An Analysis of the Availability and Incentive Effects of the R&D Tax Credit after the Omnibus Budget Reconciliation Act of 1989*

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ABSTRACT

The R&D credit has always been incremental in nature, providing a credit for qualified R&D expenses exceeding some base amount. Originally, the base amount was the average of the previous three years' R&D expenses (i.e., a moving average). After heavy criticism that the credit's incentive effects were largely offset in the following three years, Congress substituted the moving average base with a fixed-base as part of the Omnibus Budget Reconciliation Act of 1989. This study examines the effect of this structural change on the number of firms that are eligible for the credit and the type of firms that are eligible for the credit. In addition, we examine the incentive effect of the R&D tax credit for firms that qualified for the credit, and whether the incentive effect changed after the implementation of OBRA89. Using data from 1981-1994, we find overall firm eligibility declined after OBRA89, but increased for firms belonging to high-tech industries, relative to firms belonging to other industries. Fixed-effects regressions that control for various non-tax factors indicate that median R&D intensity increased approximately 11.6 (6.3) percent from 1986-1989 to 1990-1994. For qualified firms, our estimates imply approximately $2.10 of additional R&D spending per revenue dollar forgone.

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Keywords: Research and Development; Tax Credits; Tax Incentives

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Comments welcome

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INTRODUCTION

In 1989, Congress enacted one of the most significant changes in the research and development (R&D) tax credit's history by redefining the base amount used to calculate incremental R&D expenditures that determine the credit amount. This study examines the effect of this policy change on both the availability of the R&D credit and its incentive effects. Motivation for providing a tax subsidy for R&D dates back to Arrow (1962) and others who argued that private R&D represents a classic public goods problem in that it has significant positive externalities, which typically lead to underinvestment. Empirical evidence validates this argument; studies consistently show social rates of return to R&D exceeding the private return (see Griliches 1992). Thus, the bipartisan support in the U.S. Congress for a tax credit to subsidize R&D is not surprising. Despite this support, however, policymakers remain unsure about the R&D credit's availability and incentive effects, resulting in repeated tinkering with the credit.[1]

The U.S. R&D credit has always been incremental in nature, implying that firms must spend more in the current year than they did over some base amount to earn the credit.[2] Initially, a firm computed the base amount as its average R&D spending in the three tax years prior to the year in which the firm was claiming the credit (referred to as the "moving average method"). Despite its simplicity, policymakers and academics (e.g., Eisner 1985; Eisner, Albert and Sullivan 1984; Altshuler 1988) criticized the moving average base because the credit's marginal incentive effect provided in the first year was largely offset in the following three years and could even result in negative effective credit rates for rapidly growing firms. In the Omnibus Budget Reconciliation Act of 1989 (OBRA89), Congress

[1] Former Treasury Secretary Paul O'Neill's remark: "You find somebody who says, 'I do more R&D because I get a tax credit for it,' you'll find a fool" candidly reflects an extreme view of policymakers' uncertainty regarding the R&D credit's incentive effect (Schlesinger and Phillips 2001). Further reflecting this uncertainty, the R&D credit remains a temporary provision after more than two decades following its original enactment.

[2] This feature is not unique to the U.S. Hall and van Reenan's (2000) survey identifies France, Japan, Korea, Spain, and Taiwan as also having an incremental R&D tax credit, although each uses a different formula for the tax base. In contrast, Canada has a permanent, non-incremental R&D credit; every dollar spent on R&D qualifies for the tax credit.

responded to this criticism by substituting the moving average base with a fixed-base percentage equal to the ratio of a firm's research expenses to its gross receipts for the period 1984-88.

In this study, we examine two related questions: (1) what was the effect of the OBRA89 structural change on firms' eligibility and qualification for the R&D credit,[3] and (2) what was the effect of the OBRA89 structural change on firms' R&D spending intensity? Motivation for the first question stems from Congress' belief that modifying the base amount to reflect firm-specific characteristics (other than prior R&D spending) would make the credit "widely available at the lowest possible revenue cost", thereby broadening eligibility for the credit and enhancing its fairness. However practitioners contend that, even under the new structure, the R&D credit "is not simple, certain, fair, or available to many businesses" (Grigsby and Westmoreland 2001). Despite these concerns, no prior study we are aware of provides empirical evidence on the availability of the credit.

Motivation for the second question stems from the widespread conjecture that the base redefinition substantially increased the credit's incentive effects (e.g., Swenson 1992; Brumbaugh 1993; Watson 1996), perhaps even more than the original introduction of the credit (Hall and van Reenan 2000). However, empirical evidence on this conjecture is limited and at best mixed. For example, studies using primarilly pre-OBRA89 data suggest that a dollar of R&D credit stimulates a dollar of R&D spending in the short run and two dollars in the long run (e.g., Swenson 1992; Berger 1993; Hall 1993).[4] In contrast, Klassen, Pittman, and Reed (2004) use a matched sample of 110 U.S. and 58 Canadian firms and find that the U.S. R&D credit induces $2.96 of additional R&D spending for every dollar of taxes forgone, clearly much higher than previously documented, but they use only post-OBRA89 data. Thus, the incentive effect of the most significant change in the R&D credit's structure remains unexplored.

[3] We distinguish between "eligibility" and "qualification" for the R&D credit as follows (defined in greater detail later): Eligibility implies that the firm's spending on R&D satisfies the threshold defined by the tax laws for claiming the R&D tax credit. Qualified implies that the firm meets the eligibility requirements and that the firm's tax status allows it to claim the benefit of the tax credit.

[4] Hall (1993) is an exception in that her sample period covered 1980 to 1991, but that allowed only two years of post-OBRA89 data. She briefly mentions (footnote 18, p. 31) that R&D spending induced by the tax credit during 1990-1991 appeared to be on the order of $5 billion per year (as compared to an estimate of $2 billion per year in 1982). However, she then states that, "This number is almost too large to be credible …, and deserves further investigation as more data become available."

We base our empirical analysis on a sample of 1,877 firms (14,244 firm-years) that report R&D expense and have at least one year of credit qualification during 1981-1994, the entire 14-year life of the credit prior to its first discontinuity in 1995. This period spans the OBRA89 change in the credit's structure, which serves as a natural experiment and provides an important source of exogenous variation in firms' incentives. Our results indicate that the OBRA89 structural changes decreased overall firm eligibility but increased overall firm qualification for the credit. Specifically, 76 (67) percent of firm-years were eligible for the credit before (after) the OBRA89 changes; 73 (78) percent of eligible firm-years qualified for the credit before (after) the OBRA89 changes. The number of eligible high-tech (other industry) observations decreased by approximately 8 (16) percent from pre-OBRA89 levels, while the number of qualified high-tech (other industry) observations increased by approximately 12 (6) percent. Supplemental tests show that the eligibility and qualification changes after OBRA89 were due primarily to firms that are in the early, high growth stages of their life cycle.

Results of fixed-effects regression models that control for various non-tax factors known to affect R&D spending indicate that the median R&D intensity of high-tech (other) firms that qualified for the credit increased by approximately 11.6 (6.3) percent from 1986-1989 to 1990-1994. Additional tests that account for the incentives of multinational companies indicate that high-tech firms with deficit foreign tax credit positions had the largest increase in R&D intensity post-OBRA89. Our results imply that the post-OBRA89 R&D tax credit induced an estimated $2.10 of additional spending by qualified firms per revenue dollar forgone by the U.S. Treasury during 1990-1994. In contrast, median R&D intensities of firms not qualified to use the credit increased approximately 2.4 percent during the same period.

We perform various sensitivity tests that include constructing alternative samples to address the changing industry composition of firms in our sample and obtaining data directly from financial statement tax footnotes on the actual amount of the R&D credit to address the concern of using *Compustat* R&D as a proxy for qualified research expenditures. These tests support our assumptions used in determining firms' eligibility and qualification for the credit and reinforce our main findings.

THE R&D CREDIT

Overview

U.S. businesses receive tax incentives for R&D at both the federal and state levels. There are two explicit federal level subsidies for R&D. First, section 174 of the Internal Revenue Code provides an immediate deduction for most "research and experimentation" expenditures.[5] The value of this deduction has varied over time for all firms with changes in the statutory corporate tax rate, as well as for individual firms as they move in and out of taxable status. Second, section 41 of the Code provides a credit for increased expenditures on certain types of R&D activities.[6] At the state-level, several U.S. states provide an additional tax credit for research conducted within the state. In this study, we focus on the incentive effects of only the federal R&D credit and discuss the implications of both the immediate deductibility of R&D expenditures and the state-level R&D credit in the research design section later.

Congress first enacted the R&D credit as a temporary provision in the Economic Recovery Tax Act of 1981. Since then, Congress has extended the credit repeatedly such that the credit was available continuously from its original enactment in 1981 through June 30, 1995, when it lapsed. After a one-year hiatus, Congress reenacted the credit effective July 1, 1996, again temporarily.[7]

The Structure of the R&D Credit and its Change under OBRA89

An important feature of the R&D credit is its incremental nature. Initially, the credit was equal to 25% of the excess of qualified research expenditures (QRE) in a given tax year over a firm's base

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[5] Taxpayers can also elect to amortize these expenditures over 60 months, but in practice most firms immediately expense R&D. However, the IRC does not define what qualifies as R&D expenditures. Treasury regulations have generally interpreted them to mean "R&D costs in the experimental or laboratory sense."

[6] Hines (1993) identifies a third potential source of R&D subsidy at the federal level. Given the way the U.S. tax system interacts with most foreign countries, he shows that there is an implicit subsidy to the extent that R&D can be directed towards sales of foreign countries.

[7] Once again, the R&D credit expired on December 31, 2005 (IRC section 41(h)(1)(B)). Efforts to make the credit permanent, however, have not been lacking. For example, in his original "Agenda for Tax Relief," President George W. Bush listed making the research credit permanent as one of his administration's main goals citing the "on-again, off-again nature of the credit" as an impediment to innovation and economic growth (http://www.whitehouse.gov/news/reports/taxplan.pdf). However, the Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2001 subsequently enacted by Congress did not make the credit permanent. Even prior to the EGTRRA, legislators introduced several bills for this purpose and practitioners continue to assert that the lack of permanence dilutes the incentive effects of the credit (Grigsby and Westmoreland 2001). However, the permanence issue is beyond the scope of this study.

amount. Congress defined the base as the greater of: (1) average QRE in the three previous tax years or (2) 50% of the current year's QRE, as follows:

$$Base_{t \le 1989} = \max\left[\left(\frac{1}{3}\sum_{k=1}^{3} QRE_{t-k}\right),\ 50\% \times QRE_t\right]. \tag{1}$$

Congress made the credit nonrefundable and allowed firms to carry any excess back three years and forward 15 years.

Policymakers and practitioners criticized the moving average base for diminishing the credit's incentive because it created a "feedback effect" – each dollar spent on R&D in the current year limited a taxpayer's ability to claim the credit by 33 cents in each of the following three years. This increase in the subsequent year's base meant that firms always paying taxes had a zero effective tax credit rate (except for discounting), and rapidly growing firms often faced large negative credit rates (Altshuler 1988; Hall 1993). Consequently, the law indirectly encouraged firms to decrease their second and third years' R&D expenditures to maximize the credit in the fourth year.

In response to this criticism, the lawmakers responsible for OBRA89 substituted the moving average base with a fixed base percentage. This percentage was the minimum of 16 percent or the ratio of a firm's research expenses to its gross receipts for the period 1984-1988. Firms now determine the base amount as the greater of (1) their fixed-base percentage multiplied by their average gross receipts in the previous four years, or (2) 50 percent of current year QRE, as follows:

$$Base_{t>1989} = \max\left[\left(\frac{1}{4}\sum_{k=1}^{4} Sales_{t-k}\right) \times \min\left(16\%, \frac{1}{5}\sum_{j=84}^{88}\frac{QRE_j}{Sales_j}\right), 50\% \times QRE_t\right]. \tag{2}$$

Congress assigned start-up firms a fixed-base of three percent.[8]

The desire to enhance the credit's incentive effect motivated the OBRA89 base modification. By adjusting each firm's base to an index other than prior-year R&D expenditures, Congress wanted to make

[8] Congress defined start-up firms as firms that had fewer than three years of both gross receipts and qualified R&D expenses during the fixed base measurement period (1984-1988).

the credit widely available at the lowest possible revenue cost. In explaining its rationale for the specific design of the credit, the Senate Finance Committee stated:[9]

> *Because businesses often determine their research budgets as a fixed percentage of gross receipts, it is appropriate to index each taxpayer's base amount to the average growth in its gross receipts. By so adjusting each taxpayer's base amount, the committee believes the credit will be better able to achieve its intended purpose of rewarding taxpayers for research expenses in excess of amounts that would have been expended in any case. Using gross receipts as an index, firms in fast-growing sectors will not be unduly rewarded if their research intensity, as measured by their ratio of qualified research to gross receipts, does not correspondingly increase. Likewise, firms in sectors with slower growth will still be able to earn credits as long as they maintained research expenditures commensurate with their own sales growth.*

The Committee added that adjusting a taxpayer's base by reference to its gross receipts also has the advantage of indexing the credit for inflation and preventing taxpayers from being rewarded for purely inflation-induced increases in research spending.

RESEARCH QUESTIONS AND MODEL DEVELOPMENT

The above discussion about the specific change in the R&D credit's design enacted by OBRA89 and Congress' rationale for making this change motivates our two research questions: (1) what was the effect of the OBRA89 structural changes on firms' eligibility and qualification for the R&D credit, and (2) what was the effect of the OBRA89 structural changes on firms' R&D spending intensity?

The Effect of the OBRA89 *Changes on Eligibility and Qualification for the R&D Credit*

Given the Congressional objective of making the credit as widely available as possible, we expect an increase in the overall eligibility of firms for the credit after OBRA89. Further, given the Senate Finance Committee's rationale for indexing a firm's base amount to its average growth in gross receipts, we expect that the disincentive caused by the use of the moving average base will no longer affect firms with high growth potential after OBRA89. Therefore, we also expect an increase in the eligibility of high growth firms relative to other firms. In general, high growth firms have higher R&D spending but lower sales – characteristics typical of firms in high-tech industries that make large investments in intangible

[9] Senate Finance Committee Report (Part 1 of 6 Parts) (Oct. 13, 1989), 135 Cong. Rec. S13125 (10/12/89).

assets to fuel future revenue streams.[10] Hence, we operationalize our tests for this question by comparing firms in high-tech industries relative to firms in other industries. Various Congressional reports indicate that lawmakers enacted the R&D credit primarily to benefit high-tech industries.[11]

The R&D credit (as well as most other tax credits) is non-refundable, implying that taxpayers stand to benefit only if they have a positive tax liability, except to the extent of the carryback and carryforward features of the credit. Thus, even though a taxpayer may be "eligible" for the credit, they must have a positive tax liability to "qualify" for it. From a policy perspective, the design of the R&D credit can only take into consideration firms' eligibility for the credit; however, qualification ultimately determines taxpayers' benefits. Hence, we also examine whether overall firms' qualification for the credit differs between the pre- and post-OBRA89 periods and for high-tech firms relative to others.[12]

The Effect of the OBRA89 *Changes on R&D Spending Intensity*

Model Development

In the second stage of our analysis, we examine whether the structural change in the R&D tax credit after OBRA89 affected firms' R&D spending. Most prior studies that evaluate the effectiveness of the R&D credit using a natural experiment approach, such as the introduction of the credit, follow a cost-benefit approach that implicitly relies on the analytical framework summarized in Hall (1993) and Hall

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[10] This statement is consistent with the characteristics of our sample. Specifically, the mean R&D expense for high-tech (other) firms is $47.05M ($23.87M), and the mean sales for high-tech (other) firms is $580.91M ($983.49M). Additionally, the mean sales growth and R&D expense growth for high-tech firms (27.12 percent and 25.23 percent, respectively) is larger than that of other firms (11.12 percent and 18.15 percent, respectively). All differences between high-tech and other firms are significant at the $p < 0.05$ level.

[11] For instance, the House and Senate hearings prior to the adoption of IRC section 44F (dealing with research excluded from the R&D tax credit) indicate that Congress wanted to encourage investment in high-tech R&D. Only representatives from high-tech industries (e.g., American Electronics Association, the Semiconductor Industry Association, and the Computer & Business Equipment Manufacturer's Association) testified at these hearings. These hearings focused on the benefits that the IRC section 44F credit would confer on technologically intensive industries. The testimony highlighted the need to stimulate R&D in high-tech industries in order to stimulate growth in these industries. Moreover, the witnesses testified that the technological innovations made by high-tech industries in turn benefited the economy generally. Finally, the members of high-tech industries testified that a tax credit would enhance their ability to compete with foreign competitors (Nellen 2001).

[12] Lawmakers enacted an additional change to the R&D credit as part of the OBRA89 reforms (albeit unrelated to the structural change) that allows us to make a prediction regarding pre- and post-OBRA89 firm qualification. Specifically, IRC section 280C(c) further reduced the deduction available under IRC section 174 from 50 percent to 100 percent of the R&D tax credit claimed in the same year. Reducing the R&D deduction increases taxable income relative to what it would have been absent the reduction, thereby improving the tax status (taxable vs. NOL) of firms at the margin. Tax status determines firm qualification; therefore, the higher IRC section 280C(c) reduction post-OBRA89 should increase firm qualification, *ceteris paribus*.

and van Reenan (2000). These studies typically estimate the level of R&D spending (RD_{it}) as a function of a R&D credit dummy (C_{it} set to one when available) and firm-specific variables (y_{it}), such as past R&D spending, output, and cash flows, as follows:

$$RD_{it} = \alpha_0 + \beta C_{it} + \gamma' y_{it} + \varepsilon_{it}. \quad (3)$$

However, policymakers often focus on R&D intensity (commonly measured as R&D expense divided by sales) rather than the level of R&D. Reinforcing this, the Senate Finance Committee specifically incorporated R&D intensity into the fixed-base calculation (by indexing a firm's base amount to its average growth in gross receipts) to better achieve the R&D credit's intended purpose of rewarding firms only for incremental research expenses.

The theory on how tax policy affects R&D intensity is not clear and only a few studies (e.g., Tillinger 1991; Berger 1993) have empirically estimated models of R&D intensity. Hall (1993) and Hall and van Reenan (2000) use a simple model to generate predictions of the credit's incentive effects on changes in R&D spending levels. We follow a similar model to generate predictions of how the OBRA89 change might affect the R&D credit's incentive effects as captured through R&D intensity. We present the model in Appendix A.

Two predictions follow from our model. Observation 1 implies that changes to the R&D credit that lower the marginal cost of making new qualified R&D investments should positively affect R&D intensity. Since the OBRA89 structural change broke the link between current and future R&D spending that existed pre-OBRA89 under the moving-average method, the effective rate of the credit post-OBRA89 should be relatively higher which, in turn, should increase firms' R&D intensities.[13] Observation 2 predicts that OBRA89's positive impact on R&D intensity will be greater for firms with higher gross profit margins or growth rates of R&D stock, such as firms in high-tech industries.

Empirical Specification

[13] The base redefinition did not completely remove the link between current and future R&D spending. It still exists but in a more attenuated and delayed form for two reasons: (1) firms spread out increased R&D spending over four years instead of three years and (2) the effect starts to occur after two years instead of in the next year (Swenson 1992).

To test the predictions regarding OBRA89's incentive effect, we estimate regression models of R&D intensity as a function of both tax and non-tax factors. Three design features of our empirical specification stand out. First, given that OBRA89 represents a unique natural experiment, our research design is similar in spirit to other studies that used the enactment of the credit to help identify the incentive effects (e.g., Eisner et al. 1983; Swenson 1992; Berger 1993). While these studies use a R&D credit qualification dummy, we estimate regressions separately for firms grouped by their qualification status for the credit. We infer qualification status for each firm-year observation based on both eligibility for the credit (determined by whether the firm's qualified R&D spending exceeds the threshold amount as defined each year) and tax status. We believe this specification better accounts for potential differences in the sub-samples that could likely impair interpretations of the tax variables of interest. Second, we use high-tech firms to examine the prediction that OBRA89 will have a larger effect on firms with high gross profit margins and growth rates of R&D stock.[14] Third, we include firm fixed-effects, which reduce the potential for correlated omitted variables (e.g., knowledge depletion rates) and heterogeneity bias.

Based on these research design considerations, we estimate the following regression model (where subscript *i* is an index for firms and *t* for year):

$$
\begin{aligned}
RDI_{it} \quad = \quad & \alpha_0 + \delta_1 GDP_{it} + \delta_2 IRD_{it} + \gamma_1 RDI_{it-1} + \gamma_2 FUND_{it} + \gamma_3 LDTA_{it} + \gamma_4 Q_{it} + \gamma_5 SIZE_{it} + \\
& \phi_1 MTR_{it-1} + \phi_2 OBRA_t + \phi_3 (OBRA_t \times TECH_{it}) + \mu_i + \zeta_{it}.
\end{aligned} \tag{8}
$$

The dependent variable *RDI* is R&D intensity, measured as R&D expenses divided by sales.[15] We use μ_i to capture the firm fixed-effect and define the other right-hand side variables as follows (with *Compustat* data item numbers and coefficient sign predictions in parentheses):

GDP_{it}	=	Real gross domestic product.	(+)
IRD_{it}	=	Industry R&D intensity measured as *RDI* of all firms in firm *i*'s four-digit SIC code.	(+)

[14] To evaluate the appropriateness of high-tech firms satisfying these criteria, we use Lev and Souigiannis' (1996) algorithm that approximates the stock of R&D capital (G_{it}) for firm *i* in year *t* as a function of current and past R&D expense (RD_{it}) as follows: $G_{it} = RD_{it} + 0.8RD_{it-1} + 0.6RD_{it-2} + 0.4RD_{it-3} + 0.2RD_{it-4}$. For our sample firms, this algorithm yields R&D stock for high-tech (other) firms of $118.80M ($64.96M) and R&D stock growth of 27.12 percent (22.80 percent). Additionally, the mean gross profit margin for high-tech (other) firms is 43.18 percent (35.52 percent). All differences in these variables between high-tech and other firms are significant at the $p < 0.05$ level.

[15] We also use lagged sales as the scalar for R&D intensity. The inferences from all tests remain unchanged.

RDI_{it-1}	=	One-year lagged firm *RDI.*	(+)
$FUND_{it}$	=	Internal funds, measured as [income before extraordinary items (#18) + R&D expense (#46) + depreciation (#14)] ÷ sales (#12).	(+)
$LTDA_{it}$	=	Leverage, measured as long-term debt (#9) ÷ total assets (#6).	(–)
Q_{it}	=	Tobin's *q*, measured as [(price (#199) × common shares outstanding (#25)) + book value of preferred stock (#130) + long-term debt (#9) + short-term debt (#34)] ÷ total assets (#6).	(?)
$SIZE_{it}$	=	Firm size, measured as the natural logarithm of total assets (#6).	(?)
MTR_{it-1}	=	One-year lagged simulated, after-financing marginal tax rate (Graham 1996a, 1996b; Graham, Lemmon, and Schallheim 1998).	(+)
$OBRA_{t}$	=	An OBRA89 dummy coded one for the years 1990-1994, and zero otherwise.	(+)
$TECH_{it}$	=	A high-tech industries dummy coded one for firms in the following four-digit SIC classifications: Drugs (2833-2836), R&D Services (8731-8734), Programming (7371-7379), Computers (3570-3577), and Electronics (3600-3674), and zero otherwise (Kasznik and Lev 1995).	(+)

We include three tax variables in the model: *MTR*, *OBRA* and *OBRA*TECH*.[16] The *OBRA* dummy and its interaction with *TECH* are the main test variables. A positive and significant estimate of ϕ_2 would be consistent with the prediction of our model's observation 1 that the OBRA89 structural change positively impacted firms' R&D intensity. Similarly, a positive and significant estimate of ϕ_3 would be consistent with the prediction of our model's observation 2 that OBRA89's positive effect on firms' R&D intensity is greater for the high-tech firms.

We also include the firm-specific simulated after-financing marginal tax rate (*MTR*) based on Graham (1996a; 1996b). In addition to the tax credit, firms may deduct R&D expenditures in the year incurred, subject to the IRC section 280C(c) limitation. Thus, the firm's tax rate has an effect on the cost of the R&D dollar, with reductions in the tax rate reducing the benefits of expensing (relative to other capital investments). Even with no legislative changes in tax rates, changes in firms' taxable status will alter the cost of the R&D investment. Firms with lower marginal tax rates likely have smaller R&D expenditures because of the increasing after-tax cost of R&D investment. We use lagged *MTRs* to control

[16] Klassen et al. (2004) also include state-level R&D credits, which differ from state to state, and could provide another source of variation to help isolate the credit's incentive effect. We do not consider the state-level credit because of data limitations. Specifically, firms' financial statements do not reveal the amount of R&D conducted in each state, which is necessary for calculating the state-level credits. To get around this problem, Klassen et al. (2004) assign their sample firms to the states (provinces in Canada) of their head office location, but this assumption adds noise to their incentive measure. In any event, their results for the U.S. observations do not change if they consider only the federal-level R&D credit.

for the potential endogeneity of corporate tax status (Graham 1996a, 1996b; Graham, Lemmon, and Schallheim 1998).

The other explanatory variables fall into three broad categories: macroeconomic factors, financial constraints, and other firm-specific factors. To account for macroeconomic factors we include both the real gross domestic product (*GDP*) as an index of overall technological progress and industry-level R&D (*IRD*) to capture the within-industry influence of competitors. Since R&D generally is a multi-period investment characterized by large fixed costs and previous outlay/projects influence decisions about current R&D expenditures, we also include prior-year R&D intensity in the model. Klassen et al. (2004) argue that an autoregressive, instead of a random walk, process best describes the R&D expenditure decision, which also motivates including lagged *RDI* instead of estimating a change specification.

An important financial constraint faced by firms on all investment projects, including R&D, is the availability of funds from internal and external sources. Myers and Majluf's (1984) model of financing hierarchy suggests that firms will prefer internally generated funds as they tend to be cheaper than external sources of financing. If, however, firms require external financing, they prefer debt to equity. Although there does not appear to be a general agreement on a single measure of firms' capital constraints, empirical studies have focused on cash flows and leverage (e.g., Rajan and Zingales 1998). Thus, we include *FUND*, a scaled measure of pre-R&D cash flows, to proxy for a firm's ability to finance R&D from internal funds, and *LTDA*, the debt-to-asset ratio, to capture the impediments faced in obtaining additional debt financing to pursue R&D projects.

Finally, our model includes two other firm-specific attributes, Tobin's *q,* and firm size, likely to affect R&D spending. Prior literature often views Tobin's *q* (*Q*), commonly estimated as the market-to-book value of a firm, as a measure of investment opportunities or stock of intangible assets. Theory predicts that firms with greater values of *Q* will conduct more R&D; however, the effect of *Q* on R&D intensity is unclear. Likewise, a long literature explores the relationship between firm size and R&D activities. Schumpeter (1950) argues for a positive relationship between firm size and R&D investment because larger firms can afford bigger projects, wait longer for payoffs, and capture a bigger portion of the social returns to private R&D due to their market share. However, a returns-to-scale argument suggests a negative relationship between firm size and R&D intensity. Over the years, several studies have empirically attempted to reconcile these conflicting predictions (e.g., Schmookler 1959; Cohen, Levin, and Mowery 1987), with little consensus. Hence, we include the log of total assets (*SIZE*) as another control variable but do not make a sign prediction.

DATA, SAMPLE SELECTION, AND DESCRIPTIVE STATISTICS

Data and Sample Selection Procedures

Panel A of Table 1 outlines the sample selection information. We begin with all firms listed on the *Compustat* Industrial and Full Coverage Files that report R&D expense and that have at least one year of credit qualification during 1981-1994. Since the *Compustat* year 1994 includes fiscal year ends through May 31, 1995, and the credit lapsed on June 30, 1995, our choice of the sample period corresponds to within one month of the entire period during which the R&D credit was continuously available. From the initial sample, we delete firm-years missing data on variables included in the regression model. In addition, to remove the effects of outliers, we drop the highest and lowest one percent of the observations for each firm-specific regression variable in year *t*. The final sample consists of 14,244 firm-year observations representing 1,877 firms.

Descriptive Statistics

Panel B of Table 1 presents simple descriptive statistics for the sample firms. The median firm has $110.9 million of sales and $3.4 million of R&D expenses. The median firm generates a 6.14 percent profit margin on sales growth of 8.23 percent and a 3.25 percent R&D intensity. The median firm has a 34 percent marginal tax rate; therefore, a large portion of the firms in the sample receives a tax benefit from the R&D credit.

Panel C of Table 1 presents mean R&D intensities by broad industry groups as defined in Barth, Beaver, Hand, and Landsman (1999). This breakdown reveals that firms in the durable manufacturing and computer industries account for approximately 63 percent of our sample, with another 15 percent clustered in the textiles, printing and publishing, chemicals, and pharmaceuticals industries. Industries with the largest mean R&D intensities include pharmaceuticals, computers, and financial institutions.

In order to perform tests of eligibility and qualification, we need to determine the qualified R&D expenses (QRE) of each firm. To be "eligible" for the credit, a firm's current year QRE must be greater than its base spending amount. Prior studies (Eisner et al. 1983; Bailey and Lawrence 1992; Swenson 1992; Berger 1993; McCutchen 1993) assume that QRE equals book R&D spending. However, Hall and van Reenen (2000) state that typically 50 to 73 percent of reported book R&D spending qualifies for the credit. Using tax return data to study income shifting by firms claiming the Puerto Rican tax credit under IRC section 936, Grubert and Slemrod (1998) found that the R&D expense reported on the tax returns of firms claiming the credit was, on average, 50 percent of their book R&D expense reported on *Compustat*. Accordingly, we assume that QRE equals 50 percent of *Compustat* R&D expense to determine eligibility, although sensitivity tests using 73 percent yield similar results for all reported tests.[17]

To be "qualified" to use the credit, a firm must not only be eligible for the credit but must also have sufficient tax liability (currently or in preceding years) against which to use the R&D credit. Accordingly, we consider a firm "qualified" if it meets two conditions: (1) total income tax expense minus the change in deferred taxes from the balance sheet sums to a positive amount for the current plus the three preceding years (Berger 1993; Mills, Newberry, and Novack 2003), and (2) current year *MTR* is positive. Using these conditions allows us to create a tax status variable that incorporates screens for both NOLs and current tax expense, which recent research suggests provides a better mapping of tax status between financial statements and tax returns.[18]

Of the total 14,244 firm-years in the sample, 10,414 (73.1 percent) are eligible for the credit. Of the total eligible firm years, 7,756 (74.4 percent) are qualified to use the credit. Untabulated medians for

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[17] Others corroborate the appropriateness of using 50 percent of *Compustat* R&D as a proxy for QRE. For instance, in testimony before the Oversight Subcommittee of the House Ways and Means Committee, Harry Penner of the Neurogen Corporation stated that approximately one-half of book R&D qualifies for the R&D credit (95 *Tax Notes Today* 92-67, May 10, 1995).

[18] Graham's (1996a, 1996b) simulated MTR uses the entire NOL carryback/carryforward schedule (18 years). However, Graham gathers NOL information from *Compustat* and studies show that *Compustat* NOL data contains certain inaccuracies (Kinney and Swanson 1993; Manzon 1994). Mills et al. (2003) find that using additional *Compustat* data for U.S. current income tax expense reduces the error related to *Compustat's* reporting of an NOL carryforward where no U.S. tax NOL exists.

the subsamples by eligibility reveal that firms eligible for the credit are generally larger, more profitable, and more likely to pay taxes than firms not eligible for the credit. The median sales, assets, and profit margin for eligible firms are $122.68 million, $101.57 million, and 7.18 percent, while the respective numbers for ineligible firms are $81.07 million, $63.96 million, and 3.52 percent. The median marginal tax rate for eligible firms is 34 percent compared with 17.5 percent for ineligible firms. Eligible firms also have larger median R&D expenses ($4.49 million v. $1.56 million) and R&D intensities (3.89 percent v. 1.86 percent) than ineligible firms.

Untabulated medians for the qualification subsample indicate that, like eligible firms, qualified firms are also larger, more profitable, and have larger R&D expenses. However, qualified firms have lower R&D intensities than non-qualified firms. This is consistent with Joos and Plesko (2003), who find firms that incur losses and have the lowest probability of loss reversal have larger R&D intensities than other firms, a pattern that strengthened during the 1990's.

Table 2 presents descriptive statistics on the key components included in the R&D credit calculation. Panels A and B represent lower- and upper-bounds, respectively, of each credit component. For the pre-OBRA89 regime, the base amount of median QRE (*BASE*) ranged from $1.131-$1.651 million in 1981 to $1.349-$1.969 million in 1989. Median incremental QRE (*EXCESS*) ranged from $0.250-$0.365 million in 1981 to $0.463-$0.676 million in 1989. Median R&D credits (*CREDIT*) earned by sample firms increased from $0.063-$0.091 million in 1981 to $0.093-$0.135 million in 1989. After 1985, the amount of R&D tax credits earned by sample firms decreased until 1989, a pattern we attribute to the reduction of the credit rate from 25 to 20 percent in 1986.

For the post-OBRA89 regime, the R&D credit components increase dramatically relative to pre-OBRA89 amounts. During the first five years after implementing the new rules, incremental QRE and R&D credits claimed increased approximately 114 percent, while the base amount of QRE increased by approximately 45 percent. This is in stark contrast to the four years prior to the OBRA89 change; incremental QRE and R&D credits claimed decreased approximately 6.1 percent, while the base amount of QRE decreased by approximately 8.1 percent. These descriptive statistics suggest that the OBRA89 structural change appears to have achieved Congress' objective to enhance the credit's incentive effect.

RESULTS

Tests of OBRA89's Effect on Firms' Eligibility and Qualification

Full Sample Results

We use sample odds ratios ($\hat{\theta}$) to examine the changes in likelihood of eligibility and qualification for the credit between the pre- and post-OBRA89 tax regimes. The value θ=1 serves as a baseline for comparison. When $1 < \theta < \infty$ ($0 < \theta < 1$), the odds of success are higher (lower).[19]

Panel A of Table 3 shows that for the sample as a whole eligibility for the R&D credit declined from 76% in the pre-OBRA89 period to 67% post-OBRA89. This decline is statistically significant; the post-OBRA89 estimated odds of eligibility for the R&D tax credit are 0.626 times [*CI* = (0.580, 0.675)] the pre-OBRA89 estimated odds. This decline in overall firm eligibility for the R&D credit is inconsistent with OBRA89's goal of making the credit widely available.

Panel B of Table 3 reports the univariate test results for eligibility by industry groups. Although eligibility declined for both the high-tech and other firms in the post-OBRA89 period, a greater percentage of high-tech firms were eligible both before and after the structural change. Moreover, as the table shows, the estimated odds of eligibility for the R&D tax credit for high-tech firms post-OBRA89 are 1.678 times the odds for other firms, which is significantly higher than the counterpart odds ratio of 1.381 in the pre-OBRA89 period (χ^2_{BD} = 5.82, p = 0.0000).[20] Therefore, even though overall firm eligibility declined after OBRA89, the eligibility of firms in high-tech industries increased relative to firms in other

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[19] Agresti (1996) shows that in large samples, such as ours, statistical inference based on the natural log of the odds ratio ($\ln\hat{\theta}$) results in a conservative test, reduces skewness, and produces a sampling distribution closer to normality. The confidence interval (*CI*) of $\ln\theta$ = $\ln\hat{\theta} \pm z_{\alpha/2} ASE(\ln\hat{\theta})$, and we transform the endpoints back using the exponential function to form a confidence interval for θ. In a 2 × 2 table, $\hat{\theta} = n_{11}n_{22}/n_{21}n_{12}$, where n_{ij} = the frequency in cell$_{ij}$. *ASE* = the *asymptotic standard error* $\sqrt{1/n_{11} + 1/n_{12} + 1/n_{21} + 1/n_{22}}$.

[20] χ^2_{BD} is the *Breslow-Day* (1980) chi-square statistic, which has the Pearson form $\sum\left((n_{ijk} - \hat{\mu}_{ijk})^2 / \hat{\mu}_{ijk}\right)$ with $df = K - 1$ and it tests the null hypothesis that the odds ratio between two groups is the same.

industries. This result is consistent with the statute's goal of benefiting rapidly growing firms that were more prone to face negative credit rates under the pre-OBRA89 structure.

Although we do not have specific hypotheses regarding firm qualification for the R&D credit, the increased reduction in the amount of QRE that could be expensed post-OBRA89 (from 50 percent of the R&D credit claimed to 100 percent) had the effect of increasing a firm's taxable income. The greater the firm's taxable income, the more likely a firm will be qualified to take the credit. Consistent with this notion, Panel A of Table 3 shows that overall firm qualification for the R&D credit increased after OBRA89 ($\hat{\theta}$=1.353; *CI* = (1.228, 1.491)). However, Panel B of Table 3 shows the odds of credit qualification between high-tech firms and firms in other industries are not markedly different between the pre- and post-OBRA89 regimes.[21]

Alternative Sample and Period Results

A potential concern with our finding that firm eligibility declined after OBRA89 is that the sample composition in the two periods may have changed. The U.S. experienced a manufacturing exodus that began in the mid-1980s, and manufacturers comprise over 40 percent of our sample. To address this concern, we replicate our eligibility and qualification tests on two alternative samples. First, we form a balanced panel that includes only those firms present in our sample for the entire 14-year period (*BP14*). The *BP14* sample has 5,110 firm-year observations from 365 firms. Second, we form a sample of those firms present in the final year of our sample period, and include their data back to the earliest year of their inclusion in the database (*END94*). The *END94* sample has 9,735 observations, with the number of firms increasing over time.

As reported in Table 4, the results of the eligibility and qualification tests using the *END94* sample yield inferences identical to the full sample results. However, the analysis of the *BP14* sample indicates that the eligibility of high-tech firms is not statistically different from firms in other industries

[21] We also use a logistic regression (with several firm-specific control variables and Huber-White robust standard errors, which control for heteroskedasticity and serial correlation) to examine the effects of OBRA89 on eligibility and qualification. Overall, the findings and inferences from the univariate results were similar to those obtained with the logistic regression models.

either before OBRA89 [$\hat{\theta}$ = 1.0878, *CI* = (0.888, 1.333)] or after OBRA89 [$\hat{\theta}$ = 0.9436, *CI* = (0.750, 1.187)]. In addition, high-tech firms were not more likely to be eligible relative to firms in other industries (χ^2_{BD} = 0.83, p = 0.3635) after OBRA89. Therefore, it appears that the increased eligibility of high-tech firms, relative to firms in other industries, after OBRA89 was due primarily to firms that are in the early, high growth stages of their life cycle.[22]

To provide additional detail about eligibility and qualification, we also perform tests on the three different periods corresponding to major changes in the R&D tax credit: 1981-1985 (ERTA period), 1986-1989 (TRA period), and 1990-1994 (OBRA period). The Table 5 tests indicate that firms were significantly less likely to be eligible for the credit in both periods following ERTA [$\hat{\theta}_{ERTA|TRA}$ = 0.6693; $\hat{\theta}_{ERTA|OBRA}$ = 0.5148] and after TRA [$\hat{\theta}_{TRA|OBRA}$ = 0.7692]. However, high-tech firms were significantly more likely to be eligible only during the ERTA and OBRA periods [$\hat{\theta}^{ERTA}_{HT|OTH}$ = 1.9840; $\hat{\theta}^{OBRA}_{HT|OTH}$ = 1.6784]. The percentage of eligible high-tech firms drops approximately 43 percent between ERTA and TRA, but increases 27 percent between TRA and OBRA.

Eligible firms were significantly more likely to be qualified for the credit during the OBRA period relative to either the ERTA period [$\hat{\theta}_{ERTA|OBRA}$ = 1.3528] or the TRA period [$\hat{\theta}_{TRA|OBRA}$ = 1.3535]. Similar to the full sample results in Table 3, high-tech firms are significantly less likely to be qualified for the R&D credit than other firms during each period [$\hat{\theta}^{ERTA}_{HT|OTH}$ = 0.7600, $\hat{\theta}^{TRA}_{HT|OTH}$ = 0.6592, $\hat{\theta}^{OBRA}_{HT|OTH}$ = 0.8231]. The difference between TRA and OBRA is marginally significant (χ^2_{BD} = 3.4968, p = 0.0615). Thus, although firms in other industries are more likely to be qualified for the R&D credit, the percentage of high-tech firms likely to be qualified to use the credit increased 25 percent after OBRA89.

[22] The *BP14* sample includes more established, mature firms, whose growth potential is often limited. Therefore, OBRA89 is less likely to affect these firms. Conversely, the *END94* sample includes high growth start-up firms. Average sales growth, market-to-book ratio, and dividend payout ratio for the *BP14* (*END94*) subsample was 8.24 percent, 1.99, and 52.20 percent, respectively (18.16 percent, 2.37, and 33.06 percent, respectively). The differences in these variables between the two samples are significant at the $p < 0.05$ level.

Tests of OBRA89's Effect on Firms' R&D Spending

Univariate Tests

Table 6 presents descriptive statistics on the magnitude of firms' R&D intensities before and after the OBRA89 change in the structure of the R&D credit. Overall, firms eligible to use the credit have larger R&D intensities than ineligible firms, both before and after OBRA89. However, following OBRA89, the R&D intensity of eligible firms increased sharply relative to the ineligible firms (48 percent v. 14 percent).[23] Panel A of Table 6 further shows that the increase in eligible firms' mean R&D intensities after OBRA89 was not limited to firms with certain characteristics (e.g., sales, sales growth, profitability, firm size and lagged marginal tax rate), but instead occurred broadly among all firms.

In addition, Panel B of Table 6 indicates that the increase in R&D intensities of eligible firms after OBRA89 occurred for both the high-tech and other industry groups. Within group (between period) t-tests for each R&D intensity quartile are all significant at $p = 0.000$. However, R&D intensities of high-tech firms after OBRA89 are significantly larger than those of firms in other industries. Within period (between group) t-tests for each R&D intensity quartile are also significant at $p = 0.000$.

Multivariate Tests

Table 7 presents results of the fixed-effects OLS regression model of R&D intensity, estimated separately by qualification status for eligible firms. Untabulated results from the Breusch-Pagan (1980) LM test and the Hausman (1978) test indicate that a fixed-effects model is the appropriate specification.

The first column of results focuses on the R&D intensity of eligible firms that were qualified for the R&D credit during 1981-94. The variables that capture the tax factors that affect R&D spending are all significant. The coefficient on MTR_{t-1} is positive and significant ($\phi_1 = 0.0080$, $p = 0.000$), indicating that qualified firms' R&D intensities are increasing in their marginal tax rates.[24] The interaction term *OBRA*TECH* is significantly positive ($\phi_3 = 0.0071$, $p = 0.000$), which indicates that qualified high-tech

[23] The R&D intensity increase after OBRA89 is significant only for eligible firms.

[24] When we partition the sample based on industry (i.e., high-tech vs. other industries), the coefficient on MTR_{t-1} for qualified high-tech firms is 0.0142 ($p = 0.008$) and the coefficient on MTR_{t-1} for qualified firms in other industries is 0.0056 ($p = 0.000$), which suggests that high-tech firms have greater R&D spending tax incentives.

firms increased their R&D intensities by an additional 0.71 percent after OBRA89 relative to qualified firms in other industries. The coefficient estimate for *OBRA* is also positive and significant ($\phi_2 = 0.0015$, $p = 0.051$), indicating that R&D intensities of other firms increased by 0.15 percent on average post-OBRA89. Using untabulated descriptive statistics, these results indicate that the median R&D intensity for high-tech (other) firms qualified for the credit increased by approximately 11.6 (6.3) percent from 1986-1989 to 1990-1994.[25]

In general, the variables that capture the non-tax factors associated with R&D intensity are consistent with our expectations and the results found in prior studies. A notable exception is *Q*, which is negative and significant ($\gamma_4 = -0.0044$, $p = 0.000$).

The second column of results focuses on the R&D intensity of eligible firms that did not qualify for the R&D credit during 1981-94. In contrast with the results for qualified firms, the coefficients on the structural tax factor variables, *OBRA* and *OBRA*TECH,* are not significant for this sub-sample, indicating that non-qualified firms' R&D intensity did not respond to the structural changes. The results for the other variables are unremarkable, except for lagged marginal tax rate. The magnitude of the coefficient of $MTR_{t\text{-}1}$ for non-qualified firms is greater than that for qualified firms. However, this result further reinforces the positive role taxes play *at the margin* for R&D investment decisions. Since the tax status of non-qualified firms does not allow them to claim the R&D credit, the present value of the R&D credit for these firms would increase dramatically if they transitioned into a tax-paying status.

As a final check on the importance of tax factors in determining R&D intensity, we compared the explanatory power of the R&D intensity regressions for qualified and non-qualified firms. The higher R-square for the qualified firms' regression (79.87% compared with 59.39% for non-qualified firms), in conjunction with the results for the individual tax variables, presents compelling evidence that the OBRA89 structural changes to the R&D credit had a positive effect on firms' R&D intensity.

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[25] The median R&D intensity from 1986-1989 for high-tech (other) firms was 7.43 (2.39) percent. The coefficient estimates from equation (8) indicate the average increase in R&D intensity was approximately 0.0086 ($\delta_2 + \delta_3$) for high-tech firms and 0.0015 (δ_2) for other firms, which is approximately 11.6 percent (0.0086/0.0743 = 0.1157) or 6.3 percent (0.0015/0.0239 = 0.0628) of the median pre-OBRA89 R&D intensity of high-tech or other firms, respectively.

The Effect of the Foreign Tax Credit

Multinational firms provide an additional source of variation in R&D intensity. After 1986, multinational firms with excess foreign tax credits (those whose foreign income is taxed at rates exceeding the U.S. statutory tax rate) faced higher tax costs of performing R&D in the U.S., while firms with deficit foreign tax credits (those whose foreign income is taxed at rates less than the U.S. tax rate) were unaffected.[26] Using a sample of 116 multinational firms from 1984-1989, Hines (1993) compares changes in the growth rate of R&D spending by firms with excess and deficit FTCs and finds that R&D spending levels of firms with excess FTCs grew more slowly than of deficit FTC firms.[27]

To identify firms with excess FTCs, we create a dummy variable equal to one when a firm's foreign tax rate, calculated as current foreign tax expense (*Compustat* #64) divided by foreign pretax income (*Compustat* #273) is greater than the U.S. statutory rate and zero otherwise.[28] We then estimate equation (8) for eligible firms by qualification and FTC status. The results in the first two columns of Table 8 indicate that the effect of the OBRA89 structural changes for qualified firms with deficit FTCs was over two times that of firms with excess FTCs. Specifically, the coefficient on *OBRA* is positive but insignificant ($\phi_2 = 0.0007$, $p = 0.459$) for firms with excess FTCs and marginally significant for firms with deficit FTCs ($\phi_2 = 0.0017$, $p = 0.083$). The coefficient on *OBRA*TECH* is positive and significant for firms with excess FTCs ($\phi_3 = 0.0035$, $p = 0.035$) and with deficit FTCs ($\phi_3 = 0.0070$, $p = 0.000$). Therefore, it appears that high-tech firms with deficit FTC positions had the largest increase in R&D spending post-OBRA89.

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[26] U.S. R&D expense allocation rules are similar to those for interest. Since 1986, U.S. multinational firms with excess foreign tax credits (FTCs) receive partial interest deductions for domestic borrowing. U.S. multinational firms with deficit FTCs receive the full benefits of interest deductions for domestic borrowing, since any interest expenses allocated against their foreign-source incomes nevertheless reduce U.S. tax liabilities that they would otherwise incur.

[27] Additionally, Hines (1995) finds that American-owned foreign affiliates that locate in countries with high withholding taxes on royalty payments are more R&D-intensive. In a similar vein, foreign firms with United States investments are more R&D-intensive if they are subject to higher royalty withholding tax rates. Because our sample excludes foreign firms, we partially control for this additional source of tax rate variation documented for multinational firms.

[28] The U.S. corporate statutory tax rate varied considerately during our sample period (1981-1994). From 1981-1986, the rate was 46 percent, in 1987 the rate was 40 percent, from 1988-1992 the rate was 34 percent, and from 1993-1994 the rate was 35 percent. Of the 3,998 fir-years with foreign operations, 1,453 firm-years have excess FTCs and 2,545 firm-years have deficit FTCs.

Economic Consequences of OBRA89

In Table 9, we present estimates of the additional R&D spending generated by the structural changes of OBRA89. According to data obtained from the IRS Statistics of Income (SOI), the cost of the R&D tax credit for qualified firms during 1990-1994 averaged $1.79 billion per year, while QRE during this period averaged approximately $39 billion.[29] If we estimate equation (8) without the *OBRA*TECH* interaction, the coefficient estimate for *OBRA* is 0.0037, which implies that overall R&D intensity increased 10.63 percent over the median pre-OBRA89 R&D intensity of 3.48 percent. The increase in R&D intensity implies that the $39 billion of QRE was $3.75 billion higher than what it would have been absent the OBRA89 structural change. Therefore, our estimates imply that the credit induced about $2.10 (3.75/1.79) of additional R&D spending by qualified firms per revenue dollar foregone during 1990-1994.

Sensitivity Analysis

Use of Financial Statement Data

Because we do not have access to tax return data, we must estimate the R&D credit from financial statements. To examine whether our algorithm for calculating the R&D credit's components provides reasonable estimates, we conduct some simple out-of-sample tests based on 111 firms from 1995-1999 included in Schmidt (2004). For each firm-year, we estimate the amount of the R&D credit using the actual credit amounts reported in the effective tax rate (ETR) reconciliation of the income tax note to the financial statements ($CREDIT_{ETR}$), and compare those estimates to the credit amounts calculated using the R&D expense in Compustat ($CREDIT_{CST}$).

The two credit amounts are highly comparable; the mean (median) $CREDIT_{CST}$ is 2.1301 (0.6738), while the mean (median) $CREDIT_{ETR}$ is 2.1026 (0.4250). The difference between the means is not statistically significant ($t = 0.0353$, $p = 0.9719$). Moreover, the Pearson and Spearman correlations between $CREDIT_{CST}$ and $CREDIT_{ETR}$ are 0.39 and 0.70, respectively (both statistically significant at $p <$

[29] SOI has data for the amount of R&D tax credit claimed (our measure of the cost of the credit) for each year of our sample period. However, data for QRE is missing from 1986-1991 and we have been unable to obtain this data from any source. We estimate QRE each year from 1986-1991 using the percentage change in the amount of R&D tax credit claimed. Table 9 contains the data used to make the QRE estimates.

0.00). The correlations between $CREDIT_{CST}$ and $CREDIT_{ETR}$ for high-tech firms are higher (ρ_P = 0.85, p = 0.0000 and ρ_S = 0.69, p = 0.0000), while those for firms in other industries are similar to the full sample (ρ_P = 0.42, p = 0.0000 and ρ_S = 0.79, p = 0.0000). This analysis mitigates concerns about measuring the R&D credit from financial statement data, although we cannot rule out that the out-of-sample test results may be period-dependant.

SUMMARY AND CONCLUSIONS

Despite bipartisan support in Congress for a tax credit for R&D, policymakers remain uncertain and skeptical about its incentive effects. Prior research has yielded a wide range of estimated incentive effects, making the R&D credit a focus of ongoing policy debates. In this study, we examine whether the structural changes to the R&D tax credit enacted under OBRA89 had an effect on the number and the type of firms eligible for and qualified to use the credit. In addition, we examine the incentive effect of the R&D tax credit for eligible firms and whether the incentive effect changed after the implementation of OBRA89. We choose the OBRA89 legislative change because Congress fundamentally modified the credit's structure with the intent to make it widely available at the lowest possible revenue cost and to enhance the incentive effect for firms that maintained research expenditures commensurate with their own sales growth. Thus, OBRA89 provides a natural experiment that can inform the policy debate.

We are the first study to document an overall decrease in firm eligibility for the R&D credit after OBRA89. However, the structural changes attenuated the feedback effect present in the moving average base, a disincentive that disproportionately affected high-tech firms. Consequently, high-tech firms were more likely to be eligible for the credit, despite the overall eligibility decrease. We also find that eligible firms were more likely to be qualified to use the credit after OBRA89. Although firms in other industries are more likely than high-tech firms to be qualified to use the credit both before and after OBRA89, the percentage of high-tech firms qualified to use the credit increased approximately 25 percent after OBRA89. Therefore, the differences in the types of firms qualified to use the credit narrowed considerably after OBRA89.

Our regression results show that overall R&D intensities increased after OBRA89, but firms in high-tech industries with deficit FTC positions were primarily responsible for the increase. The median R&D intensity of high-tech (other) firms that qualified for the credit increased by approximately 11.6 (6.3) percent from 1986-1989 to 1990-1994. From a cost-benefit perspective, our regression estimates imply that the R&D tax credit induced approximately $2.10 of additional R&D spending per revenue dollar forgone by the U.S. Treasury in the post-OBRA89 period. Early studies that focus on the effect of the credit after its introduction in 1981 report spending effects in the range of $0.40 to $1.74. Hall and van Reenan (2000) ultimately conclude that the pre-OBRA89 R&D credit produces roughly a dollar-for-dollar increase in R&D spending. However, Hall (1993) estimated that anywhere from 17 to 30 percent of the firms faced negative effective credit rates under the moving average base, and that percentage likely fell to zero after OBRA89. Further, Hall and van Reenan's (2000) simulation results show that the large heterogeneity among firms' effective credit rates narrowed considerably after OBRA89. In addition, the median effective rate of the credit more than doubled to over 10 percent after the structural change from the 4 to 5 percent range pre-OBRA89. Together, these arguments support the larger magnitude effects of the R&D credit we find in this study.

APPENDIX A

Assuming the growth rate of R&D stock as v and the knowledge depletion rate as d, Hall and van Reenan (2000) show that, in a steady state, the level of R&D spending (RD) is related to the level of R&D stock (G) as follows (firm subscripts omitted):

$$
\begin{aligned}
RD_t &= (d+v)G_{t-1} \\
G_t &= \left[\frac{1}{d+v}\right] RD_{t+1} \equiv \varphi RD_{t+1}.
\end{aligned}
\tag{4}
$$

We further assume that the level of previous sales (i.e., $RD_t = k \times S_{t-1}$, where k = R&D intensity) determines the level of current year R&D spending, future sales is a function of current R&D stock (i.e., $S_{t+1} = F(G_t)$), and a firm's production function F is increasing and concave ($F^{'} > 0$ and $F^{''} < 0$, respectively). Therefore, a manager's investment decision at t is to choose the R&D intensity parameter (k) to maximize the firm's future profit (π) at t+1:

$$
\begin{aligned}
\underset{k}{Max}\ \ \pi_{t+1} &\equiv (S_{t+1} \times m - RD_{t+1} - A_{t+1}) \times (1 - \tau_{t+1}) \\
&= [F(G_t) \times m - k \times S_t - A_{t+1}] \times (1 - \tau_{t+1}),
\end{aligned}
\tag{5}
$$

where:

m = gross profit margin (a constant),
A = other operating expenses, and
τ = marginal tax rate.

For further simplicity we assume $A_{t+1} = 0$.

The choice of the R&D intensity parameter (k) in the above optimization problem depends in part upon the structure of the base amount used in computing the R&D credit (i.e., a fixed base or a moving-average base). For example, in a regime with a fixed base R&D credit structure, a significant increase in R&D intensity in period t decreases the marginal tax rate in t+1 $\left(\text{i.e., } \partial\tau_{t+1} / \partial k < 0\right)$. Conversely, in a regime with a moving average base structure, an increase in the current period R&D intensity k either increases the marginal tax rate at t+1 $\left(\text{i.e., } \partial\tau_{t+1} / \partial k > 0\right)$ or has a neutral effect $\left(\text{i.e., } \partial\tau_{t+1} / \partial k = 0\right)$.

The first order condition of maximizing equation (5) implies:

$$\left[F'\frac{\partial G_t}{\partial k}m - S_t\right]\times\left(1-\tau_{t+1}\right) \quad = \quad \left[\frac{\partial \tau_{t+1}}{\partial k}\right]\times\left(mS_{t+1} - RD_{t+1}\right). \tag{6}$$

Note, from the assumption of the relationship between R&D spending and the stock of R&D in equation (4) we have

$$G_t \quad = \quad \varphi \times RD_{t+1} = \varphi \times k \times S_t .$$

Thus, equation (6) implies:

$$S_t\left(F'\varphi m - 1\right)\times\left(1-\tau_{t+1}\right) \quad = \quad \left[\frac{\partial \tau_{t+1}}{\partial k}\right]\times\left(mS_{t+1} - RD_{t+1}\right). \tag{7}$$

Let k^* be the optimal R&D intensity resulting from equation (5). Assuming a firm's gross margin exceeds its R&D spending (i.e., $mS_{t+1} - RD_{t+1} > 0$), the value of k^* depends on the sign of $\partial \tau_{t+1} / \partial k$. Denote $\Delta = \partial \tau_{t+1} / \partial k$. The concavity of the production function *F* implies that the optimal R&D intensity $k^*_{\Delta<0} > k^*_{\Delta=0} > k^*_{\Delta>0}$. Therefore, we have the following observations:

Observation 1: *A firm's optimal R&D intensity in a tax regime where the structure of the base amount used in computing the R&D tax credit leads to lower future marginal tax rates* (*i.e.,* $\Delta < 0$) *is greater than the optimal R&D intensity in a tax regime where the structure of the base amount used in computing the R&D tax credit leads to constant* ($\Delta = 0$) *or higher* ($\Delta > 0$) *future marginal tax rates.*

Observation 2: *In a tax regime where the structure of the base amount used in computing the R&D tax credit leads to a lower future marginal tax rate* ($\Delta < 0$), *the induced increases in the R&D intensity of firm one is greater than that of firm two if* $m_1 > m_2$ *or* $v_1 > v_2$ (*i.e.,* $\frac{\partial^2 k^*}{\partial \Delta \partial m} > 0$ and $\frac{\partial^2 k^*}{\partial \Delta \partial v} > 0$).

<u>Proof</u>: A concave production function (F) implies Observation 1 and 2 automatically.

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Table 1
Sample Selection and Sample Firms' Profile

Panel A: Sample selection procedures and sample distribution by year

Sample Selection Procedures

	Firms	Firm-Yrs
Compustat observations with one year of credit qualification during 1981-94	2,054	17,270
Less: Observations missing data on other variables	(139)	(2,086)
Less: Extreme 1% of regression variables	(38)	(940)
Final Sample:	1,877	14,244

Sample Distribution by Year

Year	Firm-Yrs	Year	Firm Yrs
1981	896	1988	1064
1982	934	1989	1053
1983	1010	1990	1021
1984	1023	1991	1003
1985	1092	1992	1009
1986	1062	1993	1023
1987	1044	1994	1010
Total Firm-Years:			14,244

Panel B: Sample firms' descriptive statistics

Variable	Compustat Item #	Mean	25th Percentile	Median	75th Percentile
R&D Expense	46	31.2467	0.8730	3.3635	14.4400
Sales	12	855.3445	29.4325	110.8870	476.0860
Sales Growth	(12/lag12) – 1	0.1621	-0.0163	0.0823	0.2004
R&D Intensity	46/12	0.0525	0.0129	0.0325	0.0720
Profitability	170/12	0.0471	0.0118	0.0614	0.1115
Size	Log(6)	4.6848	3.2262	4.4989	5.9365
Marginal Tax Rate	N/A	0.2504	0.0035	0.3400	0.4215

Panel C: Sample firms' industry composition

Industry Membership[1]	Firm-Yrs	% of Firm-Yrs	R&D Intensity
Mining and Construction	77	0.54	0.0203
Food	293	2.06	0.0065
Textiles, Printing, and Publishing	819	5.75	0.0134
Chemicals	886	6.22	0.0287
Pharmaceuticals	592	4.16	0.1026
Extractive Industries	207	1.45	0.0143
Durable Manufacturers	6,038	42.39	0.0422
Computers	2,981	20.93	0.0911
Transportation	53	0.37	0.0310
Utilities	42	0.29	0.0201
Retail	270	1.90	0.0159
Financial Institutions	49	0.34	0.0902
Insurance, and Real Estate	30	0.21	0.0332
Personal Services	159	1.12	0.0256
Professional Services	155	1.09	0.0472
Other	1,593	11.18	0.0596
Total	14,244	100.00	0.0525

[1] We define industries according to the following four-digit SIC Codes (in parentheses): Mining and Construction (1000-1999, excluding 1300-1399); Food (2000-2111); Textiles, Printing, and Publishing (2200-2796); Chemicals (2800-2824, 2840-2899); Pharmaceuticals (2830-2836); Extractive Industries (1300-1399, 2900-2999); Durable Manufacturers (3000-3999, excluding 3570-3579 and 3670-3679); Computers (3570-3579, 3670-3679, and 7370-7379); Transportation (4000-4899); Utilities (4900-4999); Retail (5000-5999); Financial Institutions (6000-6411); Insurance and Real Estate (6500-6999); Personal Services (7000-7999, excluding 7370-7379); Professional Services (8011-8999).

Table 2

Descriptive Statistics for the Components of the R&D Credit, 1981-94

		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
	n	749	763	799	809	844	758	719	779	824	733	666	643	653	675
Panel A: Assuming QRE = 50% of Book R&D Expense															
FBP	*Mean*										0.029	0.028	0.028	0.028	0.027
	Std. Dev.										0.028	0.026	0.026	0.026	0.024
	Median										0.022	0.023	0.023	0.025	0.026
BASE	*Mean*	9.719	10.288	9.997	10.991	11.242	12.395	13.207	14.120	14.070	15.780	17.529	18.491	18.011	17.435
	Std. Dev.	29.578	30.171	31.234	34.041	34.683	38.698	43.090	48.043	49.898	54.783	62.791	68.059	63.159	56.812
	Median	1.131	1.075	1.036	1.218	1.396	1.468	1.619	1.444	1.349	1.803	1.876	2.094	2.456	2.632
EXCESS	*Mean*	1.903	2.576	3.118	3.357	3.165	3.794	4.095	4.297	4.377	6.183	6.700	7.696	7.634	8.200
	Std. Dev.	5.473	7.748	9.555	10.373	9.999	12.973	13.727	15.082	16.758	22.515	23.530	27.234	26.553	28.959
	Median	0.250	0.353	0.424	0.489	0.569	0.493	0.508	0.450	0.463	0.596	0.621	0.890	0.979	1.285
CREDIT	*Mean*	0.476	0.644	0.779	0.839	0.791	0.759	0.819	0.859	0.875	1.237	1.340	1.539	1.527	1.640
	Std. Dev.	1.368	1.937	2.389	2.5934	2.500	2.595	2.745	3.016	3.352	4.503	4.706	5.447	5.311	5.792
	Median	0.063	0.088	0.106	0.122	0.142	0.099	0.102	0.090	0.093	0.119	0.124	0.178	0.196	0.257
Panel B: Assuming QRE = 73% of Book R&D Expense															
FBP	*Mean*										0.041	0.039	0.039	0.038	0.035
	Std. Dev.										0.037	0.035	0.035	0.033	0.031
	Median										0.030	0.030	0.030	0.030	0.030
BASE	*Mean*	14.191	15.021	14.596	16.046	16.413	18.097	19.282	20.616	20.543	25.021	25.565	26.947	26.229	25.253
	Std. Dev.	43.184	44.050	45.602	49.700	50.637	56.498	62.911	70.143	72.851	79.983	91.677	99.370	92.214	82.768
	Median	1.651	1.570	1.513	1.779	2.039	2.143	2.364	2.109	1.969	2.632	2.674	2.884	3.523	3.812
EXCESS	*Mean*	2.779	3.761	4.551	4.901	4.620	5.540	5.978	6.274	6.391	9.044	9.811	11.287	11.213	12.174
	Std. Dev.	7.991	11.312	13.950	15.145	14.598	18.940	20.041	22.020	24.467	32.878	34.357	39.766	38.776	42.399
	Median	0.365	0.515	0.619	0.713	0.831	0.720	0.742	0.657	0.676	0.911	0.913	1.329	1.489	1.935
CREDIT	*Mean*	0.694	0.940	1.138	1.225	1.155	1.108	1.196	1.254	1.278	1.809	1.962	2.257	2.243	2.435
	Std. Dev.	1.998	2.828	3.486	3.786	3.650	3.788	4.008	4.404	4.893	6.576	6.871	7.953	7.755	8.480
	Median	0.091	0.129	0.155	0.155	0.207	0.144	0.148	0.131	0.135	0.182	0.183	0.266	0.298	0.387

[1] We define variables as follows: *FBP* = a firm's fixed base percentage under the post-OBRA89 regime. It is computed as the maximum of 16% or the sum of a firm's qualified research expenses from 1984-1988 divided by the sum of a firm's gross receipts from 1984-1988. We assign start-up firms a fixed base percentage of 3%. *BASE* = a firm's base amount of R&D expenses. For 1981-1989, computed as the greater of a firm's average annual qualified research expenses for the three preceding tax years or 50% of the current year's qualified research expense. For 1990-1994, computed as the greater of a firm's fixed base percentage multiplied by a firm's average annual gross receipts for the four preceding tax years or 50% of the current year's qualified research expense. *EXCESS* = a firm's incremental R&D spending for year *t*. Computed as a firm's qualified research expense less its base amount. *CREDIT* = a firm's R&D credit for year *t*. For 1981-1985, computed as 25% of a firm's incremental qualified R&D expense in year *t*. For 1986-1994, computed as 20% of a firm's incremental qualified R&D expense in year *t*.

Table 3

R&D Tax Credit Eligibility and Qualification[1]

Panel A: R&D tax credit eligibility and qualification – by period

Period	Eligible Firm-Yrs	Eligible %	Not-Eligible Firm-Yrs	Not-Eligible %	Qualified Firm-Yrs	Qualified %	Not-Qualified Firm-Yrs	Not-Qualified %
Pre-OBRA89 (1981-89)	7,018	76.47	2,160	23.53	5,099	72.66	1,919	27.34
Post-OBRA89 (1990-94)	3,396	67.04	1,670	32.96	2,657	78.24	739	21.76
All Firms (1981-94)	10,414		3,830		7,756		2,658	
	$\hat{\theta}$ = 0.6259†				$\hat{\theta}$ = 1.3531†			

Panel B: R&D tax credit eligibility and qualification – by period and industry

Period and Industry	Eligible Firm-Yrs	Eligible %	Not-Eligible Firm-Yrs	Not-Eligible %	Qualified Firm-Yrs	Qualified %	Not-Qualified Firm-Yrs	Not-Qualified %
Pre-OBRA89 ***(1981-89)***								
Other Industries	4,847	74.82	1,631	25.18	3,625	74.79	1,222	25.21
High-Tech[2]	2,171	80.41	529	19.59	1,474	67.89	697	32.11
All Firms (1981-89)	7,018		2,160		5,099		1,919	
	$\hat{\theta}$ = 1.3810†				$\hat{\theta}$ = 0.7129†			
Post-OBRA89 ***(1990-94)***								
Other Industries	2,037	63.03	1,195	36.97	1,621	79.58	416	20.42
High-Tech	1,359	74.10	475	25.90	1,036	76.23	323	23.77
All Firms (1990-94)	3,396		1,670		2,657		739	
All Firms (1981-94)	10,414		3,830		7,756		2,658	
	$\hat{\theta}$ = 1.6784†				$\hat{\theta}$ = 0.8231†			
	χ^2_{BD} = 5.8170†				χ^2_{BD} = 2.0096			

[1] This table presents descriptive statistics and univariate tests of differences in firm eligibility and qualification for the R&D tax credit by period and industry membership. We define eligibility and qualification for the R&D tax credit as follows: *Eligible* = Implies that the firm's spending on R&D satisfies the threshold defined by the tax laws for claiming the R&D tax credit. *Qualified* = Implies that the firm meets the eligibility requirements and that the firm's tax status allows it to claim the benefit of the tax credit. We consider a firm "qualified" if its *Marginal Tax Rate* > 0 and its total tax liability for the current and prior three years exceeds zero (Berger 1993; Graham 1996a; Mills, Newberry, and Novack 2003).

[2] We designate a firm as high-tech if it is in any one of the following four-digit SIC codes: 2833-2836, 3570-3577, 3600-3674, 7371-7379, and 8731-8734 (Kasznik and Lev 1995).

$\hat{\theta}$ = the sample odds ratio, defined as $\hat{\theta} = n_{11}n_{22}/n_{21}n_{12}$, where n equals the frequency in each cell. χ^2_{BD} = the Breslow-Day chi-square statistic. The symbol † denotes significance at the 0.05 (two-tail) level.

Table 4

R&D Tax Credit Eligibility and Qualification for Alternative Samples

Panel A: R&D tax credit eligibility and qualification – by period

	Alternative Samples[2]		
Period	*FULL* n = 10,414	*BP14* n = 5,110	*END94* n = 9,795
Eligibility (Pre-OBRA89 vs. Post-OBRA89)	0.6259†	0.4959†	0.5648†
Qualification (Pre-OBRA89 vs. Post-OBRA89)	1.3531†	1.4596†	1.3558†

Panel B: R&D tax credit eligibility and qualification – by period and industry

	Alternative Samples		
Period and Industry	*FULL* n = 10,414	*BP14* n = 5,110	*END94* n = 9,795
*Eligibility (Pre-*OBRA89 *vs. Post-*OBRA89*)*			
Pre-OBRA89 (High-Tech[3] vs. Other)	1.3810†	1.0878	1.2969†
Post-OBRA89 (High-Tech vs. Other)	1.6784†	0.9436	1.7545†
Pre-OBRA89 vs. Post-OBRA89 (χ^2_{BD})	5.8170†	0.8259	8.6757†
*Qualification (Pre-*OBRA89 *vs. Post-*OBRA89*)*			
Pre-OBRA89 (High-Tech vs. Other)	0.7129†	0.7148†	0.6950†
Post-OBRA89 (High-Tech vs. Other)	0.8231†	0.7113†	0.8161†
Pre-OBRA89 vs. Post-OBRA89 (χ^2_{BD})	2.0096	0.0005	1.8206

[1] This table presents sample odds ratios of the likelihood of firms' R&D tax credit eligibility and qualification for alternative samples. We define eligibility and qualification for the R&D tax credit as follows: *Eligible* = Implies that the firm's spending on R&D satisfies the threshold defined by the tax laws for claiming the R&D tax credit. *Qualified* = Implies that the firm meets the eligibility requirements and that the firm's tax status allows it to claim the benefit of the tax credit. We consider a firm "qualified" if its *Marginal Tax Rate* > 0 and its total tax liability for the current and prior three years exceeds zero (Berger 1993; Graham 1996a; Mills, Newberry, and Novack 2003).

[2] We define the samples as follows: *FULL* = The original unbalanced sample used in the main analysis of the paper. *BP14* = a balanced panel that includes all firms present in our sample for the entire 14 year period (1981-1994). *END94* = all firms in our sample during the final year of our sample period (1994), back to their earliest year of inclusion in the *Compustat* database.

[3] We designate a firm as high-tech if it is in any one of the following four-digit SIC codes: 2833-2836, 3570-3577, 3600-3674, 7371-7379, and 8731-8734 (Kasznik and Lev 1995).

$\hat{\theta}$ = the sample odds ratio, defined as $\hat{\theta} = n_{11}n_{22}/n_{21}n_{12}$, where n equals the frequency in each cell. χ^2_{BD} = the Breslow-Day chi-square statistic. The symbol † denotes significance at the 0.05 (two-tail) level.

Table 5

R&D Tax Credit Eligibility and Qualification over Alternative Periods[1]

Panel A: R&D tax credit eligibility and qualification – by period

Period	Alternative Periods[2] *ERTA|TRA* n = 9,178	*ERTA|OBRA* n = 7,350	*TRA|OBRA* n = 6,460
Eligibility (*PRE|POST*)	0.6693†	0.5148†	0.7692†
Qualification (*PRE|POST*)	0.9995	1.3528†	1.3535†

Panel B: R&D tax credit eligibility and qualification – by period and industry

Period and Industry	Alternative Periods *ERTA|TRA* n = 9,178	*ERTA|OBRA* n = 7,350	*TRA|OBRA* n = 6,460
***Eligibility* (*Pre vs. Post*)**			
Pre (High-Tech[3] vs. Other)	1.9840†	1.9840†	1.1375
Post (High-Tech vs. Other)	1.1375	1.6784†	1.6784†
Pre vs. Post (χ^2_{BD})	22.4869†	2.2332	15.7155†
***Qualification* (*Pre vs. Post*)**			
Pre (High-Tech vs. Other)	0.7600†	0.7600†	0.6592†
Post (High-Tech vs. Other)	0.6592†	0.8231†	0.8231†
Pre vs. Post (χ^2_{BD})	1.5568	0.4886	3.4968

[1] This table presents sample odds ratios that provide evidence regarding the likelihood of R&D tax credit eligibility and qualification over alternative periods. We define eligibility and qualification for the R&D tax credit as follows: *Eligible* = Implies that the firm's spending on R&D satisfies the threshold defined by the tax laws for claiming the R&D tax credit. *Qualified* = Implies that the firm meets the eligibility requirements and that the firm's tax status allows it to claim the benefit of the tax credit. We consider a firm "qualified" if its *Marginal Tax Rate* > 0 and its total tax liability for the current and prior three years exceeds zero (Berger 1993; Graham 1996a; Mills, Newberry, and Novack 2003).

[2] We define the periods as follows: *ERTA* = The Economic Recovery Tax Act of 1981 (1981-1985). *TRA* = The Tax Reform Act of 1986 (1986-1989). *OBRA* = The Omnibus Reconciliation Act of 1989 (1990-1994)

[3] We designate a firm as high-tech if it is in any one of the following four-digit SIC codes: 2833-2836, 3570-3577, 3600-3674, 7371-7379, and 8731-8734 (Kasznik and Lev 1995).

χ^2_{BD} = the Breslow-Day chi-square statistic. The symbol † denotes significance at the 0.05 (two-tail) level.

Table 6

Descriptive Statistics on the Magnitude of Firms' R&D Intensity[1]

Panel A: Mean R&D Intensity by Eligibility and Firm Characteristics

Variable	*Quartile*	*Eligible* Pre-OBRA89 (1981-89)	*Eligible* Post-OBRA89 (1990-94)	*Non-Eligible* Pre-OBRA89 (1981-89)	*Non-Eligible* Post-OBRA89 (1990-94)
Sales	*Q1 (Low)*	0.076	0.107	0.050	0.056
	Q2	0.051	0.080	0.034	0.034
	Q3	0.043	0.069	0.028	0.034
	Q4 (High)	0.034	0.047	0.019	0.026
Sales Growth	*Q1 (Low)*	0.056	0.083	0.041	0.047
	Q2	0.045	0.057	0.030	0.035
	Q3	0.045	0.070	0.029	0.033
	Q4 (High)	0.059	0.092	0.031	0.035
Profitability	*Q1 (Low)*	0.071	0.114	0.051	0.051
	Q2	0.039	0.052	0.028	0.032
	Q3	0.040	0.056	0.025	0.034
	Q4 (High)	0.054	0.080	0.026	0.032
Size	*Q1 (Low)*	0.068	0.093	0.045	0.052
	Q2	0.053	0.086	0.033	0.037
	Q3	0.046	0.071	0.032	0.033
	Q4 (High)	0.037	0.051	0.021	0.027
MTR_{t-1}	*Q1 (Low)*	0.070	0.103	0.042	0.046
	Q2	0.049	0.074	0.039	0.040
	Q3	0.043	0.061	0.027	0.034
	Q4 (High)	0.043	0.071	0.020	0.029

Panel B: R&D Intensity of Eligible Firms by Industry Groups

	Quartiles							
	Q1		*Q2*		*Q3*		*Q4*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
High Tech (1981-89)	0.022	0.010	0.052	0.009	0.085	0.011	0.168	0.093
High Tech (1990-94)	0.033	0.014	0.076	0.012	0.118	0.012	0.230	0.145
Other Industries (1981-89)	0.006	0.003	0.016	0.004	0.034	0.008	0.092	0.048
Other Industries (1990-94)	0.008	0.004	0.023	0.005	0.048	0.010	0.119	0.058

	t-statistics			
	Q1	*Q2*	*Q3*	*Q4*
High Tech (Pre vs. Post)	8.379	22.425	34.934	6.997
Other Industries (Pre v. Post)	9.755	20.699	21.049	9.585

[1] This table presents descriptive statistics on the magnitude of firms' R&D intensity before and after the "structural change" of the R&D tax credit. Eligible firms are those firms whose spending on R&D satisfies the threshold defined by the tax laws for claiming the R&D tax credit. Panel A presents R&D intensities before and after the structural change for various firm characteristics of firms that are eligible/not eligible for the R&D tax credit. Panel B presents R&D intensities before and after the structural change for eligible firms in High-Tech and other industries. We designate a firm as high-tech if it is in any one of the following four-digit SIC codes: 2833-2836, 3570-3577, 3600-3674, 7371-7379, and 8731-8734 (Kasznik and Lev 1995).

Table 7

Fixed-Effects Regression Results of the Effect of OBRA89 on R&D Intensity of Eligible Firms[1]

$$RDI_{it} = \alpha_0 + \delta_1 GDP_{it} + \delta_2 IRD_{it} + \gamma_1 RDI_{it-1} + \gamma_2 FUND_{it} + \gamma_3 LDTA_{it} + \gamma_4 Q_{it} + \gamma_5 SIZE_{it} + \phi_1 MTR_{it-1} + \phi_2 OBRA_t + \phi_3 (OBRA_t \times TECH_{it}) + \mu_i + \zeta_{it} \quad (8)$$

	Variables		*Qualified Firms*	*Non-Qualified Firms*
Non-Tax Factors	GDP_t	+	0.0000 (0.000)	0.0000 (0.000)
	IRD_t	+	0.1266 (0.000)	0.4079 (0.000)
	RDI_{t-1}	+	0.2716 (0.000)	0.2306 (0.000)
	$FUND_t$	+	0.0745 (0.000)	-0.0872 (0.000)
	$LTDA_t$	--	0.0061 (0.037)	0.0097 (0.259)
	Q_t	?	-0.0044 (0.000)	-0.0002 (0.881)
	$SIZE_t$	?	-0.0014 (0.057)	-0.0042 (0.088)
Tax Factors	MTR_{t-1}	+	0.0080 (0.000)	0.0171 (0.001)
	$OBRA_t$	+	0.0015 (0.051)	-0.0024 (0.500)
	$OBRA_t$*$TECH_t$	+	0.0071 (0.000)	0.0026 (0.604)
		R^2	0.7987	0.5939
		n	7,756	2,658

[1] This table presents results of fixed effects panel data regressions (coefficient estimates in the first row and p-values of related t-statistics in the parentheses in the second row) that evaluate the effect of tax and non-tax factors on individual firm R&D spending in the presence of *"structural changes"* to the tax code. The sample consists of all firms eligible for the R&D tax credit (i.e., current year qualified R&D expenditures exceed the statutory base amount), and we estimate the model separately for firms that qualified/did not qualify for the credit. We consider a firm "qualified" if its *MTR* > 0 and its total tax liability for the current and prior three years exceeds zero (Berger 1993; Graham 1996a; Mills, Newberry, and Novack 2003).

[2] We define the variables as follows (we omit firm subscripts): RDI_t = R&D intensity, defined as: R&D Expense/Sales; GDP_t = gross domestic product; IRD_t = industry R&D intensity, measured as the average R&D intensity of all firms in firm *i's* four-digit SIC code; RDI_{t-1} = lagged R&D intensity; $FUND_t$ = internal funds (a proxy for a firm's pre-R&D cash flow), measured as (income before extraordinary items + depreciation + R&D expense) ÷ sales; $LTDA_t$ = long-term debt to assets; Q_t = Tobin's *q*, measured as [(price × common shares outstanding) + book value of preferred stock + long-term debt + short-term debt] ÷ total assets;. $SIZE_t$ = Log(total assets); MTR_{t-1} = lagged marginal tax rate (Graham 1996a, 1996b; Graham, Lemmon, Schallheim 1998); $OBRA_t$ = a dummy variable set to one for years t > 1989 (i.e., years after the *"structural change"* of the R&D tax credit provision); $OBRA_t$*$TECH_t$ = the interaction of *OBRA* and a dummy variable set to one for firms in following high-tech, four-digit SIC categories: 2833-2836, 3570-3577, 3600-3674, 7371-7379, and 8731-8734 (Kasznik and Lev 1995).

Table 8

Fixed-Effects Regression Results of the Effect of OBRA89 on the R&D Intensity of Eligible Firms, by Foreign Tax Credit (FTC) Status[1]

$$RDI_{it} = \alpha_0 + \delta_1 GDP_{it} + \delta_2 IRD_{it} + \gamma_1 RDI_{it-1} + \gamma_2 FUND_{it} + \gamma_3 LDTA_{it} + \gamma_4 Q_{it} + \gamma_5 SIZE_{it} + \phi_1 MTR_{it-1} + \phi_2 OBRA_t + \phi_3 (OBRA_t \times TECH_{it}) + \mu_i + \zeta_{it} \quad (8)$$

	Variables		***Qualified Firms***		***Non-Qualified Firms***	
			Excess FTC = 1	Excess FTC = 0	Excess FTC = 1	Excess FTC = 0
Non-Tax Factors	GDP_t	+	0.0000 (0.008)	0.0000 (0.000)	0.0000 (0.101)	0.0000 (0.008)
	IRD_t	+	0.0707 (0.003)	0.1237 (0.000)	0.2043 (0.370)	0.4542 (0.000)
	RDI_{t-1}	+	0.4218 (0.000)	0.2544 (0.000)	0.4480 (0.001)	0.2288 (0.000)
	$FUND_t$	+	0.0439 (0.000)	0.0795 (0.000)	-0.1607 (0.001)	-0.0866 (0.000)
	$LTDA_t$	--	-0.0050 (0.349)	0.0077 (0.027)	0.0357 (0.311)	0.0123 (0.172)
	Q_t	?	-0.0035 (0.000)	-0.0045 (0.000)	-0.0008 (0.933)	0.0008 (0.559)
	$SIZE_t$	?	-0.0017 (0.266)	-0.0014 (0.120)	-0.0079 (0.496)	-0.0036 (0.165)
Tax Factors	MTR_{t-1}	+	0.0063 (0.085)	0.0079 (0.001)	0.0028 (0.906)	0.0172 (0.002)
	$OBRA_t$	+	0.0007 (0.459)	0.0017 (0.083)	-0.0035 (0.720)	-0.0013 (0.733)
	$OBRA_t{*}TECH_t$	+	0.0035 (0.035)	0.0070 (0.000)	-0.0860 (0.001)	0.0051 (0.342)
		R^2	0.9053	0.7840	0.3753	0.5955
		n	1,265	1,923	188	622

[1] This table presents results of fixed effects panel data regressions (coefficient estimates in the first row and p-values of related t-statistics in the parentheses in the second row) that evaluate the effect of tax and non-tax factors on individual firm R&D spending in the presence of *"structural changes"* to the tax code. The sample consists of all firms eligible for the R&D tax credit (i.e., current year qualified R&D expenditures exceed the statutory base amount), and we estimate the model separately for firms that qualified/did not qualify for the credit. We consider a firm "qualified" if its *MTR* > 0 and its total tax liability for the current and prior three years exceeds zero (Berger 1993; Graham 1996a; Mills, Newberry, and Novack 2003). Firms in an excess FTC position (Excess FTC = 1) have a foreign tax rate (defined as current foreign tax expense divided by foreign pretax income) that is greater than the U.S. statutory tax rate in any given year.

[2] We define the variables as follows (we omit firm subscripts): RDI_t = R&D intensity, defined as: R&D Expense/Sales; GDP_t = gross domestic product; IRD_t = industry R&D intensity, measured as the average R&D intensity of all firms in firm *i's* four-digit SIC code; RDI_{t-1} = lagged R&D intensity; $FUND_t$ = internal funds (a proxy for a firm's pre-R&D cash flow), measured as (income before extraordinary items + depreciation + R&D expense) ÷ sales; $LTDA_t$ = long-term debt to assets; Q_t = Tobin's *q*, measured as [(price × common shares outstanding) + book value of preferred stock + long-term debt + short-term debt] ÷ total assets;. $SIZE_t$ = Log(total assets); MTR_{t-1} = lagged marginal tax rate (Graham 1996a, 1996b; Graham, Lemmon, Schallheim 1998); $OBRA_t$ = a dummy variable set to one for years t > 1989 (i.e., years after the *"structural change"* of the R&D tax credit provision); $OBRA_t{*}TECH_t$ = the interaction of *OBRA* and a dummy variable set to one for firms in following high-tech, four-digit SIC categories: 2833-2836, 3570-3577, 3600-3674, 7371-7379, and 8731-8734 (Kasznik and Lev 1995).

Table 9

Estimates of Additional R&D Intensity Generated Per Dollar of Post-OBRA89 R&D Tax Credit[1]

IRS Statistics of Income Data

Year	Qualified R&D	R&D Credits
1994	50,675,058	2,422,682
1993	38,932,629	1,856,501
1992	38,347,807	1,515,413
1991	33,927,346†	1,547,279
1990	33,128,467†	1,547,279
1989	28,707,759†	1,340,808
1988	27,339,974†	1,276,925
1987	22,552,864†	1,053,341
1986	27,662,998†	1,292,012
1985	34,856,703	1,627,997
1984	31,464,690	1,589,048
1983	28,720,627	1,277,474
1982	26,433,065	839,220
1981	13,543,182	639,302

		Qualified Firms
		n = 7,756
1.	Median Pre-OBRA89 R&D Intensity	0.0348
2.	Average Increase in R&D Intensity, 1990-1994	0.0037
3.	% Increase in R&D Intensity Post-OBRA89	0.1063
4.	Average Qualified R&D Expenditures, 1990-1994	39.0023
5.	R&D Intensity Absent the Credit	35.2546
6.	Credit Induced R&D Intensity	3.7476
7.	Average Cost of the R&D Credit, 1990-1994	1.7853
8.	Additional R&D Intensity per Revenue Dollar Foregone	$2.0992

[1] This table presents estimates of additional R&D spending generated per dollar of R&D tax credit claimed during the Post-OBRA89 period (1990-1994). We obtain median Pre-OBRA89 R&D intensity (Line 1) from untabulated descriptive statistics. We obtain the average increase in R&D spending amounts (Line 2) from the OBRA coefficient of equation 8 after excluding the *OBRA*TECH* interaction (untabulated). We obtain average qualified R&D expenditures (Line 4) and the average cost of the R&D credit (Line 7) from the IRS Statistics of Income data reported in the left side of the table. We compute R&D intensity absent the credit (Line 5) as (Line 4 ÷ (1 + Line 3)).

† The data for qualified R&D from 1986-1991is missing. We estimate the missing qualified R&D expenses using the percentage change in R&D credits. For example, 1986 QRE = 34,856,703 * [1 + ((1,292,012/1,627,997) – 1)] = 27,662,998.