, including q, it becomes clear in these two figures that the treatment group firm investments increase after 1999 compared to those of the control group firm investments, and that the two groups investment behaviors do not appear to be different entering the bonus depreciation period.

2.7.1 Baseline Regression Difference-in-Difference

In this section, I examine the impact of the AMT reform on firm investment based on equation (2.17) using a difference-in-difference approach. Through this analysis, I attempt to achieve three goals: (1) to investigate differences in investment between the two groups in a transparent way, (2) to use the bonus depreciation period to check the validity of my identifying assumption – the same tax responsiveness of both groups – and (3) to use the preceding period to check for the pre-treatment

[38]That is, the residuals are constructed as follows:

$$\widehat{e}_{it} = \frac{I_t}{K_{t-1}} - \widehat{c_1} \cdot q_{it} - \widehat{c_2} \cdot X_{it} - \widehat{\alpha_i} - \widehat{\gamma_t}.$$

[39]Industry-year fixed effects are included to control for unobserved industry-specific shocks over time.

trends of the two groups. I hence consider the following specification:

$$\begin{aligned}\frac{I_t}{K_{t-1}} = a_0 &+ b_1(D_i^{treat} \cdot D_t^{a1999}) + b_2(D_i^{treat} \cdot D_t^{bonus}) + b_3(D_i^{treat} \cdot D_t^{a1996}) \\ &+ c_1 \cdot q_{it} + d_3 \cdot X_{it} + \alpha_i + \gamma_t + e_{it}, \end{aligned} \tag{2.19}$$

where D_i^{treat} is a dummy variable for the treatment group, D_t^{a1999} is a time dummy variable for the post-reform period (in or after year 1999), D_t^{bonus} is a time dummy variable for the bonus depreciation period (year 2002-2004), and D_t^{a1996} is a time dummy variable for the post-preceding period (in or after year 1996). The other variables are as described in equation (2.18). The main variable of interest is the interaction term, $D_i^{treat} \cdot D_t^{a1999}$.

The regression results are reported in Table 2.6. In column (1), which uses equation (2.19) from year 1996 through year 2001, the main coefficient of interest, b_1, is estimated as 0.0614. In column (2), I control for industry-year fixed effects to address potential concerns that the result in column (1) could be driven by an unobserved shock, such as unexpected increases in output prices, which benefits only those industries heavily comprised of AMT firms. However, controlling for such effects increases the estimate (0.0656), suggesting that AMT-firm-heavy industries may have experienced, if any, a negative unobserved investment shock after 1999.

Column (3) is extended to include the preceding period so that the regression runs from year 1993 to year 2001. The estimate for the interaction of the treatment group dummy with the time dummy for after-1996, b_3, is insignificant; thus I cannot reject the null that the two groups have the same trends before the treatment.[40]

Column (4) includes the bonus depreciation period, so that the regression uses the full sample years, 1993 to 2004. The estimate for the coefficient of D_t^{bonus} is insignificant and fairly small, indicating that the two groups exhibit a similar response to

[40] Nonetheless, one can interpret $b_1 - b_3$ as the pure impact of the AMT reform on investment, which is 0.0427 (= 0.0624 - 0.0197).

bonus depreciation. Recall that the identification of this difference-in-difference comes from the assumption of similar investment responsiveness to tax changes across the two groups. On the one hand, if the main result is driven by a higher responsiveness in the treatment group, then I would expect a relatively larger increase in investment in response to bonus depreciation by this group. On the other hand, if my identifying assumption is satisfied, the coefficient estimate for the interaction term $D_i^{treat} \cdot D_t^{bonus}$ would be insignificant. Thus, the results in column (4) suggest that the main result is not likely to be driven by unobserved heterogeneous responsiveness between the two groups.

Columns (5) to (6) repeat the analysis with two- and three-year average investments as the dependent variable in order to address possible serial correlation problems. As emphasized by Bertrand et al. (2004), a study is likely to suffer from serial correlation problems when the dependent variable is highly serially correlated and the treatment indicator changes little over time. A simple method for addressing this concern is to collapse annual time series into pre and post periods. Consequently, column (5) collapses the sample years 1996 through 2001 into two three-year periods;[41] column (6) collapses the sample years 1997 through 2000 into two two-year periods. In column (5) and (6), the main estimates for b_1 are similar to those in the previous columns, suggesting that the main results of this table are not likely to result from a serial correrlation problem.

2.7.2 The Role of the Perfect Foresight Assumption

So far the analysis has been based on a 10-year tax window beginning in 1996; the main period in the analysis is the *first* 6-year period out of the 10-year window. However, as discussed in Section 2.6, the perfect foresight assumption generates year-by-year expectation-induced variation in depreciation savings, so the length of

[41] The three-year-averaged investment during a period has been constructed in column (5) as $\frac{1}{3}\sum \frac{I_t}{K_{t-1}}$.

the *remaining* AMT spell may also be important in understanding firm investment incentives.

Figure 2.6 illustrates the selection windows under the perfect foresight assumption. Note that the first selection window is the baseline for the analysis conducted so far. However, to test the effect of the perfect foresight assumption using the 6-year period before the reform (i.e., 1993-1998), one would also need to construct treatment and control groups based on the 10-year window starting in the same year as the main period, namely, 1993. This way, the period to be analyzed (i.e. 1993-1998) is the *first* 6 years out of the 10-year selection window, so that it can be tested whether expectation-induced variation affects the investment behaviors of the treatment group firms during the first six years. Thus, to check the role of the perfect foresight assumption, I select firms subject to the AMT from 1993 to 2002 as the treatment group, and firms subject to the regular tax system during the same period as the control group. See the second selection window in Figure 2.6.

Likewise, to test the existence of heterogeneous responsiveness for the 2002 bonus depreciation under the perfect foresight assumption, I select the treatment and control groups based on the 10-year selection window starting from 1999.

Table 2.7 presents the regression results. Column (1) provides the baseline selection window (1996-2005), and is repeated here for comparison. Columns (2) and (3) use the 10-year selection window starting from 1993 to examine pre-treatment trends under the perfect foresight assumption. The sample years used for this specification are 1993-1998. In column (2), the variable of interest is the interaction term of the treatment group dummy with the after-1996 time dummy, so one can consider the after-1996 period as the placebo treatment. In column (3), I include group-specific time trends, so that the main variable of interest is the time trend of the treatment group. In both specifications, although the coefficients of interest are statistically insignificant, the sizes are non-negligible. In column (2), relative to the control group firms, the treatment group firms increase their investment by as much as 0.0225 before and after 1996. This result is also consistent with the results in column (3) which implies that treatment group firms increase their investment as much as 0.0079 every year (0.0079 * 3 year $\approx$ 0.0225) during the six-year period.

Based on my findings in this section, therefore, I conclude that perfect foresight appears to be too strong an assumption to describe expectations regarding future AMT status for firms subject to the AMT for at least 10 years. I nonetheless provide conservative estimates for the impact of AMT reform by subtracting the estimates of the impact of perfect foresight from the main results reported in column (1), yielding 0.0393 (=0.0618-0.0225).

Finally, column (4) selects the treatment and control groups based on the 10-year selection window from 1999 to 2008. In this window, I select sample years from 1999 to 2004 to test whether both groups exhibit similar responses to the 2002 bonus depreciation under the perfect foresight assumption. The small, insignificant coefficient for the interaction term of the treatment group dummy with the dummy for year 2002-2004 suggests that it is indeed reasonable to attribute the main results in this study to firm responsiveness to the AMT reform.

2.7.3 Robustness Checks

Recall that the treatment group includes 84 firms subject to the AMT for at least 10 years starting from 1996. Having shown that firms in the treatment group are more likely to behave as if they are permanently subject to the AMT, a natural question is whether the results are sensitive to the length of the selection window. Hence, I now examine whether the result that firms subject to the AMT for 10 years behave as if they are permanently subject to the AMT, is robust to a longer selection window. To check this, I choose two other lengths of selection windows and repeat the main regression, the results of which are provided in Table 2.8.

In column (1), I use a 12-year selection window starting from 1996. This stricter selection rule reduces the size of the treatment group to 62 firms. The estimate for b_1 (0.0597) is approximately in the same range as for the other specifications in the main table. In column (2), I pick the period from year 1996 to year 2001, so that firms continuously subject to the AMT for only six years are now also included in the analysis. I find that the main estimate (0.0412) loses its size and significance. This finding is consistent with the theory in Section 2.5 that suggests, with a small n_1^e, the AMT system would not dominate a firm's investment incentives for the AMT reform to be appreciated. Hence, I conclude that a 10-year window is likely to be sufficiently long, but that a selection window less than 10 years may not be long enough.

So far, to avoid dealing with extreme values reported in accounting measures in Compustat, I have followed the corporate finance literature in truncating investment at the highest and lowest 1% levels. To check whether my truncation level matters, I also use the 0.5% truncation level. Note that the number of the treatment group firms (84) does not change, because only control group firms are being truncated due to extreme values. The main results in column (3) are largely close to the baseline results, qualitatively and quantitatively.

2.7.4 Other Explanations

With strong evidence that the 84 treatment group firms increase their investment in response to the AMT reform, I conduct additional analyses to determine if firm-specific investment fluctuation over the sample years drives the results. That is, AMT firm's cyclical increase in investment might have coincided with the post-reform period. In this case, a treatment group firm with a smaller pre-reform investment level would have seemingly stronger responses to the tax reform than a firm with larger pre-reform investment. Moreover, this effect would be larger for a smaller firm less able to smooth out its investment over periods. Thus, I check whether a treatment group firm with a smaller level of pre-reform investment responds to the reform more strongly; and whether a smaller treatment group firm (measured as the ratio of the physical assets to the total assets)[42] responds more strongly.

To do so, I divide the 84 treatment group firms into two categories based on their pre-reform levels of investment. That is, a treatment group firm is classified based on whether its pre-reform investment level falls into the lower half or the upper half of all the treatment group firms, and I interact the post-reform time dummy with the dummy for treatment group firms with high pre-reform investment level (i.e., $D_i^{treat-highI} \cdot D_t^{a1999}$). Likewise, I divide the treatment group firms on the pre-reform levels of physical asset and create the interaction term of the post-reform time dummy with the dummy for treatment group firms with high pre-reform asset level, $D_i^{treat-highA} \cdot D_t^{a1999}$.

See Table 2.9 for the regression results. The baseline estimation is repeated in column (1) for comparison. Results in column (2) and column (3) show that the coefficients for the interaction dummies, $D_i^{treat-highI} \cdot D_t^{a1999}$ and $D_i^{treat-highA} \cdot D_t^{a1999}$, are statistically indistinguishable from zero, suggesting there is little evidence that AMT firms with a smaller pre-reform investment level or smaller physical asset level increase investment more strongly during the post-reform period. Hence, it is unlikely that factors related to investment cycles derive the main results.

2.8 Discussion: Estimation of the Tax-adjusted q Model

Having run a difference-in-difference analysis to exploit a transparent identification, checked the identifying assumptions, and performed various robustness checks, I now discuss the estimation of the tax-adjusted q model. Recall that the baseline tax-adjusted q equation in this study is given by equation (2.17):

[42]This measure is called as capital intensity in the later chapters.

$$\frac{I}{K} = a + b_1 \underbrace{\left[\frac{q - (1 - \overline{\Gamma(n_1^e)})}{1 - W_\eta(n_1^e)}\right]}_{\substack{\text{tax-adjusted } q \\ \text{holding depreciation} \\ \text{savings fixed}}} + b_2 \underbrace{\left[\frac{1 - \Gamma(n_1^e)}{1 - \overline{W_\eta(n_1^e)}}\right]}_{\text{main tax variable}}. \tag{2.17}$$

As discussed in Section 2.6, the variation in the main tax variable $\left[\frac{1-\Gamma(n_1^e)}{1-\overline{W_\eta(n_1^e)}}\right]$, generated purely by the AMT reform, is -0.015 (assuming η=1) or -0.014 (assuming η=0) for the baseline treatment and control group firms.[43] Furthermore, in Section 2.7, the empirical results imply that AMT firms increase investment by 0.039 to 0.065, depending on specifications. Therefore, b_2, the inverse of the adjustment cost parameter, is estimated to be from -2.6 to -4.2.[44]

In the literature, efforts have been made to estimate the size of the adjustment cost parameter. Recently, in their own baseline estimates, Desai and Goolsbee (2004) and Edgerton (2010) both report the estimates slightly less than one (in absolute value). Thus I discuss which factor is likely to explain the differences, although their estimates of around one is within the 95%, or even 90%, confidence interval for $\widehat{b_2}$ estimated in Section 2.7. I first explain possible causes for the discrepancy, and then discuss tests, when needed, related to the respective causes.

1. Different Tax Instruments Targeted by Tax Reforms. Whereas this essay uses changes in depreciation allowances around the AMT reform as a natural experiment, previous studies use tax reforms that typically change investment tax credits and depreciation allowances at the same time. For example, the 1971 reform and the 1986 reform both change the two tax instruments (ITC and z) in the same direction. Thus, it is unclear whether ITC or z drives their main results. Nonetheless, as ITC is likely to have a larger impact on investment incentives than depreciation

[43] See Table 2.4 for $\eta = 1$ and Table A4 for $\eta = 0$.

[44] Note that b_2 is also interpreted as the price elasticity of investment. Intuitively, the larger are adjustment costs, the less responsive is investment to its tax price.

allowances, this difference would not explain why their estimates are *smaller* than the estimates reported in this essay.

2. Different Sources of Identification. Recall that, by including year fixed effects in their papers, previous studies have the common effects of tax reforms on investment incentives absorbed; thus, the remaining variations in the tax term occur across asset types. Roughly speaking, these studies test whether the type of asset that benefits the most from a tax reform is purchased most after the tax reform. Hence, they implicitly assume that the price elasticities (or the adjustment cost parameters) are the same across asset types.[45] However, this assumption may be too strong: that is, on asset levels, the size of adjustment costs and the benefits from a tax reform may be positively related. For example, the type of asset that benefits the least from a tax reform, such as computers, is likely to have the shortest recovery period, and also expected to have smaller adjustment costs. This endogeneity would make their estimates biased toward zero, implying that it could potentially explain at least some of the differences in the estimates for b_2.[46]

3. Different Periods in Analysis. In addition, the previous studies use more than 40 years as the sample period, while I use only 6 years from 1996 to 2001. Consequently, one might think that firm responses to tax reforms are larger these days, compared to 20 to 40 years ago, for reasons not related to tax reforms.

To check this possibility, I run an additional regression of equation (2.17) using the 2002 bonus depreciation as the only treatment, with sample years from 1999 to 2004 (excluding the AMT reform in the sample period). In this way, the only source of variation in the regression comes from different tax treatments across different assets

[45] In addition, in converting the asset-level investment incentives reflected in ITC and z into industry-level information, another assumption implicitly made in their papers is the same price elasticity across different industries.

[46] While this is likely the main reason for the differences in the estimates, because other reasons can be reasonably ruled out (see other causes), testing the heterogeneous adjustment costs across asset types is beyond the scope of this study. As a follow-up study, one can conduct asset-level research with exogenous price changes, such as impacts of tariffs, oil prices, and so on.

(and industries) which is identical to that of previous papers, whereas the sample period is similar to that of this study. Hence, this setting helps separate the effect of the two factors. Table 2.10 provides a comparison across the studies. The first two rows summarize Desai and Goolsbee (2004) and Edgerton (2010), respectively. The third row describes the main empirical results of this essay, and the fourth row presents the results of the additional regression described above. Note that the additional regression, using a similar period of sample years as in my main empirical analysis, estimates the coefficient for the tax term to be around -1.2 (albeit insignificant), which is a similar estimate to that of the two previous papers. Therefore, the different sample periods are not likely to explain the large gap between the two sets of estimates.

4. Different Specifications of Tax Terms. Another possible explanation is that the new tax term $\left[\frac{1-\Gamma}{1-\overline{W_\eta}}\right]$ from the alternative specification developed in this essay measures investment incentives in a different way than the usual tax term $\left[\frac{1-\Gamma}{1-\tau}\right]$. However, recall that the main contribution of the specification developed here is to provide a tax term robust to assumptions on η: that is, $\Delta\left[\frac{1-\Gamma}{1-\overline{\tau}}\right] \approx \Delta\left[\frac{1-\Gamma}{1-\overline{\Gamma}}\right]$.[47] Furthermore, the main variations around the AMT reform are the changes in depreciation savings (Γ), so that it is straightforward to see $\Delta\left[\frac{1-\Gamma}{1-\overline{\tau}}\right] \approx \Delta\left[\frac{1-\Gamma}{1-\tau}\right]$ as well. That is, the tax term in the specification developed here measures investment incentives similarly to what the usual tax term (with the full-expensing assumption) would have measured around the AMT reform.[48] This implies the new specification developed in Section 2.5 plays little role in explaining the large gap in the estimates.

5. Selection Issues Regarding AMT Firms. It may also be possible that AMT firms (the treatment group) behave differently in terms of investment behaviors than the regular tax firms due to selection bias. Three possible concerns include:

[47] To see this, first note that $\overline{W_\eta}$ can be as high as $\overline{\tau}$ with $\eta = 1$ and as low as $\overline{\Gamma}$ with $\eta = 0$. Suppose now a tax reform changes z by as much as 0.1. Since the absolute value of z is typically greater than 0.8, $\overline{\Gamma} \approx \overline{\tau} \cdot \overline{z} \geq \overline{\tau} \cdot 0.85$, which is fairly close to $\overline{\tau}$.

[48] Thus, in a sense, this alternative specification provides a justification for the widely-used full expensing assumption.

(1) heterogeneous responsiveness to changes in depreciation savings between the two groups; (2) heterogeneous time trends in investment between the two groups; and (3) heterogeneous firm-specific short run investment cycles that are orthogonal to the AMT reform. Although all these three concerns have been addressed in Section 2.7, I briefly summarize the relevant discussion below.

First, recall that while the 2002 bonus depreciation is available to both groups of firms, the treatment group firms do not behave differently than the control group firms. Hence, the heterogeneous responsiveness to changes in depreciation is not likely to have biased my estimates. Second, there is evidence, albeit insignificant, that the AMT status itself *might* contribute to increases in investment regardless of the AMT reform (see Section 2.7) However, this concern is reflected in the lower set of my estimates (0.039), still implying a large coefficient for b_2 (that is, 2.6 in absolute value). Thus, this possibility does not explain the observed differences. Lastly, it is possible that AMT firm's cyclical increase in investment coincided with the AMT reform. However, such short-run investment cycles would be better described as industry-level, rather than firm-level, but I do control for industry-level shocks in my specification. Furthermore, in section 2.7.4., I sort the AMT firms into two subgroups based on their pre-reform investment, and conclude that their investment behaviors are indistinguishable. Thus, it is unlikely that unobserved heterogeneity between the two groups accounts for the large difference in the results.

6. Salience of Tax Policy. Finally, the AMT reform may have been more salient, especially to my treatment group firms, than were other various depreciation policies. Recall that AMT firms have their average tax rates higher than otherwise, just due to the AMT structure, and that the 1999 AMT reform effectively, and directly, decreases their current average tax rates (or their current tax liabilities). Furthermore, the AMT reform only affects depreciation allowance, among the three major tax instruments, which is one of the major causes to make a firm subject to

AMT. Consequently, AMT firms might have paid closer attention to the reform.

In contrast, there is evidence, for example, Knittel (2007) and Kitchen and Knittel (2011), that some eligible firms do not even try to claim their tax credits especially when they are in a loss status. One interpretation of this evidence is that, even though tax credits should be valuable in the future even for a firm in a loss status, they do not directly decrease the firm's current tax liability, which makes the firm less likely to claim the credits. In addition, the major tax reforms in the U.S., including ERTA and TRA86, contain multiple changes with a change increasing the tax term, and another one decreasing the tax term. Thus, it may be less clear, even for a real firm, to realize how much a tax reform affects its investment decision. In this regard, the high salience of the AMT reform may potentially explain some of the differences in estimating b_2.

2.9 Conclusion

This study investigates whether firms respond to changes in a particular tax instrument, namely, depreciation savings, by using the 1999 shortening of the Alternative Minimum Tax depreciation recovery periods. I first characterize a firm's investment incentives in the presence of AMT, and show that the AMT system affects investment incentives only for firms that expect to be subject to the AMT for a long period. Using data obtained from the tax footnotes to the financial statements reported to the SEC, I then show empirically that firms whose investment incentives are characterized by the AMT system around the 1999 reform increase investment significantly compared to firms never subject to the AMT. Given the observed and unobserved heterogeneity between the treatment and control groups, I use the bonus depreciation policy available to both groups, and find no significant differences in firm responses between the two groups. I also report evidence that firms subject to one tax system for a long time are likely to form their expectations regarding future tax status following the adaptive expectation assumption rather than the perfect foresight assumption. That is, their investment behaviors are more closely described when assumed to behave as if they are permanently subject to such tax system.

This essay is, to my knowledge, one of the first attempts to directly investigate firm investment responses to changes in depreciation savings. In the analysis, I propose an alternative empirical specification of the tax-adjusted q model that is immune to changes in assumptions about the tax treatment of adjustment costs. I find the responsiveness coefficient estimated here to be around three to four times larger than the estimates in Desai and Goolsbee (2004) and Edgerton (2010). I discuss possible reasons for the differences in the estimates, and conclude that the new identification strategy is likely to be the main factor to account for the differences.

Table 2.1: Present value of depreciation allowances z

Example: Assets used in the manufacture of aerospace products.

Year	1	2	3	4	5	6	7	8	z
Deduction Allowed	.1429	.2449	.1749	.1249	.0893	.0892	.0893	.0446	.845

Note: z is calculated using an interest rate of 5% and a 200% balancing method. (Source: IRS Publication 946, Table A1)

Table 2.2: Calculating an AMT bill

1.		Regular taxable income, before net operating losses
2.	+	Adjustments and preferences
3.	=	Taxable income before net operating losses
4.	-	AMT net operating losses (up to 90% of line 3)
5.	=	Alternative minimum taxable income
6.	-	Exemption amount
7.	=	Alternative minimum taxable income net of exemptions
8.	×	20 %
9.	=	AMT before credits
10.	-	Allowable AMT foreign tax credits
11.	=	Tentative minimum tax
12.	-	Regular tax (before all credits except foreign tax credit and possessions tax credit)
13.	=	AMT (if greater than zero)

Source: Lyon (1997) Table 2.3.

Table 2.3: Changes in z before and after 1999

Example: Assets used in the manufacture of aerospace products.

Tax System	Before 1999			After 1999		
	Recovery Period	Balancing Method	z	Recovery Period	Balancing Method	z
Regular	GDS (7-year)	200%	0.845	GDS (7-year)	200%	0.845
AMT	ADS (10-year)	150%	0.752	GDS (7-year)	150%	0.818

Note: z is calculated using an interest rate of 7%.

Table 2.4: Size of variation in the tax variable

A. Adaptive Expectation – *Permanently* subject to the AMT ($n_1^e = \infty$)

		Control		Treatment	
Periods	Years	Value	Δ	Value	Δ
Pre-Reform	1996-1998	1.069	-	1.056	-
Post-Reform	1999-2001	1.069	0.000	1.041	0.015
Bonus Depreciation	2002-2004	1.035	0.034	1.020	0.021

B. Perfect Foresight – *Temporarily* subject to the AMT ($n_1^e = n_1$)

		Control		Treatment	
Periods	Years	Value	Δ	Value	Δ
Pre-Reform	1996-1998	1.069	-	1.095	-
Post-Reform	1999-2001	1.069	0.000	1.057	0.038
Bonus Depreciation	2002-2004	1.035	0.034	1.006	0.049

Note: Adjustment costs are assumed to be full expensed. ($\eta = 1$)

Table 2.5: Summary statistics

		Control Group (1299 firms)			Treatment Group (84 firms)		
Year		1996-1998	1999-2001	2002-2004	1996-1998	1999-2001	2002-2004
Variables							
Investment	(median)	.2547	.1977	.1518	.2105	.1606	.1216
	(mean)	.3946	.2919	.2156	.3073	.2622	.2025
	(std. dev.)	.5059	.3448	.2663	.3372	.3955	.2897
q	(median)	1.553	1.340	1.390	1.229	1.128	1.204
	(mean)	2.027	1.964	1.727	1.528	1.502	1.542
	(std. dev.)	1.670	2.086	1.038	.920	1.203	.910
Cash flow	(median)	.355	.285	.294	.151	.141	.153
	(mean)	.281	.129	.144	.039	.087	.096
	(std. dev.)	2.628	3.282	2.826	2.029	1.803	2.836
S-A index	(median)	-3.222	-3.405	-3.572	-3.275	-3.428	-3.564
	(mean)	-3.289	-3.466	-3.627	-3.321	-3.472	-3.626
	(std. dev.)	.722	.674	.645	.652	.623	.580
K-Z index	(median)	.209	.475	.336	1.040	1.207	1.109
	(mean)	.093	.373	.268	1.037	1.090	1.128
	(std. dev.)	2.006	1.669	1.834	1.346	2.568	1.255
Sales ratio	(median)	1.258	1.119	1.045	.959	.887	.883
	(mean)	1.469	1.300	1.209	1.091	1.076	1.099
	(std. dev.)	1.316	.898	.822	1.008	.886	1.041
Capital intensity	(median)	.267	.263	.248	.492	.443	.400
	(mean)	.329	.318	.306	.473	.446	.427
	(std. dev.)	.226	.223	.220	.265	.270	.275

Industries	**Number of Firms**	
Mining (sic 10-14)	65 (5.0%)	13 (15.5%)
Construction (sic 15-17)	20 (1.5%)	2 (2.4%)
Manufacturing (sic 20-39)	868 (66.8%)	46 (54.7%)
Transportation (sic 40-47)	35 (2.7%)	6 (7.2%)
Utility (sic 48-49)	130 (10.0%)	9 (10.7%)
Trade (sic 50-59)	181 (13.9%)	8 (9.5%)
All	1299 (100%)	84 (100%)

Note: The table presents summary statistics for the baseline control and treatment group firms. The baseline control group includes firms subject to the regular tax from 1996 to 2005, and the baseline treatment group includes firms subject to the AMT during the same period.

Table 2.6: Baseline regression of investment

	(1)	(2)	(3)	(4)	(5)	(6)
$D_i^{treat} \cdot D_t^{a1999}$	.0614*	.0656**	.0624*	.0618*	.0582*	.0502*
	(.0324)	(.0323)	(.0324)	(.0324)	(.0321)	(.0293)
$D_i^{treat} \cdot D_t^{bonus}$				-.0167		
				(.0343)		
$D_i^{treat} \cdot D_t^{a1996}$			.0197	.0105		
			(.0286)	(.0282)		
q	.0227***	.0242***	.0286***	.0383***	.0686***	.0420***
	(.0080)	(.0086)	(.0059)	(.0058)	(.0147)	(.0146)
Cash Flow	-.0214	-.0222	.0049	-.0032	-.0385***	-.0344***
	(.0208)	(.0208)	(.0233)	(.0226)	(.0074)	(.0105)
S-A Index	.0189	-.0344	.0672	.0859*	.1220	-.2890*
	(.1006)	(.1005)	(.0627)	(.0509)	(.1204)	(.1499)
Cash Flow	-.0070	-.0074	-.0002	-.0016	-.0155***	-.0127***
× S-A index	(.0062)	(.0062)	(.0059)	(.0068)	(.0036)	(.0042)
Years	1996 ∼ 2001	1996 ∼ 2001	1993 ∼ 2001	1993 ∼ 2004	1996 ∼ 2001	1997 ∼ 2000
Periods "collapsed"	No	No	No	No	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed	No	Yes	Yes	Yes	Yes	Yes
Observations	8298	8298	11627	15465	2766	2766
# of Treatment Group	84	84	84	84	84	84
# of Control Group	1299	1299	1299	1299	1299	1299

Note: The dependent variables in column (1) through (4) are annual investment (capital expenditures to lagged capital stock); three-year-averaged investment in column (5); and two-year-averaged investment in column (6). For specifications (5) and (6), all the covariates are also averaged over each period. The main variable of interest is $D_i^{treat} \cdot D_t^{a1999}$, the interaction of the treatment group dummy with the post-reform time dummy. Variable descriptions appear in Appendix 6. All standard errors are clustered at the firm-level. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively.

Table 2.7: The role of the perfect foresight assumption

Selection Window:	1996 - 2005 (10 year)	1993 - 2002 (10 year)		1999 - 2008 (10 year)
	Baseline	(2)	(3)	(4)
$D_i^{treat} \cdot D_t^{a1999}$	.0618*			
	(.0324)			
$D_i^{treat} \cdot D_t^{bonus}$	-.0167			.0260
	(.0343)			(.0270)
$D_i^{treat} \cdot D_t^{a1996}$	.0105	.0225		
	(.0282)	(.0230)		
Time Trend			.0038	
			(.0123)	
Time Trend × D_i^{treat}			.0079	
			(.0068)	
q	.0383***	.0239***	.0240***	.0319***
	(.0058)	(.0092)	(.0092)	(.0072)
Cash Flow	-.0032	-.1634*	-.1634*	-.0568***
	(.0226)	(.0950)	(.0095)	(.0179)
S-A index	.0859*	-.0109	-.0113	-.3841***
	(.0509)	(.0810)	(.0810)	(.0967)
Cash Flow × S-A index	-.0016	-.0723	-.0723	-.0144***
	(.0068)	(.0327)	(.0328)	(.0050)
Years	1993 ∼ 2004	1993 ∼ 1998	1993 ∼ 1998	1999 ∼ 2004
Firm Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
Industry-Year Fixed	Yes	Yes	Yes	Yes
Observations	15465	7920	7920	9198
# of Treatment Group	84	39	39	84
# of Control Group	1299	1282	1282	1450

Note: The dependent variable is annual investment (capital expenditures to lagged capital stock). Variable descriptions appear in Appendix 6. All standard errors are clustered at the firm-level. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively.

Table 2.8: Robustness checks

Truncation Cutoffs:	1% (baseline)		0.5%
Selection Window:	1996 - 2007 (12 year)	1996 - 2001 (6 year)	1996 - 2005 (10 year)
	(1)	(2)	(3)
$D_i^{treat} \cdot D_t^{a1999}$	.0597*	.0412	.0704*
	(.0316)	(.0256)	(.0368)
q	.0211***	.0233***	.0235***
	(.0081)	(.0080)	(.0092)
Cash Flow	-.0275	-.0236	-.0287
	(.0208)	(.0204)	(.0220)
S-A index	-.0188	-.0042	-.0925
	(.1052)	(.0927)	(.1407)
Cash Flow × S-A index	-.0086	-.0078	-.0089
	(.0061)	(.0061)	(.0068)
Years	1996 ∼ 2001 (all columns)		
Firm Fixed	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes
Industry-Year Fixed	Yes	Yes	Yes
Observations	7932	9462	8358
# of Treatment Group	62	156	84
# of Control Group	1260	1421	1309

Note: The dependent variable is annual investment (capital expenditures to lagged capital stock). Variable descriptions appear in Appendix 6. All standard errors are clustered at the firm-level. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively.

Table 2.9: Testing observed heterogeneity

Heterogeneity in:		Pre-reform Investment	Pre-reform Asset
	(1)	(2)	(3)
$D_i^{treat} \cdot D_t^{a1999}$	.0656**	.0993***	.1039*
	(.0323)	(.0242)	(.0561)
$D_i^{treat-highI} \cdot D_t^{a1999}$		-.0713	
		(.0661)	
$D_i^{treat-highA} \cdot D_t^{a1999}$			-.0830
			(.0709)
q	.0242***	.0244***	.0247***
	(.0086)	(.0086)	(.0087)
Cash Flow	-.0222	-.0221	-.0243
	(.0208)	(.0208)	(.0208)
S-A Index	-.0344	-.0359	-.0409
	(.1005)	(.1021)	(.1024)
Cash Flow × S-A index	-.0074	-.0073	-.0078
	(.0062)	(.0062)	(.0061)
Years		1996 ∼ 2001	
Firm Fixed	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes
Industry-Year Fixed	Yes	Yes	Yes
Observations	8298	8298	8298
# of Treatment Group	84	84	84
# of Control Group	1299	1299	1299

Note: The dependent variable is annual investment (capital expenditures to lagged capital stock). Variable descriptions appear in Appendix 6. All standard errors are clustered at the firm-level. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively.

Table 2.10: Comparison of tax term coefficients

	Tax Term Coefficient	q Term Coefficient	Sample Years	Tax Reforms	Source of Variations
Desai and Goolsbee (2004)	-.889***	.023***	1962-2003	Various	Across industries
Edgerton (2010)	-.842***	.038***	1967-2005	Various	Across industries
Main analysis in this study	-2.6** ∼ -4.3**	.025***	1996-2001	AMT reform	Across tax systems
Additional "test"	-1.192	.020***	1999-2004	Bonus Depreciation	Across industries

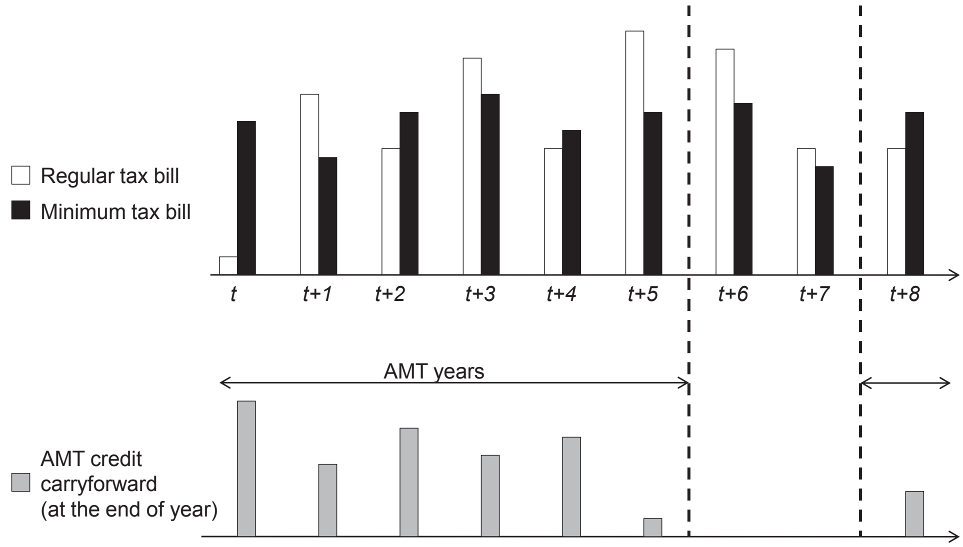


Figure 2.1: AMT years and the evolution of AMT credit carryforwards

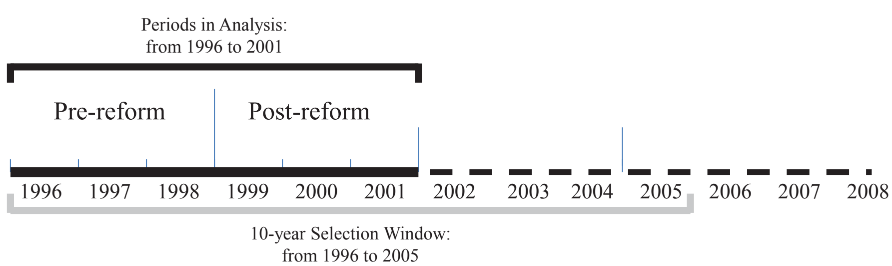


Figure 2.2: 10-year selection window for treatment and control groups

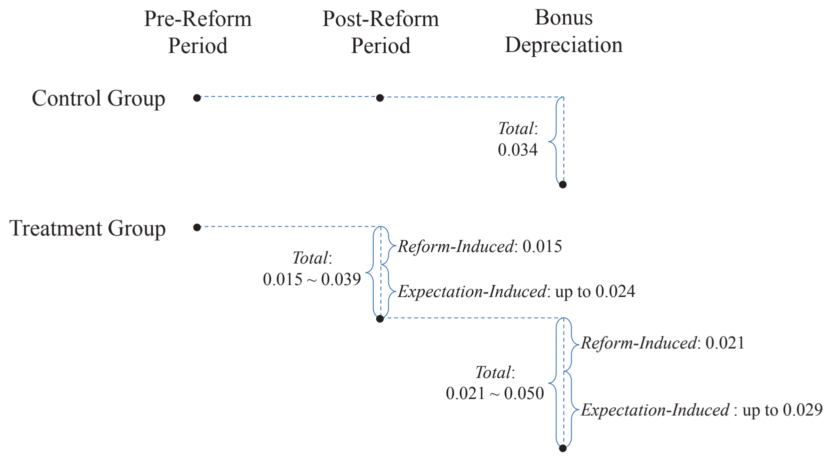


Figure 2.3: Decomposition of variations in the tax variable

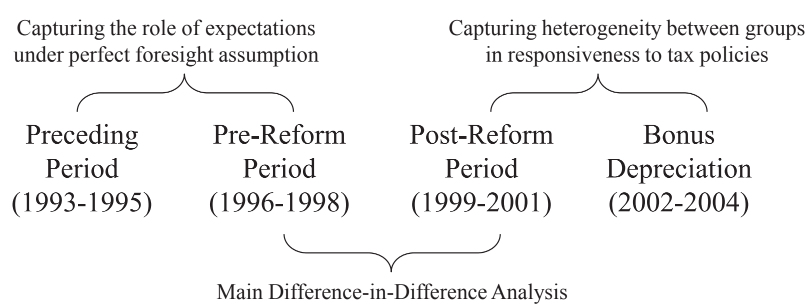
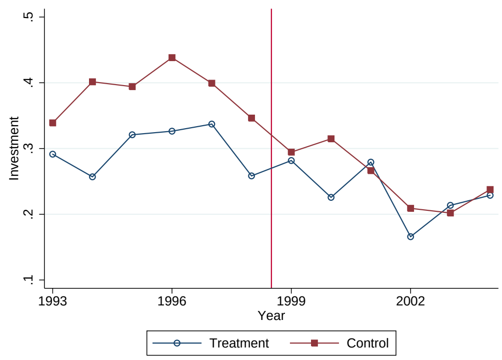
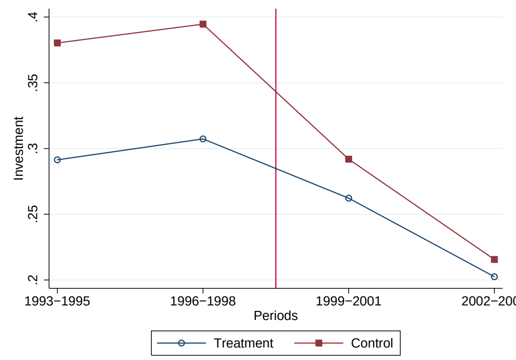


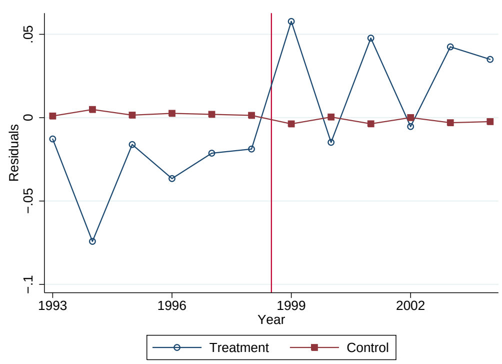
Figure 2.4: Research design



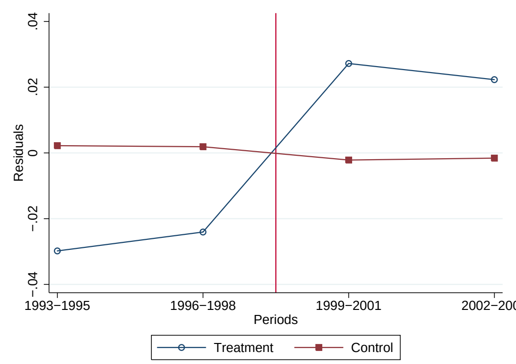
A. Annual Investment



B. 3-year-average Investment



C. Annual Investment (residual)



D. 3-year-average Investment (residual)

Figure 2.5: Investment trends.

The control group includes firms subject to the regular tax from 1996 to 2005, and the treatment group includes firms subject to the AMT during the same period. Panel A and Panel B present the trends of the original investment rate, $\frac{I_t}{K_{t-1}}$, in an annual base and in a 3-year period base, respectively. Panel C and Panel D present the trends of the investment residual in an annual base and in a 3-year period base, respectively. The residuals are constructed as
$\widehat{e}_{it} = \frac{I_t}{K_{t-1}} - \widehat{c}_1 \cdot q_{it} - \widehat{c}_2 \cdot X_{it} - \widehat{\alpha}_i - \widehat{\gamma}_t$.

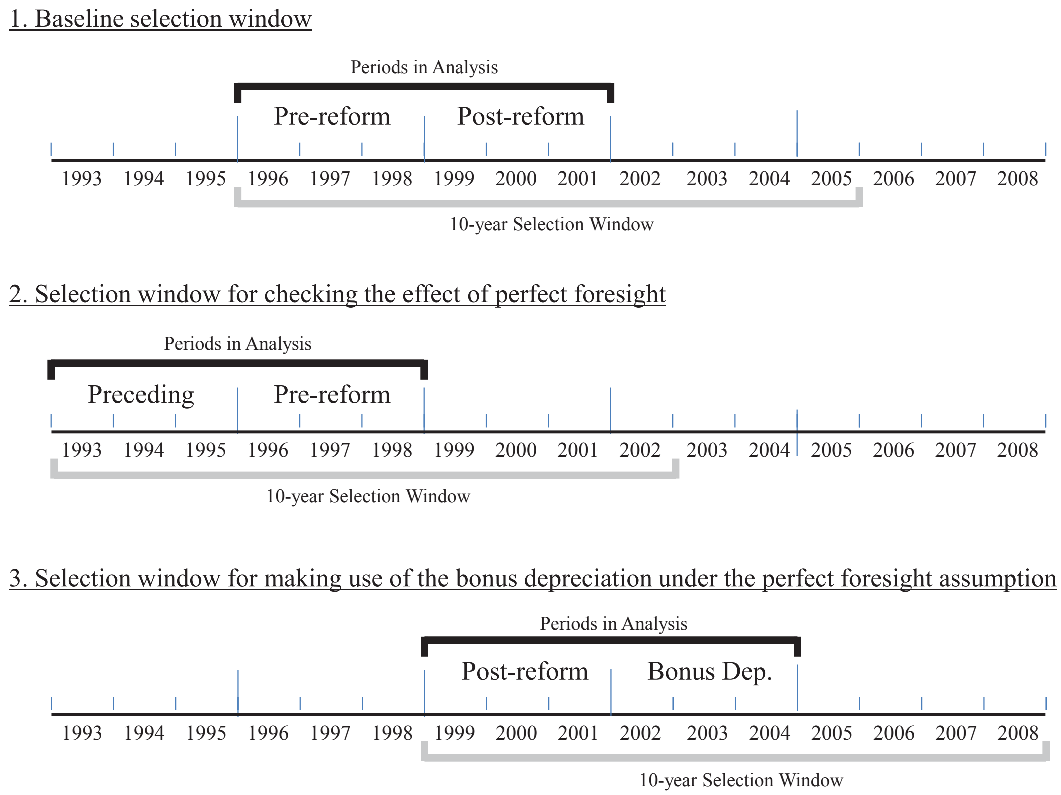


Figure 2.6: Various 10-year selection windows under perfect foresight assumption

2.10 Appendix

Appendix 1. GDS and ADS Recovery Periods

Capital Goods	ADS recovery (Pre-reform)	GDS recovery (Post-reform)
Tractor Units for Over-the-road Use	4	3
Racehorses With Over 2 Years in Service	5	
Horses Over 12 Years Old	10	
Light Vehicles	5	5
Computers & Office Equipment	6	
Trucks	6	
Buses	9	
Office Furniture	10	7
Agricultural Equipment	10	
Single-purpose Agricultural Structures	15	10
Water Transportation Equipment	18	
Radio Towers	20	15
Engines and Turbines	20	
Land Improvements	20	
Pipelines	22	
Electricity Generation and Distribution Systems	22	
Cable Lines	24	
Farm Buildings (other than Single Purpose Structures), Railroad Structures, Telephone Communications, Electric utilities, Water Utilities Structures Including Dams, and Canals	25	20

Source: IRS Publication 946. Capital goods are selected based on House and Shapiro (2008), Table 2.

Appendix 2. The Evolution of AMT Credit Carryforwards in an AMT year

To show AMT credit carryforwards are positive in an AMT year, I consider the two cases discussed in Section 2.4.

Case 1: Positive AMT payment at time s

In this case, $TB_s^m > TB_s^R$ at time s, thus from equation (2.6),

$$CF_s = F(K_s) - (1 + \Psi(\cdot))I_s - TB_s^m,$$

and the AMT payment $(TB_s^m - TB_s^R)$ is accumulated into the next year's AMT credit carryforwards, so that:

$$\underbrace{M_{s-1} + (TB_s^m - TB_s^R)}_{=M_s} > M_{s-1} \geq 0.$$

Case 2: No AMT payment, but the use of AMT credit carryforwards is limited

In this case, $TB_s^R > TB_s^m$ at time s but this firm cannot use all of its AMT credit carryforwards against its current tax bill because the lower bound of the firm's annual tax bill is the minimum tax bill. That is, $M_{s-1} > TB_s^R - TB_s^m > 0$, then again

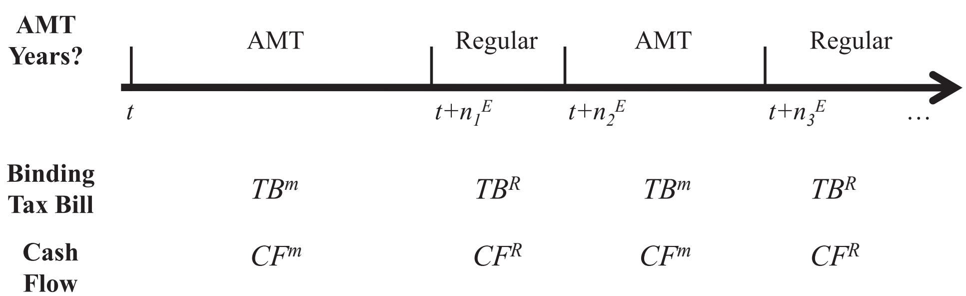
$$CF_s = F(K_s) - (1 + \Psi(\cdot))I_s - TB_s^m,$$

and the role of $(TB_s^R - TB_s^m)$ is to reduce the next year's AMT credit carryforwards, so that:

$$M_{s-1} > \underbrace{M_{s-1} + (TB_s^m - TB_s^R)}_{=M_s} > 0.$$

Appendix 3. General Characterization of Investment Incentives in the Presence of AMT

For a more general characterization of investment incentives in the presence of AMT than is presented in Section 2.5, let's now consider a firm which is currently subject to the AMT at time t, and expects the following scenario to happen: it will continuously be subject to the AMT system until it starts to be subject to the regular tax system at time $t + n_1^e$. And later at time $t + n_2^e$ it returns back to the AMT system, and so on, where $n_1^e < n_2^e < n_3^e < ....$[49] That is, this general expected path is illustrated in the figure below.



Binding tax bills are minimum tax bills in AMT years and regular tax bills in regular tax years. Recall from Section 2.5 that at time $t + n_1^e$, $t + n_3^e$, and so on, there are one-time realizations of leftover AMT credit carryforwards. These realizations are measured as the sum of annual differences between the two cash flows:

$$L_{t+n_1^e} = \sum_{s=t}^{t+n_1^e-1} (TB_s^m - TB_s^R), \quad \text{and} \quad L_{t+n_3^e} = \sum_{s=t+n_2^e}^{t+n_3^e-1} (TB_s^m - TB_s^R),$$

[49]This characterization is generalized enough to encompass all the possibilities regarding future AMT status. In one extreme, if a firm is never subject to the AMT, $n_1^e = 0$ and $n_2^e = n_3^e = ... = \infty$. In the other extreme, if a firm is always subject to the AMT, $n_1^e = n_2^e = ... = \infty$.

and so on. Thus a firm maximizes

$$V_t = \sum_{s=t}^{t+n_1^e-1} \rho^{s-t} CF_s^m + \sum_{s=t+n_1^e}^{t+n_2^e-1} \rho^{s-t} CF_s^R + \sum_{s=t+n_2^e}^{t+n_3^e-1} \rho^{s-t} CF_s^m + \sum_{s=t+n_3^e}^{t+n_4^e-1} \rho^{s-t} CF_s^R + ... + \rho^{n_1^e} L_{t+n_1^e} + \rho^{n_3^e} L_{t+n_1^e} + ...$$

subject to $K_{s+1} = (1-\delta)K_s + I_s$, where

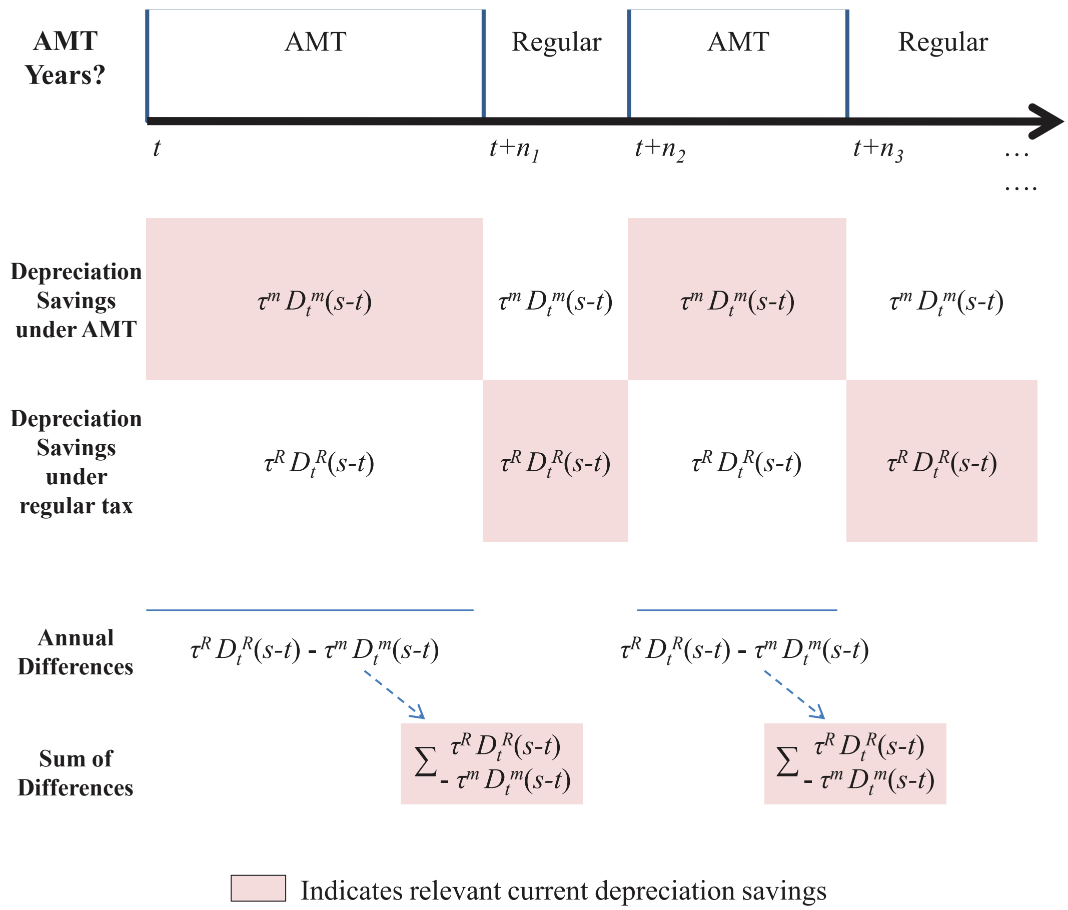
$$CF_s^m = F(K_s) - (1+\Psi(\cdot))p_s I_s - \tau_s^m \left[F(K_s) + G - \eta \cdot \Psi(\cdot) p_s I_s - \sum_{u=-\infty}^{s} \left(D_u^m(s-u)\right)(1+(1-\eta)\Psi(\cdot))p_u I_u \right],$$

$$CF_s^R = F(K_s) - (1+\Psi(\cdot))p_s I_s - \tau_s^R \left[F(K_s) - \eta \cdot \Psi(\cdot) p_s I_s - \sum_{u=-\infty}^{s} \left(D_u^R(s-u)\right)(1+(1-\eta)\Psi(\cdot))p_u I_u \right].$$

Consequently, the expected depreciation savings based on the expected path is given by:

$$\Gamma_t^m(n_1^e, n_2^e, ...) \equiv \underbrace{\tau^m \left[z_t^m(0, n_1^e\text{-}1)\right] + \widetilde{\tau z}_t(0, n_1^e\text{-}1)}_{\substack{\text{depreciation savings} \\ \text{from year 0 to } n_1^e\text{-1}}} + \underbrace{\tau^R \left[z_t^R(n_1^e, n_2^e\text{-}1)\right]}_{\substack{\text{depreciation savings} \\ \text{from year } n_1^e \text{ to } n_2^e\text{-1}}} + \underbrace{\tau^m \left[z_t^m(n_2^e, n_3^e\text{-}1)\right] + \widetilde{\tau z}_t(n_2^e, n_3^e\text{-}1)}_{\substack{\text{depreciation savings} \\ \text{from year } n_2^e \text{ to } n_3^e\text{-1}}} + ...$$

Recall that for the treatment group in this study, a large n_1^e is chosen for the first term $\tau^m \left[z_t^m(0, n_1^e\text{-}1)\right]$ to dominate other terms, just as the first term in this general set up does. Therefore, the simple characterization developed in Section 2.5 was general enough to characterize investment incentives for the analysis in this study. For a graphical illustration of depreciation saving streams on the expected path, see the figure below.


AMT Years?
AMT
Regular
AMT
Regular
t
t+n1
t+n2
t+n3
Depreciation Savings under AMT
τm Dtm(s-t)
Depreciation Savings under regular tax
τR DtR(s-t)
Annual Differences
τR DtR(s-t) - τm Dtm(s-t)
Sum of Differences
∑ τR DtR(s-t) - τm Dtm(s-t)
Indicates relevant current depreciation savings

Appendix 4. Replication of Table 2.4 in Section 2.6. Assuming Full Capitalizing (η= 0)

A4-1. Adaptive Expectation – *Permanently* Subject to the AMT

		Control Group		Treatment Group	
Periods	Years	Value	Δ	Value	Δ
Pre-Reform	1996-1998	1.008	-	1.016	-
Post-Reform	1999-2001	1.008	0.000	1.002	0.014
Bonus Depreciation	2002-2004	0.976	0.032	0.982	0.020

A4-2. Perfect Foresight – *Temporarily* Subject to the AMT

		Control Group		Treatment Group	
Periods	Years	Value	Δ	Value	Δ
Pre-Reform	1996-1998	1.008	-	1.048	-
Post-Reform	1999-2001	1.008	0.000	1.011	0.037
Bonus Depreciation	2002-2004	0.976	0.032	0.963	0.048

Appendix 5. Comparison of aggregate AMT information in 2002

	Tax Return Data		SEC 10-K Filing Data	
Selection Criteria	Firms pay the AMT or the use of business credit carryforwards are limited		Firms pay the AMT or the use of AMT credit carryforwards are limited	
Assets Size	# of All Firms	# of AMT Firms	# of All Firms	# of AMT Firms
Over $10M	43761	3425 (7.8%)	3432	453 (13.2%)
Over $50M	17484	1715 (9.8%)	2948	417 (14.1%)
Over $1B	2577	415 (16.1%)	1442	250 (17.3%)

Note: The "Tax Return Data" column shows how many firms were actually subject to the AMT in 2002, taken from Carlson (2005a) that is based on tax return data. For "SEC 10-K filing data," I count the number of firms that mention one of the "AMT credit" keywords in 2002. Carlson's (second) definition of AMT firms, which uses the limited use of business credit carryforwards as the criteria, instead of the limited use of AMT credit carryforwards, is similar to mine. Because, unlike other credits, AMT credit carryforwards have no expiration date, I assume that firms exhaust other tax credits before they use AMT credit carryforwards. Thus, Carlson's condition might be weakly stricter than my corresponding condition.

Appendix 6. Variable descriptions for chapter 2

- Investment is the ratio of the current year's capital expenditures (item 128) to the prior year's net property, plant, and equipment (item 8).

- q is the sum of the market value of equity (item 199 × item 25) and book liabilities minus deferred taxes (item 6 - item 60 - item 74), divided by book assets (item 6).

- Cash Flow is the ratio of the current year's operating income plus depreciation (item 18 + item 14) to the prior year's net property, plant, and equipment (item 8).

- S-A index is measured as -0.737 × Size plus 0.043 × Size^2 minus 0.040 × Age, where size is the log of inflation-adjusted book assets (item 6) and age is the number of years the firm is listed on Compustat. Size is capped at log($4.5 billion) and age is at thirty-seven years.

- K-Z index is calculated as 3.139 × current year's debt (item 142 + item 34) over the current year's total capital (item 142 + item 34 + item 144) minus 39.368 × current year's dividend (item 19 + item 21) over the prior year's book assets (item 6) minus 1.315 × current year's cash (item 1) over the prior year's book assets (item 6). As in Edgerton (2010), I exclude cash flow and q in calculating the index since these two variables are already included in all empirical equations.

- Capital Intensity is the ratio of the current year's net property, plant, and equipment (item 8) to the current year's book assets (item 6).

- Sales Ratio is the ratio of the current year's sales (item 12) to the prior year's book assets (item 6).

Appendix 7. List of Firms of the Baseline Treatment Group

Industry	Firm
Mining (sic 10-14)	Coeur D'Alene Mines Corp, Freeport-Mcmoran Cop & Gold, Burlington Resources Inc.*, Castle Energy Corp., Forest Oil Corp., Goodrich Petroleum Corp., KCS Energy Inc., Patterson-Uti Energy Inc., Primeenergy Corp.*, Range Resources Corp., Stone Energy Corp., Swift Energy Co., U S Lime & Minerals
Construction (sic 15-17)	Tutor Perini Corp., Goldfield Corp
Manufacturing (sic 20-39)	Craft Brewers Alliance Inc., Penford Corp., Hartmarx Corp., Pope & Talbot Inc., Smurfit-Stone Container Corp., Temple-Inland Inc., Cenveo Inc., Multi-Color Corp., Cyanotech Corp., E-Z-Em Inc.*, IGI Laboratories Inc., LSB Industries Inc., MGI Pharma Inc., Neurocrine Biosciences Inc., Neurogen Corp., Potash Corp Sask Inc., TOR Minerals Intl Inc., Valhi Inc., Hess Corp., American Biltrite Inc PW Eagle Inc.*, Owens-Illinois Inc., NS Group Inc., Oregon Steel Mills Inc., Phelps Dodge Corp., Titanium Metals Corp., 3D Systems Corp., Cummins Inc., Delphax Technologies Inc., Flow Intl Corp., Joy Global Inc., Network Equipment Tech Inc., Scientific Games Corp., Stratasys Inc.*, Wells-Gardner Electronics., WSI Industries Inc., Cobra Electronics Corp.*, Lamson & Sessions Co., Spire Corp., Symmetricom Inc., Westell Tech Inc., Fountain Powerboat Inds Inc., Itron Inc., Millipore Corp., Orbit International Corp., Possis Medical Inc.
Transportation (sic 40-47)	Railamerica Inc., P.A.M. Transportation Svcs*, AMR Corp., Mesa Air Group Inc., US Airways Group Inc.*, World Air Holdings Inc.,
Utility (sic 48-49)	Allied Waste Industries Inc., Aquila Inc., Blue Dolphin Energy Co., Delta Natural Gas Co Inc., Southern Union Co., Southwestern Energy Co., Western Gas Resources Inc., Williams Cos Inc., York Water Co.*
Trade (sic 50-59)	Newpark Resources, Officemax Inc., Gottschalks Inc., Checkers Drive-In Restaurant, Dennys Corp, Caremark RX Inc.*, Matria Healthcare Inc., Michaels Stores Inc

Note: * indicates that the firm's AMT credit carryforwards were positive only for 9 years during the 10-year selection window (from 1996 to 2005).

CHAPTER III

Investment Ramifications of Distortionary Tax Subsidies

3.1 Introduction

Governments frequently use tax policies to encourage certain activities and discourage others. Higher rates of taxation generally reduce aggregate business investment, but it is common for certain assets to receive preferential tax treatment designed to enhance their attractiveness to investors. In the United States, the prevailing view of such preferences is decidedly skeptical; nevertheless, the current U.S. tax code offers special incentives for foreign investment, investment in R&D, and other restricted categories of activity. In the years before 1987, the use of special incentives was considerably more widespread.

This essay examines the impact of tax incentives that are limited to specific categories of investments. The results indicate that, if there is a chance that firms will default on their debts, these tax incentives have significantly smaller effects on aggregate investment than they do when firms are certain not to default. Indeed, there are plausible circumstances in which higher tax subsidy rates may reduce total investment by firms receiving the incentives. The reason is that tax preferences for specific activities indirectly discourage others by worsening the conflict of interest between shareholders and bondholders. Bondholders do not benefit from investment tax incentives, since the state of the world about which they are most concerned - bankruptcy - is one in which tax incentives are valueless since firms have no tax liabilities.

If a firm loses money and is unable to pay off its debts, bondholders may be able to claim the firm's assets (net of its operating losses and any costs associated with bankruptcy). Conflict of interest stems from anticipation of this possibility, since shareholders, who control firms, invest in assets to maximize returns in those states of the world in which they, and not bondholders, are the residual claimants. Optimizing equity investors allocate resources between assets so as to equalize after-tax marginal returns. Bondholders prefer that firms equalize before-tax marginal returns, since such a rule maximizes the value of the firm if in default. Since the bond market anticipates that shareholder-controlled firms invest to maximize after-tax returns, borrowing rates rise in response to the introduction of specific investment tax incentives. Higher interest rates, in turn, reduce profits and make investment more costly. It is possible that interest rate reactions are so powerful that firms reduce total investment in response to greater incentives.

The agency problems between bondholders and shareholders generate inefficient outcomes that could be avoided if borrowers and lenders had perfect information about present and future conditions and could use enforceable and complete debt contracts specifying the types of investments firms are permitted to undertake. An efficient contract would appropriately weight the interests of both bondholders and shareholders. In practice it is not possible to draft perfectly efficient bond contracts; instead, bonds may have covenants containing rather crude restrictions on the disposition of funds by borrowers, or the financial circumstances in which loans may be called. The model analyzed in the paper assumes that lenders do not have sufficient information to write bond covenants that avoid the agency problems created by tax incentives, and the empirical work examines the use of bond covenants in practice.

As an alternative, the agency problems created by debt contracts could be avoided by financing firms entirely by equity, but doing so means relinquishing the tax benefits of debt described by Modigliani and Miller (1963) and Stiglitz (1973), and foregoing access to an important market for funds.

The apparent little power of tax incentives to stimulate aggregate investment spending is one of the puzzles of the empirical investment literature.[1] Part of the solution may lie in the noisiness of investment data, empirical specifications that are insensitive to decision making lags and adjustment costs, the importance of cash flow and other omitted variables, and the endogeneity of capital asset prices to investment demand.[2] This essay considers an additional possibility: that standard empirical specifications incorrectly capture the impact of tax incentives on the demand for capital. Since corporate borrowing rates reflect the bond market's anticipation of behavior that is endogenous to tax incentives, it is inappropriate to treat interest rates on corporate debt as exogenous in evaluating the effects of tax policies on investment.

Jorgenson-style cost of capital calculations imply that tax incentives for investments in specific assets affect the composition of new investment and increase the total volume of investment. These implications depend on an assumed zero probability of bankruptcy. The model in this essay implies that if there is a chance that investors will default on their debts, then these two phenomena - significant asset substitution and rapidly rising total investment - should not both accompany higher distortionary tax subsidies.

---

[1]Hassett and Hubbard (2002) and Chirinko (1993) survey this literature. Edgerton (2010) is a recent effort to estimate the investment impact of tax incentives on investment, one that reports only small effects from the introduction of bonus depreciation for U.S. equipment investment. Djankov et al. (2010), in a cross-country study using an entirely different methodology, draws the conclusion that tax burdens significantly affect investment levels.

[2]See, for example, Auerbach and Hassett (1992), Cummins et al. (1994), Goolsbee (1998), and House and Shapiro (2008).

There is an extensive literature on the inability of some firms - typically, those in tax loss situations - to benefit from the availability of tax deductions or tax credits.[3] Most of these situations reflect the tax law's asymmetric treatment of profits and losses. This problem is typically treated as one in which firms that act in the interest of their shareholders react little to tax subsidies if there is a substantial probability of having tax losses. There is, however, a potentially much more powerful implication of the asymmetric treatment of profits and losses that stems from the inability of creditors of bankrupt firms to use their accumulated tax credits. Neither of these implications is important if owners of unprofitable firms can benefit from tax incentives by effectively selling them to profitable firms through takeovers or sale-leaseback operations. In practice, unprofitable firms seldom benefit from tax credits;[4] this essay analyzes cases in which investors anticipate that tax credits have no value to firms with tax losses.

It is well established that bond prices are correlated with a firm's profitability,[5] but the distinction between pre-tax and after-tax profitability has heretofore received scant if any attention in empirical studies of bond pricing. The provision of extremely generous depreciation allowances for U.S. equipment investment, but not for other investment, during 2002-2004 encouraged firms to distort the composition of investment in favor of tax-preferred assets.[6] Detailed evidence of bond covenants from time periods prior to 2002, the 2002-2004 period, and after 2004 confirm that borrowing contracts during the bonus depreciation period were more likely than at other times to contain significant restrictions. These covenants were concentrated

[3] See, for example, Auerbach (1983), Auerbach (1986), Auerbach and Poterba (1987), Majd and Myers (1987), Mintz (1988), Altshuler and Auerbach (1990), Graham (1996), Graham (2000) and Edgerton (2010).

[4] Auerbach and Reishus (1991) and Gilson (1990) note the infrequency with which defaulting firms are acquired by profitable entities, and Hotchkiss (1995) documents the subsequent poor financial performance of bankrupt firms that undergo reorganization.

[5] See, for example, Kwan (1996).

[6] House and Shapiro (2008) offer evidence that U.S. firms significantly increased their investment in classes of equipment that received the greatest increase in tax benefits during 2002-2004, relative to investment in other classes of equipment.

among contracts involving borrowers with precarious financial situations and whose assets were concentrated among equipment investments that were the focus of the tax-induced distortion. Corporate borrowing fell during the bonus depreciation period, with the decline concentrated among financially precarious firms whose assets were concentrated in equipment investment.

Section 3.2 of the paper analyzes the properties of a simple model in which certain assets receive favorable tax treatment. Section 3.3 considers extensions of the model. Section 3.4 examines evidence from bond contracts before, during, and after the 2002-2004 bonus depreciation period. Section 3.5 is the conclusion.

3.2 Model

In order to clarify the issues raised by distortionary tax incentives, it is useful to analyze a model in which management acts in the interest of shareholders and there is no conflict between the interests of shareholders and the interests of bondholders in the absence of taxation. More general treatments of the investment problem would consider situations in which there are interactions between various agency problems, including those introduced by taxation.

3.2.1 Framework

Consider a firm that invests in two assets, K_1 and K_2, prior to the realization of a stochastic shock to its output. For simplicity the model has only two periods; the firm chooses K_1 and K_2 in the first period, while the state of the world is revealed and contracts are closed in the second. The firm's (reduced-form) production function is $y(K_1, K_2)\theta$ in which $y(\cdot)$ is a deterministic function and $\theta \in [0, \infty]$, is the realization of the shock. The production function is taken to be concave and homothetic, which rules out unusual outcomes stemming simply from output scale effects. Output is assumed to be verifiable to all investors. θ is distributed according to a known density function $g(\theta)$.

Firms are assumed to be risk-neutral, in the sense that managers maximize expected profits without regard to the correlation between θ and the market return. Alternatively, one can think of θ as reflecting purely idiosyncratic shocks to a firm's production function.

Assets 1 and 2 each depreciate at one-period rate δ.[7] The firm's investments are financed by a combination of owner's equity (E) and bonds (B) held by unrelated parties. Aggregate firm capital is denoted $K \equiv K_1 + K_2$; the firm's capital constraint is the requirement that $K \leq E + B$.

The shock, θ, is realized at the start of the second period. The realization of θ influences both the pre-tax profitability of the firm and its tax liability. There are three possible outcomes in the second period. The first possibility is that the firm is profitable and has positive tax liability. If so, the firm pays corporate taxes at rate τ on its output net of interest charges and depreciation. In addition, and this is the focus of the subsequent analysis, the firm receives a tax credit of c for every unit of K_1 it installs. The second possibility is that the firm has tax losses (and therefore no tax liability) but is not in default. The third possibility is that the firm's revenues are so low that it defaults on its debt obligations.

The tax credit is assumed to be nonrefundable if the firm has tax losses. Nonrefundability is at the heart of the agency problem, since the bondholders, who are residual claimants on the firm's assets in the event of default, receive no benefits from the tax credit because default is also a state in which the firm has no tax obligations.

Aggregate production is a function of K, the total capital stock, and its allocation between assets 1 and 2. Since the production function is homothetic, the interasset

[7] As a general matter, assets depreciate at differing rates - and in particular, the history of U.S. experience with investment tax credits is that tax-favored assets tend to have higher depreciation rates. This issue is important in interpreting the empirical work presented in section 3.4. Depreciation rates are assumed to be equal in this section in order to consider a situation in which there is no conflict of interest between shareholders and bondholders in the absence of special tax incentives.

allocation of capital is independent of the scale of output, being instead a function of the relative cost of the two assets as determined by c. It is useful to introduce the following quasi-reduced form notation for output: $Q(K,c)\theta$, in which $Q(K,c) = y\left[K\sigma_1(c), K(1-\sigma_1(c))\right]$ and $\sigma_1 \equiv K_1/K$ is the firm's share of credit-eligible capital.

A firm that borrows in the first period must redeem its debt, along with any agreed-upon interest, in the second period, unless the firm defaults, in which case bondholders are entitled to seize control of the firm and its assets. $r(B,K,c)$ denotes the required payment (in non-bankruptcy states) to debtholders in the second period, representing interest $[r(B,K,c)-B]$ plus repayment of debt principle (B). As the notation indicates, interest rates are functions of total borrowing, total investing (and thereby implicitly the equity contributions of shareholders), and the incentives created by the tax system. Figure 3.1 depicts the sequence of events. In the first period, investors commit E of equity to the firm, after which the firm borrows B in the bond market. The firm then selects K_1 and K_2.

Shareholders of profitable, taxpaying firms receive:

$$\{Q(K,c)\theta - [r(B,K,c)-B] - \delta K\}(1-\tau) - B + K + cK\sigma_1.$$

The term in braces is the firm's sales revenue, minus the sum of its depreciation charges and interest payments. Depreciation for tax purposes is assumed to equal economic depreciation. The second term in the expression (-B) reflects the repayment of debt principle. Finally, investors have claims on the firm's capital stock and receive the tax credits associated with investing in K_1.

It is possible that the firm's earnings will be sufficient to cover its required payment of $r(B,K,c)$ to bondholders but insufficient to generate positive tax liability, either because the firm incurs losses or because its tax credits $(cK\sigma_1)$ equal or exceed its tax liabilities.[8] Since the firm pays no taxes, shareholders receive:

$$Q(K,c)\theta + (1-\delta)K - r(B,K,c).$$

The third possibility is that the firm's losses are so great that bondholders cannot be fully paid off; instead, bondholders receive the firm's assets (net of operating losses and bankruptcy costs) and shareholders receive nothing in the second period.

Shareholder expected profits (π^e) are:

$$\begin{aligned} \pi^e = \quad & \{[Q(K,c)\theta_1 - r(B,K,c) - \delta K](1-\tau) - B\tau + K + (cK\sigma_1)\}\, p_1 \\ + \quad & \{Q(K,c)\theta_2 - r(B,K,c) + (1-\delta)K\}\, p_2 \end{aligned} \tag{3.1}$$

in which p_1 denotes the support of the distribution of θ over which the firm has positive tax liability and θ_1 is the average value of θ within that region. Similarly, p_2 denotes the support of the distribution of θ over which the firm meets its debt obligations but has no tax liability; θ_2 is the average value of θ within that region. For notational simplicity it is convenient to treat θ as though it has a point distribution taking the value θ_1 with probability p_1, the value θ_2 with probability p_2, and the value θ_3 with probability p_3, in which $p_1 + p_2 + p_3 = 1$ and p_3 is the probability of default.[9] p_1 is defined to equal the probability of θ falling in the range that:

$$\tau\{Q(K,c)\theta - [r(B,K,c) - B] - \delta K\} - cK\sigma_1 > 0.$$

[8] This statement assumes that taxpayers are entitled to use tax credits to offset 100% of their tax liabilities. In practice, many countries (including the United States) limit the extent to which certain kinds of tax credits can be so used. Explicitly incorporating such restrictions would change the analysis very little.

[9] Note that, since θ takes nonnegative values, $\theta_1 \geq \theta_2 \geq \theta_3 \geq 0$. The appendix analyzes the model in a setting in which θ is distributed continuously, making the probability of default (as well as p_1 and p_2) endogenous to tax polices and to investment decisions of firms. The results are identical to those described in the text (in which θ is distributed discretely).

p_2 is defined to equal the probability of falling in the range that:

$$\tau \{Q(K,c)\theta - [r(B,K,c) - B] - \delta K\} - cK\sigma_1 \leq 0,$$

$$Q(K,c)\theta + (1-\delta)K - r(B,K,c) \geq 0.$$

Expected returns as defined in (3.1) are operating returns that make no allowance for the cost of invested equity (E). Denote the opportunity cost of equity (measured in second period units) by ρ. The firm chooses K_1, K_2, B, and E to maximize:

$$\pi^e - \rho E \tag{3.2}$$

subject to:

$$E + B \geq K \tag{3.3}$$

The first-order condition corresponding to maximizing (3.2) over the choice of K, subject to (3.3), is:

$$\frac{\partial Q}{\partial K}[p_1\theta_1(1-\tau) + p_2\theta_2] + \left[(1-\delta) - \frac{\partial r}{\partial K}\right][p_1(1-\tau) + p_2] + p_1\tau + p_1\sigma_1 c = \lambda \tag{3.4}$$

in which $\lambda \geq 0$ is the lagrange multiplier corresponding to the value of the constraint (3.3). In addition, there are two first order conditions corresponding to alternative sources of finance:

$$\frac{\partial r}{\partial B}[p_1(1-\tau) + p_2] - p_1\tau = \lambda \tag{3.5}$$

which must be satisfied for firms issuing positive amounts of debt, and

$$\rho = \lambda \tag{3.6}$$

for firms with positive equity. In equilibrium, firms using both debt and equity must be indifferent between them (as in Miller (1977) and DeAngelo and Masulis (1980)). Market equilibrium is characterized by firms with internal debt-equity ratios that generate probabilities of bankruptcy making them indifferent at the margin between the two sources of finance. In order to evaluate the role of tax parameters in influencing the cost of debt (and therefore also equity) finance, it is necessary to consider the nature of equilibrium in the bond market.

3.2.2 Bond Market Equilibrium

Interest rates on risky debt reflect the requirement that lenders receive risk-adjusted normal returns. Bondholders receive $r(B, K, c)$ if the firm is solvent in period two, and receive less if the firm is insolvent. Bondholders of bankrupt firms are entitled to seize their assets, though the process of doing so typically entails some costs. Recognizing these costs, shareholders and bondholders of firms in default often prefer to settle their claims without recourse to formal bankruptcy proceedings. A simplified characterization of default is that bondholders receive in period two the firm's assets, net of its operating losses, and net of associated bankruptcy costs. Lenders are assumed to know B and K, but not to be able to contract over the breakdown of K into K_1 and K_2. Denoting the required certainty-equivalent rate of interest by $\overline{r}$, bond market equilibrium requires that

$$(1 + \overline{r})B = (p_1 + p_2)r(B, K, c) + p_3 \left[Q(K, c)\theta_3 + (1 - \delta)K\right] \qquad (3.7)$$

in which the first term on the right side of (3.7) is the payoff to bondholders in non-bankruptcy states, and the second term is the payoff in bankruptcy. For the purpose of this expression, any bankruptcy costs are assumed to be incorporated in the relevant value of θ_3. Differentiating (3.7),

$$\frac{\partial r}{\partial K} = \frac{-p_3}{1-p_3}\left[\frac{\partial Q(K,c)}{\partial K}\theta_3 + (1-\delta)\right] \tag{3.8}$$

and

$$\frac{\partial r}{\partial B} = \frac{1+\overline{r}}{1-p_3}. \tag{3.9}$$

Equation (3.9) reflects that additional borrowing yields bondholders (in aggregate) no additional returns in bankruptcy states, since bondholders receive simply the value of the firm (minus bankruptcy costs), which is unaffected by the amount of capital raised on the debt market.

By contrast, (3.8) illustrates that new investment reduces interest rates, since with B held constant, any additional investment is financed with equity. Equity-financed investments reduce the severity of bankruptcy outcomes from the standpoint of bondholders, though the extent to which new investments reduce interest rates is a function of differences between shareholder and bondholder interests induced by nonzero values of c.

3.2.3 Investment Implications

Combining (3.4), (3.5), (3.8) and (3.9),

$$\frac{\partial Q(K,c)}{\partial K}\left[p_1\theta_1(1-\tau) + p_2\theta_2 + \frac{p_3\left[p_1(1-\tau)+p_2\right]}{p_1+p_2}\theta_3\right] = \frac{(\overline{r}+\delta)\left[p_1(1-\tau)+p_2\right]}{p_1+p_2} - c\sigma_1 p_1. \tag{3.10}$$

This equation is standard in the Hall-Jorgenson analysis of investment, since if p_1=1 and $p_2 = p_3 = 0$, then it simply implies that $\frac{\partial Q(K,c)}{\partial K}\theta_1 = (\overline{r}+\delta-c\sigma_1)/(1-\tau)$. In that setting, changes in c have direct impact on the marginal product of capital and an implied effect on capital demand. Earlier studies analyze the importance of $p_2 > 0$ in reducing the impact of c on investment. In the setting described by (3.10), however, $p_3 > 0$ has much greater potential to affect the impact of c on capital demand than does $p_2 > 0$.

Since the influential work of Hall and Jorgenson (1967), it is customary to evaluate the investment effects of tax policies by calculating tax-induced changes in the cost of capital. In equation (3.10), the cost of capital appears as $\frac{\partial Q(K,c)}{\partial K}$, the tax-induced marginal product of capital. Decomposing the effect of c on $\frac{\partial Q(K,c)}{\partial K}$,

$$\frac{d\left[\frac{\partial Q(K,c)}{\partial K}\right]}{dc} = \frac{\partial^2 Q(K,c)}{\partial K^2}\frac{dK}{dc} + \frac{\partial^2 Q(K,c)}{\partial K \partial c} \tag{3.11}$$

in which the first term on the right side of (3.11) is the change in the cost of capital due to interactions between changes in investment levels and the concavity of the production function, and the second term on the right side is the change in the marginal product of capital induced by substitution of K_1 for K_2. Since the effect of c on output, holding K fixed, stems from induced changes in the composition of capital inputs, it follows that

$$\frac{\partial Q(K,c)}{\partial c} = \left[\frac{\partial y}{\partial K_1} - \frac{\partial y}{\partial K_2}\right] K \frac{d\sigma_1}{dc}. \tag{3.12}$$

It is straightforward to establish, in a manner similar to the derivation of (3.4), that the firm's profit-maximizing choice of K_1 and K_2 satisfies:

$$\frac{\partial y}{\partial K_1} - \frac{\partial y}{\partial K_2} = \frac{-cp_1}{p_1\theta_1(1-\tau) + p_2\theta_2}. \tag{3.13}$$

Since the right side of (3.13) is independent of K, it follows that (3.12) implies:

$$\frac{\partial^2 Q(K,c)}{\partial K \partial c} = \left[\frac{\partial y}{\partial K_1} - \frac{\partial y}{\partial K_2}\right] \frac{d\sigma_1}{dc}. \tag{3.14}$$

Totally differentiating (3.10) yields:

$$\frac{d\left[\frac{\partial Q(K,c)}{\partial K}\right]}{dc} = \frac{-p_1\left(\sigma_1 + c\frac{d\sigma_1}{dc}\right)}{p_1\theta_1(1-\tau) + p_2\theta_2 + \frac{p_3[p_1(1-\tau)+p_2]}{p_1+p_2}\theta_3}. \tag{3.15}$$

Then rearranging (3.11), and imposing (3.14), (3.13) and (3.15) implies:

$$\frac{\partial^2 Q(K,c)}{\partial K^2}\frac{dK}{dc} = \frac{p_1 c\frac{d\sigma_1}{dc}}{p_1\theta_1(1-\tau) + p_2\theta_2} + \frac{p_1\left(\sigma_1 + c\frac{d\sigma_1}{dc}\right)}{p_1\theta_1(1-\tau) + p_2\theta_2 + \frac{p_3[p_1(1-\tau)+p_2]}{p_1+p_2}\theta_3}. \tag{3.16}$$

It is useful to define a measure, f, of the extent to which the firm's output is expected to come in default states:

$$f \equiv \frac{p_3\theta_3\left[p_1(1-\tau)+p_2\right]}{\left[p_1\theta_1(1-\tau)+p_2\theta_2\right]\left[p_1+p_2\right]}.$$

If default is impossible (p_3=0) then f=0. If p_2=0 then $f = p_3\theta_3/p_1\theta_1$, so f may exceed unity at sufficiently high default probabilities. Then letting

$$\eta \equiv \frac{\partial\sigma_1}{\partial c}\frac{c}{\sigma_1}$$

define the elasticity of the share of capital of type one in the firm's capital stock with respect to the tax credit, (3.16) becomes:

$$-\frac{\partial^2 Q(K,c)}{\partial K^2}\left[p_1\theta_1(1-\tau)+p_2\theta_2\right](1+f)\frac{dK}{dc} = p_1\sigma_1(1-f\eta). \tag{3.17}$$

Concavity of the production function implies that $\frac{\partial^2 Q(K,c)}{\partial K^2} < 0$, so $(1-f\eta) < 0$ means that $\frac{dK}{dc} < 0$. Higher tax credit rates reduce investment if $f\eta > 1$, which arises if substantial fractions of output come in default states of the world and if firms substitute strongly toward tax-preferred assets in response to higher tax credits. These two conditions are jointly necessary, since if f=0, then default is impossible and there is no agency cost associated with shareholder control of the firm, while if η=0, then firms do not respond to tax credits by substituting assets in a way that is costly to bondholders.

It is noteworthy that, from its definition, η=0 if $\frac{d\sigma_1}{dc} = 0$ or c=0, so either of these conditions is sufficient to guarantee that $\frac{dK}{dc} > 0$. If $\frac{d\sigma_1}{dc} = 0$ then firms do not substitute one capital good for another in response to relative price changes. If c=0 then bondholders are unharmed by asset substitution, since pretax marginal products of different capital types are equal.

The term $(1 - f\eta)$ in (3.17) is the factor by which excessive asset substitution reduces the investment impact of specific tax subsidies.[10] In order to evaluate the magnitude of this factor, it is useful to replace η in with a more commonly-estimated parameter, ϵ, the elasticity of substitution between K_1 and K_2. The substitution elasticity is:

$$\epsilon \equiv \frac{d(K_1/K_2)}{d(c_1/c_2)} \frac{c_1/c_2}{K_1/K_2}$$

in which c_1 is the user cost of capital goods of type one and c_2 is the user cost of capital goods of type two. From its definition, $\sigma_1 = \frac{K_1}{K_1+K_2} = \frac{K_1/K_2}{1+(K_1/K_2)}$. Furthermore, homotheticity of the production function implies that $\frac{d(K_1/K_2)}{dc} = \frac{d(K_1/K_2)}{d(c_1/c_2)} \frac{d(c_1/c_2)}{dc}$, since ratios of factor inputs are affected by relative costs but not by output levels. Consequently,

$$\frac{d\sigma_1}{dc} = \frac{\frac{d(K_1/K_2)}{d(c_1/c_2)} \frac{d(c_1/c_2)}{dc}}{[1 + (K_1/K_2)]^2} = \frac{\epsilon\sigma_1(1 - \sigma_1)\frac{d(c_1/c_2)}{dc}}{c_1/c_2} \tag{3.18}$$

From the standard Hall-Jorgenson formula, the user cost of capital of type one, for an investment financed by equity, is: $c_1 = (r^e + \delta)(1 - c - \tau z)/(1 - \tau)$, in which r^e is the appropriately-adjusted required rate of return on equity investment, and z is the present discounted value of depreciation allowances. It is appropriate to use this

[10] Since p_1 premultiplies the right side of (3.17), the term $(1 - f\eta)$ captures the effect of asset substitution conditional on potential unprofitability. Previous studies of investment tax incentives when $p_1 < 1$ implicitly assume that $p_2 = 1 - p_1$, and therefore $p_3 = 0$, so it is necessary to adjust their calculations by $(1 - f\eta)$ when $p_3 > 0$.

expression because firms are indifferent at the margin between financing investments with debt and with equity. It follows that $c_1/c_2 = (1-c-\tau z)/(1-\tau z)$, which in turn implies that $\frac{d(c_1/c_2)}{dc} = -1/(1-\tau z)$. Finally, the present value of economic depreciation allowances is given by $z = \frac{\delta}{\bar{r}+\delta}$ (Hall and Jorgenson (1971)). These substitutions yield:

$$\eta = \frac{-\epsilon(1-\sigma_1)c}{1-c-\frac{\tau\delta}{\bar{r}+\delta}}. \tag{3.19}$$

High values of f and c, and large negative values of ϵ, conspire greatly to reduce $\frac{dK}{dc}$. For example, if $f = 1, \sigma_1 = 0.2, c = 0.3, \tau = 0.45, \delta = .10, \bar{r} = 0.05$, and ϵ =-1, then $(1-f\eta)$ =0.4. With otherwise the same parameters but ϵ=-2, $(1-f\eta)$ =-0.2. At higher absolute values of ϵ, asset substitution means that small increments to c will be accompanied by significant shifting of investment into tax-favored assets with relatively low pre-tax marginal products. Higher values of f likewise reduce $\frac{dK}{dc}$. While calculations can illustrate the possibility that investment falls with higher levels of c, the more general point is that it is necessary to adjust standard cost of capital formulas by the factor $(1-f\eta)$ in order to capture the incentives created by the tax system.

3.2.4 Implications for Profitability

The same considerations that reduce the investment impact of specific tax credits also reduce the effect of higher tax credits on profitability. Indeed, identical terms appear in both the profitability and investment equations. Higher tax credit rates raise borrowing costs as lenders anticipate substitution into tax-preferred assets. If this effect is sufficiently large, it can overwhelm the direct effect of tax credits on profitability.

Differentiating the bond market equation (3.7) produces:

$$(p_1+p_2)\frac{\partial r(B,K,c)}{\partial c} + p_3\theta_3\frac{\partial Q(K,c)}{\partial c} = 0, \tag{3.20}$$

which, together with (3.12) and (3.13), implies:

$$\frac{\partial r(B,K,c)}{\partial c} = K\frac{d\sigma_1}{dc}cp_1\frac{p_3\theta_3}{[p_1\theta_1(1-\tau)+p_2\theta_2]\,[p_1+p_2]} \tag{3.21}$$

From (3.1) and the envelope theorem, the effect of c on expected profits is:

$$\frac{d\pi^e}{dc} = -\frac{\partial r(B,K,c)}{\partial c}\,[p_1(1-\tau)+p_2] + K\sigma_1 p_1. \tag{3.22}$$

Then combining (3.21) and (3.22) yields:

$$\frac{d\pi^e}{dc}\frac{1}{K} = p_1\sigma_1(1-f\eta) \tag{3.23}$$

the right side of which is identical to the right side of (3.17). The same moral hazard costs associated with higher tax credit rates that reduce investment also reduce expected profitability. Since investors must be indifferent between holding riskless government debt and risky corporate bonds, the costs or benefits of distortionary tax incentives are borne entirely by shareholders.

Figure 3.2 illustrates the equivalent (and much more easily depicted) effect of tax credits on the cost of producing a given quantity of output. The two solid lines in the figure reflect after-tax relative prices of K_1 and K_2 before and after the introduction of a credit for purchases of K_1. For simplicity consider the case in which $p_2 = 0$, so that the firm is either taxable or bankrupt. The distance between the points at which the two budget lines, tangent to the same isoquant, intersect the vertical axis equals the cost reduction for which the tax credit is responsible if the firm is taxable. The dotted line in Figure 3.2 is constructed to be parallel to the original price line while intersecting the input combination that maximizes expected returns to shareholders after introduction of the tax credit. The distance between the points at which this line and the original budget line intersect the vertical axis equals the extent to which pre-tax input costs rise due to substitution induced by the tax credit. If the product of this higher cost and the probability of default exceeds the product of the after-tax cost reduction and the probability of being taxable, then the tax credit raises expected after-tax costs. This is possible because, with p_2=0, the input combination that maximizes shareholder value is independent of the probability of default and the value of θ in default states; consequently, shareholders have excessive incentives to substitute K_1 for K_2. If the probability of bankruptcy is sufficiently great, and the two inputs are highly substitutable, then the costs associated with asset substitution may exceed the direct benefits of receiving tax credits.

3.2.5 Relation to other Agency Cost Models

The cost of the inefficiency generated by incentives to overinvest in tax-preferred assets (to the detriment of bondholders) is ultimately borne by shareholders, who are unable to commit their firms not to do so, and who therefore must pay higher interest rates. This result is similar in spirit to earlier work on incentives to distort the portfolio of investments financed using incomplete debt contracts. The option aspect of an equity claim implies that there are situations in which firms serve the interests of shareholders by making risky investments with negative expected present values and by foregoing safe investments with positive present values.[11] Lenders, who understand these incentives, demand higher interest rates in response. The incentive to overinvest in risky assets is perhaps somewhat subtler than the incentive to overinvest in tax-preferred assets, though it is similar in that the conflicting interests of shareholders and bondholders distort behavior and drive up interest rates in response. The bonus depreciation provisions introduced in 2002, the focus of the empirical analysis in Section 3.4, are noteworthy in this respect, as it is well known that longer-lived

[11] Jensen and Meckling (1976) and Green (1984) analyze the incentives to undertake risky investments, Myers (1977) considers the role of debt overhang in discouraging safe investments, and Gertner and Scharfstein (1991) evaluate these incentives in the context of U.S. reorganization law.

assets benefit significantly more from bonus depreciation than do shorter-lived assets. To the extent that longer-lived assets are believed to be used for riskier investment projects, therefore, this investment subsidy program could be expected to aggravate this asset-substitution problem.

Incomplete debt contracts that distort investment decisions may simultaneously serve to correct other inefficiencies. There is considerable attention devoted to the use of debt to discipline managers and thereby reduce some of the agency problems between shareholders and managers.[12] Debt used for this purpose nevertheless becomes more costly when some assets but not all receive preferential tax treatment.

3.3 Extensions to the Model

This section considers four issues related to the model analyzed in section 3.2. The first is the ability of shareholders and bondholders to design contracts that reduce the agency costs that otherwise arise due to incomplete contracting. The second is the legal process that accompanies default, and the associated possibility that bondholders may not be able to recover the full value of a firm's assets in the face of determined opposition by shareholders. The third is the potential incompleteness of tax carryforwards and carrybacks in settings with more than two periods. And the fourth is the applicability of the model to the case of foreign tax credits.

3.3.1 Bond covenants

In principle, bondholders have available to them information that could be used to avoid some of the agency problems described in section 3.2. The model in section 3.2 posits that lenders are unable to observe the investment mix chosen by borrowers. Another possibility is that lenders could attach covenants to bond contracts that

[12] See, for example, Grossman and Hart (1982), Dewatripont and Tirole (1994), and Hart and Moore (1995).

specify the types of investments borrowers are permitted to undertake. Optimally-chosen covenants would then be endogenous to the tax treatment of different assets, limiting the extent of permitted substitution into tax-preferred investments.

There are several well-known difficulties that such arrangements encounter in practice.[13] The first stems from the difficulty of recontracting in stochastic environments. Borrowers will want to change their investment plans over time based on new information. If strictly enforced, covenants prevent efficient adaption to changing circumstances and thereby reduce the interest rates that borrowers are willing to pay. If not strictly enforced, then - in the absence of symmetric information between borrowers and lenders - covenants will not prevent excessive substitution into tax-preferred investments. A second difficulty with bond covenants is that, in the presence of informational asymmetries, lenders will generally not have sufficient information to be able to write efficient covenants. Lenders may suspect that borrowers will adjust the composition of their investments in favor of assets that are eligible for tax credits, but do not know what fraction of the capital stock such assets would represent in the absence of tax incentives. A third difficulty with bond covenants has to do with their enforcement. Covenant violations can lead to renegotiation or termination of bond contracts, but dramatic remedies are costly to all parties and may increase the chance of an even costlier subsequent default. Partly for this reason, it is common for lenders to waive at least some violations of covenant provisions.[14] From an ex ante standpoint, the potential costs associated with verifying compliance with covenant provisions and assessing damages for noncompliance reduces the desirability of attaching an excessive number of such restrictions to bond contracts, except in circumstances in which covenants are desperately needed.

Despite these difficulties, it is possible for bondholders to impose restrictions on borrowers that attenuate some of the effects analyzed in section 3.2. For example,

[13]See, for example, Smith and Warner (1979), McDaniel (1986), and Berlin and Loeys (1988).
[14]See, for example, Chen and Wei (1993) and Beneish and Press (1993).

borrowing rates could be made contingent on the fraction of tax-preferred assets in which a borrower invests. This type of restriction would change somewhat the solution derived in section 3.2 without changing its character unless such contracts could be applied perfectly. In practice, bond covenants typically do not have the kind of detailed provisions that would be required to tailor investment optimally, instead making their terms contingent on readily measured features of borrower behavior.[15]

As noted by Smith and Warner (1979), and empirically demonstrated by Bradley and Roberts (2004), borrowing rates tend to be lower when financial debt covenants are included in loan contracts, controlling for observable risks. This is consistent with the covenant hypothesis that borrowers receive favorable borrowing rates in return for accepting debt covenants. Therefore, the analysis in Section 3.2 about the impact of investment credits on borrowing rates carries implications for financial debt covenants, which are extensively explored in Section 3.4. Financial debt covenants specify one or more accounting index and the thresholds of each variable at the inception of a loan. Each quarter, lenders examine the borrower's financial reports to determine whether the borrower's reported index exceeds the threshold. Upon violation of a financial debt covenant, a borrower is considered in technical default, in which case the lender can demand immediate repayment of a loan. Dichev and Skinner (2002) report that this extreme event rarely happens - instead, the loan terms are typically renegotiated, including the loan covenants. During this process, however, lenders may intervene the borrower's operating decisions by limiting the borrower's ability to make new investments, acquire other firms, or engage in other – possibly value-enhancing – actions. Dichev and Skinner (2002) also find that financial debt covenants are set relatively tight, and technical defaults occur quite frequently (in a typical quarter, about 15-20% of outstanding loans are in technical default), which implies that financial debt covenants provide lenders with at least a partial control

[15]See the evidence reported by Smith and Warner (1979), Kalay (1982), McDaniel (1986), Lehn and Poulsen (1991), and Beneish and Press (1993).

over borrower actions that reflect moral hazard.

3.3.2 Default and bankruptcy

The model presented in section 3.2 contains a stylized treatment of the consequences of default. In the model, firms that are unable to meet contractual debt obligations become the property of bondholders; this ownership transfer does not otherwise affect the value of the ongoing concern. In practice, firm value may be adversely affected by the displacement of previous owners and by costs incurred during bankruptcy proceedings - and anticipation of such loss in value influences negotiations between defaulting firms and their creditors. Consequently, creditors of financially distressed firms may accept terms in which they are paid less than the value of existing assets.[16]

It is possible to reinterpret the model's parameters to incorporate renegotiation and bankruptcy costs, as well as value transfers between bondholders and shareholders triggered by default. Costs associated with renegotiation and bankruptcy are reflected in reduced values of θ_3. In the model's risk-neutral setting, the prospect of rent transfers from bondholders to shareholders of distressed firms is captured by higher than actual values of θ_2 and corresponding lower values of θ_3. Such changes do not alter the model's properties and implications, though they do affect its empirical application.

3.3.3 Timing of tax credits

In the two-period model analyzed in section 3.2, profitable firms receive the benefits of tax credits at the same time that uncertainty is resolved and bondholders are paid. In practice, certain tax credits are available when investments are made

[16]Ang et al. (1982) document the administrative costs of corporate bankruptcies and subsequent liquidations. Franks and Torous (1989), Franks and Torous (1994), Eberhardt et al. (1990), and Weiss (1990) offer evidence of the costs associated with recontracting and reorganization of firms in financial distress, and of value acquisition by shareholders in reorganizations.

and prior to the resolution of uncertainty.[17] There are two significant features of this difference. The first is that it is possible for firms that are ultimately unprofitable to benefit from tax credits if the credits are received enough years prior to subsequent losses that the tax law does not permit the losses to be carried back against the credits. Under U.S. law, net operating losses can be carried back only two years for tax purposes. Hence if an unprofitable firm's losses do not begin in earnest until more than two years after its initial investment, the firm benefits from any first-year credits.

There is a second aspect of tax credits received in the first year of an investment, which is that cash need not be disposed of in ways that are satisfactory to bondholders. In the absence of restrictions, credits received from tax-favored investments may be paid to shareholders as dividends or else invested in ways that benefit shareholders and not bondholders. If the firm defaults within the period of allowable carrybacks, the tax credit takes on the feature of a loan from the government that (from the standpoint of bondholders) shareholders are free to squander. Anticipating this, the bond market demands higher interest rates on loans to firms receiving up-front tax credits. Alternatively, lenders can insist on covenants that restrict the ability of borrowers to pay dividends, but such restrictions introduce other inefficiencies and are often not included in bond contracts.[18]

To formalize these ideas, suppose that n years elapse between initial investment and the resolution of uncertainty (in the second period). A profitable firm receives a tax credit of $c\beta^{-n}\sigma_1 K$ in the first period, in which $\beta = \frac{1}{1+d} > 0$ is the firm's discount

[17] An important exception is the foreign tax credit, which is the subject of the next section.

[18] Black and Scholes (1973) discuss the endogeneity of bond prices to anticipated dividend payout behavior. Smith and Warner (1979) report that only 23% of the bonds they examine (issued in 1974-75) restrict dividend payments; Kalay (1982) indicates that virtually all of the bond issues he analyzes have covenants limiting dividends; and McDaniel (1986) finds that, of the outstanding bonds of Fortune 100 companies in 1984, only 35% restrict dividend payments, and Lehn and Poulsen (1991) report that, of the bonds they examine, 33% of those issued in 1986 and 45% of those issued in 1989 contain covenants restricting dividend payments. Interestingly, Kalay (1982) finds that most of the firms in his sample pay fewer dividends than their bond covenants permit.

factor, and d its annual rate of discount, so the tax credit is worth $c\sigma_1 K$ in second-period terms. If the firm incurs a loss in the second period, then it is eligible to claim a refund for (nominal) taxes paid earlier. The fact that the firm received the tax credit in the first period reduces its second period refund by $c\beta^{-n}\sigma_1 K$. Consequently, the tax credit is worth $c(1-\beta^{-n})\sigma_1 K$ in present value to a firm that is ultimately unprofitable. $n = \infty$ corresponds to situations in which default occurs beyond the time limit for tax carrybacks.

Consider the case in which a firm receiving a tax credit in the first period allocates a fraction γ of the credit to its shareholders (in the form of dividends), with $(1-\gamma)$ remaining within the firm and therefore accessible to bondholders in the case of default in the second period. In this setting, shareholders benefit from tax credits even if the firm ultimately defaults. Hence, this modification changes equation (3.1) to:

$$\begin{aligned} \pi^e &= \{[Q(K,c)\theta_1 - r(B,K,c) - \delta K](1-\tau) - B\tau + K + cK\sigma_1\} p_1 \\ &\quad + \left\{Q(K,c)\theta_2 - r(B,K,c) + (1-\delta)K + c(1-\beta^{-n})\sigma_1 K\right\} p_2 \\ &\quad + \{\gamma c K\sigma_1\} p_3. \end{aligned} \tag{3.24}$$

Equation (3.7) is likewise affected, since bond market equilibrium must satisfy:

$$(1+\bar{r})B = (p_1+p_2)r(B,K,c) + p_3\left[Q(K,c)\theta_3 + (1-\delta)K + c(1-\gamma-\beta^{-n})\sigma_1 K\right] \tag{3.25}$$

Imposing (3.24) and (3.25) changes the expression that appears on the right sides of equations (3.17) and (3.23); for example, (3.23) becomes:

$$\begin{aligned} \frac{d\pi^e}{dc}\frac{1}{K} &= \left[p_1 + (1-\beta^{-n})p_2 + \gamma p_3\right]\sigma_1(1-f\eta) \\ &\quad + \sigma_1 \frac{p_1(1-\tau)+p_2}{p_1+p_2}(1-\gamma-\beta^{-n}). \end{aligned} \tag{3.26}$$

The right side of equation (3.26) exhibits features similar to those of the right sides of (3.17) and (3.23). If $n = 0$ and $\gamma = 0$ then of course they are identical. If $n = \infty$ and $\gamma = 0$ then the right side of (3.26) becomes: $(p_1 + p_2)\sigma_1(1 + \frac{p_1(1-\tau)+p_2}{(p_1+p_2)^2} - f\eta)$, so a somewhat larger value of $f\eta$ is required for higher levels of c to be associated with reduced investment and profitability. If $\gamma = (1 - \beta^{-n})$, then the right side of (3.26) becomes $[p_1 + (1 - \beta^{-n})(p_2 + p_3)]\,\sigma_1(1 - f\eta)$, and again $f\eta$ =1 is the critical value at which the effect of c on investment and profitability changes sign. What these scenarios illustrate is that the implications of (3.17) and (3.23) apply generally to settings in which tax credits are received prior to the resolution of investment uncertainty.

3.4 Bond Covenants and Borrowing around the Bonus Depreciation Era

This section considers evidence of the behavior of U.S. firms before, during, and after the 2002-2004 bonus depreciation experience. Congress in March 2002 enacted legislation permitting firms to take 30 percent bonus depreciation for equipment investments in assets with depreciable lifetimes of 20 years or less; firms were also entitled to take normal first-year accelerated depreciation on the remaining 70 percent of their basis in new equipment assets. The March 2002 bonus depreciation provision applied retroactively to investments made on or after 11 September 2001; and in May 2003 the bonus amount was increased to 50 percent, a provision that expired at the end of 2004. Bonus depreciation offers a very generous tax incentive for equipment investment, particularly for long-lived equipment for which depreciation deductions would otherwise have a significantly lower present value. As a result, firms can be expected to substitute relatively tax-favored investments for relatively tax-disfavored investments during the bonus depreciation period.

Bondholders have very little interest in firms taking advantage of bonus depreciation to improve their after-tax returns by investing in qualifying long-lived equipment assets, since expected returns to bondholders are maximized by firm actions that maximize the present value of expected pretax profits. Consequently, lenders have incentives to impose greater restrictions on loans during the bonus period than they do at other times; while these restrictions may entail greater costs of impeding efficient ex post decision making and triggering costs associated with recontracting, they address the greater moral hazard introduced by bonus depreciation. As a result of these costs, and the residual inefficiency in investment asset composition due to incentives created by bonus depreciation, firms are also less apt to find it worthwhile to finance their new investments with loans from third parties. The propositions that new loans are more likely to come with restrictions and that there will be fewer new loans are both testable with the available data.

3.4.1 Data

Data on loan covenants are collected by Dealscan, which is maintained by Thompson Reuters LPC. Dealscan contains detailed information on private debt, including identities of lender and borrowers, loan types, loan maturities, loan inception date, and covenants. Dealscan collects the great majority of loan data from SEC filings, from newspapers, or through LPC's relationships with major banks. Chava and Roberts (2008) and Carey and Hrycray (1999) report that Dealscan coverage includes more than 50-75% of the value of all commercial loans since 1995. Starting in 1993, Dealscan began to include detailed covenant information, which is the most important element in the dataset for our analysis.

Dealscan data are matched with Compustat for borrower information through the company codes from Dealscan-Compustat Link Data created by Michael Roberts. Since the focus of the empirical work is the restrictiveness of new loans, company codes and loan inception dates from Dealscan are matched with company codes and year-quarters from Compustat. The analysis excludes financial firms (SIC codes 6000-6999), as a result of which there remain 6149 firms in the sample. Restricting attention to the years surrounding the 2002-2004 bonus depreciation period - 1999 to 2007 - further reduces the number of firms in the sample to 5064.

The Dealscan data include counts of different types of debt covenants - financial debt covenants, prepayment covenants, dividend covenants, and secured covenants. The focus of the empirical work is on financial debt covenants used by lenders to constrain borrower operations. Other types of debt covenants are typically used to limit the ability of borrowers to distribute resources in a way that is not recoverable by lenders. Dealscan provides 17 different accounting indexes used with financial debt covenants, including current ratio, net worth, EBITDA, and capital expenditure. Table 3.1 presents summary statistics of firms for which there are both Dealscan and Compustat data, and, for comparison, statistics of Compustat firms.

The left panel of Table 3.1 presents summary statistics for Compustat firms that have at least one loan reported in Dealscan, while the right panel is for all Compustat firms. The mean and medians across all variables are quite similar, except for mean values of q - which has an extremely high variance. As a general matter, firms for which there are both Dealscan and Compustat data are larger in size, older, and financially stronger than average firms in Compustat. This is consistent with the data collection procedure of Dealscan, since the SEC 10-K filings that serve as the primary source for Dealscan require mandatory reporting only for larger loans.

Among Dealscan-Compustat firms there is a 9.5% chance that at least one loan is reported in a given quarter. Approximately half of these loans (49.9%) have at least one financial covenant attached. The mean number of any financial covenants attached to a loan is 1.43; the mean number of capital expenditure covenants is 0.17; and the mean number of EBITDA covenants is 0.3714.

3.4.2 Loan Covenants and Bonus Depreciation.

The extent to which loans bear covenant restrictions can be measured four ways, the first of which is simply the number of all financial covenants attached to a loan. Greater numbers of covenants typically offer lenders greater control over borrowers' operating decisions by making technical defaults more likely to occur; Bradley and Roberts (2004) add all financial and non-financial covenants to measure "covenant intensity." A second measure of loan restrictiveness is simply the likelihood that any given loan includes a financial covenant. A third measure of loan restrictiveness is the number of capital expenditure covenants attached to a loan; these typically limit total capital spending. Given the moral hazard introduced by favorable tax treatment of certain classes of capital spending, this type of financial covenant directly addresses an important conflict of interest. And the fourth measure of loan restrictiveness is the number of EBITDA (earnings before interest, taxes, depreciation, and amortization) covenants attached to a loan. Since the moral hazard implied by bonus deprecation has the effect of reducing EBITDA in return for an even greater reduction in taxes, EBITDA restrictions are potentially quite attractive to lenders.

Figure 3.3 depicts the aggregate use of bond covenants in the Dealscan data between 1999 and 2007, as measured by these four proxies. Across all the four measures, the aggregate restrictiveness of new loans appears countercyclical. This is not surprising, because lenders benefit most from greater control over borrower operations when moral hazard carries the greatest consequences for lenders - and that is when default probabilities are highest, commonly during recessions.

Firms starting at least one new loan between 1999 and 2004 can be classified in three types. Type I firms start at least one new loan in each of two periods: (i) 1999-2001 and (ii) 2002-2004. Type II firms start at least one loan during 1999-2001, but do not start new loans during 2002-2004. Type III firms have no reported loans from 1999-2001, but start at least one new loan during 2002-2004. Table 3.2 illustrates these classifications.

Due to the somewhat arbitrary nature of the period division, many infrequent borrowers, defined by borrowers whose typical borrowing intervals are longer than 3 years, may be thought of as randomly assigned into all three groups, which are denoted as I-2, II-2, and III-2. What makes one type different from another is, however, the existence of firms with a typical borrowing interval less than 3 years, and their self-selection into three types. That is, some of these firms, denoted as I-1 in Table 3.2, do stay in the private debt market even during the recession period and start a new loan, while there are other firms, denoted as II-1, which otherwise would have wanted to borrow, but did not do so, during the same period. Therefore, one can expect that only Type I includes frequent borrowers that successfully finance through private debts during the recession period, and Type II includes firms that may have wanted to borrow in 2002-2004, but did not.

Table 3.3 offers cross-type comparisons for 1999-2001. Table 3.3 indicates that Type I firms are bigger and financially healthier than other two types; and that Type II firms, compared to Type III firms, are smaller, younger, and financially more constrained.

Table 3.4 presents aggregate evidence of the dynamics of loan restrictiveness, measured four ways, for each type of firm.

Across all types of firms, loans have more restrictive covenants during the bonus depreciation period. During 1999-2001, the average number of financial covenants attached to a loan for Type I firms is 1.35, but the average rises to 1.51 during the bonus depreciation period. The average subsequently decreases to 1.13 during 2005-2007. Similarly, the likelihood of a loan having at least one covenant to attached to it for Type I firms is 47.25% during 1999-2001, 55.61% during 2002-2004, and 50.92% during 2005-2007. Financial covenants restricting capital expenditures and levels of EBITDA exhibit similar trends.

It is noteworthy that loans taken by Type II and Type III firms include more covenants than those taken by Type I firms for all periods. This is perhaps not surprising, since only Type I includes frequent borrowers who may have higher credit ratings and better ongoing relationships with lenders. It is also significant that differences in numbers of financial covenants between Type I and Type II prior to the introduction of bonus depreciation are generally larger than the differences between Type I and Type III during the bonus depreciation period. Coupled with the observation from Table 3.3 that Type II is the financially weakest group, it suggests that, being financially constrained, firms that drop out of the private debt market during the bonus period (and thus are included in Type II by construction) would have been offered more restrictive loan terms than they could afford.

In estimating the impact of tax policy on borrowing restrictions, it is helpful to distinguish firms by the extent to which they are financially constrained and the extent to which their assets are likely to be affected by tax changes. Firms subject to greater financial constraints are at greater risk of bankruptcy than are other firms, and are therefore trigger the most concern for lenders. A recent study by Hadlock and Pierce (2010) proposes a financial constraint index consisting solely of information on a firm's size and age; Hadlock and Pierce argue that, among the available alternatives, this index is the least likely to suffer from problems associated with endogenous financial decisions. The Hadlock and Pierce ("S-A") measure is: (-0.737* size) + (0.043* size^2) - (0.040*age): so that the higher is the S-A index of a firm, the more financially constrained it is. Presumably, lenders have more serious concerns over firms with higher measured values of the S-A index.

Firms whose balance sheets contain larger fractions of longer-lived capital assets benefit the most from bonus depreciation and have production technologies that can accommodate greater shifting of assets to tax-preferred categories in response to tax changes. In the Compustat data, capital intensity is measured as the ratio of after-depreciation plant and equipment to total assets in 2000 (the same ratio constructed using 1998 data serves as a robustness check), so higher measured capital intensity implies an emphasis on longer-lived assets. As a result of the introduction of bonus depreciation, lenders are apt to be most concerned with financially constrained firms of high capital intensity, and attempt to place new restrictions on their borrowing.

Figure 3.4 compares the trends in the aggregate use of debt covenants by firms prone to asset-substitution with the aggregate use of debt covenants by other firms. For the purpose of Figure 3.4, firms are classified as prone to asset-substitution if their average SA indexes and capital intensities both lie in the top 1/3 of the sample firms. The aggregate use of debt covenants by firms prone to asset-substitution (596 firms) peaked during the 2002-2004 bonus depreciation period, whereas this bunching of debt covenant use is much less pronounced among unconstrained firms (4468 firms).

To examine the impact of bonus depreciation on private debt market participation, the baseline empirical equation is:

$$\begin{aligned}\text{Restrictiveness}_{it} = &\ b_0 + b_1 \cdot \text{Bonus}_t + b_2 \cdot \text{SA}_{it} + b_3 \cdot \text{CI}_i + b_4 \cdot \text{Bonus}_t * \text{SA}_{it} \\ &+ b_5 \cdot \text{Bonus}_t * \text{CI}_i + b_6 \cdot \text{SA}_{it} * CI_i + b7 \cdot \text{Bonus}_t * \text{SA}_{it} * \text{CI}_i \\ &+ b_8 \cdot q_{it} + b_9 \cdot \text{LoanAmount}_{it} + \text{firm-fixed}_i + \text{time-fixed}_t + \epsilon_{it} \end{aligned} \quad (3.27)$$

where $\text{Restrictiveness}_{it}$ is the dependent variable for loan restrictiveness measured in the four different ways described above, Bonus_t is a time dummy equal to one when the year-quarter lies in the period 2001.Q4 to 2004.Q4, and SA_{it} and CI_i are Size-Age index and Capital intensity, respectively.[19] In order to control for a potential relationship between the number of debt covenants and the size of a loan, the equation also includes LoanAmount_{it}, measured as the total size of private loans firm i starts

[19]Note that capital intensity, being time-invariant (it is measured in year 2000), is omitted due to the inclusion of firm fixed effects. The Size-Age index is included in the empirical equation, but has very little effect on the regression results, reflecting that the Size-Age index is quite stable over time.

at time t, divided by total assets.[20]

Note that, in order to measure the restrictiveness of loans, the sample for this regression includes only firms starting at least one new loan from 1999-2007. This restriction may introduce some bias due to the omission of observations of characteristics of loans that were discouraged by the introduction of bonus depreciation, though this generally works against the findings that appear in the regression tables.

The first panel of Table 3.5, consisting of Columns (1) to (2), presents estimated coefficients from regressions that examine average numbers of financial debt covenants attached to a loan. Column (1) reports estimated coefficients from a panel regression, with all types of firms, using firm and year fixed effects. The coefficient on the variable of primary interest, $\text{Bonus}_t\text{*SA}_{it}\text{*CI}_i$, is estimated to be 0.3081 and statistically significant. To interpret this result it is necessary also to consider the coefficient on $\text{Bonus}_t\text{*CI}_i$, which is estimated to be 1.0957, also significantly different from zero. An increase in capital intensity index by 1 is correlated with an increase in the number of covenants attached to a loan by 1.0957 during the bonus period. Since the standard deviation of capital intensity is around 0.25 (see Table 3.1), a one standard deviation increase in capital intensity is correlated with a 0.275 (=1.0957 * 0.25) increase in the number of covenants. The sign and significance of the 0.3081 coefficient suggests that the increase correlated with capital intensity is even more pronounced among financially constrained firms. That is, compared to a firm in the 25th percentile of SA index (-3.7640), a firm in the 75th percentile of SA index (-2.6978) would have on average 0.357 (= 0.275 + 0.3081*0.25*1.0664) more covenants, rather than 0.275, when its capital intensity increases by 0.25 (one standard deviation increase).

The second panel of Table 3.5 presents estimated coefficients from regressions in which the dependent variable is the likelihood of a firm having a loan which has at least one covenant attached to it. The signs of the estimated coefficients are

[20]The other coefficient estimates reported in Table 3.5 change very little when the equations are rerun omitting the LoanAmount_{it} variable.

consistent with the hypothesis that the introduction of bonus depreciation increased the likelihood that firms for which the accompanying moral hazard is more costly to lenders are the most likely to borrow with covenants, though the relevant coefficients (0.0504 and 0.0660) are statistically indistinguishable from zero. The larger estimated magnitude and greater statistical strength of the results reported in the first panel of the table suggests that the effects of bonus depreciation on the use of loan covenants materializes largely among firms that are in sufficiently precarious financial positions that their loans have covenants prior to the introduction of bonus depreciation.

The third and fourth panels of Table 3.5 present coefficients from regressions using the same independent variables as those presented in the first panel, but with the number of Capital Expenditure covenants as the dependent variable in the third panel and EBITDA covenants as the dependent variable in the fourth panel. The tax policy-related coefficients remain significant but decline in magnitude, reflecting the lower mean values of these dependent variables. Thus, the coefficient on the interaction of bonus depreciation, the S-A index, and capital intensity in the Capital Expenditure covenants regressions is 0.1021, which suggests that a firm in the 75th percentile of SA index, compared to a firm in the 25th percentile of SA index, is expected to have 0.116 (=0.3582*0.25 + 0.1021*0.25*1.0664) more Capital Expenditure covenants during the bonus depreciation period. This compares to an implied effect of 0.089 (=0.3582*0.25) when its capital intensity increases by 0.25 (one standard deviation increase). In the same situation, the firm is expected to have 0.132 (=0.3971*0.25 + 0.1277*0.25* 1.0664) more EBITDA covenants, rather than 0.098 (=0.3971*0.25).

These estimates imply that the combined impact on the number of Capital Expenditure covenants as well as on the number of EBITDA covenants explains two-thirds on the impact on the total number of covenants attached to a loan: that is, $0.3081 \approx 2/3*(0.1021 + 0.1277)$. Given that Capital Expenditure and EBITDA covenants are not the most frequently used covenants, this pattern is consistent with an interpretation that these two types of covenants may have been used particularly to control for moral hazard problems aggravated by bonus depreciation.

3.4.3 Bonus Depreciation and Borrowing

The greater moral hazard introduced by bonus depreciation raises the cost of borrowing and thereby discourages the likelihood and level of borrowing. It is possible to use the Dealscan and Compustat data to measure the extent to which corporate borrowing declined during 2002-2004, particularly among firms most apt to be affected by the tax change.

One important measure of borrowing is whether a firm takes a new loan in a given quarter. Tax effects can be measured by the following empirical equation:

$$\begin{aligned} \text{BorrowingDummy}_{it} = b_0 + b_1 \cdot \text{Bonus}_t + b_2 \cdot \text{SA}_{it} + b_3 \cdot \text{CI}_i + b_4 \cdot \text{Bonus}_t * \text{SA}_{it} \\ + b_5 \cdot \text{Bonus}_t * \text{CI}_i + b_6 \cdot \text{SA}_{it} * CI_i + b7 \cdot \text{Bonus}_t * \text{SA}_{it} * \text{CI}_i \\ + b_8 \cdot q_{it} + \text{firm-fixed}_i + \text{time-fixed}_t + \epsilon_{it} \end{aligned} \tag{3.28}$$

in which $\text{BorrowingDummy}_{it}$ is dummy for whether firm i starts a new loan at time t, and the independent variables are the same as in prior equations. The intuition behind the specification of equation (3.28) resembles that underlying equation (3.27). The more financially constrained and capital-intense a firm is, the more likely it faces restrictive loan contracts with borrowing terms that contain high default premiums. Consequently, these firms are more likely than others either not to invest or to finance their investments with equity or retained earnings.

The first three columns of Table 3.6 report estimated coefficients from linear probability regressions in which the dependent variable takes the value one if a firm has a Dealscan-reported loan in a quarter, and zero otherwise. In the regression reported in Column (1), the -0.0287 coefficient on the interaction of bonus depreciation, the

S-A index, and capital intensity suggests that, during the bonus depreciation period, a firm at the 75th percentile of SA index is 0.76% point (0.0287*0.25*1.0664) less likely to borrow from the private debt market than a firm at the 25th percentile of SA index when its capital intensity increases by 0.25 (one standard deviation increase of capital intensity). Controlling for industry-specific shocks, column (2) reports a similar set of coefficients as column (1).

The fixed-effect logit regressions reported in columns (3) and (4) report similar patterns. In the specification reported in Column (3), the coefficient on $\text{Bonus}_t*\text{CI}_i$ is estimated to be -2.0369. Thus, one standard deviation increase, or 0.25, in capital intensity reduces the odds of financing through private debt by 40% (=1-exp(-2.0369*0.25)). In addition, the coefficient on the interaction of bonus depreciation, the S-A index, and capital intensity, $\text{Bonus}_t*\text{SA}_{it}*\text{CI}_i$, is estimated to be -0.5527. Thus, compared to a firm with an average SA index, a firm with an SA index one standard deviation higher has a 14% = (1- exp (-0.5527*0.25*1.0664)) reduced chance of borrowing during the bonus depreciation period.[21]

Although the empirical work focuses on behavior in private debt markets, borrowers have the option of turning to the public debt market instead. There are two reasons, however, why this type of substitution is unlikely to offer a satisfactory substitute for expensive and constrained private borrowing. First, as noted by "pecking order" theory of finance, there is a significant entry barrier for lower-credit borrowers to enter the public debt markets, so firms that are most affected by potential moral hazard considerations are the least likely to be able to access public debt markets. Second, public debt participants have the same moral hazard concerns as private

[21] One might argue that the relation between private debt market *participation* and tax policy does not necessarily imply that the *size* of private debt is also sensitive to tax policy. Table 3.7 reports the results of estimating regressions similar to equation (3.28), using as a dependent variable the total size of private loans taken by firm i at time t, divided by total assets. Column (1) presents coefficients estimated from a linear regression. The sign and significance of the coefficient on $\text{Bonus}_t*\text{SA}_{it}*\text{CI}_i$ are as expected. Since the dependent variable is zero for many of the observations, it is also useful to estimate a Tobit regression, the coefficients of which are presented in column (2), and are qualitatively similar to those appearing in column (1).

lenders, and are just as likely to require covenants and high default premiums in response to the introduction of bonus depreciation.

It is instructive to consider the determinants of total borrowing reported by Compustat, and to compare the results with those obtained using the Dealscan private debt data. Net debt issuance is measured two ways, using the Compustat data and following Kahle and Stulz (2010). The first debt issuance measure is long-term debt issuance minus retirement, both of which come from firms' cash flow statements. Specifically, the first measure is calculated as long term debt issuance minus long term debt retirement divided by lagged assets. Significantly, this includes information only on long term debt. The second measure comes from firms' balance sheets. With current liabilities information, the second measure includes short-term debt issuance as well, calculated as changes in long-term debt and debt in current liabilities divided by lagged assets.[22]

The regressions reported in Table 3.8 estimate the following equation:

$$\begin{aligned}\mathrm{DebtIssuance}_{it} = b_0 + b_1 \cdot \mathrm{Bonus}_t + b_2 \cdot \mathrm{SA}_{it} + b_3 \cdot \mathrm{CI}_i + b_4 \cdot \mathrm{Bonus}_t * \mathrm{SA}_{it} \\ + b_5 \cdot \mathrm{Bonus}_t * \mathrm{CI}_i + b_6 \cdot \mathrm{SA}_{it} * CI_i + b7 \cdot \mathrm{Bonus}_t * \mathrm{SA}_{it} * \mathrm{CI}_i \\ + b_8 \cdot q_{it} + \text{firm-fixed}_i + \text{time-fixed}_t + \epsilon_{it} \quad (3.29)\end{aligned}$$

Net total debt issuance is the dependent variable in the regressions reported in the first two columns of Table 3.8, while net long-term debt issuance is the dependent variable in the regressions reported in Columns (3) and (4). Column (1) presents the results of estimating the equation with data from 1999 to 2005 (that is, before and during the bonus depreciation period), and offers evidence that capital-intensive financially constrained firms are less likely than others to issue debt during the bonus depreciation period. Column (2) reports estimated coefficients from estimating the

[22]See Appendix for variable descriptions in detail.

equation over the full sample period from 1999 to 2007, in which the estimated coefficient on the interaction variable of interest is statistically indistinguishable from zero, suggesting that the apparent impact of bonus depreciation on total debt issuance as measured by Compustat variables is highly sensitive to the time period of the estimation. The regressions reported in Columns (3) and (4) offer qualitatively similar findings for long term debt issuance. It is not clear whether the difference between the findings using the Dealscan and Compustat variables for the 1999-2007 sample period reflects differences in firm coverage, noisiness in construction of the dependent variables, or possibly behavioral effects in which average borrowing by all Compustat firms is less affected by tax-induced moral hazard than is private borrowing by Dealscan firms. The bond covenant evidence is clearly consistent with higher borrowing costs in the bonus depreciation period, though how large an impact these higher costs have on amounts borrowed is more difficult to identify clearly.

3.5 Conclusion

The availability of tax subsidies for investments in some assets and not others gives firms incentives to change the composition of their investments. Such substitution is inefficient, and, if anticipated, will raise borrowing costs, reduce the payoff to new investments, and thereby reduce the stimulatory effect of investment credits on aggregate investment. This effect is so strong that there are plausible circumstances in which greater investment credits are associated with reduced aggregate investment.

Aggregate investment studies typically find only limited evidence of stimulatory effects of tax subsidies on investment. Studies of disaggregated investment behavior report significant tax effects that reflect, at least in part, the ability of investors to substitute some asset types for others. The aggregate findings are consistent with firm-level evidence if asset substitutability reduces the aggregate effect of tax credits targeted at specific categories of investments. Evidence from borrowing behavior around the introduction of bonus depreciation for U.S. equipment investment conforms to predictions of the model. Corporate bonds contained greater numbers of restrictive covenants during the period in which U.S. tax policy distorted the composition of U.S. investment in favor of equipment; furthermore, it appears that corporate borrowing declined during this period. These effects were most pronounced for firms in precarious financial positions and those whose investments where most apt to be affected by the tax incentives.

The unequal taxation of differing assets is understood to distort the allocation of resources in society, and there are numerous studies of the magnitudes of these distortions in various settings.[23] Summers (1987b) challenges their implications, arguing that, since economies generally underinvest due to tax and other distortions, policies that affect the rate of investment have far greater influence on economic welfare than do policies that affect the composition of investment. What is not generally appreciated is the connection between these two considerations, that the distortionary nature of many tax subsidies influences the level as well as the composition of investment. Bond covenants impose costly restrictions, so are used only when lenders are sufficiently concerned about moral hazard that they feel the costs are worth paying. The greater use of bond covenants when firms were entitled to bonus depreciation, and accompanying drop in borrowing, are consistent with a model in which concerns about asset substitution increased the cost of debt-financed investment, thereby reducing the aggregate stimulatory effect of investment incentives.

[23]See, for example, Harberger (1966), Shoven (1976), Boadway (1978), Gravelle (1981), Auerbach (1983), Auerbach (1989a), Jorgenson and Yun (1986), Jorgenson and Yun (1990), Feldstein (1999) and Chetty (2009).

Table 3.1: Summary statistics

	Panel A: Dealscan-Compustat (6149 firms)			Panel B: Compustat (10044 firms)		
	mean	std. dev.	median	mean	std. dev.	median
Investment	.0772	.1043	.0452	.0852	.1248	.0439
q	2.3258	12.6889	1.3224	5.8444	150.1638	1.4385
Size	5.6809	1.9025	5.7274	4.9336	2.3448	5.0031
Age	14.4514	12.8791	9.0000	12.3693	12.3214	7.0000
Size-Age Index	-3.2235	.8499	-3.1612	-2.8477	1.1360	-2.9270
Capital Intensity	.3165	.2443	.2460	.3019	.2541	.2191
Total-Debt-to Asset (Stock)	.6402	3.3129	.5692	1.1069	21.0548	.5226
Net Total-Debt Issuance (Flow)	.0105	.2126	.0000	.0101	.2217	.0000
Net Long-Term-Debt Issuance (Flow)	.0071	.1235	.0000	.0182	1.5050	.0000
Likelihood of Having a Dealscan Loan in a Given Quarter	.0949	.2930	.0000			
Average Number of Any Covenants Attached to a Loan	1.4287	1.6754	1.0000			
Likelihood of Having Any Covenants Attached to a Loan	.4991	.4921	.5000		N/A	
Average Number of CapEx Covenants Attached to a Loan	.1706	.3716	.0000			
Average Number of EBITDA Covenants Attached to a Loan	.3714	.6255	.0000			

Note: The table presents summary statistics for firms in the Dealscan-Compustat merged sample (panel A) and for firms in the Compustat sample (panel B) from 1999 to 2001. Financial firms are excluded. Variable descriptions appear in Appendix.

Table 3.2: Illustration of firm-types

Type	Sub-type	Frequent Borrower	Actual Borrowing Before Bonus 1999-2001	 After Bonus 2002-2004	"Drop-outs"
I	I-1	Yes (actual)	O	O	No
	I-2	No	O	O	
II	II-1	Yes (would-have-been)	O	X	Yes
	II-2	No	O	X	No
III	III-2	No	X	O	No

Note: The table illustrates firm types assigned based on whether a firm starts a new loan before the bonus period, during the bonus period, or both. Frequent borrowers are defined as those firms having a typical borrowing interval less than 3 years. Drop-outs are defined as those firms who would have borrowed during the 2002-2004 period, but did not.

Table 3.3: Firm characteristics comparison across firm types

Panel A presents summary statistics for firms in the Dealscan-Compustat merged sample from 1999 to 2001. Type I includes firms that have started at least one new loan during each period, before and during the bonus period. Type II includes firms that have started at least one new loan before the bonus depreciation period (1999.Q1 to 2001.Q3) the bonus depreciation period (2001.Q4 to 2004.Q4), but have not started a loan during the bonus period. Type III includes firms that have started at least one new loan only during the bonus depreciation period. Panel B compares Type II firms and Type III firms. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively. Variable descriptions appear in Appendix.

Variables	Panel A			Panel B
	Type I	Type II	Type III	Type II vs. Type III Comparison
Number of Firms	2151	1430	1146	
Size	6.6065	5.3648	5.4759	0.1110***
Age	16.8028	12.0449	14.8076	2.7632**
Size-Age Index	-3.5588	-3.0617	-3.1957	-.1340***
Capital Intensity	.3508	.3036	.3161	.0124***
log(Total Assets)	6.6638	5.2522	5.3352	.0829***
log(Property, plant and equipment)	5.2974	3.6538	3.8183	.1644***
Debt to Asset Ratio	.6200	.5874	.6225	.0351***
Likelihood of Starting a New Loan	.1763	.1383	n/a	n/a
Net Long Term Debt Issuance to Asset	.0104	.0113	.0035	-.0078***
Net Total Debt Issuance to Asset	.0153	.0155	.0096	-.0059*

Table 3.4: Debt restrictiveness comparison across firm types

This table presents comparisons of debt covenant intensity among the three types of firms. Panel A uses the average number of total financial covenants attached to a loan as the proxy for debt covenant intensity. Panel B uses the likelihood of a loan having at least one debt covenant as the proxy for debt covenant intensity. Panel C uses the average number of Capital Expenditure covenants attached to a loan as the proxy for debt covenant intensity. Panel D uses the average number of EBITDA financial covenants attached to a loan as the proxy for debt covenant intensity. Type I includes firms that have started at least one new loan during each period, before and during the bonus period. Type II includes firms that have started at least one new loan before the bonus depreciation period (1999.Q1 to 2001.Q3) the bonus depreciation period (2001.Q4 to 2004.Q4), but have not started a loan during the bonus period. Type III includes firms that have started at least one new loan only during the bonus depreciation period. The first column compares the average number of total financial covenants between Type I and Type II before the bonus depreciation period. The second column compares the average number of total financial covenants between Type I and Type III during the bonus depreciation period. The third column calculates the differences in the average of each column. The fourth compares the average number of total financial covenants among the three types. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively. Variable descriptions appear in Appendix.

Panel A. Average Number of Total Financial Covenants Attached to a Loan

Firm Types	Before Bonus	During Bonus	Differences	After Bonus
Type I	1.3536	1.5071	.1534 (.0367)***	1.1301
Type II (before) Type III (during)	1.5651 (Type II)	1.6681 (Type III)	.1030 (.0612)*	1.4234 (Type II); 1.2966 (Type III)

Panel B. Likelihood of Having Any Covenant Attached to a Loan

Firm Types	Before Bonus	During Bonus	Differences	After Bonus
Type I	.4725	.5561	.0836 (.0111)***	.5092
Type II (before) Type III (during)	.5423 (Type II)	.6170 (Type III)	.0747 (.0176)***	.5793 (Type II); .5515 (Type III)

This table presents comparisons of debt covenant intensity among the three types of firms. Panel A uses the average number of total financial covenants attached to a loan as the proxy for debt covenant intensity. Panel B uses the likelihood of a loan having at least one debt covenant as the proxy for debt covenant intensity. Panel C uses the average number of Capital Expenditure covenants attached to a loan as the proxy for debt covenant intensity. Panel D uses the average number of EBITDA financial covenants attached to a loan as the proxy for debt covenant intensity. Type I includes firms that have started at least one new loan during each period, before and during the bonus period. Type II includes firms that have started at least one new loan before the bonus depreciation period (1999.Q1 to 2001.Q3) the bonus depreciation period (2001.Q4 to 2004.Q4), but have not started a loan during the bonus period. Type III includes firms that have started at least one new loan only during the bonus depreciation period. The first column compares the average number of total financial covenants between Type I and Type II before the bonus depreciation period. The second column compares the average number of total financial covenants between Type I and Type III during the bonus depreciation period. The third column calculates the differences in the average of each column. The fourth compares the average number of total financial covenants among the three types. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively. Variable descriptions appear in Appendix.

Panel C. Average Number of Capex Covenants Attached to a Loan

Firm Types	Before Bonus	During Bonus	Differences	After Bonus
Type I	.1433	.1812	.0379 (.0082)***	.1092
Type II (before) Type III (during)	.2196 (Type II)	.2401 (Type III)	.0205 (.0152)*	.1549 (Type II); .1462 (Type III)

Panel D. Average Number of EBITDA Covenants Attached to a Loan

Firm Types	Before Bonus	During Bonus	Differences	After Bonus
Type I	.3681	.4598	.0917 (.0147)***	.3995
Type II (before) Type III (during)	.3692 (Type II)	.4892 (Type III)	.1200 (.0240)*	.5424 (Type II); .4429 (Type III)

Table 3.5: Regressions of debt covenant intensity during the 1999-2007 period

The sample consists of firms in the Dealscan-Compustat merged sample that have borrowed at least once during the 1999-2007 period. The table presents regression results of debt covenant intensity. The dependent variable of column (1) - (2) is the average number of total financial covenants attached to a loan; the dependent variable of column (3) - (4) is the likelihood of a loan having at least one covenant; the dependent variable of column (5) - (6) is the average number of Capital Expenditure covenants attached to a loan; and the dependent variable of column (7) - (8) is the average number of EBITDA covenants attached to a loan. The specifications in the even-numbered columns also include industry-year fixed effects to absorb industry-wide shocks. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively. All standard errors are clustered at the firm-level. Variable descriptions appear in Appendix.

Dependent Variable:	Total Number of Covenants		Likelihood to Have Covenants		CapEx Covenants		EBITDA Covenants	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
S-A	.0771	-.3300	.0771	-.0350	.0135	-.0308	-.3491***	-.4447***
	(.2239)	(.2407)	(.0638)	(.0695)	(.0538)	(.0612)	(.0963)	(.1075)
S-A * C-I	-.0808	.1519	.1306	.2337	-.0277	-.0150	.0314	.1316
	(.3838)	(.4760)	(.1248)	(.1490)	(.0902)	(.1168)	(.1613)	(.1910)
Bonus * S-A	-.1322*	-.1340*	-.0276	-.0274	-.0346**	-.0258	-.0266	-.0233
	(.0679)	(.0722)	(.0220)	(.0231)	(.0175)	(.0186)	(.0275)	(.0296)
Bonus * C-I	1.0957*	.9569	.1602	.1663	.3582**	.3065*	.3971*	.2711
	(.5893)	(.6439)	(.2019)	(.2139)	(.1497)	(.1635)	(.2366)	(.2624)
Bonus * S-A * C-I	.3081**	.3273**	.0504	.0660	.1021***	.1003**	.1277**	.1064
	(.1519)	(.1644)	(.0536)	(.0566)	(.0376)	(.0408)	(.0597)	(.0674)
q	-.0051	-.0182	.0005	-.0026	-.0054	-.0074*	-.0048	-.0080
	(.0159)	(.0156)	(.0063)	(.0059)	(.0040)	(.0043)	(.0066)	(.0067)

Table 3.5 – *Continued from previous page*

Dependent Variable:	Total Number of Covenants		Likelihood to Have Covenants		CapEx Covenants		EBITDA Covenants	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cash Flow	.6032	.8373	.0001	.0001	-.2717	-.2069	-.0464	.1262
	(1.11226)	(1.0607)	(.0003)	(.0003)	(.2690)	(.2867)	(.4335)	(.4805)
Loan Amount	.0012	.0030	-.0012	-.0007	.0005	.0004	.0051	.0052
	(.0074)	(.0067)	(.0029)	(.0025)	(.0008)	(.0009)	(.0039)	(.0040)
Years	1999-2007							
Year-Quarter Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed	No	Yes	No	Yes	No	Yes	No	Yes
Observations	13001							
Firms	4052							

Table 3.6: Regressions of private debt market participation

The sample consists of firms in the Dealscan-Compustat merged sample. The table presents regression results of likelihood of a firm having a new private loan started in a quarter. The dependent variable is the dummy for whether firm i starts a new loan at time t. Columns (1) and (2) present the result of linear probability regressions. Column (1) includes cash flow and q as additional controls. Column (2) additionally controls for industry-level shocks. Column (3) and (4) present the result of fixed-effect logit regressions. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively. Variable descriptions appear in Appendix.

Dependent Variable:	Dummy for whether firm i has a new loan at time t			
Specification	Linear Regression		Fixed-Effect Logit	
	(1)	(2)	(3)	(4)
S-A	-.0190***	-.0192***	-.7151***	-.7163***
	(.0047)	(.0048)	(.1118)	(.1119)
S-A * C-I	-.0613***	-.0420**	-.8792***	-.8816***
	(.0177)	(.0179)	(.2514)	(.2516)
Bonus * S-A	.0041	.0039	.1493***	.1463***
	(.0027)	(.0028)	(.0467)	(.0492)
Bonus * C-I	-.1081***	-.0900***	-2.0369***	-1.9180***
	(.0259)	(.0260)	(.4326)	(.4689)
Bonus * S-A * C-I	-.0287***	-.0227***	-.5227***	-.4544***
	(.0082)	(.0082)	(.1187)	(.1294)
q	.0001***	.0001***	.0024**	.0024**
	(.0000)	(.0000)	(.0011)	(.0011)
Cash Flow	.0041***	.0038**	1.4794	1.4247
	(.0016)	(.0014)	(1.5743)	(1.5790)
Years	1999-2007			
Year-Quarter Fixed	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes
Industry-Period Fixed	No	Yes	No	Yes
Observations	136308	136308	111571	111571
Firms	5469	5469	4066	4066

Table 3.7: Regressions of private debt size

The sample consists of firms in the Dealscan-Compustat merged sample. The table presents regression results of the size of private loans reported in Dealscan. The dependent variable of column (1) and (2) is the total size of private loans which firm i starts at time t. Column (1) runs a linear fixed-effect panel regression with standard errors clustered at the firm-level. Column (2) runs a fixed-effect Tobit regression with standard errors calculated using bootstrap, as specified by a Stata command file created by Bo E. Honore. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively. Variable descriptions appear in Appendix.

Dependent Variable:	Total amount of private loan that firm i makes at time t	
	Linear Regression (1)	Tobit Regression (2)
S-A	-.0042***	-.1201***
	(.0015)	(.0360)
S-A * C-I	-.0101*	-.0997
	(.0053)	(.0660)
Bonus * S-A	.0023***	.0443***
	(.0006)	(.0104)
Bonus * C-I	-.0159**	-.3420***
	(.0063)	(.1159)
Bonus * S-A * C-I	-.0038**	-.0863***
	(.0017)	(.0302)
q	.0000***	.0010
	(.0000)	(.0030)
Cash Flow	.0008	-1.2212
	(.0007)	(1.8436)
Years	1999-2007	
Year-Quarter Fixed	Yes	Yes
Firm Fixed	Yes	Yes
Observations	136064	136064
Firms	5469	5469

Table 3.8: Regressions of total debt issuance (Compustat measures)

The sample consists of firms in the Dealscan-Compustat merged sample. The table presents regression results of net debt issuance measures defined in Appendix. Columns (1) and (2) regress net total debt issuance. Columns (3) and (4) regress net long-term debt issuance. Column (1) and (3) present the results with the sample period from 1999 to 2004. Column (2) and (4) present the results with the sample period from 1999 to 2007. *, **, *** indicate significance at the 10%, 5%, 1% level, respectively. All standard errors are clustered at the firm-level. Variable descriptions appear in Appendix.

Dependent Variable:	Net Total Debt Issuance		Net Long Term Debt Issuance	
	(1)	(2)	(3)	(4)
S-A	-.1946***	-.0753	-.0494***	.0106
	(.0707)	(.0468)	(.0127)	(.0321)
S-A * C-I	.1737	.0096	.0049	-.0648
	(.1222)	(.0412)	(.0224)	(.0509)
Bonus * S-A	.0261***	.0032	.0116***	-.0093
	(.0091)	(.0071)	(.0024)	(.0099)
Bonus * C-I	-.1514**	.0181	-.0792***	.0608
	(.0590)	(.0503)	(.0191)	(.0662)
Bonus * S-A * C-I	-.0482***	-.0044	-.0217***	.0183
	(.0178)	(.0146)	(.0052)	(.0195)
q	.0001	-.0004	-.0001*	-.0000
	(.0001)	(.0005)	(.0000)	(.0001)
Cash Flow	-.2435	-.0398	-.0748	.0101
	(.2253)	(.0328)	(.0693)	(.0097)
Years	1999-2004	1999-2007	1999-2004	1999-2007
Period	Before and During Bonus Period	All	Before and During Bonus Period	All
Year-Quarter Fixed	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes
Observations	94148	131043	98107	136301
Firms	5333	5394	5441	5468

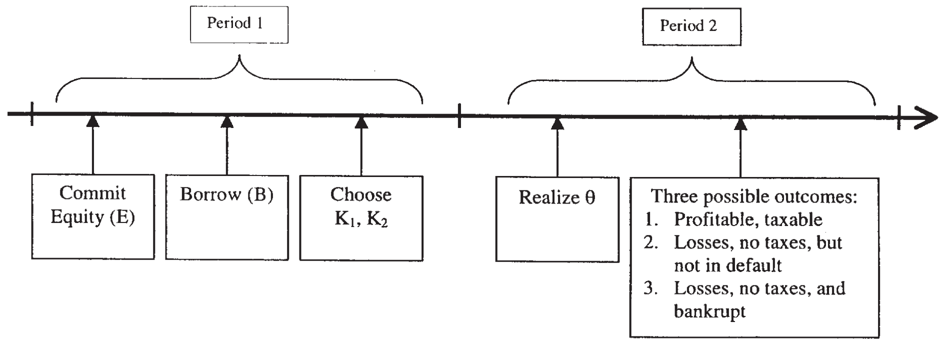


Figure 3.1: Timeline of events

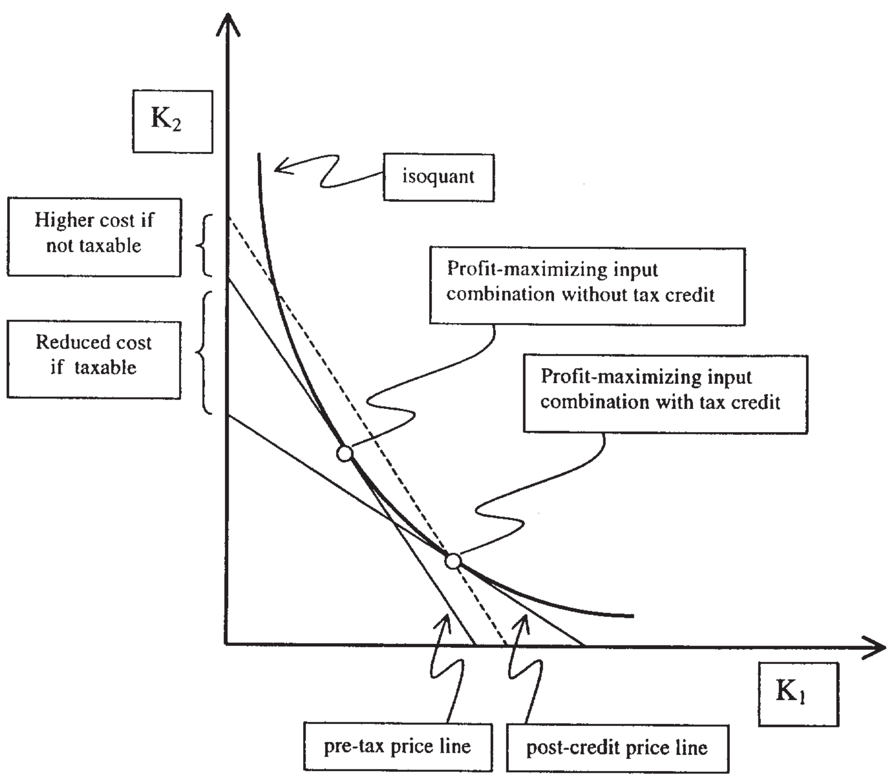


Figure 3.2: Credit-induced cost changes along an isoquant

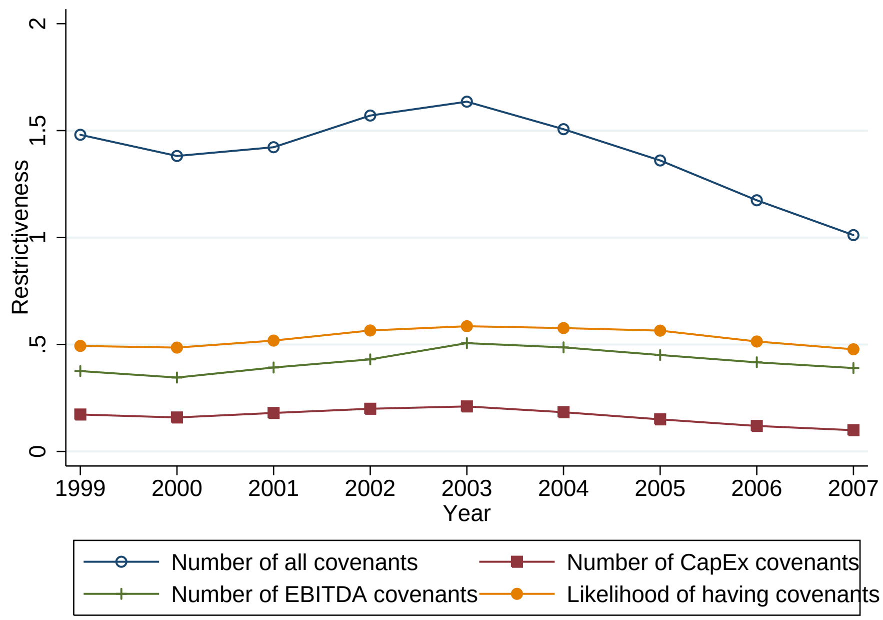


Figure 3.3: Aggregate use of bond covenants: Trends of four proxies

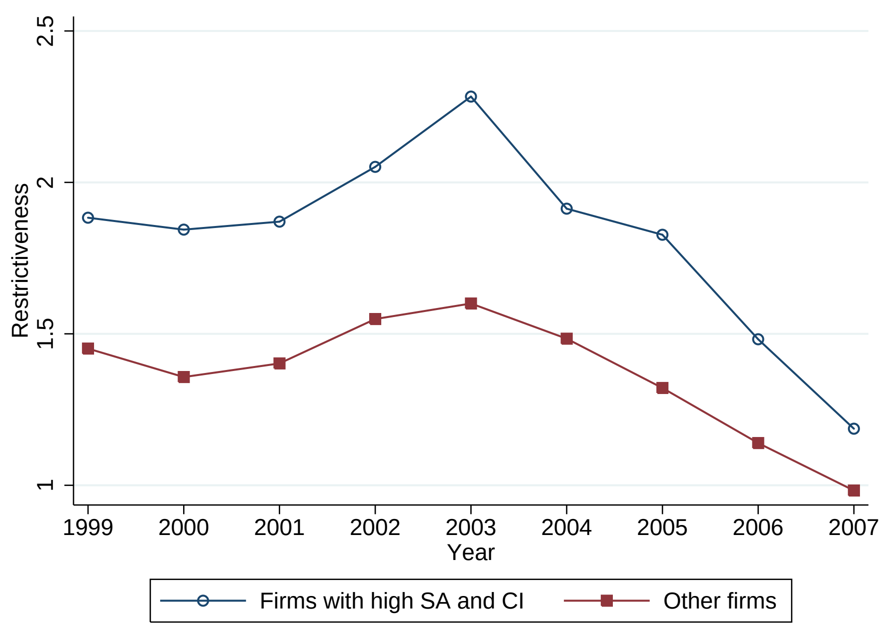


Figure 3.4: Aggregate trends of number of all financial covenants

3.6 Appendix

Appendix 8. Variable descriptions for chapter 3

Compustat Measures

- Investment is the ratio of the current year's capital expenditures (iqitems 90) to the prior year's net property, plant, and equipment (iqitems 42).

- q is the sum of the market value of equity (iqitems 14 $\times$ 61) and book liabilities minus deferred taxes (iqitems 44 - iqitems 59 - iqitems 52), divided by book assets (iqitems 44).

- Cash Flow is the ratio of the current year's operating income plus depreciation (iqitems 8 + iqitems 5) to the prior year's net property, plant, and equipment (iqitems 42). For reporting convenience, it is divided by 1,000 whenever used in the regressions.

- S-A index is measured as -0.737 $\times$ Size plus 0.043 $\times$ Size^2 minus 0.040 $\times$ Age, where size is the log of inflation-adjusted book assets (iqitems 44) and age is the number of years the firm is listed on Compustat. Size is capped at log($4.5 billion) and age is at thirty-seven years.

- Capital Intensity is the ratio of the current year's net property, plant, and equipment (iqitems 42) to the current year's book assets (iqitems 44).

- Total Debt to Assets (Stock measure) is the sum of long-term debt (iqitems 51) and debt in current liabilities (iqitems 45) divided by lagged book assets (item 44).

- Net Total Debt to Assets (Flow measure) is the change in Total Debt to Assets (Stock measure).

- Net Long-term Debt to Assets (Flow measure) is long term debt issuance (iqitems 86) minus long term debt retirement (iqitems 92) divided by lagged book assets (iqitems 44).

Dealscan Measures

- Restrictiveness$_{it}$ is measured in four different ways as discussed in Section 3.4.
  - **Proxy 1: The number of all financial covenants attached to a loan.** The number of all financial covenants attached to a loan (package-level) is first counted. Restrictiveness$_{it}$ is then calculated as the expected number of all financial covenants attached to a loan for firm i at time t. For example, when firm i has two loan packages at time t, one with 5 financial covenants, the other with 0 financial covenant, Restrictiveness$_{it}$ is measured as 2.5.
  - **Proxy 2: The number of EBITDA covenants attached to a loan.** Restrictiveness$_{it}$ is calculated essentially the same as above, except that only EBITDA-related covenants are counted. EBITDA-related covenants are "Max. Debt to EBITDA," "Max. Senior Debt to EBITDA," and "Min. EBITDA."
  - **Proxy 3: The number of Capital Expenditure covenants attached to a loan.** Restrictiveness$_{it}$ is calculated essentially the same as above, except that only Capital Expenditure-related covenants are counted. In Dealscan data, there is only one type of such covenant ("Max. Capex"), so it is similar to a dummy variable.
  - **Proxy 4: The likelihood that any given loan includes a financial covenant.** A dummy is coded as one when a loan package has any financial covenant, otherwise zero. Restrictiveness$_{it}$ is then calculated as the

expected value of this dummy for firm i at time t. In the example above, the likelihood that firm i has a loan that has a financial covenant at time t is 50%.

- Borrowing Dummy_{it} is equal to one when firm i has a new loan at time t; zero otherwise.

- Loan Amount_{it} is the sum of all private loan amounts, reported in Dealscan, firm i starts at time t, divided by total assets. By construction, it is positive when Borrowing Dummy_{it} is one; zero otherwise.

CHAPTER IV

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

4.1 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 essay 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 essay, 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 essay, 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 4.2 discusses the institutional background for leasing. Section 4.3 derives the demand for leased investment, while Section 4.4 discusses the empirical strategy. Section 4.5 describes the data, and explains my leased investment variable. Section 4.6 presents the empirical results and interpretations, and Section 4.7 discusses policy implications. Section 4.8 concludes.

4.2 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 essay, 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

[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

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 essay, therefore, I treat operating leases, for which data are publicly available from Compustat, as true leases.[7] Thus, as lessors are the recipients 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

---

discussion about safe harbor leasing.

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

the first bonus depreciation policy expired at the end of 2004, the second bonus depreciation was enacted in 2008.

4.3 Model

4.3.1 Tax and Leasing

Table 4.1 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.

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., 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.

$$\text{Tax liability differences} = (\tau_R - \tau_i)(z + D - L_R) \equiv NAL, \tag{4.1}$$

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

[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 4.3.3.

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 essay 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., $\frac{\partial^2 NAL}{\partial \tau_i \partial z} < 0$).

4.3.2 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 (4.1) 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 (4.1) 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

[10] Throughout this essay, 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 essay. This implies that the empirical results based on this assumption would make estimates for tax elasticity of leasing towards zero.

(4.1) may be positive for some types of assets, but negative for others. Then equation (4.1) 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.

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 essay include all these types of unobserved costs which are not expressed as cash flow components in Table 4.1.

The model of leasing behavior in this essay 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 essay 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 4.1, 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, with the weights being α and $(1 - \alpha)$, plus

[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).

adjustment costs. That is,

$$
\begin{aligned}
& \text{Total cash flow from one dollar of investment} \\
= \; & (1-\alpha)\underbrace{[(1-\tau_i)CF-(1-\tau_i z-\tau_i D)]}_{\text{cash flow when purchasing}} \\
& +\alpha\underbrace{[(1-\tau_i)CF-(1-\tau_R z-\tau_R D)+(\tau_i-\tau_R)L_R]}_{\text{cash flow when leasing}}-\sigma(\alpha) \\
= \; & (1-\tau_i)CF-1+[(1-\alpha)(\tau_i z+\tau_i D)+\alpha(\tau_R z+\tau_R D-(\tau_i-\tau_R)L_R)]-\sigma(\alpha) \\
= \; & [(1-\tau_i)CF]-[1-(\tau_i z+\tau_i D)]+\left[\alpha\underbrace{(\tau_R-\tau_i)(z+D-L_R)}_{\equiv NAL}\right]-\sigma(\alpha). \qquad (4.2)
\end{aligned}
$$

In equation (4.2), 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:

$$\sigma'(\alpha)=\underbrace{(\tau_R-\tau_i)(z+D-L_R)}_{\equiv NAL}. \qquad (4.3)$$

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 (4.3) can be expressed as:

$$\alpha=c_1+c_2\left[(\tau_R-\tau_i)(z+D-L_R)\right]. \qquad (4.4)$$

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 $\left.\frac{\partial^2 \alpha}{\partial z \partial \tau_i}\right|_{\overline{\tau_R}} = -c_2 < 0$.

4.3.3 Source of Non-tax Financial Benefit of Leasing

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,

$$L_R = w \left[\sum_{j=0}^{n-1} \delta_R^j \right], \tag{4.5}$$

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 4.1, the second column consists of all the lessor's cash flows. Thus, w

[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.

is priced in such a way that the sum of those cash flows is zero. That is,

$$w = \frac{1}{\sum_{j=0}^{n-1} \delta_R^j} \frac{1 - \tau_R(z + D)}{1 - \tau_R}. \tag{4.6}$$

Similarly,

$$L_i = w \left[\sum_{j=0}^{n-1} \delta_i^j \right], \tag{4.7}$$

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 (4.1), but instead is calculated as follows:

$$\begin{aligned}
&\text{Tax liability differences between purchasing and leasing} \\
= \; & (\tau_R - \tau_i)(z + D) + [(1 - \tau_R)L_R - (1 - \tau_i)L_i] \\
= \; & (\tau_R - \tau_i)(z + D - L_R) + (1 - \tau_i)(L_R - L_i) \\
= \; & \underbrace{(\tau_R - \tau_i)(z + D - L_R)}_{\equiv NAL} + (1 - \tau_i)w \underbrace{\sum_{j=0}^{n-1} (\delta_R^j - \delta_i^j)}_{\equiv FW},
\end{aligned} \tag{4.8}$$

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,

$$FW = \sum_{j=0}^{n-1} (\delta_R^j - \delta_i^j) \geq 0. \tag{4.9}$$

4.4 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:

$$\alpha_{it} = c_1 + c_2 \left[(\tau_R - \tau_{it})(z_t + D - L_R) + (1 - \tau_{it}) w_t \cdot FW_i \right], \tag{4.10}$$

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 (4.6). 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:

$$\alpha_{it} = \beta_1 + \beta_2 \left[\tau_{it}(z_t + D - L_R) - (1 - \tau_{it})w \cdot FW_i\right] + f_i + y_t + \epsilon_{it}, \tag{4.11}$$

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 (4.11) then becomes:

$$\alpha_{it} = \beta_1 + \beta_2 \left[\tau_{it}(z_t + D + L_R)\right] + f_i + y_t + \epsilon_{it}. \tag{4.12}$$

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

$$\alpha_{it} = \beta_1 + \beta_2 \left(D_t^{bonus} \cdot \tau_{it} \right) + \beta_3 \tau_{it} + f_i + y_t + \epsilon_{it}. \tag{4.13}$$

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 (4.11), the non-tax incentive for leasing, would respond to changes in the depreciation allowances in the opposite direction of the first term. That is,

$$\alpha_{it} = \beta_1 + \beta_2 \Bigg[\underbrace{\tau_{it}(z_t + D - L_R)}_{\text{tax incentive } \uparrow} - \underbrace{(1 - \tau_{it}) w \cdot FW_i}_{\text{non-tax incentive } \downarrow} \Bigg] + f_i + y_t + \epsilon_{it}, \tag{4.14}$$

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 4.6.

4.5 Data Description and Variable Construction

4.5.1 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):

$$I_t^n = \frac{\mathrm{CE}_t}{PPE_{t-1}}. \tag{4.15}$$

4.5.2 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]

[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.

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:

$$I_t^f = \frac{RE_t + (RC5_t - RC5_{t-1})}{PPE_{t-1}}. \tag{4.16}$$

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 4.1. 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 (4.16) gives us $(C_0 + C_1)$.

4.5.3 The Relative Use of Leased Investment

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

$$\alpha_t = \frac{I_t^f}{I_t^f + I_t^n}. \tag{4.17}$$

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)

[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 $\sum_{j=0}^{n-1} C_j$.

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 (4.17) 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]

4.5.4 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.

[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).

4.5.5 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 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 previous chapters.[18]

4.5.6 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 4.2 summarized the data for all the firm-year observations.

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

[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.

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 4.2 provides an illustration of the empirical relationship between marginal tax rates and $ZScore$s. Figure 4.2-1 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 4.2-2 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, 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.

[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).

4.6 Empirical Analysis

Figure 4.3 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).

It is also possible that this trend may simply reflect aggregate macroeconomic factors that affect leasing behaviors during the period, as discussed in Section 4.4. 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:

$$\alpha_{it} = \beta_1 + \beta_2 D_t^{bonus} * \tau_{it} + \beta_3 \tau_{it} + \gamma X_{it} + f_i + y_t + \epsilon_{it}, \tag{4.18}$$

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 4.3 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 4.4.

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 4.4, are similar quantitatively and qualitatively, so I conclude that the main results in Table 4.3 are not sensitive to the choice of financial strength measures.

4.7 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 essay 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 (4.2):

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

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,

$$\begin{aligned}\text{Tax saving per one-dollar of investment} &= 1 - \text{After-tax price of investment} \\ &= [\tau_i(z+D)] + \underbrace{[\alpha(\tau_R - \tau_i)(z+D-L)]}_{\equiv \alpha \cdot NAL} - \sigma(\alpha). \quad (4.19)\end{aligned}$$

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):

$$[\tau_i \Delta z] + [\alpha_1 NAL_1 - \alpha_0 NAL_0] + [\sigma(\alpha_1) - \sigma(\alpha_0)]\,, \tag{4.20}$$

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

$$[\tau_i \Delta z] + [\alpha_1 NAL_1 - \alpha_0 NAL_0]\,. \tag{4.21}$$

The calculation of the first term of equations (4.20) and (4.21) is straightforward. To calculate the second and third terms, see Figure 4.4 for the optimal level of leased investment given the amount of tax saving. In Figure 4.4, 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.

Furthermore, in Figure 4.4, the area A+A'+C+C' measures the second term of equation (4.20) and (4.21), while the area C+C' measures the third term (i.e., the deadweight loss) of equation (4.20). Thus, the deadweight loss can be calculated approximately as:

$$\text{Deadweight loss} \approx (\alpha_1 - \alpha_0)NAL_1 = (\alpha_1 - \alpha_0)(\tau_R - \tau_i)(z_1 + D - L), \qquad (4.22)$$

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

To calculate the deadweight loss, I use the parameter values discussed in Table 4.5. 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 4.3.

Based on these parameter values, table 4.6 calculates each term of additional tax saving after the introduction of the 2002 bonus depreciation (i.e., equation (4.20)) for the three marginal tax rate brackets: 0 to 0.15; 0.15 to 0.25; and 0.25 to 0.35.

In Table 4.6, 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.

4.8 Conclusion

In this essay, 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.

Table 4.1: Comparison of purchasing vs. leasing cash flow

Description of cash flow	Purchased Investment User Firm i (Buyer)	Leased Investment Lessor R	Leased Investment 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 4.2: Summary statistics

	All firms (769)			Financially Strong Firms (357)		
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 descriptions appear in section 4.5.

Table 4.3: 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 descriptions appear in section 4.5. 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 4.4: 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 descriptions appear in section 4.5. 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 4.5: Parameter values for deadweight loss calculations

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 with bonus depreciation	$0.3 + 0.3405 * (0.35 - \tau_i)$	Estimated in Section 4.6

Note:

1. According to BizStats.com, 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 (4.6).
3. z_1 and z_0 are calculated assuming a seven-year MACRS GDS period; and using a 5% interest rate.
4. The relative use of leased investment prior to bonus depreciation was approximately 30%. See Figure 4.3.

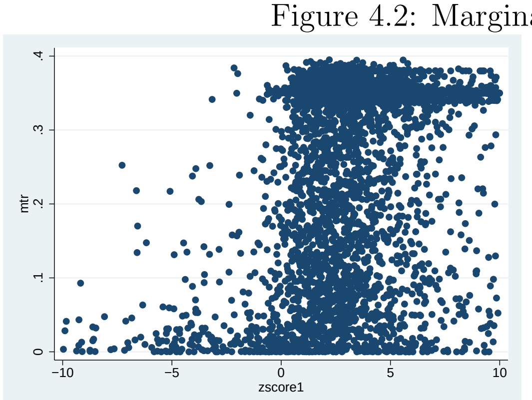
Table 4.6: Efficiency cost calculation

	(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 4.1: 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 4.2: Marginal tax rates and Z-score

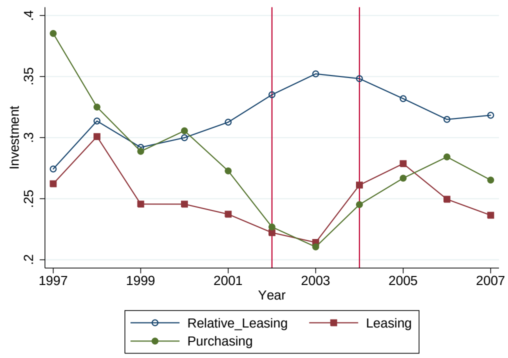


4.2-1. All firms

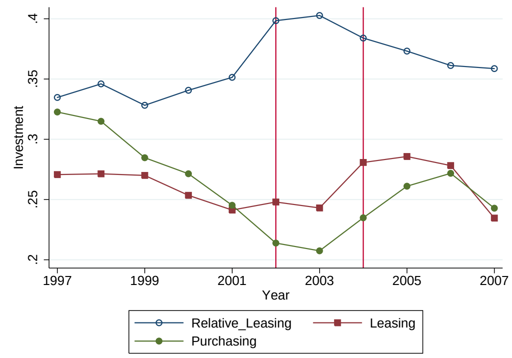
4.2-2. Financially strong firms

Note: These figures plot the marginal tax rates and *ZScore*s for all firms (Figure 4.2-1) and for solvent firms (Figure 4.2-2) 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 4.3: Trends in investment and the relative use of leased investment



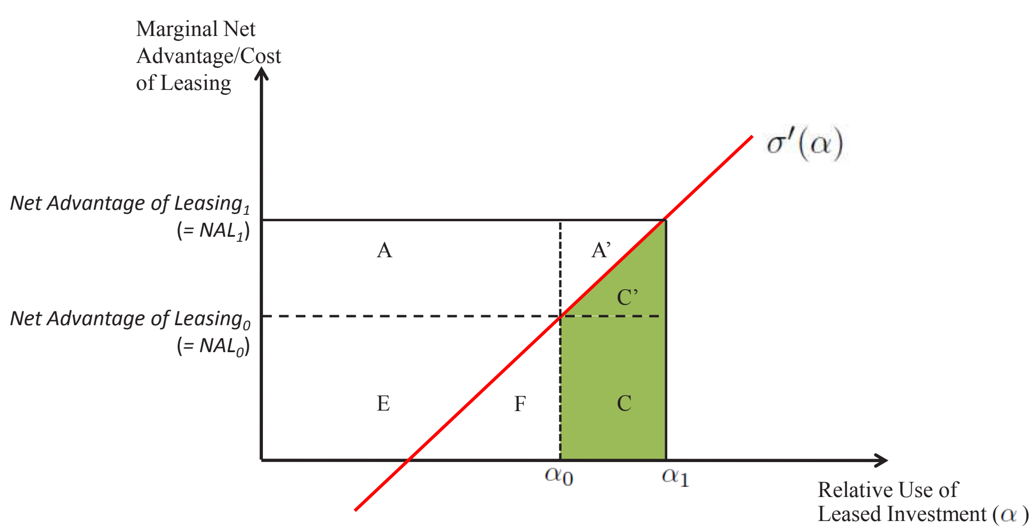
4.3-1. All firms



4.3-2. Financially strong firms

Note: Figure 4.3-1 and 4.3-2 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 descriptions appear in section 4.5. Financially strong firms are defined as firms with an average $ZScore$ above 2.99 and a standard deviation less than 2.5.

Figure 4.4: Illustration of efficiency costs associated with leasing activity



BIBLIOGRAPHY

BIBLIOGRAPHY

Altman, Edward, "Financial ratios, discriminant analysis and the prediction of corporate bankruptcy," *Journal of Finance*, 1968, *23* (4), 589–609.

Altshuler, Rosanne and Alan J. Auerbach, "The significance of tax law asymmetries: An empirical investigation," *Quarterly Journal of Economics*, 1990, *105* (1), 61–86.

_ **and Jason G. Cummins**, "Tax policy and the dynamic demand for domestic and foreign capital by multinational corporations," *Technical Committee on Business Taxation, Ottawa, Canada*, 1997, *working paper 97-4.*

Ang, James, Jess Chua, and John McConnell, "The administrative costs of corporate bankruptcy: A note," *Journal of Finance*, 1982, *37* (1), 219–226.

Auerbach, Alan J., "Corporate taxation in the United States," *Brookings Papers on Economic Activity*, 1983, (2), 451–513.

_ , "The dynamic effects of tax law asymmetries," *Review of Economic Studies*, 1986, *53* (2), 205–225.

_ , "The deadweight loss from 'non-neutral' capital income taxation," *Journal of Public Economics*, 1989, *40* (1), 1–36.

_ , "Tax reform and adjustment costs: The impact on investment and market value," *International Economic Review*, 1989, *30* (4), 939–962.

_ **and David Reishus**, "The effects of taxation on the merger decision," in Alan J. Auerbach, ed., *Corporate Takeovers: Causes and Consequences*, Chicago: University Of Chicago Press, 1991.

_ **and James M. Poterba**, "Tax loss carryforwards and corporate tax incentives," in Martin Feldstein, ed., *The Effects of Taxation on Capital Accumulation*, Chicago: University of Chicago Press, 1987.

_ **and Kevin A. Hassett**, "Recent U.S. investment behavior and the tax reform act of 1986: A disaggregate view," *Carnegie-Rochester Conference Series on Public Policy*, 1991, *35*, 185–215.

_ **and** _ , "Tax policy and business fixed investment in the United States," *Journal of Public Economics*, 1992, *47* (2), 141–170.

Barclay, Michael J. and Clifford W. Smith, "The maturity structure of corporate debt," *Journal of Finance*, 1995, *50* (2), 609–631.

Beneish, Massod D. and Eric Press, "Costs of technical violation of accounting-based debt covenants," *Accounting Review*, 1993, *68* (2), 233–257.

Berlin, Mitchell and Jan Loeys, "Bond covenants and delegated monitoring," *Journal of Finance*, 1988, *43* (2), 397–412.

Bernheim, Douglas, "Incentive effects of the corporate alternative minimum tax," in Lawrence H. Summers, ed., *Tax Policy and the Economy*, Vol. 3, Cambridge: MIT Press, 1989, pp. 69–96.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, "How much should we trust differences-in-differences estimates?," *Quarterly Journal of Economics*, 2004, *119* (1), 249–275.

Black, Fischer and Myron Scholes, "The pricing of options and corporate liabilities," *Journal of Political Economy*, 1973, *81* (3), 637–654.

Boadway, Robin, "Investment incentives, corporate taxation, and efficiency in the allocation of capital," *Economic Journal*, 1978, *88* (351), 470–481.

Bowman, Robert, "The debt equivalence of leases: An empirical investigation," *Accounting Review*, 1980, *55* (2), 237–253.

Bradley, Michael and Michael R. Roberts, "The structure and pricing of corporate debt covenants," *Duke University Working Paper*, 2004.

Carey, Mark and Mark Hrycray, "Credit flow, risk, and the role of private debt in capital structure," *Federal Reserve Board Working Paper*, 1999.

_ **, Mitch Post, and Steven A. Sharpe**, "Does corporate lending by banks and finance companies differ? Evidence on specialization in private debt contracting," *Journal of Finance*, 1998, *53* (3), 845–878.

Carlson, Curtis, "The corporate alternative minimum tax aggregate historical trends," *Department of the Treasury Office of Tax Analysis, OTA Paper*, 2005, *93.*

_ , "The effect of the 2001 recession and recent tax changes on the corporate alternative minimum tax," *Department of the Treasury Office of Tax Analysis, OTA Paper*, 2005, *94.*

Chava, Sudheer and Michael R. Roberts, "How does financing impact investment? The role of debt covenants," *Journal of Finance*, 2008, *63* (5), 2085–2121.

Chen, Kevin and John Wei, "Creditors' decisions to waive violations of accounting-based debt covenants," *Accounting review*, 1993, *68* (2), 218–232.

Chetty, Raj, "Is the taxable income elasticity sufficient to calculate deadweight loss? The implications of evasion and avoidance," *American Economic Journal: Economic Policy*, 2009, *1* (2), 31–52.

Chirinko, Robert S., "Business fixed investment spending: Modeling strategies, empirical results, and policy implications," *Journal of Economic literature*, 1993, *31* (4), 1875–1911.

Cummins, Jason G., Kevin A. Hassett, and Glenn R. Hubbard, "A reconsideration of investment behavior using tax reforms as natural experiments," *Brookings Papers on Economic Activity*, 1994, (2), 1–74.

Cutler, David M., "Tax reform and the stock market: An asset price approach," *American Economic Review*, 1988, *78* (5), 1107–1117.

DeAngelo, Harry and Ronald W. Masulis, "Optimal capital structure under corporate and personal taxation," *Journal of Financial Economics*, 1980, *8* (1), 3–29.

Desai, Mihir and Austan Goolsbee, "Investment, overhang, and tax policy," *Brookings Papers on Economic Activity*, 2004, (2), 285–355.

Dewatripont, Mathias and Jean Tirole, "A theory of debt and equity: Diversity of securities and manager-shareholder congruence," *Quarterly Journal of Economics*, 1994, *109* (4), 1027–1054.

Dichev, Ilia D. and Douglas J. Skinner, "Large-sample evidence on the debt covenant hypothesis," *Journal of Accounting Research*, 2002, *40* (4), 1091–1123.

Djankov, Simeon, Tim Ganser, Caralee McLiesh, Rita Ramalho, and Andrei Schleifer, "The Effect of Corporate Taxes on Investment and Entrepreneurship," *American Economic Journal: Macroeconomics*, 2010, *2* (3), 31–64.

Eberhardt, Allan C., William T. Moore, and Rodney L. Roenfeldt, "Security pricing and deviations from the absolute priority rule in bankruptcy proceedings," *Journal of Finance*, 1990, *45* (5), 1457–1469.

Edgerton, Jesse, "Taxes and business investment: new evidence from used equipment," *Unpublished Working Paper*, 2009.

_ , "Investment incentives and corporate tax asymmetries," *Journal of Public Economics*, 2010, *94* (11-12), 936–952.

Feldstein, Martin S., "Tax avoidance and the deadweight loss of the income tax," *Review of Economics and Statistics*, 1999, *81* (4), 674–680.

Franks, Julian R. and Walter N. Torous, "An empirical investigation of U.S. firms in reorganization," *Journal of Finance*, 1989, *44* (3), 747–769.

_ **and** _ , “A comparison of financial recontracting in distressed exchanges and Chapter 11 reorganizations,” *Journal of Financial Economics*, 1994, *35* (3), 349–370.

Gertner, Robert and David Scharfstein, “A theory of workouts and the effects of reorganization law,” *Journal of Finance*, 1991, *46* (4), 1189–1222.

Gilson, Stuart C., “Bankruptcy, boards, banks, and blockholders:: Evidence on changes in corporate ownership and control when firms default,” *Journal of Financial Economics*, 1990, *27* (2), 355–387.

Goolsbee, Austan, “Investment tax incentives, prices, and the supply of capital goods,” *Quarterly Journal of Economics*, 1998, *113* (1), 121–148.

Graham, John R., “Debt and the marginal tax rate,” *Journal of Financial Economics*, 1996, *41* (1), 41–73.

_ , “How big are the tax benefits of debt?,” *Journal of Finance*, 2000, *55* (5), 1901–1941.

_ **and Lillian Mills**, “Using tax return data to simulate corporate marginal tax rates,” *Journal of Accounting and Economics*, 2008, *46* (2-3), 366–388.

_ **, Michael Lemmon, and James Schallheim**, “Debt, leases, taxes, and the endogeneity of corporate tax status,” *Journal of Finance*, 1998, *53* (1), 131–162.

Gravelle, Jane G., “The social cost of nonneutral taxation: Estimates for nonresidential capital,” in Charles R. Hulten, ed., *Depreciation, inflation, and the taxation of income from capital*, Washington, DC: Urban Institute, 1981.

Green, Richard C., “Investment incentives, debt, and warrants,” *Journal of Financial Economics*, 1984, *13* (1), 115–136.

Grossman, Sanford J. and Oliver D. Hart, “Corporate financial structure and managerial incentives,” in John J. McCall, ed., *The economics of information and uncertainty*, Chicago: University of Chicago Press, 1982.

Hadlock, Charles J. and Joshua R. Pierce, “New evidence on measuring financial constraints: moving beyond the KZ index,” *Review of Financial Studies*, 2010, *23* (5), 1909–1940.

Hall, Robert E. and Dale W. Jorgenson, “Tax policy and investment behavior,” *American Economic Review*, 1967, *57* (3), 391–414.

_ **and** _ , “Application of the theory of optimum capital accumulation,” in Gary Fromm, ed., *Tax Incentives and Capital Spending*, Washington, DC: Brookings, 1971.

Harberger, Arnold C., "Efficiency effects of taxes on income from capital," in Marian Krzyzaniak, ed., *Effects of corporation income tax*, Detroit: Wayne State University Press, 1966.

Hart, Oliver and John Moore, "A theory of debt based on the inalienability of human capital," *Quarterly Journal of Economics*, 1994, *109* (4), 841–879.

_ **and** _ , "Debt and seniority: An analysis of the role of hard claims in constraining management," *American Economic Review*, 1995, *85* (3), 567–585.

Hassett, Kevin A. and Glenn R. Hubbard, "Tax policy and business investment," in Alan J. Auerbach and Martin Feldstein, eds., *Handbook of Public Economics*, Vol. 3, Elsevier, 2002, pp. 1293–1343.

Hines, James R., Jr., "Credit and deferral as international investment incentives," *Journal of Public Economics*, 1994, *55* (2), 323–347.

_ , "Altered states: Taxes and the location of foreign direct investment in America," *American Economic Review*, 1996, *86* (5), 1076–1094.

_ **and Eric M. Rice**, "Fiscal paradise: Foreign tax havens and American business," *Quarterly Journal of Economics*, 1994, *109* (1), 149–182.

Hotchkiss, Edith Shwalb, "Postbankruptcy performance and management turnover," *Journal of Finance*, 1995, *50* (1), 3–21.

House, Christopher L. and Matthew D. Shapiro, "Temporary investment tax incentives: Theory with evidence from bonus depreciation," *American Economic Review*, 2008, *98* (3), 737–768.

Jensen, Michael C. and William H. Meckling, "Theory of the firm: Managerial behavior, agency costs and ownership structure," *Journal of Financial Economics*, 1976, *3* (4), 305–360.

Jorgenson, Dale W. and Kun-Young Yun, "Tax policy and capital allocation," *Scandinavian Journal of Economics*, 1986, *88* (2), 355–377.

_ **and** _ , "Tax reform and U.S. economic growth," *Journal of Political Economy*, 1990, *98* (5), S151–S193.

Kahle, Kathleen M. and Rene M. Stulz, "Financial policies and the financial crisis: How important was the systemic credit contraction for industrial corporations?," *NBER Working Papers W16310*, 2010.

Kalay, Avner, "Stockholder-bondholder conflict and dividend constraints," *Journal of Financial Economics*, 1982, *10* (2), 211–233.

Kitchen, John and Matthew Knittel, "Business use of special provisions for accelerated depreciation: Section 179 expensing and bonus depreciation, 2002-2009," *Paper presented at the 104th National Tax Association Annual Conference on Taxation*, 2011.

Knittel, Matthew, "Corporate response to accelerated tax depreciation: Bonus depreciation for tax years 2002-2004," *Department of the Treasury Office of Tax Analysis, OTA Paper*, 2007, *98.*

Kwan, Simon H., "Firm-specific information and the correlation between individual stocks and bonds," *Journal of Financial Economics*, 1996, *40* (1), 63–80.

Lehn, Kenneth and Annette Poulsen, "Contractual resolution of bondholder-stockholder conflicts in leveraged buyouts," *Journal of Law and Economics*, 1991, *34* (2), 645–673.

Lyon, Andrew, "Investment incentives under the alternative minimum tax," *National Tax Journal*, 1990, *43* (4), 451–465.

_ , *Cracking the code: making sense of the corporate alternative minimum tax*, Washington, D.C.: Brookings Institution Press, 1997.

Majd, Saman and Stewart C. Myers, "Tax asymmetries and corporate tax reform," in Martin Feldstein, ed., *The effects of taxation on capital accumulation*, Chicago: University of Chicago Press, 1987.

McDaniel, Morey W., "Bondholders and corporate governance," *Business Lawyer*, 1986, *41*, 413–460.

Miller, Merton H., "Debt and taxes," *Journal of Finance*, 1977, *32* (2), 261–275.

Mintz, Jack, "An empirical estimate of corporate tax refundability and effective tax rates," *Quarterly Journal of Economics*, 1988, *103* (1), 225–231.

Modigliani, Franco and Merton H. Miller, "Corporate income taxes and the cost of capital: a correction," *American Economic Review*, 1963, *53* (3), 433–443.

Myers, Stewart C., "The determinants of corporate borrowing," *Journal of Financial Economics*, 1977, *5* (2), 147–175.

Neubig, Thomas, "Where's the applause? Why most corporations prefer a lower rate," *Tax Notes*, 2006, *111*, 483–486.

Shoven, John B., "The incidence and efficiency effects of taxes on income from capital," *Journal of Political Economy*, 1976, *84* (6), 1261–1283.

Smith, Clifford W. and Jerold B. Warner, "On financial contracting: An analysis of bond covenants," *Journal of Financial Economics*, 1979, *7* (2), 117–161.

_ **and MacDonald Wakeman**, "Determinants of corporate leasing policy," *Journal of Finance*, 1985, *40* (3), 895–908.

Standard and Poor's, *Standard and Poor's security price index record*, New York: Standard and Poor's, 1988.

Stiglitz, Joseph E., "Taxation, corporate financial policy, and the cost of capital," *Journal of Public Economics*, 1973, *2* (1), 1–34.

Summers, Lawrence H., "Taxation and corporate investment: A q-theory approach," *Brookings Papers on Economic Activity*, 1981, (1), 67–127.

_ , "Investment incentives and the discounting of depreciation allowances," in Martin Feldstein, ed., *The Effects of Taxation on Capital Accumulation*, Chicago: University of Chicago Press, 1987, pp. 295–304.

_ , "Should tax reform level the playing field?," in "Proceedings of the seventy-ninth annual conference" National Tax Association 1987.

Warren, Alvin C. and Alan J. Auerbach, "Transferability of tax incentives and the fiction of safe harbor leasing," *Harvard Law Review*, 1982, *95* (8), 1752–1786.

_ **and** _ , "Tax policy and equipment leasing after TEFRA," *Harvard Law Review*, 1983, *96* (7), 1579–1598.

Weiss, Lawrence A., "Bankruptcy resolution:: Direct costs and violation of priority of claims," *Journal of Financial Economics*, 1990, *27* (2), 285–314.

Yan, An, "Leasing and debt financing: Substitutes or complements?," *Journal of Financial and Quantitative Analysis*, 2006, *41* (03), 709–731.