Financial Accounting Consequences of Temporary Tax Law:
Evidence from the R&D Tax Credit

by

Jeffrey Lamro Hoopes

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Doctoral committee:

Professor Michelle L. Hanlon, Co-Chair, MIT
Professor Gregory S. Miller, Co-Chair
Professor James R. Hines, Jr.
Professor Reuven Lehavy
Professor Joel B. Slemrod

"The curious task of economics is to demonstrate to
men how little they really know about what
they imagine they can design."

F.A. Hayek

To GOMD

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Abstract

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Jeffrey Lamro Hoopes

Co-Chair: Michelle Hanlon
Co-Chair: Gregory Miller

This paper investigates the extent to which extensions of a temporary tax law reduce market participants' ability to predict and understand corporate earnings. Examining evidence from eight separate extensions of the R&D tax credit, I find that market participants adjust their expectations for corporate earnings upwards in response to extensions of the R&D tax credit, but doing so incrementally decreases the accuracy of earnings forecasts. The evidence also suggests that abnormal bid-ask spreads around quarterly earnings announcements increase for firms affected by an expired R&D tax credit, suggesting that trading costs rise when markets have difficulty interpreting earnings affected by the expired R&D tax credit. The results of this study call attention to previously unexplored costs of temporary tax laws—capital market confusion related to corporate earnings affected by expired tax laws.

CHAPTER 1

Introduction

U.S. tax law contains an increasing number of temporary provisions. In the late 1990s, there were fewer than a dozen temporary tax measures. As of 2010, there were 141 (McKinnon, Fields and Saunders, 2010). A key feature of these temporary tax provisions is that they are often extended. Many extensions are made retroactively, after the provision has expired. Although such provisions are increasingly common, little is known about the consequences of these temporary tax laws. Temporary tax laws directly affect financial reporting because financial accounting requires firms to assume expired tax provisions will not be extended. This means managers must initially report a different tax expense in quarterly earnings reports than will be reported at year end.

To what extent temporary tax laws create unintended consequences is an open question. To address this question, I examine eight separate retroactive extensions of the Research and Development (R&D) tax credit. I find that when market participants revise their quarterly earnings forecasts following an extension of the R&D tax credit, the portion of the revision attributable to the R&D tax credit extension makes the revised forecast less accurate, moving the forecast incrementally *away* from earnings by $0.039. I also find that bid-ask spreads are significantly larger in earnings announcement periods affected by the expired R&D tax credit. My results call attention to previously unexplored costs of temporary tax laws: the inability of capital market participants to understand the financial accounting consequences of temporary tax laws.

The R&D tax credit was introduced in 1981 in an effort to spur corporate investments in research, and has since expired and been extended 15 times.[1] Since 1992, these extensions have all been retroactive. Most recently, the credit expired on December 31, 2011, and was retroactively extended on January 2, 2013.[2] Several studies find that the R&D credit accomplishes its intended purposes of stimulating incremental R&D investment.[3] However, this literature has generally ignored the temporary nature of the credit and has also ignored the financial reporting and capital market consequences of the credit (Klassen et al., 2004).

The investment effects of the temporary nature of the R&D credit are difficult to study because their study is predicated upon understanding managers' priors about the tax credit's extension. Therefore, I focus on financial reporting related outcomes, both because they are interesting in their own right and because they do not depend upon managers' expectations about extension. Financial reporting outcomes will be affected because financial accounting requires managers to assume that expired provisions will not be extended when calculating the tax expense (ASC 740-10-30-2).[4] When an extension occurs, managers must include the effect of the adjustment for all previous quarters in the quarter of extension.

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[1] The R&D tax credit is called the "Credit for Increasing Research Activities" on Form 6765, in Internal Revenue Code §41, and in §221 of the Economic Recovery Tax Act of 1981, which initiated the credit. Official IRS sources call it the "Corporate Research Credit." It is also called the Research and Experimentation tax credit. The credit allows taxpayers a nonrefundable tax credit for a percentage of the difference between their qualifying R&D expenditures and a calculated base that is based on prior year's R&D spending sales Calculating the credit requires subjective judgments which must be documented, and is often audited by the IRS (Daily Tax Report, 2012).

[2] Had the credit been extended on or before December 31, 2012, calendar-year firms would have been able to take advantage of the credit in their 2012 annual earnings.

[3] This literature examines the effects of the R&D tax credit on investments in R&D, the trade-off between qualified (incented) expenditures versus non-qualifying expenditures and implicit taxes associated with increased prices of R&D related goods (e.g., Altshuler, 1988; Hines, 1994; Hall and Van Reenen, 2000; Berger, 1993; Bloom, Griffith and Van Reenen, 2002; Klassen, Pittman and Reed, 2004; Wilson, 2009; Rao, 2010 and Gupta, Hwang and Schmidt, 2011).

[4] This is even the case if the credit is extended in the time period between the fiscal period end and the disclosure of the financial statements. For example, for their quarterly report for their fiscal quarter ending October 1, 2004, Scientific Atlanta reported that, "On October 4, 2004, President George W. Bush signed the "Working Families Tax

Forecasting earnings per share (EPS) requires understanding the earnings effect of a firm's tax position. Market participants may not understand the impact of the tax effect on earnings or may not have enough information to calculate the impact. Alternatively, they may understand. Market participants may correctly revise earnings expectations because some temporary tax laws, such as the R&D tax credit, are well known and frequently expire. Such frequent expirations and extensions may allow market participants to understand the effect of the extension of the R&D credit. Further, the extension of the R&D credit is relatively simple. Plumlee (2003) finds that analysts' understanding of tax law changes decreases in the complexity of the change—analysts understand simple tax law changes. To what extent market participants understand the effect of temporary tax laws is an empirical question.

I examine eight instances when the R&D tax credit expired and was then extended retroactively. I find that market participants misforecast the R&D tax credit's effect on earnings directly following extensions of the R&D credit. This is not because analysts merely ignore extensions of the credit—analysts discuss the R&D tax credit just after the credit is extended and the magnitude and frequency of forecast revisions following extensions of the R&D tax credit increase. However, these revisions make analysts' EPS forecasts incrementally less accurate. The average incremental effect of the R&D tax credit extension on EPS forecast revisions moves the outstanding forecast *away* from earnings by $0.039, decreasing accuracy. This incremental decrease is material. The average forecast revision for all revisions in my sample (both R&D tax credit firms and non-R&D tax credit firms) moves forecasts $0.065 *closer* to realized earnings.

Relief Act of 2004", which retroactively reinstated the research tax credit to the June 30, 2004 expiration date. If this change in the law had occurred on or before October 1, 2004, we would have reduced our tax provision in the first quarter of fiscal year 2005 by approximately $1,000, or 1.2 percentage points…"

I next examine whether this lack of predictability increases trading costs. Prior literature suggests that if earnings are less predictable, trading costs (i.e., bid-ask spreads) will increase (Affleck-Graves, Callahan and Chipalkatti, 2002). I find that the abnormal bid-ask spread associated with the release of quarterly earnings incrementally increases by 25% for firms that usually receive the credit in quarters when the credit is expired. For 2008, the most recent expiration year with available data, the aggregated increase in trading costs is about 2% of claimed R&D tax credits.[5]

The results are robust to an array of sensitivity tests that control for observed and unobserved heterogeneity across forecasters, firms and earnings announcement periods. For the tests related to earnings predictability, I conduct several robustness tests that consider other parts of the legislation that extend the R&D tax credit. Further, I conduct a placebo test examining time periods (placebo bill enactment dates) not affected by the R&D credit. These tests fail to obtain the same results as when using the true treatment (time periods that should be affected by the credit). I also find predictable cross-sectional variation related to the level of corporate disclosure in the relationship between forecast accuracy and the R&D tax credit, and related to the level of investor sophistication in the relationship between bid-ask spreads and the R&D tax credit.

These findings are useful to both researchers and policymakers. This paper adds to the academic literature that examines market participants' understanding of tax law changes (e.g., Givoly and Hayn, 1992; Chen and Schoderbek, 2000; Plumlee, 2003) in the novel environment of frequently extended temporary tax laws. As an increasing number of tax incentives are

[5] Like the R&D tax credit itself, this increase in trading costs is not a net cost to society, but a transfer of wealth. The actual cost (deadweight loss) comes from the decreased market efficiency and foregone trades resulting from increased trading costs. Comparing the trading costs associated with the temporary credit to the expenditure cost of the R&D tax credit compares the size of one transfer to another, providing a useful comparison.

temporary, my findings are useful to those trying to understanding the effect of taxes on corporate behavior.

Policymakers will find this evidence useful for several reasons. First, I document nontrivial costs associated with temporary tax laws. These costs should be netted against any benefits of maintaining temporary tax laws in order to assess the advisability of making these laws permanent or rescinding them. Second, this paper confirms concerns that tax law changes may have unanticipated financial reporting consequences (e.g., Neubig, 2006; Raedy, Seidman and Shackelford, 2011; Hanlon, 2012). Lastly, the results in my cross-sectional test of disclosure speak to concerns regulators have had regarding the sufficiency of tax-related disclosures in firms' financial statements (e.g., Jaworski, 2012).[6,7]

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[6] This study also has implications for studies that look at the intra-year properties of effective tax rates, as extensions frequently happen in the fourth quarter, for a set of firms which may systematically vary with effects being studied (i.e. Dhaliwal, Gleason and Mills, 2004 and Comprix, Mills and Schmidt, 2012). While these papers consider the effects of tax credits and so are likely robust to the effect that expiring tax credits have on ETRs, this study makes clear the necessity of such robustness checks.

[7] Exact policy implications are difficult when many different costs and benefits exist, each with a magnitude measured only with uncertainty. Indeed, as Keynes suggested, "About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know." However, policymakers must decide, for example, what to do with temporary tax credits. Keynes continues, "Nevertheless, the necessity for action and for decision compels us as practical men to do our best to overlook this awkward fact and to behave exactly as we should if we had behind us a good Benthamite calculation of a series of prospective advantages and disadvantages, each multiplied by its appropriate probability, waiting to be summed (Keynes, 1937)."

CHAPTER 2

Background and Hypothesis Development

2.1 Background on R&D Tax Credit

The R&D tax credit is a temporary tax credit meant to incent incremental investments in corporate research. Companies compare their current level of qualifying R&D spending to a calculated base, and are permitted to claim a credit for spending above that base (subject to limitations).[8] It was implemented in 1981 as a way to fight the economic recession of the early 1980s by spurring corporate investment in R&D, and was legislated to expire in 1985.[9] However, previous to the first expiration, Congress extended the credit, while simultaneously reforming it (Kysar, 2005).

This pattern has continued since then. Since its installation in 1981, the credit has expired many times, and was reinstated (often retroactively) all but one of those times.[10] There have been numerous proposals and attempts to make the credit permanent, and while both political

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[8] This is, of necessity, an extremely simplified explanation of the credit calculation. Calculating the credit is both difficult and cumbersome, and involves legal judgment on issues that are unsettled (for example, such as what, precisely, is a qualified expenditure). It is for this reason that, anecdotally, many firms declare a fixed percentage of their claimed R&D tax credit as an uncertain tax benefit, and that the IRS has R&D tax credit claims as a Tier I issue (Grigsby, 2001).

[9] Three reasons are commonly given for why tax provisions are not permanently included in the tax code (Altshuler (2012). First, some provisions are meant to solve a temporary problem, so are initially intended to be only temporary. Second, making a provision temporary will force Congress to reassess the success of the measure before allowing the measure to remain law. Third, making provisions temporary provide benefits to members of Congress, through adding opacity to the scoring and budgetary process, and by providing potential lobbying benefits from interested parties frequently petitioning Congress for an extension of tax benefits. Kysar, 2005 argues that while initially, the first and second reasons for temporary tax provisions applied to the R&D tax credit, it remains temporary now largely to provide benefits to members of Congress.

[10] The credit was allowed to lapse without extension in 1995 and 1996 for 18 months, as detailed in Appendix A.

parties have continuously expressed support for both expanding and making the credit permanent, as of yet, this has not happened. For example, President Obama's budget proposal for 2013 both increases the size of the credit, and makes it permanent (Joint Committee on Taxation, 2012), and Mitt Romney's publically stated corporate tax proposals would have made the credit permanent (Romney, 2012).

The investment effects of the R&D tax credit have been well studied in the literature (e.g. Altshuler, 1988; Hines, 1994; Hall and Van Reenen, 2000; Berger, 1993; Bloom et al., 2002; Klassen et al., 2004; Wilson, 2009; Rao, 2010 and Gupta et al., 2011). This literature examines the effects of the R&D tax credit on investment in R&D, the trade-off between qualified (incented) expenditures versus non-qualifying expenditures, equilibrium effects, implicit taxes associated with increased prices of R&D related goods, and so on. Studies use a variety of empirical methods, use different data which have different limitations (e.g. public financial statement data, proprietary tax return data, aggregated public data), and generally find that the credit does spur additional R&D spending. However, these studies have largely ignored the effect of the temporary nature of the R&D tax credit, and none have examined the financial reporting consequences of the temporary tax credit.

2.2 Descriptive Analysis of R&D Tax Credit

In order to better understand the R&D tax credit as applied to public U.S. firms, this section summarizes descriptive statistics on the R&D tax credit. The R&D tax credit is one of the largest tax credits offered to firms in the United States. In 2008, the IRS reported that firm claims for the R&D tax credit were $8.1 billion (for all firms, public and private). In order to understand better the magnitude of the R&D tax credit for public firms in the U.S., and how these values change over time, I use Computer Assisted Hand Collection (explained in Appendix D) to collect approximately 4,600 firm-year disclosures about the R&D tax credit from 10-Ks from firms' effective tax rate reconciliation. These reconciliations generally contain data for three years.[11] Many of these observations contain a value of zero for the R&D tax credit for at least one year disclosed. Of the 3,697 observations with non-zero values of the credit, there is a huge range for values of the R&D tax credit. The 1st to 99th percentile range for firms with non-zero values of the R&D tax credit is $13,594 to $92,327,000 (from the firms Advanced Analogic Tech in 2004 and Genentech Inc in 2008). The median value of the credit in this sample is $ 656,968, and the mean is $ 4,591,177. In per share terms, the median firm's earnings are increased by $0.0218 per share on an annual basis (firms only disclose effective tax rate reconciliations on an annual basis). The median firm with a non-zero value of the credit has its effective tax rate is reduced by 2.2 percentage points

The credit exhibits some predictability across years for the same firm. For example, of the 4,596 firm-years in my sample, 3,697 have non-zero values for the R&D tax credit. The remaining firms explicitly disclose a value of zero for the credit in at least one of the three years in the effective tax rate reconciliation. This suggests that even knowing if the firm will receive the credit in a given year may be difficult. However, in the sample of firms that disclose receiving the R&D credit, the correlation between the value of the R&D tax credit in year t and in year t-1 is 84%. The AR(1) parameter across the whole sample is 0.75. However, estimated on an individual firm level, the average absolute value of the AR(1) parameter for the firms in this sample is 0.377, suggesting that for some firms, predictability is low.

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[11] While CAHC greatly increases the ability of the researcher to collect data quickly, it also induces some error into the data collection process, meaning that this brief summary of the R&D credit for public firms is based on data collected with some error.

2.3 Hypothesis Development

Temporary tax provisions such as the R&D tax credit have become a common feature of the U.S. tax code (e.g., McKinnon et al., 2010). They are often derided for being "year-to-year, start-and-stop, lobby-fest[s] (Beller, 2012)," and are considered one of the largest problems with U.S. corporate tax law (U.S. Chamber of Commerce, 2011). However, little is known about the consequences of temporary, but frequently extended, tax laws in general.[12] Even less is known about the financial reporting and market consequences of temporary tax laws.[13]

There is work that examines the financial accounting related effects of permanent tax law changes.[14] Givoly and Hayn (1992) examine market reactions surrounding news events related to the Tax Reform Act of 1986 (TRA 86). They find that the market impounded the effect of the tax rate decrease on firms' deferred tax liabilities. Partially consistent with these findings, Plumlee (2003) also finds that analysts are able to impound the results of simple tax law changes into their forecasts, but cannot understand more complex tax law changes.[15]

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[12] There is a literature that discusses tax uncertainty, or tax risk. This notion of tax uncertainty, or tax risk, is defined in several ways. My paper discusses what Neubig (2004) calls "legislative risk," although Neubig, 2004 does not draw the distinction between tax laws that may change because Congress always has power to change laws, or laws that will change unless Congress takes action (temporary laws legislated with an expiration date).

[13] A discussion of any effect of temporary tax laws is currently absent from the literature (Shackelford and Shevlin, 2001; Hanlon and Heitzman, 2010, and Graham, Raedy and Shackelford, 2011 do not discuss temporary tax provisions). There are non-empirical legal papers that discuss the potential causes and consequences of temporary tax law (e.g., Kysar, 2005) but these focus on political reasons such laws are not made permanent. There are also papers that examine the effects of temporary tax laws, but not laws that are frequently extended. These papers find timing of transactions and events to take advantage of favorable tax treatment (e.g., Kopczuk and Slemrod, 2003; House and Shapiro, 2008; Hanlon and Hoopes, 2012).

[14] This literature examine whether market participants' understand this tax motivated behavior, finding that market participants understand this behavior (Gleason and Mills, 2008), that they do not understand (Shane and Stock, 2006), and that it depends on the market participant whether the behavior is understood (Erickson, Heitzman and Zhang, 2011).

[15] To measure complexity, Plumlee (2003) classifies tax law changes based on the AICPA's Tax Complexity Index. This 15 question assessment, applicable to any tax law change, is used to score the six different tax law changes that Plumlee (2003) examines. The examined tax law changes received scores ranging from 1.7 to 31.0. The temporary tax law I evaluate, the R&D credit extensions, are relatively simple. For example, Section 301 of the Working Families Tax

While there is evidence of market participants understanding one-time (non-recurring) tax law changes, there is also evidence to the contrary. Chen and Schoderbek (2000) find that the market did not correctly impound the deferred tax effects of a 1% change in the corporate tax rate in 1993. This change occurred shortly after the financial accounting rules for taxes changed with the adoption of SFAS No. 109 (now part of ASC 740). Chen and Schoderbek (2000) attribute some of the failure to correctly impound information to the new accounting standard.

There is conflicting evidence regarding whether market participants understand one-time tax law changes. Whether market participants understand repeated tax law changes like the R&D credit extensions hinges on several factors. These factors include whether the specific temporary tax law under consideration (e.g., the R&D credit) is relatively simple (Plumlee, 2003) and whether market participants understand the financial accounting rules behind the law change (Chen and Schoderbek, 2000). In general, while calculation of the credit is complicated, the effects of the expiration and reinstatement of the credit are relatively simple. Further, as the credit has expired repeatedly, market participants could learn from past expirations.

Forecasting the effects of the R&D tax credit also depends on whether the requisite information is available to calculate the expected change in earnings because of an expired or extended tax credit. Disclosure regarding corporate research and the R&D tax credit is often scant, creating an environment where market participants lack relevant information (Merkley, 2011). Even for firms that disclose precisely how the R&D credit has impacted them in the past,

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Relief Act of 2004, which extended the R&D tax credit, has a score of 3. Market participants may well be able to understand these tax law changes.

this may not help predict the effect of the credit in the future.[16,17] In light of the above arguments, it is unclear whether market participants will understand the earnings effect of the R&D tax credit. This leads to the first formal hypothesis, which I present in alternative form:

H1: Retroactive extension of the R&D credit decreases market participants' earnings forecast accuracy.

If earnings are less predictable as a result of the R&D tax credit's temporary nature, prior evidence suggests real trading costs will increase (Affleck-Graves et al., 2002).[18] Kim and Verrecchia (1994) consider a market where firms disclose information that is elsewhere unobtainable, and that leads to differing interpretations regarding the information's implications for value.[19] They show that information disclosures in this environment will increase bid-ask spreads.[20]

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[16] This is because past values of qualifying R&D expenditures as a fraction of sales affect the current ability to qualify for the credit. Further, firms without taxable income will be limited in the benefit they receive from the credit. For example, Hawker Beechcraft Acquisition stated on 6/27/2010 that "due to our net operating losses and full valuation allowance, a reinstatement of the credit during the year would have no impact on our effective tax rate."

[17] The net value of the credit as it impacts earnings may well be less than the value of a reduction in taxable income as represented on the tax return, as, anecdotally, many firms reserve some portion of the R&D tax credit as an uncertain tax benefit, as the computation of the credit is difficult, and the IRS frequently challenges firms' assessment of the value of their credit. Firms may also lack a positive tax liability against which to deduct the credit. This analysis ignores the potential effect of the interaction between firms' ability under IRC §174 to deduct the full amount of R&D expenses in the year incurred and limitations on that deduction as a result of the §41 tax credit under §280C(c).

[18] One could also examine price responses around earnings announcement dates. Returns analysis would conflate the ability to predict the earnings impact of the credit and the cash flow implications surrounding expectations regarding extension of the credit. Under variations in assumptions regarding these items, one could plausibly predict very different returns responses, and it is difficult, if not impossible, to unravel which assumptions hold.

[19] In the model laid out by Kim and Verrecchia, 1994, the effect on earnings caused by the expired R&D credit (that earnings are lower this period but will be increased after a retroactive extension) is modeled by $\tilde{\delta}$, the noise portion of the mapping of earnings into future cash flows that is observed by informed traders as they uncover $\tilde{O}_i = \tilde{\delta} + \tilde{\varepsilon}_i$ through analysis of the firm. Noise in this signal, $\tilde{\varepsilon}_i$, may result from a failure of firms to exactly disclose the effect of the U.S federal R&D tax credit on their earnings in every period.

[20] My discussion and analysis of bid-ask spreads generally refers to the adverse selection portion of the bid-ask spread. However, if the expiration of the R&D tax credit led only to an increase in the transitory spread component (i.e. inventory holding cost or order processing costs), this would still be a cost of the R&D tax credit, and would still be important in assessing the consequences of its temporary nature. The inventory holding costs and order processing component of bid-ask spread may actually decrease during earnings announcement periods (Krinsky and Lee, 1996).

In my specific setting, traders come to an earnings announcement event with different information, beliefs, and expectations about the R&D tax credit and how it will affect earnings. During the earnings announcement, firms disclose the value of earnings, and also, to some extent, information about the R&D tax credit. Traders use the value of earnings to try to map earnings into firm value in order to make trading decisions. If the R&D credit is expired, this mapping is made more difficult because it is difficult to determine how much the depressed earnings is caused by the expired credit, and how much of that earnings will retroactively be realized after the extension of the credit. Knowing that this mapping is difficult, traders (especially relatively less informed traders who may be less confident about their ability to understand the credit) will price protect themselves by being less willing to trade at low costs. [21] By doing this, they hope to prevent losses that would result from trading with relatively more informed traders. As a result, bid-ask spreads will increase.[22]

H2: Bid-ask spreads will increase around earnings announcements affected by the expired credit.

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[21] Correspondence with analysts shows variation in understanding the credit. One analyst stated, incorrectly, that "the credit is for smaller firms, whereas we are tracking and analyzing companies with well over $100M in assets." In 2008, 86.9% of R&D tax credit dollars went to firms with assets over $50 million.

[22] The obverse may, of course, be true—earnings announcements, and any information they may have about the expired credit, may act as substitutes for public information, taking away the private advantage those with non-public information have, and therefore reducing the market makers need to price-protect by increasing the bid-ask spread. However, the empirical evidence seems to suggest that most earnings announcements are the type of disclosure which offers advantages to the informed. For example, Lee, Mucklow and Ready (1993) find that bid-ask spreads increase just following an earnings announcement, and Affleck-Graves et al. (2002) find that this result is concentrated among firms with less predictable earnings.

CHAPTER 3

Sample Selection, Variable Measurement and Research Design

3.1 Sample Selection

To test these hypotheses, I use a sample of publically traded U.S. firms from non-regulated and non-financial industries (excluding SICs 4900–4949 and 6000–6999) that have coverage on the Compustat Quarterly file from 1994–2011.[23] I retain only U.S. based firms so the sample is more homogeneous with regard to reporting systems. I retain only non-regulated and non-financial industries because the financial accounting and tax rules are different for these firms. My sample period covers only 1994-2011 because machine readable 10-K filings are only available since 1994, and I rely on 10-Ks to determine that firms receive the R&D tax credit. Only calendar-year-end firms are used, allowing comparability across firms (i.e., extension in October is always in the fourth quarter).[24] For the earnings forecast analysis, the firm/quarter data is merged with detailed analyst revisions from IBES. In the bid-ask spread analysis, the quarterly firm/year data is merged with data gathered from the TAQ database, allowing a

[23] I purposefully include firms that never receive the R&D credit, and come from industries which rarely receive the credit, in order to take advantage of variation in credit receipt. This allows me to achieve identification both from receipt of the credit, and being in a time period affected by the expired credit. I examine the interaction of these two effects, essentially controlling for both firm type (credit receiving or not) and time period specific effects. Isolating only a sample of firms that received the credit would not allow me to use variance in credit receipt in order to achieve identification.

[24] This does not appear to systematically eliminate any research-focused firms from my sample. 71% of U.S. based, non-regulated firms in Compustat in 2011 are calendar year end firms. In this same sample, 74% of the total R&D expense was recorded by calendar year end firms (as well as 79% of assets and 69% of sales).

measure of bid-ask spread. Table 1, Panels A and B contain an outline of the sample selection procedure. [25]

Panel C of Table 1 shows the percentage of the firm/quarter level sample by industry, for all industries that comprise over 1% of the sample. The first column represents the entire sample. Columns 2–4 show the composition of the portion of the sample that receive the R&D tax credit during the year, using three different measures of *R&D Credit Exposure (*described in the next section). As is expected, the data show that some industries are more likely to receive the credit than others. For example, Pharmaceutical Products, Electronic Equipment, and Medical Equipment are much more likely than other industries to have *R&D Credit Exposure*.

3.2 Variable Measure and Research Design

This section describes how I identify which firms will be affected by the R&D tax credit. Before I test my hypotheses, I also conduct analysis to ensure that analysts incorporate the effect of the credit in their forecasts just following extensions of the credit (i.e., analysts do not ignore extensions of the R&D credit). I find that revisions following an extension of the R&D credit contain analysts' understanding of the extension of the R&D credit on earnings.

3.2.1 Measurement of Research and Development Tax Credit Exposure

There are at least two methods of identifying firms affected by the R&D tax credit (referred to as *R&D Credit Exposure*): 1) estimating *R&D Credit Exposure* using R&D expense from the financial statements, and 2) hand collecting the firm's own disclosures regarding the R&D tax

[25] Another potential sample constraint would be to limit the expirations I examine to those which occur at least two years after the credit had previously expired. This may be useful because market participants who use quarterly earnings from the previous year as a benchmark would be comparing the quarter of the expired credit to a quarter that contained the credit, as evidence suggests that investors benchmark current quarter earnings against the same quarter in the previous year (Brown and Caylor, 2005). They may provide a more powerful setting in which to test my hypothesis, however, in doing this, I would also be classifying quarters that did not have a currently enacted tax credit as if they did.

credit from SEC filings. I choose the second option, as Rao (2010) finds financial accounting R&D expense is a poor proxy for R&D tax credit use.[26] Using firm disclosures, I measure *R&D Credit Exposure* in three different ways.[27] First, *R&D Mention* is an indicator variable coded to equal one for all firms that mention the R&D tax credit anywhere in a 10-K (obtained by searching for a variety of R&D tax credit related words, detailed in Appendix B). Second, *R&D Expire Firm* is an indicator variable coded to equal one if the firm ever explicitly discloses that its earnings were impacted by the expiring R&D tax credit. I obtain this measure by using a computer program to find over 500 10-Qs that mention the R&D tax credit's expiration having affected quarterly earnings. I then manually read each one to ensure the disclosure relates to the U.S. federal R&D tax credit. Finally, *R&D in ETR Reconciliation* is coded to equal one if the R&D tax credit is a line item in the annual effective tax rate (ETR) reconciliation in year *t*. I obtain this measure by locating any instance of the word "research" or "R&D" in the annual effective tax rate reconciliation portion of firms' 10-Ks. I then manually examine each of these reconciliations and determine whether the line item involves the federal U.S. R&D tax credit.[28]

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[26] Using disclosed R&D spending is a poor proxy for R&D tax credit receipts. Expensed R&D for financial accounting purposes is not equal to qualifying R&D spending for R&D tax credit purposes. Rao (2010) uses a sample 755 firm/year observations for which she has both IRS and Compustat data, and she finds that using only the Compustat data, her model incorrectly determines whether a firm is eligible for an unlimited credit 44% of the time, and that only 38% of financial accounting R&D expense qualifies for the R&D tax credit.

[27] Using explicit credit related disclosures maximizes construct validity at the cost of external and internal validity. Firms that choose to disclose *R&D Credit Exposure* may not be representative of all R&D tax credit firms (external validity). Firms that disclose *R&D Credit Exposure* may be systematically different than other firms in ways related to my outcome variables, and that this sample selection bias results in invalid inference (internal validity). Another concern is that my measures capture disclosure generally. However, I predict that *R&D Credit Exposure* leads to less predictability and higher bid-ask spreads. Better disclosure generally results in lower bid-ask spreads and more forecastable earnings (e.g., Leuz and Verrecchia, 2000; Lang and Lundholm, 1996).

[28] Another method of measuring which firms are affected by the R&D tax credit, proprietary data from the IRS, is not available to me at this time. However, even this data would have its limitations. While this could provide the actual dollar value of firm's historical receipt of the U.S. federal R&D tax credit, it would not provide the exact impact on earnings, as consolidation differences for financial accounting tax purposes, and, more importantly, portions of the credit reserved against as uncertain tax benefits, would cause differences between the credit as per the tax return, and its impact on earnings.

3.2.2 Timing of Analysts Reaction to R&D Tax Credit Extension

In order to test how accurately analysts forecast earnings following an R&D tax credit extension, I first ensure that analysts are aware of the extension and try to forecast earnings taking the effect of the R&D credit into account. This examination helps assuage concerns that analysts merely ignore the effects of the tax credit or that they try to include its effect on earnings before the credit is officially extended.[29]

First, analysts' discussion of the credit peaks just after the credit is extended. Figure 1 graphs the number of analyst reports by month that reference the "R&D Tax Credit" or the "research and development tax credit," for 1997–2011 (years with enough data to have meaning) for all analyst reports on Thomson One. This number is scaled by the total number of reports on Thomson One in each month. The dark vertical lines represent months when the R&D tax credit was extended. The credit is mentioned more frequently surrounding extension months, consistent with financial analysts not ignoring the effects the R&D tax credit.[30]

Next, analysts that cover *R&D Credit Exposure* firms issue more revisions just following an extension of the R&D tax credit. Figure 2 graphs the number of standardized forecast revisions per day in event time for *R&D in ETR Reconciliation* firms and for *Non-R&D in ETR Reconciliation* firms. Event day zero represents the eight extensions of the R&D credit. This graph suggests an increase in the number of revisions for *R&D in ETR Reconciliation* firms versus *Non-R&D in ETR Reconciliation* firms. The number of revisions per day for the *R&D in ETR Reconciliation* firms is

[29] Correspondence with analysts suggests some analysts ignore the credit. Some analysts stated, "the R&D tax credit often gets lost in the wash…" or "I don't model anything specific to the tax credit…" Alternatively, others indicated they forecast the credit just after extension of the credit. This occurred in a Prudential Equity Group research report on February 1, 2006: "We will re-visit our EPS estimates once the R&D tax credit is formally extended."

[30] Inspection of some reports reveals that these discussions are about including the credit after extension. For example, Robert Gold of Brigantine Advisors noted on February 9, 2011 that "As a result of the reinstatement of the federal R&D tax credit, we raise our Q4 EPS forecast by $0.02 to $0.20…"

higher than for *Non-R&D in ETR Reconciliation* firms 15 of the first 20 days. This difference is statistically significant—if R&D and non-R&D firms had an equal chance of having more revisions than the other type of firm, there is a 2.069% chance of 15 or more out of 20 days having more revisions for *R&D in ETR Reconciliation* firms than for *Non-R&D in ETR Reconciliation*. The data suggest that analysts respond to the extension of the credit by issuing more revisions of forecasted earnings.[31]

In order to confirm that this heightened number of revisions is not spurious, I replicate this analysis using placebo extension dates (1 year and 6 months before the actual dates). I obtain 8, 12, and 11 instances in the first 20 days following extensions where *R&D Credit Exposure* firms have more revisions than the non-*R&D Credit Exposure* firms (outcomes that happen with greater than 25% probability).

Finally, I find that revisions that span an R&D tax credit extension for *R&D Credit Exposure* firms are larger than other revisions. To test this, I estimate the following regression on a panel of analysts' forecast revisions of EPS that is outlined in Table 1, Panel A.

$$Revision = \beta_0 + \beta_1 Extension\ Between\ Revisions + \beta_2 R\&D\ Tax\ Credit\ Exposure + \beta_3 Extension\ Between\ Revisions \times R\&D\ Tax\ Credit\ Exposure + \sum \beta_k Fixed\ Effects + \epsilon \quad (1)$$

Revision is equal to the value of the forecast revision of EPS (the outstanding forecast less the most recent outstanding forecast, scaled by price per share at the beginning of the quarter and multiplied by 100). *Extension Between Revisions* is coded to equal one if the analysts' most recent outstanding forecast is before an extension of the credit, and the revision occurs after the

[31] This analysis assumes that whether the difference between the number *R&D in ETR Reconciliation* and *Non-R&D in ETR Reconciliation* revisions in a day is positive is distributed binomial, with p=0.50. Duplicating this analysis for the other two proxies of *R&D Credit Exposure*, *R&D Mention* and *R&D Expire Firm* yields 15 and 19, respectively, out of the first 20 days having more revisions for *R&D Credit Exposure* firms. Combined, the chances of achieving 15+19+15=44 or more revisions for *R&D Credit Exposure* than *Non-R&D Credit Exposure* out of 60 days (20 days each across the three proxies) of having more revisions for *R&D Credit Exposure* firms is 0.00000030 (this joint test assumes independence between the three measures of *R&D Credit Exposure*).

extension of the credit. β_3 represents the incremental change in the EPS forecast for a firm with *R&D Credit Exposure* where the revision spanned the passage of a R&D credit extension. If analysts include the earnings effects of the extended credit in their revision β_3 will be positive. The results of estimating Model 1 are in Table 3. The coefficient on the variable of interest, *Extension Between Revision X R&D Credit Exposure*, is significantly positive, with values across the three proxies ranging from 0.127 to 0.200. These values suggest that analysts do not ignore the R&D credit, and include the credit's effects in their revision following its extension.

In sum, analysts discuss the credit in their reports around credit extensions, they issue more revisions, and the revisions they issue are on average larger following an extension of the R&D tax credit than for revisions not following an R&D credit extension for non-R&D credit firms. This evidence is consistent with analysts incorporating the credit into their forecasts just after the extension of the credit.[32]

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[32] In untabulated analysis, I investigate when analysts remove the effects of the R&D tax credit from their estimates. I find no evidence that analysts remove the effects of the R&D tax credit just following an expiration of the R&D tax credit. Specifically, using annual forecasts of EPS, I find no consistent change in *Forecast Improvement* following expirations of the R&D tax credit for firms that receive the R&D tax credit.

CHAPTER 4

Test of First Hypothesis - Earnings Forecasts and the R&D Tax Credit

4.1 Research Design

The main test of H1 examines the accuracy of analysts' forecast revisions when an analyst has an outstanding forecast, the R&D tax credit is extended, and the analyst revises their earnings forecast. The test examines the effect of two simultaneous treatments using a difference in difference test design. For a revision to include the effect of the newly extended R&D tax credit I argue that the firm must receive the R&D tax credit (the first treatment, *R&D Credit Exposure*) and that the revision must be updating a forecast that happened before the extension of the R&D tax credit (the second treatment, *Extension Between Revisions*). As a result, I separate forecast revisions into four different categories: 1) revisions for firms that do not receive the R&D tax credit and are not updating a forecast that happened before the extension of the R&D tax credit, 2) revisions for firms that do not receive the R&D tax credit but are updating a forecast that happened before the extension of the R&D tax credit, 3) revisions for firms that do receive the R&D tax credit but are not updating a forecast that happened before the extension of the R&D tax credit, and finally, 4) revisions for firms that both receive the R&D tax credit and update a forecast that happened before the extension of the R&D tax credit. My test compares whether revisions in the fourth category move the forecast incrementally further away from earnings than the other three categories.[33] This test is done in a regression framework:

$$\textit{Forecast Improvement} = \beta_0 + \beta_1 \textit{Extension Between Revisions} + \beta_2 \textit{R\&D Tax Credit Exposure} + \beta_3 \textit{Extension Between Revisions X R\&D Tax Credit Exposure} + \sum \beta_k \textit{Fixed Effects} + \epsilon. \quad (2)$$

The coefficient of interest, β_3, represents the incremental effect of receiving the credit combined with having the revision update a forecast that occurred before an extension of the R&D tax credit.[34] *Forecast Improvement* is equal to the signed difference between the absolute forecast error of a quarterly EPS forecast and the absolute forecast error of the revision to that forecast, all scaled by price per share at the beginning of the quarter and multiplied by 100.[35] It represents the relative degree to which the revision moves the forecast towards (or away from) actual realized earnings. Positive values of *Forecast Improvement* mean that the revision improved the forecast (i.e. made the forecast more accurate, moving it closer to realized earnings), and negative values indicate that the revision made the forecast less accurate. *Extension Between Revisions* is coded to equal one if, after the enactment of the R&D tax credit, the analyst revised a forecast that occurred before the R&D tax credit extension (extension dates are in Appendix A).[36] *Fixed Effects* include year and quarter fixed effects, controlling for annual

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[33] This identification strategy assumes that forecasts just following an extension of the R&D tax credit for firms that receive the credit contain the analysts' assessment of the effect of the credit for the firm. Analysts may, however, coincidentally revise just after an extension of the R&D credit, without making an explicit adjustment for the firm. I assume that these revisions will not be systematically different than other revisions, and will bias β_3 towards 0.

[34] β_3 will be the difference of the mean value of *Forecast Improvement* for category 4 less the mean of category 3, all less the mean of category 2 less the mean of category 1. Using the notation of Figure 3, β_3 will be the mean value of *Forecast Improvement* of (AB-BC)-(DE-EF).

[35] Cheong and Thomas (2012) document that scaling by price may impose bias on coefficient estimates. They recommend sensitivity tests using dependent variables not scaled by price, and including price as a control variable. Not scaling by price and including price as a control variable does not alter my inference.

[36] Returns analysis around these dates of extension of the R&D tax credit would likely not be useful for several reasons. One main reason is that the date of the enactment likely contains very little information for the market. For

and repeated intra-year variation in *Forecast Improvement*. I cluster standard errors by analyst. A negative β_3 supports H1, meaning that forecast revisions following extensions of the tax credit for *R&D Credit Exposure* firms incrementally decrease the accuracy of the outstanding forecast, suggesting that the retroactive extension of the R&D credit adversely affects analysts' ability to predict earnings.

To clarify the test done by regression 1, Figure 3 contains a timeline of quarterly earnings forecasts and the R&D tax credit extension date. Firm A has *R&D Credit Exposure*, while Firm B does not. The test of H1 compares *Forecast Improvement* for revisions (i.e., the difference between forecast A and forecast B, revision AB) that span a R&D tax credit extension date (the lines down the middle of the figure) for *R&D Credit Exposure* firms (Firm A), to the other types of revisions. If H1 holds, I expect to see the incremental effect in forecast accuracy improvements for revisions that span an extension of the credit for firms affected by the credit (revisions like revision AB in Figure 3) to be negative, and therefore, β_3 to be negative.

4.2 Results

The results of estimating regression 2 are tabulated in Table 4. β_1 is positive, which is consistent with revisions that span an extension of the tax credit being more accurate for firms that do not receive the R&D tax credit than revisions that do not span an enactment date. I discuss this more fully in Section 7.2.[37]

example, the 1998 R&D tax credit extension was signed into law by President Clinton on October 21, 1998. The Clinton Administration had announced its support of the 1998 R&D tax credit extension as early as late January of 1998 (Markoff, 1998), and Clinton's 1998 budget, released shortly thereafter, included the R&D tax credit, extended through 2003 (Clinton, 1998). The bill that extended the credit, H.R. 4328, was introduced on July 24, 1998, and passed the House and the Senate (with changes), by July 30, 1998. However, it was not signed into law until October 21, 1998. There is reason to believe this is the case.

[37] *Extension Between Revisions* is inclined to be coded to equal one the longer the delay between a forecast and a revision, and the longer the delay, the more accurate a revision. This may bias the estimate of β_1. To limit the effect this has on my estimation, I choose a relatively narrow time frame, 30 days, for declaring a forecast stale and discarding it. Limiting my sample to revisions with no more than 30 days also increases the likelihood that the only

The coefficient on *Extension Between Revisions X R&D Credit Exposure*, β_3, is reliably negative across all three proxies for *R&D Credit Exposure*, consistent with H1. The coefficient ranges from negative 0.125 to negative 0.159. The coefficients suggest a non-trivial impact on forecast accuracy. The most conservative coefficient on the interaction term, obtained using *R&D Mention* as a proxy for *R&D Credit Exposure*, is -0.125, and, after unscaling by lagged price and dividing by 100, represents a $0.039 incremental movement *away* from actual earnings. Thus, the data are consistent with forecasts becoming incrementally less accurate. Put in perspective, the mean value of *Forecast Improvement* for my entire sample is 0.19, which corresponds to a $0.065 movement closer to earnings per share.[38, 39, 40]

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material event for the firm in that time period was the R&D tax credit extension. I discuss other sensitivity tests I do to assuage concerns related to the coding of *Extension Between Revisions* later in the paper.

[38] Firms may be cognizant of this variability caused by the R&D tax credit and take additional earnings smoothing measures in order to minimize the extent that actual variability in earnings numbers are realized as a result of the R&D tax credit. The extent of this behavior is currently beyond the scope of this paper.

[39] In an untabulated test, I replace *Extension Between Revisions* with a variable equal to the number of quarters the credit had been expired when it was extended, and equal to zero for *Extension Between Revision* equal to zero. The coefficient on the interaction term is still negative and significant. Further, if I replace *Extension Between Revision* with a vector of indicators for the number of quarters the credit had been expired before being extended (1, 2 or 4), the fourth quarter indicator is the largest. This suggests that analysts misinterpret the credits' effects more when there are more quarters of the credit included in the "catch-up" quarter of extension.

[40] It is important to note that the signs of the coefficients across Tables 3 and 4 are exactly opposite, and the absolute magnitude of these coefficients is very similar. This result is discussed in depth in Appendix G.

CHAPTER 5

Test of Second Hypothesis – Bid-Ask Spreads

I next explore the increase in trading costs associated with earnings announcements affected by the expired R&D tax credit.[41] To do this, I examine bid-ask spreads surrounding earnings announcements in the quarters when the R&D tax credit is expired, but is eventually retroactively extended. I place firm-quarter observations into four different categories: 1) quarters for firms that do not receive the R&D tax credit where the credit is not temporarily expired, 2) quarters for firms that do not receive the R&D tax credit where the credit is temporarily expired, 3) quarters for firms that receive the R&D tax credit where the credit is not temporarily expired, and, 4) quarters for firms that receive the R&D tax credit where the credit is temporarily expired. Model 3 compares the size of the change in the abnormal bid-ask spread surrounding earnings announcements for firm-quarters in these four categories, examining whether observations in category four are systematically different than the other categories:[42]

$$\textit{Abnormal Bid-Ask Spread} = \beta_0 + \beta_1 \textit{Lapsed Credit Quarter} + \beta_2 \textit{R\&D Tax Credit Exposure} + \beta_3 \textit{Lapsed Credit Quarter X R\&D Tax Credit Exposure} + \sum \beta_k \textit{Fixed Effects} + \epsilon \quad (3)$$

Abnormal Bid-Ask Spread is the average bid-ask spread from the event period surrounding the earnings announcement date *t* (trading day *t* to *t*+1), less the average bid-ask spread from

[41] I examine quarters when the credit is expired because this will reduce earnings, and an increase in bid-ask spreads may be more responsive to unexpected losses than unexpected gains. After adding an additional indicator variable for quarters where the credit was extended, and the interaction of this variable and *R&D Credit Exposure*, the effect on *R&D Credit Expiration Quarter X R&D Credit Exposure* remains positive and significant, and the sign on the interaction between the after extension quarter indicator and *R&D Credit Exposure* is either insignificant (in two cases), or significant and positive (in the remaining one case).

[42] Specifically, β_3 (without the fixed effects) would be the mean value of *Abnormal Bid-Ask Spread* for firms in categories (4-3)-(2-1).

the days *t*-45 to *t*-5. Bid-ask spreads are calculated using TAQ intra-day data, where the bid-ask spread is first computed at a quote level as the offer price less the bid price, divided by the average of the offer and bid price, all multiplied by 100. This offer level measure is then averaged during each day for all offers occurring during normal trading hours, resulting in a daily measure of bid-ask spread.[43] The formulation of the dependent variable differences out firm- and time- specific components of the bid-ask spread, leaving only the component due to the specific earnings announcement period for a specific firm (Eleswarapu, Thompson and Venkataraman, 2004).[44] This estimation looks for systematic differences in *Abnormal Bid-Ask Spread* for firms affected by the R&D tax credit (*R&D Tax Credit Exposure*) in quarters when quarterly earnings will be affected by the expired tax credit (*Lapsed Credit Quarter*). An increase in trading costs due to the expiration of the R&D tax credit will result in $\beta_3 > 0$.

The results of this estimation are tabulated in Table 5. Column 1 uses *R&D Mention* as a measure of *R&D Credit Exposure*. $\beta_1 < 0$ indicates that in the quarter in which the credit is expired, bid-ask spreads are also generally smaller. The estimate of a negative β_2 reveals that firms with

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[43] For firms where an exact announcement time is available from IBES, if the earnings announcement took place after 4:00 PM Eastern Time, day *t* is moved to *t*+1 (Berkman and Truong, 2009). Limiting bid-ask spread calculations to trading hours is common (e.g., Lee et al., 1993). Much of the increase in bid-ask spread happens within the first half hour after an earnings annoucement (Lee et al. (1993)). Of all quarterly earnings announcements in IBES during my sample period, 15% happen during trading hours. In a random period, January and February, 2004, the mean *Abnormal Bid-ask Spread* (defined above) during market hours was 4.6, and during nonmarket hours was 9.9. To what extent my results are affected by limiting the bid-ask spread calculation to trades during market hours is not known, and is a limitation of this paper.

[44] For example, systematic differences in bid-ask spreads related to the exchange on which the shares are traded (Affleck-Graves, Hedge and Miller, 1994), the number of market makers (Affleck-Graves et al., 2002), specialist monopoly power (Glosten, 1989), market determined tic-size (Goldstein and Kavajecz, 2000), and general characteristics of the firm and economic conditions should all be differenced out. My simple model of abnormal bid-ask spread is similar to that used by Blankespoor, Miller and White (2012). Van Ness, Van Ness and Warr (2001) note that structural models intended to capture only the adverse selection component of bid-ask spread perform poorly, suggesting that use of a more complex model may induce noise in my measurement.

R&D Credit Exposure generally have smaller bid-ask spreads than other firms.[45] Using *R&D Mention,* the coefficient of interest, β_3, has a positive value of 0.066 (significant at the $p<.05$ level), consistent with an increase in trading costs as a result of the expired credit. The estimates using the other two proxies for *R&D Credit Exposure* are also statistically significant at a $p<0.05$ level or better, and range from 0.126 to 0.164 across the measures of *R&D Credit Exposure*.

The size of the smallest coefficient of the three estimates using the three proxies for *R&D Credit Exposure*, 0.066, suggests that the effect of the expiration of the R&D tax credit on trading costs is non-trivial. Taking out the effects of scaling, this equates to a mean incremental increase per share traded of $0.013 associated with the expiration of the R&D credit for affected firm-quarters.

To put this estimate in perspective, I estimate regression 3, replacing the two R&D tax credit related variables and their interaction with an indicator variable, *Big Miss*, an indicator variable equal to one for a firm missing the outstanding consensus quarterly earnings forecast by more than $0.01 per share. The estimated coefficient on *Big Miss* is 0.208, which equates to a $0.019 increase in bid-ask spreads over the earnings announcement period. While the lapsed R&D tax credit appears to have a material impact on the increase in bid-ask spreads, it is not as substantial as the increase that results from missing quarterly earnings.[46, 47]

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[45] This is somewhat contrary to the finding of Van Ness et al. (2001), who argue that information asymmetry for R&D intensive firms should be larger than for other firms. *R&D Credit Exposure* firms, however, are different from R&D intensive firms, in that the former are necessarily profitable (else there is no tax liability against which to use the credit), and are generally large, whereas R&D intensive firms could be younger, initially unprofitable firms.

[46] These estimates can be compared to a contemporaneous examination of *Abnormal Bid Ask Spread*. Using a similar measure of *Abnormal Bid Ask Spread*, and a similar empirical framework, Blankespoor et al. (2012 estimate the increase in information asymmetry as a result of the recently mandated requirement of XBRL tagging in SEC filings. They estimate that firms subject to the XBRL tagging requirement, in the period where XBRL tagging was required, had a seemingly large increase in *Abnormal Bid Ask Spread*. While their sample of firms is different than mine, they do calculate *Abnormal Bid Ask Spread* in almost exactly the same way, suggesting that they also estimate relatively large changes in bid-ask spread.

The aggregate effect of the lapsed R&D credit is large. There are 8,305 *Lapsed Credit Quarters* for *R&D Mention* firms, which have a mean volume of 4.735 million shares during the earnings announcement period. This results in an aggregate trading cost for R&D credit exposed firms in expiration quarters from 1994–2011 of $519 million (4,735,828*0.0132*8,305). Put in context, in 2008, the most recent expiration year with data available, the IRS reports that non pass-through entities filing for a R&D tax credit claimed a total of $8.1 billion dollars in R&D tax credits (including firms not publicly traded). The trading cost increase during earnings announcement periods when the credit was expired in 2008 was $142 million, or nearly 2% of R&D tax credits claimed.[48]

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[47] The standard deviation of Abnormal Bid-Ask Spread is large (1.99), relative to the change related to the expired tax credit (the coefficient estimate of 0.066). Interpretation of the size of the effect must also be done keeping this in mind.

[48] These estimates related to social cost are obviously limited. As Hayek noted, the "inherent limitations of our numerical knowledge … are so often overlooked… It has led to the illusion…that we can use this technique for the determination and prediction of the numerical values of those magnitudes; and this has led to a vain search for quantitative or numerical constants (Hayek, 1974)."

CHAPTER 6

Additional Analyses

6.1 Cross-Sectional Test of Disclosure

Lack of disclosure may be one reason analysts are unable to understand tax law changes (Chen and Schoderbek, 2000). I examine the effect of disclosure on the ability of analysts to improve their forecasts by augmenting Model 2 with a proxy for corporate disclosure, *Guide*, which is an indicator variable coded to equal one if the firm issued EPS guidance in that quarter (Miller, 2002):[49]

$$\textit{Forecast Improvement} = \beta_0 + \beta_1 \textit{Extension Between Revisions} + \beta_2 \textit{Guidance} + \beta_3 \textit{R\&D Credit Exposure} + \beta_4 \textit{Extension Between Revisions X Guidance} + \beta_5 \textit{Extension Between Revisions X R\&D Credit Exposure} + \beta_6 \textit{R\&D Credit Exposure X Guidance} + \beta_7 \textit{Extension Between Revisions X R\&D Credit Exposure X Guidance} + \sum \beta_k \textit{Fixed Effects} + \epsilon. \quad (4)$$

The variable of interest is β_7. I expect β_7 to be positive, meaning that revisions after R&D tax credit extensions for *R&D Credit Exposure* firms incrementally improve forecast accuracy more for guidance firms than non-guidance firms. Table 6 tabulates the results of estimating Model 4. The estimate for β_7 is positive for all three proxies of *R&D Credit Exposure*, suggesting a mitigating effect of disclosure on the relationship between extension of the R&D tax credit and

[49] To ensure that my results are not biased by the documented biases in the CIG data, I follow Chuk, Matsumoto and Miller (2012) and also estimate my regression using a sample of firms with an above mean amount of analyst coverage. The statistical strength of my results substantially improves in this sample, with all three of the three way interactions being positive and significant at a $p<0.05$ level or better.

Forecast Improvement.[50] The estimates using *R&D Mention* and *R&D Expire Firm* as a proxy for *R&D Credit Exposure* are both significant at the p<.05 level. [51, 52]

The use of more tax-specific ways to gauge *Disclosure* yields the same relationship. Using the number of numbers (Blankespoor, 2012) or the number of words (Li, 2008) in the tax footnote (for the portion of the sample for which I am able to extract the tax footnote), the natural log of both of these numbers, or an indicator variable coded to one if the firm has an above mean number of numbers in their tax footnote relative to other firms in the year with the three proxies for *R&D Credit Exposure* (for 15 total regressions), the coefficient on the three-way interaction term, *Extension Between Revisions X R&D Credit Exposure X Disclosure,* is positive in 15 of the 15 regressions, and significant at a two-tailed p<.10 level or better 6 of those 15 times.

6.2 Cross-Sectional Test of Investor Sophistication

Hand (1990) documents that market understanding of difficult accounting issues is aided by having a sophisticated investor base. Having a larger proportion of the firm held by relatively

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[50] This analysis brings to question why managers do not merely disclose more information to enable analysts to understand the effects of R&D credit extensions. There are several reasons why managers may not disclose information regarding the effects of the R&D tax credit. Managers may not disclose because they do not have the information to disclose (some firms do not calculate quarterly estimates of the credit if it is not current law), their desire to limit disclosure about R&D generally (Merkley, 2011), or other costs associated with disclosure. However, in untabulated regressions, I find that manager issued guidance is more common for firms with *R&D Credit Exposure* in quarters of expiration, and quarters of extension, so some managers may be trying to overcome the information problem.

[51] While guidance improving understanding of the forecast seems plausible, it also may be the case that managers are not specific enough with their guidance to aid in forecasting the effects of the R&D tax credit. For example a Prudential Equity Group report from February 1, 2006 covering Johnson & Johnson indicates that, "It is unclear if other companies in our coverage universe have also excluded the R&D tax credit from their 2006 tax guidance." While Johnson and Johnson did clarify if R&D was included in their guidance, other firms had not, and so guidance may not help, and could possibly hinder, the markets' understanding of the R&D tax credit extensions.

[52] Another possibility for systematic misunderstanding of the credit extensions is that the disclosures that firms issue may themselves contain bias. For example, many firms disclose the impact of the R&D tax credit on their effective tax rate by combining it with other items (other credits, the R&D credit for other jurisdictions, etc.), which would have the effect of creating the perception that the R&D credit received by the firm is larger than it really is. I investigate this by investigating whether firms that have the R&D tax credit as a line item in the ETR reconciliation, but combine it with other items, have a systematically different coefficient on Extension Between Revisions X R&D Credit Exposure. I find no systematic difference.

sophisticated investors increases the probability that any two investors trading will be sophisticated. Two sophisticated investors trading with each other may decrease the probability that the bid-ask spread related to information asymmetry will decrease because both traders will be more likely to understand the effects of the credit on earnings. If institutional investors understand the effect of the R&D tax credit on firms' earnings, I would expect the bid-ask spread to be lower during earnings announcement periods affected by the expired R&D tax credit for firms held by institutional investors. To test this prediction, I estimate the following regression:

Abnormal Bid-Ask Spread = β_0 + β_1 *Lapsed Credit Quarter* + β_2*Institutional Investors* + β_3*R&D Credit Exposure* + β_4 *Lapsed Credit Quarter X Institutional Investors* + β_5 *Lapsed Credit Quarter X R&D Credit Exposure* + β_6*R&D Credit Exposure X Institutional Investors* + β_7 *Lapsed Credit Quarter X R&D Credit Exposure X Institutional Investors* + $\sum \beta_k$*Fixed Effects* + ϵ. (5)

The variable of interest is β_7, and it is expected to be negative. I obtain the percentage of the firm held by institutional investors through Thomson-Reuter's Institutional Holdings (13F) database. If a firm-quarter has more than the mean percentage of the firm held by institutions for the year, then the variable *Institutional Investors* is coded to equal one. Model 5 is estimated in Table 7. The coefficient on *Lapsed Credit Quarter X R&D Credit Exposure X Institutional Investors*, β_7, is negative in all three of the regressions, and negative and significant at a $p<.01$ level in two of the three regressions. This result is consistent with the effects of the R&D credit's extension being better understood at firms with a relatively more sophisticated investor base.

CHAPTER 7

Robustness Tests of H1

The difference in difference test design used to test both H1 and H2 is designed to eliminate many threats to validity, however, some validity threats remain. This section outlines several robustness tests I do to help validate my findings for H1 and H2. Different sensitivity tests are required to help validate H1 and H2, as the two tests have differing characteristics, different treatments, and differing available data.[53]

7.1 Correlated Omitted Variables

My difference in difference identification strategy limits the ability of correlated omitted variables to affect my inference. However, in order to verify that my results are robust to the inclusion of factors that may affect *Forecast Improvement*, I include controls for time-varying attributes of the analyst (e.g., Clement, 1999) the firm, and the specific forecast (e.g., Cooper, Day and Lewis, 2001 and Gleason and Lee, 2003). First, I control for *Firm Specific Experience* (the number of years since an analyst issued their first forecast for the firm), *General Experience* (the number of years since the analyst's first forecast is recorded on IBES), *Number of Firms Covered* (the number of different firms covered by the analyst in the fiscal year), and *Percent R&D Exposure Firms* (the percentage of an analyst's forecasts related to firms with R&D tax credit exposure in the fiscal year). Adding these control variables to Model 2 does not affect inference.

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[53] For example, the availability of forecasts from forecasters other than equity analysts, and forecasts not affected by the tax credit (pretax income forecasts) allow for tests not available in the bid-ask spread setting. Further, since the treatment imposed in the tests of H1 involve the passage of a specific bill that contains many other legislative items, the possibility that those other items affect my inference must be examined.

Next, I control for firm and forecast specific attributes. I control for *Momentum* (as a result of the findings of Cooper et al. (2001), measured as the buy and hold return for the six months before the earnings announcement), *Time Between Forecasts* (days between the outstanding forecast and the revision), *Book to Market* (the beginning of quarter book to market), *Analyst Coverage* (the number of analysts forecasting earnings for the quarter), *Forecast Horizon* (the days between quarter end and the forecast date) and *Ln(MVE)* (the beginning of quarter logged market value of equity). Controlling for these factors also does not affect inference. In additional tests, adding analysts fixed effects to Model 2 also does not change my inference.

Table 8 tabulates the results of adding all these controls to Model 2. The three coefficients from the interaction between *R&D Credit Exposure* (using the three proxies) and *Extension Between Revisions* are -0.143, -0.191, and -0.192 (all significant at the p<.01 level), comparable to the previous estimates (-0.123, -0.141, -0.159). This suggests that the results are robust to the inclusion of these effects, and that the difference in difference approach was relatively successful in controlling for these factors.[54]

7.2 Placebo Tests

I next conduct two placebo tests. First, while market participants such as equity analysts likely suffer from a lack of information and may therefore be unable to forecast the R&D tax credit, managers do not face this same information shortage. Aboody and Lev (2000) show that

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[54] I also examine the possibility that the effect on *Forecast Improvement* is heterogeneous across bills, depending on certain bill characteristics. I augment model 2 by adding the three way interaction term *Extension Between Revisions X R&D Tax Credit Exposure X Bill Characteristic*. Since *Bill Characteristic* does not vary within *Extension Between Revisions* = 0, including the extra two-way interaction terms, or *Bill Characteristic* by itself, induces perfect multicollinearity in the estimation. *Bill Characteristic* is a measure of bill specific characteristics. Specifically, it is the 1) the number of days between the bill's introduction and final passage (range, 40 to 565 days), 2) the number of words in the bill (range, 13,911 to 458,849 words), 3) the percentage of words in the bill dedicated to extending the R&D tax credit (range, 0.00021 to 0.010), 4-7) the log of (1) and (2), and indicator variables for above median values of (1) and (2). Between these seven measures of *Bill Characteristic* and the three proxies for *R&D Credit Exposure*, 21 separate regressions are estimated. In untabulated analysis, no consistent pattern emerges wherein these bill characteristics mediate the relationship between *Extension Between Revisions X R&D Tax Credit Exposure* and *Forecast Improvement*.

managers have access to and understand firm specific R&D related information. Given that managers have better information than other market participants, I therefore expect to see no deterioration in managers' forecast accuracy surrounding credit extensions. Alternatively, if managers understand the credit's impact on earnings and add the effect of the credit back to earnings the coefficient on β_3 should be positive. To examine this, I estimate Model 2 using managers' forecasts of EPS from the CIG database in place of analysts' forecasts.[55] The estimates from this test are displayed in Table 9. Using all three proxies for *R&D Credit Exposure* (*R&D Mention*, *R&D Expire Firm* and *R&D in ETR Reconciliation*), the interaction between *R&D Credit Exposure* and *Extension Between Revisions* has positive and significant coefficients. These coefficients are in line with managers having the appropriate information to understand the credit's impact on the firm.

Next, as another way to corroborate that the result for H1 is not due to random chance, I conduct a bootstrapping placebo test by scrambling the indicator variable *Extension Between Revision* and *R&D Credit Exposure* across random observations, creating a placebo treatment. Counting the number of times I estimate a coefficient β_3 using the placebo treatment that is larger than β_3 using the true treatment is an estimate of the probability that results of a similar magnitude would obtain if the treatment were random (specifically, random in exactly the same way I randomized, in this case, equally likely to apply to any observation in the dataset). I repeat this procedure 1,000 times for the regression explaining *Forecast Improvement* for all three measures of *R&D Credit Exposure*. For these three tests, I obtain coefficients that are larger than

[55] Few guidance revisions span an R&D credit extension for *R&D Credit Exposure* firms. As a result, even after allowing 60 days between revisions, only 16, 4 and 5 observations are equal to one for both *Extension Between Revision* and *R&D Mention*, *R&D Expire Firm* or *R&D in ETR Reconciliation*, respectively. Further, Chuk et al. (2012) indicate that the dates of managers' guidance in the CIG database may not always be accurate, further limiting this analysis.

the true treatment 0, 0 and 2 times, for the 1,000 replications. This helps confirm that I am documenting an analyst response to the R&D tax credit, and not a random effect.

7.3 Other Portions of the R&D Tax Credit Extending Bills

The simple legislative language that extends the R&D credit is often included in other legislative vehicles—omnibus bills that cover material from a broad range of topics.[56] The explicit purpose of each of the bills is listed in Appendix E. Firms that claim the R&D tax credit may be systematically affected by the other portions of these bills in a way that decreases forecast accuracy.[57] I attempt to alleviate this concern with four separate tests. First, I use a set of placebo omnibus bills that do not extend the R&D tax credit. I use the Library of Congress' Thomas system to locate 20 bills from the 104th to the 112th Congress that contain the word "omnibus" in their title, and randomly choose eight with non-duplicative months that do not extend the R&D tax credit.[58] I use these dates to estimate Model 2, using the legislation dates of these bills in place of the actual dates of R&D credit extensions. I expect β_3 to be insignificant. In untabulated analysis, I re-estimate Model 2, and find no consistent pattern of negative, significant coefficients on β_3 across the three proxies for *R&D Tax Credit Exposure*.

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[56] For example, the 2010 R&D credit extension in The Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 required only 59 words to extend the credit, while the whole bill includes 12,192 words. The bill, as recorded by Govtrac.us, contained 79 different subject areas, from topics as diverse as "Pedestrians and bicycling" to "Terrorism." While the R&D tax credit is legislatively important, there is often much else happening in the legislation that extends it.

[57] For example, bills that have extended the R&D tax credit have also impacted the Indian employment tax credit, work opportunity credit, Puerto Rican economic activity credit, orphan drug tax credit, welfare-to-work credit, foreign tax credit, Puerto Rico and possession tax credit, biodiesel fuel use credits, credit for refined coal facilities, excise tax credit, new markets tax credit, railroad track maintenance credit, mine rescue team training credit, employer wage credit, low-income housing credit, energy credit, renewable energy credit, coal gasification investment credit and the credit for steel industry fuel.

[58] The Library of Congress Thomas system's search function is located at http://thomas.loc.gov/home/multicongress/multicongress.html.

Next, I replace the placebo "omnibus" bills with placebo "tax" bills. I use the Thomas system to obtain a list of all bills with the word "tax" in their title, and select all that seem relevant to a large number of taxpayers and that do not extend the R&D tax credit.[59] When I use these placebo dates in place of the dates of real R&D tax credit extensions in Model 2, I do not find consistently negative and significant coefficients on the interaction term between *R&D Credit Exposure* and *Extension Between Revisions*. This suggests that *Forecast Improvement* does not deteriorate for R&D credit firms upon the extension of these non-R&D tax related bills.

The non-R&D tax credit portions of the R&D credit extension bills may make earnings difficult to predict for specific industries. For example, the effect of the extension of the Orphan Drug tax credit on pharmaceutical firms may make earnings difficult to predict. If industries affected by the Orphan drug tax credit also receive the R&D credit (as some pharmaceutical firms do), this may affect inference. To limit this concern, I estimate within industry regressions by both including industry fixed effects interacted with *Extension Between Revisions*, and including industry fixed effects separately. Inference is not changed, suggesting that my results are robust to both static industry characteristics, as well as industry characteristics such as industry specific tax credits that vary at the *Extension Between Revisions* level.

Finally, I directly control for the mean effect of the R&D tax credit extension bills on firms affected by these bills. I do this by examining the text of each bill and developing a bill specific dictionary of terms contained in, and related to, the bill, for each of the eight extending bills. Appendix C contains these dictionaries for each bill. I look for these words in each 10-K for

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[59] I eliminating irrelevant bills such as H.R. 5394, which has as its sole goal "modify[ing] the taxation of arrow components." As of 2012, this bill was one of only two successful pieces of legislation sponsored by Congressman Paul Ryan (the other named a post office) (Franke-Ruta, 2012). The final bills I use are the Tax Increase Prevention and Reconciliation Act of 2005, Tax Increase Prevention Act of 2007 and the Economic Growth and Tax Relief Reconciliation Act of 2001.

firms in my sample. If terms in the dictionary for Bill *b* that was passed in year *t* are in a firm's 10-K in year *t*, year *t* for the firm is coded as having been affected by bill *b*. I add this indicator linearly to Model 2 as a control, as well as interact it separately with *Extension Between Revisions*. In a separate test, I also limit the dictionary to contain only words specifically about tax credits (bolded words in Appendix C), as well as search for only the title of the bill, and use indicators for those 10-Ks matching those sets of words. Controlling for the specific effect of a bill on firms using these different ways does not change the inference—the estimates of β_3 remain negative and significant. This result is consistent with my documented result being the effect of the R&D tax credit and not some other part of the legislation that extends the R&D tax credit.[60]

7.4 Construction of the Variable Extension Between Revision

Next, I investigate whether the construction of the variable *Extension Between Revision* imposes a relationship between *Extension Between Revision* and *Forecast Improvement*, affecting the β_1 coefficient and potentially affecting inference. This may pose a problem because *Forecast Improvement* is increasing in the amount of time that elapses between two forecasts (as more

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[60] I also examine the possibility that the effect on *Forecast Improvement* is heterogeneous across bills, depending on certain bill characteristics. In untabulated analysis, I examine this bill heterogeneity, examining whether it explains any of the variance in Forecast Improvement. I estimate the following regression:

Forecast Improvement = $\beta_0 + \beta_1$*Extension Between Revisions* + β_2*R&D Tax Credit Exposure* + β_3*Extension Between Revisions X R&D Tax Credit Exposure* + β_4*Extension Between Revisions X R&D Tax Credit Exposure X Bill Characteristic* + $\sum \beta_k$*Fixed Effects* + ϵ

Since *Bill Characteristic* does not vary within *Extension Between Revisions*=0, including the extra two-way interaction terms, or *Bill Characteristic* by itself, induces perfect multicollinearity in the estimation. *Bill Characteristic* is a measure of several bill specific characteristics. Specifically, it is the 1) the number of days between the bills initial introduction, 2) an indicator for the four bills that took the longest to pass (the most days in between the day of introduction and the enactment date) (range, 40 to 565 days), 3) the log of the number of days taken to enact the bill, the number of words in the bill (range, 13,911 to 458,849 words), 4) the number of words in each bill, 5) the log of the number of words in the bill, 6) an indicator for the four bills will the most words, and 7) the percentage of the total bills words dedicated to extending the R&D tax credit (range, 0.00021 to 0.010). Between these seven measures of *Bill Characteristic* and the three proxies for *R&D Credit Exposure*, 21 separate regressions are estimated. In untabulated analysis, no consistent pattern emerges wherein these bill characteristics mediate the relationship between *Extension Between Revisions X R&D Tax Credit Exposure* and *Forecast Improvement*.

time passes analysts have more information and are more accurate). In addition, the longer between two forecasts, the more likely it is that any random date will fall between two forecasts.[61] My main tests limit this effect by requiring that the two forecasts be no more than 30 days apart. Further, the null result documented in the placebo test that randomly assigns a treatment to observations also addresses this concern. However, while β_1 does not have any direct implications for my hypotheses, understanding the effect of the construction of *Extension Between Revision* is important to validating my empirical design.

To further ensure that the way *Extension Between Revision* is constructed is not a problem for my inference, I estimate 24 untabulated regressions. Specifically, I 1) control for the time between the two forecasts (*Time*) linearly, 2) control for *Time*, *Time*^{2} and *Ln(Time)*, allowing for nonlinearity, 3) include *Ln(Time)* and its interaction with *Extension Between Revisions*, 4) include *Ln(Time)*, and its interaction with both *Extensions Between Revisions* and *R&D Credit Exposure*, 5) limit the variance in *Time* by allowing only 15 days in between forecasts, 6) regress *Forecast Improvement* on *Time*, *Time*^{2} and *Ln(Time)* and then use the residual from that model as the dependent variable in Model 2, 7) scale *Forecast Improvement* by *Time*, thus estimating the effect of the credit per unit time, and finally, 8) include *Time* fixed effects, estimating a separate intercept where *Time* is equal to *x* days, for x=1,2,3…30.

These different specifications alter the interpretation of the coefficients. However, all address, in different ways, the concern that *Extension Between Revisions* may be mechanically

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[61] For this reason, the median number of days in between the two forecasts for an observation in the sample coded as *Extension Between Revisions*=1 is 23, whereas for *Extension Between Revisions*=0 it is 16. This contrasts with the difference, for example, between the median number of days for observations with *R&D Mention* = 1 and *R&D Mention* = 0, which are both 16. This difference in days is 1 or less for the other two measures of *R&D Credit Exposure*. It may also be the case that, given a reason to revise (the extension of the R&D tax credit), analysts more quickly update their forecasts. This problem would not occur if revisions were made at some fixed interval, as, for example, in Plumlee (2003) (as result of the use of First Call monthly forecasts).

related to *Forecast Improvement*. I estimate these eight different specifications for all three of my proxies for *R&D Credit Exposure*. In 24 of the 24 regressions, the interaction term between *Extension Between Revisions* X *R&D Credit Exposure* is negative, and in 18 of the 24 is significant at the two-tailed 10% level or better. Further, the size of the main effect for *Extension Between Revisions* is reduced in these models (in some cases becoming insignificant), suggesting that some of the size of the estimated β_1 is due to the relationship between the time between forecasts and *Forecast Improvement.*

7.5 Analyst-Level Specification

Next, I change the unit of observation in my estimation. This change helps assuage concerns related to using forecast revisions as the unit of observation, which may place more weight on firms or analysts that issue more revisions. Changing the unit of observation has the downside of reducing the variance available in the estimations. I estimate the following model:

$$\textit{Average Forecast Improvement} = \beta_0 + \beta_1 \textit{Extension Bill Month} + \beta_2 \textit{R\&D Analyst} + \beta_3 \textit{Extension Bill Month} \times \textit{R\&D Analyst} + \sum \beta_k \textit{Fixed Effects} + \epsilon. \quad (7)$$

This regression is estimated on a panel of analyst/month observations, where observations from the original sample of forecast revisions are aggregated to the analyst/month level. *Average Forecast Improvement* is the average *Forecast Improvement* (as previously defined) for an analyst in the month. *Extension Bill Month* is an indicator variable coded to equal one if the R&D tax credit was extended in the month of the observation. *R&D Analyst* is measured in two different ways. First, I use an indicator variable coded to equal one if the analyst only revised earnings for *R&D Credit Firms* in the month. Second, I define *R&D Analyst* as the percentage of the analyst's total revisions in the month that are for *R&D Credit Firms*. For this test, the measure of *R&D Credit Firm* is a combination of all three measures used elsewhere in the paper (i.e., it is the max of *R&D Mention*, *R&D Expire Firm* and *R&D in ETR Reconciliation*).

I expect the coefficient of interest, β_3, to be negative. A negative β_3 means that analysts that cover *R&D Credit Firms* are less accurate when they forecast in months with an extension of the R&D tax credit, relative to analysts that do not cover *R&D Credit Firms* (or cover a smaller percentage of *R&D Credit Firms*), and months that do not extend the R&D tax credit. The results from the estimation of Model 7 are in Table 10. In both columns 1 and 2, which use different measures of *R&D Analyst*, the interaction between *R&D Analyst* and *Extension Bill Month* is negative and significant. These regressions suggest that extension of the R&D tax credit decreases the ability of analysts to forecast earnings for firms affected by the R&D tax credit.

7.6 Persistence of the Misunderstanding

If analysts initially misinterpret the effects of the R&D tax credit extension, but in subsequent revisions correct their previous error, my evidence regarding misunderstanding of the R&D credit suggests a much lower cost of temporary tax laws than if the misunderstanding was not eventually corrected. To examine this possibility, I examine whether the three revisions following an *Extension Between Revision* revision are systemically more, or less, accurate, for firms that receive the R&D tax credit. Replacing *Extension Between Revision* with indicators for the subsequent revisions separately, one at a time, yields two of the three, one of the three, and two of the three coefficients (one each for each measure of *R&D Credit Exposure*) negative and significant for the second, third, and fourth revisions following an extension of the R&D tax credit, respectively. This suggests that, rather than ultimately understanding the credit on subsequent revisions, the three revisions following an extension of the R&D tax credit are, to some extent, also systemically less accurate than other revisions.[62]

[62] This general result holds if the subsequent revision indicators interacted with *R&D Credit Exposure* are all entered into the regression together with *Extension Between Revision X R&D Credit Exposure* (yielding four interaction terms). These tests are subject to limitations. For example, few analysts forecast with enough frequency to have three subsequent revisions after an extension of the R&D tax credit, meaning that, for example, the coefficient on the

7.7 The Effects of Initial Forecast Bias

Another potential threat to validity is that if analysts start off with a positive bias in their estimates, any positive revision will move the forecast further away from realized earnings, decreasing the value of *Forecast Improvement*. I investigate this concern in two different ways. First, I examine whether revisions that start with a positive bias and then revise the forecast upwards are more likely for *R&D Credit Exposure* firms just following an extension of the R&D tax credit. To examine this, I regress an indicator equal to one for upward revisions that start with a positive bias on *R&D Credit Exposure*, *Extension Between Revisions*, and their interaction. For all three measures of *R&D Credit Exposure* the interaction is positive, but never statistically significant. This suggests that for R&D credit firms with revisions that span an extension of the credit there is statistically no more chance of starting with a positive bias and revising upwards than for other observations.

Next I explicitly control for the initial bias of analysts in the first forecast that defines the revision, the second forecast that composes the revision, the direction of the revision, and the interaction of the direction of the revision and the initial bias of the forecast. Controlling for these terms does not alter my inference. Lastly, when I include these control variables, but also explicitly control for the size of the forecast revision by including the scaled signed magnitude of the revision, the interaction between *R&D Credit Exposure* and *Extension Between Revisions* is still negative and significant at the p-value<0.05 in two of the three regressions (the third regression is marginally significant, with a two sided p-value of .108).

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interaction term *R&D Credit Exposure* and *Revision 4* is based off of very few observations. This is especially the case when the sample is limited to forecasts that are restricted to 30 days or fewer apart, as is done throughout this paper.

7.8 Adding Observations for Analysts That Do Not Revise

One limitation of the test of H1 is that only analysts who actively revised their forecasts have observable revisions. Analysts that determined that the R&D tax credit would have no effect on the firms they cover and did not revise will not be included in my analysis. If these analysts are somehow systematically different than other analysts my test may not be representative of the average analyst. First, it is important to note that limiting the analysis to summarize the behavior of market participants that do respond to the credit does not affect the main take away of the result—a large group of financial market participants are unable to understand the effects of the R&D tax credit. Second, I perform a test to ensure that the inference from H1 does not change as a result of this potential bias. For every active analyst (analysts who issue more than 5 forecasts for the firm in a quarter) who issues their terminal forecast of the quarter within 10 days of an R&D credit extension, and does not revise after the extension of the credit, I add an observation with *Forecast Improvement* coded to equal 0, and *Extension Between Revision* equal to 1. This captures the notion that their final forecast directly before an extension of the credit is their understanding of the firm until the earnings announcement date, and their final revision is equal to zero. This increases the number of observations in the test, but, does not change my inference.

7.9 Alternatives to Quarter Fixed Effects

One final concern is that extensions of the R&D tax credit have not been randomly distributed across quarters, and analysts' forecast accuracy (and earnings numbers, including the incentives to manipulate earnings) may vary systematically by quarter (i.e., Dhaliwal et al., 2004). Of particular concern is that most of the extensions happened in the fourth quarter. First, all of my models estimate a within-quarter effect by including quarter fixed effects, so this problem is likely corrected for in my main models. Second, the dependent variable, *Forecast*

Improvement, does not take on an extreme value in the fourth quarter. *Forecast Improvement* has an average value of 0.200 for fourth quarter observations, for the third quarter 0.175, and for the second quarter 0.2038—the fourth quarter has neither the highest or lowest mean value.

However, to further assuage this concern, I reestimate my model dropping all observations from the fourth quarter, and inference is unchanged. Further, the results for H1 also hold when dropping observations from any single quarter (dropping all first quarter observations, all second quarter observations, etc.). Finally, I interact the vector of quarter fixed effects with the interaction between *R&D Credit Exposure* and *Extension Between Revisions*. The three way interaction (for any of the quarters) between *R&D Credit Exposure* and *Extension Between Revisions* is not consistently statistically significant for any of the quarters.

CHAPTER 8

Robustness Tests of H2

8.1 Correlated Omitted Variables

I also conduct robustness tests to validate the results from my second hypothesis. Some factors, such as those that vary from earnings announcement to earnings announcement by firm, may be correlated omitted variables. If these variables are correlated with the interaction between *R&D Credit Exposure* and *Lapsed Credit Quarters*, inference could be confounded. Several factors have been shown to influence bid-ask spreads around earnings announcements, and in untabulated sensitivity tests, I control for some of these factors.

First, I control for *Unexpected Earnings*. Since the results from H1 show that analysts' earnings expectations with regards to the R&D tax credit are biased, I use a simple time-series expectation model of *Unexpected Earnings*, where *Unexpected Earnings* is equal to earnings per share less special items in quarter *q* of year *t*, less earnings per share less special items in quarter *q* of year *t*-1. I also control for *Ln(MVE)* (the logged market value of equity from the end of the previous quarter ($CSHFDQ_{q-1}$*$PRCCQ_{q-1}$)), and *Abnormal Share Volume* (the average amount of share turnover (CRSP variables VOL/SHROUT) during the earnings announcement period minus the average amount of share turnover from the 45 days prior to the earnings announcement). Following Armstrong, Core, Taylor and Verrecchia (2011), I also control for the *Number of Shareholders* (a rank variable, 1–5, for quintiles of Compustat variable CSHR, ranked by year). Finally, I control for *Earnings Announcement Lag* (the time lag between a firm's fiscal period end and the earnings announcement date, Compustat variables RDQ-DATADATE).

After adding these controls, the coefficients on *Lapsed Credit Quarter X R&D Tax Credit Exposure* remain positive and significant. Across the three different measures of R&D tax credit exposure, the coefficient on the interaction term takes on values ranging from 0.05 to 0.14, suggesting that even when controlling for these other factors, firms experience higher bid-ask spreads during earnings announcement associated with the R&D tax credit's expiration.[63] Calculating the economic magnitude of this result as I did after the main result, the aggregate cost of the credit's expiration in bid-ask spread term was to raise bid-ask spread by $447 million in the earnings announcements affected by the expired credit. This is not dramatically less than the estimate obtained without using controls ($519).

8.2 Other expired Credits

While the R&D credit being expired complicates the understanding of earnings releases affected by the expired R&D tax credit, if other tax credits are also expired for R&D credit firms (i.e., other credits included in the corporate extenders) then my result may reflect credits other than the R&D credit being expired, posing a threat to the validity of the results. To alleviate this concern, I conduct two tests. First, if other expired credits focused in specific industries, estimating within industry regressions should help control for these other credits. My results hold if I control for Fama-French 48 industry effects by interacting the vector of industry fixed effects with *Lapsed Credit Quarter* while including industry effects separately, suggesting that the effect is not due to industry effects that change with the expiration of the R&D tax credit.

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[63] Another reason I do not include these control variables in my main test is that, for example, these unexpected earnings are likely part of what is causing the increase in bid-ask spread in credit affected quarters. The slight decrease in earnings due to the lack of the credit in the quarters of expiration is able to be processed much differently by some market participants than others, controlling for unexpected earnings may be partially controlling away the very effect I am studying.

Second, I explicitly control for the existence of tax credits that are extended simultaneously with the R&D tax credit. I examine each extension bill in my sample, and compile a list of tax credits included in each bill (the bolded words in Appendix C). I then search the text of the 10-K for each firm in my sample in year *t* for words associated with a bill passed in year *t*. If a credit was legislated in year *t* and is mentioned in a firm's 10-K in year *t*, then a variable, *Credit*, is coded to equal one. I augment model 3 to include the variable *Credit* independently, and interact it will *Lapsed Credit Quarter*. The interaction between *Credit* and *Lapsed Credit Quarter* represents the effect on the change in bid-ask spread associated with having a credit that was passed along with the R&D tax credit extension in that year. The interaction term between *Credit* and *Lapsed Credit Quarter* is significant and positive, consistent with legislated credits causing difficulties in the quarters before they were passed/extended. Further, the interaction term between *R&D Credit Exposure* and *Lapsed Credit Quarter* is positive and significant. This result suggests that, even controlling for credits that were passed/extended, the R&D credit's being expired is still associated with increased trading costs.

8.3 Placebo Test

As an additional way to check the robustness of the results, I conduct a placebo test using a bootstrapping technique. I randomly assign 12 quarters (the number of quarters with expired credits) that did not actually contain the expired R&D credit as having a placebo treatment. I then re-estimate the regressions in Model 3 replacing *Lapsed Credit Quarter* with *Placebo Treatment*, repeating this random assignment 1,000 times. I then count the number of times the coefficient on the interaction between *R&D Tax Credit Exposure* and *Placebo Treatment* is larger than the coefficients generated by Model 3 with the true treatment. In this untabulated analysis, 72 out of 1,000, 16 out of 1,000 and 6 out of 1,000 of the coefficients on the interaction between *Placebo Treatment* and *R&D Mention, R&D Expire Firm* and *R&D in ETR Reconciliation*, respectively, are larger than the coefficients estimated when using the true treatment effect. This provides additional assurance that the result I am documenting is not due to random chance.

CHAPTER 9

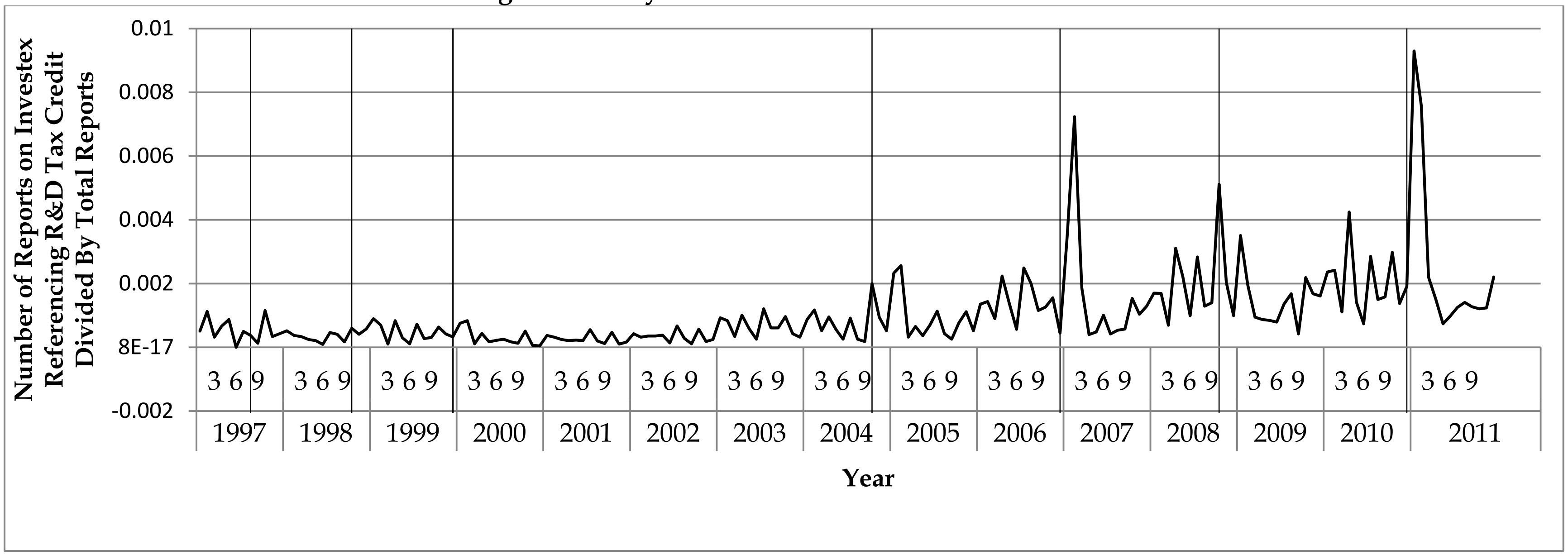
Conclusion

I investigate two financial accounting related consequences of temporary tax laws, using the R&D tax credit as a case. Critics have long asserted that the temporary status of tax laws is costly, but have not empirically tested their assertions. I provide evidence that the temporary nature of the R&D tax credit decreases the predictability of quarterly earnings, degrading the accuracy of revisions directly following extensions of the R&D tax credit. While market participants revise their earnings in response to an extension of the R&D tax credit, these revisions make forecasts incrementally less accurate. This result is robust to many different specifications and sensitivity tests. I also find that bid-ask spreads incrementally increase during the three-day earnings announcement periods affected by the expired credit. This increase in trading costs represents a material and measurable cost of temporary tax laws.

These results point to two specific consequences of temporary tax laws that are often retroactively extended, and especially of the R&D tax credit. There are likely other consequences of the temporary nature of temporary tax laws, most notably, that the temporary nature of the credit likely dampens its ability to actually stimulate additional research. Policymakers should combine the costs documented in this paper with other potential costs associated with temporary tax laws, and compare them with the benefit society receives from maintaining temporary tax laws (benefits such as potentially mitigating unintended distortions caused by tax policy (i.e., (Arya and Mittendorf, 2013)). This comparison should inform policymakers' choices as they determine whether to make temporary tax laws permanent, maintain them as temporary, or eliminate these laws altogether.

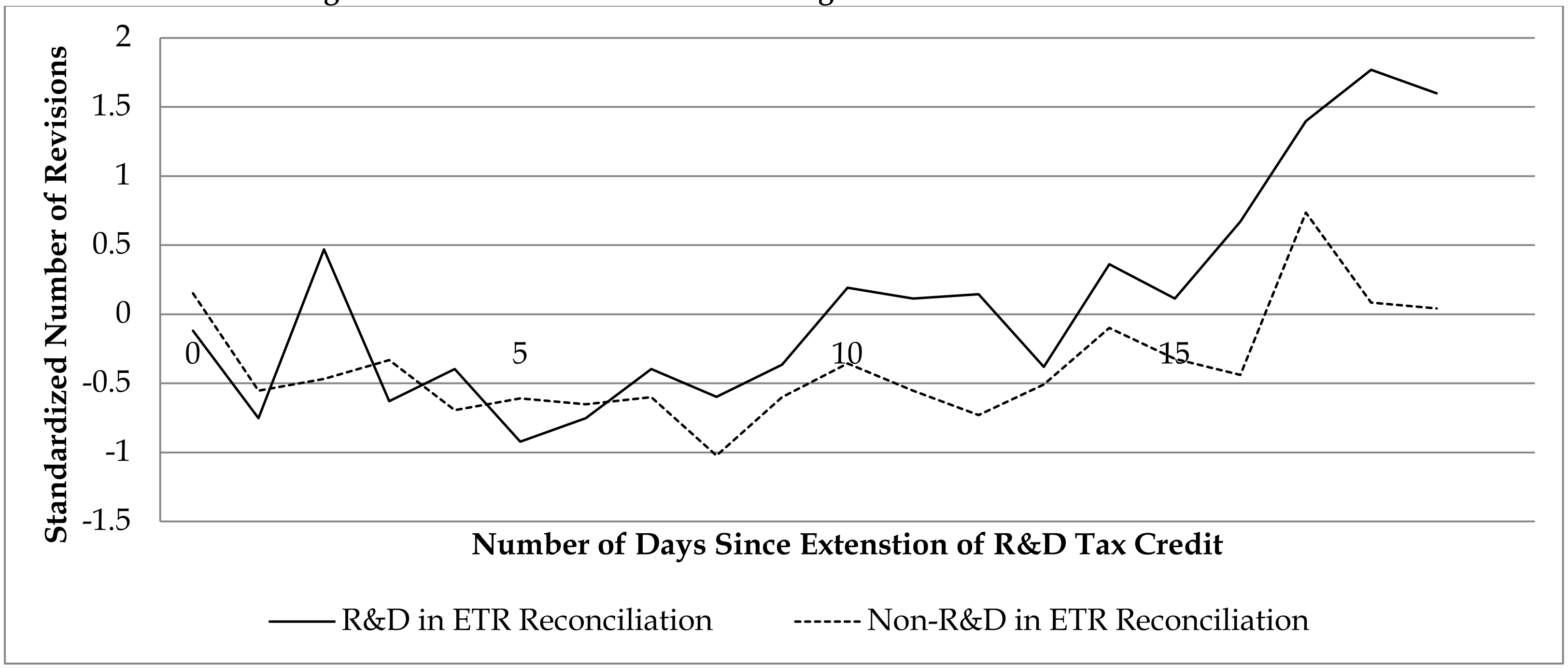
Figures

Figure 1. Analysts' Mention of the R&D Tax Credit



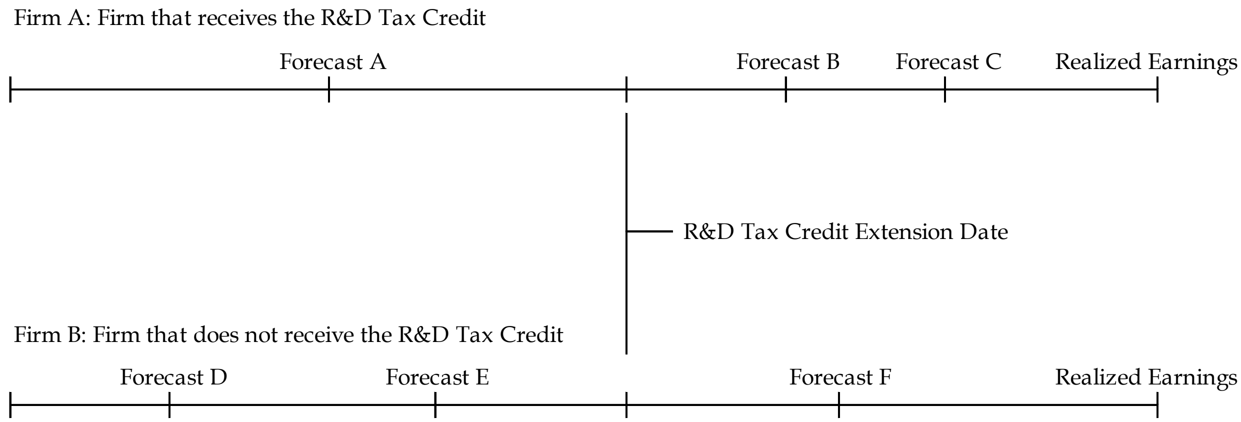
Notes: This graph depicts the number of company specific reports on the Investex analyst research service that mention the "R&D Tax Credit" in the text or title of the report, divided by the total number of reports on Investex, graphed by month. The vertical bars represent October 1998, December 1999, October 2004, December 2006, October 2008 and December 2010, which are the months in which the R&D tax credit was extended.

Figure 2. Number of Revisions Following Extension of the R&D Tax Credit



Notes: This graph depicts the standardized number of revisions of forecasts of EPS for the sample of firms outlined in Table 1, Panel A. The standardized number of revisions is the number of revisions in a day for *Non-R&D in ETR Reconciliation* (*R&D in ETR Reconciliation*) firms, less the mean number of revisions for *Non-R&D in ETR Reconciliation* (*R&D in ETR Reconciliation*) firms in the 180 days following the date of extension of the R&D tax credit, scaled by the standard deviation of the number of revisions in that same 180 days. Event day 0, the passage of an extension of the R&D tax credit, is 8/20/1996, 8/5/1997, 10/21/1998, 12/17/1999, 10/4/2004, 12/20/2006, 10/3/2008, or 12/17/2010. An *R&D in ETR Reconciliation Firms* is a firm/quarter where the R&D tax credit is included as a line item on the annual effective tax rate reconciliation (as outlined in Appendix B).

Figure 3. Timeline of Forecast Revisions and R&D Tax Credit Extension



Notes: This figure represents a quarter of earnings forecasts for two firms covered by the same single analyst. Firm A receives the R&D tax credit, and Firm B does not. Interrupting the quarter is the extension of the R&D tax credit, at R&D Tax Credit Extension Date.

Tables

Table 1. Sample Selection

Panel A. Sample Selection for Earnings Forecasts Tests

Sample Restriction	Resultant Number of Observations
IBES Forecast Revisions 1994-2011	2,471,064
Compustat Quarterly Data Available	2,408,289
Calandar Year End Firms	1,774,513
U.S. Headquartered and Incorporated	1,606,142
Non-regulated industries	1,261,838
Time between forecasts 30 days or less	448,377
Required data available	446,647

Panel B. Sample Selection for Bid-ask Spread Tests

Sample Restriction	Resultant Number of Observations
Observation on Compustat Quarterly 1994-2011	835,204
Calandar Year End Firms	559,320
U.S. Headquartered and Incorporated	446,231
Non-regulated industries	298,544
Required data not missing from Compustat	250,479
Bid-ask spreads available from TAQ	161,108

Table 1. Sample Selection, Continued

Panel C. Industry Composition of Sample

Industry	(1) All	(2) R&D Mention = 1	(3) R&D Expire Firm = 1	(4) R&D in ETR Reconciliation = 1
Business Services	15.30%	15.71%	10.68%	17.41%
Pharmaceutical Products	9.45%	22.45%	21.63%	21.15%
Electronic Equipment	5.95%	11.16%	11.56%	17.70%
Petroleum and Natural Gas	5.68%	1.04%	0.00%	0.00%
Telecommunications	4.63%	1.67%	0.74%	1.28%
Computers	4.49%	7.42%	6.67%	9.48%
Medical Equipment	4.09%	8.52%	12.40%	8.91%
Transportation	3.73%	0.52%	0.00%	0.00%
Machinery	3.71%	5.35%	7.99%	4.43%
Wholesale	3.62%	0.25%	0.00%	0.00%
Retail	2.98%	0.26%	0.00%	0.03%
Healthcare	2.69%	0.69%	0.00%	0.41%
Measuring and Control Equip	2.48%	5.36%	8.12%	6.71%
Chemicals	2.37%	2.48%	2.21%	1.24%
Restaurants, Hotel, Motel	2.33%	0.00%	0.00%	0.00%
Construction Materials	2.30%	1.44%	2.21%	0.22%
Entertainment	1.82%	0.22%	0.58%	0.00%
Miscellaneous	1.74%	0.95%	0.71%	0.67%
Automobiles and Trucks	1.71%	2.21%	0.00%	2.06%
Consumer Goods	1.65%	1.88%	4.44%	2.19%
Steel Works, Etc.	1.64%	1.37%	0.81%	0.06%
Business Supplies	1.52%	0.95%	1.16%	0.80%
Construction	1.38%	0.31%	0.00%	0.00%
Apparel	1.25%	0.27%	1.06%	0.00%
Food Products	1.14%	0.50%	0.00%	0.35%
Utilities	1.09%	0.44%	0.00%	0.00%
Recreational Products	1.02%	0.87%	2.33%	0.69%
Rubber and Plastic Products	1.02%	0.93%	0.00%	1.43%
Electrical Equipment	1.00%	1.15%	1.14%	1.01%

Table 2. Descriptive Statistics

Variable	n	Mean	S.D.	0.25	Mdn	0.75
Sample Used for Earnings Forecasts Tests						
Revision	446,647	-0.1726	1.09	-0.1903	-0.0267	0.0794
Forecast Improvement	446,647	0.1945	1.0077	-0.052	0.0369	0.1891
Extension Between Revisions	446,647	0.0163	0.1266	0	0	0
R&D Mention	446,647	0.2842	0.451	0	0	1
R&D Expire Firm	446,647	0.0715	0.2576	0	0	0
R&D in ETR Reconciliation	446,647	0.0545	0.2269	0	0	0
Sample Used for Bid-ask Spread Tests						
Abnormal Bid-Ask Spread	161,108	0.054	1.9865	-0.3802	0.0085	0.3811
Lapsed Credit Quarter	161,108	0.1681	0.3739	0	0	0
R&D Mention	161,108	0.2824	0.4502	0	0	1
R&D Expire Firm	161,108	0.0376	0.1902	0	0	0
R&D in ETR Reconciliation	161,108	0.0426	0.2019	0	0	0

Notes: *Revision* is equal to the value of forecast revision in EPS, scaled by beginning of fiscal period price, all multiplied by 100. *Forecast Improvement* is equal to the unsigned forecast error before the revision less the unsigned forecast error after the revision, scaled by price at the beginning of the fiscal year period, all multiplied by 100. *Extension Between Revisions* is coded as one if the two forecasts span the enactment date from the sample of R&D credit extensions (i.e., spans 8/20/1996, 8/5/1997, 10/21/1998, 12/17/1999, 10/4/2004, 12/20/2006, 10/3/2008, or 12/17/2010). *R&D Credit Exposure* is measured three ways. *R&D Mention* is an indicator variable equal to one if a firm's 10-K ever mentions the R&D tax credit. *R&D Expire Firm* is an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly ETR was lower because of the expiration of the R&D tax credit. *R&D in ETR Reconciliation* is an indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*. *Abnormal Bid-Ask Spread* is the bid-ask spread from the event period surrounding the earnings announcement date (*t* to *t*+1), less the average bid-ask spread from the period *t*-45 to *t*-5. *Lapsed Credit Quarter* is an indicator variable coded to one if the R&D tax credit was expired during the entire quarter.

Table 3. R&D Tax Credit Extensions and Earnings Forecast Revisions

	(1)	(2)	(3)
Dependent Variable:		Forecast Revision	
Measure of R&D Credit Exposure:	*R&D Mention*	*R&D Expire Firm*	*R&D in ETR Reconciliation*
Extension Between Revisions	-0.250***	-0.226***	-0.225***
	(-5.42)	(-5.86)	(-5.91)
R&D Credit Exposure	-0.021**	0.096***	-0.052***
	(-2.39)	(11.97)	(-3.24)
Extension Between Revisions X R&D Credit Exposure	0.127**	0.151***	0.200***
	(2.53)	(3.29)	(3.14)
Constant	-0.192***	-0.205***	-0.195***
	(-24.61)	(-28.51)	(-28.31)
Year Fixed Effects	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes
Analyst Clustering	Yes	Yes	Yes
Observations	446,647	446,647	446,647
R-squared	0.01	0.01	0.01

Notes: The sample used for this analysis is all forecast revisions of all U.S. unregulated and nonfinancial calendar year firms between 1994 and 2011. *Revision* is equal to the value of forecast revision in EPS, scaled by beginning of fiscal period price, all multiplied by 100. *Extension Between Revisions* is coded as one if the two forecasts span the enactment date from the sample of R&D credit extensions (i.e., spans 8/20/1996, 8/5/1997, 10/21/1998, 12/17/1999, 10/4/2004, 12/20/2006, 10/3/2008, or 12/17/2010). *R&D Credit Exposure* is measured three ways. *R&D Mention* is an indicator variable equal to one if the firm's 10-K ever mentions the R&D tax credit. *R&D Expire Firm* is an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly ETR was lower because of the expiration of the R&D tax credit. *R&D in ETR Reconciliation* is an indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*. Standard errors are clustered at the analyst level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Table 4. R&D Tax Credit Extensions and Forecast Improvement

	(1)	(2)	(3)
Dependent Variable:	Forecast Improvement		
Measure of R&D Credit Exposure:	*R&D Mention*	*R&D Expire Firm*	*R&D in ETR Reconciliation*
Extension Between Revisions	0.235***	0.211***	0.208***
	(6.47)	(7.06)	(7.03)
R&D Credit Exposure	0.017**	-0.120***	0.038**
	(2.18)	(-16.09)	(2.36)
Extension Between Revisions X R&D Credit Exposure	-0.125***	-0.141***	-0.159***
	(-2.87)	(-3.86)	(-2.98)
Constant	0.199***	0.213***	0.202***
	(28.49)	(33.08)	(32.92)
Year Fixed Effects	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes
Analyst Clustering	Yes	Yes	Yes
Observations	446,647	446,647	446,647
R-squared	0.01	0.01	0.01

Notes: The sample used for this analysis is all forecast revisions of all U.S. unregulated and nonfinancial calendar year firms between 1994 and 2011. *Forecast Improvement* is equal to the unsigned forecast error before the revision less the unsigned forecast error after the revision, scaled by price at the beginning of the fiscal year period, all multiplied by 100. *Extension Between Revisions* is coded as one if the two forecasts span the enactment date from the sample of R&D credit extensions (8/20/1996, 8/5/1997, 10/21/1998, 12/17/1999, 10/4/2004, 12/20/2006, 10/3/2008, or 12/17/2010). *R&D Credit Exposure* is measured three ways. *R&D Mention* is an indicator variable equal to one if the firm's 10-K ever mentions the R&D tax credit. *R&D Expire Firm* is an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly ETR was lower because of the expiration of the R&D tax credit. *R&D in ETR Reconciliation* is an indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*. Standard errors are clustered at the analyst level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Table 5. Bid-Ask Spreads during Earnings Announcement Periods Affected by the Expiration of the R&D Tax Credit

Dependent Variable:	Abnormal Bid-Ask Spread		
Measure of R&D Credit Exposure:	R&D Mention	R&D Expire Firm	R&D in ETR Reconciliation
R&D Credit Expiration Quarter	-0.246***	-0.232***	-0.234***
	(-10.25)	(-10.43)	(-10.52)
R&D Credit Exposure	-0.022*	-0.026**	-0.022
	(-1.92)	(-1.97)	(-1.08)
R&D Credit Expiration Quarter X R&D Credit Exposure	0.066**	0.126***	0.164***
	(2.49)	(3.70)	(3.63)
Constant	0.019*	0.014	0.014
	(1.78)	(1.37)	(1.36)
Year Fixed Effects	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes
Firm Clustering	Yes	Yes	Yes
Observations	161,108	161,108	161,108
R-squared	0.01	0.01	0.01

Notes: The sample used for this analysis is quarterly earnings announcement periods of all U.S. unregulated and nonfinancial calendar year firms between 1994 and 2011. *Abnormal Bid-Ask Spread* is the bid-ask spread from the event period surrounding the earnings announcement date (*t* to *t*+1), less the average bid-ask spread from the period *t*-45 to *t*-5. *Lapsed Credit Quarter* is an indicator variable coded to one if the R&D tax credit was expired during the entire quarter and was later retroactively extended. *R&D Credit Exposure* is measured three ways. *R&D Mention* is an indicator variable equal to one if the firm's 10-K ever mentions the R&D tax credit. *R&D Expire Firm* is an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly ETR was lower because of the expiration of the R&D tax credit. *R&D in ETR Reconciliation* is an indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*. Standard errors are clustered at the firm level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Table 6. Cross-Sectional Test of Disclosure, R&D Tax Credit Extensions and Forecast Improvement

	(1)	(2)	(3)
Dependent Variable:	Forecast Improvement		
Measure of R&D Credit Exposure:	R&D Mention	R&D Expire Firm	R&D in ETR Reconciliation
Extension Between Revisions	0.274***	0.243***	0.244***
	(6.37)	(6.62)	(6.64)
Guidance	-0.088***	-0.087***	-0.090***
	(-10.10)	(-10.44)	(-11.60)
R&D Credit Exposure	0.033***	-0.139***	0.038*
	(3.22)	(-14.42)	(1.86)
Extension Between Revisions X Guidance	-0.150***	-0.090*	-0.096*
	(-2.95)	(-1.75)	(-1.91)
Extension Between Revisions X R&D Credit Exposure	-0.164***	-0.177***	-0.193***
	(-3.06)	(-3.91)	(-2.76)
R&D Credit Exposure X Guidance	-0.008	0.085***	0.033
	(-0.66)	(7.77)	(1.28)
Extension Between Revisions X R&D Credit Exposure X Guidance	0.187***	0.112**	0.098
	(2.79)	(2.02)	(1.07)
Constant	0.226***	0.244***	0.233***
	(25.93)	(29.81)	(29.69)
Year Fixed Effects	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes
Analyst Clustering	Yes	Yes	Yes
Observations	402,965	402,965	402,965
R-squared	0.01	0.01	0.01

Notes: The sample used for this analysis is all forecast revisions of all U.S. unregulated and nonfinancial calendar year firms between 1994 and 2010. *Forecast Improvement* is equal to the unsigned forecast error before the revision less the unsigned forecast error after the revision, scaled by price at the beginning of the fiscal year period, all multiplied by 100. *Guidance* is coded to one if the firm issued an EPS forecast in quarter *t*. *Extension Between Revisions* is coded as one if the two forecasts span the enactment date from the sample of R&D credit extensions. *R&D Credit Exposure* is measured three ways. *R&D Mention* is an indicator variable equal to one if the firm's 10-K ever mentions the R&D tax credit. *R&D Expire Firm* is an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly ETR was lower because of the expiration of the R&D tax credit. *R&D in ETR Reconciliation* is an indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*. Standard errors are clustered at the analyst level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Table 7. Cross-Sectional Test of Institutional Ownership R&D Tax Credit Expirations and Bid-ask Spreads

Dependent Variable:	Abnormal Bid-Ask Spread		
Measure of R&D Credit Exposure:	R&D Mention	R&D Expire Firm	R&D in ETR Reconciliation
R&D Credit Expiration Quarter	-0.017	-0.050	-0.080**
	(-0.79)	(-1.20)	(-2.30)
R&D Credit Exposure	-0.357***	-0.347***	-0.341***
	(-10.87)	(-11.81)	(-11.70)
Instiitional Investors	0.025*	0.018	0.019*
	(1.96)	(1.63)	(1.75)
R&D Credit Expiration Quarter X R&D Credit Exposure	0.079	0.347***	0.329***
	(1.59)	(3.44)	(2.59)
R&D Credit Exposure	-0.014	0.043	0.061
	(-0.62)	(0.94)	(1.58)
R&D Credit Expiration Quarter X Institutional Investor	0.245***	0.241***	0.236***
	(7.81)	(9.19)	(9.05)
R&D Credit Expiration Quarter X R&D Credit Exposure X Institional Investors	-0.061	-0.346***	-0.347***
	(-1.14)	(-3.31)	(-2.78)
Constant	0.008	0.005	0.005
	(0.58)	(0.43)	(0.41)
Year Fixed Effects	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes
Firm Clustering	Yes	Yes	Yes
Observations	161,108	161,108	161,108
R-squared	0.01	0.01	0.01

Notes: The sample used for this analysis is quarterly earnings announcement periods of all U.S. unregulated and nonfinancial calendar year firms between 1994 and 2011. *Abnormal Bid-Ask Spread* is the bid-ask spread from the event period surrounding the earnings announcement date (*t* to *t*+1), less the average bid-ask spread from the period *t*-45 to *t*-5. *Lapsed Credit Quarter* is an indicator variable coded to one if the R&D tax credit was expired during the entire quarter and was later retroactively extended. *R&D Credit Exposure* is measured three ways. *R&D Mention* is an indicator variable equal to one if the firm's 10-K ever mentions the R&D tax credit. *R&D Expire Firm* is an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly ETR was lower because of the expiration of the R&D tax credit. *R&D in ETR Reconciliation* is an indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*. *Institutional Investors* is an indicator variable coded to equal one when the share of the firm owned by institutional investors in the quarter is larger than the mean among all firms in year *t*. Standard errors are clustered at the firm level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Table 8. Sensitivity Analysis for R&D Tax Credit Extensions and Forecast Improvement

	(1)		(2)		(3)	
Dependent Variable:	Forecast Improvement					
Measure of R&D Credit Exposure:	R&D Mention		R&D Expire Firm		R&D in ETR Reconciliation	
Extension Between Revisions	0.221***	(5.70)	0.194***	(6.11)	0.190***	(6.06)
R&D Exposure	0.009	(1.05)	-0.077***	(-8.99)	0.015	(0.99)
Between Revisions X R&D Credit Exposure	-0.143***	(-3.11)	-0.191***	(-5.13)	-0.192***	(-3.63)
Ln(MVE)	-0.091***	(-21.11)	-0.089***	(-20.84)	-0.091***	(-21.15)
Book to Market	0.123***	(7.40)	0.123***	(7.38)	0.123***	(7.35)
Analyst Coverage	0.005***	(8.16)	0.005***	(8.28)	0.005***	(8.15)
Momentum	-0.150***	(-13.68)	-0.149***	(-13.63)	-0.150***	(-13.68)
Time Between Forecasts	0.001***	(3.58)	0.001***	(3.46)	0.001***	(3.59)
Forecast Horizon	-0.000***	(-10.07)	-0.000***	(-10.02)	-0.000***	(-10.08)
Percent R&D Exposure Firms	0.068***	(4.71)	0.098***	(8.25)	0.072***	(6.89)
General Experience	-0.002**	(-2.19)	-0.002**	(-2.19)	-0.002**	(-2.20)
Firm Specific Experience	0.009***	(5.15)	0.009***	(5.23)	0.009***	(5.16)
Number of Firms Covered	-0.001	(-0.93)	-0.001	(-1.06)	-0.001	(-0.92)
Constant	0.772***	(20.26)	0.760***	(19.99)	0.774***	(20.32)
Year Fixed Effects	Yes		Yes		Yes	
Quarter Fixed Effects	Yes		Yes		Yes	
Analyst Clustering	Yes		Yes		Yes	
Observations	409,523		409,523		409,523	
R-squared	0.04		0.04		0.04	

Notes: The sample used for this analysis is all forecast revisions of all U.S. unregulated and nonfinancial calendar year firms between 1994 and 2011. *Forecast Improvement, Extension Between Revisions, R&D Credit Exposure, R&D Mention, R&D Expire Firm, R&D in ETR Reconciliation* are all defined in Appendix B. *Ln(MVE*) is the logged market value of equity of the firm. *Book to Market* is the book to market ratio from the end of the prior quarter. *Analyst Coverage* is the number of unique analysts forecasting earnings in the quarter for the firm. *Momentum* is the buy and hold equity return for the six months prior to the month of the earnings announcement. *Time Between Forecasts* is the number of days between the two forecasts that comprise the revision. *Forecast Horizon* is the number of days between the end of the fiscal quarter and the forecast date. *Percent R&D Exposure Firms* is the percentage of an analyst's forecasts related to firms with R&D tax credit exposure in the fiscal year. *General Experience* is the number of years since the analyst's first forecast was recorded on IBES. *Firm Specific Experience* is the number of years since an analyst issued their first forecast for the firm. *Number of Firms Covered* is the number of different firms covered by the analyst in the fiscal year. Standard errors (on the right) are clustered at the analyst level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Table 9. Managers' Forecast Improvement and R&D Tax Credit Extensions

	(1)	(2)	(3)
Dependent Variable:	Managers' Forecast Improvement		
Measure of R&D Credit Exposure:	R&D Mention	R&D Expire Firm	R&D in ETR Reconciliation
Extension Between Revisions	-0.121*	0.035	0.049
	(-1.76)	(0.39)	(0.49)
R&D Credit Exposure	-0.024	-0.094***	-0.045
	(-0.78)	(-3.70)	(-1.00)
Extension Between Revisions X R&D Credit Exposure	0.842***	1.444**	1.039*
	(2.97)	(2.18)	(1.80)
Constant	0.184***	0.182***	0.177***
	(7.11)	(8.01)	(7.86)
Year Fixed Effects	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes
Firm Clustering	Yes	Yes	Yes
Observations	2,235	2,235	2,235
R-squared	0.06	0.06	0.06

Notes: The sample used for this analysis is all EPS forecast revisions from the CIG database of managers' forecasts of all U.S. unregulated and nonfinancial calendar year firms between 1994 and 2010, comprising 2,235 revisions from 657 unique firms. *Forecast Improvement* is equal to the unsigned forecast guidance error before the managers' revision less the unsigned forecast error after the revision, scaled by price at the beginning of the fiscal year period, all multiplied by 100, where no more than 60 days elapse between revisions. *Extension Between Revisions* is coded as one if the two forecasts span the enactment date from the sample of R&D credit extensions. *R&D Credit Exposure* is measured three ways. *R&D Mention* is an indicator variable equal to one if the firm's 10-K ever mentions the R&D tax credit. *R&D Expire Firm* is an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly ETR was lower because of the expiration of the R&D tax credit. *R&D in ETR Reconciliation* is an indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*. Standard errors are clustered at the firm level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Table 10. Analyst-Month Level Analysis of Forecast Improvement

	(1)	(2)
Dependent Variable:	Analyst's Average Forecast Improvement in Month	
Measure of R&D Analyst:	Only R&D Credit Firms Forecasted in Month	Percentage R&D Credit Firms Forecasted in Month
Extension Bill in Month	0.086***	0.083***
	(4.74)	(4.13)
R&D Analyst	0.005	0.013*
	(0.66)	(1.66)
Extension Bill Month X R&D Analyst	-0.073**	-0.051*
	(-2.47)	(-1.65)
Constant	0.058	0.054
	(1.28)	(1.20)
Analyst Clustering	Yes	Yes
Month Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	106,891	106,891
R-squared	0.01	0.01

Notes: This estimation is estimated on a panel of analyst-month observations created by aggregating the sample described in Table 1, Panel A up to the analyst-month level. *Average Forecast Improvement* is equal to the unsigned forecast error before the revision less the unsigned forecast error after the revision, scaled by price at the beginning of the fiscal year period, all multiplied by 100. This is then averaged for each analyst in each month. *Extension Bill Month* is an indicator variable coded to equal one for months when the R&D tax credit is extended (8/1996, 8/1997, 10/1998, 12/1999, 10/2004, 12/2006, 10/2008, and 12/2010). *R&D Analyst* is measured two ways. *Only R&D Credit Firms Forecasted in Month* is an indicator variable coded to equal one when the analyst only forecasted firms that have *R&D Credit Exposure, R&D Mention, R&D Expire Firm* or *R&D in ETR Reconciliation* equal to one in the month. *Percentage R&D Credit Firms Forecasted in Month* is a continuous variable that is equal to the number of forecasts issued for firms with *R&D Credit Exposure, R&D Mention, R&D Expire Firm* or *R&D in ETR Reconciliation* equal to one in the month, divided by the total number of forecasts in the month. Standard errors are clustered at the analyst level, and p-values are indicated as *, **, and *** representing two tailed significance at the 10%, 5% and 1% level.

Appendices

Appendix A. Legislative History of the R&D Tax Credit

Law	Signed Into Law	Effective Date	End Date	Retroactive	In Sample
Economic Recovery Tax Act of 1981	13-Aug-81	1-Jul-81	31-Dec-85	Yes	
Tax Reform Act of 1986	22-Oct-86	1-Jan-86	31-Dec-88	Yes	
Technical and Miscellaneous Revenue Act of 1988	10-Nov-88	1-Jan-89	31-Dec-89	No	
The Omnibus Budget Reconciliation Act of 1989	19-Dec-89	1-Jan-90	31-Dec-90	No	
The Omnibus Budget Reconciliation Act of 1990	5-Nov-90	1-Jan-91	31-Dec-91	No	
Tax Extension Act of 1991	11-Dec-91	1-Jan-92	30-Jun-91	No	
Omnibus Budget Reconciliation Act of 1993	3-Aug-93	1-Jul-92	30-Jun-95	Yes	
No credit	N/A	1-Jul-95	30-Jun-96	N/A	
Small Business Job Protection Act of 1996	20-Aug-96	1-Jul-96	31-May-97	Yes	Yes
Taxpayer Relief Act of 1997	5-Aug-97	1-Jun-97	30-Jun-98	Yes	Yes
Omnibus Consolidated and Emergency Supplemental Appropriations Act	21-Oct-98	1-Jul-98	30-Jun-99	Yes	Yes
Ticket to Work Incentive Improvement Act of 1999	17-Dec-99	1-Jul-99	30-Jun-04	Yes	Yes
Working Families Tax Relief Act of 2004	4-Oct-04	1-Jul-04	31-Dec-05	Yes	Yes
Tax Relief and Health Care Act of 2006	20-Dec-06	1-Jan-06	31-Dec-07	Yes	Yes
Emergency Economic Stabilization Act of 2008	3-Oct-08	1-Jan-08	31-Dec-09	Yes	Yes
Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010	17-Dec-10	1-Jan-10	31-Dec-11	Yes	Yes
American Taxpayer Relief Act of 2012	2-Jan-13	1-Jan-12	31-Dec-13	Yes	No

Appendix B. Measurement of Variables

Abnormal Bid-Ask Spread = The bid-ask spread from the event period surrounding the earnings announcement date (*t* to *t*+1), less the average bid-ask spread from the period *t*-45 to *t*-5. The bid-ask spread is first computed at a transaction level as the offer price (TAQ variable OFR) less the bid (BID) price, divided by the average of the offer and bid price, all multiplied by 100. This transaction level measure is then averaged during each day for all transactions occurring during normal trading hours, resulting in a daily measure of bid-ask spread.

Extension Between Revision = An indicator variable coded to one if the two forecasts span the enactment date from the sample of R&D credit extensions (i.e., spans 8/20/1996, 8/5/1997, 10/21/1998, 12/17/1999, 10/4/2004, 12/20/2006, 10/3/2008 or 12/17/2010).

Forecast Improvement = The unsigned forecast error before the revision (IBES variable abs(VALUE – ACTUAL)) less the unsigned forecast error after the revision, scaled by price at the beginning of the fiscal year period (Compustat Quarterly variable PRCCQ), all multiplied by 100.

Lapsed Credit Quarter = An indicator variable coded to one if the R&D tax credit was expired during the entire quarter. Specifically, if the quarters fiscal period beginning and fiscal period end fall between 7/1/1998 and 10/21/1998 or 7/1/2004 and 10/4/2004 or 1/1/2006 and 12/20/2006 or 1/1/2008 and 10/3/2008 or 1/1/2010 and 12/17/2010 or 7/1/1996 and 8/20/1996 or 7/1/1997 and 8/5/1997 or 7/1/1999 and 12/17/1999 or 1/1/2010 and 12/17/2010.

R&D Expire Firm = an indicator variable equal to one if the firm ever mentions in a 10-Q that its quarterly earnings were affected because of the expiration of the R&D tax credit.

R&D in ETR Reconciliation = An indicator variable equal to one if the firm had a line item for the U.S. Federal Research and Development tax credit in its effective tax rate reconciliation in year *t*.

R&D Mention = an indicator variable equal to one if the firm's 10-K ever has the words "research and development tax credit," "R&D tax credit," "research and experimentation tax credit" or "research tax credit."

Revision = The value of the revision in quarterly EPS (the difference in IBES variables VALUE from one forecast to the forecast directly after follow) scaled by price at the beginning of the fiscal period (Compustat Quarterly variable PRCCQ), all multiplied by 100.

Appendix C. Dictionaries for Identifying Firms Affected by R&D Credit Extension Bills

Bill Title = tax relief and health care act; emergency economic stabilization act; tax relief, unemployment insurance reauthorization, and job creation act; omnibus consolidated and emergency supplemental appropriations act; taxpayer relief act; ticket to work and work incentives improvement act of 1999; working families tax relief act; small business job protection act

Small Business Job Protection Act of 1996 = 104-188; small business job protection act; august 20, 1996; biomass and coal facilities; contributions of stock to private foundations; diesel fuel dyeing; employer-provided educational assistance programs; fasit; financial asset securitization investment trusts; futa exemption for alien agricultural workers; gas station convenience stores and similar structures; modified guaranteed contracts; newspaper distributors treated as direct sellers; **orphan drug**; ozone-depleting chemicals; **puerto rican economic activity credit**; **puerto rico and possession tax credit**; **r&d credit**; **r&d tax credit**; **research credit**; **work opportunity tax credit**

Taxpayer Relief Act of 1997 = 105-34; taxpayer relief act; august 5, 1997; airport and airway trust fund; aviation fuel; brownfields; certain preferred stock treated as boot; clarification of authority to use semi-generic designations on wine labels; clean fuel vehicle; community development financial institutions; computer technology and equipment for elementary or secondary school purposes; contributions of stock to private foundations; controlled foreign corporations not subject to pfic inclusion; distilled spirits excise tax; electric and other clean-fuel motor vehicles; employer-provided educational assistance; employment tax status of securities brokers; empowerment zones; enterprise communities; exception from treatment of publicly traded partnerships as corporations; exemption from alternative minimum tax; expensing of environmental remediation costs; family-owned business exclusion; farmers' installment sales; foreign tax credit carrybacks; foreign tax credit limit; holding period applicable to dividends received deduction; incentives for education zones; limitation on exception for investment companies under section 351; livestock sold on account of weather-related conditions; multiple gasoline retail outlets treated as wholesale distributor; national railroad passenger corporation; **orphan drug**; passive foreign investment company; percentage depletion for marginal production; presidentially declared disaster; **r&d credit**; **r&d tax credit**; **research credit**; **research tax credit**; restoration of leaking underground storage tank trust fund taxes; revitalization of the district of columbia; section 355; self-employment tax for certain termination payments received by former insurance salesmen; separate depreciation lives for minimum tax purposes; shrinkage for inventory accounting; simplified section 904; subpart f; tax treatment of redemptions involving related corporations; temporary unemployment tax; translating foreign taxes; virgin island bonds; **welfare-to-work**; **work opportunity tax credit**

Omnibus Consolidated and Emergency Supplemental Appropriations Act of 1998 = 105-277; omnibus consolidated and emergency supplemental appropriations act; october 21, 1998; active financing income; biodiesel; commodity credit corporation; **fuel use credits**; **orphan drug**; **r&d credit**; **r&d tax credit**; **research credit**; subpart f; **welfare-to-work credit**; **work opportunity credit**

Ticket to Work Incentive Improvement Act of 1999 = 106-170; ticket to work and work incentives improvement act of 1999; december 17, 1999; active financing income; cancellation of indebtedness income; conversion of character of income from constructive ownership transactions; distributions by a partnership to a corporate partner of stock in another corporation; electricity from certain renewable resources; employer-provided educational assistance; environmental remediation costs; excess pension assets used for retiree health benefits; installment method for accrual method taxpayers; **orphan drug**; percentage depletion for marginal production; qualified zone academy bonds; **r&d credit**; **r&d tax credit**; **research credit**; rum excise tax; subpart f; subpart f exemption; tax treatment of income and loss on derivatives; **ticket to work**; **welfare-to-work credit**; **work opportunity credit**

Working Families Tax Relief Act of 2004 = 108-311; working families tax relief act; october 4, 2004; accelerated depreciation for business property on indian reservation; clean-fuel vehicle; corporate donations of scientific property and computer technology; electricity produced from certain renewable resources; expensing of environmental remediation costs**; indian employment tax credit**; indian reservation; investment in the district of columbia; medical savings accounts; new york liberty zone benefits; **orphan drug**; percentage depletion for oil and natural gas; qualified electric vehicles; qualified zone academy bonds; **r&d credit**; **r&d tax credit**; **research credit**; tax on distilled spirits; **welfare-to-work credit**; **work opportunity credit**

Tax Relief and Health Care Act of 2006 = 109-432; tax relief and health care act; december 20, 2006; advanced mine safety equipment; **american samoa economic development credit**; brownfields remediation costs; cellulosic biomass ethanol; clean renewable energy bonds; **credit for electricity produced from certain renewable resources**; distilled spirits; domestic production activities in puerto rico; **energy credit**; energy efficient commercial buildings; energy efficient homes; ethanol; gulf opportunity zone property; **indian employment tax credit**; indian reservation; investment in the district of columbia; kerosene used in aviation; marginal properties; methanol; **mine rescue team training tax credit**; **new markets tax credit**; **orphan drug**; qualified restaurant property; qualified zone academy bonds; **r&d credit**; **r&d tax credit**; railroad track maintenance credit; **research credit**; residential energy efficient property; section 355; tonnage tax; **welfare-to-work credit**; **work opportunity tax credit**

Emergency Economic Stabilization Act of 2008 = 110-343; emergency economic stabilization act; october 3, 2008; advanced coal project investment; advanced mine safety equipment; **alternative fuel credit**; **alternative fuel vehicle refueling property credit**; biodiesel; carbon dioxide sequestration; cellulosic biofuel; certain improvements to retail space; clean renewable energy bonds; coal excise tax; **coal gasification investment credit**; controlled foreign corporations; domestic production activities in puerto rico; economic development credit for american samoa; **energy credit**; **energy efficient appliance credit**; energy efficient commercial buildings deduction; **energy efficient home credit**; environmental remediation costs; exxon valdez litigation; film and television productions; financial stability oversight board; geothermal heat pump systems; gulf opportunity zone; hope for homeowners amendments; hurricane katrina employees; indian employment credit; **indian reservations**; **investment in the district of**

columbia; marginal properties; marine renewables; **mine rescue team training credit**; **motorsports racing track facility**; **new markets tax credit**; **orphan drug**; plug-in electric drive motor vehicles; qualified energy conservation bonds; qualified restaurant improvements; qualified zone academy bonds; **r&d credit**; **r&d tax credit**; railroad track maintenance; renewable diesel; **renewable energy credit**; **research credit**; residential energy efficient property; reuse and recycling property; rum excise tax; small wind property; smart grid systems; smart meters; steel industry fuel; subpart f; troubled asset relief program; troubled assets; wooden arrows designed for use by children; **work opportunity tax credit**

Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 = 111-312; tax relief, unemployment insurance reauthorization, and job creation act; december 17, 2010; alcohol used as fuel; alternative fuel; american samoa economic development credit; biodiesel; bonus depreciation; certain film and television productions; **credit for nonbusiness energy property**; **credit for refined coal facilities**; domestic production activities in puerto rico; **employer wage credit**; empowerment zone tax incentives; **energy efficient appliance credit**; **energy efficient home credit**; environmental remediation costs; **excise tax credits**; go zone; **indian employment tax credit**; indian reservation; **investment in the district of columbia**; **low-income housing credit**; marginal wells; **mine rescue team training credit**; **motorsports entertainment complexes**; **new markets tax credit**; **orphan drug**; qualified leasehold improvements; qualified restaurant buildings; qualified retail improvements; **r&d credit**; **r&d tax credit**; **railroad track maintenance credit**; **rehabilitation credit**; renewable diesel; **research credit**; rum excise taxes; rum excise taxes to puerto rico and the virgin islands; small business stock; temporary 100 percent expensing; work opportunity credit

Appendix D. Computer Assisted Hand Collection

This appendix briefly describes how I used Computer Assisted Hand Collection (CAHC) to collect data used in my paper. CAHC combines the power of a computer to quickly locate word strings in documents and create datasets with the ability of the human hand-coders to discern nuances that the computer cannot understand (or that a computer could only be made to understand at great cost). Hand collection typically involves locating a set of documents from which to code (press releases, news articles, 10-Ks, S-1s, or other documents), and manually going through each document to find firm specifically information. After a specific usable document is located, the information is found within the document, and is recorded along with a firm identifier in a separate document. While a computer's search function (or a search engine's search function) might be used to locate specific information, much of the work is done by hand.

CAHC automates most of this process. For example, for my paper, I was interested in locating firm disclosures about the R&D tax credit. Standardized numerical disclosures about the credit are most often found in firms' effective tax rate reconciliation that is contained in firms' 10-K filing. To obtain this information, I followed these steps:

1. Create a dictionary of terms used to start the tax rate reconciliation.[64] This is done by examining, by hand, many different 10-Ks' effective tax rate reconciliations.

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[64] My dictionary contained the following terms: reconciliation of the statutory, U.S. federal income tax rate to the effective rates, Amount at statutory U.S. rate, Computed (expected) tax expense (benefit), Computed (expected) provision for, Computed at statutory rate, Computed statutory amount, Computed tax provision at statutory rate, Computed U.S. federal income taxes, Federal income tax expense at the (34% or 35%) statutory rate, Federal Income Taxes at Statutory Rate, Federal statutory rate, Federal statutory tax rate, Federal tax rate , Financial statement net

2. Create a dictionary of terms used to refer to the R&D tax credit (I used the term R&D or research).

3. Obtain all 10-Ks available on EGAR.

4. Strip out all HTML from the 10-Ks, maintaining the integrity of the structure of tables. For example, empty spaces in a table are recognizable as empty spaces, or are replaced with 0s. I thank Jason Chen for assistance in stripping out the HTML from 10-Ks while maintaining the structure of the tables.

5. Use a computer program (such as perl) to locate 10-Ks that have a term referring to the R&D tax credit within a short number of characters of the start of the tax rate reconciliation.

6. Have the computer capture the text starting with the beginning of the effective tax rate reconciliation and several lines below the reference to the R&D tax credit.

7. Have the computer locate the three (or two) years that the tax rate reconciliation is referring to in the document, and store them.

8. Have the computer print out a well formatted text document with a firm identifier and fiscal year end for the firm (obtained from the 10-K itself), with the three (or two) years that the tax rate reconciliation refers to, all in a single line.

9. Have the computer print out the text captured from the tax rate reconciliation below this line.

10. The computer will do this for each 10-K. This will produce a single text document with many observations worth of data on it. The following is an example of a single observation which represent the firm with CIK = 0000012208 for their fiscal year ended 12/31/2012. :

---

loss before income taxes, Income tax benefit at [0-3], Income tax provision at [0-3], Income tax computed at, Income tax expense at the statutory rate, Statutory federal income tax rate, Statutory provision, Statutory rate, Computed expected income tax benefit at 34%, Statutory tax rate, Tax at statutory rate, Tax at U.S. statutory rate, Taxes computed at statutory rate, Federal income tax expense benefit, 35% 35 % 35 %, 35.0 % 35.0 % 35.0 %, 34.0 % 34.0 % 34.0 %, 34 % 34 % 34 %, U.S. statutory tax rate, Statutory rate benefit, U.S. Federal statutory rate applied.

```
0000012208   20101231     2010   2009   2008

  The reconciliation between our effective tax rate on income before
  taxes and the statutory tax rate is as follows:

                   Year Ended December 31,

                                          2010           2009  2008

  U. S. statutory tax rate                 35%           35%   35%
  Impact of foreign operations              6            8   6
  Research and development tax credits      4            7   9
  Change in valuation allowance             --           1    3
  Examination settlements                   --           1   2
  Repatriation of foreign earnings          10           --   --
  Goodwill impairment                       --           --   7
  Other                                     --           --   1
  Provision for income taxes                15%            20%   31%


  Deferred tax assets and liabilities reflect the tax effects of losses,
```

10. A human will take this single text document and delete the text that is not required, and using the text, add other information needed to standardize the information across firms (such as whether the firms provides their reconciliation in dollar terms, thousands of dollars, or millions of dollars, or in percentage terms (as is used in the example above)). This yields a single line per firm year observation, in this case, the CIK, fiscal year end of the firm, the three years for which this 10-K has data, the values of the R&D tax credit for those three years, and a notation suggesting this is in percentage terms (meaning this data will need to be merged in with Compustat to obtain pre-tax income to turn those percents into dollars):

```
0000012208    20101231     2010   2009   2008 4   7   9  p
```

11. This data is then arranged cleaned and formatted for use in a standard statistical package to be used for data analysis.

Using the computer program to locate relevant 10-Ks, locate the relevant location within the 10-K, and locate and record the firm identifier and years in a well formatted text document saves an enormous amount of coding time. Other applications of CAHC may merely involve having a human verify that the text captures relevant information. For example, for the coding of *R&D in ETR Reconciliation*, I merely manually verified whether the rate reconciliation mentioned the R&D tax credit.

Appendix E. Explicitly Stated Legislated Purpose of Bills Extending R&D Tax Credit

Small Business Job Protection Act	To provide tax relief for small businesses, to protect jobs, to create opportunities, to increase the take home pay of workers, to amend the Portal-to-Portal Act of 1947 relating to the payment of wages to employees who use employer owned vehicles, and to amend the Fair Labor Standards Act of 1938 to increase the minimum wage rate and to prevent job loss by providing flexibility to employers in complying with minimum wage and overtime requirements under that Act.
Taxpayer Relief Act	To provide for reconciliation pursuant to subsections (b)(2) and (d) of section 105 of the concurrent resolution on the budget for fiscal year 1998.
Omnibus Consolidated and Emergency Supplemental Appropriations Act	Making omnibus consolidated and emergency appropriations for the fiscal year ending September 30, 1999, and for other purposes.
Ticket to Work Incentive Improvement Act	To amend the Social Security Act to expand the availability of health care coverage for working individuals with disabilities, to establish a Ticket to Work and Self-Sufficiency Program in the Social Security Administration to provide such individuals with meaningful opportunities to work, and for other purposes.
Working Families Tax Relief Act	To amend the Internal Revenue Code of 1986 to provide tax relief for working families, and for other purposes.
Tax Relief and Health Care Act	To amend the Internal Revenue Code of 1986 to extend expiring provisions, and for other purposes.
Emergency Economic Stabilization Act	To provide authority for the Federal Government to purchase and insure certain types of troubled assets for the purposes of providing stability to and preventing disruption in the economy and financial system and protecting taxpayers, to amend the Internal Revenue Code of 1986 to provide incentives for energy production and conservation, to extend certain expiring provisions, to provide individual income tax relief, and for other purposes.
Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act	To amend the Internal Revenue Code of 1986 to extend the funding and expenditure authority of the Airport and Airway Trust Fund, to amend title 49, United States Code, to extend authorizations for the airport improvement program, and for other purposes.

Appendix F. Examples of Disclosures and Discussion of the R&D Tax Credit

Examples of Disclosures in 10-Qs

Synaptics Inc—September 25, 2010

> The federal research tax credit expired December 31, 2009. In the past, the federal research credit has expired and has been retroactively reinstated. It is not clear if the research credit will be retroactively reinstated or reinstated at all.

Cymer Inc, March 31, 2010

> The currently expired United States research and development tax credit is expected to be reinstated; however, it is unknown when this event will take place.

Invitrogen Corp – March 3, 2006

> The statutory provisions allowing the Federal research and development tax credit in the United States have expired but are expected to be renewed.

DRS Technologies Inc – September 30, 2008

> Federal legislation to extend research tax credits has been drafted, but we have no assurances regarding the outcome of this potential legislation.

Linear Technology Corp, December 30, 2007

> The Company believes that the R&D tax credit will be restored by legislation retroactive to the beginning of calendar year 2008, but there can be no assurance that this will happen.

Company Name: Adobe Systems Inc—March 1, 1996

> The effective tax rate for first quarter of 1996 was higher than the same quarter of 1995 due to the fact that the Company was not able to utilize the federal research and experimentation tax credit which expired on June 30, 1995. It remains unclear whether the research and experimentation credit will be renewed. Nonrenewal would continue to adversely impact the Company's 1996 effective tax rate.

FSI International Inc – January 24, 1996

> The effective tax rate should be at the lower end of the range if Congress retroactively reinstates the research and development tax credit, which expired in June 1995.

Eagle Point Software Corp – March 31, 1996

> The research and development tax credit was expected to be renewed, but due to the current federal budget uncertainty, there can be no assurances that the research and development credit will be renewed.

ADTRAN Earnings Conference Call - January 16, 2013

The company's income tax rate was 38.1% for the fourth quarter of 2012 compared to 31.3% for the fourth quarter of 2011. The higher tax rate for the fourth quarter of 2012 relates primarily to a delay in legislation to extend research tax credits and adjustments in the deferred tax asset valuation allowance for the acquired BBA business.

Linear Technology Management - January 16, 2013

Our quarterly effective income tax rate was 27%, similar to last quarter, and once again, we had no discrete tax items. Year-end legislation in the U.S.A. pertaining to the fiscal cliff reinstated the R&D credit. The impact of this will benefit our effective tax rate in the upcoming quarters. The catch-up effect will lower our effective rate in Q3 to roughly 20%. Our estimated ongoing effective tax rate in Q4 and beyond without discrete items will be approximately 25.5%, down from the 27% reported in recent quarters.

Rockwell Collins – Q1 - January 18, 2013

The American Taxpayers Relief Act of 2012 was signed into law in early January, resulting in the retroactive application and extension of the Federal Research and Development Tax Credit through December 31, 2013. The effect of this credit will reduce our full year tax rate from 32% to about 27%. The change creates about a 30% improvement to the earnings per share, of which about half of that benefit will go to fund increased employee incentive compensation costs. That will result in a net $0.15 increase to earnings per share guidance, resulting in a full year target range between $4.45 and $4.65 per share.

Parker Hannifin – Q2 -January 18, 2013

Li Lustgarten - Longbow Securities: Okay. And the R&D tax credit that we bought something like in the center of $0.07 to $0.08 and will that all be taken in the third quarter?

Jon Marten - Executive Vice President and Chief Financial Officer: Yes.

Eli Lustgarten - Longbow Securities: So, the third quarter has helped and is it about $0.08 a share or something like that, that the magnitude of the R&D tax credit?

Pamela Huggins - Vice President and Treasurer: You are close I think, but let’s follow up after the call to make sure on that.

Appendix G. Emailed Background Questions to Analysts

In order to gain background information, I communicated with analysts about how they deal with the R&D tax credit. The text to my information request is below. I obtained the email addresses of two groups of analysts. One group was a list of general analysts (153 analysts) and the other group was analysts that had issued a report mentioning the R&D tax credit (64 analysts). Several analysts replied back indicating I should call them, which I did. I obtained some response from 41 analysts. For those that responded with useful replies conveyed in an email, I have included their replies below.

Text to e-mail:

> Analysts First Name,
>
> I am a PhD student in Business Administration at the University of Michigan. I am working on a dissertation that deals with the R&D tax credit and its effect on analysts' forecasts of quarterly EPS. I am especially interested in what analysts do about forecasting the effect of the credit on EPS when the credit is expired (as it currently is), and when it gets retroactively reinstated (as has happened many times). For example, I am wondering how analysts know how much the expired credit will affect forecasted quarterly EPS for a given company? Do they pay attention to the extensions of the credit, and revise quarterly EPS forecasts as a result, or do they try to predict when the credit will be extended before it happens? Where do analysts get information regarding companies' use of the R&D tax credit? Do analysts even pay attention to the credit, and its expiration/reinstatement? I am interested in any comments/thoughts/insights you have on this topic, whether it addresses one of my specific questions or not. Anything would be appreciated. Thanks for your help.

Responses (with identifying information omitted):

- I have in the past worked in a catch up credit in my tax rate estimates when I think there is a high likelihood of a deferred renewal. Like all estimates we use our best guess on media reports as to when the credit is due to be voted on and when it expires. [For information regarding companies' use of the R&D tax credit,] we ask the company CFO's or investor relations officers
- From what I have observed, many analysts treat R&D credits as extraordinary items and as such exclude them when calculating "adjusted" or "pro forma" EPS which is supposed to represent the company's true earning power.
- Generally excluded for operating eps (ie use a normalized tax rate)
- The practical answer when covering the large conglomerates is that the R&D tax credit often gets lost in the wash. As you know there are so many tax planning strategies in place and so many regional variations in rates that change the effective rate of a company. Some companies have called out R&D credit expiration as a reason for a higher tax rate guidance, but these tend to be smaller companies (not GE, HON, etc). Realistically, most Wall Street analysts simply take tax rate guidance from company management for a given year and then take a realistic estimate in the forward years. Sounds like a dumb answer but we don't have enough data to make informed forecasts of tax rate. Exceptions would be for small companies and simpler business models.
- We rarely try to predict R&D tax credit impacts unaided by the company's guidance as it is difficult to predict (even for mgmt sometimes) and it can be somewhat of a moot point if we're looking at "non-GAAP" earnings. I would be surprised to see that other analyst or even investors consider these impacts.
- I can tell you that R&D tax credit analysis is not anywhere near the top of the list of things we are looking at. On tax-related issues, most analysts generally look to management guidance for help in making projections, unless tax rate becomes a controversial issue for a particular company, in which case we'll do more digging and possibly consult with a tax expert.
- I can't speak for everyone of course, but I can say that while I know of the tax credit and have noted its impact on several of my companies. For valuation purpose we generally remove/adjust out its effect as we consider it non-recurring / irregular. In most instances we use a "normalized" tax rate (statutory rates + expected impact from NOL benefit where applicable) in our models.
- I cannot speak for all analysts, but I suspect what you will find is that we don't pay much attention to it. Whether earnings are "good" or "bad" is really dictated at the operating profit line. If the tax line swings one way or the other more than modeled, it is noted, but in no way does it distract from operating performance. So for the most part I think its presence or absence, and the timing at which those may or may not reverse, are ignored from an earnings model standpoint and is even more ignored in terms of valuing individual stocks. I find out any details I have to know about the R&D tax credit when it is brought up during the conference call to explain swings in tax rate; I don't keep up with it at all between quarters. It is just not a relevant metric from an operating standpoint.
- I think what typically happens is that most companies tell you that their guidance for taxes either reflects or does not reflect the R&D tax credit. Then what ussually what happens is that the tax credit gets renewed and the calendar Q4 tax rate is a lot lower

than the rest of the year. There may be a little more to it than that, but not much from a modeling standpoint.

- I would say all analysts are generally aware of any major changes in the legislated tax treatment of R&D spending (although often we get the news from the companies directly, vs. monitoring the developments in DC ourselves). I would also guess that a small minority of Internet analysts explictly factor these changes into their earnings models, although it's likely that analysts in other tech sub-sectors factor it in.
- I would suggest that analysts do not pay close attention as tax rate is dependent on so many variables that we generally look to company guidance to forecast tax rate.
- I don't model anything specific to the tax credit. My tax rate modeling is usually based on prior years' as long as I have no reason to expect it to change dramatically (like with my dealer stocks). Guidance also plays a role as many firms do give annual tax rate guidance. A good example is XXX who all last year said once they reverse their deferred tax asset valuation allowance they will have a rate close to statutory. Thus, I now a much higher tax rate for XXX than in the past as the allowance was reversed in Q4 2011. With my other responsibilities, picking apart the tax rate to a more granular level is most likely not going to be worth the time. Hope that helps I'll pass your note along to other analysts on the Industrials team.
- If there was a retroactive adjustment and it hit the P&L all in one quarter we'd prob back it out. So, we wouldn't try to fcst it.
- On a go-fwd basis we'd probably try to account for it as long as it was big enough to move EPS by a couple %... and as long as we believed it would continue for at least a year.
- We'd probably look for company guidance on how to model it… and we'd probably build it in throughout our fcst horizon all at once, as long as there was reason to expect a continuation.
- In all though, I don't think it would get much attention from the investment community… it could help a little, but everyone's more focused on macro backdrop, end markets and operational issues… I suspect this would be an afterthought.
- It is not something on my radar screen, haven't given it even a second of thought (R&D is not a big expense for the retail companies that I follow). So, while that does answer one of your questions (do analysts even pay attention to the credit), it doesn't answer any of the others…my apologies!
- The short answer is that estimating taxes is always a bit tricky since taxes for EPS purposes don't equal cash taxes. If the R&D credit is material, companies usually include the impact in guidance or offer analysts some detail about the impact. We generally don't revise historical results unless the company restates them. Hope that helps – if you'd like to chat sometime next week, let me know.
- For the 2 "tech" companies I cover, XXX and XXX, we generally value the companies on a pre tax or free cash flow basis.
- In general, I believe the market does a weak job valuing the impact of the r+d tax credit. In general, the market will value the impact of the change when it gets both implemented and repealed. The difficulty really lies in placing probabilities on what happens in Washington. Astute market participants will always try to look forward and account for the impact in a forward year estimate if it is a certainty it will be implemented or repealed. However, if there is a doubt, it will prospectively assign some probability and value that into the account (or some similar method).

- It is not on our radar; the effect is likely immaterial to earnings, anyway. As I understand it, the credit is for smaller firms, whereas we are tracking and analyzing companies with well over $100M in assets. Furthermore, many of the companies that we cover provide tax guidance in forecasting EPS, as it would involve considerable time on the analyst's part in trying to model a company's tax line, and information given by the company in the pursuit of such could give away company-sensitive information.
- Some companies provide tax guidance that assumes the R&D tax credit and others do not. Our models generally reflect guidance with some upside possible with guidance that has not factored in the R&D tax credit. Regardless, our EPS forecasts are not only modestly impacted by the R&D credit.
- We don't try to predict when the credit is going to be extended. We base our calculations under current regulations. Most of the information relating to the forecast comes from the management during the earnings call or during conference presentations. Generally, they directly give us their forecasted effective tax rates and analysts take those to figure out ultimate tax expense. Most of the analyst do not bother about going deep into tax credits because the information on effective tax rates are readily available from the management. We definitely pay attention to the expiration and reinstatement of these credits as these affect our model and EPS forecast. But if something like this happens, then we direct our question to the management to tell us the resulting change in tax rate. In rare cases, where tax information is not provided, then we dive into 10K to see what has happened in the past. For example, the ethanol credit was given on per gallon of production. So, we will try to see the projected production and forecast it. But this has never happened with any of our coverage companies till now. I hope this helps.
- The R&D tax credit is generally not a significant item in my coverage universe (XXXXX) as R&D spending is modest. Accordingly, this is not something I devote significant attention to. In at least one case a company I cover has called out the impact of the tax credit expiration, but it represented an impact of 1%-2% on EPS so effectively falls into the category of rounding error. My earnings forecast for this company is based on an assumption that the credit is not reinstated. If/when it is, I'll revise the numbers.
- Typically, analysts view tax very simply - they will often simply extrapolate the current year tax rate forward, unless a company specifically calls out a long-term run-rate tax rate which should be used instead. I wouldn't say much analysis on the R&D tax credit happens in the space.
- Unfortunately the companies that I follow (XXX) are not in the R&D business, so it does not impact their business model if the tax credit expires or not.
- We have learned to not apply the R&D tax credit on a looking forward basis in the current year. However, when companies provide forward financial guidance (usually in January or February), they often explain whether they are assuming renewal of the R&D tax credit or not, which will dictate our model assumption. If management does not provide explicit tax rate guidance, we will assume a higher tax rate at least through Q3, followed by a lower tax rate in Q4 and for the year if we have a relatively high level of conviction that the R&D tax credit ultimately will be passed.
- We honestly don't do a lot of work on it and usually rely on the company's guidance for their tax rate. There are so many inputs into a company's tax rate that we don't have visibility into that it's impossible for us to really accurately model. Most of our companies operate internationally and have various credits / NOLs, etc that all factor into the tax rate. Some of our names don't pay any cash taxes and won't for the next

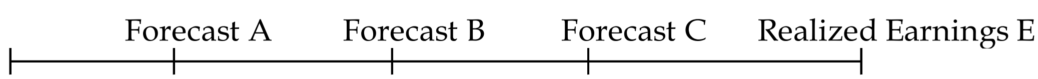
several years and other companies are more mature and tax is more of an issue-- but again, we rely on company guidance. If a company misses or beats EPS because of tax, it's not something investors care a whole lot about-- revenue / EBITDA is much more important for software companies. Let me know if you have any more questions.

- We model mostly w/o when it hasn't been extended except for those who adjust for it on a pro forma basis assuming its extended to be consistent with their guidance commentary. Info in 10k on amounts. We pay attention as its meaningful amounts for some, not so much for others. Companies also give commentary on impact. Hope that helps
- We typically assume it is renewed. The issue is that certain companies guide EPS including the assumption it is renewed, whereas others do not. Either way it is not a major factor in investor investment considerations or valuations.

Appendix H. Examining the Relationship between Forecast Revision and Extension Between Revisions

The coefficients on my three independent variables when using *Forecast Revision* and *Extension Between Revisions* as dependent variables in Tables 3 and 4 are of exactly different signs, but of similar magnitudes, across the two models (i.e., the coefficient on *Extension Between Revision* when using *Forecast Revision* as the dependent variable is of similar absolute magnitude but of exactly opposite sign as when using *Forecast Improvement* as the dependent variable). This appendix investigates this result in several different ways.

In order to better understand the relationship between these two models, consider the composition of these two variables. The following represents a quarter of earnings forecasts, culminating in Realized Earnings E.



Forecast Improvement is defined as:

$$|B- E| - |A - E| \qquad (1)$$

Forecast Revision is defined as:

$$|B-A| \qquad (2)$$

As a result, in many cases, *Forecast Revision* exactly equals *Forecast Improvement*, or equals the negative value of *Forecast Improvement*. Specifically, *Forecast Revision* will exactly equal *Forecast Improvement* when both of the two following conditions are satisfied:

$$B \geq E \text{ and } A \geq E \qquad (3)$$

This is the case when the analyst has an initially positive bias, revises, and still has a positive bias. Alternatively, *Forecast Revision* will exactly equal the negative value of *Forecast Improvement* when:

$$B \leq E \text{ and } A \leq E \qquad (4)$$

This occurs when an analyst has an initially negative bias, revises, but still has a negative bias. Empirically, (3) and (4) are often satisfied in my data. Specifically, box (b) below, (4) above is satisfied, and in box (c), (3) is satisfied:

Appendix H, Table 1

	Forecast Revision ≠ -Forecast Improvement	Forecast Revision= -Forecast Improvement	Totals
Forecast Revision ≠ Forecast Improvement	(a) 100,382	(b) 171,815	272,197
Forecast Revision = Forecast Improvement	(c) 170,447	(d) 4,003	174,450
Totals	270,829	175,818	446,647

Box (d) represents cases in which the analyst formally updates his revision, but does not change the forecast. Interestingly, in about the same number of cases does the analyst issue two positively biased forecasts in a row (c) as two negatively biased forecasts in a row (b). However, 22% of the time, the analyst reduces a positively biased forecast below E, or increases a negatively biased forecast above E (box a). This same ratio for firms with *R&D Mention*=1 is 22.8%, for *Extension Between Revision*=1 is 25.4%, and for both *R&D Mention*=1 and *Extension Between Revision*=1 is 24.3%.

Given the discussion above, it is not clear that one would expect the relationship between *Revision* and *Forecast Improvement* the two variables to be, and between coefficients on regressions using each variable as a dependent variable. The actual correlation is -47%. The spearman rank correlation is -20%.

To investigate this phenomena, first, I alter the specifications of my model using the empirical data. For example, using the same scalar could induce a relationship between the two different dependent variables. However, removing the quarter and year fixed effects, adding in other sets of fixed effects (analyst or firm), removing the constant term, and using unscaled dependent variables does not change this result.

Next, I estimate regression 1 and 2 on the different samples suggested in Table 3 above. To be clear, I do not expect the empirical results documented in my paper to hold up in each of these samples—these samples represent very different types of analysts with differing biases. Estimating my regression tabulated above only on observations in boxes (c) and (d) yields positive and insignificant coefficients when using both *Forecast Revision* and *Forecast Improvement* (the two results are obviously identical, because in those two boxes *Forecast Revision* = *Forecast Improvement*). This is tabulated in Columns 1-3 of Appendix G, Table 2 (found at the end of his appendix). Estimating the regressions only on observations in (a) and (b) yields coefficient estimates of the same sign and somewhat similar magnitudes (within a factor of 2) of the results from my original estimations, as tabulated in Columns 4-9. Estimating my regression on observations in (a) yields coefficient estimates using the two dependent variables of the same sign and somewhat similar magnitudes (within a factor of 2) of my original estimates, as found in Columns 10-15.

From these estimations, two things stand out. First, my empirical results do, for the most part, hold up, even in these very selective samples. This suggests that, as documented in my sensitivity analysis, my results are not dependent upon the initial bias or direction of the revision. Second, the coefficients still hold the same relationship as in the full sample—for example, the estimated coefficients in Column 4 and Column 7 are of similar magnitude, but of opposite sign, for all three coefficients in my model. This suggests that the relationship between these coefficients is not dependent upon the relationship between the two dependent variables (whether they, themselves, are equal to each other, etc.).

As a final way of examining this issue, I simulate data and estimate my regressions. If the observed relationship between the coefficients is mechanical merely as a result of the construction of the two dependent variables, I should be able to observe a similar relationship in simulated data. Further, it will be important to *not* observe similar coefficient values and significances as I do in the real data, as in the simulation, the relationship between the dependent and independent variables will be random.

I start by creating 446,647 observations. I simulate two forecasts that target the same actual realized value of earnings. From that single forecast revision, I calculate *Forecast Revision*, and *Forecast Improvement*. I then generate *Extension Between Revisions*, *R&D Exposure*, and the interaction of these two variables to match the first and second moments of these variables in my real data. After creating year and quarter variables, I estimate regressions 1 and 2, and then examine the relationship between the coefficients on my three coefficients of interest across the two models.

I simulate the data using two different assumptions about the data generating process behind an analysts forecast. Under the first assumption, in Columns 1-6, the Actual value of earnings is 38 (the mean actual value of earnings, in cents, in my sample). Forecast 1 and Forecast 2 are then generated, independent of both each other and the actual value of earnings. In Columns 1 and 2, the analyst has an initial forecast of 45 (creating an initial bias of 7 (which is the initial bias in the data)), and revises downward on average by 2, and ends with a positive bias (as is the case in the data). In this case, the correlations between the two dependent variables (*Forecast Revision* (R) in Column 1 and *Forecast Improvement* (FI) in Column 2) is similar to what we observe in the empirical data—the coefficient estimates are of similar magnitude (Row 8-10, which tabulates the ratio of the two coefficients, are close to 1) and opposite sign (rows 4-6 are all "Yes"). Columns 3 and 4, and 5 and 6, use this same forecast generating process, but, assume a final unbiased forecast (in Columns 3 and 4) and a final negatively biased forecast (in Columns 5 and 6). Only in Columns 5 and 6 do the coefficients have opposite signs, but, their magnitudes are not of a similar value (as seen in Row 8-9).

In Columns 7-16 I change the generating process of the two forecast. In these columns, the Actual value is a random variable with a given mean and variance, Forecast 1 is a random variable added to the Actual value, and Forecast 2 is another random variable added to Forecast 1. Columns 7 and 8 tabulates the estimation of the model under these assumptions. I select an Actual value, Forecast 1, and Forecast 2, to try to match the firm moment of these variables in my real data. Doing this yields a correlation similar to that observed in the empirical data (-42%), but, does not yield similar absolute magnitudes or opposite signs, as observed in the empirical data.

Columns 9 and 10 do obtain opposite signs on the coefficients, but, dissimilar absolute magnitudes. These columns assume an analyst's mean Revision is 0 (that Forecast 2 is merely a noised-up version of Forecast 1, making it clear why the coefficient values would be of opposite signs, as Condition 3 above is almost always met under these assumptions). Columns 11-16 use different assumptions about the size of the analyst's initial bias and the size of the revision. However, in no case in these columns are the absolute magnitude of the coefficients similar in size, and the signs exactly opposite.

There are two main conclusions from these simulations. Under certain assumptions, a similar relationship to what I observe in the data can be generated using simulated data. This suggests that the relationship I observe between the coefficients is a result of the underlying relationship between the two dependent variables—that they are constructed using the two same forecasts, and given a specific relationship to the Actual value of earnings, the coefficients generated will be of similar absolute value but of differing signs. However, it is important that in these simulations, the signs on the coefficients rarely match what I estimate empirically, and the significance of the coefficients is never close to what I observe in the real data (coefficients significant at the two-tailed, $p<.10$ level are printed in bold). Thus, the relationship between the two coefficients appears to be an artifact of how the variables are constructed, but the coefficient estimates, and their estimated standard errors, do support my hypotheses, and are not merely an artifact of the construction of the dependent variables.

Appendix H, Table 2. Defining Estimation Samples by Relationship between Forecast Revision and Forecast Improvement

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Dependent Variable:	Forecast Revision/Forecast Improvement			Forecast Revision			Forecast Improvement			Forecast Revision			Forecast Improvement		
Sample of Observations:	Forecast Revision = Forecast Improvement			Forecast Revision ≠ Forecast Improvement						Forecast Revision ≠ Forecast Improvement and Forecast Revision ≠ - Forecast Improvement					
Measure of R&D Credit Exposure:	*R&D Mention*	*R&D Expire Firm*	*R&D in ETR Reconciliation*	*R&D Mention*	*R&D Expire Firm*	*R&D in ETR Reconciliation*	*R&D Mention*	*R&D Expire Firm*	*R&D in ETR Reconciliation*	*R&D Mention*	*R&D Expire Firm*	*R&D in ETR Reconciliation*	*R&D Mention*	*R&D Expire Firm*	*R&D in ETR Reconciliation*
Extension Between Revisions	-0.013	-0.007	-0.006	-0.275***	-0.245***	-0.249***	0.275***	0.241***	0.241***	-0.373***	-0.337***	-0.335***	0.366***	0.316***	0.304***
	(-0.97)	(-0.57)	(-0.49)	(-4.77)	(-5.01)	(-5.12)	(5.86)	(6.15)	(6.17)	(-3.08)	(-3.24)	(-3.27)	(3.99)	(4.15)	(4.07)
R&D Credit Exposure	-0.006**	-0.027***	-0.015***	-0.048***	0.155***	-0.094***	0.045***	-0.167***	0.087***	-0.061**	0.243***	-0.148***	0.055**	-0.282***	0.129**
	(-2.50)	(-11.45)	(-3.39)	(-3.50)	(11.44)	(-3.70)	(3.70)	(-13.50)	(3.43)	(-2.23)	(8.42)	(-2.90)	(2.34)	(-10.78)	(2.49)
Extension Between Revisions X R&D Credit Exposure	0.027	0.025	0.016	0.159**	0.165***	0.294***	-0.176***	-0.175***	-0.247***	0.193	0.224*	0.299	-0.255**	-0.271***	-0.195
	(1.29)	(1.12)	(0.41)	(2.52)	(2.84)	(3.50)	(-3.12)	(-3.57)	(-3.46)	(1.39)	(1.83)	(1.33)	(-2.08)	(-2.84)	(-1.08)
Constant	0.029***	0.030***	0.028***	-0.316***	-0.341***	-0.325***	0.293***	0.318***	0.302***	-0.518***	-0.552***	-0.528***	0.456***	0.489***	0.465***
	(12.38)	(13.27)	(12.71)	(-27.16)	(-31.39)	(-31.07)	(28.18)	(32.91)	(32.55)	(-22.28)	(-26.13)	(-25.46)	(22.79)	(27.15)	(26.38)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Analyst Clustering	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	174,450	174,450	174,450	272,197	272,197	272,197	272,197	272,197	272,197	100,382	100,382	100,382	100,382	100,382	100,382
R-squared	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02

Appendix H, Table 3. Estimation of Regressions 1 and 2 using Simulated Data Under Various Assumptions

Row	Dependent Variable:	(1) R	(2) FI	(3) R	(4) FI	(5) R	(6) FI	(7) R	(8) FI	(9) R	(10) FI	(11) R	(12) FI	(13) R	(14) FI	(15) R	(16) FI
1	Actual	38		38		38		N(38,76)		N(38,76)		N(38,76)		N(38,76)		N(38,76)	
2	Forecast 1	N(45,10)		N(45,10)		N(45,10)		Actual+N(7,7)		Actual+N(7,7)		Actual+N(2,2)		Actual+N(-2,2)		Actual+N(5,5)	
3	Forecast 2	N(43,10)		N(38,10)		N(35,10)		Forecast 1+N(-2,2)		Forecast 1+N(0,2)		Forecast 1+N(-1,1)		Forecast 1+N(1,1)		Forecast 1+N(-4,4)	
4	β1Revision = - β1 Forecast Improvement?	Yes		No		Yes		No		Yes		No		No		Yes	
5	β2Revision = - β2 Forecast Improvement?	Yes		No		Yes		No		Yes		No		Yes		Yes	
6	β3Revision = - β3 Forecast Improvement?	Yes		No		Yes		Yes		Yes		Yes		Yes		Yes	
7	Correlation between Forecast Revision and Forecast Improvement	-64%		-39%		-21%		-42%		-69%		-29%		30%		-11%	
8	|β3Revision / β3 Forecast Improvement|	0.843		1.717		4.427		0.563		1.368		0.591		1.143		1.098	
9	|β3Revision / β3 Forecast Improvement|	1.400		13.000		6.929		0.500		3.333		5.000		0.800		3.667	
10	|β3Revision / β3 Forecast Improvement|	1.017		1.097		1.406		0.385		0.557		0.308		2.214		0.175	
11	Extension Between Revisions	0.043	-0.051	-0.103	-0.060	**-0.332**	0.075	-0.009	-0.016	**-0.052**	0.038	0.013	0.022	0.008	0.007	0.045	-0.041
12	R&D Exposure	**-0.126**	**0.090**	0.052	0.004	**-0.097**	0.014	-0.005	-0.010	-0.010	0.003	0.005	0.001	-0.004	0.005	0.022	-0.006
13	Extension Between Revisions X R&D Exposure	0.484	**-0.476**	0.227	0.207	0.353	-0.251	0.020	-0.052	0.044	-0.079	0.012	-0.039	-0.031	0.014	-0.027	0.154
14	Constant	-2.005	0.900	-7.017	1.885	-9.996	1.517	-1.992	1.046	-0.003	-0.134	-1.006	0.372	0.998	0.374	-4.017	0.679
15	Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	Observations	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647	446,647
18	R-squared	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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