R&D Spending Fools? An Analysis of the R&D Credit's Incentive Effects after the Omnibus Budget Reconciliation Act of 1989*

Sanjay Gupta,* Yuhchang Hwang, Andrew Schmidt

W.P. Carey School of Business, School of Accountancy, Arizona State University, Tempe, AZ 85287-3606, USA

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 impact 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 11.0 (5.4) percent from 1986-1989 to 1990-1994, producing credit induced additional spending by high-tech (other) firms of $3.54 ($1.68) per revenue-dollar forgone. Overall this translates into an estimate of $2.40 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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* Corresponding author: Email: Sanjay.Gupta@ASU.edu; Tel: 480-965-6618; Fax: 480-965-8392.

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Abstract

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1.0. Introduction

Motivation for providing a tax subsidy for research and development (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. Validating this argument is empirical evidence consistently showing social rates of return to R&D exceeding the private return (see Grilliches 1992). Thus it is not surprising that a tax credit for R&D has enjoyed bipartisan support in the U.S. Congress. Despite this support, however, policymakers remain unsure about the credit's incentive effects resulting in repeated tinkering with its design that, in turn, has affected the cost of performing R&D for different companies at different times. Further reflecting this uncertainty, the R&D credit remains a temporary provision after more than two decades following its original enactment.[1] An extreme view of policymakers' uncertainty regarding the credit's incentive effect is probably best reflected in 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."[2]

Notwithstanding the uncertainty and skepticism about the credit's incentive effects, a summary of the empirical evidence based on firm-level publicly-reported data suggests, albeit imperfectly, that the R&D credit produces roughly a dollar-for-dollar increase in reported R&D spending on the margin (Hall and van Reenan 2000). However, the estimated effects vary widely. Early studies reported almost negligible spending effects (Eisner, Albert and Sullivan 1984; Altshuler 1988), some studies put the figure around $0.40 (U.S. GAO 1989; Tillinger 1991), others at $1.74 (Berger 1993), whereas recent evidence documents the credit-induced spending at $2.96 per dollar of revenue forgone (Klassen, Pittman and Reed 2003). This wide range of estimates provides little comfort to the policy debate and begs for reconciliation. Hall and van Reenan (2000) cite changes in the credit's design that result in firms facing "very heterogenous prices" (p. 467) as providing a useful source of variation to identify the credit's incentive effects, but that few studies have exploited this opportunity.

The Omnibus Budget Reconciliation Act of 1989 (OBRA89) made one of the most significant changes in the R&D credit's design by altering the definition of the base used for calculating the credit. 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.[3] When the credit was originally enacted, this base amount was computed as the average spending for R&D in the three tax years before the year for which the credit was sought (referred to as the "moving average method"). This structure was heavily criticized because the credit's marginal incentive effect provided in the first year was largely offset in the following three years, which led some to question the "logic of retaining the credit in its present form" (Altshuler 1988). In response to the criticism, OBRA89 substituted the moving average base method with a fixed-base percentage equal to the ratio of a firm's research expenses to its gross receipts for the period 1984-88.[4]

A 1993 Congressional Research Service report noted that the structural changes enacted under OBRA89 likely increased the credit's incentive effect "substantially" and may have increased the credit's impact "beyond what is shown by the existing data" (Brumbaugh 1993). Similarly, the U.S. GAO (1996) noted that "[t]he current version of the credit has not been studied … and little is known about the actual incentives provided by the current credit." Based on a calculation of the effective credit rate under the two different structures, Hall and van Reenan (2000) conclude that the base redefinition likely had a greater effect than even the introduction of the credit. However, no study we are aware of has examined if the changes in computing the base amount actually increased the R&D credit's impact or incentive effect. Prior studies typically use data either before OBRA89 (e.g., Eisner et al. 1984; Altshuler 1988; Swenson 1992; Berger 1993) or after OBRA89 (e.g., Klassen et al. 2003), but not both periods and thereby fail to exploit an important source of exogenous variation in firms' incentives.[5] Finally, practitioners continue to exhort that greater attention should be paid to the structure of the R&D credit because under it the credit "is not simple, certain, fair, or available to many businesses" (Grigsby and Westmoreland 2001).

In this study, we examine two related questions. First, we examine whether the OBRA89 change in the R&D credit's structure affected firms' eligibility for the credit. Second, we examine the incentive effect of the R&D credit for firms that qualified for the credit under the new structure enacted by OBRA89.[6]

Using firm-specific data spanning the entire 14-year life of the credit prior to its first discontinuity in 1995, we find that overall firm eligibility for the credit declined after OBRA89, but firms belonging to high-tech industries are more likely to be eligible for the credit. We also find that eligible high-tech firms are more likely to be qualified to use the credit after OBRA89, although the increase is marginally significant when comparisons are made to qualified high-tech firms prior to OBRA89.

Estimates from fixed-effects regressions that control for various non-tax factors known to affect R&D spending indicate that the median R&D intensity increased by approximately 11.0 (5.4) percent from 1986-1989 to 1990-1994 for high-tech (other) firms that qualified for the credit. These estimates further imply that the R&D tax credit induced \$3.54 (\$1.68) of additional spending by high-tech (other) 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 period and obtaining data directly from tax footnotes on the actual amount of the R&D credit. These tests, which evaluate potential concerns with the use of financial statement data, reinforce our main findings and support our assumptions used in determining firms' eligibility and qualification for the credit.

The paper proceeds as follows: Section 2 discusses the legislative history of the credit during our sample period, 1981-1994. Section 3 outlines the hypotheses development, which is followed in section 4 by a description of the empirical procedures and sample used to test our predictions. Section 5 contains the results from our univariate and multivariate tests, as well as supplemental analysis, and section 6 concludes.

2.0. Tax Incentives for Research & Development

2.1 Overview

In the U.S., tax incentives for R&D are provided to business at both the federal and state levels. There are two federal level subsidies for R&D. First, section 174 of the Internal Revenue Code provides an immediate deduction for most "research and experimentation" expenditures.[7] 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.[8] At the state-level, several U.S. states provide an additional tax credit for research conducted within the state.

While in this study we are interested in only the incentive effects of the federal R&D credit, both the immediate deductibility of R&D expenditures and the state-level R&D credit have implications for our research design and we address them later.

2.2. The R&D Credit – A Brief Legislative History

The R&D credit was first enacted as a temporary provision in the Economic Recovery Tax Act of 1981. 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 amount. This base was defined as the greater of: (1) average QRE in the three previous tax years or (2) 50% of the current year's QRE, as follows:

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

The credit was nonrefundable, with the excess allowed to be carried back three years and forward 15 years.

Congress made the first significant changes in the credit with the Tax Reform Act of 1986 (TRA86), which extended the credit through December 31, 1988 and also modified it in three ways. First, the credit rate was lowered from 25% to 20%. Second, the definition of QRE was narrowed to cover only activities directed at generating new technical information useful in developing new commercial products or processes. Further, expenditures relating to internal-use software had to satisfy additional requirements. Finally, a separate credit was established for basic research conducted by universities for corporations. The Technical and Miscellaneous Revenue Act of 1988 (TAMRA) extended the credit through December 31, 1989, but further reduced the effective rate of the credit by decreasing the deduction allowed under section 174 for QRE by 50% of the R&D credit claimed in the same year.

OBRA89 made the next significant change in the R&D credit. Unlike previous changes that essentially altered the effective rate of the credit, OBRA89 was the first time that Congress altered the credit's structure by revising the method for calculating a firm's base amount. This change, which is the focus of our study, is discussed in greater detail below. OBRA89 also made research related to lines of business a firm wanted to enter eligible for the credit; previously, the credit applied only to research related to a firm's current lines of business. Lastly, OBRA89 further reduced the amount of QRE that could be expensed from 50 percent of the R&D credit claimed to 100 percent.

Subsequent to the OBRA89, changes in the credit have related mostly to its extension from the previous expiration date such that the credit has been 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. Although the temporary nature of the credit is also an important policy issue as evidenced by numerous attempts to make it permanent, it is beyond this study's scope.[9]

3.0. The Structural Change in the R&D Credit under OBRA89

3.1. Overview

As equation (1) shows, the credit as originally enacted applied only to increases in a firm's R&D spending over its average R&D spending during the previous three years. This moving average base for calculating the credit was criticized 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 experienced a zero effective tax credit (except for discounting), and rapidly growing firms possibly faced large negative credit rates (Hall 1993). Consequently, firms were encouraged to decrease their second and third years' R&D expenditures so as to maximize the credit in the fourth year.

In response to this criticism, 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. The base amount was then determined by multiplying a firm's average gross receipts in the previous four years by its fixed-base percentage:

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

Start-up firms were assigned a fixed-base of three percent.[10]

The OBRA89 modification was motivated by the desire to not undercut the credit's incentive effect but instead to enhance it, while at the same time have the base adjustments reflect firm-specific factors other than prior R&D spending. By adjusting each firm's base to its own experience, Congress wanted to make 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:[11]

> *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 be better able to achieve its intended purpose of rewarding taxpayers for research expenses in excess of amounts which they 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 effectively indexing the credit for inflation and preventing taxpayers from being rewarded for purely inflation-induced increases in research spending.

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-pronged focus in this study: (1)

OBRA89's impact on firms' eligibility for the credit, and (2) the post-OBRA89 credit's incentive effect on R&D spending.

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

3.2.1. Eligibility

In the first stage of our analysis, we examine the effects of the OBRA89 change in the structure of the R&D credit on firms' eligibility and qualification for the credit. Given the Congressional objective of making the credit as widely available as possible, we expect the overall eligibility of firms for the credit to increase 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 also examine whether firms with high growth potential were no longer adversely effected by potentially negative effective credit rates due to the moving average base used before the OBRA89 structural change. Hence we expect an increase in the eligibilty of high growth firms relative to other firms. In general, high growth firms are characterized by higher R&D spending but lower sales – characteristics typical of firms in high-tech industries that make large investments in intangible assets to fuel future revenue streams.[12] Hence we operationalize our tests for this question by comparing firms in high-tech industries relative to firms in other industries. This operationalization is also consistent with various Congressional reports indicating that the R&D credit was enacted primarily to benefit high-tech industries.[13]

3.2.2. Qualification

An important feature of the R&D credit (and indeed most other tax credits) is that it 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 tax liability to "qualify" for it. Although from a policy perspective, the design of the R&D credit can only take into consideration firms' eligibility for the credit, taxpayers' benefits are ultimately tied to their qualification. 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.[14]

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

3.3.1. 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 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 1 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, R&D intensity (commonly measured as R&D expense divided by sales) rather than the level of R&D, is often of interest to policymakers. This was made particularly explicit with the OBRA89 change in the credit's structure. The Senate Finance Committee specifically incorporated R&D intensity into the OBRA89 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. Although only a few studies (e.g., Tillinger 1991; Berger 1993) have estimated models of R&D intensity, the theory on how tax policy likely affects R&D intensity is not clear. Hence, we develop a simple analytical model using the basic framework in Hall (1993) and Hall and van Reenan (2000) to generate predictions of how the OBRA89 structural changes might enhance the incentive effects of the R&D credit.

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

$$RD_t = (d+v)G_{t-1}$$

$$G_t = \left(\frac{1}{d+v}\right) RD_{t+1} \equiv \varphi RD_{t+1}. \quad (4)$$

We further assume that the level of current year R&D spending is determined by the level of previous sales (i.e., $RD_{t+1} = k \times S_t$, where k = R&D intensity), 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 (p) at t+1:

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

where:

m = gross profit margin (a constant),
A = other operating expenses, and
t = 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 that:

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

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

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

Thus, equation (6) implies:

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

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.*

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 (i.e., $\Delta < 0$) should positively affect R&D intensity. Since OBRA89's 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. *Ceteris Paribus*, higher R&D tax credits reduce the marginal cost of R&D investments; therefore, firm R&D intensities should increase after OBRA89. Observation 2 predicts that OBRA89's positive impact on R&D intensity is expected to be greater for firms with higher gross profit margins (*m*) or growth rates of R&D stock (*v*), such as firms in high-tech industries.

3.3.2 Empirical Specification

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 are noteworthy. First, given that OBRA89 represents a unique natural experiment, our research design is similar in spirit to other studies that also use such a setting (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 according to their qualification status for the credit. Qualification status is determined 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, to examine the prediction of observation 2, we identify firms belonging to high-tech industries that typically are characterized by high gross profit margins and growth rates of R&D stock.[15] Third, we include firm fixed-effects, which reduces the potential for correlated omitted variables (e.g., knowledge depletion rates).

Based on these research design considerations, we estimate the following regression model:

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

RDI is firm i's R&D intensity, measured as R&D expense ÷ sales, both measured in year *t*,[16] μ_i is the firm fixed-effect, and the explanatory variables are defined as follows (*Compustat* item numbers and coefficient sign predictions in parentheses).

GDP_{it}	=	The year *t* level of real gross domestic product.	(+)
IRD_{it}	=	The year *t* *RDI* of all firms in firm *i*'s four-digit SIC code.	(+)
$RDI_{it\text{-}1}$	=	The year *t* – 1 *RDI*	(+)
$FUND_{it}$	=	The year *t* level of firm *i*'s pre-R&D cash flow, measured as [income before extraordinary items (#18) + R&D expense (#46) + depreciation (#14)] ÷ sales (#12).	(+)
$LTDA_{it}$	=	Debt to assets, 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).	(?)
$MTR_{it\text{-}1}$	=	The year *t*-1 level of firm *i*'s marginal tax rate.	(+)
$OBRA_t$	=	The variable is set to one for the years after OBRA89 (1990-1994), zero otherwise.	(+)
$TECH_{it}$	=	An indicator variable designed to differentiate firms in high-tech industries. The variable is set to 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), zero otherwise (Kasznik and Lev 1995).	(+)

The tax variables included in the model are *MTR*, *OBRA* and *OBRA*TECH*. We do not consider state-level tax credits because of data limitations.[17] 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 observation 1, while a positive and significant estimate of ϕ_3 would be consistent with the prediction of observation 2. *MTR* is the firm's marginal tax rate. Apart from the tax credit, R&D expenditures are fully deductible in the year incurred. 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 are sufficient to alter the cost of the R&D investment. Firms with lower marginal tax rates are likely to have smaller R&D expenditures as a result of the increasing after-tax cost of R&D investment. Lagged *MTRs* are used to control for potential endogeneity of corporate tax status (Graham 1996a, 1996b; Graham, Lemmon, and Schallheim 1998).

The other included explanatory variables fall into three broad categories: macroeconomic factors, financial constraints, and other firm-specific factors. Most of these variables are drawn from prior research (Tillinger 1991; Swenson 1992; Berger 1993; Hall 1993; Klassen et al. 2003).

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 decisions about current R&D expenditures are heavily influenced by previous outlays and projects, we also include prior-year R&D intensity. As noted by Klassen et al. (2003), R&D is better viewed as an autoregressive rather than a random walk process, motivating the inclusion of lagged *RDI* rather than estimating a change specification.

An important financial constraint faced by firms on all investment projects, including R&D, is the sufficient 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 external financing is required, then firms prefer debt to equity. Although there does not appear to be a general agreement on a single measure of firms' capital constraints, the empirical research on the subject (e.g., Rajan and Zingales 1998) has focused on cash flows and leverage. Thus, we include two variables, *FUND* and *LTDA*, to control for firms' financial constraints to expend resources on R&D. *FUND*, a scaled measure of pre-R&D cash flows, proxies for a firm's ability to finance R&D from internal funds. *LTDA*, the debt-to-asset ratio, should capture the impediments faced in obtaining additional debt financing to pursue R&D projects.

Finally, we include two other firm-specific attributes usually included in R&D spending models are Tobin's q and firm size. Tobin's q (*Q*), commonly estimated as the market-to-book value of a firm, is often viewed as a measure of investment opportunities or stock of intangible assets. Although firms with greater values of *Q* are expected to conduct more R&D, its effect on R&D intensity is unclear. Likewise, there is a long literature exploring the relationship between R&D activities and firm size dating back to studies like Schmookler (1959). It has been argued that 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, all of which suggest a positive relation between firm size and R&D. However, a returns-to-scale argument or the notion that larger firms are typically more mature and less likely to make disproportionate investments in R&D to fuel accelerated growth would argue for a negative relation between firm size and R&D intensity. Regardless, we include the log of total assets (*SIZE*) as another control variable.

4.0. Data, Sample Selection, and Descriptive Statistics

4.1. 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 expired 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 regression variable in year *t*. The final sample consists of 14,244 firm-year observations representing 1,877 firms. The observations are distributed fairly uniformly throughout the 14-year sample period; no one year accounts for more than 8% of the total firm-year observations.

4.2. Descriptive Statistics

Panel B of Table 1 presents descriptive statistics for the sample firms subdivided by their eligibility and qualification status for the R&D credit. We define eligibility and qualification for the credit as follows. To be "eligible" for the credit, a firm's current year QRE must be greater than its base spending amount. Prior studies (Bailey and Lawrence 1992; Swenson 1992; Berger 1993; Eisner, Albert, and Sullivan 1983; 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. We assume that QRE equals 50 percent of *Compustat* R&D expense to determine eligibility, athough sensitivity tests using 73 percent yield similar results for all reported tests.[18] Of the total 14,244 firm-years in the sample, 73.1 percent are eligible for the credit.

To be "qualified" to use the credit, a firm must not only be eligible but must also have sufficient tax liability against which the R&D credit can be either used currently or carried back to offset against previous years' tax liability. Thus the qualification subsample is a subset of the eligible firms. We consider a firm qualified to use the credit 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 greater than zero (Graham 1996a; Graham 1996b). Using these conditions is akin to creating 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.[19] Of the total 10,414 eligible firm years in the sample, 74.4 percent are qualified to use the credit.

The medians for 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. Turning to the qualification subsample, we find inferences similar to that for eligibility -- qualified firms are larger, more profitable and have larger R&D expenses, except they have lower R&D intensities than non-qualified firms.[20]

Table 2 presents mean R&D intensities by broad industry groups as defined by Barth, Beaver, Hand, and Landsman (1999). This breakdown reveals that approximately 60 percent of our sample is concentrated in the durable manufacturing and computer industries, with another 15 percent clustered in the textiles, printing and publishing, chemicals, and pharmaceuticals industries. The three industries with the largest mean R&D intensities include pharmaceuticals, computers, and financial institutions.

Tables 3A and 3B present descriptive statistics on key components of the calculation of the R&D credit. Panels A and B of each table are designed to 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, which can primarily be attributed to the reduction of the credit percentage from 25 percent 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 the implementation of the new rules regarding the computation of a firm's base amount of QRE, incremental QRE and R&D credits claimed by firms 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 implementation of the OBRA89 reforms; incremental QRE and R&D credits claimed by firms decreased approximately 6.1 percent, while the base amount of QRE decreased by approximately 8.1 percent. These descriptive statistics appear to indicate that the structural changes introduced by OBRA89 achieved one of the objectives set out by Congress -- to enhance the incentive effect of the R&D credit.

5.0. Results

5.1. Tests of Eligibility and Qualification

Since our eligibility and qualification data are categorical, we use sample odds ratios ($\hat{\theta}$) to examine the changes in likelihood of eligibility and qualification for the credit across the tax regimes. Agresti (1996) shows that in large samples, such as ours, statistical inference based on the natural log of the odds ratio ($\ln\hat{\theta}$) is preferred as it reduces skewness and produces a sampling distribution closer to normality, as well as results in a conservative test. The confidence interval (*CI*) of $\ln\theta$ is $\ln\hat{\theta} \pm z_{\alpha/2} ASE(\ln\hat{\theta})$, the endpoints of which are then transformed back (using the exponential function) to form a confidence interval for θ.[21] The value $\theta = 1$ serves as a baseline for comparison. Odds ratios on each side of one reflect certain types of associations. When $1 < \theta < \infty$ ($0 < \theta < 1$), the odds of success are higher (lower). Values of θ farther from 1 in a given direction represent stronger levels of association.

In terms of eligibility, Panel A of Table 4 shows the estimated odds of eligibility post-OBRA89 are 0.6259 times [CI = (0.580, 0.675)] the odds during the pre-OBRA89 regime. The odds ratio of less than one indicates that overall firm eligibility for the R&D credit declined after OBRA89. When examined by industry membership, Panel B of Table 4 shows the estimated odds of eligibility of high-tech firms pre-OBRA89 are 1.381 times [CI = (1.234, 1.542)] the odds for firms in other industries. During the post-OBRA89 period, the counterpart estimated odds for high-tech firms are 1.678 times [CI = (1.479, 1.905)]. A test of the hypothesis that the odds ratio between high-tech and other industries is the same during the pre- and post-OBRA89 periods (i.e., H_0: $\theta_{XY}^{Pre\text{-}OBRA89} = \theta_{XY}^{Post-OBRA89}$) is strongly rejected ($\chi^2_{BD} = 5.82$, $p = 0.0000$).[22] Thus, contrary to the Congressional goal of making the credit more widely available, our results indicate that overall firm eligibility declined after OBRA89; however, eligibility of firms in high-tech industries increased relative to firms in other industries after OBRA89.[23]

Although we do not have specific hypotheses regarding firm qualification for the R&D credit during the pre- and post-OBRA89 regimes, as mentioned before the increased reduction in the amount of QRE that could be expensed from 50 percent of the R&D credit claimed to 100 percent post-OBRA89 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, the qualification portion of Panel A of Table 4 shows that overall firm qualification for the R&D credit increased after OBRA89 (the estimated odds of qualification post-OBRA89 are 1.353 times [CI = (1.228, 1.491)] the pre-OBRA89 odds), but the odds of credit qualification between high-tech firms and firms in other industries for the pre- and post-OBRA89 regimes are not markedly different.

5.2. *Tests of the Incentive Effects of OBRA89*

5.2.1. *Univariate Tests*

Table 5 presents univariate evidence regarding industry and firm R&D intensities for our sample period. Panel A of Table 5 reports mean R&D intensities of eligible and non-eligible firms by a variety of firm characteristics. During the pre-OBRA89 period, R&D intensities of eligible firms were generally larger than that of firms that were not eligible to use the credit. In the period following OBRA89, the R&D intensities of eligible firms increased sharply relative to non-eligible firms.[24] Panel B of Table 5 indicates that the increase in R&D intensities of eligible firms after OBRA89 applied across broad 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 all significant at $p = 0.000$.

5.2.2. *Multivariable Tests*

Table 6 presents the results of the fixed-effects OLS models, which provide inferences regarding the incentive effects associated with the structural change of the R&D tax credit. 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 firms that qualified for the R&D credit during 1981-94. 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 literature. A notable exception is *Q*, which is negative and significant (-0.0045, $p = 0.000$).

The variables that capture the tax factors that affect R&D spending are all significant. MTR_{t-1} is significantly positive (0.0079, $p = 0.000$), which suggests that qualified firms' R&D intensities are increasing in their marginal tax rates.[25] The coefficient on the *OBRA* variable is marginally significant (0.0013, $p = 0.079$); the structural changes enacted by OBRA89 increased R&D intensities of other firms by 0.13 percent. The interaction term *OBRA*TECH* is significantly positive (0.0069, p = 0.000), which indicates that qualified high-tech firms increased their R&D intensities by an additional 0.69 percent after OBRA89 relative to qualified firms in other industries.

The second column of results focuses on the R&D intensity of 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 MTR. The magnitude of the coefficient of MTR_{t-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. The tax status of non-qualified firms does not allow them to claim the R&D tax credit. Therefore, the present value of the R&D tax credit for non-qualified firms would increase dramatically if these firms transitioned into a tax-paying status

As a final check on the importance of tax factors in determining R&D spending, we compared the explanatory power of the R&D spending regressions for qualified and non-qualified firms. The R-square for the R&D spending regression of qualified firms is 79.9 percent compared with 23.1 percent for non-qualified firms. This finding, in conjunction with the results in the qualified regression, present compelling evidence of the tax incentives provided by the structural changes to the R&D credit.

5.3. Economic Consequences of **OBRA89**

The results from the R&D spending models can also be used to provide estimates of the additional spending by firms qualified for the credit that was generated per dollar of credit. These estimates are presented in Table 8. The R&D tax credit's cost for high-tech (other) qualified firms during 1990-1994 averaged $1.30 ($0.51) billion per year per the *Corporate Source Book* (U. S. IRS various years). QRE during this period averaged $46.08 ($16.68) billion for high-tech (other) firms. Our regression estimates from Table 6 indicate that the $46.08 ($16.68) billion of R&D spending was about 11.04 (5.43) percent higher than it would have been absent the credit, which is approximately $4.58

($0.86) billion per year. Therefore, our estimates imply that the credit induced $3.54 ($1.68) of additional R&D spending by high-tech (other) firms per revenue dollar foregone during 1990-1994. For our overall sample, this translates into an estimate of $2.40 of additional R&D spending per revenue dollar foregone

5.4. Sensitivity Analysis

5.4.1. Eligibility and Qualification for the R&D Tax Credit

A potential concern with our finding that firm eligibility declined after OBRA89 is that the decline may be due to sample attrition. It is well known that there has been a manufacturing exodus from the U.S. that began in the mid-1980s, and over 40 percent of our sample is comprised of manufacturers. To address this concern, we replicate our eligibility and qualification tests on two alternative samples. First, we form a balanced panel that includes all firms present in our sample for the entire 14-year period (*BP14*). The *BP14* sample has 5,110 firm-year observations from 365 firms. The second sample consists of data on those firms present in our sample in the final year of our sample period, back to the earliest year of their inclusion in the database (*END94*). The *END94* sample has 9,735 observations, and the number of observations increases over time.

The inferences from the univariate tests on eligibility and qualification on the *END94* sample are identical to those reported in Table 4 for the full sample. Conversely, analysis on the *BP14* sample indicates that the estimated odds of eligibility for high-tech firms versus firms in other industries during both the pre- and post-OBRA89 regimes are not statistically different from one [$\hat{\theta}_{PRE} = 1.0878$, $CI =$ (0.888, 1.333); $\hat{\theta}_{POST} = 0.9436$, $CI =$ (0.750, 1.187)]. In addition, high-tech firms were not more likely to be eligible relative to firms in other industries ($\chi^2_{BD} = 0.83$, $p = 0.3635$) 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 a company's life-cycle.[26]

We also perform eligibility and qualification tests (untabulated) on the three different subperiods corresponding to major changes in the R&D tax credit -- 1981-1985 (ETRA subperiod), 1986-1989 (TRA subperiod), and 1990-1994 (OBRA subperiod). Tests indicate that firms were significantly less likely to be eligible for the credit for both subperiods 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 for the credit than firms in other industries only during the ERTA and OBRA subperiods [$\hat{\theta}^{ERTA}_{HT/OTH} = 1.9840$; $\hat{\theta}^{OBRA}_{HT/OTH} = 1.6784$]. The percentage of high-tech firms likely to be eligible for the credit 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 subperiod relative to either the ERTA subperiod [$\hat{\theta}_{ERTA/OBRA} = 1.3528$] or the TRA subperiod [$\hat{\theta}_{TRA/OBRA} = 1.3535$]. Similar to the results presented for the full sample in Table 4, high-tech firms are significantly less likely to be qualified for the R&D credit than other firms during each subperiod [$\hat{\theta}^{ERTA}_{HT/OTH} = 0.7600$, $\hat{\theta}^{TRA}_{HT/OTH} = 0.6592$, $\hat{\theta}^{OBRA}_{HT/OTH} = 0.8231$]. The difference between TRA and OBRA is marginally significant ($\chi^2_{BD} = 3.4968$, $p = 0.0615$). So, although firms in other industries are more likely to be qualified for the R&D credit than high-tech firms, the percentage of high-tech firms likely to be qualified to use the credit increased 24.86 percent after the structural changes enacted under OBRA89.

5.4.2. Credit Components Calculation

Because we do not have access to tax return data, we must estimate the R&D tax credit, as well as the components used in calculating the R&D tax credit, using financial statement data. To ensure that our algorithm used to calculate the components of the R&D tax credit provides reasonable estimates, we conduct some simple out-of-sample tests utilizing actual R&D tax credit amounts from the effective tax rate (ETR) reconciliations reported in the income tax notes to the financial statements of 111 firms from 1995-1999 included in Schmidt (2003). We then estimate the amount of the R&D tax credit for each of the 111 firms using Compustat data ($CREDIT_{CST}$) and compare these estimates to the actual R&D tax credit amounts from the ETR reconciliations ($CREDIT_{ETR}$).

The mean (median) $CREDIT_{CST}$ is 2.1301 (0.6738), while the mean (median) $CREDIT_{ETR}$ is 2.1026 (0.4250). The difference between means is not statistically significant ($t = 0.0353$, $p = 0.9719$). The correlation coefficient between $CREDIT_{CST}$ and $CREDIT_{ETR}$ is statistically significant ($\rho_{Pearson} = 0.3892$, $p = 0.0000$ and $\rho_{Spearman} = 0.6998$, $p = 0.0000$). The correlation coefficient between $CREDIT_{CST}$ and $CREDIT_{ETR}$ for high-tech firms is extremely strong ($\rho_P = 0.8472$, $p = 0.0000$ and $\rho_S = 0.6886$, $p = 0.0000$), while the correlation coefficient between $CREDIT_{CST}$ and $CREDIT_{ETR}$ for firms in other industries is similar to that of the full sample ($\rho_P = 0.4172$, $p = 0.0000$ and $\rho_S = 0.7916$, $p = 0.0000$). This analysis somewhat alleviates concerns about measuring R&D tax credits using financial statement data, although we acknowledge that inferences from the simple tests above may be period-dependant.

6.0. 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 effects, making the credit a focus of ongoing policy debates. In this study, we examine whether the change in the R&D tax credit's structure enacted under OBRA89 had an effect on the number and the type of firms 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. 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.

Using firm-specific data spanning the entire 14-year life of the credit prior to its first discontinuity in 1995, we find that overall firm eligibility for the R&D credit declined after OBRA89, but firms belonging to high-tech industries were more likely to be eligible. In terms of incentive effects, our regression results show that overall R&D intensities increased after OBRA89, but this increase was driven primarily by firms in high-tech industries while the benefit for firms in slower-to-normal growth industries was less pronounced. Thus, the incentive effect of structural change of OBRA89 benefits had a greater effect on high-tech firms than firms in other industries. The finding is also consistent with Swenson(1992) who used data prior to OBRA89.

From a cost-benefit perspective, our regression estimates imply that the R&D tax credit induced $3.54 ($1.68) of additional R&D spending by qualified high-tech (other) firms per revenue dollar forgone by the U.S. Treasury during 1990-1994. For the overall sample, this translates into about $2.40 of additional R&D spending per revenue dollar forgone in the post-OBRA89 period. Our estimated spending effects are much larger than Hall and van Reenan's (2000) conclusion from a survey of the current research that the R&D credit produces roughly a dollar-for-dollar increase in R&D spending. However, that evidence is based largely on data from the pre-OBRA89 period during which Hall (1993) estimated that anywhere from 17 to 30 percent of the firms faced negative effective credit rates, whereas 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 we find in this study. Our estimates are also empirically corroborated by Klassen et al.'s (2003) recent study in which they estimate the credit's incentive effect at $2.96 of additional R&D spending per dollar of credit, although their evidence is based on a limited sample of 110 U.S. firms and only post-OBRA89 data.

Thus, our study suggests that the structural change in the R&D credit's design from a moving average base to a fixed-base appears to have had the desired effect on firms' R&D spending, especially for firms in the high-tech sector. However, the new structure does not appear to have met the Congressional objective of making the credit as widely available to different firms as possible.

Endnotes

[1] From its very inception in 1981, the R&D credit has been a temporary credit with a sunset date, but it has been extended each time when it lapsed, often retroactively. The one exception is when the credit lapsed in 1995, and in fact did not exist for one year after which Congress reinstated it, but again as a temporary credit. Currently, the credit remains a temporary measure and is set to expire again on June 30, 2004.

[2]Jacob M. Schlesinger and Michael M. Phillips, "Treasury Secretary O'Neill indicates proposal to reduce tax withholdings," *The Wall Street Journal*, January 26, 2001 (quoting then Treasury Secretary Paul O'Neill).

[3] In contrast, Canada, which is generally considered to provide the most generous tax treatment of R&D, has a non-incremental R&D credit, that is the tax credit is available for every dollar spent on R&D. Further, the Canadian credit is permanent. See Klassen et al. (2003) for details of the Canadian system.

[4] OBRA89 has also been referred to as the Revenue Reconciliation Act of 1989. The modification to the base amount calculation was made to Internal Revenue Code section 41(c) and is detailed in the Senate Finance Committee Report (Part 1 of 6 Parts) (Oct. 13, 1989), 135 Cong. Rec. S13125 (10/12/89).

[5] Hall's (1993) study 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). But she then states that, "This number is almost too large to be credible …, and deserves further investigation as more data become available."

[6] We distinguish between "eligibility" and "qualification" for the R&D credit as follows (defined in greater detail later): firms are *eligible* for the credit if their R&D spending satisfies the thresholds defined in the tax laws for claiming the credit, and firms are *qualified* for the credit when they are both eligible and their tax status is such that they can claim the benefit of the tax credit.

[7] Taxpayers can also elect to amortize these expenditures over 60 months, but in practice most firms immediately expense R&D. What qualifies as research and experimentation expenditures, however, is not defined in the Code. Treasury regulations have generally interpreted them to mean "research and development costs in the experimental or laboratory sense."

[8] 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.

[9] Currently, the R&D credit is set to expire on June 30, 2004 (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). But 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 EEGEGTRRA, several bills were introduced in Congress for this purpose and practitioners continue to assert that the lack of permanence dilutes the incentive effects of the credit (Grigsby and Westmoreland 2001).

[10] Start-up firms were defined 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).

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

[12] This statement is consistent with the characteristics observed in 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.

[13] For instance, the House and Senate hearings prior to the adoption of 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 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).

[14] OBRA89 enacted an additional change to the R&D credit (albeit unrelated to the structural change) that allows us to make a prediction regarding pre- and post-OBRA89 firm qualification. Specifically, section 280C(c) further reduced the deduction available under 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. Since firm qualification is directly tied to a firm's tax status, the higher section 280C(c) reduction post-OBRA89 should increase firm qualification, *ceteris paribus*.

[15] 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 ($RDXP_{it}$) as follows: $G_{it} = RDXP_{it} + 0.8RDXP_{it-1} + 0.6RDXP_{it-2} + 0.4RDXP_{it-3} + 0.2RDXP_{it-4}$. For our sample firms, the mean gross profit margin for high-tech (other) firms is 43.18 percent (35.52 percent) and the R&D stock for high-tech (other) firms is $118.80M ($64.96M). Additionally, the R&D stock growth for high-tech firms (27.12 percent) is larger than that of other firms (22.80 percent). All differences between high-tech and other firms are significant at the $p < 0.05$ level.

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

[17] As Klassen et al. (2003) point out, R&D tax credits are also available at the state-level and that they differ from state to state providing another source of variation that can help isolate the incentive effect of the credit. However, 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. (2003) assign their sample firms to the states (provinces in Canada) of their head office location, but this assumption adds noise to their incentive measure. Despite this problem, they are compelled to use the state-level incentives because, absent the state- (province-) level variation in tax rates, they would have no variation in their Canadian observations resulting in a credit variable almost constant across all Canadian firm-years. Given our sample consists only of U.S. firms, we do not have the lack of variability problem. In any event, their results for the U.S. observations are unchanged if they consider only the federal-level R&D credit.

[18] The appropriateness of using 50 percent is corroborated by others. For instance, in his 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 (May 10, 1995; 95 TNT 92-67). Similarly, in a study of income-shifting by firms claiming the Puerto Rican tax credit under section 936, Grubert and Slemrod (1998) found that the R&D expense reported on the tax returns of the firms claiming the credit was, on average, 50 percent of their book R&D expense reported on *Compustat*.

[19] Graham's (1996a, 1996b) simulated MTR uses the entire NOL carryback/carryforward schedule (18 years). However, Graham gathers NOL information from *Compustat* and research has shown 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 works well in reducing error related to *Compustat's* reporting of an NOL carryforward where no U.S. tax NOL exists.

[20] This is consistent with Joos and Plesko (2003), who find that firms that incur losses and have the lowest probability of loss reversal have larger R&D intensities than other firms. This pattern becomes more pronounced during the 1991-2000 period.

[21] In a 2 × 2 table, $\hat{\theta} = n_{11}n_{22}/n_{21}n_{12}$, where n_{ij} is the frequency in cell$_{ij}$. *ASE* is the *asymptotic standard error* equal to $\sqrt{1/n_{11} + 1/n_{12} + 1/n_{21} + 1/n_{22}}$, such that the confidence interval of ln θ is $\ln\hat{\theta} \pm z_{\alpha/2} ASE(\ln\hat{\theta})$. We also used a more sophisticated logistic regression model to study OBRA89's effects on eligibility. Overall, the findings and inferences were similar. For simplicity, we report the findings of the univariate analysis only.

[22] We use 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 $df = K - 1$, to test the hypothesis that the odds ratio between high-tech and other industries is the same during the pre- and post-OBRA89 periods.

[23] It is important to note that the odds of eligibility for firms in high-tech industries increased *relative* to firms in other industries. Careful examination of Panel B in Table 4 indicates that the eligibility of both types of firms decreased after OBRA89 (which is consistent with the eligibility results in Panel A of Table 4).

[24] R&D intensities increased 48.25 (13.99) percent on average for eligible (non-eligible) firms after OBRA89. The R&D intensity increase after OBRA89 was significant only for eligible firms.

[25] 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 the tax incentives of R&D spending are greater for high-tech firms.

[26] The *BP14* sample includes more established, mature firms, whose growth potential is often limited and therefore less likely to be affected by OBRA89. Conversely, the *END94* sample includes start-up firms that are characterized by high growth. 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). All differences between the two samples are significant at the $p < 0.05$ level.

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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-Years
Compustat Firms with one year of credit qualification during 1981-94	2,054	17,270
Less: Firms 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	Firms	Year	Firms
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: Descriptive statistics by eligibility and qualification for the R&D tax credit (mean, standard deviation, and median)[1]

Variable	Compustat Item	Eligible	Not-Eligible	Qualified	Not-Qualified
R&D Expense	46	36.5691	16.7747	41.7378	21.4869
		124.3568	68.9489	136.6649	76.0793
		4.4875	1.5600	5.5940	2.6000
Sales	12	895.7950	745.3570	1,022.7700	525.2714
		2,262.8800	2,140.9700	2,443.0700	1,569.4800
		122.6835	81.0725	163.1905	49.7060
Sales Growth	(12/lag12) – 1	0.2018	0.0544	0.1798	0.2659
		3.4983	0.6849	0.5413	6.8631
		0.1015	0.0248	0.1125	0.0473
R&D Intensity	46/12	0.0590	0.0348	0.0513	0.0817
		0.0675	0.0454	0.0498	0.0996
		0.0389	0.0186	0.0350	0.0545
Profitability	170/12	0.0591	0.0145	0.0983	-0.0553
		0.1399	0.1379	0.0822	0.1984
		0.0718	0.0352	0.0876	-0.0121
Size	log(6)	4.7774	4.4330	5.0165	4.0799
		1.9616	1.9712	1.9300	1.8855
		4.6208	4.1582	4.8778	3.7849
Marginal Tax Rate	N/A	0.2740	0.1862	0.3439	0.0703
		0.1839	0.1848	0.1369	0.1488
		0.3400	0.1748	0.3500	0.0000
	n	10,414	3,830	7,756	2,658

[1] This panel presents descriptive statistics for firm financial characteristics by eligibility and qualification for the R&D tax credit. Eligibility and Qualification are defined as follows: *Eligible* = implies that the firm's spending on R&D satisfies 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. A firm is considered "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).

Table 2

Industry Analysis of R&D Intensity

Industry Membership	Eligible		Not-Eligible		Qualified		Not-Qualified	
	Mean *RDI*	% of Firms	Mean *RDI*	% of Firms	Mean *RDI*	% of Firms	Mean *RDI*	% of Firms
Mining and Construction	0.0263	0.45%	0.0110	0.78%	0.0300	0.48%	0.0123	0.38%
Food	0.0068	2.21%	0.0052	1.64%	0.0064	2.59%	0.0097	1.09%
Textiles, Printing, and Publishing	0.0149	5.48%	0.0101	6.48%	0.0139	6.19%	0.0197	3.42%
Chemicals	0.0309	6.75%	0.0203	4.78%	0.0307	8.15%	0.0328	2.67%
Pharmaceuticals	0.1074	4.84%	0.0752	2.30%	0.0766	5.29%	0.2415	3.54%
Extractive Industries	0.0175	1.33%	0.0078	1.78%	0.0181	1.32%	0.0156	1.39%
Durable Manufacturers	0.0472	40.86%	0.0303	46.55%	0.0422	40.12%	0.0608	43.00%
Computers	0.0997	22.04%	0.0622	17.91%	0.0913	20.84%	0.1197	25.55%
Transportation	0.0345	0.35%	0.0237	0.44%	0.0273	0.32%	0.0507	0.41%
Utilities	0.0282	0.23%	0.0094	0.47%	0.0092	0.17%	0.0507	0.41%
Retail	0.0182	1.73%	0.0113	2.35%	0.0150	1.74%	0.0277	1.69%
Financial Institutions	0.1039	0.35%	0.0521	0.34%	0.0819	0.37%	0.1952	0.26%
Insurance, and Real Estate	0.0412	0.21%	0.0114	0.21%	0.0352	0.17%	0.0498	0.34%
Personal Services	0.0314	0.92%	0.0167	1.64%	0.0282	0.88%	0.0391	1.05%
Professional Services	0.0569	0.90%	0.0322	1.59%	0.0415	0.84%	0.0914	1.09%
Other	0.0658	11.35%	0.0417	10.73%	0.0574	10.55%	0.0846	13.69%
Total	0.0590		0.0348		0.0513		0.0817	
		$n = 10{,}414$		$n = 3{,}830$		$n = 7{,}756$		$n = 2{,}658$

[1] This panel reports the industry composition of the sample and the means of RDI (*R&D Intensity* = *R&D Expense/Sales*) for each industry. The industry breakdown is adapted from Barth, Beaver, Hand, and Landsman (1999); Rajgopal, Shevlin, and Venkatachalam (2003); and Schmidt (2003). Industries are defined 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).

[2] Eligibility and Qualification are defined as follows: *Eligible* = implies that the firm's spending on R&D satisfies 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. A firm is considered "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).

Table 3A

Descriptive Statistics for the Components of the Pre-OBRA89 R&D Tax Credit

		1981	1982	1983	1984	1985	1986	1987	1988	1989
Panel A: Assuming QRE = 50% of Book R&D Expense										
BASE	*Mean*	9.719	10.288	9.997	10.991	11.242	12.395	13.207	14.120	14.070
	Std. Dev.	29.578	30.171	31.234	34.041	34.683	38.698	43.090	48.043	49.898
	Median	1.131	1.075	1.036	1.218	1.396	1.468	1.619	1.444	1.349
EXCESS	*Mean*	1.903	2.576	3.118	3.357	3.165	3.794	4.095	4.297	4.377
	Std. Dev.	5.473	7.748	9.555	10.373	9.999	12.973	13.727	15.082	16.758
	Median	0.250	0.353	0.424	0.489	0.569	0.493	0.508	0.450	0.463
CREDIT	*Mean*	0.476	0.644	0.779	0.839	0.791	0.759	0.819	0.859	0.875
	Std. Dev.	1.368	1.937	2.389	2.5934	2.500	2.595	2.745	3.016	3.352
	Median	0.063	0.088	0.106	0.122	0.142	0.099	0.102	0.090	0.093
	n	749	763	796	806	840	754	715	775	820
Panel B: Assuming QRE = 73% of Book R&D Expense										
BASE	*Mean*	14.191	15.021	14.596	16.046	16.413	18.097	19.282	20.616	20.543
	Std. Dev.	43.184	44.050	45.602	49.700	50.637	56.498	62.911	70.143	72.851
	Median	1.651	1.570	1.513	1.779	2.039	2.143	2.364	2.109	1.969
EXCESS	*Mean*	2.779	3.761	4.551	4.901	4.620	5.540	5.978	6.274	6.391
	Std. Dev.	7.991	11.312	13.950	15.145	14.598	18.940	20.041	22.020	24.467
	Median	0.365	0.515	0.619	0.713	0.831	0.720	0.742	0.657	0.676
CREDIT	*Mean*	0.694	0.940	1.138	1.225	1.155	1.108	1.196	1.254	1.278
	Std. Dev.	1.998	2.828	3.486	3.786	3.650	3.788	4.008	4.404	4.893
	Median	0.091	0.129	0.155	0.155	0.207	0.144	0.148	0.131	0.135
	n	749	763	796	806	840	754	715	775	820

[1] This table presents descriptive statistics for the components of the R&D tax credit during the Pre-OBRA89 period (1981-1989).

[2] Variables are defined as follows: *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. *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 1986-1989, computed as 20% of a firm's incremental qualified R&D expense in year *t*.

Table 3B

Descriptive Statistics for the Components of the Post-OBRA89 R&D Tax Credit

		1990	1991	1992	1993	1994
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*	15.780	17.529	18.491	18.011	17.435
	Std. Dev.	54.783	62.791	68.059	63.159	56.812
	Median	1.803	1.876	2.094	2.456	2.632
EXCESS	*Mean*	6.183	6.700	7.696	7.634	8.200
	Std. Dev.	22.515	23.530	27.234	26.553	28.959
	Median	0.596	0.621	0.890	0.979	1.285
CREDIT	*Mean*	1.237	1.340	1.539	1.527	1.640
	Std. Dev.	4.503	4.706	5.447	5.311	5.792
	Median	0.119	0.124	0.178	0.196	0.257
	n	729	662	639	649	671
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*	25.021	25.565	26.947	26.229	25.253
	Std. Dev.	79.983	91.677	99.370	92.214	82.768
	Median	2.632	2.674	2.884	3.523	3.812
EXCESS	*Mean*	9.044	9.811	11.287	11.213	12.174
	Std. Dev.	32.878	34.357	39.766	38.776	42.399
	Median	0.911	0.913	1.329	1.489	1.935
CREDIT	*Mean*	1.809	1.962	2.257	2.243	2.435
	Std. Dev.	6.576	6.871	7.953	7.755	8.480
	Median	0.182	0.183	0.266	0.298	0.387
	n	729	662	639	649	671

[1] This table presents descriptive statistics for the components of the R&D tax credit during the Post-OBRA89 period (1990-1994).

[2] Variables are defined as follows: *FBP* = a firm's fixed base percentage. For 1990-1994, 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. Start-up firms are assigned a fixed base percentage of 3%. *BASE* = a firm's base amount of R&D expenses. 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 1990-1994, computed as 20% of a firm's incremental qualified R&D expense in year *t*.

Table 4
R&D Tax Credit Eligibility and Qualification[1]

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

Period	**Eligible** Firm-yrs	%	**Not-Eligible** Firm-yrs	%	**Qualified** Firm-yrs	%	**Not-Qualified** Firm-yrs	%
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	%	**Not-Eligible** Firm-yrs	%	**Qualified** Firm-yrs	%	**Not-Qualified** Firm-yrs	%
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 univariate statistics that provide evidence regarding firm eligibility and qualification for the R&D tax credit by period and industry membership. Eligibility and Qualification for the R&D tax credit are defined 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. A firm is considered "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] A firm is designated 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).

[3] $\hat{\theta}$ = 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 statistic

The symbol † denotes significance at the 0.05 (two-tail) level.

Table 5
Descriptive Statistics on the Magnitude of Firms' R&D Intensity across Periods[1]

Panel A: Mean R&D Intensity by 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 Technology Groups and Periods

	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
All Others (1981-89)	0.006	0.003	0.016	0.004	0.034	0.008	0.092	0.048
High Tech (1990-94)	0.033	0.014	0.076	0.012	0.118	0.012	0.230	0.145
All Others (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
All Others (Pre vs. 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 provision. 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. A firm is designated 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 6
Fixed-Effects Estimates of the Impact of OBRA89 on R&D Spending[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	+	0.1270 (0.000)	0.4262 (0.000)
	RDI_{t-1}	+	0.2734 (0.000)	0.1677 (0.000)
	$FUND_t$	+	0.0759 (0.000)	-0.0812 (0.000)
	$LTDA_t$	--	0.0060 (0.039)	0.0099 (0.247)
	Q_t	?	-0.0045 (0.000)	-0.0006 (0.668)
	$SIZE_t$	?	-0.0015 (0.035)	-0.0040 (0.110)
Tax Factors	MTR_{t-1}	+	0.0079 (0.000)	0.0144 (0.007)
	$OBRA_t$	+	0.0013 (0.079)	-0.0019 (0.591)
	$OBRA_t$*$TECH_t$	+	0.0069 (0.000)	0.0033 (0.510)
Specification Tests	*Breusch-Pagan LM Test*		14.36 (0.000)	81.41 (0.000)
	Hausman Test		1507.65 (0.000)	2575.52 (0.000)
	R^2		0.7990	0.2307
	N		7,756	2,658

[1] This table presents results of a fixed effects panel data regression that evaluates the impact 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 that are eligible for the R&D tax credit (i.e., current year qualified R&D expenditures exceed the statutory base amount), and the equation is estimated separately for firms that qualified/did not qualify for the credit. A firm is considered "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] Variables are defined as follows (firm subscripts are omitted): 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 7

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

			Qualified Firms	
		All	**Tech n = 2,510**	**Others n = 5,246**
1.	Median Pre-OBRA89 R&D Intensity		0.0743	0.0239
2.	Average increase in R&D Spending, 1990-1994		0.0082	0.0013
3.	% Increase in R&D Spending Post-OBRA89 (Line 2 ÷ Line 1)		0.1104	0.0543
4.	Average Qualified R&D Expenditures, 1990-1994		46.0768	16.6754
5.	R&D Spending Absent the Credit (Line 4 ÷ (1 + Line 3))		41.4972	15.8167
6.	Credit Induced R&D Spending (Line 4 – Line 5)		4.5796	0.8588
7.	Average Cost of the R&D Credit, 1990-1994		1.2950	0.5110
8.	Additional R&D Spending per Revenue Dollar Foregone (Line 6 ÷ Line 7)	$2.4042	$3.5364	$1.6806

[1] This table presents estimates additional R&D spending generated per dollar of R&D tax credit claimed during the Post-OBRA89 period (1990-1994). Median Pre-OBRA89 R&D intensity (Line 1) and average qualified R&D expenditures from 1990-1994 (Line 4) are obtained from untabulated descriptive statistics. The average increase in R&D spending amounts (Line 2) are obtained from the fixed effects coefficient estimates of qualified firms ($OBRA_t*TECH_t$ = 0.0069; $OBRA_t$ = 0.0013) from Table 6. The average cost of the R&D tax credit during 1990-1994 is obtained from information disclosed in the annual *Corporate Source Book* (U.S. IRS various years).

Table 8

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

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

	Alternative Sample Periods[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 Sample Periods		
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 that provide evidence regarding the likelihood of R&D tax credit eligibility and qualification over alternative sample periods. Eligibility and Qualification for the R&D tax credit are defined 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. A firm is considered "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] The samples are defined as follows: *FULL* = The original unbalanced sample used in the main analysis of the paper. *BP14* = a balanced panel that includes all firms that are 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] A firm is designated 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).

The symbol † denotes significance at the 0.05 (two-tail) level